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# HIGHLY COMPLEX SYLLABLE STRUCTURE: A TYPOLOGICAL STUDY OF ITS PHONOLOGICAL CHARACTERISTICS AND DIACHRONIC DEVELOPMENT

BY

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B.S., Physics, University of Notre Dame, 2004 M.A., Linguistics, University of New Mexico, 2010

# DISSERTATION

Submitted in Partial Fulfillment of the Requirements for the Degree of **Doctor of Philosophy** 

## Linguistics

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# Highly complex syllable structure: A typological study of its phonological characteristics and diachronic development

by

**Shelece Easterday** 

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# ABSTRACT

The syllable is a natural unit of organization in spoken language. Strong crosslinguistic tendencies in syllable size and shape are often explained in terms of a universal preference for the CV structure, a type which is also privileged in abstract models of the syllable. Syllable patterns such as those found in Itelmen *qsattxff* 'follow!' and Tashlhiyt *tsskfftstt* 'you dried it (F)' are both typologically rare and theoretically marginalized, with few approaches treating these as natural or unproblematic structures. This dissertation is an investigation of the properties of languages with highly complex syllable patterns. The two aims are (i) to establish whether these languages share other linguistic features in common such that they constitute a distinct linguistic type, and (ii) to identify possible diachronic paths and natural mechanisms by which these patterns come about in the history of a language. These issues are investigated in a diversified sample of 100 languages, 24 of which have highly complex syllable patterns.

Languages with highly complex syllable structure are characterized by a number of phonological and morphological features which serve to set these languages apart from languages with simpler syllable patterns: these include specific segmental and

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suprasegmental properties, a higher prevalence of vowel reduction processes, higher rates of morphologically complex clusters, and higher average morpheme/word ratios. The results suggest that highly complex syllable structure is a linguistic type distinct from but sharing some characteristics of other proposed holistic language types, including stresstiming, agglutination, and consonantal languages. The results also point to word stress and specific patterns of gestural organization as playing important roles in the diachronic development of these patterns out of simpler syllable structures.

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# ABBREVIATIONS

1	first person	INTERROG	interrogative
3	third person	ITER	iterative
AGT	agentive	М	masculine
CAUS	causative	NMLZ	nominalizer
CL	noun class	NOM	nominative
CONT.P	past continuous	PL	plural
DAT	dative	PS	predicate specifier
DEM	demonstrative	PST	past
DUB	dubitive	REALIS	realis
F	feminine	RECP	reciprocal
FUT	future	REFL	reflexive
INCL	inclusive	SG	singular
INF	infinitive		

RNS	translated from the original by Ricardo Napoleão de Souza
SME	translated from the original by Shelece Easterday
TZ	translated from the original by Tim Zingler

#### **CHAPTER 1:**

# **INTRODUCTION**

## 1.1 Focus of the dissertation

A syllable is typically thought of as a unit which speakers use to organize sequences of sounds in their languages. The division of the speech stream into syllables reflects the higher levels of organization which are used in the cognitive processes by which speech is planned and perceived. Syllables are a common unit of abstract linguistic analysis; however, this unit seems to be more concrete and accessible to speakers than other phonological units such as segments. A speaker's intuition of what is a pronounceable sequence of sounds is strongly influenced by the syllable patterns of the language they speak. Most languages have relatively simple syllable patterns, in which the alternation between relatively closed (consonantal) and relatively open (vocalic) articulations is fairly regular: syllable patterns such as those in the English words *pillow*, *cactus*, and *tree* are cross-linguistically prevalent. Compare these patterns to the examples below (1.1)-(1.5):

## (1.1) **Sahaptin** (*Sahaptian*; United States)

ksksa

'elephant ear (mushroom)'

(Hargus & Beavert 2006: 29)

(1.2) Georgian (Kartvelian; Georgia)

br<del>t͡</del>s'χ'ali

'claw'

(Butskhrikidze 2002: 204)

(1.3) **Tashlhiyt** (*Afro-Asiatic*; Morocco)

tssk∬ftstt

t-ss-k∫f-t=stt

'you dried it (F)'

(Ridouane 2008: 332)

(1.4) **Tehuelche** (*Chon*; Argentina)

ktʃa?ʃpʃkn

k-t͡ʃa?∫p-∫-kn

REFL-wash-PS-REALIS

'it is being washed'

(Fernández Garay & Hernández 2006: 13)

(1.5) **Itelmen** (*Chukotko-Kamchatkan*; Russia)

kłtxuniŋe?n

kł-txuni-ŋe?n

'very dark'

(Georg & Volodin 1999: 55)

To speakers of most languages, the long strings of consonants in these examples are not pronounceable without a great deal of practice, being so different from the relatively simpler patterns that are cross-linguistically prevalent. Yet such patterns are fluently acquired and maintained by native speakers of these languages, and may even be relatively frequent in those languages.

Languages with syllable patterns like those illustrated above are typologically rare, constituting between 5-10% of the world's languages. These languages tend to be found in close geographical proximity to one another, with the Pacific Northwest, the Caucasus region, the Atlas Mountains region, Patagonia, and Northeast Asia being particular 'hotspots' for such patterns. The accelerating rates of indigenous language obsolescence in those regions mean that such patterns stand to become even rarer in the coming generations.

The patterns exemplified above are also famous in the literature for the problems they present to standard models of syllabic and phonological representation. While much effort is made to attempt to fit these patterns into various theoretical frameworks, much less research explores the motivations behind their historical development and maintenance in languages.

This dissertation is a typological study exploring the properties of languages with patterns like those above, which I call *highly complex syllable structure*. The studies herein examine a number of phonetic, phonological, and morphological features of these languages. The aims of the dissertation are to establish whether highly complex syllable

structure has other linguistic correlates which may suggest a path by which such patterns are likely to come about over time.

The dissertation is organized as follows: in the following sections, I discuss findings and accounts for cross-linguistic syllable patterns and their implications for highly complex syllable structure, discuss accounts for syllable complexity more generally, and introduce the research questions for the dissertation. In Chapter 2 I discuss considerations in constructing the language sample and propose a definition for highly complex syllable patterns. In Chapter 3 I conduct analyses of syllable structure patterns in the sample. Analyses of segmental and suprasegmental patterns in the sample are presented in Chapters 4 and 5, respectively. Chapter 6 includes analyses of vowel reduction patterns in the sample. In Chapter 7, I examine specific kinds of consonant allophony in the language sample. In Chapter 8, the results are summarized and their implications for the research questions are examined.

# **1.2 Background**

#### 1.2.1 The syllable

The syllable is a natural unit of spoken language by which sounds are organized in speech. The hierarchical organization of speech sounds into syllables is said to be "a fundamental property of phonological structure in human language" (Goldstein et al. 2006: 228), and this unit plays a well-established role in linguistic analysis and description. However, the syllable eludes precise definition: research has not yet established clear and consistent correlates for it at the phonetic, physiological or phonological levels (Bell & Hooper 1978, Laver 1994, Krakow 1999). Much like consonants and vowels, syllables are characterized by distributional, phonetic, and phonological features, of which no single criterion is sufficient for perfectly describing or predicting the trends observed. To take one example of such a criterion, in a review of research on the physiological organization of the syllable, Krakow (1999: 23-34) states that years of study into this topic have yielded "one disappointment after another" and that from an articulatory point of view, the speech stream "simply cannot be divided into discrete, linearly-ordered units the size of the segment or the syllable." What empirical research has managed to establish with respect to physiological definitions of the syllable is a general association between syllable-initial and syllable-final consonants and distinct intra- and inter-articulatory patterns, at least in careful speech. Patterns in the acoustics, phonology, and perception of syllable constituents play an important role in determining and differentiating syllables, but they do not constitute complete or exceptionless definitions of the syllable, either alone or in combination with one another.

Nevertheless, the syllable enjoys a well-established role in phonology, proving to be a highly useful unit in linguistic analysis and description. For many languages, it has been demonstrated that stress placement, tone, reduplication, and other phonological and morphological phenomena operate on the domain of the syllable. Similarly, the different boundary edges of a syllable are associated with special coarticulatory properties and may serve as environments for allophonic processes. While native speaker intuitions regarding the precise location of syllable boundaries is not always consistent, there is a wealth of evidence that the unit has psychological reality to speakers: e.g., in the

existence of syllabary writing systems, word games and secret languages using syllables as target structures, poetry and lyrical song which exploit syllable counts and patterns in a systematic way, and consistent speaker intuitions regarding the number of syllables in a word (Bell & Hooper 1978, Blevins 1995, Vallée et al. 2009).

Additional evidence for the syllable as an organizational unit of language is in the observation that those sequences of sounds analyzed as syllables pattern in remarkably similar ways across languages. In fact, strong cross-linguistic tendencies are observed for practically every dimension along which syllable structure can be analyzed. Some of these patterns will be summarized in the following section.

## **1.2.2** Cross-linguistic patterns in syllable structure

Here I describe some of the cross-linguistic patterns of syllable structure that have been observed in the literature. In the following sections I use the descriptive terms *onset*, *nucleus*, and *coda* to refer to constituent parts of the syllable: the nucleus consists of the auditory peak of the syllable, typically a vowel; the onset refers to the consonant or group of consonants preceding the nucleus; and the coda refers to the consonant or group of consonants following the nucleus. It is useful to make these distinctions because these constituents have been shown to behave independently of one another in many respects, both within languages and cross-linguistically. In the following sections, the terms are used in a more or less theoretically neutral sense, and often in reference to phonetic realizations, rather than abstract representations, of the syllable. In theoretical models, the

phonological constituency of syllables may be posited to take other forms; some of these issues will be discussed in §1.2.3.

## 1.2.2.1 CV as a universal syllable type

One robust pattern in syllable structure typology is the cross-linguistic ubiquity of syllables of the shape CV: a single consonant followed by a vowel.<sup>1</sup> Though it has been claimed that CV syllables are found in all languages, for a few languages it has been posited that this structure does not occur (cf. Breen & Pensalfini for Arrernte, Sommer 1969 for the Oykangand dialect of Kunjen, both Australian languages). Such analyses are typically highly abstract and apply only to 'underlying' syllable forms: for both Arrernte and Kunjen it has been shown that CV structures do occur in 'surface' phonetic forms (Anderson 2000, Sommer 1969, 1981).

Due to its cross-linguistic prevalence, the CV structure has been called the universal syllable type and the least marked of all syllable structures (Zec 2007). Bell & Hooper (1978) argue that the characterization of the CV type as 'unmarked' is misleading and simplified, as this assumption can be derived from a collection of generalizations regarding other specific patterns of segment sequences. They argue that the universal status of CV structures emerges from a conspiracy of other cross-linguistic patterns which include frequent limitations on vowel hiatus and consonant clusters, tendencies toward obligatory consonant-initial or vowel-final word forms, and the fact that the existence of large consonant strings in any word position in a language implies the

<sup>&</sup>lt;sup>1</sup> In syllable structure analysis, the notations C and V are used for consonant and vowel segments, respectively.

existence of simple (single C) structures in those positions. As a result of these interacting patterns, it follows that the canonical syllable patterns of any language will include structures of the form CV.

Nevertheless, CV structures are set apart from other syllable types in numerous aspects of their behavior. If only one syllable type occurs in a language, that type will be of the form CV. Such languages are rare, but attested; these include Hawaiian (Austronesian, Maddieson 2011) and Hua (Trans-New Guinea, Blevins 1995). CV structures are acquired before even V structures in babbling stages of vocal development and language acquisition (cf. Levelt et al. 2000 for Dutch). Finally, the CV structure overwhelmingly predominates in frequency distributions of syllable types within and across languages. In ULSID, a database containing the syllabified lexicons of 17 genealogically and geographically diverse languages, CV syllables account for roughly 54% of the 250,000 syllables, despite the languages having a wide range of attested syllable patterns (Vallée et al. 2009).

Much of the research on motivations behind cross-linguistic trends in syllable patterns returns to the idea of CV as a universal or otherwise privileged syllable type. Some of these proposals will be discussed in the following sections, as other crosslinguistic patterns relating to syllable structure are discussed.

## 1.2.2.2 Asymmetries in onset and coda patterns

Many of the typological patterns involving syllables reveal asymmetries in the structure, distribution, and frequency of onsets versus codas. It follows from the cross-

linguistic ubiquity of the CV syllable type that all languages have syllables with onsets. By comparison, languages in which syllable codas do not occur are not uncommon: for example, 12.6% of the languages whose syllable structures were analyzed in the World Atlas of Language Structures Online (WALS) have canonical CV or (C)V structures only. Thus an implicational relationship holds between codas and onsets: if a language has syllables with codas, then it also has syllables with onsets.

While the CV shape dominates in frequency distributions within and across languages, its mirror image, the VC structure, is not nearly so freely distributed. Its crosslinguistic lexical frequency distribution is tiny compared to that of CV: only 2.5% of the syllables in the ULSID database are of the VC type (Vallée et al. 2009). The presence of VC shapes in a language generally implies the presence of V, CV, and CVC structures as well (Blevins 1995). These striking differences in distribution indicate that onsets and codas are not equivalent structures.

In many languages with single-member codas, consonants in the coda position are restricted to a smaller set of segments than what can be found in onset position. For example, Cocama (Tupi-Guaraní) has a consonant phoneme inventory of /p t k ts tf x m n r w j/. Any of these consonants may function as a syllable onset, but only alveolar nasal /n/ and glides /w j/ occur in coda position (except for under certain structural and prosodic conditions, Vallejos Yopán 2010: 110). Krakow (1999) reports that some classes of segments, such as oral stops, are cross-linguistically disfavored in syllable-final position. Similarly, Clements observes that when both sonorants and obstruents occur in syllable-final position in a language, the set of permissible obstruents tends to be smaller

than the set of permissible sonorants (1990: 301). In a cross-linguistic investigation of syllable frequencies in the lexicons of Hawaiian, Rotokas, Pirahã, Eastern Kadazan, and Shipibo, Maddieson & Precoda (1992) found that CV sequences are relatively unrestricted in their occurrence. Most onset-nucleus combinations in the study occur at rates approximating the values that would be expected from their component segment frequencies. Meanwhile, nucleus-coda combinations are more restricted in their consonants in the coda position, but also to restrictions on sequences of particular segments.

Both within and across languages, onsets and codas are most frequently simple, consisting of just one consonant. When languages do have tautosyllabic consonant clusters, they are more likely to occur in the onset position (Blevins 2006). In languages that have tautosyllabic clusters in both onset and coda positions, it is often the case that more elaborate structures are permitted for onsets: these tend to be larger, more frequent, and less restricted in their internal patterns than coda clusters (Greenberg 1965/1978, Blevins 2006). There are of course exceptions to these patterns: Central Dizin (Afro-Asiatic), for instance, has a canonical syllable pattern of (C)V(C)(C)(C) (Beachy 2005). However, as will be shown in §3.3.1, such patterns are cross-linguistically less frequent than their mirror images.

Diverse accounts have been put forth in the literature to account for asymmetries in onset and coda patterns. A long line of research starting with Sievers (1881) and Jespersen (1904) has argued that the internal organization of the syllable is governed by

the phonological principle of sonority, a scalar perceptual property of speech sounds. A typical sonority scale is given in (1.6) with sonority increasing from left to right:

$$(1.6)$$
 stop < fricative < nasal < liquid < glide < vowel

In this view, the sonority contour of typical and preferred syllable types rises steeply at the beginning of the syllable and falls less steeply from the nucleus to the end of the syllable (Zwicky 1972, Hooper 1976, Greenberg 1965/1978, Clements 1990). Thus an ideal syllable would consist of a simple onset consisting of a low-sonority sound such as a stop, a vocalic nucleus, and either a coda of high sonority, such as a nasal or a liquid, or no coda at all.

Kawasaki-Fukumori (1992) proposes an acoustic-perceptual motivation for certain cross-linguistic syllable patterns, finding that CV sequences are more spectrally dissimilar from one another, and therefore better contrasted, than VC structures. This suggests that onsets are more likely to be correctly perceived by the listener and maintained in languages. In the speech processing literature, it has been found that onsets are more easily identified by listeners than codas (Content et al. 2001) and that codas affect syllable complexity in such a way as to increase the time required for tautosyllabic onset processing (Segui et al. 1991).

Mechanical and temporal constraints on jaw oscillation have been proposed as physiological motivations for the onset-coda asymmetry and predominance of CV patterns observed. In particular, MacNeilage (1998) proposes that CV patterns derive

from the earliest forms of human speech, in which open-close alternations of the mouth, simultaneous with phonation, provided a 'frame' for articulatory modulation and the emergence of distinct segmental patterns. From an articulatory point of view, the onset-coda asymmetry may reflect differences in intergestural timing between vowels and consonants in onset versus coda position (Byrd 1996a, Browman and Goldstein 1995, Gick et al. 2006, Marin & Pouplier 2010). This body of research has established that the gestural coordination between onset and nucleus is synchronous, with the production of the consonant and vowel being nearly simultaneous and representing a stable timing relationship. As compared to the asynchronous and more variable timing relationship between nucleus and coda, the onset-nucleus relationship is more stable in the motor control aspects of its production.

Finally, from a diachronic point of view, the relatively restricted status of codas may reflect the effects of reductive sound change: consonants in articulatorily weak word-final and syllable-final positions are particularly vulnerable to assimilation, lenition, and elision processes. Such processes can be observed in synchronic allophony and in patterns of historical sound change (Bybee 2015b).

#### **1.2.2.3 Consonant clusters**

Cross-linguistic patterns in consonant clusters are not limited to the tendency by which onset clusters tend to be larger and less restricted than coda clusters. It has long been observed that some cluster shapes are cross-linguistically more frequent than others. In fact, the phonological shape of clusters has been used, along with cluster size, as a

diagnostic for syllable structure complexity. In the classification used by Maddieson (2013a), an onset cluster in which the second member is a liquid or a glide is considered less complex than one in which the second member is a nasal, fricative, or stop.

Studies investigating onset and coda clusters have revealed trends in the voicing, place, manner, and sonority of consonant sequences in tautosyllabic clusters. Greenberg (1965/1978) was one of the first large-scale studies of this kind, investigating both the size and specific phonotactic patterns of onset and coda clusters in 104 languages. This study yielded dozens of implicational generalizations. For instance, the presence of a cluster in a language tends to imply the presence of smaller sequences within it; e.g., in English, the onset /spr/ as in *spring* implies the onsets /sp/ as in *spy* and /pr/ as in *pry*. Greenberg also derived universals regarding phonetic and phonological properties of consonants in sequence: for example, sonorant+voiced obstruent codas tend to imply the occurrence of sonorant+voiceless obstruent codas. Many cross-linguistic studies in a similar vein have followed from this work. In general, such studies tend to be limited in scope to biconsonantal onset patterns. VanDam (2004) is an exception, in that it explores tendencies in cluster size and composition in word-final codas of all sizes from 18 diverse languages. Some cross-linguistic studies of cluster patterns investigate voicing and manner implications regarding patterns of typologically rare structures, such as tautosyllabic sequences of obstruents (Morelli 1999, 2003, Kreitman 2008). However, studies seeking to account for the cross-linguistically most frequent biconsonantal onset patterns — a stop followed by a liquid or a glide, such as /g1/ or /pl/ — are much more

common in the literature (Clements 1990, Berent et al. 2008, Berent et al. 2011, Parker 2012, Vennemann 2012).

Many of the latter studies appeal to the notion of sonority in explaining predominant cluster patterns. In fact, it would seem that a sonority model of syllable structure is more often used to explain cluster patterns than it is to explain the onset-coda asymmetries discussed in the preceding section. In this line of reasoning, cluster patterns in which there is an increasing sonority slope towards the nucleus (e.g., a /kl/ onset) are preferred to sonority plateaus (e.g., a /pk/ onset) or reversals (e.g., an /lb/ onset). Implicational universals using various sonority-based scales are often proposed to describe cluster inventory patterns, particularly the  $C_2$  patterns observed in onsets. For example, Morelli (1999) proposes a universal by which the presence of stop-stop onsets in a language implies the presence of stop-fricative onsets. Lennertz & Berent (2015) predict that stop-nasal onsets are universally preferred to both stop-stop and stop-fricative onsets. Parker (2012) proposes that the presence of biconsonantal onsets in a language implies the presence of a liquid or glide as C<sub>2</sub>. Vennemann (2012) argues that stop-initial biconsonantal onset inventories can be predicted by a six-point sonority scale, in which the occurrence of a consonant as C<sub>2</sub> implies the occurrence of all consonants to the left of it as C<sub>2</sub> (1.7).

(1.7) glide < rhotic < lateral approximant < nasal < fricative < stop

There are exceptions to the above generalizations. For example, languages may have onset clusters in which only obstruents occur as  $C_2$  (e.g., Ingush, Nichols 2011). In a study of 46 diverse languages, it was found that stop-initial biconsonantal onset inventory patterns diverged from the patterns predicted by (1.7) roughly one-third of the time (Easterday & Napoleão de Souza under review).

While a sonority account does capture predominant trends in onset patterns, specifically the predominance of stop-glide and stop-liquid onsets, accounts of syllable patterns appealing to sonority have been criticized for their circularity. Though sonority has been proposed to be correlated with intensity (Gordon 2002, Parker 2002), degree of constriction (Chin 1996, Cser 2003), and manner of articulation (Parker 2011), it lacks a clear and cross-linguistically consistent phonetic definition.<sup>2</sup> Instead, the notion of sonority is largely derived from phonotactic patterns, which are then explained in terms of sonority. Some have argued that sonority is in fact an epiphenomenon arising from perceptually motivated constraints, and that the only cross-linguistically consistent sonority contrast is the one between obstruents and sonorants (Jany et al. 2007, Henke et al. 2012). Ohala & Kawasaki-Fukumori (1997) reject the validity of sonority altogether, arguing that it is both circular and too broadly defined to account for the cross-linguistic rarity of sequences such as /pw/ and /dl/ and cross-linguistic prevalence of sequences such as /sk/. They propose that prevalent onset patterns reflect the high 'survivability' of certain sequences, which in turn reflect strong modulations — long trajectories in

<sup>&</sup>lt;sup>2</sup> In this sense, the notion of sonority is much like that of the syllable.

acoustic space — in amplitude, periodicity, spectral shape, and fundamental frequency. In this view, sequences such as /ba/ are more strongly modulated than sequences like /ske/ or /ble/, which in turn are more strongly modulated than /pwe/, /pte/, and so on.

# **1.2.2.4 Nucleus patterns**

Cross-linguistic tendencies have also been observed in the patterns of syllable nuclei, which function as the auditory peaks of syllables. The prototypical syllable nucleus consists of a vowel, and indeed there are many languages which allow only vowels in nucleus position. However, there is a range of cross-linguistic variability in the types of segments observed to occur as syllable nuclei. In some languages, liquids or nasals may function as syllabic; e.g. Slovak krv [krv]'blood' (Zec 2007: 186), and English *button* [bʌ?n]. Such patterns are generally well-accepted in the literature: liquids and nasals are vowel-like in some properties of their acoustic structure, so it is clear how such sounds might function as auditory peaks of syllables. More rarely, obstruents are reported to occur as syllable nuclei: e.g. Puget Salish sqwəłps [sqwəł.ps] 'cutthroat trout' (Hoard 1978: 62), Lendu zżzź [zż.zź] 'drink' (Demolin 2002: 483), Tashlhiyt tftktstt [tf.tk.tstt] 'you sprained it (F)' (Ridouane 2008: 332). Such cases are often considered problematic, as they involve sounds which are not vowel-like in their acoustic properties and which may even be voiceless. This view discounts the fact that there are many kinds of obstruents with highly salient auditory properties, such as sibilant fricatives and ejective stops.

As is the case with consonant clusters, accounts for cross-linguistic patterns of syllabic consonants often appeal to sonority, with predominant cross-linguistic patterns said to reflect a preference for high-sonority syllable nuclei. Along similar lines of reasoning, nucleus patterns in languages are said to follow a sonority-based implicational hierarchy by which the presence of a given sound as a syllable nucleus in a language implies the presence of all more sonorous types of sounds as syllable nuclei (Blevins 1995, Zec 2007). Thus a language with syllabic nasals is predicted to also have syllabic liquids and vowels. In this model, syllabic obstruents are dispreferred and predicted to be the rarest kind of syllabic consonant.

A survey of syllabic consonant patterns in 182 diverse languages suggests that the sonority account for syllable nucleus patterns does not capture some important cross-linguistic trends (Bell 1978a). Of the 85 languages with syllabic consonants, 29 had syllabic liquids, 63 had syllabic nasals, and 34 had syllabic obstruents. The patterns considered in this survey include syllabic consonants arising through synchronic processes of vowel reduction, in addition to invariable syllabic consonant patterns, which are more often used to argue for a sonority basis for syllable nucleus patterns. However, the findings suggest that syllabic obstruents are not exceedingly rare, as often claimed, and may in fact be more common than syllabic liquids. A sonority-based implicational hierarchy does not account for a robust minority of the patterns observed in the study: 10/34 (29%) of the languages with syllabic obstruents do not have syllabic liquids or nasals.
As illustrated by the Lendu and Tashlhiyt examples above, in languages with syllabic obstruents, entire words or phrases without vowels may occur. There are many studies which seek to tackle the problem that such languages pose to models of the syllable (e.g., Bagemihl 1991 for Nuxalk, Coleman 2001 for Tashlhiyt). This is despite the fact that words without vowels are easily pronounceable by fluent speakers and may be relatively frequent in the languages in which they occur: for instance, Ridouane (2008: 328f) reports that in Tashlhiyt, 7.9% of syntactic words in running text are composed entirely of voiceless obstruents.

#### 1.2.2.5 Syllable structure and morphology

It has long been understood that morphological patterns can play an important role in syllable structure complexity. There are many languages in which the largest tautosyllabic consonant clusters arise through inflection or other morphological processes, for example in the coda /ksts/ in English *texts*. On the basis of such observations, morphologically complex clusters have often been viewed with suspicion in theoretical treatments of the syllable. Comments casting doubt on their status as valid phonological structures can be found throughout the literature examining syllable patterns from both formal theoretical and descriptive typological perspectives: for example, many typological studies of consonant clusters, such as Greenberg (1965/1978) and others mentioned above, explicitly exclude morphologically complex clusters from their analyses.

When morphologically derived syllable structures are explicitly addressed in empirical studies of cluster patterns, it tends to be in order to examine how they differ from purely phonological (morpheme-internal) clusters in aspects of their composition, processing, and acquisition. A recent research program has studied patterns of phonotactic (morpheme-internal) and morphonotactic (morphologically complex) consonant clusters (Dressler & Dziubalska-Kołaczyk 2006). Several studies in this vein have approached the issue by analyzing properties of cluster inventories, finding that morphologically complex clusters are typically larger and more complex (in terms of sonority or alternatives such as perceptual distance) than those which occur within morphemes (Dressler & Dziubalska-Kołaczyk 2006, Orzechowska 2012).

Studies of L1 cluster acquisition have revealed earlier production and lower reduction rates for morphologically complex clusters than for morpheme-internal clusters, suggesting that the extra grammatical-semantic function carried by these structures may work in favor of their stability and maintenance, even if the shapes themselves are 'dispreferred' (Kamandulytė 2006, Zydorowicz 2010). Morphologically complex clusters with phonotactically 'dispreferred' patterns have in fact been proposed to facilitate parsing in speech perception, since they more reliably signal the morphological compositionality of words and thus feed back into the productivity of those morphemes (Hay & Baaven 2003, Dressler et al. 2010).

#### 1.2.3 Theoretical models and cross-linguistic patterns of syllable structure

The purpose of models of linguistic structure is to provide a framework and context within which to situate and explain observed language patterns. As a result, models are often heavily influenced by frequent or well-documented cross-linguistic trends. Theoretical models of the syllable reflect many of the cross-linguistic patterns described above.

Many formalist models of the syllable reflect cross-linguistic trends which privilege CV over other patterns. The model of syllable structure in Government Phonology (Kaye et al. 1990) follows in the tradition of generative syntax, in that every element in phonological structure is governed by some other element in a hierarchical fashion and an element may govern at most two constituents. In this model, the syllable element governs the onset and the rime. The rime branches into a nucleus and an optional simple coda. Depending upon the formulation of the model, the onset may branch into two consonants. A more extreme model following from this tradition, the Strict CV approach, posits only onset and nucleus constituents (Lowenstamm 1996, Rowicka 1999). Because of the cross-linguistic tendency towards simple or biconsonantal onsets and simple or absent codas, these approaches are sufficient for describing syllable patterns in many languages. Where patterns do not fit into the proposed frame, empty nuclei are posited in order to preserve the underlying structure. Thus onset clusters are assumed to have intervening empty nuclei between the consonants, and codas are assumed to be followed by empty nuclei.

Common cross-linguistic cluster patterns such as /s/+stop onsets and stop+/s/ codas have been considered problematic in some frameworks, as they represent sonority plateaus or reversals. In order to deal with such issues, it has been proposed that the /s/ in such patterns is not a part of the core syllable, but functions as an extrasyllabic appendix to it (Vaux & Wolfe 2009, Duanmu 2011). Appendices and extrasyllabic elements are often posited for peripheral members of clusters which belong to separate morphemes. Interestingly, this approach may result in some of the most frequent clusters in a language (e.g., clusters coming about through inflectional markers) being set apart from morphologically simple ones in their phonological representation.

In Optimality Theory, syllable patterns are not governed by a rigid model, but are motivated by universal constraints whose relative importance (ranking) is determined on a language-specific basis (Prince & Smolensky 1993). In this framework, surface phonetic forms are those which reflect the best possible output, that is, the fewest violations, with respect to the constraint ranking. Cross-linguistic variation in syllable patterns is explained in terms of different rankings of these violable constraints. Many of the constraints reflect common cross-linguistic patterns, e.g. ONSET, in which a violation mark is assigned to a syllable without an onset, and \*NUCLEUS/X, in which a violation mark is assigned to syllable nuclei belonging to some sonority class X (e.g., obstruents; McCarthy 2008).

In the Articulatory Phonology framework, researchers have developed a coupled oscillator model of syllable structure which is heavily influenced by findings in the motor control literature (Nam & Saltzman 2003, Goldstein et al. 2006, Nam et al. 2009). In this

model, speech gestures are associated with planning routines, or oscillators, which activate the production of that gesture in speech. These oscillators are coupled to one another in one of two stable modes — in-phase or anti-phase — which determine the relative timing of the production of gestures. Gestures coupled in-phase are initiated synchronously, while gestures coupled anti-phase are initiated sequentially. These coupling phases are proposed to correspond to instrumentally established timing relationships observed in the syllable, in which onset gestures are produced synchronously with the vowel but coda gestures are timed sequentially with respect to the vowel. This model provides a motor control basis for the privileged status of CV in language acquisition and frequency distributions, as well as the distinct timing patterns associated with onsets, codas, and clusters in each of those positions.

# **1.3 Highly complex syllable structure: typological outlier, theoretical problem**

Having discussed some of the predominant cross-linguistic trends in syllable patterns, as well as frequent accounts for them, we return to the patterns presented in the first section of this chapter (1.8)-(1.12)

#### (1.8) **Sahaptin** (*Sahaptian*; United States)

ksksa

'elephant ear (mushroom)'

(Hargus & Beavert 2006: 29)

(1.9) Georgian (Kartvelian; Georgia)

br<del>ί</del>s'χ'ali

'claw'

(Butskhrikidze 2002: 204)

(1.10) Tashlhiyt (Afro-Asiatic; Morocco)

tssk∬ftstt

 $t-ss-k\int f-t = stt$ 

'you dried it (F)'

(Ridouane 2008: 332)

(1.11) **Tehuelche** (*Chon*; Argentina)

ktʃa?ʃpʃkn

k-t͡ʃa?∫p-∫-kn

REFL-wash-PS-REALIS

'it is being washed'

(Fernández Garay & Hernández 2006: 13)

(1.12) Itelmen (Chukotko-Kamchatkan; Russia)

kłtxuniŋe?n

kł-txuni-ŋe?n

'very dark'

(Georg & Volodin 1999: 55)

In the context of the issues previously discussed, highly complex syllable patterns may be considered problematic in all respects.

The syllable patterns in (1.8)-(1.12) are, first of all, extremely large in comparison to the universally privileged CV shape. This fact has been pointed to explicitly in the literature as a reason to dismiss such patterns: Kaye et al. (1990: 195), in a discussion of syllable patterns with four-consonant codas in Nez Perce, write that "[t]he sheer length of such sequences makes one doubtful of their status as syllable constituents of one and the same syllable." The example in (1.11) is chosen to reflect that codas may be much longer than onsets in Tehuelche, which goes against predominant cross-linguistic trends. Further, the word-initial patterns in (1.8) and (1.12) consist entirely of obstruents, which should be strongly dispreferred according to both sonority models (e.g., Clements 1990) and acoustic-perceptual models (Ohala & Kawasaki-Fukumori 1997) of syllable structure. The word without vowels in (1.10) is typologically exotic and implies syllabic obstruents, which are cross-linguistically 'dispreferred.' The patterns in (1.10)-(1.12) are further regarded as dubious because their clusters are morphologically complex and therefore perhaps not 'valid' phonological structures. All of the patterns above, besides being typologically rare, are theoretically marginalized in that they represent the exact opposite of the predominant cross-linguistic patterns which models of the syllable seek to capture and describe.

When highly complex syllable patterns are explicitly treated in the literature, it tends to be with the purpose of making their patterns fit into prevailing theoretical models. An example of this is Bagemihl's (1991) analysis of Nuxalk syllable structure.

On the basis of reduplication data, Bagemihl analyzes the language as having "relatively ordinary" CRVVC syllable structure,<sup>3</sup> in which vowels, liquids, and nasals may function as V nuclei. Segments that do not fit into that syllable frame remain phonologically unsyllabified. Thus a word without sonorants — like  $\frac{1}{2}\chi^{w}ttcx^{w}$  'you spat on me — while being fully and fluently pronounceable by speakers, is analyzed as being entirely unsyllabified at the phonological level. Similarly, a strict CV approach has been used to account for 'ghost vowels' - vowels which alternate with zero - in Mohawk and Polish, both of which have highly complex syllable patterns (Rowicka 1999). However, this has the effect of positing long sequences of simple onsets followed by empty nuclei for the large consonant clusters which occur in those languages, as in Mohawk khninus 'I buy' or Polish <u>źdźbł</u>o /**zd**zbwo/ 'blade of grass'. These novel analyses are by no means haphazard, being based upon careful consideration of both language-specific patterns and theoretical implications. However, such treatments of highly complex syllable structure have the effect of theoretically 'normalizing' these rare syllable patterns: not by taking them at face value as corresponding to possible cognitive representations of language, but by arguing away their unusual properties until they more closely resemble familiar patterns.

Even more problematic are approaches which treat highly complex syllable structure as anomalous or exotic. Such attitudes, as reflected by assumptions about what constitutes possible syllable length and constituency (cf. the quote by Kaye and colleagues above), make it all too easy for researchers to dismiss such patterns as

<sup>&</sup>lt;sup>3</sup> Here R stands for 'resonant,' corresponding to a sonorant consonant.

improbable or regard them as statistical aberrations from an established norm. This seems to be more often the case when highly complex syllable patterns occur in underdescribed non-Eurasian languages with little sociopolitical power. It sets a worrisome precedent when the patterns of minority, indigenous, and endangered languages are dismissed in this way. This reinforces a European bias and serves to further marginalize and exoticize these languages, which are already historically and socially marginalized in our discipline.

Related to this point is the fact that much of the research in linguistics, including syllable structure typology, is influenced by an overrepresentation of data from European languages. A survey of cross-linguistic studies of consonant cluster patterns, for example, revealed an Indo-European bias which ranged from 24% (Morelli 1999) to 79% (Vennemann 2012) of the languages in those samples (Easterday & Napoleão de Souza under review). In an investigation of the conformity of plosive-initial biconsonantal onset inventories to the predictions of a sonority-based implicational hierarchy in 46 diverse languages, only five of which were Indo-European, it was found that nearly one-third of the languages had patterns diverging from these predictions (ibid.). None of the diverging patterns were found in Indo-European languages, and nearly all were from regions or families which tend to be underrepresented in linguistic research. Furthermore, morphology played at most a minor role in accounting for the unpredicted patterns, suggesting that at least some of the reported norms of syllable structure typology are heavily biased towards what has been observed in Indo-European.

Other issues which often go unexplored in accounts for cross-linguistic patterns of syllable structure are the influence of processes of language change and the relationship between syllable patterns and other elements of the phonology and the grammar. These issues are of special importance for typologically rare patterns, such as highly complex syllable structure, as they provide a natural explanation for the emergence and maintenance of these purportedly dispreferred patterns. In the following section I briefly discuss some lines of research which situate the issue of syllable structure complexity within holistic typologies of language by relating it to other phonological and grammatical features.

# 1.4 Syllable structure complexity: accounts and correlations

## **1.4.1 Speech rhythm typologies**

A long line of research in linguistics has sought to characterize and measure rhythmic properties of language which are perceptually and psychologically salient to speakers and play an important role in language acquisition (Cutler & Mehler 1993). The typology proposed by Pike (1945) distinguished two speech rhythm types: stress-timed languages and syllable-timed languages, with English being a prototypical example of the former and Spanish being a prototypical example of the latter. This typology was later expanded to include a third category of mora timing, for which Japanese is a prototypical example. In its initial formulation, it was postulated that the rhythmic properties of these language types reflect equal timing intervals between those units: between stresses for stress-timed languages, syllables for syllable-timed languages, and morae for mora-timed

languages. This 'isochrony hypothesis' was eventually instrumentally disconfirmed (Roach 1982). Speech rhythm typologies subsequently began to focus on phonological holism, relating rhythm types to a confluence of factors involving syllable structure, vowel reduction, vowel length contrasts, and properties of stress placement (Roach 1982, Dauer 1983). In this typology, simple syllable structure is proposed to occur with syllable timing, and complex syllable structure is proposed to occur with stress timing. Reduction of vowels in unstressed syllables and variation in lexical stress patterns are additionally proposed to occur with complex syllable structure in stress-timed languages (Auer 1993). These proposed co-occurrences are not meant to be categorical, and as will be discussed in Chapter 5, they may reflect the patterns of European languages specifically (Schiering 2007).

Proposed measurements of the acoustic properties of speech rhythm have been suggested to relate directly to syllable structure. Metrics developed by Ramus et al. (1999) correspond to the proportion of vocalic intervals and standard deviation of consonantal intervals in speech. In languages with high syllable complexity, a greater standard deviation of consonant intervals and a lower proportion of vocalic intervals is expected, corresponding to both the greater variation in syllable types and the higher probability of consonant sequences in running speech in such languages. When languages are plotted according to these metrics, they fall into groups which largely correspond to traditional rhythm categories of stress timing and syllable timing (but see Wiget et al. 2010 for criticisms of this approach). When these metrics were calculated in a crosslinguistically diverse sample of languages controlled for syllable structure and other

phonological variables, it was found that syllable structure complexity is indeed significantly correlated with the expected indices (p < .005), lending empirical validation to the suggested relationship (Easterday et al. 2011). However, the direction of causality behind the relationship is unclear from these findings: while syllable structure contributes heavily to the acoustic-perceptual properties of speech rhythm, it is not clear whether syllable structure necessarily causes or constitutes stress timing. It may instead be that syllable structure is affected by and comes about through the other prosodic and phonological features associated with stress timing, such as vowel reduction.

# **1.4.2 Other holistic typologies**

Some holistic typologies which consider syllable complexity attempt to relate the phonology, morphology, syntax, and discourse properties of language to one another. An example of one such ambitious typology is that proposed in various forms by Vladimir Skalička from 1958 to 1979 (Plank 1998). Skalička (1979) proposed five ideal types which actual languages were supposed to approximate, if not attain: polysynthesis (an idiosyncratic use of the term that does not correspond to modern uses), agglutination, flection, introflection, and isolation. The many phonological and grammatical properties proposed to co-occur in each of these types were meant to be mutually supportive. In two of the types — agglutination and introflection — complex consonant clusters are said to co-occur with rich consonant systems and a high amount of verbal inflection. Other properties of these very specifically-defined classes include a prevalence of vowel harmony and looser fusion between gramemes and the stem in the agglutination type, and

root-internal marking in the introflection type. Like many proposed holistic typologies, Skalička's is largely impressionistic and not based in extensive empirical evidence.

A series of empirical studies by Gertraud Fenk-Oczlon and August Fenk have sought to establish correlations between certain grammatical and discourse properties of language and syllable structure specifically. Fenk & Fenk-Oczlon (1993) tested Menzerath's Law (paraphrased as "the bigger the whole, the smaller the parts") and found a significant negative linear correlation between the number of syllables per word and the number of phonemes per syllable, a measure roughly analogous to syllable complexity. Working from the observation that words have more syllables in agglutinating languages, Fenk-Oczlon & Fenk (2005) established a correspondence between complex syllable structure and a tendency towards prepositions and a low number of cases on the one hand and simple syllable structure and a tendency to postpositions and a high number of cases on the other. Finally, Fenk-Oczlon & Fenk (2008) found that high phonological complexity (determined by the number of distinct monosyllables in a language) was correlated with low morphological complexity and high semantic complexity (i.e., high degrees of homonymy and polysemy), as well as rigid word order and idiomatic speech. They explain these results in terms of complexity trade-offs which balance the different sub-systems of language.

The results of Shosted (2006) conflict with those of Fenk-Oczlon & Fenk. This empirical study attempts to test the negative correlation hypothesis, which holds that if one component of language is simplified, then another must be elaborated. Specifically, Shosted considers correlations between syllable structure and inflectional synthesis of the

verb in a diversified sample of 32 languages. He finds a slightly positive but statistically insignificant correlation between complexity in the two measures. Shosted's measure of phonological complexity is not based on measurements of maximum syllable complexity, but instead on the potential (not actual) number of distinct syllables allowed in each language, a figure which is calculated from the number of phonemic contrasts, canonical syllable patterns, and various phonotactic constraints reported for each language.

# 1.4.3 Consonantal and vocalic languages

In phonological descriptions and general typological studies, the terms

consonantal and vocalic are sometimes used to describe the holistic phonological

character of languages (1.13)-(1.18).

(1.13) "In this group, we find on the one hand highly consonantal languages like Kabardian and other Northwest Caucasian languages [...], and on the other hand vocalic languages with long morphemes, for example Indonesian and related languages [...]"<sup>4</sup>

(Skalička 1979: 309)

(1.14) "Syntagmatically, all (indigenous) Caucasian idioms can be called 'consonanttype languages,' with more consonants in a speech sequence than vowels [...] The same term ('consonantal languages') can be applied to them paradigmatically as well, all Caucasian languages being notorious for the richness of their consonantal inventories, versus restricted or very restricted vowel systems."

(Chirikba 2008: 43)

<sup>&</sup>lt;sup>4</sup> Translation TZ.

(1.15) "[Polish] can be described as a 'consonantal' language, in two respects: (a) it has a rich system of consonant phonemes [...] and (b) it allows heavy consonant clusters ..."

(Jassem 2003: 103)

(1.16) "Slovak is a more consonantal language than German (27 vs. 21) ..."

(Dressler et al. 2015)

(1.17) "Since Italian is clearly a less consonantal language than English ..."

(Dressler & Dziubalska-Kołaczyk 2006: 263)

(1.18) "Tashlhiyt can be described as a 'consonantal language.' [...] What makes Tashlhiyt a 'consonantal language' *par excellence* is the existence of words composed of consonants only ..."

(Ridouane 2008)

The use of these terms is especially prevalent in Slavic and Caucasian linguistics. In such contexts, the terms may refer directly to a holistic phonological typology of Slavic languages developed by Isačenko (1939/1940). In that work, *consonantal* languages are defined as having complex syllable structure, a higher proportion of consonants in the phoneme inventory, the presence of certain consonant contrasts such as secondary palatalization, and fixed or lexically-determined stress. By comparison, *vocalic* languages have simpler syllable structure, lower proportions of consonants in the phoneme inventory, fewer consonant place contrasts, and pitch accent or 'musical intonation.' Several of the descriptions above also make reference to the overall size of the consonant phoneme inventory and sequences of consonants in word patterns or the speech stream. The relationship between syllable structure complexity and consonant phoneme inventory size indicated above is an empirically established one: as will be discussed further in Chapter 4, Maddieson (2013a) found a weak but highly significant positive relationship between these features in a set of 484 languages. These findings suggest that the use of the terms consonantal and vocalic is at least to some extent grounded in observable cross-linguistic patterns.

Impressionistic descriptions of the phonetic characteristics of languages with highly complex syllable structure are evocative of descriptions of consonantal languages. I present some of these below (1.19)-(1.22).

(1.19) Kabardian (Northwest Caucasian; Russia, Turkey)

"On the whole, the vowels have comparatively little prominence, in comparison with the consonants."

(Kuipers 1960: 24)

"[T]he typical Kabardian pronunciation is imitated most easily if one pronounces the word without vowels other than *a* and with a stress immediately after the initial consonant: the result will show the predominance of consonants over vowels that is typical of Kabardian speech, and the syllabic peaks will be determined automatically by the stress and by the sonority of the sounds in the sequence."

(Kuipers 1960: 43)

(1.20) Camsá (Isolate; Colombia)

"Words are pronounced rapidly with vowels practically eliminated word medially. A degree of emphasis is placed on the vowel of the first syllable with the following syllables squeezed together before the stressed syllable."

(Howard 1967: 86-7)

# (1.21) **Thompson** (*Salishan*; Canada)

"Basic vowel adjustments reflect the general tendency of the language to drop vowels from unstressed syllables wherever possible and to convert to /a/ those vowels that are not dropped. In rapid speech, this tendency is nearly fully realized, so that few tense vowels are heard outside of stressed syllables."

(Thompson & Thompson 1992: 31)

# (1.22) Itelmen (Chukotko-Kamchatkan; Russia)

"I suppose it is little exaggeration to say that in the [Itelmen] language there are no vowels, or, perhaps, their vowels are so obscure that it is hardly possible to translate them to European [equivalents]."<sup>5</sup>

(Volodin 1976: 40-1; quoting V. N. Tyushov)

These vivid descriptions of fluent speech in languages with highly complex

syllable structure are surely influenced by the stark differences between these phonetic patterns and those of the languages spoken natively by the researchers. However, taken along with observations regarding consonantal languages, as well as findings in the speech rhythm and holistic typology literature, they suggest a path forward for investigating highly complex syllable structure as a coherent linguistic type characterized by an array of phonetic and phonological features.

# 1.5 The current study

This dissertation is a cross-linguistic investigation of highly complex syllable patterns, their properties, their associations with other linguistic features, and their

<sup>&</sup>lt;sup>5</sup> Translation SME.

emergence over time. The two aims of the dissertation are (i) to establish whether languages with highly complex syllable structure constitute a linguistic type, in the sense denoted by the holistic typologies described above, and (ii) to identify possible diachronic paths and natural mechanisms by which these patterns come about in the history of a language. A secondary goal of the dissertation is to 'de-exoticize' these rare syllable patterns by considering them at face value as natural language structures rather than as typological and theoretical outliers.

# **1.5.1 Research questions**

The two broad research questions of the dissertation follow directly from the aims of the dissertation listed above. The first is given in (1.23).

(1.23) Do languages with highly complex syllable structure share other phonetic and phonological characteristics such that this group can be classified as a linguistic type?

This research focus seeks to establish whether highly complex syllable structure is a linguistic type characterized by a convergence of associated phonetic and phonological properties. The properties to be considered follow in part from the findings and proposals in the holistic typologies described above. These include properties of syllable structure, phoneme inventories, suprasegmental patterns, and processes of vowel reduction and consonant allophony (see the following section for a detailed list of considerations). The specific hypotheses regarding the associations between syllable complexity and these properties will be presented with each analysis in upcoming chapters.

While the term 'linguistic type' is used in the formulation of (1.23), this is not meant in the sense that I expect the results of the analyses to set these languages apart from others in a strict categorical way. As with the holistic language typologies discussed above, it is more likely that phonetic and phonological properties will *tend* to cluster together. If such expectations are borne out in the analyses, they may aid in addressing the second research question:

#### (1.24) How does highly complex syllable structure develop over time?

As will become apparent in the following chapters, capturing the development of highly complex syllable structure in real time is not a straightforward endeavor: syllable patterns seem to be remarkably stable and persistent over time and within language families (Napoleão de Souza 2017). Where synchronic and historical accounts based on direct (that is, not reconstructed) evidence are available, these are useful in approaching the research question in (1.24). Additionally, methods of diachronic typology can be used. This will be discussed further below.

#### **1.5.2 Proposed analyses and framework**

The research questions outlined above will be investigated in a sample of 100 languages representing four different categories of syllable complexity and selected to

maximize genealogical and geographic diversity. The size and construction of the sample is designed to allow for a maximally systematic investigation of both of the research questions (see Chapter 2 for further detail). For practical reasons, the scope of the dissertation will be largely limited to the analysis of phonological and phonetic properties, but in a few cases morphological factors will additionally be considered. The analyses are grouped into five coherent studies, each corresponding to a chapter in the dissertation. These are listed below.

# (1.25) Phonological and phonetic properties considered in the dissertation

# Syllable patterns (Chapter 3)

Size, location, phonological shape, and morphological complexity of maximum clusters

Nucleus patterns, including syllabic consonants Morphological patterns of syllabic consonants Relative prominence of highly complex patterns within languages Phonetic properties of large clusters

# Segmental inventories (Chapter 4)

Consonant phoneme inventory size

Consonant articulations present

Vocalic nucleus inventory size

Vocalic contrasts present

# **Suprasegmental properties (Chapter 5)**

Presence of tone and word stress Predictability of word stress placement Phonological asymmetries between stressed and unstressed syllables Phonetic processes conditioned by stress Phonetic correlates of stress Vowel reduction (Chapter 6) Presence and prevalence of vowel reduction Affected vowels Conditioning environments

Consonant allophony (Chapter 7)

Presence of specific types of assimilation, lenition, and fortition Conditioning environments

The results of these analyses will be used to directly address the research question in (1.23) regarding the establishment of languages with highly complex syllable structure as a linguistic type. While one goal of the dissertation is to quantify associations between syllable structure complexity and specific linguistic features, qualitative patterns in the data will also be considered in this endeavor.

Additionally, the results will be used to inform diachronic paths by which highly complex syllable patterns develop, addressing the research question in (1.24).

Specifically, the methods of diachronic typology — the use of "synchronic variation to dynamicize a typology" (Croft 2003: 272) — will be used. In this method, diachronic processes and paths are inferred, with careful consideration of attested processes and known directionality of language change, from synchronic patterns. This method is especially valuable in the current study, as many of the languages with highly complex syllable structure have little to no historical documentation. Strong tendencies in the phonetic and phonological properties of languages with highly complex syllable patterns may point to processes of language change which tend to precede, accompany, or follow the development of these structures, hinting at steps in the historical evolution of this linguistic type.

Like most typological studies, the analyses in the dissertation rely on written reference materials and are therefore based on standard features of structural linguistic analysis, such as phoneme inventories and phonological processes. However, the interpretations of patterns are informed by a theoretical framework which views the patterns of organization within language as dynamic, interactive, and emergent from use (Beckner et al. 2009, Bybee 2001, 2010).

While I do not have a finely articulated hypothesis regarding the diachronic development of highly complex syllable structure, I enter into these studies with a few ideas and assumptions regarding this issue. Following findings in the speech rhythm literature, I expect that vowel reduction, especially processes resulting in vowel deletion or the development of syllabic consonants, will be highly relevant in the development of these patterns. Since vowel reduction is often associated with unstressed syllables, it is

also expected that stress will play an important role. These phenomena may be accompanied by particular processes of consonant allophony, such as palatalization, which over time have the effect of increasing consonant phoneme inventory sizes. Finally, an important aspect of syllable structure development that can only be briefly considered here is the role of morphology. Based upon observations of morphologically complex clusters in languages with highly complex syllable structure, as well as associations posited between syllable complexity and morphological patterns in the literature, I expect that the development of these syllable patterns are often facilitated by a high degree of inflectional or derivational morphology in a language. In a speculative scenario, it is easy to imagine highly complex syllable patterns developing in a highly inflectional language in which stress falls on the root or stem and eventually has segmental effects which include the reduction and eventual deletion of unstressed vowels, resulting in long heteromorphemic consonant sequences at word edges. The plausibility of the various aspects of such a scenario will be explored in upcoming chapters.

#### **CHAPTER 2:**

#### LANGUAGE SAMPLE

This chapter describes the language sample used in the dissertation. In §2.1 I discuss general issues of language sampling and specific considerations for sampling in the current study. In §2.2 I examine a previous typology of syllable structure complexity and propose a definition for a category of Highly Complex syllable structure. In §2.3 I discuss the procedure underlying the construction of the language sample in the dissertation. In §2.4 I present the language sample and describe its areal, genealogical, and sociolinguistic features. In §2.5 I briefly discuss the general method of data collection for the dissertation.

# 2.1 Language sampling

Cross-linguistic comparison is "the fundamental characteristic of typology" (Croft 2003: 6). In order to make general statements about some structural or functional linguistic feature, such as syllable complexity, it is necessary to examine the properties of and variation within that feature in a wide variety of languages. Today, linguists have access to a greater array of grammatical descriptions, corpora, and audiovisual materials than ever before. However, for many languages, reference materials are either not available or not descriptive enough for inclusion in most typological studies. Therefore researchers must rely on samples much smaller than the set of the 7,097 languages known to be living today (Lewis et al. 2016). Because typology is a data-driven science, the

issue of sampling - that is, determining which languages will serve as data sources for addressing the question(s) at hand - is critical in any study. The relative merits of different sampling techniques and methods of controlling for various types of bias have long been the subject of debate in the field (see Bakker 2011 for an overview of the relevant literature).

Before introducing the sample used in the current study, I discuss some of the known sources of bias in typological work. I also discuss the potential effect of these factors on investigating issues of syllable structure or phonology more generally.

## 2.1.1 Common sources of bias in language sampling

The three most commonly discussed sources of bias in language sampling are *genealogical, areal,* and *bibliographic* bias (Bakker 2011).

A typological study may suffer from *genealogical bias* if it includes data from related languages. This presents a potential confound in the interpretation of results, because similar patterns in related languages may not be independent of one another, but instead inherited from a common ancestor. Of all the sources of bias in language sampling, genealogical bias is perhaps the most discussed, and the one most explicitly controlled for. Strategies for minimizing this kind of bias include systematic stratification of the language sample itself at a particular time depth or level of genetic classification (Bell 1978b, Maddieson 1984, Dryer 1989), or postponement of sampling to post-hoc analysis, when the independence of the feature(s) under study can be determined at each taxonomic level within a language family (Bickel 2008). In practice, though, most

typological studies are based on small convenience samples which are heavily skewed towards large, well-known, and well-described language families. Language isolates, which account for up to one-third of known language families (Campbell 2016), and smaller, lesser-known language families often go altogether unrepresented.

Another bias which is often considered in constructing language samples is areal bias, in which languages spoken in the same geographical and/or cultural area may have influenced one another through prolonged contact. The literature has long noted the existence of linguistic areas, in which languages from more than one language family share sets of traits in common with each other but not with other related languages spoken outside the area (Aikhenvald & Dixon 2001a, Chirikba 2008). Attempts to minimize such bias include consideration of cultural areas in addition to genealogical affiliations in constructing a language sample, with the ideal sample containing no two languages from the same family or area (Perkins 1985). But while traditional linguistic areas are relatively small and geographically delimited (e.g., the Balkan Sprachbund), studies of individual features have revealed even larger areas of linguistic convergence; e.g., North America has a higher prevalence of head-marking agreement strategies as compared to the rest of the world (Dryer 1989). To minimize the effects of areal bias, Dryer proposes a method by which a language sample may be divided into five large continental areas (later refined to six, Dryer 1992), which can be shown to be independent of one another along at least some typological measures.

As many as two-thirds of spoken languages do not have reference materials which are thorough enough to be consulted in any but the most basic of typological surveys

(Bakker 2011: 106). As a result, virtually every language sample suffers from severe bibliographic bias. The best documented languages in the world tend to correspond to those which, for whatever historical reason, have the greatest political, social, and economic power and wide geographic spread (e.g., English, Mandarin Chinese, Spanish, Arabic). Thus we find that bibliographic bias is genealogically and areally skewed, with small, less powerful language families and remote geographic areas particularly underrepresented. The least documented language families in the world, for example, tend to be found in lowland New Guinea and parts of the Amazon region (Hammarström 2010). Similar to, or perhaps a subset of, bibliographic bias is what Moreno Cabrera describes as the *written language bias*. Most of the world's languages do not have a written or standard form, and references for such languages often describe a specific dialect or ideolect. When languages do have a written or standard form, reference materials often describe that form. A result of this is that typological studies often compare data from "highly heterogeneous sources": standardized, highly formal registers for written languages, and unstandardized, informal registers of ideolects for unwritten languages (2008: 118).

All three of the sources of bias described above — genealogical, areal, and bibliographic bias — may complicate typological studies of syllable structure. As discussed in the introduction, the prevalence of particular consonant cluster patterns in Indo-European languages may skew general perceptions regarding the universality of these patterns (Easterday & Napoleão de Souza under review). In that study, exceptions to the predicted sonority-driven onset inventory patterns were more common in the non-

Indo-European families and language isolates of the sample. There are also clear areal asymmetries in the global distribution of syllable structure complexity. Languages with Simple syllable structure tend to be spoken near the equator (Maddieson 2013a). Complex syllable structure has been described as a prominent areal feature of specific regions such as the Caucasus (Chirikba 2008) and the Pacific Northwest (Thompson & Kinkade 1990), though a recent study suggests that maximal syllable structure is more strongly associated with genealogical affiliation even within these linguistic areas (Napoleão de Souza 2017). Insofar as the global distribution of syllable structure complexity is genealogically and areally skewed, the issue of bibliographic bias is relevant. For example, underdocumented areas such as the New Guinea are known to have a higher than average proportion of languages with canonical (C)V syllable structure (Maddieson 2013a).

# 2.1.2 Other factors which may influence phonological structure and syllable complexity

#### 2.1.2.1 Population

Speaker population may have an affect on language structure. It has been proposed that rare or linguistically marked structures, such as Object-initial basic word orders, are more likely to arise and persist in small speech communities (Nettle 1999a). Moreover, lingua franca which have wide areal spreads and large speaker populations with many second-language speakers may be more vulnerable to simplificatory pressures than languages whose use is limited to small, close-knit communities (Nettle 1999b,

Lupyan & Dale 2010). These proposals suggest that simpler syllable structures may be found in languages with large speaker populations or in situations of heavy language contact. Recent research on emerging creoles does not necessarily support the latter claim: despite many statements to the contrary, a broad range of syllable structure complexity has been found in these languages (Schramm 2014). Elsewhere in the field of phonology, a positive correlation between phoneme inventory size and speaker population has been noted (Hay & Bauer 2007). Proposed motivations for this pattern, including founder effects analogous to those found in genetics (Atkinson 2011), are controversial (Bybee 2011, Maddieson et al. 2011, Hunley et al. 2012, *inter alia*).

# 2.1.2.2 Language endangerment

Today, language diversity is in precipitous decline due to rapid social, economic, and environmental changes which now have global reach. It has been projected that 84% or more of today's languages may be lost within the next century (Nettle 1999b: 113-114). Of course, the most profound consequences of language death occur in the affected speaker communities. Language death also has a negative effect on typological research, which relies crucially on data from a diverse array of languages. Additionally, there is evidence that language vitality may influence language structure itself. Languages which are obsolescing (dying) — currently about 13% of all living languages (Lewis et al. 2013) — are known to undergo special kinds of structural change (see Romaine 2010 for a review of research on the structural effects of language obsolescence). In the phonological systems of obsolescing languages, it is common for

distinctive contrasts to be leveled and for the regularity of phonological processes to break down. Attested effects of obsolescence on syllable structure include reduction and simplification of syllable margins (Cook 1989, for obsolescing dialects of Chipewyan and Sarcee) and the deletion of entire unstressed syllables in certain word positions (Mithun 1989, for Oklahoma Cayuga).

# **2.1.2.3 Ecological factors**

There is a growing body of work investigating the effect of ecological factors on language structure. Recent studies have explored the hypothesis that the sound systems of human languages may be adapted to features of the natural environment such as elevation, ambient temperature, density of vegetation, and humidity (Everett 2013, Maddieson & Coupé 2015, Everett et al. 2016). Syllable structure has been a subject of particular focus in this research paradigm. A positive correlation between warm climates and the frequency of CV shapes in languages has been proposed to reflect the communication needs of an outdoor lifestyle, in which more sonorous elements of the speech signal may overcome environmental noise and large distances between speakers (Munroe et al. 1996). Similarly, a negative correlation between density of vegetation and complex syllable structures may reflect the poor transmission qualities of higher frequency sounds (certain consonants and consonant clusters) in densely forested environments (Maddieson & Coupé 2015).

## 2.1.3 Specific considerations in the current study

Bakker states that "the construction of a sample should follow the precise formulation of the research questions one would like to answer on the basis of it" (2011:106). Recall the two broad research questions motivating this dissertation, presented in (2.1)-(2.2):

- (2.1) Do languages with highly complex syllable structure share other phonetic and phonological characteristics such that this group can be classified as a linguistic type?
- (2.2) How does highly complex syllable structure develop over time?

These research questions, and their more specific formulations laid out in Chapter 1, necessitate a carefully constructed language sample. The first broad research question seeks to determine whether there are structural features correlated with highly complex syllable structure such that this phenomenon can be considered characteristic of a language type. For the purposes of gaining a thorough understanding of a language type, genealogical and areal diversity are important considerations in the construction of the sample. However, because this study does not aim to quantify the range or overall distribution of highly complex syllable structure, it is not necessary that the sample be genealogically *balanced* in a systematic way. If quantitative analysis reveals cross-linguistically robust patterns of features correlated with syllable structure complexity, these can inform specific predictions about the evolution of highly complex syllable

structure, addressing the second broad research question. In approaching that question, it may actually prove useful to have pairs of related languages with different syllable structure complexity in the sample. The effectiveness of the predictions can then be tested and qualitatively evaluated within these pairs, in which the structures are known to derive from the same origin at some point in the past.

In order to test for correlations between syllable structure complexity and other structural features, typological bias (Comrie 1989: 12) must be built into the sample. That is, the languages of the sample must be deliberately chosen on the basis of their syllable patterns, so that features of languages with different syllable structure complexity may be compared against one another in a principled way to determine whether the hypothesized correlations exist and are cross-linguistically robust. An important question, then, is how syllable structure complexity is defined in the current study. This issue is discussed in §2.2, and the procedure for constructing the sample is discussed in §2.3.

# 2.2 Defining the categories of syllable structure complexity

The topic of syllable structure complexity is typically approached in terms of the size of the onset and the coda. The particular shape of the onset and coda are also important considerations, owing to the aforementioned cross-linguistic trends which seem to favor some sequences and sonority profiles over others. Other factors, such as the many observed asymmetries in the structure and behavior of onsets versus codas, may also be taken into account.

A classification of syllable complexity which considers all of the above factors the size, shape, and differential behavior of onsets and codas, as well as dominant crosslinguistic patterns — is given in Maddieson (2013a). While broad, this classification captures prevalent cross-linguistic trends in syllable structure and has proven useful in establishing correlations between syllable structure complexity and other features of language structure, such as consonant phoneme inventory size. In a 486-language survey, languages are classified into three categories according to the size and shape of their largest observed onsets and codas:

**Simple:** languages in which the onset is maximally one consonant, and codas do not occur.

**Moderately Complex:** languages in which the onset is maximally two consonants, the second of which is a liquid or a glide (e.g., /tr-/ or /pj-/); and/or the coda consists of maximally one consonant.

**Complex:** languages in which the maximal onset is two consonants, the second of which is a consonant other than a liquid or a glide, or larger than two consonants; and/or the maximal coda consists of two or more consonants.

The distribution of the 486 languages in Maddieson's survey according to these three categories can be found in Table 2.1.

Syllable Structure Complexity	N languages	Percentage		
Simple	61	12.6%		
Moderately Complex	274	56.4%		
Complex	151	31.1%		

**Table 2.1.** Distribution of syllable structure complexity in languages of Maddieson(2013a).

In contrast to the tightly-defined Simple and Moderately Complex categories, the Complex category in Maddieson (2013a) is diverse and open-ended. Languages in this category range from those whose most complex syllable is only a slight expansion on the Moderately Complex types — such as a CVCC shape, in which the first consonant of the coda is limited to a liquid or glide — to those having far more complex structures involving up to eight consonants in a tautosyllabic cluster. In order to better understand the internal structure of the Complex category and the distribution of languages within it, I analyzed the size and shape of the maximal syllable structure of these 151 languages, using the reference(s) cited in Maddieson (2013a) wherever possible. A list of the languages in the sample, along with the references consulted, can be found in Appendix C. The distribution of these languages can be found in Table 2.2, according to the size of their maximum onsets and codas.<sup>6</sup>

<sup>&</sup>lt;sup>6</sup> Note that there are only 145 languages represented in Table 2.2: for six of the languages in the Complex category in Maddieson (2013a), I could not confirm the occurrence of native biconsonantal onsets ending in consonants other than a liquid or a glide, or codas larger than one consonant. Therefore I have reclassified these languages (Canela-Krahô, Ik, Indonesian, Kala Lagaw Ya, Yagaria, and Yakut) as Moderately Complex for the current analysis.

Onset → Coda ↓	С	CC	CCC	CCCC	CCCCC	CCCCCC	CCCCCCC
(none)		2	1	1	-	-	-
С	1	22	9	1	-	-	-
CC	33	21	13	3	-	-	-
CCC	3	5	8	3	-	-	-
CCCC	4	2	4	2	-	1	-
CCCCC	1	-	-	1	-	-	1
CCCCCC	-	1	-	-	1	-	-
CCCCCCC	-	-	-	-	-	-	-
сссссссс	-	-	-	1	-	-	-

**Table 2.2.** Distribution of languages in Complex syllable structure category in Maddieson (2013a), according to the most complex onset (columns) and coda (rows) structures observed in each language.

The visual distribution of the languages in Table 2.2 is striking: most languages cluster toward the upper lefthand corner of the table. Over half of the languages in the Complex category (79/145, 54.5%) have syllable-marginal clusters of two consonants or fewer; that is, onsets and codas no more complex than a sequence of two obstruents. Though onsets of up to seven consonants and codas of up to eight consonants occur, it is very rare for a language to have more than four consonants at either margin (7/151, 4.8%).

Another interesting property of the distribution in Table 2.2 is that as cluster size increases, the cross-linguistic size asymmetry in onsets and codas appears to level out and then reverse. As discussed in Chapter 1, cross-linguistically it is more common for a language to have complex onsets than complex codas. This pattern is one of the

motivations behind the definition chosen for the Moderately Complex category in Maddieson (2013a). When smaller cluster sizes are considered, this pattern is clear even within the Complex category: languages which have three or more consonants in the onset are more common (50 languages) than languages which have these patterns in the coda (38 languages).<sup>7</sup> However, when larger clusters are considered, we find that there is a reversal of the pattern: it is *less* common for languages to have onsets of four or more consonants (15 languages) than to have codas of the same size (19 languages). Examining the specific patterns in more depth than what is presented in Table 2.2, it seems that this reversal occurs when clusters of three *obstruents* are taken as the cutoff point: 24 languages have these, or more complex clusters, as an onset, and 26 languages have these, or more complex clusters, as a coda.

The above point relates to an interesting feature of attested large onset and coda patterns, as mentioned in Chapter 1, which is that many of these structures do not exhibit the sonority-related sequencing restrictions and contours that are so common of languages with smaller onsets and codas. It is not unusual to observe tautosyllabic clusters consisting entirely of obstruents in languages with large onsets or codas (2.3)-(2.4):

<sup>&</sup>lt;sup>7</sup> Here I give the comparison for cluster sizes of three consonants or more, because a comparison within the Complex category using cluster sizes of two consonants or more is complicated by the fact that many languages with biconsonantal onsets are classified as Moderately Complex due to the way the categories are defined.
(2.3) Cocopa (*Hokan*; United States, Mexico) *pştf?árw*'I hang up several (things)'

(Crawford 1966: 36)

(2.4) Itelmen (Chukotko-Kamchatkan; Russia) qsałtxtſ

'Follow!'

(Georg & Volodin 1999: 44)

Thus a common characteristic of the more extreme cases of Complex syllable structure is the presence of long sequences of obstruents. This phenomenon can also be found in Tashlhiyt, a language which is classified as having Complex syllable structure, but which descriptions list as having only simple (Ridouane 2008) or maximally biconsonantal (Puech & Louali 1999) onsets and codas. Because the language also has syllabic obstruents, it is possible to find words without vowels which consist entirely of voiceless obstruents (2.5a-b):

- (2.5) **Tashlhiyt** (*Afro-Asiatic*; Morocco)
- (a) tfsxt

'you cancelled'

(b) *tftxtst*<sup>I</sup>

'you rolled it (F)'

(Ridouane 2002: 95)

There is evidence in the literature that word-initial *onset clusters* and word-initial consonant sequences with syllabic obstruents exhibit different gestural timing patterns between the rightmost consonant and vowel. Goldstein et al. (2007) instrumentally investigated the predictions of a coupled oscillator model of syllable structure for these two different kinds of word-initial sequences. In Georgian, the timing lag between gestures associated with the rightmost consonant and the vowel decreased with larger word-initial consonant sequences, in line with the model's predictions for onset clusters. Thus word-initial consonant sequences, such as that in *tsk'riala* 'shiny clean,' can be interpreted as syllable onsets in Georgian. In Tashlhiyt, no such pattern was found with increasingly larger word-initial consonant sequences; that is, the instrumental evidence suggested that only the consonant directly adjacent to the vowel was coupled to it. Thus the initial sequence in *tsmun* '3FS-CAUS-accompany' was interpreted as being syllabified as [ts.mun]. These results, expanded and confirmed by Hermes et al. (2011), lend support to the analysis of Tashlhiyt as having simple onsets and nucleus patterns which include syllabic obstruents, rather than large onset clusters.

While the results summarized above suggest that onset clusters and word-initial consonant sequences with syllabic consonants are categorically different structures in terms of articulation, the situation is actually more complex. The Georgian data in Goldstein et al. (2007) was from two speakers, but only one speaker showed the expected effect. The other speaker had timing patterns which more closely resembled the Tashlhiyt pattern. An examination of this speaker's productions revealed the regular presence of an

epenthetic vowel between [k'] and [r] in *k'riali* 'glitter' and *fs'k'riala* 'shiny clean.' When epenthesis occurred, the decreased timing lag between the rightmost consonant and vowel was not observed; that is, the word-initial sequence of consonants was split by a syllable boundary. The authors note that epenthesis occurred in the speech of both Georgian speakers, but not always in the same forms. However, when epenthesis did occur, it was in very specific environments: when the place of articulation for C<sub>1</sub> was more posterior than that of C<sub>2</sub>. Setting aside the issue of vowel epenthesis for now,<sup>8</sup> an interesting finding from Goldstein et al. (2007) is that both timing patterns may occur for the same word-initial sequence in the same language.

A related observation regarding large tautosyllabic clusters and syllabic obstruents is that some languages are analyzed as having both in their canonical syllable structure. For example, Crawford (1966) analyzes Cocopa as having large onset clusters, such as [pst]?] in (2.3) above. In addition, he proposes that some unstressed syllables can be entirely consonantal, consisting of "an onset only or of an onset and a coda with a predictable 'murmur' vowel following the onset as phonetic peak" (1966: 34). For example, *ptfxmukáp* 'he embraced her' is syllabified as  $[p^i.t]x^a.mu.káp]$  (1966: 43; quality of 'anaptyctic' vowel determined by environment). Patterns of this sort occur in specific consonantal combinations in Cocopa, much like the Georgian results described above.

There are also a number of languages which are analyzed by one author as having large tautosyllabic clusters, and by another as having simpler syllable margins but also syllabic obstruents. Hoard (1978) gives several examples of languages from the Pacific

<sup>&</sup>lt;sup>8</sup> Of course, the issue of vowel epenthesis is an important and complex one which has obvious implications for the analysis of syllable structure; this will be discussed further in Chapter 3.

Northwest which had previously been analyzed as having large onsets and/or codas but might be better thought of as having smaller syllable margins in addition to syllabic stops and affricates (e.g. Quileute, Puget Salish, and Nez Perce). Hoard bases his analysis on impressionistic transcriptions, considering syllables to reflect "the number of audible pulses" in the form which are delineated by "relative separation or detachment" from other segments or groups of segments (1978: 59-60). Similar disagreements of analysis can be found for Piro (Arawakan; Matteson 1965, Lin 1997, Hanson 2010). Perhaps these languages are like Georgian and Cocopa above, in which different timing patterns are exhibited by different speakers or in different consonant combinations. Without experimental data it is difficult to say whether one or both analyses are correct. What is clear, however, is that it is not uncommon for the same language, when exhibiting long sequences of consonants (especially obstruents) at word margins, to be alternately described as having large tautosyllabic clusters and/or syllabic obstruents. For this reason I argue that it is appropriate to group languages of both types together in the current study.

The above approach also has some support in instrumental findings in the literature regarding the articulatory properties of consonantal nuclei. Pouplier & Beňuš (2011) found that for syllabic liquids in Slovak, the kinematic properties of the consonantal gestures did not undergo consistent changes in nucleus position. The authors conclude that in this respect, syllables with consonantal nuclei behave like consonant clusters. According to other instrumental measures, syllabic liquids exhibit timing and gestural coordination relationships with adjacent consonants which are reminiscent of

those found in onset or coda clusters, but still distinct from those found in both nonsyllabic consonant clusters and vocalic nuclei. Similarly, Fougeron & Ridouane (2008) found that /k/ in Tashlhiyt does not undergo consistent acoustic or articulatory changes when syllabic. However, it does exhibit consistent and stable patterns of temporal alignment and coordination relationships with flanking consonants which are, as noted in the discussion of Goldstein et al. (2007) above, similar to those expected for onsetnucleus-coda patterns. Thus the instrumental evidence point to syllabic consonants as phenomena which exhibit some of the coordination properties of vocalic nuclei, but maintain the articulatory properties of non-syllabic consonants.

Motivated by all of the observations above — the distribution of languages in Table 2.2, three-obstruent clusters as the locus of the reversal of the onset/coda asymmetry, and the similar patterns observed in languages with large tautosyllabic obstruent clusters and those with syllabic obstruents — I define Highly Complex syllable structure as follows:

**Highly Complex**: languages in which the maximal onset or coda consists of three obstruents, or four or more consonants of any kind; and/or syllabic obstruents occur, resulting in word-initial or -final sequences of three or more obstruents.

Table 2.3 shows how the 486 languages in Maddieson (2013a) are distributed with the addition of the Highly Complex category as defined above. The definition of the Complex category is adjusted accordingly, and the Simple and Moderately Complex

Syllable Structure Complexity	N languages	Percentage
Simple	61	12.6%
Moderately Complex	280	57.6%
Complex	108	22.2%
Highly Complex	37	7.6%

categories are defined as in the previous work.

**Table 2.3.** A reanalysis of the data in Maddieson (2013a), with the added category of Highly Complex as defined in the current work. Note that 6 languages which were coded as Complex in the original sample have been coded as Moderately Complex here.

While the structural divisions between the syllable structure complexity categories are not evenly distributed, they capture predominant cross-linguistic patterns and serve the specific aims of the current study. These categories provide a four-point scale by which syllable structure complexity can be correlated with other structural features. The Highly Complex category is also defined in such a way as to include the extreme end of the syllable structure complexity cline, but not so narrowly as to introduce extreme genealogical and areal bias into this group. This will allow for meaningful examination, both quantitative and qualitative, of the characteristics of this group of languages.

### **2.3** Constructing the language sample

Three major criteria shaped the design of the language sample for this study: (i) the size of the sample must be large enough for meaningful quantitative analysis, but

small enough for in-depth qualitative analysis of the languages with highly complex syllable structure; (ii) the proportional representation of the four syllable structure complexity categories must be similar enough to allow for meaningful comparisons between the groups, and (iii) as per the discussion of bias in typological studies in §2.1, the sample should be both genealogically and areally diverse, and include coding for other observed types of bias.

Addressing the first criterion, it was decided that a sample size of approximately 100 languages would be appropriate for investigating the research questions of this study. Though the size of this sample does not approach that of the variety samples used in larger-scale phonological surveys such as Maddieson (2013a), Moran et al. (2014), or van der Hulst et al. (2010), it is comparable to the sample sizes used in phonological typological studies such as Bateman (2007) and Bybee & Easterday (under review), which have both quantitative and qualitative components. Furthermore, in the ideal case in which the languages of the sample are divided evenly among the four syllable structure complexity categories defined above - Simple, Moderately Complex, Complex, and Highly Complex - a 100-language sample would yield 25 languages in the Highly Complex category, a number that is manageable for the heavier qualitative analysis that languages of this type will be subjected to.

A sample size of 100 languages is moderate for a study of phonological typology. Therefore, following the second and third criteria above, building as much structural, geographical, and genealogical diversity as possible into the 100-language sample itself is important for the purposes of both statistical analysis and broader qualitative

interpretation of results. Ideally, the resulting language sample would be equally representative of each of the four syllable structure complexity categories defined above. Within each of those groups, all six geographical macro-regions as defined by Dryer (1989, 1992) would be roughly equally represented. Additionally, as discussed in §2.1.3, the genealogical diversity of the sample would be maximized to the greatest extent possible while also including some related pairs of languages with different syllable structure complexity as 'test cases' in which to examine hypotheses.

Of course, the actual distribution of languages and language structures in the world is such that the ideal sample presented above is impossible to construct. The largest obstacle in doing so is the issue of syllable structure complexity itself. As mentioned above, there is a strong areal component to the distribution of syllable structure complexity in the languages of the world. Additionally, the languages of the world are not equally distributed among the four categories of syllable structure complexity as defined in this study. Languages in the Simple and Highly Complex categories are particularly rare, as illustrated in Table 2.3. A combined result of these facts is that the distribution of languages among the four syllable structure complexity categories differs widely from region to region. For example, the macro-region of South America has a relatively high proportion of languages in the Simple category (in Maddieson 2013a, this proportion is 20/65, or 31% of the languages in the region). The macro-region of Eurasia, on the other hand, has relatively high proportions of languages in the Complex and Highly Complex categories (a combined 54/73, or 74% of the languages in the region in Maddieson 2013a). Such skewed distributions no doubt owe to genealogical factors as well: in

Eurasia, the proportion of Complex and Highly Complex patterns is augmented at least in part by languages from the large Indo-European family.<sup>9</sup>

Another practical issue in constructing the current sample is the availability, level of description, and consistency of existing language references. In general, languages whose references give explicit descriptions of syllable structure and other phonetic and phonological phenomena were chosen for inclusion over those whose descriptions of these features are partial or lacking entirely. In particular, languages for which instrumental phonetic data exists were preferred for inclusion in the Highly Complex category. The existence of several highly inconsistent descriptions of the same language was generally grounds for exclusion of that language from the sample; where descriptive inconsistencies were minor or clearly due to dialectal or historical factors, the reference written in greater detail or providing more data to support the analysis was preferred. In some cases a language whose reference materials are not ideally thorough was included in the sample because it provided a rare example of an infrequent syllable structure pattern in the region (e.g., Doyayo, a language with Highly Complex syllable structure in the African macro-region).

In constructing the language sample for this study, I attempted to strike a reasonable balance between the ideal sample composition and the many practical considerations described above. The resulting sample is described in the following section.

<sup>&</sup>lt;sup>9</sup> The 24 Indo-European languages included in the survey of Maddieson (2013a) are distributed into four categories of syllable structure complexity as follows. Moderately Complex: four languages; Complex: 14 languages; Highly Complex: six languages. None of the languages have Simple syllable structure.

# 2.4 Language sample for dissertation

The language sample includes 22 languages in the Simple category, 27 languages in the Moderately Complex category, 27 languages in the Complex category, and 24 languages in the Highly Complex category. Tables 2.4-2.7 list the languages of the sample by syllable structure complexity, geographical macro-region, and genealogical affiliation. A more detailed list which includes ISO 639-3 codes, speaker populations, and language endangerment and development status, can be found in Appendix A.

Region	Language	Family	Genus	
	Hadza	(isolate)		
	Toro So	Dogon	Dogon	
AFRICA	Grebo (Southern)	Mande	Western Mande	
	Yoruba	Niger-Congo	Defoid	
	Southern Bobo Madaré	Niger-Congo	Kru	
	Savosavo	Solomons East Papuan	Savosavo	
AUSTRALIA	Kewa (Eastern)	Trans-New Guinea	Engan	
& NEW GUINEA	Koiari	Trans-New Guinea	Koiarian	
	Rotokas	West Bougainville	West Bougainville	
Norma	Jemez	Kiowa-Tanoan	Kiowa-Tanoan	
NORTH America	Mixtec (Pinotepa)	Oto-Manguean	Mixtecan	
	Ute	Uto-Aztecan	Numic	
	Urarina	(isolate)		
Course	Warao	(isolate)		
SOUTH America	Apurinã	Arawakan	Purus	
	Karajá	Macro-Ge	Karajá	
	Cubeo	Tucanoan	Tucanoan	
Southeast Asia & Oceania	Tukang Besi (North)	Austronesian	Celebic	
	Maori	Austronesian	Oceanic	
	Nakanai	Austronesian	Oceanic	
	Rukai (Budai)	Austronesian	Rukai	
	Yi (Nuosu)	Sino-Tibetan	Burmese-Lolo	

**Table 2.4.** Languages in **Simple** syllable structure category, by macro-region and genealogical affiliation.

Region	Language	Family	Genus	
	Hausa	Afro-Asiatic	West Chadic	
	Fur	Fur	Fur	
AFRICA	Nkore-Kiga	Niger-Congo	Bantoid	
	Ewe	Niger-Congo	Kwa	
	Kanuri	Saharan	Western Saharan	
	Alyawarra	Pama-Nyungan	Central Pama-Nyungan	
AUSTRALIA	Kamasau	Torricelli	Marienberg	
& NEW GUINEA	Selepet	Trans-New Guinea	Finisterre-Huon	
	Maybrat	West Papuan	North-Central Bird's Head	
	Mangghuer	Altaic	Mongolic	
	Kharia	Austro-Asiatic	Munda	
Eurasia	Telugu	Dravidian	South-Central Dravidian	
	Darai	Indo-European	Indic	
	Khanty (Eastern)	Uralic	Ugric	
	Karok	(isolate)		
North	West Greenlandic	Eskimo-Aleut	Eskimo	
America	Choctaw	Muskogean Muskogean		
	Slave (Hare)	Na-Dene	Athapascan	
	Carib	Cariban	Cariban	
South	Ngäbere	Chibchan	Guaymiic	
America	Quechua (Imbabura)	Quechuan	Quechuan	
	Cocama	Tupian	Tupi-Guaraní	
	Pacoh	Austro-Asiatic	Katuic	
	Ilocano	Austronesian Northern Luzon		
SOUTHEAST ASIA & Oceania	Kim Mun (Vietnam)	Hmong-Mien Hmong-Mien		
	Cantonese	Sino-Tibetan	Chinese	
	Lao	Tai-Kadai Kam-Tai		

**Table 2.5.** Languages in **Moderately Complex** syllable structure category, by macroregion and genealogical affiliation.

REGION	Language	Family	Genus	
	Kotoko (Makary)	Afro-Asiatic	Biu-Mandara	
	Dizi (Central)	Afro-Asiatic	Dizoid	
AFRICA	Ingessana	Eastern Sudanic	Eastern Jebel	
	Lunda	Niger-Congo	Bantoid	
	Diola-Fogny	Niger-Congo	Northern Atlantic	
	Mangarrayi	Mangarrayi-Maran	Mangarrayi	
	Nimboran	Nimboran	Nimboran	
AUSTRALIA & NEW GUINEA	Bardi	Nyulnyulan	Nyulnyulan	
	Oksapmin	Oksapmin	Oksapmin	
	Ungarinjin	Worrorran	Worrorran	
	Basque	(isolate)		
	Burushaski	(isolate)		
Eurasia	Nivkh (West Sakhalin)	(isolate)		
	Bashkir	Altaic	Turkic	
	Ket	Yeniseian	Yeniseian	
Nonth	Pech	Chibchan	Paya	
AMERICA	Aguacatenango Tzeltal	Mayan	Mayan	
	Lakhota	Siouan	Core Siouan	
	Kadiwéu	Guaicuruan	Kadiweu	
South	Apinayé	Macro-Ge	Ge-Kaingang	
AMERICA	Mamaindê	Nambikuaran	Nambikuaran	
	Chipaya	Uru-Chipaya	Uru-Chipaya	
	Sre (Kơho)	Austro-Asiatic	Bahnaric	
Southeast Asia & Oceania	Lelepa	Austronesian	Oceanic	
	Ma'ya	AustronesianSouth Halmahera - WNew Guinea		
	Lepcha	Sino-Tibetan	Lepcha	
	Chepang	Sino-Tibetan	Mahakiranti	

**Table 2.6.** Languages in **Complex** syllable structure category, by macro-region and genealogical affiliation.

REGION	Language	Family	Genus	
AEDICA	Tashlhiyt	Afro-Asiatic	Berber	
AFRICA	Doyayo	Niger-Congo	Adamawa	
	Kunjen	Pama-Nyungan	Northern Pama-Nyungan	
AUSTRALIA	Alamblak	Sepik	Sepik Hill	
& NEW GUINEA	Wutung	Skou	(uncertain)	
	Menya	Trans-New Guinea	Angan	
	Itelmen	Chukotko-Kamchatkan	Southern Chukotko- Kamchatkan	
	Albanian (Tosk)	Indo-European	Albanian	
Eurasia	Polish	Indo-European	Slavic	
	Georgian	Kartvelian	Kartvelian	
	Lezgian	Nakh-Daghestanian	Lezgic	
	Kabardian	Northwest Caucasian	Northwest Caucasian	
	Passamaquoddy- Maliseet	Algic	Algonquian	
	Сосора	Hokan	Yuman	
North	Mohawk	Iroquoian	Northern Iroquoian	
AMERICA	Sahaptin (Yakima)	Penutian	Sahaptian	
	Thompson	Salishan	Interior Salish	
	Tohono O'odham	Uto-Aztecan	Tepiman	
	Nuu-chah-nulth	Wakashan	Southern Wakashan	
	Camsá	(isolate)		
South America	Qawasqar	Alacalufan	Alacalufan	
	Piro	Arawakan Purus		
	Tehuelche	Chon Chon Proper		
Southeast Asia & Oceania	Semai	Austro-Asiatic	Aslian	

**Table 2.7.** Languages in **Highly Complex** syllable structure category, by macro-region and genealogical affiliation.

### 2.4.1 Areal features of sample

The 100 languages are roughly evenly distributed among the six geographical macro-regions as defined by Dryer (1989, 1992).<sup>10</sup> Africa, Australia & New Guinea, North America, and South America are represented by 17 languages each. Two regions, Eurasia and Southeast Asia & Oceania, are represented by 16 languages each. See Figure 2.1 for a plotted map of the languages of the sample.



**Figure 2.1.** Geographic distribution of languages in the sample, with colors denoting syllable structure complexity. S=Simple, MC=Moderately Complex, C=Complex, HC=Highly Complex.

Major asymmetries in the areal representation of syllable structure complexity in

the sample are as follows. In Eurasia, the Simple category is unrepresented. In Africa and

<sup>&</sup>lt;sup>10</sup> The geographical macro-regions are specifically defined as follows (Dryer 1989: 268; 1992: 83, 133-5). **Africa**: continent of Africa, including Semitic languages of southwest Asia. **Australia & New Guinea**: Australian continent and Melanesia, excluding Austronesian languages of Melanesia. **Eurasia**: Eurasian landmass, excluding Semitic and languages from families of southeast Asia as defined below, and including the Munda languages of Austro-Asiatic. **North America**: North American continent, including languages of Mexico, Mayan and Aztecan languages in Central America, and some branches of Chibchan-Paezan. **South America**: South American continent, including languages of Central America except Mayan and Aztecan languages, and some Chibchan-Paezan branches. **Southeast Asia & Oceania**: Southeast Asian region, including all Sino-Tibetan, Tai-Kadai, Hmong-Mien, and Austro-Asiatic languages excluding Munda, and Oceania region (Austronesian languages).

Southeast Asia & Oceania, the Highly Complex category is underrepresented, accounting for only two and one of the languages in those regions, respectively. In North America, the Highly Complex category is relatively overrepresented, accounting for 7/17 languages, but the size of the Complex category has been reduced to three languages in an attempt to provide more balance in the language sample for this region.

#### 2.4.2 Genealogical features of sample

The 100 languages of the sample belong to 68 different language families.<sup>11</sup> 55 of the language families are represented by one language each; this figure includes eight language isolates (Basque, Burushaski, Camsá, Hadza, Karok, Nivkh, Urarina, and Warao). Another six language families — Altaic, Arawakan, Chibchan, Macro-Ge, Pama-Nyungan, and Uto-Aztecan — are represented in the sample by two languages each. The remaining seven language families are represented as follows: Indo-European by three languages; Afro-Asiatic, Austroasiatic, Sino-Tibetan, and Trans-New Guinea by four languages; and Niger-Congo and Austronesian each by seven languages. All of the language families represented by more than two languages in the sample are within the top ten in the world by size in number of languages (Lewis et al. 2016). Every attempt was made to maximize the diversity of genera within language families represented by more than one language in the sample; however, due to the uneven areal and genealogical distribution of syllable patterns this was not always possible. The genera represented by

<sup>&</sup>lt;sup>11</sup> For family and genus affiliations, I use the genealogical classifications listed in the World Atlas of Language Structures Online (Dryer & Haspelmath 2013) In these classifications, the genus unit is "roughly comparable to the subfamilies of Indo-European, like Germanic and Romance" (Dryer 1989). It should be noted that other classifications, such as those given in Ethnologue 19 (Lewis et al. 2016) and Glottolog 2.7 (Hammarström et al. 2016), may give different affiliations for some languages.

more than one language in the sample are Bantoid (Niger-Congo family, two languages), Oceanic (Austronesian family, three languages) and Purus (Arawakan family, two languages). There are no pidgins or creoles in the sample.<sup>12</sup>

Most often, a language family is represented by only one language within a syllable structure complexity category. In the Highly Complex category, only Albanian and Polish come from the same language family (Indo-European); the other 22 languages are each from different families. The Simple category is somewhat less genealogically diverse than the others, with only 17 families represented by the 22 languages. Four of these languages are from the Austronesian family, with two from the same genus (Maori and Nakanai, both Oceanic).

As mentioned in §2.1.3, the relatedness of some of the languages in the sample may prove useful for testing some of the hypotheses of this study. In each region, there is at least one pair of related languages with very different syllable structure. A list of pairs of related languages in the sample which are separated by more than one degree of syllable structure complexity can be found in Table 2.8.

<sup>&</sup>lt;sup>12</sup> There is ongoing debate on whether Cocama may be appropriately classified as a creole. While the language is typically classified as Tupi-Guaraní, it is quite divergent from other languages of the family in aspects of its phonology and morphosyntax, perhaps owing to factors of language contact. See Vallejos Yopán (2010) for a critical discussion of this topic.

Region	Syllable structure complexity	Language	Family	Genus
Africa	Simple Highly Complex	Yoruba Doyayo	Niger-Congo	Defoid Adamawa
Australia	Simple	Koiari	Trans-New Guinea	Koiarian
& New Guinea	Highly Complex	Menya		Angan
Eurasia	Moderately Complex Highly Complex	Darai Albanian	Indo-European	Indic Albanian
North	Simple	Ute	Uto-Aztecan	Numic
America	Highly Complex	Tohono O'odham		Tepiman
South	Simple	Apurinã	Arawakan	Purus
America	Highly Complex	Piro		Purus
SOUTHEAST ASIA	Simple	Maori	Austronesian	Oceanic
& OCEANIA	Complex	Lelepa		Oceanic

**Table 2.8.** Pairs of related languages in the sample which are separated by more than one degree of syllable complexity. The Niger-Congo, Trans-New Guinea, and Austronesian families are represented by more than one language with Simple syllable structure. In all three cases I have chosen to include in the table the language which is proposed to be more closely related to the language with more complex syllable structure.

### 2.4.3 Sociolinguistic features of sample

Speaker population of the languages in the sample, broken down by category of

Syllable structure complexity category	Range of speaker populations	Median speaker population
Simple (N=22 lgs.)	920-19,043,700	11,750
Moderately Complex (N=27 lgs.)	12-74,244,300	150,000
Complex (N=27 lgs.)	12-1,245,990	4,000
Highly Complex (N=24 lgs.)	5-40,248,740	3,770

syllable structure complexity, can be found in Table 2.9.

**Table 2.9.** Speaker population by category of syllable structure complexity. Population data has been taken from Ethnologue 19 (Lewis et al. 2016) except for where noted otherwise in Appendix A.

The speaker populations for the languages of the sample vary widely, ranging from five for Tehuelche (Chon, Patagonia) and Yakima Sahaptin (Sahaptian, Pacific Northwest) to 74,244,300 for Telugu (Dravidian, Southern India). The median speaker population for the entire sample is 11,100.<sup>13</sup> Sixteen of the languages in the sample have a speaker population of over one million. Twenty-four of the languages have fewer than 1,000 speakers. Nine languages have fewer than 100 speakers, and five of these are languages in the Highly Complex category. In general, the languages in the Simple and Moderately Complex categories have larger speaker populations than those in the Complex and Highly Complex categories, though there are many exceptions to this trend, and the language sample size is too small to make definitive claims in this regard. The prevalence of very smaller speaker populations for languages in the Highly Complex category is no doubt related to issues of language endangerment, which will be discussed below.

The Expanded Graded Intergenerational Disruption Scale (EGIDS) is an assessment of language vitality developed by Lewis and Simons (2010), following work by Fishman (1991), UNESCO (Brenzinger et al. 2003), and others. It considers many different factors of language use, including rates and means of intergenerational transmission, domains of language use, and official recognition of the language. Using EGIDS as a starting point, Ethnologue (Lewis et al. 2016) has developed a coarse-grained estimate of the relative development versus endangerment of languages. By this measure,

<sup>&</sup>lt;sup>13</sup> By comparison, the median number of speakers for all known living languages is 7,000 (Lewis et al. 2016).

languages are classified into categories according to their development status:

	Language development status				
Syllable structure complexity category	(N languages)				
	Institutiona l	Developing	Vigorous	In Trouble	Dying
Simple (N=22 lgs.)	4	6	6	6	-
Moderately Complex (N=27 lgs.)	9	7	1	8	2
<b>Complex</b> (N=27 lgs.)	4	6	4	7	6
Highly Complex (N=24 lgs.)	5	7	1	5	6

Institutional, Developing, Vigorous, In Trouble, and Dying.<sup>14</sup>

**Table 2.10.** Development status of languages in sample, by category of syllable structure complexity. Data on language development has been taken from Lewis et al. (2016).

Table 2.10 shows how the languages of the sample are classified into levels of language development. 60 of the languages in the sample have strong vitality, belonging to the Institutional, Developing, or Vigorous categories. The remaining 40 languages, belonging to the In Trouble and Dying categories, are highly endangered, moribund, or nearly extinct. Language development status is not evenly distributed in the sample. Languages with robust language development status are more common in the Simple and Moderately Complex portions of the sample. The Highly Complex category has the

<sup>&</sup>lt;sup>14</sup>The language development categories are defined as follows (Lewis et al. 2016). **Institutional:** language has wide use in the home and community and official status at educational, provincial, national, and/or international levels. **Developing:** language is used in the home, community, and sometimes broader contexts, and in initial stages of developing a system of writing and standardization. **Vigorous:** language is used in the home and community by speakers of all generations, but has not yet developed a system of graphization or standardization. **In Trouble:** language is currently in the process of losing intergenerational transmission, with the community shifting to other languages for daily use, but there are still speakers of child-bearing age. **Dying:** language has lost intergenerational transmission entirely, all fluent speakers are above child-bearing age.

highest percentage of languages classified as Dying (25%, which is just marginally higher than 22% for the Complex category). Due to the small sample size, it is possible that these rates, like the population figures described above, may not be accurately reflective of language endangerment and syllable structure complexity on a global scale. However, it should be noted that in North America, which has perhaps the highest proportion of languages with Highly Complex patterns of all the macro-regions, rates of language endangerment and language loss are extreme. Ethnologue 19 classifies 238/256 (92%) of the living languages spoken north of the US-Mexico border in North America as In Trouble or Dying (Lewis et al. 2016).

The sociolinguistic features of the language sample lead to an interesting observation: highly complex syllable structure is a rare language feature by many different measures, including non-structural ones. As noted in Chapter 1, highly complex syllable patterns are often treated as anomalies and theoretical outliers, especially when occurring in underdescribed non-Eurasian languages with little sociopolitical power. A very small proportion of the world's languages have structures of this kind. It would also seem that languages with these structures tend to have very small speaker populations, unless the language happens by historical accident to have Institutional (e.g., Polish, Georgian) or Developing status (e.g., Tashlhiyt, Kabardian). A related fact is that a large proportion of languages with highly complex syllable structure are highly endangered. Thus highly complex syllable structure seems to be a marginalized pattern in theoretical, descriptive, historical, and social terms. This is all the more reason to dedicate a typological study to this linguistic feature.

## 2.5 Data collection

Information about the languages in the sample was collected from published reference grammars, phonetic and phonological studies, and other relevant language descriptions. In a few cases, an expert researcher on the given language was additionally consulted. Data was collected with the guidance of coding sheets whose questions were designed to address the research questions and hypotheses of each chapter. As the methodology behind the coding of the data differs for each part of the dissertation, it will be discussed separately within each chapter.

Because the language references consulted were written in different time periods and reflect different descriptive practices, they use a variety of transcription standards. Using the phonetic descriptions of sounds in the language references, I have transcribed all phoneme inventories and phonetic and phonemic transcriptions into International Phonetic Alphabet (IPA) symbols. Where there is some ambiguity in interpreting the phonetic description provided by the source consulted, I have noted this in Appendix B. In the examples given in this chapter and throughout the dissertation, I have replaced any non-IPA symbols with their IPA counterparts.

#### CHAPTER 3:

#### SYLLABLE STRUCTURE PATTERNS IN SAMPLE

This chapter presents an analysis of properties of syllable structure in the language sample for the dissertation. In §3.1 I discuss common topics of research in cross-linguistic studies of syllable structure and specific considerations in the current study. In §3.2 I describe the methodology and coding strategies employed in the current study. In §3.3 I present results on onset, coda, and nucleus patterns, as well as morphological constituency patterns in maximum clusters, for the language sample as a whole. In §3.4 I analyze in greater detail the syllable patterns of the languages in the sample with Highly Complex syllable structure. In §3.5 I summarize the findings and relate them to following chapters.

### **3.1 Introduction**

### **3.1.1** Cross-linguistic studies of syllable structure

A common approach to studying syllable structure on a cross-linguistic scale is to compare canonical syllable patterns across languages. This is the range of occurring syllable patterns in a language represented as a sequence of Cs for consonants and Vs for vowels, with parentheses indicating optional components of the onset, nucleus, and coda (e.g., (C)(C)(C)(C)(C)(C)(C)(C))(C) for English). Many databases of phonological patterns include canonical syllable structure as one of the coded features along with consonant and vowel phoneme inventories; e.g., the World Phonotactics Database (Donohue et al. 2013), LAPSyD (Maddieson et al. 2013), and a modified version of the WALS 100language sample presented in Gordon (2016). Though it is a very general measure, the size and shape of canonical syllable patterns can be used to categorize languages in such a way as to capture predominant global trends (cf. Maddieson 2013a and the current project).

More often, cross-linguistic studies of syllable patterns are focused on finergrained aspects of syllable structure, including sub-syllabic constituents. A number of studies investigating the properties of syllable margins have revealed trends regarding the size, voicing, place, manner, and sonority of consonant sequences in the onset and coda, as well as implications regarding the makeup of onset and coda inventories (cf. Greenberg 1965/1978, see Chapter 1). Large-scale studies of syllable margins are typically limited to biconsonantal clusters, as these are cross-linguistically the most frequent cluster type, but larger clusters have been explored as well (VanDam 2004, and a few of the analyses in Greenberg 1965/1978). A few typological studies of cluster patterns focus specifically on implicational relationships in obstruent clusters. For instance, Morelli (1999, 2003) examines implicational relationships in biconsonantal onsets composed of stops and fricatives in 30 languages, finding that fricative-plosive sequences are cross-linguistically more frequent than all other obstruent combinations. Kreitman (2008) investigates implicational relationships among obstruent clusters of mixed voicing, proposing that the occurrence of voiced-voiceless onsets implies the occurrence of voiceless-voiceless onsets and voiceless-voiced ones. There are also studies which examine the patterns of simple onsets and codas; for example, Rousset (2004)

compares, among other things, the relative proportion of consonants which occur in onset versus coda position in 15 diverse languages. Nucleus patterns have also been a topic of typological investigation, with much of the research emphasizing the sonority-based implications that can be gleaned from global distributions of syllable nuclei patterns (Blevins 1995, Zec 2007). As discussed in §1.2.2.4, Bell (1978a) explores global and areal patterns of syllabic consonants in a sample of 182 diverse languages, deriving implicational generalizations regarding the manner and place of articulation of such sounds. Hoard (1978) is a survey of syllabic obstruent patterns in languages of the Pacific Northwest and Northwest Plateau regions of North America, and includes analyses of data from five diverse languages as well as brief references to others.

Relationships among the different constituents of the syllable have also been investigated cross-linguistically. An analysis of syllable frequencies in the lexicons of five languages revealed that simple onsets and nuclei — CV sequences — may combine relatively freely (Maddieson & Precoda 1992). By contrast, relationships between other pairs of subsyllabic constituents tend to show more restrictions across languages. Onsets and codas have often been treated independently of one another with respect to their internal patterns and relationships to the larger syllable; however, Davis & Baertsch (2011) show that the coda and the second member of a biconsonantal onset are often restricted to the same subset of consonants in a language. Similarly, Blevins (2006) observes that languages with only open syllables tend to have optional onsets. Gordon (2006) investigates the wide range of behavior exhibited by languages with respect to issues of syllable weight, which may be dependent upon complex combinations of

nucleus and coda patterns, and minimal requirements for root and/or word structures, which may consider onset patterns in addition to those of the rime.

Many researchers have investigated the properties of syllables in contact with one another or within the context of larger domains. Cross-linguistically, syllabification patterns are such that sonority tends to fall from the coda of one syllable to the onset of the next; this observation is supported by evidence from diachronic processes of sound change in various languages (Hooper 1976, Murray & Vennemann 1983). Syllable margins can also exhibit differing patterns with respect to their position within larger domains. Côté (2011) observes cross-linguistic asymmetries in coda patterns in final versus medial position in stem, word, and phrasal domains. Similarly, 'prominent' environments such as word- and phrase-initial syllables and stressed syllables are often the locus of the highest amount of phonemic contrast and variety in syllable margins in a language, though there are areal exceptions to this global trend. For example, Gasser & Bowern (2014) note more onset restrictions in word-initial as compared to word-internal position in Australian languages.

Cross-linguistic studies also investigate the distribution of syllable types within syllable inventories, lexicons, and words of varying lengths in order to determine frequency patterns and uncover implicational hierarchies. The presence of VC structures in a language, for example, generally implies the presence of V, CV, and CVC structures as well (Blevins 1995). Frequency distributions of syllable types in the lexicons of diverse languages reveal a heavy cross-linguistic dominance of the CV type, despite wide variation in canonical syllable structures (Rousset 2004, Vallée et al. 2009). There is also

evidence of a relationship between syllable length and word length. Fenk & Fenk-Oczlon (1993) tested Menzerath's Law (paraphrased as 'the bigger the whole, the smaller the parts') in a sample of 29 languages and found a significant negative linear correlation between the number of syllables per word and the number of phonemes per syllable.

Another facet of syllable structure that has received cross-linguistic treatment is that of the morphological constituency of clusters at syllable margins. Several of the studies listed above (e.g., Greenberg 1965/1978, Morelli 1999, Kreitman 2008) exclude morphologically complex clusters from analysis on the assumption that these clusters may exhibit different patterns than clusters found within the boundaries of a single morpheme. Dressler & Dziubalska-Kołaczyk (2006) examine syllable patterns in a sample of four Indo-European languages and propose two types of clusters defined by morphological constituency: phonotactic clusters, which are phonologically motivated and tautomorphemic, and morphonotactic clusters, which come about through morphological processes. They conclude that the latter are often longer and more marked in comparison to the former.

### **3.1.2** Considerations in the current chapter

While all of the above issues are important in developing a detailed understanding of cross-linguistic syllable patterns, for practical purposes the current study is limited to exploring just a few of these in depth. In this chapter I investigate issues of syllable structure that are directly pertinent to addressing the main research questions and hypotheses of the dissertation. Specifically, I limit the scope of analysis here to features

of syllable structure which have been previously demonstrated or hinted in the literature to be correlated with other linguistic, and especially phonological, features, and those which I hypothesize may reveal clues about the diachronic development of highly complex syllable structure. Additionally, I examine the syllable patterns of the languages in the Highly Complex portion of the sample in greater detail than the other categories, in order to develop a better understanding of the coherence of that group. The features under consideration are listed in (3.1)-(3.2):

#### (3.1) Features examined for entire sample

- (a) *Canonical syllable patterns*
- (b) *Nucleus patterns*
- (c) Morphological constituency of maximum syllable margins and syllabic consonants
- (3.2) Features examined for languages in the Highly Complex category
- (a) Specific Highly Complex syllable patterns occurring
- (b) *Restrictions on Highly Complex syllable patterns*
- (c) *Relative frequency of Highly Complex patterns within languages*
- (d) Phonetic characteristics of Highly Complex clusters

The coding of feature (3.1a), canonical syllable structure, is motivated by previous findings in the research. As mentioned in Chapter 1, positive correlations have been established between syllable structure complexity (defined categorically with

reference to canonical syllable structure) and consonant phoneme inventory size (Maddieson 2013a). A positive relationship has also been established between syllable structure complexity and the number of consonants belonging to certain classes within a language (Maddieson et al. 2013). Gordon (2016) has demonstrated that the trend by which consonant phoneme inventory size increases with syllable complexity occurs on a more fine-grained scale as well, when complexity is measured as the combined sum of canonical onset and coda constituents. Along another line of inquiry, Blevins (2006: 336) has described a cross-linguistic tendency by which languages without codas tend to have optional onsets. This suggests a relationship between obligatoriness of constituents and canonical syllable structure patterns which, to my knowledge, has not been investigated in a language sample controlled for syllable structure complexity.

Nucleus patterns (3.1b), and syllabic consonant patterns more specifically, have also been suggested in the literature to bear some relation to syllable structure complexity. On the one hand, the holistic phonological typology proposed by Isačenko (1939/1940) predicts that 'vocalic' languages — those which have simpler consonant sequences and relatively higher vowel/consonant ratios — are more likely to develop syllabic consonants than 'consonantal' languages. This suggests that we might expect a greater prevalence of syllabic consonants in languages of the Simple and Moderately Complex categories. On the other hand, Bell (1978a) notes that syllabic consonants often come about through vowel deletion, often in unstressed syllables, which is also known to be a common source of consonant clusters. Based on that observation, we might expect a higher occurrence of syllabic consonants in languages with Complex or Highly Complex syllable structure. The way that the language sample is constructed allows us to test these predictions directly. My hypothesis, rooted in the discussion of speech rhythm typology in Chapter 1, is that the latter prediction will be borne out (3.3).

(3.3) *H*<sub>1</sub>: Languages with more complex syllable structure are more likely to have syllabic consonants.

Feature (3.1c), morphological constituency, is related to both of the issues discussed above. Greenberg (1965/1978: 250) and Dressler & Dziubalska-Kołaczyk (2006) predict that as the size of a syllable margin increases, so does the probability that it contains morpheme boundaries. Additionally, syllabic consonants are often noted to be largely or entirely restricted to grammatical particles and affixes (Bell 1978a: 159), suggesting additional potential interactions between syllable structure complexity and morphology if syllabic consonants are found to occur more frequently in languages on one end of the syllable complexity scale. In coding for (3.1c) I consider the morphological patterns of the largest syllable margins in each language, as well as the kinds of morphemes in which syllabic consonants occur in the languages which have them. These analyses will provide a rough measure of the relationship between morphology and the syllable patterns of a language, which can then be explored in greater depth at a later point, especially if the results point towards a heavy role of morphology in the development of highly complex syllable structure. My hypotheses regarding morphological constituency follow (3.4a-b):

- (3.4)
- (a) H<sub>2</sub>: As syllable structure complexity increases, so does the likelihood that the largest syllable margin types in a language will be morphologically complex.
- (b) H<sub>3</sub>: As syllable structure complexity increases, so does the likelihood that syllabic consonants occurring in a language will belong to grammatical elements.

The examination of features (3.2a-d) is intended to develop a more detailed picture of the syllable patterns of the languages in the Highly Complex portion of the sample. The purpose of this portion of the analysis is twofold: to determine whether the languages form a coherent phonological type with respect to their syllable patterns, and to gather information that may be relevant to uncovering how these structures come about over time. The specific syllable patterns falling under the definition of Highly Complex will be examined for each language and compared with those of the other languages of the group to determine how similar they are to one another. In an attempt to characterize the prevalence of Highly Complex syllable patterns within each language, restrictions on the patterns will be examined for each language. Finally, descriptions of the phonetic characteristics of Highly Complex syllable structures will be noted and compared.

Apart from those which are aimed at testing the two specific hypotheses listed above, the analyses in this chapter are largely exploratory in nature. The findings here are intended to provide a baseline characterization of the syllable patterns of the four categories of the language sample. Additionally, the in-depth examination of the Highly Complex portion of the sample will serve as a point of reference in which to ground the results of later chapters.

## 3.2 Methodology

### **3.2.1 Patterns considered**

As discussed in Chapter 1, interpretations of syllable patterns may vary dramatically according to the theoretical framework which is used. For example, even simple coda consonants and biconsonantal onsets, both cross-linguistically common patterns, are problematic in a strict CV approach, which must posit empty nuclei for phonetic occurrences of these structures (cf. Rowicka 1999). Though less restrictive models of the syllable may accept small onset and coda clusters, large clusters and syllabic obstruents are typically considered problematic, with members being relegated to an appendix or left entirely unsyllabified at the level of phonological representation (Vaux & Wolfe 2009, Bagemihl 1991). In their language descriptions, authors often choose a model which is compatible with the occurring syllable patterns of the language. However, some researchers work within a strict theoretical framework in which the abstract syllable structure has been predetermined, and the patterns of the language are made to fit into the model. This causes obvious complications for cross-linguistic comparison of syllable patterns.

Because such a wide range of frameworks is used by researchers in their descriptions of syllable structure, and because the choice of model may have strong

implications for the patterns reported, I opt instead to use a definition of canonical syllable structure motivated largely by the patterns observed at word margins. Here onset clusters include patterns occurring word-initially before a vowel (and, if they differ at all from word-initial patterns, patterns occurring word-internally before a vowel where syllabification is supported by language-internal evidence). Likewise, coda clusters include patterns occurring word-finally after a vowel (with the same considerations given to word-internal post-vocalic patterns). In this view, all consonants are syllabified as part of an onset or coda, or, in the case of syllabic consonants, as a nucleus. Heteromorphemic pre-/post-vocalic sequences, such as the word-initial sequence in (3.5) below, are thus considered as onset or coda patterns, in addition to tautomorphemic sequences.

### (3.5) Ma'ya (Austronesian; Indonesia)

/**t-s**o<sup>21</sup>lo<sup>3</sup>n/ 1.PL.INCL-sit 'we (incl.) sit'

(Van der Leeden 1993: 21)

Pre-/post-vocalic sequences in phonological words are also considered as syllable margins, even if they belong to separate units syntactically or orthographically (3.6).

#### (3.6) **Polish** (*Indo-European*; Poland)

z pstrągiem

/spstronjem/

'with (the) trout'

(Jassem 2003: 103)

Syllable margins reported to occur only in recent loanwords or as a result of variable phonetic processes, such as vowel elision in rapid speech, were not considered in the determination of canonical patterns, or included in the present analysis (the latter issue will be treated extensively in Chapter 6, which examines vowel reduction in the sample). Here 'canonical' is used in the sense of syllable patterns which are regular and not reported to occur in variation with other patterns. For instance, /pt/ would not be characterized as a canonical onset in American English, because it is an optional, if frequent, variant of a form which preserves the original vowel: *potato*  $[p^{h} \rightarrow t^{h} e i rou] \sim$ [p<sup>h</sup>t<sup>h</sup>errou]. Returning to the issue of abstract models of the syllable versus observed patterns, when syllable margins were described in one way at the phonological level but reported as consistently exhibiting a different pattern at the 'surface' level, the latter was taken to be representative of syllable patterns in the language. For example, sequences analyzed as clusters at an abstract level but which were invariably split by epenthesis, as illustrated by the Maybrat example below, were not considered to be canonical clusters (example 3.7; see §3.2.2 for a discussion of issues of epenthesis).

#### (3.7) Maybrat (*West Papuan*; Indonesia)

An epenthetic vowel invariably occurs between two consonants in word-initial position.
/pnem/
[panem]
'it is flat'

(Dol 2007: 35-6)

Sounds with multiple articulations or which consist of phonetic sequences, such as labialized consonants, prenasalized stops, or diphthongs, present complications for determining canonical syllable patterns, which are traditionally expressed in segmental terms. Wherever the author has presented convincing language-internal evidence for the phonological unity of such sounds, I have considered them to be single segments for the purpose of syllable structure coding. The issue of complex segments will be discussed in greater detail in Chapter 4, where I analyze the segmental inventory patterns in the language sample.

As described in §2.2, similar patterns observed in languages with large tautosyllabic obstruent clusters and those with syllabic obstruents led me to include the latter in the Highly Complex category, so long as syllabic obstruents were observed to result in word-marginal sequences of three obstruents or longer in those languages. However, syllabic obstruents were not explicitly coded as part of the onset or coda. Instead, Highly Complex patterns involving long tautosyllabic obstruent clusters and

those involving syllabic obstruents were coded differently so that these patterns could be disambiguated if necessary in later analyses. For languages with syllabic obstruents, the author's description of 'true' tautosyllabic onset and coda patterns was taken to be canonical. Separately, the largest word-marginal consonant sequences occurring as a result of syllabic obstruents in those languages were coded but not entered as maximum coda or onset structures.

It is important to note that while syllabic obstruents were considered in determining whether a language has Highly Complex syllable structure, syllabic nasals and liquids were never used as a diagnostic for membership in this or any category. The reasoning behind this is related to how these patterns are described and analyzed in the language references. Recall that syllabic obstruents and large tautosyllabic obstruent clusters often co-occur in languages, and that it is also common for the same language to be analyzed as having either pattern, to the exclusion of the other, by different authors. This was the case for a number of languages in the sample, including Chipaya, Nimboran, Piro, and Tashlhiyt: all of these languages have been reported in some descriptions to have syllabic obstruents, and in others to have larger obstruent clusters. By comparison, only two languages were described as having syllabic nasals or liquids as an alternative analysis to larger tautosyllabic clusters (Georgian and Piro). This is despite the fact that syllabic nasals and liquids are much more commonly reported in the sample than syllabic obstruents (see §3.3.3). Nasals and liquids do not seem to be as susceptible as obstruents to ambiguous or competing interpretations with respect to syllabicity. This is perhaps not surprising, given the perceptual properties of nasals and liquids.

Nevertheless, the reported patterns justify separate treatment of syllabic nasals and liquids on one hand, and syllabic obstruents on the other, in the coding of canonical syllable patterns in the sample.

### 3.2.2 Status of inserted vowels

The Maybrat example in (3.8) brings up another important issue in the analysis of syllable structure, which is the status of inserted vowels. Compare the Maybrat example, reproduced in (8), with the examples from Camsá (3.9a-b).

## (3.8) Maybrat (West Papuan; Indonesia)

An epenthetic vowel invariably occurs between two consonants in word-initial position.
/pnem/
[panem]
'it is flat'

(Dol 2007: 35-6)

# (3.9) Camsá (Isolate; Colombia)

"A nonphonemic transitional voicoid [ə] occurs between stop plus stop [...] Initial fricatives [...] have optional off-glide before nonfricative consonants at a different place of articulation."

## (a) /tkanipe/

[t<sup>a</sup>kanine]

'broken'
## (b) /ftsenga/

[futsenga]

'black'

#### (Howard 1967: 81)

There are several important differences between the descriptions of the Maybrat and Camsá examples. In the Maybrat example the vowel is described as epenthetic, while in the Camsá example it is described as a nonphonemic transitional vocoid or an offglide. In Maybrat, the process is described as invariable, while in Camsá it is described, in the case of the off-glide, as optional. Finally, in Maybrat, the epenthesized vowel is transcribed as [a], while in Camsá it is transcribed as a superscripted [<sup>a</sup>] in one case and [<sup>u</sup>] in another. These differences in the descriptions and transcription conventions suggest different phenomena. This raises the question of whether the patterns in Maybrat and Camsá should be treated separately for the purposes of syllable structure analysis.

In a typological survey of reported inserted vowel patterns, Hall (2006) makes a distinction between epenthetic vowels and intrusive vowels. She argues that the motivations for the two types of inserted vowels are quite different. The function of epenthetic vowels is to provide a nucleus to repair marked or non-occurring syllable structures in a language; that is, it has the effect of producing syllable patterns that are already attested in the language. Perhaps a textbook example of this would be the adaptation of loanwords from one language into another; e.g. English *technostress* is borrowed into Japanese as *tekunosutoresu* because the consonant clusters in the original

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form are not part of the sound pattern of the borrowing language (Kay 1995: 69). Hall states that epenthetic vowels tend to be 'visible' to phonological processes, behaving like syllable nuclei for the purposes of stress assignment and other processes, and speakers are generally aware of their presence. For example, in Mono, epenthetic vowels occur to 'repair' monomoraic lexical words:  $/3\overline{i}/ > [\overline{i}3\overline{i}]$  'tooth' (Hall 2006: 6, citing Olson 2003).

By contrast, intrusive vowels are not structurally motivated but come about through natural processes of gestural retiming and overlap, and are simply a result of the acoustic effects of these transitions. For example, in Kekchi, an intrusive vowel identical in quality to the preceding vowel may appear within final clusters consisting of a glottal stop followed by a consonant: /po?t/ > [po?ot] 'blouse' (Hall 2006: 7, citing Campbell 1974). This is analyzed not as the addition of a new vowel articulation, but as the offset of the vowel gesture carrying over the duration of the glottal stop articulation, which does not require an oral articulation, such that the effects of the vowel can still be heard between the glottal stop and the onset of the following consonant articulation. Hall states that intrusive vowels tend to be 'invisible' to such phonological processes, and speakers are typically unaware of their presence, or if they are aware, view them as optional.

The properties described above — behavior with respect to phonological processes and speaker awareness — are for Hall the primary means of determining whether an inserted vowel is epenthetic or intrusive. She argues persuasively for the use of speaker intuition in making these determinations, giving several examples of cases where the phonological behavior of a vocalic element matches the native speaker's, rather than the fieldworker's, intuitions about syllabicity. This is supported by growing evidence

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in the experimental literature that listeners are biased by the timing patterns of their own language when identifying the syllable patterns of another language (Kwon et al. 2017). However, while information regarding native speaker intuition is valuable, it is often unreported. Based on the typological patterns represented in her survey, Hall develops a set of additional features which tend to be associated with epenthesis and intrusion. Epenthetic vowels tend to have the following characteristics: (i) the vowel quality is fixed or copied from a neighboring vowel; (ii) the vowel occurs regardless of speech rate; and (iii) the vowel repairs a structure that is likely to be avoided through other processes in the same language. Intrusive vowels tend to have these characteristics: (i) the vowel quality is neutral, or influenced by the place of articulation of the surrounding consonants; (ii) the vowel is typically found in heterorganic clusters; (iii) the vowel is often optional, has variable duration and voicing, and may disappear as speech rate increases; and (iv) the vowel does not seem to have a repairing function (Hall 2006: 391).<sup>15</sup>

Returning to (3.8)-(3.9) above, we see that the Maybrat example falls under Hall's definition of epenthetic vowels, while the Camsá example falls under her definition of intrusive vowels. Further descriptions by the authors support this view. Dol presents instrumental evidence showing that epenthetic [a] is as prominent as other vowels in the language (2007: 36). Meanwhile, examples given by Howard indicate that the transitional vocoid is not counted for the purposes of stress assignment. This suggests that the

<sup>&</sup>lt;sup>15</sup> As noted by Browman & Goldstein (1992a:53), epenthetic vowels may have their origin in the intrusive elements arising from gestural organization. Hall gives several examples of historical cases of vowel epenthesis that may have started with vowel intrusion and then phonologized; e.g., Irish Gaelic *gorm* > *gorəm* 'blue' (2006: 35).

Maybrat example [panem] is best analyzed as a CV.CVC structure, while the Camsá examples [t<sup>a</sup>kanine] and [f<sup>u</sup>tsenga] are best analyzed as having initial onset clusters.

The matter of vowel intrusion is relevant to the issue of syllabic consonants as well. Recall the Cocopa example discussed in §2.2, reproduced below as (3.10).

(3.10) Cocopa (Yuman; USA and Mexico)

/ptfxmukáp/

[p<sup>i</sup>.t)x<sup>a</sup>.mu.káp]

'he embraced her'

(Crawford 1966: 43)

Crawford proposes that some unstressed syllables in Cocopa may be entirely consonantal, consisting only of an onset or onset and coda, but with a predictable 'murmur' vowel functioning as a phonetic peak in such cases (1966: 34). What is described as the murmur vowel here has properties of an intrusive vowel: its quality is determined by that of surrounding consonants, and it is transcribed as a superscript, suggesting brevity or an offglide status.

Similar descriptions of other languages in the sample suggest an association between intrusive or transitional elements and consonants analyzed as syllabic (e.g., in certain environments in Tashlhiyt; Dell & Elmedlaoui 2002). Hargus & Beavert (2006) list several languages in which arguments for consonant (specifically obstruent) syllabicity are rooted in the distribution of epenthetic vowels. Additionally, Bell (1978a: 185-6) reports that speakers are unaware of the short vocalic element associated with syllabic obstruents in Koryak, similar to reports of speaker intuition of intrusive vowels in consonant clusters. Hall notes cross-linguistic associations between vowel intrusion, aspiration (also analyzable as voiceless vowel intrusion), and syllabic consonants, and suggests that all of these phenomena are different acoustic manifestations of fundamentally similar processes of gestural overlap (2006: 413). This issue will be revisited in §3.4, when I discuss the phonetic properties of languages in the Highly Complex portion of the sample.

In coding for syllable structure patterns in the sample, I used the diagnostics proposed in Hall (2006) to determine the status of reported inserted vowels. Where possible, behavior in phonological processes and speaker intuition were used as primary diagnostics, but the other characteristics of epenthetic and intrusive vowels reported by Hall were considered as well.

# **3.2.3 Edges of categories**

After syllable patterns in the sample were determined with reference to the above criteria, these patterns were recorded and coded for analysis. First, the syllable patterns were used to classify the languages into the four categories of syllable structure complexity as defined in Maddieson (2013a) and §2.2, and reproduced here:

**Simple:** languages in which the onset is maximally one consonant, and codas do not occur.

**Moderately Complex:** languages in which the onset is maximally two consonants, the second of which is a liquid or a glide (e.g., /tr-/ or /pj-/); and/or the coda consists of maximally one consonant.

**Complex:** languages in which the maximal onset is two consonants, the second of which is a consonant other than a liquid or a glide, or three consonants, so long as all three are not obstruents; and/or the maximal coda consists of two consonants, or three consonants so long as all three are not obstruents.

**Highly Complex**: languages in which the maximal onset or coda consists of three obstruents, or four or more consonants of any kind; and/or syllabic obstruents occur, resulting in word-initial or -final sequences of three or more obstruents.

A common complication for typological work is that languages sometimes do not fall neatly into the categories defined by the researcher. Like languages themselves, linguistic features are dynamic and constantly changing form, however slowly or subtly. There is often some ambiguity at play when categorizing languages according to some structural feature, because a language may exhibit behavior characteristic of several categories. In this study I took advantage of such ambiguity in constructing the language sample in order to increase genealogical diversity or the representation of syllable structure complexity categories in some regions.

The Simple syllable structure pattern is very rare in North America. Two of the North American languages included in this category in the sample, Jemez and Ute, can be argued not to have Simple syllable structure in the strictest definition of the term. In Jemez (Kiowa-Tanoan, US Southwest), there are no complex onsets. Simple codas /ʃ/ and /l/ may occur, but in practice this happens very rarely. Codas created by the morphosyntax of the language are very rarely produced as such by speakers: for instance, word-final /ʃ/, which always corresponds to Inverse suffix /-ʃ/, is omitted from a phrasemedial noun stem unless it is followed by a vowel-initial pronominal prefix, in which case it is resyllabified as an onset (Yumitani 1998: 22-24). Coda / (/ may occur utterancefinally, but because the language is predominantly verb-final, the frequency of this pattern is expected to be rare in natural discourse (Logan Sutton, p.c.). In a 244-word text included in Yumitani (1998), there are no examples of phonetic codas in Jemez. In Ute (Uto-Aztecan, US Southwest), syllable structure is almost entirely of the shape CV(V), but a recent process devoicing unstressed vowels in the language has resulted in some invariant patterns that could be analyzed as codas or sequences of oral consonants and glottal fricatives (Givón 2011: 20-3, 28). It would appear that Ute has until recently had Simple syllable structure, but is in the process of developing more complex syllable patterns. Though neither Jemez nor Ute present uncontroversial cases of languages with Simple syllable structure, I judge their patterns to be close enough to justify their inclusion as such, thereby increasing the representation of North American languages in this category.

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Toro So (Dogon, Mali, Burkina Faso) is another language in the Simple category which has marginal Moderately Complex structures. While Bendor-Samuel et al. (1989) state that syllable structure is canonically (C)V, Hantgan (2012) reports rare sonorant codas in specific morphological paradigms. Plungian (1995: 8) reports rampant reduction of final and medial vowels in related dialect Tommo So, especially in younger speakers, suggesting that at least some codas may be a recent development in the language. In order to increase the genealogical diversity of this category in the African macro-region, I categorize Toro So as having Simple syllable structure.

On similar grounds, Eastern Khanty (Uralic, Russia) was admitted to the Moderately Complex category. The syllable patterns of this language include occasional coda clusters which are always a result of derivation or inflection in the language. Typically when this happens, vowel epenthesis is employed "robustly and productively" such that most of these sequences are not realized as clusters (Filchenko 2007: 55). However, derived coda clusters with a sonorant preceding a homorganic stop (e.g., *lol-t* 'crack, dent-PL') are sometimes retained as such. The author states that the probability of such consonant clusters occurring is extremely low. As a complex coda, this pattern falls under the definition of Complex syllable structure, but since its status in the language is extremely marginal, I place this language into the Moderately Complex category.

Piro (also known as Yine; Arawakan, Peru) was admitted to the Highly Complex category despite being a somewhat ambiguous case. Two major descriptions of Piro (Hanson 2010, Matteson 1965) describe the occurrence of biconsonantal and triconsonantal onset clusters in the language. Both describe onset clusters as being

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relatively unrestricted: "[c]onsonant clusters in Yine show enough range in attested combinations, both word-initially and word-internally, to suggest that there are no sonority-based restrictions imposed on them" (Hanson 2010: 27). Examples of biconsonantal onsets are plentiful and include combinations as varied as f(k/, sp/, and/ns/. Matteson (1965: 24) gives few examples of triconsonantal onsets and states that the very low frequency of these shapes had decreased in comparison to a count made a decade previously. However, Hanson, writing 45 years later, writes that "words beginning" with three consonants in a sequence are very common" (2010: 27). She describes these clusters as resulting from the affixation of a Class 2 pronominal prefix (/n-/, /p-/, /t-/, /w-/, /h-/) to a stem beginning with a biconsonantal cluster; e.g. /p-knoya-te/ 'your tortoise' (2010: 26). Other examples given include /pcr/, /nmtf/, and /ntfk/, but there are no explicit examples of three-obstruent clusters listed. Whether this is due to nonoccurrence is unclear, and the conflicting descriptions of the frequency of triconsonantal clusters does not help shed light on the issue. Nevertheless, I include this language in the Highly Complex category to increase representation of the category in the South American portion of the sample, acknowledging that it may be a very marginal case.

#### 3.2.4 Coding

The analyses described in §3.2 were conducted as part of the process of constructing the language sample (Chapter 2). After the sample was constructed, more specific information on syllable structure was collected for each language, and coded as described below:

Size of maximum onset: in number of Cs

Size of maximum coda: in number of Cs

**Onset obligatory:** Yes, No

Coda obligatory: Yes, No

Vocalic nucleus patterns: Short vowels, Long vowels, Diphthongs, Vowel sequences

Syllabic consonant patterns: Nasal, Liquid, or Obstruent

- Size of maximum word-marginal sequences with syllabic obstruents: in number of Cs
- **Predictability of syllabic consonants:** Phonemic, Predictable from word/ consonantal context, or Varies with CV sequence
- Morphological constituency of maximum syllable margin: Tautomorphemic, Heteromorphemic, or Both patterns occur

Morphological pattern of syllabic consonants: Lexical items, Grammatical items, Both

Additionally, more detailed information on syllable patterns, restrictions on cluster patterns, syllable type frequency data, and the phonetic characteristics of clusters was gathered for the Highly Complex portion of the sample. Analysis of these features was more qualitative and will be discussed when the results are presented in §3.4.

An example of the syllable structure coding for Ket, a language with Complex syllable structure, can be found below (3.11).

(3.11) **Ket** (*Yeniseian*; Russia)

Size of maximum onset: 2
Size of maximum coda: 3
Onset obligatory: No
Coda obligatory: No
Vocalic nucleus patterns: Short vowels
Syllabic consonant patterns: Nasals
Size of maximum word-marginal sequences with syllabic obstruents: N/A
Predictability of syllabic consonants: Predictable from word/consonantal context
Morphological constituency of maximum syllable margin: Heteromorphemic (Onsets), Both patterns (Codas)
Morphological pattern of syllabic consonants: Grammatical items

All syllable structure coding for the language sample, including illustrative examples and notes on specific onset and coda patterns, can be found in Appendix B.

### **3.3 Results for language sample**

In this section I present analyses of general patterns of maximum onsets, codas, and syllabic consonants in the language sample. In §3.3.1 I present the maximum onset and coda sizes in the data, and discuss maximum word-marginal patterns in the languages which have syllabic obstruents. In §3.3.2, I briefly examine the relationship between onset and coda complexity. In §3.3.3 the relationship between syllable structure complexity and obligatoriness of syllable margins is investigated. In §3.3.4 and §3.3.5 the patterns of vocalic nuclei and syllabic consonants, respectively, are presented and analyzed with respect to syllable structure complexity. §3.3.6 is a longer subsection which addresses the issue of morphological constituency in maximum syllable margins and syllabic consonants in the data.

#### 3.3.1 Maximum onset and coda sizes

The distribution of maximum onset and coda patterns in the sample, by number of consonants, can be found in Figures 3.1-3.2.



Figure 3.1. Maximum onset sizes in sample.



Figure 3.2. Maximum coda sizes in sample.

Note that Figure 3.1 includes as a language with maximum onset of one consonant the Oykangand dialect of Kunjen. This is one of the few examples of a language for which underlying CV syllables, and onsets in general, are argued to be absent.<sup>16</sup> Sommer (1969) claims that all words in Oykangand are consonant-final and vowel-initial, except for small handful of lexical items which are realized without the initial vowel when they occur sentence-initially. This analysis is not without controversy, and has been challenged by other researchers (Dixon 1970, Darden 1971). Dixon argues for word-internal onsets in a related dialect, Olgolo, on the basis that consonants preceding stressed vowels have fortis realization and there are some vowel-final words in the variety. Sommer (1981) notes that Dixon bases his critique on a dialect which is more distant from Oykangand than the ones Sommer describes in (1969). He also states that fortis realization of consonants occurs both before and after stressed vowels in the

<sup>&</sup>lt;sup>16</sup> Another language argued not to have CV syllables is Arrente, an Arandic language of central Australia (cf. Breen & Pensalfini 1999), though Anderson (2000) reports a canonical surface syllable structure of (C) (C)V(C) for Western Arrente.

language, and presents reduplication data to support his analysis of no underlying wordinternal onsets. This data has been considered ambiguous by some researchers, who propose alternative analyses (Blevins 1995: 230-1). Here I slightly adjust Sommer's analysis to reflect that one consonant may occur in the onset, as he himself describes for that small group of lexical items. With canonical (C)VC(C)(C)(C) syllable structure, the Oykangand dialect of Kunjen has syllable patterns which are typologically rare in two regards, in that it has Highly Complex syllable structure *and* a very marginal onset pattern, occurring sentence-initially only in a small set of words. An example of a Highly Complex structure in this language can be found in (3.12).

## (3.12) Kunjen (Pama-Nyungan; Australia)

albmb

'opossum'

(Sommer 1969: 33)

The data presented in Figures 3.1 and 3.2 are for onset and coda patterns determined through the procedure described in §3.2.1. They do not include the largest word-marginal patterns which occur in languages with syllabic obstruents. There are four languages in the sample which are reported to have syllabic obstruents resulting in

Maximum Maximum Maximum Maximum word-initial word-final obstruent string obstruent string Language coda onset 5 3 3 Cocopa 4 Semai 2 1 4 1 Tashlhiyt 1 (words without vowels) (word without vowels) 1 Tehuelche 2 3 3 >3

Highly Complex patterns at word margins.<sup>17</sup> These patterns are presented in Table 3.1, along with the reported maximum onset and coda patterns in the languages.

**Table 3.1.** Languages in Highly Complex category with syllabic obstruents. Maximum reported onsets and codas are given in first two columns. The sizes of the maximum word-marginal obstruent strings which occur as the result of syllabic obstruents are given in last two columns.

In Tashlhiyt, maximum word-marginal obstruent strings cannot be determined,

because there are many examples of words without vowels in this language (3.13).

(3.13) Tashlhiyt (Afro-Asiatic; Morocco)

tftktstt

tf.tk.tstt

'you took it off (F)'

(Ridouane 2008: 332)

<sup>&</sup>lt;sup>17</sup> Additionally, Tohono O'odham has syllabic obstruents, but only in independent grammatical particles consisting of a single consonant (determiners and conjunctives). Apparently these are not phonologically attached to adjacent words. Therefore I do not include Tohono O'odham in Table 3.1.

In Tehuelche, the reference indicates that sequences of up to six consonants may occur word-finally, but the only illustrative example given is (3.14).

(3.14) Tehuelche (Chon; Argentina)
ktfa?ſpſk'n
k.tſa?ſp.ſ.k'n
'it is being washed'

(Fernández Garay & Hernández 2006: 13)

This example includes a nasal which may be syllabic (syllable peaks in CC syllables are not marked by the authors). It is clear from the language description that long obstruent sequences come about when syllabic consonants are strung together, but unclear as to what the upper limit is on their size. Examples of four-obstruent word-final sequences may be found (3.15).

(3.15) **Tehuelche** (*Chon*; Argentina)

*ma:le∫p∫k'* ma:.le∫p.∫.k' 'they steal'

(Fernández Garay & Hernández 2006: 63)

### 3.3.2 Relationship between onset and coda complexity

Here I present an analysis similar to the one presented in §2.2 for the Complex portion of the Maddieson (2013a) sample. The languages of the current study are distributed according to their maximum onset and coda patterns.

		Number of Cs in onset							
		One	Two	Three	Four	Five	Six	Seven	Eight
Number	None	19	2	2	1				
	One	20	13	5	1				
	Two	6	6	6					
coda	Three	1	3	2	4				
-	Four	3			2				
	Five			_		1		1	1
	Six			1					



Interestingly, it is common for languages with large clusters at one syllable margin to also exhibit large clusters at the other syllable margin in their canonical patterns. Roughly half of languages in the sample which have a maximum cluster of four or more consonants at one syllable margin will have a similarly large maximum cluster at the other syllable margin. It is striking that *all* languages in the sample with maximum onsets of five or more consonants (Georgian, Itelmen, and Polish) also have maximum codas of five consonants. Meanwhile, the bottom left and top right corners of Table 3.2 are sparsely populated; that is, there are relatively few languages with very large maximum clusters at one syllable margin and very small clusters (or none at all) at the

other margin. A similar pattern can be observed in Table 2.2 in §2.2, which uses a larger sample of 145 languages. Speaking from a strictly distributional point of view, there is no obvious motivation for this pattern. If we consider onset and coda structures to be independent structures, then we would expect to see the full range of possible variation in their combination cross-linguistically. This point will be revisited in §3.5 and again in Chapter 8.

#### 3.3.3 Syllable structure complexity and obligatoriness of syllable margins

Blevins notes another cross-linguistic pattern linking onset and coda structures: she observes that languages with only open syllables tend to have optional onsets (2006: 336). In Table 3.3 I examine this relationship in the current language sample. There are some languages in which optional onsets may be reported for the canonical syllable structure, but regular and obligatory consonant epenthesis (usually of a glottal stop or fricative) occurs to produce onsets in all 'surface' forms. In the analysis below, I consider such languages as having obligatory onsets.

N languages	Codas occur?	Onset obligatory?
15	Y	Y
61	Y	Ν
2	Ν	Y
22	Ν	Ν

**Table 3.3.** Languages in sample distributed according to occurrence of codas and obligatoriness of onsets.

The relationship reported by Blevins is upheld in the current sample. Of the 24 languages with only open syllables (no codas), only two are reported to have obligatory onsets. Obligatory onsets are more common in languages with coda structures (15/76). The two languages in the sample with obligatory onsets and only open syllables are Hadza (Simple) and Piro (Highly Complex). It should also be noted that the Oykangand dialect of Kunjen used here is reported to have obligatory codas. As discussed above, Kunjen has very marginal onset patterns, with onsets occurring sentence-initially in a just a few lexical items. Therefore Kunjen shows a very similar pattern to Hadza and Piro, except that the syllable margins are reversed.

The analysis above motivated a more general examination of obligatory syllable margin patterns in the language sample with respect to syllable structure complexity (Table 3.4).

	Syllable Structure Complexity						
	Simple (N = 22 lgs)	Moderately Complex (N = 27 lgs)	Complex (N = 27 lgs)	Highly Complex (N = 24 lgs)			
Onset obligatory	Hadza Ute (2)	Hausa Ilocano Karok Lao Pacoh (5)	Chepang Lepcha Mangarrayi Sre (4)	Nuu-chah-nulth Piro Semai Thompson Tohono O'odham Yakima Sahaptin (6)			
Coda obligatory				Kunjen (1)			

**Table 3.4.** Languages in sample with obligatory syllable margins.

Obligatory syllable margins are a minority pattern in the language sample,

occurring in only 18 languages, but this feature does seem to show a trend with respect to

syllable structure complexity. Generally speaking, as syllable structure complexity increases, so does the number of languages reported to have obligatory syllable margins, such that this is the case for nearly one-third (7/24) of the languages with Highly Complex syllable structure.

Obligatory syllable margins are more common in some areas than others: Seven of the 18 languages in Table 3.4 are from Southeast Asia & Oceania. North America is also heavily represented, accounting for another six languages and 4/7 languages with obligatory syllable margins from the Highly Complex group. It should also be noted that most of the North American languages with obligatory syllable margins in the Highly Complex group are from the Pacific Northwest (Nuu-chah-nulth, Thompson, and Yakima Sahaptin), so areal factors may be at play. Nevertheless, the Highly Complex group shows the greatest areal diversity of all the syllable structure complexity groups in this analysis, with languages from four macro-regions: North America, South America, Southeast Asia & Oceania, and Australia & New Guinea. Additionally, the description of Itelmen (Eurasia) suggests that this language had obligatory onsets in its history: morphophonological processes suggest that present-day vowel-initial syllables were at one time initiated by a glottal stop (Georg & Volodin 1999: 48).

While the results in Table 3.4 are not statistically significant in a chi-squared test, the trend suggests an association between syllable structure complexity and obligatoriness of syllable margins which, to my knowledge, had not been previously reported or examined in this way.

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## **3.3.4 Vocalic nucleus patterns**

Vocalic nucleus patterns have until now been excluded from the discussion of syllable patterns, as they are not considered in the definitions of syllable structure complexity used here. However, it is important to note that vocalic nucleus patterns can also exhibit different degrees of complexity. In Table 3.5 I present a very general analysis of these patterns in the sample, showing the distribution of simple and complex vocalic nuclei by syllable structure complexity.

	Syllable Structure Complexity					
Languages with:	Simple (N = 22 lgs)	Moderately Complex (N = 27 lgs)	Complex (N = 27 lgs)	Highly Complex (N = 24 lgs)		
Simple vocalic nuclei only	13	9	12	8		
Complex vocalic nuclei (long vowels, diphthongs, and/or vowel sequences)	9	18	15	16		

**Table 3.5.** Vocalic nucleus patterns in language sample, by syllable structure complexity.

Simple vocalic nuclei — those consisting of a single short vowel — occur in every language. The first row of Table 3.5 shows the number of languages in each complexity category for which this is the only vocalic nucleus pattern occurring. Languages in which complex vocalic nuclei occur in addition to simple vocalic nuclei are shown in the second row. For the sake of simplicity I have collapsed three different kind of complex vocalic nucleus patterns in the analysis here. A language is counted as having long vowels if it has contrastive vowel length, but not if it has predictable vowel lengthening, e.g., a longer variant preceding a voiced coda. Diphthongs and vowel sequences are difficult to disentangle from one another, as their analyses by different authors may vary widely; however, vowel sequences reported here as syllable nuclei are those explicitly shown by the author to belong to one syllable, like a diphthong. That is, this figure does not include cases of hiatus, in which the two vowels in sequence belong to different syllables.

Table 3.5 shows that complex vocalic nuclei are much less likely to occur in languages with Simple syllable structure than in languages from the other categories. This suggests that the potential for more syllable types in languages with more complex syllable structure may not be just a function of larger canonical syllable margins, but also of greater diversity in syllable nucleus patterns. Nevertheless, the analysis above is too coarse to draw strong conclusions about vocalic nucleus patterns and syllable structure complexity. The issue of contrastive vowel length will be treated in greater detail in Chapter 4, along with contrastive nasalization, voicing, and glottalization patterns in the vowel inventories of the sample.

## **3.3.5** Syllabic consonants

In this section I investigate patterns of syllabic consonants in the data. Recall that the previous literature suggests two competing predictions for the relationship between syllable complexity and the presence of syllabic consonants. Isačenko's (1939/1940) phonological typology predicts that 'vocalic' languages, which tend to have simpler syllable structure, will be more likely to develop syllabic consonants, and specifically syllabic sonorants. Meanwhile, Bell (1978a) notes that syllabic consonants, including

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syllabic obstruents, often come about through vowel reduction processes, which are also known to produce the clusters characteristic of languages with more complex syllable structure. In §3.1.2 I formulated a hypothesis based on the latter observation (3.16):

(3.16) *H*<sub>1</sub>: Languages with more complex syllable structure are more likely to have syllabic consonant patterns.

Here I analyze languages in which the syllabic consonants are reported as invariant patterns. Most often, the syllabicity of these consonants is predictable from the surrounding consonantal and/or word environment, as illustrated by (3.17). Less frequently, syllabic consonants are analyzed as separate phonemes which are contrastive with their non-syllabic counterparts (3.18a-b).

## (3.17) Itelmen (Chukotko-Kamchatkan; Russia)

A word-initial alveolar or bilabial nasal stop preceding another consonant is realized as syllabic. /młim/ [młim] 'blood'

(Georg & Volodin 1999: 16)

- (3.18) **Ewe** (*Niger-Congo*; Ghana, Togo)
- (a) jóṁ 'call me'
- (b) kampé

'scissors'

(Ameka 1991: 38)

Three languages are excluded from the current analysis: Chipaya, Nimboran (both from the Complex category), and Piro (from the Highly Complex category). For all three

of these languages, there are conflicting reports regarding the occurrence of syllabic

consonants, sometimes by the same author.<sup>18</sup> For example, Matteson gives the following

description for Piro, which seems to suggest that consonants both belong to a syllable

with a vocalic nucleus and are simultaneously themselves syllabic:

"We number the consonants of the syllable, beginning with the consonant that immediately precedes the nuclear vowel:  $\pm C^3 \pm C^2 \pm C^1 V$ . In the positions of consonants C<sup>2</sup> and C<sup>3</sup> occur syllabic allophones of the consonants. Thus the syllable is a complex unit consisting of from one to three syllabic units."

(Matteson 1965: 23)

<sup>&</sup>lt;sup>18</sup> There are a few other languages for which there are suggestions of alternate analyses. The dialect of Sahaptin analyzed here, Yakima, is argued not to have syllabic consonants by Hargus & Beavert (2006) on the basis of distributional and phonological behavior of consonants in sequences. However, it should be noted that Minthorn (2005) argues for syllabic consonants, including obstruents, in the closely related dialect of Umatilla Sahaptin, on the basis of speaker intuition and acoustic analysis. Additionally, one description of Alamblak lists an example of a vowelless word: *kpt* 'basket type' (SIL 2004: 1); however, no further elaboration is given and obstruents are not included in the description of syllabic consonants in Bruce (1984), so it is unclear whether syllabic obstruents are an issue of debate for this language. Finally, for Itelmen, Volodin (1976: 42) gives transcriptions of lexical items consisting entirely of obstruents ( $\hat{t}kpt\hat{f}$  'spoon'). In a later reference, he describes only syllabic sonorants in the language (Georg & Volodin 1999).

Because of the conflicting descriptions of these languages, I opted to exclude them from the current analysis. Georgian and Tashlhiyt also have conflicting descriptions with respect to the occurrence of syllabic consonants, but in both of these cases instrumental evidence and/or native speaker intuition has been presented to support one analysis over another. The articulatory and acoustic experiments in Ridouane (2008) and Goldstein et al. (2007) support a syllabic consonant analysis for Tashlhiyt, while native speaker intuition reported in Chitoran (1999) does not support an analysis of syllabic sonorants for Georgian. It is interesting to note that all of the languages with conflicting descriptions — those discussed here and the ones mentioned in the footnote — are from the Complex and Highly Complex categories. This recalls the observation noted previously, in which transitions in consonant clusters and syllabic consonants may have similar motivations and acoustic manifestations.

	Syllable Structure Complexity					
Languages with:	Simple (N = 22 lgs)	Moderately Complex (N = 27 lgs)	Complex (N = 25 lgs)	Highly Complex (N = 23 lgs)		
Syllabic consonants	2	8	6	10		
No syllabic consonants	20	19	19	13		

**Table 3.6.** Presence of syllabic consonants in language sample, by syllable structure complexity. Chipaya, Nimboran (both from Complex category) and Piro (from Highly Complex category) excluded.

The syllabic consonant patterns reported for the languages of the sample can be found in Table 3.6. Considering the two extremes of the syllable structure complexity spectrum, we do find different patterns: only 9% (2/22) of languages with Simple syllable

structure are reported to have syllabic consonants, while roughly 43% (10/23) of the languages in the Highly Complex category have these structures. However, the trend is not linear when the Moderately Complex and Complex categories are considered, nor is it statistically significant in a chi-squared test. In Table 3.7 the syllabic consonant patterns of the language sample are examined in more detail.

	S				
Languages with:	Simple (N = 2 lgs)	Moderately Complex (N = 8 lgs)	Complex (N = 6 lgs)	Highly Complex (N = 10 lgs)	<b>Totals</b> (N=25 lgs)
Syllabic nasals	2	7	6	9	23
Syllabic liquids		2	1	6	9
Syllabic obstruents				5	5

**Table 3.7.** Languages in sample with syllabic consonants. For each type of syllabic consonant, number of languages in which that type occurs is given. Some languages have more than one type of syllabic consonant, so the columns do not necessarily add up to the N given in the heading.

The patterns here are similar to what is reported in Bell (1978a), in that most languages with syllabic consonants have syllabic nasals, and languages with syllabic obstruents are rare. When syllable structure complexity is considered, additional patterns emerge. While languages from all four categories have syllabic nasals and most have syllabic liquids, syllabic obstruents are only reported for languages in the Highly Complex category. This trend is certainly influenced by the way that the categories have been defined in the current study, in that languages with syllabic obstruents are categorized as Highly Complex *if* these structures result in sequences of three obstruents or more. However, it is striking that no languages with simpler syllable structure are reported to have syllabic obstruents. Even if the three languages excluded from the previous analysis were included here, the distribution of syllabic obstruents would be among two languages with Complex syllable structure and six languages with Highly Complex syllable structure.

It should also be noted that most of the languages with syllabic obstruents (Cocopa, Semai, Tashlhiyt) are reported to also have both syllabic nasals and syllabic liquids. Tehuelche does not have syllabic liquids. Tohono O'odham is the only language which has syllabic obstruents but not syllabic sonorant consonants. This indicates that the trend in Table 3.6 — by which Highly Complex languages are more likely than any of the other categories to have syllabic consonants — is not driven by the inclusion of syllabic obstruents in the definition of that category, or skewed by potential misanalyses which confound syllabic obstruents and large tautosyllabic clusters. The trend can be obtained from the syllabic nasal and liquid patterns in the sample.

While the analyses presented above are for the invariant syllabic consonant patterns observed in the sample, there were also several cases in which syllabic consonants were reported to occur in variation with CV or VC sequences, as illustrated by (3.19)-(3.20).

(3.19) Nuosu Yi (Sino-Tibetan; China)

Nasals and laterals preceding [i] occur in free variation with syllabic consonants. /li/ [li]~[l]

(Gerner 2013: 31)

(3.20) Mamaindê (Nambikuaran, Brazil)

When an unstressed vowel is lost resulting in a sequence of nasal plus consonant,

a preceding nasal becomes syllabic.

/weih**na**lat<sup>h</sup>awa/

[weihnlathawa]

'she is pregnant'

(Eberhard 2009: 262-3)

	S				
Languages with variable:	Simple (N = 1 lg)	Moderately Complex (N = 2 lgs)	Complex (N = 1 lg)	Highly Complex (N = 4 lgs)	<b>Totals</b> (N=8 lgs)
Syllabic nasals	1	2	1	4	8
Syllabic liquids	1			3	4
Syllabic obstruents				1	1

**Table 3.8.** Languages in sample with syllabic consonants occurring in variation with VC or CV structures. For each type of syllabic consonant, the number of languages in which that type occurs is given. Some languages have more than one type of syllabic consonant, so the columns do not necessarily add up to the N given in the heading.

Table 3.8 shows the distribution of variable processes producing syllabic

consonants in the data. Though the data set in Table 3.8 is very small, it is interesting that the distributional pattern roughly mirrors those presented in Tables 3.6 and 3.7. That is, the occurrence of syllabic consonants in variation with VC or CV structures is most frequent among languages with Highly Complex syllable structure. None of the languages outside the Highly Complex category have optional syllabic obstruent variants of CV or VC structures. In Kabardian, syllabic obstruents were reported to occur as a result of optional processes of contraction of high vowels (3.21):

(3.21) Kabardian (*Northwest Caucasian*; Russia, Turkey)

/ɬ'əʒ/ [ɬ'iʒ]~[ɬ'ʒ] 'old man'

(Kuipers 1960: 24)

Kabardian is also the only language in the sample reported to have both invariable syllabic consonants (for sonorants in certain consonant environments) and variable syllabic consonants as a result of active phonetic processes such as the above.

Returning to the hypothesis stated at the beginning of this section, we do find some evidence that languages with more complex syllable structure are more likely to have syllabic consonant patterns. Specifically, we find that languages with Highly Complex syllable structure are the most likely of all the languages in the sample to have invariant syllabic consonants, while languages with Simple syllable structure are the least likely. There are also suggestions in the data that languages with Highly Complex syllable structure are more likely than others to have variable processes resulting in syllabic consonants.

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## **3.3.6 Morphological patterns**

In this section I analyze the morphological patterns associated with syllable patterns in the language sample. First, I report the morphological constituency patterns observed in the maximum onset and coda structures in each language. Then I present an analysis of the kinds of morphemes (lexical or grammatical) in which syllabic consonants in the language sample occur. Recall the hypotheses formulated in §3.1.2 with respect to these patterns:

(3.22)

- (a) H<sub>2</sub>: As syllable structure complexity increases, so does the likelihood that the largest syllable margin types in a language will be morphologically complex.
- (b) H<sub>3</sub>: As syllable structure complexity increases, so does the likelihood that syllabic consonants occurring in a language will belong to grammatical elements.

Since heteromorphemic instances of syllable patterns are typically not explicitly reported and must be gathered from the examples, it was impractical and in many cases impossible to find tautomorphemic and heteromorphemic instances of the same specific consonant sequence in each language, especially for the larger clusters. The patterns analyzed here are for the maximum onset and coda *types*, e.g. CC. For example, the maximum coda in Ingessana is two consonants. The word-final patterns shown in the examples below would be taken as evidence that the maximum coda occurs in both tautomorphemic (3.23a) and heteromorphemic (3.23b) contexts.

(3.23) Ingessana (Eastern Sudanic; Sudan)

- (a) bāgdars'lizard type'
- (b) gàū**r-d** stomach-SG 'stomach'

(Stirtz 2011: 32, 37)

Note also that the definition of *heteromorphemic* here refers to sequences derived by any morphological process. That is, sequences derived through reduplication or nonconcatenative processes such as subtractive morphology are considered to be heteromorphemic, even though this may not be the conventional definition of the term.

First I test Greenberg's (1965/1978) prediction in the data: as the size of a syllable margin increases, so does the probability that it contains morpheme boundaries. Figures 3.3 and 3.4 show morphological constituency patterns in maximum onset and coda types in the data.



**Figure 3.3.** Morphological constituency patterns in maximum onset types in data. For each maximum onset type (CC, CCC, etc.), figure shows proportion of languages exhibiting the given morphological patterns for that type.



**Figure 3.4.** Morphological constituency patterns in maximum coda types in data. For each maximum coda type (CC, CCC, etc.), figure shows proportion of languages exhibiting the given morphological patterns for that type.

For both maximum onset and coda patterns in the data, the proportion of languages having these clusters in solely heteromorphemic contexts increases with cluster size in a roughly similar way for the two syllable margins. However, heteromorphemic patterns also occur alongside tautomorphemic patterns in the maximum margins for a number of languages (the "Both patterns" trend in Figures 3.3 and 3.4). When this trend is additionally considered, we find that maximum coda cluster types are generally more likely than maximum onset types to exhibit heteromorphemic patterns. We also find that all maximum cluster types of five consonants or larger are found in heteromorphemic contexts only.

Interestingly, there are some language-internal patterns in the data which go against Greenberg's prediction. In Lelepa there are biconsonantal onsets showing both morphological patterns, but the only attested triconsonantal onsets are tautomorphemic (3.24a-c).

(3.24) Lelepa (Austronesian; Vanuatu)

(a) n-malogo
 NMLZ-darken
 'darkness'
 (b) nmal

'trunk'

(c) psruki

'speak'

(Lacrampe 2014: 107, 207, 42)

The analyses presented in Figures 3.3-3.4 test Greenberg's specific predictions regarding cluster size. The hypothesis in (3.22a) is formulated with respect to syllable structure complexity, which is a slightly different question, though we expect to find a similar pattern due to how the categories are defined. In Tables 3.9-3.11 I present the

morphological constituency patterns observed in the syllable structure complexity

	N languages with onset clusters	N languages with coda clusters
Tautomorphemic contexts only	9	_
Both contexts	1	—
Heteromorphemic contexts only	—	1
Total	10	1

categories which have tautosyllabic clusters.

**Table 3.9.** Morphological constituency of maximum onsets and codas in languages with Moderately Complex syllable structure. Note that the one language with coda clusters, Eastern Khanty, was admitted to this category on the basis of this pattern being extremely marginal in the language.

	N languages with onset clusters	N languages with coda clusters
Tautomorphemic contexts only	14	12
Both contexts	5	6
Heteromorphemic contexts only	2	—
Total	21	18

**Table 3.10.** Morphological constituency of maximum onsets and codas in languages with Complex syllable structure.

	N languages with onset clusters	N languages with coda clusters
Tautomorphemic contexts only	8	5
Both contexts	2	4
Heteromorphemic contexts only	10	9
Total	20	18

**Table 3.11.** Morphological constituency of maximum onset and coda clusters in languages with Highly Complex syllable structure.

The trends show that both maximum onset and coda clusters are more likely to show heteromorphemic patterns as syllable structure complexity increases, confirming the hypothesis in (3.22a).

Figure 3.5 combines the data from Tables 3.9-3.11 to show general morphological patterns of clusters with respect to syllable structure complexity in the language sample. In this figure onset and coda patterns are collapsed, and the "both contexts" and "heteromorphemic contexts only" patterns are combined to show the simple presence or absence of heteromorphemic patterns in maximum syllable margins.





Heteromorphemic patterns can be found in the maximum syllable margins of most languages from the Highly Complex category. However, there are six languages in this category for which I could determine only tautomorphemic patterns in the maximum syllable margins. In Wutung, the maximum margin is explicitly described as occurring within a few apparently monomorphemic lexical items. In Kunjen and Lezgian, maximum coda and onset clusters, respectively, seem to be limited to monomorphemic lexical items, though the references consulted do not explicitly state this. In Menya, the only heteromorphemic instance of a maximum cluster that could be found was in an abstract phonemic transcription for which the phonetic form was unclear. In Passamaquoddy-Maliseet, heteromorphemic instances of maximum clusters could not be found, though it seems as though the morphology could produce them. The remaining language, Semai, has syllabic consonants and will be discussed below.

Recall that there are four languages in the Highly Complex portion of the sample for which the largest word-marginal obstruent sequences include syllabic consonants. The maximum 'true' onset/coda clusters reported for these languages (cf. Table 3.2) were included in the previous analyses in this section, but the maximum word-marginal sequences were not. I present the morphological patterns for these sequences in Table 3.12.

Language	Maximum word-initial obstruent string	Morphological pattern	Maximum word-final obstruent string	Morphological pattern
Cocopa	5	Heteromophemic	3	Heteromorphemic
Semai	4	Heteromorphemic	1	_
Tashlhiyt	(words without vowels)	Heteromorphemic	(words without vowels)	Heteromorphemic
Tehuelche	3	Heteromorphemic	>3	Heteromorphemic

**Table 3.12.** Morphological patterns of maximum word-marginal obstruent sequences in languages with syllabic obstruents.

All of the maximum word-marginal obstruent sequences in the languages in Table

3.12 occur in heteromorphemic contexts. For example, in Semai, all maximum word-
initial consonant sequences, and indeed all word-initial sequences of more than two consonants, are derived through reduplication processes (3.25).

(3.25) Semai (Austro-Asiatic; Malaysia)

gp.g.hup (< ghup )

'irritation on skin (e.g., from bamboo hair)'

(Sloan 1988: 320; Diffloth 1976a: 256)

Though maximum word-marginal sequence length cannot be determined in Tashlhiyt due to the occurrence of many words without vowels in this language, the longest words consisting entirely of obstruents are heteromorphemic (3.26).

(3.26) Tashlhiyt (Afro-Asiatic; Morocco)

t-ss-k∫f-t=stt ts.sk.∫f.tstt 'you dried it (F)'

(Ridouane 2008: 332; interlinear gloss not given)

Now we turn to the hypothesis in (3.22b): as syllable structure complexity increases, so does the likelihood that syllabic consonants occurring in a language will belong to grammatical elements. This is based partly on Bell's (1978a) observation that

the syllabic consonants in his typological survey were often restricted to grammatical particles and affixes.

Only the languages reported in §3.3.5 as having invariant syllabic consonant patterns are included in the analysis here. Additionally, Kabardian is excluded from the present analysis because its precise patterns could not be determined. For each kind of syllabic consonant analyzed in that section (nasal, liquid, and obstruent), I determine whether that type occurs in lexical morphemes, grammatical morphemes, or both. For example, in Nkore-Kiga, syllabic nasals can be found in both lexical and grammatical morphemes (3.27).

(3.27) Nkore-Kiga (Niger-Congo; Uganda)

(a) ņ∫a

'empty'

(b) ŋ-kora

1.SG-work

'I work'

(Taylor 1985: 203)

In Tables 3.13-3.15 I present analyses for the morphological patterns of each kind of syllabic consonant (nasal, liquid, and obstruent) observed in the data.

	Syllable Structure Complexity			
Languages with syllabic nasals in:	Simple (N = 2 lgs)	Moderately Complex (N = 7 lgs)	Complex (N = 6 lgs)	Highly Complex (N = 8 lgs)
Lexical morphemes only		3	3	1
Lex. and gram. morphemes	1	4	1	4
Grammatical morphemes only	1		2	3

**Table 3.13.** Morphological patterns of syllabic nasals in sample, by syllable structure complexity. Pattern for Kabardian (Highly Complex) could not be determined.

	Syllable Structure Complexity			
Languages with syllabic liquids in:	Simple (N = 0 lgs)	Moderately Complex (N = 2 lgs)	Complex (N = 1 lg)	Highly Complex (N = 5 lgs)
Lexical morphemes only		2	1	1
Lex. and gram. morphemes				3
Grammatical morphemes only				1

**Table 3.14.** Morphological patterns of syllabic liquids in sample, by syllable structure complexity. Pattern for Kabardian (Highly Complex) could not be determined.

	Syllable Structure Complexity			
Languages with syllabic obstruents in:	Simple (N = 0 lgs)	Moderately Complex (N = 0 lgs)	Complex (N = 0 lgs)	Highly Complex (N = 5 lgs)
Lexical morphemes only				
Lex. and gram. morphemes				1
Grammatical morphemes only	—			4

**Table 3.15.** Morphological patterns of syllabic obstruents in sample, by syllable structure complexity.

In general, the pattern by which syllabic consonants are found to occur in grammatical morphemes, either exclusively or in addition to lexical morphemes, is the dominant one in the data. This is the case for 16/23 languages with syllabic nasals, 4/8 languages with syllabic liquids, and all of the languages with syllabic obstruents. Excluding the pattern with syllabic nasals in the Simple category in Table 3.13, the proportion of languages having each kind of syllabic consonant in grammatical morphemes roughly increases with syllable structure complexity. Below the data is collapsed into one figure to show general morphological patterns of syllabic consonant inventories in the languages of the sample (Figure 3.6).



**Figure 3.6.** Morphological patterns occurring in syllabic consonant inventories of the language sample, represented as proportion of languages with the pattern in each syllable structure complexity category. Kabardian (Highly Complex) excluded from this analysis.

Again, excluding the pattern in the Simple syllable structure category, which is based on the patterns of only two languages, we find support for the hypothesis. As syllable structure complexity increases, so does the likelihood that languages with syllabic consonants will have these sounds occurring in grammatical morphemes. In the Highly Complex category, there is only one counterexample in the nine languages with syllabic consonants considered here: Alamblak has syllabic nasals in lexical items but not grammatical morphemes. In general, most kinds of syllabic consonants found in languages with Highly Complex syllable structure can be found in grammatical morphemes. In Tehuelche, for example, *all* syllabic consonants correspond to or belong to grammatical morphemes (3.28).

(3.28) **Tehuelche** (*Chon*; Argentina)

k.t͡ʃa?ʃp.ʃ.k'n k-t͡ʃa?ʃp-ʃ-k'n REFL-wash-PS-REALIS 'it is being washed'

(Fernández Garay & Hernández 2006: 13)

To summarize, in this section I have examined the morphological patterns present in both maximum onset and coda types and syllabic consonant inventories in the data. In both cases I have found support for the hypotheses in (3.22). Maximum syllable margins are more likely to exhibit heteromorphemic patterns in languages with more complex syllable structure. Additionally, as syllable structure complexity increases, so does the likelihood that syllabic consonants occurring in a language can be found in grammatical morphemes. Clearly morphology contributes an important role to the development of complex syllable patterns. While this point will be only briefly revisited in the discussion in §3.5, it will be discussed in further detail in Chapter 8.

### 3.4 Properties of highly complex syllable structure

Having described the general patterns of maximum onsets, maximum codas, and syllabic consonants in the data, I now turn to an examination of the properties of syllable structure in the languages in the Highly Complex portion of the sample. In §3.4.1 I give examples of the syllable patterns occurring in each of these languages. In §3.4.2 I attempt to characterize the prevalence of Highly Complex structures within each of the languages by examining restrictions on consonant combinations and reported frequency patterns. In §3.4.3 I present information on the acoustic and perceptual properties of Highly Complex structures.

## 3.4.1 Examples of Highly Complex syllable patterns in sample

In order to provide a better picture of what specific syllable patterns occur in the languages of the Highly Complex portion of the sample, I list some representative structures in Table 3.16. The definition of Highly Complex syllable structure includes any onset or coda structure of three obstruents, or of four consonants or more in length. It also includes any word-marginal sequence containing syllabic obstruents such that a sequence of three or more obstruents occurs at a word margin. For each language I give a set of examples for each onset, coda, and/or word-marginal cluster that occurs at each of the following lengths: three consonants, four consonants, and five or more consonants. For Tashlhiyt, I have given some examples of vowelless words in the rightmost column, but have not assigned them to a word margin.

	Highly Complex structures		
Language	3-obstruent structures	4-C structures	5-C and larger structures
Alamblak	Onset: tkb		
Menya	Onset: tpq, ptq		
Piro	<b>Onset:</b> (pcr, ntsp, ntsk)		
Kabardian	Onset: zby, p¢t, psk'		
Lezgian	Onset: ∫tk, kst, ktk		
Camsá	<b>Onset:</b> stx, stJb, sJts	<b>Onset: </b> $\phi$ <b>stx</b>	
Semai	Word-initial: st.s	Word-initial: gp.g.h	
Nuu-chah-nulth	Coda: $\widehat{tJtq}$ , kqs, q $\widehat{tts}$ , th $\widehat{ts}$	Coda: mtq∫, ħsqħ, nkqħ	
Wutung		Onset: hmbl	
Doyayo		Coda: ßlts, yldz, mnts	
Kunjen		Coda: lbmb, 1dnd, jgŋg	
Passamaquodd y-Maliseet	<b>Onset:</b> psk, ksp, psk <sup>w</sup> <b>Coda:</b> psk <sup>w</sup> , ksk <sup>w</sup>		
Qawasqar	Onset: qsq, qst, qsk Coda: qsq	Onset: qsqj	
Tehuelche	Word-initial: k∫.x, k∫.? Coda: ?∫p	Word-final: ∫p.∫.k'	
Albanian	Onset: skt, p∫t Coda: p∫t, kst	<b>Onset:</b> tjmpl, zmbr	
Mohawk	<b>Onset:</b> ksk, kts, kst, kht <b>Coda:</b> ?ks, ?ts, kst	Onset: shnj khnj	
Yakima Sahaptin	<b>Onset:</b> p∫χ, tk <sup>w</sup> s, q'∫p <b>Coda:</b> tks, stk, ptPk	Onset: ʃtχn, ksks Coda: wtkʷʃ, wq'χʃ, jlps	
Tohono O'odham	<b>Coda:</b> gsp, tpk, $bst \hat{f}$ , psk	Onset: ndş? Coda: ʃt͡ʃkt͡ʃ, t͡ʃspk, gşsp	
Polish	Onset: p∫t, x∫t, tkf <sup>j</sup> Coda: psk, stf, ∫t∫p	Onset: pst∫, fks∫, vzgl Coda: ɲstf, tstf, rstf, pstf	Onset: spstr Coda: mpstf

**Table 3.16.** Representative sample of Highly Complex patterns occurring in data. (—) indicates that there are no reported patterns of this kind in the given language. The Piro patterns are in parentheses because they are representative triconsonantal clusters for the language but do not contain three obstruents (see discussion in §3.2.3).

	Highly Complex structures		
Language	3-obstruent structures	4-C structures	5-C and larger structures
Thompson	Onset: spt, st͡s'k Coda: x <sup>w</sup> kt, x <sup>w</sup> st͡s, pst͡s	Coda: fsxsfs, jxsfs, łkst	Coda: łqsxtx <sup>w</sup>
Itelmen	Onset: kth kp'k' łqz Coda: płh sht	Onset: ttxn, ksxw, ktxl Coda: nt͡ʃpx, mpłx, łtxt͡ʃ	Onset: kpłkn, tksxqz, kstk'łkn Coda: nxłxt͡ʃ, mstxt͡ʃ
Georgian	<b>Onset:</b> t'k'b p'ts'k' psk'	Onset: txzβ, fs'q'rt, brfs'q' Coda: rtxl, rt'q'l, nf∫xl	Onset: p'rts'k'ß, gßprtskßn Coda: ntJxls, rts'q'ßs, rt'k'ls
Сосора	Onset: sxt, psk <sup>w</sup> , xps Coda: qsk, ssk, xsk	Onset: st͡ʃx? pst͡ʃ?, p.t͡ʃx.m	Word-initial: pk.Jkw
Tashlhiyt	Word-initial: ts.t Word-final: k <sup>w</sup> tt, ∫.kd	Word-initial: ts:χs Word-final: stst:	(Words without vowels:) ts:ftχt, tftktst:, ts:k∫ftst:

**Table 3.16. (cont.)** Representative sample of Highly Complex patterns occurring in data. (—) indicates that there are no reported patterns of this kind in the given language. The Piro patterns are in parentheses because they are representative triconsonantal clusters for the language but do not contain three obstruents (see discussion in §3.2.3).

The languages in Table 3.16 are organized so as to highlight several coherent patterns in the data. In the first set of languages (Alamblak, Menya, Piro, Kabardian, Lezgian, Camsá, Semai, and Nuu-chah-nulth), Highly Complex patterns are limited to one syllable margin, usually the onset (or word-initial). The Highly Complex patterns in these languages are typically limited to triconsonantal clusters, though four-consonant clusters occur in Camsá, Semai, and Nuu-chah-nulth. In the second group of languages (Wutung, Doyayo, and Kunjen), four-consonant clusters occur at one syllable margin, but triconsonantal patterns falling under the definition of Highly Complex (that is, sequences of three obstruents) do not occur. In this group, the four-consonant clusters include at least one, but usually two, sonorants. Finally, in the remaining 13 languages, Highly Complex patterns occur in both margins and almost always include clusters of various sizes.

It is typically the case in the language sample that if a language has syllable margins of three obstruents, then any larger margins which occur in the language may also include sequences of three or more obstruents. The only apparent exceptions to this trend are four-consonant onsets in Albanian and Mohawk, and four-consonant codas in Georgian. In these cases, the larger clusters always include more than one sonorant, such that sequences of more than two obstruents do not occur, e.g. Georgian /-rt'q'l/. In all other languages with both triconsonantal and larger Highly Complex structures, long strings of obstruents are a hallmark characteristic of the larger structures. That is, the patterns in the third group of languages described above are not simply an amalgamation of the patterns from the first and second groups of languages described above. The second group represents a minority pattern in that the only Highly Complex structures occurring in these languages do not involve strings of more than two obstruents.

It should also be noted that languages with syllabic consonants do not behave any differently than the other languages with respect to the distribution of their Highly Complex sequences. Semai patterns with the first group of languages, while Tehuelche, Cocopa, and Tashlhiyt pattern with the third group.

Table 3.16 does not provide an exhaustive list of Highly Complex structures for each language; however, for a few languages for which this is a minor pattern, an exhaustive or near-exhaustive list is given. This is the case for both Alamblak and Menya. The Highly Complex onsets listed for these languages are not explicitly stated in the

references to be the only structures of this sort, but a search of the examples and texts yielded only these patterns. In Wutung, the four-consonant onset given is explicitly stated by the author to be the only one occurring in the language. For other languages, the lists given for larger structures may be exhaustive, but those given for smaller structures may be a small representative sample. This is the case for Polish, which has few onsets and codas of five consonants, but a much larger variety of smaller clusters than what is shown here. In the next section, I will discuss issues of prevalence of Highly Complex syllable patterns in more detail.

### **3.4.2** Prevalence of Highly Complex syllable patterns within languages

Here I attempt to characterize the prevalence of Highly Complex syllable patterns in the sample. First I examine restrictions on the combinations of consonants occurring in Highly Complex structures in each language. Then I present information on the relative frequency (either quantified or impressionistic) of these patterns as reported in the language descriptions. Together, these measures provide a rough diagnostic of the relative prevalence of the target syllable patterns within the Highly Complex language of the sample.

The analysis of restrictions on consonant combinations presented below is based primarily on the patterns of the smaller Highly Complex structures in each language. This is because the point here is to characterize the prevalence of Highly Complex patterns in general, and not just the maximum patterns occurring in each language. The analysis of restrictions on consonant combinations relies on patterns explicitly reported by the

author. In some cases, no explicit description of consonant combinations is given, and I rely on patterns gleaned from the available examples.

For each language, I have classified the Highly Complex patterns which occur into three categories based on their combinatorial restrictions: Severely Restricted, Relatively Restricted, and Relatively Free. Where a language has Highly Complex structures in both margins and the patterns are qualitatively different, I examine the onset and coda separately. In (3.29)-(3.31) I give the definition for each category and illustrative examples from the data. The raw number of potential consonant combinations in a language is, of course, a function of the number of consonants in its phoneme inventory. I have attempted to define these categories so that they do not refer to or depend heavily upon the size of the consonant inventory of the given language.

- (3.29) **Severely Restricted:** There is a handful (< 5) of occurring Highly Complex sequences, and/or every member of the sequence has specific restrictions.
- (a) **Wutung** (*Skou*; Papua New Guinea)

Restrictions on onsets of four consonants:

Only /hmbl/ occurs.19

e.g. hmblie

'left hand'

(Marmion 2010: 69)

<sup>&</sup>lt;sup>19</sup> The /h/ here appears to be a separate consonant segment and does not represent a modification of the phonation of the following nasal. Marmion (2010: 54) describes it as a segment which can optionally elide preceding sonorant consonants.

Doyayo (Niger-Congo; Cameroon)Restrictions on codas of four consonants:C1: must be /b g m ŋ/ (/b g/ usually realized as [β ɣ] in clusters)C2: must be /l r n/C3: must be /d t/C4: must be /s z/Additionally, C3 and C4 must match in voicing.e.g. deβrts

'be cut off for'

(b)

(Wiering & Wiering 1995: 41-2)

- (3.30) Relatively Restricted: There are general restrictions on the voicing, place, or manner of some or all members, and/or specific restrictions on one or two (but not all) members.
- (a) Lezgian (*Nakh-Daghestanian*; Russia)

Restrictions on onsets of three consonants:

C1: voiceless obstruent

C<sub>2</sub>: voiceless obstruent or /r/

- C3: voiceless obstruent or sonorant
- e.g.  $k^h sta\chi$

'spoiled child'

(Haspelmath 1993: 37)

# (b) **Passamaquoddy-Maliseet** (*Algic*; Canada, United States)

Restrictions on onsets of three consonants:

Apart from a few exceptions, triconsonantal onsets or codas are always of the form CsC.

e.g. kspison

'belt'

(LeSourd 1993: 121)

(3.31) **Relatively Free:** There may be a few abstract restrictions on consonant combinations, and/or combinations are described by author as free or unrestricted.

(a) **Yakima Sahaptin** (*Sahaptian*; United States)

Restrictions on codas of three and four consonants:

Clusters of glottalized or labialized obstruents do not occur.

e.g. *χip*χ*p* tawq'χ∫

'cottonwood'

'kerchief, neck scarf'

(Hargus & Beavert 2002: 270-1)

The distribution of the languages with respect to the three categories above is given in Table 3.17.

Severely Restricted	<b>Relatively Restricted</b>	<b>Relatively Free</b>
Alamblak Doyayo Kunjen Menya Qawasqar <i>(codas)</i> Wutung	Albanian Camsá Georgian Kabardian Lezgian Mohawk Passamaquoddy-Maliseet Polish <i>(codas)</i> Qawasqar <i>(onsets)</i> Semai Tehuelche Tohono O'odham	Cocopa Itelmen Nuu-chah-nulth Piro Polish <i>(onsets)</i> Tashlhiyt Thompson Yakima Sahaptin

**Table 3.17.** Degree of restriction on consonant combinations in Highly Complex syllable patterns.

There are two languages — Polish and Qawasqar — which have different degrees of restriction in their Highly Complex onset and coda patterns. Besides Qawasqar, there are five languages for which all Highly Complex patterns are severely restricted. Interestingly, in only one of these (Doyayo) are the severely restricted patterns associated with specific heteromorphemic sequences; in the others, the severely restricted patterns occur within morphemes. There is an areal skewing to this set of languages: it includes all of the languages from the Australia & New Guinea macro-region in the Highly Complex category. Most often, languages have Highly Complex structures that are relatively restricted in their consonant combinations. Besides Polish and Qawasqar, there are ten languages which have this pattern. Finally, there are seven languages besides Qawasqar which have relatively free consonant combinations in their Highly Complex structures. It is striking that the set of languages with relatively free patterns is larger than the set of languages with severely restricted patterns, given the general rarity of languages with Highly Complex syllable structure. Below I present information on the frequency of Highly Complex structures in the languages of the sample. Frequency of syllable patterns is explicitly remarked upon for only 15 of the 24 languages in this category. Most often, reports are impressionistic in nature, but occasionally a researcher provides type frequency data for patterns in the syllable inventory, lexicon, or text. In Table 3.18 I note the nature of the frequency data given for each language. Note that not all of the patterns reported below are strictly Highly Complex patterns; authors often did not make a distinction between different kinds of triconsonantal clusters, for instance.

Language	Nature of frequency data	Reported frequency of HC patterns
Camsá	Impressionistic	"Consonant clusters are very common in Camsá. [] <i>Clusters of three consonants are not as common</i> in the language as clusters of two." (Howard 1967: 81-4).
Сосора	Impressionistic	"[i]t is <i>quite common</i> to find Cocopa words consisting of a single vowel preceded by several consonants." (Bendixen 1980: 1)
Georgian	Type frequency in syllable inventory Type frequency in text	<ul> <li>28/276 (10%) of onset patterns occurring stem-initially are HC (calculated from data in Butskhrikidze 2002: 197-205).</li> <li>In an excerpt of descriptive prose, 24/550 (4.4%) of word-initial patterns and 7/559 (1.3%) of word-final patterns consist of three or more consonants (Vogt 1958: 79-80).</li> </ul>
Kabardian	Impressionistic	"Clusters consist of not more than three, and in the large majority of cases, of two consonants." (Kuipers 1960: 29)
Kunjen	Type frequency in lexicon	"VCCCC syllables occur only as the initial syllable of the word, and have been recorded in <i>only twenty words</i> ." (Sommer 1969: 35)
Itelmen	Impressionistic	"The <i>frequent occurrence of complex consonant clusters</i> is one of the most notable traits of Itelmen phonology." (Georg & Volodin 1999: 38; translation TZ)
Lezgian	Impressionistic	"[w]ord-initial CC- and even <i>CCC- clusters are now common.</i> " (Haspelmath 1993: 46).

**Table 3.18.** Reported frequency of Highly Complex syllable patterns. Emphasis my own in all quotations.

Language	Nature of frequency data	Reported frequency of HC patterns
Mohawk	Type frequency in syllable inventory	<b>6/43 (14%)</b> of word-initial onsets and <b>3/25 (12%)</b> of word-final codas are HC (calculated from data in Michelson 1988: 12-13).
Piro	Type frequency in lexicon Impressionistic	"A little less than one-third of the total number of syllable margins consists of $C^2C^1$ ; <i>not more than one in several hundred, of</i> $C^3C^2C^1$ . The present count of clusters of three consonants shows <i>lower</i> <i>frequency</i> than a similar count made ten years ago." (Matteson 1965: 24). "Words beginning with three consonants in sequence are <i>verv</i>
		<i>common.</i> " (Hanson 2010: 26).
Polish	Type frequency in syllable inventory	64/426 (15%) of onset patterns occurring word-initially are HC, 18/141 (13%) of coda patterns occurring word-finally are HC (calculated from data in Bargiełowna 1950).
Tashlhiyt	<i>Type frequency in text</i>	<b>451/5700 (7.9%)</b> of syntactic words in running text are composed of voiceless obstruents only (Ridouane 2008: 328f).
Thompson	Impressionistic	"Sequences of six obstruents are <i>not uncommon</i> ." (Thompson & Thompson 1992: 25).
Tohono O'odham	Impressionistic	Morphological and phonological processes "yield <i>a high frequency</i> of complex moras and very intricate syllables" (Hill & Zepeda 1992: 355).
Wutung	Type frequency in syllable inventory	<i>1/40 (2.5%)</i> of onset patterns are HC (calculated from data in Marmion 2010).
Yakima Sahaptin	Type frequency in lexicon	13/295 (4.4%) of underived nouns and adjectives have onsets of three or four Cs, 8/295 (3%) have codas of three or four Cs (calculated from data in Hargus & Beavert 2006).

Table 3.18. (cont.) Reported frequency	of Highly Complex	syllable patterns.	Emphasis
my own in all quotations.			

Comparing the relative frequency patterns in Table 3.18 to the combinatorial restriction patterns in Table 3.17, we find some correspondences between patterns which are not all that surprising. For example, it follows that Wutung, whose Highly Complex syllable patterns are restricted to a single four-consonant onset (3.29a), would also have a very low type frequency of this pattern in its syllable inventory. Similarly, it is expected that Georgian and Polish, both of which have larger clusters and fewer restrictions on consonant combinations, should have a higher type frequency of these patterns in their

syllable inventories.<sup>20</sup> The other kinds of frequency data — type frequency in the lexicon and in running text — also show this correspondence, with higher frequencies typically corresponding to languages with freer consonant combinations in their Highly Complex patterns. It should also be noted that frequency patterns are reported for all but one language with relatively free consonant combinations (Nuu-chah-nulth). Though quantitative type frequency data isn't given for Cocopa, Itelmen, or Thompson, the authors make a point of mentioning the high frequency and commonplace nature of Highly Complex structures in these languages.

Combining the results of the analyses in this section and §3.4.1, we can identify two extreme patterns in the prevalence of Highly Complex patterns in the data. On one extreme, there is a group of languages for which Highly Complex structures are a minor pattern. These languages have Highly Complex structures at only one syllable/word margin. The structures consist of three or maximally four consonants which are severely restricted in their combination, and have relatively low type frequencies (Table 3.19). On the other extreme, there is a group of languages for which Highly Complex structures are a prevalent pattern. These languages have Highly Complex structures at both syllable/ word margins. The structures may be more than four consonants in length, are relatively free in their combination, and have relatively high type frequencies (Table 3.20).

<sup>&</sup>lt;sup>20</sup> Mohawk presents an unexpected pattern, in that its cluster patterns are relatively restricted but it has a type frequency of Highly Complex clusters which is on par with that of Georgian and Polish. This is due to the very small consonant phoneme inventory of the language (ten consonants), which limits the overall size of the syllable inventory.

Language	Family	Region
Alamblak	Sepik	Australia & New Guinea
Doyayo	Niger-Congo	Africa
Kunjen	Pama-Nyungan	Australia & New Guinea
Menya	Trans-New Guinea	Australia & New Guinea
Wutung	Skou	Australia & New Guinea

Table 3.19. Languages with minor Highly Complex patterns.

Language	Family	Region
Cocopa	Yuman	NORTH AMERICA
Georgian	Kartvelian	Eurasia
Itelmen	Chukotko-Kamchatkan	Eurasia
Polish	Indo-European	Eurasia
Tashlhiyt	Afro-Asiatic	Africa
Thompson	Salishan	NORTH AMERICA
Tohono O'odham	Uto-Aztecan	NORTH AMERICA
Yakima Sahaptin	Sahaptian	NORTH AMERICA

Table 3.20. Languages with prevalent Highly Complex patterns.

Roughly half of the languages in the Highly Complex portion of the sample have syllable patterns which are at one of these extremes. There are different areal distributions for the two groups of languages. The languages with Highly Complex syllable structure as a very minor pattern include all those from the Australia & New Guinea macro-region, as well as one language from Africa (Doyayo). The languages with prevalent Highly Complex patterns are spoken in Eurasia, North America, and the Atlas Mountain region of Africa; i.e., regions identified in Chapter 1 as being well-known for their complex syllable patterns. I will return to discussion of these patterns in §3.5.

## 3.4.3 Acoustic and perceptual characteristics

Researchers often remark upon the phonetic characteristics of the long tautosyllabic clusters of obstruents which are characteristic of most languages with Highly Complex syllable structure. Descriptions typically note the presence of salient release or aspiration of stops, transitional vocalic elements between consonants at different places or with different manners of articulation, and lengthened consonant articulation for syllabic obstruents. These descriptions are relevant in the establishment of Highly Complex syllable structure as a language type which may have specific acoustic characteristics in addition to abstract phonological characteristics. It is also possible that clues to the development of Highly Complex syllable structure may be found in the acoustic and perceptual properties of these clusters. For example, it has been found that clusters resulting from historically recent processes of vowel syncope may retain traces of the previous vowel in the transitions between consonants (cf. Chitoran & Babaliyeva 2007 for Lezgian).

Descriptions of the acoustic and perceptual characteristics are available for 18/24 of the languages in the Highly Complex portion of the sample. This is somewhat remarkable, given that many of the languages are underdescribed, and that such detailed phonetic descriptions of consonant clusters are not a standard topic for inclusion in language references. In Table 3.21 I present these descriptions.

Language	Description of phonetic realization of consonant clusters
Alamblak	"Open transition," transcribed as [i], varies freely with release in obstruent and other sequences (Bruce 1984: 56-9).
Albanian	Release between obstruents varies freely with much rarer epenthetic [ə] in slow or careful speech (Klippenstein 2010: 24-6).
Camsá	"Nonphonemic transitional vocoid [ə]" occurs between stops or consonant plus nasal at different points of articulation; initial fricatives are lengthened and may have voiceless or voiced off-glide, transcribed as [ <sup>u</sup> ] or [ <sup>o</sup> ], before a non-fricative consonant at a different place of articulation (Howard 1967: 81).
*Сосора	Consonants in some sequences separated by "anaptyctic phonetic vowel" or "indistinct 'murmur' vowel" whose quality, transcribed [ <sup>i</sup> ], [ <sup>a</sup> ], or [ <sup>u</sup> ], is determined by surrounding consonants (Crawford 1966: 37-45).
Georgian	Stops in sequences nearly always released, sometimes with voicing if both are voiced; voiceless stops and affricates have strongly aspirated release; length of interval between $C_1$ and $C_2$ release depends on relative place of articulation of the consonants (Chitoran 1999).
Itelmen	Indeterminant "overtone" transcribed as [ə] and described as "extremely short, with an overtone indeterminant in timbre," occurs in words without vowels and certain consonant combinations (Volodin 1976: 40-1; translation SME).
Kunjen	"Brief transitional vocoids" may sometimes be heard between consonants in a cluster. (Sommer 1969: 33)
Lezgian	Before a voiceless stop or fricative, voiceless stops are always aspirated (Haspelmath 1993: 47); in clusters resulting from historical or synchronic syncope, traces of previous vowel remain audible in stop release and fricative noise (Chitoran & Babaliyeva 2007).
Menya	"Non-homorganic consonants are phonetically separated by extremely short vocalic segments which are more and more not being written"; quality of short segments is conditioned by surrounding consonants and vowels (Whitehead 2004: 9, 226).
Mohawk	Stops are "strongly aspirated" before another (non-identical) consonant. (Bonvillain 1973: 28)
Nuu-chah-nulth	The first stop or affricate of a like sequence has "a release typical for such consonants" (Kim 2003: 163-4). Epenthetic [I] occurs between a nasal and back stop or affricate (Rose 1981: 26-7). Voiceless plain stops are aspirated when they appear in syllable coda clusters (Davidson 2002: 12).
Piro	"A very salient feature of Yine consonant clusters is the prevalence of an audible interval between the release of the first consonant ( $C_1$ ) and the closure of the second consonant ( $C_2$ )". This "intra-cluster release" varies in duration, quality, and voicing, and is never obligatory (Hanson 2010: 28-9). Matteson & Pike (1958) describe these "non-phonemic transition vocoids" at length.

**Table 3.21.** Descriptions of acoustic and perceptual characteristics of clusters in languages with Highly Complex syllable structure. Languages omitted due to lack of description are Doyayo, Kabardian, Passamaquoddy-Maliseet, Polish, Qawasqar, and Wutung. \* indicates that reported pattern is for syllables with obstruent nuclei.

Language	Description of phonetic realization of consonant clusters
*Semai	Minor syllables consisting of consonants are "clearly heard and perceived as distinct syllables." (Sloan 1988: 321). Vocalic element in consonantal minor syllable "usually a very short, non-phonemic, epenthetic [ə]", but can vary in quality, and is "optional if the two consonants are easily pronounced without the epenthetic vowel." (Philips 2007: 2)
*Tashlhiyt	Short "voiced transitional vocoids" whose quality is predictable by surrounding vowels split consonant sequences when one is voiced (Dell & Elmedlaoui 2002: 16); Gordon & Nafi report this for occasional sequences of voiceless consonants (2012: 16), contra Ridouane (2008). "[S]top release is obligatory before another stop which is not homorganic with it." (Ridouane 2008: 210).
*Tehuelche	The "accumulation of consonants is made possible by the development of [] supporting vowels." These have "a neutral vowel quality which play the role of lubricator and which corresponds to the neutralization of all other vowels," and are transcribed as $[a]$ or $[u]$ depending upon consonantal environment (Fernández Garay & Hernández 2006: 13; Fernández Garay 1998; translation RNS)
Thompson	Plain stops are "somewhat aspirated" before another stop and often before spirants, and strongly aspirated syllable-finally (Thompson & Thompson 1992: 4). "Laryngeals are usually separated from preceding obstruents by a brief central vowel" whose precise quality is determined by the consonantal environment (1992: 44).
Tohono O'odham	Surface clusters resulting from historical vowel deletion have "very short, voiceless elements", phonetically transcribed as [ <sup>h</sup> ] but which may retain previous vowel quality coloration in the case of high vowels (Hill & Zepeda 1992: 356). Combinations of voiceless stops "might be considered as separated by a voiceless epenthetic." (Mason 1950: 81f).
Yakima Sahaptin	Excrescent [ <sup>i</sup> ] is possible in some consonant combinations, such as when a fricative precedes two stops (Hargus & Beavert 2002); aspiration accompanying voiceless stops has "formant structure that may superficially resemble" that of [i] (2002: 273-4f).

**Table 3.21. (cont.)** Descriptions of acoustic and perceptual characteristics of clusters in languages with Highly Complex syllable structure. Languages omitted due to lack of description are Doyayo, Kabardian, Passamaquoddy-Maliseet, Polish, Qawasqar, and Wutung. \* indicates that reported pattern is for syllables with obstruent nuclei.

Even though many of the descriptions make mention of 'epenthetic' vowels, the

patterns described above are consistent with those features listed by Hall (2006) as being

associated with intrusive vowels. The transitional elements in these clusters are

characterized by neutral vowel qualities that may be heavily influenced by surrounding

consonants, and may vary in their duration and voicing. In some cases the transitions are

described as occurring between specific combinations of consonants with different places of articulation.

Most of the references consulted for the above analysis were written by researchers who are not native speakers, and for whom the different timing patterns of these languages may be especially salient.<sup>21</sup> As mentioned in  $\S3.2.2$ , native speakers are often not aware of the presence of these transitional elements, and when they are aware of them, view them as optional. Menya provides an interesting illustration of this in its writing conventions. The short vocalic elements between non-homorganic consonants in the language are written only sporadically by literate native speakers, and even when they are written, there is unsystematic variation in the grapheme used (Whitehead 2004: 9, 226; the quote given in Table 3.21 may also be suggestive of a recent process of vowel reduction). Another piece of evidence for determining the intrusive nature of a vowel is in its 'invisibility' to phonological processes. In some cases, explicit descriptions of this are given. For example, the vocalic element transcribed as [1] that occurs between nasals and back stops or affricates in Nuu-chah-nulth is explicitly described as not being included in the syllable count which determines a vowel lengthening pattern in the language (Rose 1981: 27).

The striking similarities in the phonetic descriptions of Highly Complex structures in the 18 languages in Table 3.21 indicate that the languages of this category share more in common than just phonological structure. The presence of transitional elements is a

<sup>&</sup>lt;sup>21</sup> It is interesting to note that for Polish, which has a wealth of available descriptive material, I could find few details on the phonetic characteristics of clusters. Many of the references for this language were written by native speakers (e.g., Jassem, Rubach, Bargiełowna).

prominent phonetic characteristic of Highly Complex syllable structure. It is also notable that the phonetic descriptions of syllabic obstruents in Cocopa, Semai, Tashlhiyt, and Tehuelche are virtually indistinguishable from the phonetic descriptions of tautosyllabic clusters in the other languages. This recalls Hall's observation that vowel intrusion and syllabic consonants are motivated by similar processes of gestural overlap, and is further justification for grouping these languages together with the others.

## **3.5. Discussion**

As mentioned in §3.1, the studies in this chapter serve two purposes: first, to provide a baseline characterization of syllable patterns in the language sample as a whole; and second, to elucidate in greater detail the specific patterns occurring in languages with Highly Complex syllable structure.

In Table 3.22 I summarize the results from §3.3 regarding syllable patterns in the language sample as a whole, and describe how the findings relate to syllable structure complexity.

Aspect of syllable structure	Finding	
<b>1.</b> <i>Relationship between maximum onset and coda complexity (§3.3.2)</i>	A large cluster at one margin typically implies a large cluster at the other margin.	
<b>2.</b> <i>Obligatoriness of syllable margins</i> (§3.3.3)	Least common in S lgs, most common in HC lgs.	
<b>3.</b> <i>Complex vocalic nuclei (§3.3.4)</i>	Much less likely to occur in S lgs.	
<b>4.</b> <i>Presence of syllabic consonants</i> (§3.3.5)	Least common in S lgs, most common in HC lgs.	
<b>5.</b> <i>Morphological constituency patterns</i> (§3.3.6)		
<b>a.</b> of maximum syllable margins	Heteromorphemic patterns increase with syllable structure complexity.	
<b>b.</b> of syllabic consonants	More likely to be found in grammatical items as syllable structure increases.	

**Table 3.22.** Summary of findings regarding syllable patterns in language sample as a whole.

Some of the analyses presented in §3.3, corresponding to the findings in lines 1-3 of Table 3.22, were exploratory and conducted without any underlying hypotheses. Nevertheless these analyses yielded relevant results with respect to syllable structure complexity.

The relationship between maximum onset and coda complexity, in which the presence of large (four or more consonants) sequences at one syllable margin in a language typically implies the presence of large sequences at the other margin, is especially interesting. This is not an expected pattern in terms of probabilistic distribution: if onsets and codas are independent structures, then we would expect to observe a wider range of combinations in maximum onset and coda sizes. However, if syllable structure is viewed not as an entity with abstract phonological motivations, but as a phenomenon reflecting articulatory routines carried out over many generations in the

history of a language, this pattern may not be surprising. It is reasonable to imagine, for instance, a scenario in which a strong tendency toward vowel reduction in a language with prefixation and suffixation of stress-carrying stems might result in the eventual deletion or complete gestural overlap of many or most unstressed vowels, yielding long clusters of consonants in both word-marginal contexts. This issue will be discussed further in Chapters 5, 6, and 8.

Similarly, the pattern observed with respect to obligatory syllable margins and syllable structure complexity is not necessarily expected. In languages with Simple syllable structure, obligatory onsets significantly limit the size of the syllable inventory. However, this effect on the syllable inventory would be much smaller in languages in the other syllable structure complexity categories. It does not necessarily follow that the Highly Complex category should have a higher rate of obligatory margins than the other categories. Three of the languages with obligatory onsets in the Highly Complex category (Thompson, Tohono O'odham, and Yakima Sahaptin), as well as one language in this group which likely had obligatory onsets historically (Itelmen), also happen to be in the group of languages whose Highly Complex patterns are most prevalent (§3.4.2). Placed in the context of languages in which large consonant clusters are prevalent and the consonant to vowel ratio is presumably higher than average, perhaps the high rate of obligatory syllable margins is not surprising for this category.

Greater syllable structure complexity is also associated with greater likelihood of a language having complex vocalic nuclei (long vowels, diphthongs, or vowel sequences) and/or syllabic consonants. The specific combinatorial restrictions between syllable

margins and nuclei are not explored here and therefore not quantified. However, the general effect of these patterns could be that as syllable structure complexity increases, so does the range of possible syllable types, and not just as a result of increased consonant combinations. The diversity in syllable margins which provide the basis for the definitions of syllable structure complexity may be accompanied by greater diversity in syllable nuclei as syllable structure complexity increases. This issue will be explored in greater depth in §4.3.

The data here confirms the hypothesis that languages with more complex syllable structure are more likely to have syllabic consonants. This pattern is strongly present even when syllabic obstruents are not considered. These results are not in line with the predictions of Isačenko (1939/1940), who observed that 'vocalic' languages — a term defined in part by a low consonant to vowel ratio and simpler syllable patterns — are more likely to develop syllabic sonorants. Isačenko's study is limited to Slavic languages, so it is possible that this group of languages presents an exception to the cross-linguistic patterns. However, the findings of the current study should be considered in the context of Isačenko's larger point that 'vocalic' and 'consonantal' languages are characterized not only by different segmental inventory and syllable patterns, but also by different diachronic and synchronic processes of language change. It is known that syllabic consonants often come about through vowel reduction (Bell 1978a), and indeed we observe a set of variable syllabic consonants in the data which come about through vowel reduction. Independently of the observation that vowel reduction is known to create tautosyllabic clusters in some languages, the syllabic consonant patterns here suggest a

higher occurrence of vowel reduction processes, both diachronic and synchronic, in languages with more complex syllable structure. This issue will be explored in greater detail in Chapter 6.

The hypothesis with respect to morphological patterns in the data was also confirmed. As syllable structure increases, maximum onset and coda clusters are more likely to exhibit heteromorphemic patterns, and syllabic consonant inventories are more likely to have members which correspond to grammatical morphemes. These findings point toward a strong influence of morphology in the development of more complex, and specifically Highly Complex, syllable structures. The scope of this dissertation is limited to phonological systems and does not allow for an in-depth study of the morphological patterns of the language sample. However, the issue of the role of morphology in the syllable patterns of languages in the Highly Complex group will be revisited in Chapter 8.

The analysis of the Highly Complex patterns in §3.4 reveals important patterns within this group of languages that should be considered in the coming chapters. The first is that there are measures by which this is not a coherent group of languages. Analyses of the specific syllable structures occurring in these languages, as well as the restrictions on these structures and their frequency of occurrence, suggests that there are instead several groups. In one group of five languages, mostly from Australia & New Guinea, Highly Complex syllable structure is an extremely minor pattern, and includes low frequencies of highly restricted structures, often containing several sonorants, at one syllable margin. In another group of eight languages, mostly from Eurasia and North America, Highly

Complex syllable structure is a prevalent pattern, and involves high frequencies of long, fairly unrestricted strings of obstruents at both syllable margins. While it wasn't explicitly discussed in §3.4, these two groups also have different morphological patterns in their maximum syllable structures. Most of the languages with minor Highly Complex patterns have tautomorphemic patterns in their maximum syllable margins (the single exception being Doyayo). By comparison, all of the languages with prevalent Highly Complex patterns have heteromorphemic patterns in their maximum syllable/word margins.

Thus there are two extreme groups within the Highly Complex category which can be set apart from the rest on the basis of having different sets of coherent behavior in their syllable patterns. The other 11 languages of the sample fall somewhere between these two extremes. In the upcoming studies it will be discussed how languages on the two extremes of the Highly Complex category also exhibit coherent differences in their segmental inventories, stress patterns, and phonological processes, and how the languages in between the extremes behave more like one group or another.

The second important finding in §3.4 is that there is another measure by which the languages of the Highly Complex category *are* a coherent group of languages. In all languages for which phonetic properties of clusters were described, Highly Complex clusters were described as having largely similar acoustic and perceptual characteristics. This is true of both languages with large tautosyllabic clusters and those with syllabic obstruents, suggesting that these phenomena are qualitatively similar and/or have similar origins. This point will be revisited in Chapter 8.

#### **CHAPTER 4:**

# PHONEME INVENTORIES AND SYLLABLE STRUCTURE COMPLEXITY

The central research questions of the dissertation seek to (i) establish whether highly complex syllable structure is associated with other phonological features such that it can be identified as a coherent linguistic type, and (ii) use these findings to inform diachronic paths of development for these structures. The purpose of this chapter and the ones that follow is to address these research questions by examining other phonological properties of the language sample as they relate to syllable structure complexity. In this chapter I examine the properties of segment inventories in the language sample. Specifically, I test several hypotheses relating the size and constituency of vowel, and especially consonant, inventories to syllable structure complexity.

The chapter is organized as follows. In §4.1 I discuss previous findings in the literature regarding properties of consonant and vowel inventories, and accounts put forth to explain predominant cross-linguistic trends in the patterns observed. I then discuss relevant findings relating the structure of sound inventories to syllable structure complexity, and introduce the hypotheses to be tested in the current study. In §4.2 I describe the methodology behind the data collection and the coding process. In §4.3 I present a brief analysis of vowel inventory properties and test the hypothesis that syllable structure complexity is associated with larger vocalic nucleus inventories. §4.4 is a longer section presenting several different analyses testing hypotheses regarding the size and makeup of consonant inventories with respect to syllable structure complexity. In §4.5 I

discuss the results as they relate to highly complex syllable structure, its development, and syllable structure-based phonological typologies more generally.

## 4.1 Introduction

The scope of the current study is limited to examining the properties of segmental phonemes, the more or less discrete units corresponding to contrastive sounds in a language. Suprasegmental properties, including stress and tone, will be considered in Chapter 5. Certain kinds of variation in segments, including vowel reduction and specific kinds of consonant allophony, will be considered in Chapters 6 and 7.

A segmental phoneme is an abstract unit corresponding to a set of sounds, usually phonetically similar to one another, which have some functional, cognitive, and/or perceptual equivalence in a language. A language's phoneme inventory is the group of such units which meaningfully contrast with one another in that language, e.g., /l/ and /b/ in the English pair *leek* and *beak*. This concept is well over a century old and has been modified over the years (e.g., Sapir 1925, Chomsky & Halle 1968), but is still widely used in both theoretical models and language descriptions.

A disadvantage of phonemic analysis is that it forces a discrete linear analysis on the continuous speech stream. The result of this segmental phonemic analysis, argues Moreno Cabrera, is a theoretical representation which is more reflective of the alphabetic scripts used by the majority of linguists in everyday life than it is of any real property of spoken language (2008: 122). Noting these problems, some models posit that phonological structures are emergent from more general speech processes. For example,

in the Articulatory Phonology framework (Browman & Goldstein 1992b), syllable patterns emerge from the coordination and phasing of gestures. In Lindblom's (2000) model, segments and gestures themselves are adaptations to biophysical constraints on perception and production, as well as processes of memory encoding. Indeed, alternative views such as Articulatory Phonology and exemplar models of language (Bybee 2001) may provide more satisfactory accounts for the fine-grained and gradient nature of sound variation and change. Nevertheless, for all the problematic aspects of phonemic analysis, phoneme inventories are useful points of comparison in typological studies such as the current work. Most language references provide such an analysis at the very minimum, even if no other phonetic or phonological description is given.

Phoneme inventories are perhaps the best-researched topic in phonological typology, with numerous large-scale surveys dedicated to their study. Standard works on the typology of phoneme inventories occur as early as the mid-20th century (e.g., Hockett 1955). The Stanford Phonology Archive (Crothers et al. 1979), a project undertaken in connection to the Stanford Universals Project, was the first computerized database of phoneme inventories. Maddieson (1984) drew upon this work in his survey of 317 genealogically balanced languages, the UCLA Phonological Segment Inventory Database (UPSID). Since then, many such large typological surveys of phoneme inventories have been developed, including an expanded version of UPSID (451 languages, Maddieson & Precoda 1990), the Lyon-Albuquerque Phonological Systems Database (~700 languages, Maddieson et al. 2013), PHOIBLE (1,672 languages, Moran et al. 2014), and portions of the World Atlas of Language Structures (~565 languages, Maddieson 2013b, 2013c, inter

alia). In addition to these, there have been extensive surveys of phoneme inventories in specific geographical areas (e.g., Michael et al. 2015 for South America, Gasser & Bowern 2014 for Australia). There are also a great many studies examining the cross-linguistic properties and patterns of specific kinds of sounds, including nasalized vowels (Hajek 2013), ejectives (Fallon 2002), consonants with secondary palatalization (Hall 2000), affricates (Berns 2013), and post-velar consonants (Sylak-Glassman 2014).

In sections §4.1.1 and §4.1.2 I briefly discuss some typological findings regarding consonant and vowel inventories, respectively, and some proposed accounts for these patterns. In §4.1.3 I discuss findings in the literature associating properties of segmental inventories with syllable structure complexity, and in §4.1.4 I formulate several specific hypotheses for the current study.

#### **4.1.1** Typological patterns in consonant inventories

In articulatory terms, consonants and vowels are distinguished from one another by the degree to which the vocal tract is constricted in their production, with consonants having greater constriction than vowels. Consonants are typically classified according to their articulatory characteristics, which include phonation, the place of constriction in the vocal tract, and the manner of constriction.

Consonant phoneme inventory size is a common point of comparison in crosslinguistic studies of phonological systems. In the 563-language sample in Maddieson (2013b), the languages have an average of 22.7 consonant phonemes, though values range widely from six consonants (in Rotokas) to 122 consonants (in !Xóõ). There are areal patterns to the distribution of consonant inventory size. Small inventories (6-14 consonants) are common in New Guinea and the Amazon region of South America. Large consonant inventories (26 or more consonants) are concentrated in the Pacific Northwest and northern coast of North America, northern Europe, the Caucasus region, and regions of Africa.

One of the contributions of the 317-language survey in Maddieson (1984) was the establishment of cross-linguistic frequency patterns for consonant phonemes. The following consonants are the 20 most frequently present in the inventories of the language sample (\* indicates that dental and alveolar consonants have been pooled).

(4.1) /p b \*t \*d k g ? t∫ f \*s ∫ h m \*n ŋ ŋ w \*l \*r j/

(Maddieson 1984: 12)

None of the consonants in (4.1) were found to occur in every language in the sample, and some (/?  $\widehat{t} \int \int p r/$ ) were found in less than 50% of the languages. It follows that strict implicational hierarchies derived from these frequency measures do not accurately predict the makeup of observed consonant phoneme inventories, small or large. Nevertheless, all spoken languages have at least several of the consonants in (4.1), even though there are hundreds of other consonants from which inventories could hypothetically be entirely drawn. The constituency of the set in (4.1) in terms of numbers of stops, fricatives, nasals, and so on closely resembles the modal makeup of consonant inventories in the sample overall. Lindblom & Maddieson (1988) note that this set of

consonants is nearly identical to that reported for stages of early speech and babbling. Furthermore, in a sample of 32 diverse languages, Gordon finds that there is a strong positive correlation between the frequency of these consonants cross-linguistically (that is, across consonant inventories) and the type frequency of these consonants within languages (2016: 73-4).

The convergence of these patterns suggests a phonetic naturalness to the consonants in (4.1) which many researchers have attempted to account for. Stevens (1989) shows that there are configurations of articulators within the vocal tract where the acoustic and auditory properties of a sound are fairly stable with respect to variations in the articulation. He suggests that these regions of acoustic-perceptual stability underly the common distinctions found in phoneme inventories. Maddieson (1996) proposes that phonological patterns are motivated by gestural economy, in that optimal contrastive sounds will involve gestures which are both inherently efficient in their motor requirements and have a high degree of auditory distinctiveness. Other accounts take a more abstract approach. Ohala (1979) observes that consonants in small phoneme inventories may be perceptually close to one another and differ by a minimum rather than maximum of distinctive features. On the basis of this he proposes that consonant phoneme inventories are motivated by a principle of Maximum Utilization of Available Features (MUAF). In a similar vein, Clements (2003) proposes that consonant inventories tend towards economy in their constituency; that is, sounds are less likely to occur in a language if their distinctive features are not employed elsewhere in the phoneme inventory, and more likely to occur if all their distinctive features occur

elsewhere in the phoneme inventory. The set of consonants in (4.1) is quite coherent in this respect. A typological study of borrowed sounds lends support to these accounts: Maddieson (1985) finds that borrowed sounds are statistically much more likely to fill gaps in the phonological inventory of the recipient language than to alter the basic contrasts of the system.

Lindblom & Maddieson (1988) propose an account for the observed crosslinguistic tendencies which is rooted in properties of articulatory complexity. In their model, consonants are divided into three sets: Set I, basic articulations which often correspond to those in (4.1); Set II, elaborated articulations corresponding with properties to be described below; and Set III, complex articulations, consisting of combinations of elaborated articulations. Elaborated articulations are defined as those which depart from default modes of phonation and manner (especially airstream mechanism), as well as place articulations which depart from the neutral near-rest positions of active articulators in the vocal tract. A list of these elaborations is reproduced in Table 4.1.

Phonation	Manner	Place
breathy voice creaky voice voiced fricatives/affricates voiceless sonorants pre-aspiration post-aspiration	prenasalization nasal release lateral release ejectives implosives clicks	labiodental palatoalveolar retroflex uvular pharyngeal palatalization labialization pharyngealization velarization

**Table 4.1.** Elaborated consonant articulations, as presented in Lindblom & Maddieson (1988: 67).

The model predicts that as consonant inventory sizes increase, languages will include phonemes from Set I (e.g., /k/) until that set is more or less exhausted, at which point Set II consonants (e.g., /k<sup>w</sup>/) and then eventually Set III consonants (e.g., /k<sup>w</sup>'/) may occur. Lindblom & Maddieson show that this prediction is borne out in the obstruent inventories of the 317-language sample from Maddieson (1984). They suggest that these patterns, at all levels of consonant inventory size, reflect a balance between competing pressures to keep articulatory complexity low while maintaining a sufficient level of perceptual contrast in the system (1988: 72).

There are of course many other issues related to consonant inventory patterns which are too numerous to discuss here (e.g., common gaps in stop inventories with respect to place of articulation and voicing). An overview of many such patterns and proposed phonetic accounts for them can be found in Ohala (1983).

The issues of consonant phoneme inventory size and elaborated articulations will be revisited in §4.1.3 and §4.1.4. In the following section I discuss reported typological patterns of vowel phoneme inventories.

### **4.1.2** Typological patterns in vowel inventories

As described above, vowels are speech articulations which involve relatively less constriction in the vocal tract than consonants. Vowels are typically classified according to the height and backness of the tongue body and the rounding of the lips, which together constitute vowel 'quality'. Other articulatory characteristics, such as length,
nasalization, and voicing may also be contrastive for these sounds, but only in addition to vowel quality.

Perhaps the most common point of typological comparison for vowel phoneme systems is the number and nature of vowel qualities present. Over half of the languages in the 564-language survey in Maddieson (2013c) have five or six vowel qualities present in their phoneme inventories. Like consonant phoneme inventory size, vowel quality inventory size has strong areal patterns with respect to its distribution. Smaller than average systems are common in the Americas, Australia, and isolated smaller regions. Larger than average systems are common in the central belt region of Africa, Southeast Asia, and parts of Eurasia. Areal patterning may be observed in other vowel features, including contrastive nasalization, which is predominantly concentrated in Western Africa and the Amazon region.

The five most common vowel quality phonemes in Maddieson's (1984) survey are /i a u "o" "e"/ (where quotations indicate that these may not be distinguishable from other vowels in the mid area in the references consulted). Unlike the situation with consonants above, there are many languages which have a triangular system of five vowels corresponding exactly to this set (1984: 136). Generally speaking, there are strong cross-linguistic tendencies relating the size of vowel quality inventories to the vowel qualities observed to occur. For example: for example, 3-vowel systems are most often of the shape /i a u/.

Just as with cross-linguistic tendencies in consonant inventories, both acoustic/ perceptual and articulatory accounts have been put forward to explain the observed facts.

Liljencrants & Lindblom (1972) test the hypothesis that vowel inventories pattern in such a way as to maximize perceptual distance, measured as a function of formant values. The predictions of their model match very closely the most common vowel quality inventories for vowel systems of three, four, and five vowels, but for larger inventories, there are discrepancies between the model and observed cross-linguistic patterns. The study by Stevens (1989) mentioned above considered vowel systems in addition to consonant systems, and determined /i a u/ to be regions of acoustic/perceptual stability with respect to articulatory variation. Lindblom & Maddieson (1988) also explored vowel inventory patterns and concluded that as with consonant systems, common vowel system patterns reflect competing pressures of maximization of perceptual contrast and minimization of articulatory complexity. Thus it is not expected that articulatorily 'complex' contrasts such as phonation, nasalization, length, and so on would be present in a system of five total vowels, where perceptual distinctiveness can be easily achieved by vowel quality differences alone. Analogous to their model of consonant elaborations, differences in phonation, nasalization, and so on should be expected to occur only in larger systems where vowel quality contrasts have already been exploited. From a diachronic point of view, such contrasts in vowel systems typically imply larger vowel inventories because they come about through sound changes that are systematic across the vowel system or large portions of the vowel system.

#### 4.1.3 Segmental inventories and syllable structure complexity

The typological patterns described above and the proposed accounts for them are limited to phoneme inventories themselves and do not consider possible interactions between phoneme inventories with other aspects of language structure. Yet correlations between phoneme inventories and other phonological structures, most notably syllable structure complexity, have been found.

Maddieson (2006) determined that there is a highly significant positive correlation between consonant phoneme inventory size and syllable structure complexity in a sample of roughly 520 languages. In that study, it was found that languages with Simple syllable structure had an average of 19.3, languages with Moderately Complex syllable structure an average of 21.8, and languages with Complex syllable structure an average of 25.7 consonant phonemes (Maddieson 2013a reports similar findings). Within this sample, there are some overlapping geographical distributions of small consonant inventories and simpler syllable structures on the one hand and large consonant inventories and more complex syllable structure on the other hand. The Pacific Northwest region of North America would be an example of a region with the latter pattern, and the Amazon Basin would be an example of a region with the former pattern. However, Maddieson rejected the idea that the overall correlation was the result of several small-scale patterns, finding the general trend to hold up significantly in all but one of the large geographical regions examined. He concludes that the association between consonant phoneme inventory size and syllable structure complexity is cross-linguistically robust and suggests that "paths of

natural historical linguistic change" may be behind this mutually reinforcing pattern of complexity (2006: 118).

Consonant phoneme inventory size is positively correlated with syllable structure complexity when it is measured in non-categorical ways, too. Maddieson (2011) reports a positive correlation between consonant inventory size and Syllable Index values. The Syllable Index is a sum of maximum onset, nucleus, and coda complexity values, closely but not perfectly corresponding to the number of segments in the maximum syllable type. Gordon (2016) plots consonant inventory size against the sum of maximum syllable margins for each language in the modified WALS 100-language sample and finds an increasing, if not stepwise trend. He reports similar results for analyses considering only onset or coda size.

There has been limited research into the patterns of specific segment types and syllable structure complexity. Maddieson et al. (2013) report a relationship between segmental complexity in phoneme inventories and syllable structure complexity in the ~700-language LAPSyD sample. In this study they consider the number of consonants with one or more elaborated articulations, as defined by Lindblom & Maddieson (1988) and listed in Table 4.1 above. They find that languages with Complex syllable structure have a mean of 9.6 consonants with elaborated articulations, as compared to a mean of 6.2 and 4.8 such consonants in the Moderately Complex and Simple categories, respectively. The difference between the Complex pattern and the two other patterns combined was found to be statistically significant.

There have also been suggestions of correlations between phoneme inventory properties and other phonological features at smaller scales, within regions or language families. In his holistic phonological typology of Slavic languages, Isačenko (1939/1940) notes that 'consonantal' languages are defined by a collection of features, including more complex syllable structure, a larger proportion of consonants in the phoneme inventory, and the presence of contrastive secondary palatalization at various places of articulation. Russian and Polish are prototypical examples of such languages. By comparison, 'vocalic' languages have simpler syllable structure, smaller proportions of consonants in the phoneme inventory, and secondary palatalization which is limited to dental consonants or altogether absent. The Ljublana dialect of Slovene exemplifies this type. Chirikba calls all languages of the Caucasus "consonant-type languages", a term which encompasses a heavy dominance of consonants over vowels in the speech signal, rich consonant inventories, and restricted vowel systems (2008: 43). Chirikba specifically notes the typologically unusual nature of consonant systems in the languages of the region, which include ejectives and richly elaborated sibilant and post-velar articulations.

The above observations bring up another relationship worth mentioning, which is that between consonant inventory size and vowel inventory size. While no correlation has ever been established between consonant inventory size and vowel quality inventory size (Maddieson 2013c), a positive correlation has been found between consonant inventory size and total vowel inventory size (Maddieson 2011). In that study, the 'total vowel inventory' includes vowels which contrast in length, nasalization, and phonation properties, as well as diphthongs analyzed as unitary, but does not include tautosyllabic

vowel sequences or diphthongs that can be parsed into constituents corresponding to basic vowels in the language.

#### 4.1.4 The current study and hypotheses

The findings described above indicate that the relationship between properties of segment, and especially consonant, inventories and syllable structure complexity is notable at global, regional, and family levels, and thus worthy of further investigation. The findings are directly relevant to the broad research questions of the dissertation, which I reproduce below (4.2)-(4.3).

- (4.2) Do languages with highly complex syllable structure share other phonetic and phonological characteristics such that this group can be classified as a linguistic type?
- (4.3) How does highly complex syllable structure develop over time?

The hypotheses I introduce and test here build on the previous findings by investigating the relationships between more specific properties of phoneme inventories and syllable structure complexity, addressing (4.2). Depending on their nature, these findings may help to shed light on those "paths of natural historical linguistic change" suggested by Maddieson (2006:118) to motivate the observed correlations, thus addressing (4.3).

The first hypothesis concerns vocalic nucleus inventory size and syllable structure complexity. Recall that in §3.3.4 it was found that complex vocalic nuclei, defined there

as long vowels, diphthongs, and/or tautosyllabic vowel sequences, were more frequently present in languages with more complex syllable structure. There is reason to explore this pattern in more depth here. As noted above, a positive correlation between total vowel inventory size and consonant phoneme inventory size has been established in the literature (Maddieson 2011). A corresponding linear trend was not found between total vowel inventory size and syllable structure complexity. However, the measure of total vowel inventory size did not include tautosyllabic vowel sequences or diphthongs that can be alternatively analyzed as sequences of segments. Thus it would be interesting to test whether a relationship exists between the *total number of vocalic nuclei* in a language and syllable structure complexity. If such a relationship is found, it would suggest that higher syllable margin diversity is accompanied by higher nucleic diversity in languages with more complex syllable structure, a fact that would have to be considered in any diachronic account of the development of highly complex syllable structure. The hypotheses is as follows (4.4).

(4.4) H<sub>1</sub>: As syllable structure complexity increases, languages will have larger inventories of vocalic nuclei.

(4.4) is the only hypothesis regarding vowel patterns in the sample. The remaining hypotheses are concerned with consonant patterns. The second hypothesis follows the findings of Maddieson (2006), and simply predicts that the previously determined positive association between syllable structure complexity and consonant phoneme

inventory size will be upheld when the additional category of Highly Complex syllable structure is included in the analysis. Following observations by Gordon (2016), I also expect that consonant phoneme inventory size will increase with syllable structure complexity when it is measured not just categorically but also as a sum of maximum syllable margins. This hypothesis is given in (4.5).

(4.5) H<sub>2</sub>: As syllable structure complexity increases, so does the size of consonant phoneme inventories.

The third hypothesis is aimed at quantifying the number of articulatory elaborations present in the consonant inventories of languages with different syllable structure complexity. Maddieson et al. (2013) found a higher mean number of consonants with elaborated articulations in languages with more complex syllable structure. However, the reported findings of that study did not consider whether languages with more complex syllable structure also had more distinct elaborations present in their consonant inventories. That is, the findings do not indicate whether languages with more complex syllable structure have more elaborations in general, or just more consonants sharing the same elaboration. Reported phonological patterns for areas well-known for having complex syllable patterns suggest the presence of more elaborations in their consonant inventories (e.g., ejectives and uvulars in the Caucasus, lateral release and ejectives in the Pacific Northwest). This would also follow indirectly from Lindblom & Maddieson (1988), who found a higher number of consonants with combinations of elaborated articulations in languages with large consonant inventories. This leads me to formulate the third hypothesis as follows (4.6).

(4.6) H<sub>3</sub>: As syllable structure complexity increases, so does the number of articulatory elaborations present in consonant phoneme inventories.

The final hypothesis relates syllable structure complexity to the occurrence of specific consonant types. This hypothesis is motivated by the observation that there are certain consonants which seem characteristic of languages with more complex syllable structure. Specifically, post-velar and especially uvular consonants, though cross-linguistically rare, are common in regions also famous for complex syllable structure, including the Pacific Northwest, the Caucasus, and the Atlas Mountain region. Similarly, it is my observation that ejectives are often found in languages with complex syllable structure, and often co-occur with uvular consonants in those languages. Based on these observations, I formulate the following hypothesis.

(4.7) H<sub>4</sub>: Languages with differing degrees of syllable structure complexity will exhibit different consonant contrasts in their phoneme inventories.

The data analyses addressing the hypotheses will be presented in §4.3 and §4.4. In the next section I describe the methodology behind the data collection and coding for these analyses.

#### 4.2 Methodology

#### **4.2.1 Patterns considered**

In this chapter, only the segmental patterns of the language sample are considered. While most of the analyses here will treat specific articulations that do not constitute segments on their own (i.e., those associated with place, manner, voicing, length, etc.), it must take as a starting point the consonant and vowel phoneme inventories of the language sample. These are understood to be the more or less discrete units which are mostly unpredictable in their distribution and meaningfully contrastive in the native lexicon and grammar of a language. Though consonant and vowel phoneme inventories are reliably reported in most language references, phonemic analysis is not always a straightforward endeavor. Here I discuss some issues that arise in determining phoneme inventory patterns.

Phonemic inventories are always the result of an analysis. It is common for there to be slight disagreements regarding the composition of the phoneme inventory in different descriptive materials for the same language. Authors may be writing in different time periods, describing different dialects and/or speech styles, or, in the case of highly endangered languages, working with speakers with varying degrees of proficiency in the language. When sources disagree on just a few elements of the phoneme inventory, I take these factors into consideration. For example, two of the sources on Nuu-chah-nulth, Stonham (1999) and Davidson (2002), list uvular ejectives /q' q<sup>w</sup>/ in the consonant phoneme inventory, but a third source (Kim 2003) does not. The former analyses are

based primarily on the field notes of Edward Sapir, who worked with the language from 1914-1924. Kim (2003) shows that ejective uvulars have long since merged with pharyngeal /S/ in the present language. I take the more recent analysis to be accurate for the current state of the language.

Of course, the choices made in a phonemic analysis may reflect a number of other factors, including the data available and the author's own theoretical training and native language biases. When sources present dramatically different phoneme inventories, I accept the source which supports the analysis more thoroughly with illustrative language-internal data. For example, Oliveira (2005) presents a consonant phoneme inventory for Apinayé which includes an entire prenasalized consonant series which is not listed in Burgess & Ham (1968), who take a more abstract formalist approach. Oliveira shows that although prenasalized consonants are often in complementary distribution with nasals in the language, there are minimal pairs showing that these sounds are meaningfully contrastive in some environments, an observation that is reinforced by reported native speaker intuition about the forms. Therefore I take Oliveira's analysis to be accurate.

Sounds which are limited to recent loanwords, the speech of bilinguals, and certain speech styles were not included in the present study. For instance, in Cocopa, mid front vowel /e/ is described as occurring only in loanwords from Spanish and English, and even then is often replaced by native /i/ (Crawford 1966: 26). In Aguacatenango Tzeltal, voiceless labial fricative

/f/ and alveolar trill /r/ are reported to occur only in loanwords in the speech of 'acculturated' Spanish bilinguals (Kaufman 1971: 13). In Chipaya, glottal stop /?/ occurs

in one obsolescing morpheme, *-?a*, a declarative suffix used when women address other women (Cerrón-Palomino 2006: 55-6). In all these and similar cases, the given sounds were omitted from the current analysis.

Authors of language descriptions often present 'marginal' phonemes — those occurring with very low frequency, highly limited distributions, or in just a few lexical items — in addition to more straightforward ones. Where authors show these to be contrastive in lexical items, I have generally included such phonemes here. For example, in Kharia, retroflex flap [r] is normally an intervocalic allophone of voiced retroflex stop /d/. But because the flap contrasts with the stop in at least one minimal pair, I have counted /r/ as a separate phoneme for this analysis (4.8a-b).

- (4.8) Kharia (*Austro-Asiatic*; India)
- (a) [odo?]

'become more; more; and'

(b) [oro?]

'get stuck'

(Peterson 2011: 29)

Where a marginal phoneme is described as clearly obsolescing or merging with another sound to the point where the contrast is no longer meaningful, I have excluded it. For example, in West Greenlandic, voiceless apico-postalveolar fricative /s/ is described as occurring only in the central dialect region, where it has rapidly receded and merged with

voiceless alveolar fricative /s/ for most speakers (Fortescue 1984: 334). Thus I have not included /s/ as a separate phoneme in the consonant inventory of the language.

As mentioned in §3.2.1, sounds with multiple articulations, such as labialized consonants, affricates, or diphthongs, present obvious complications for a study of this sort. The analysis of a phonetic sequence, such as [mb], as either a sequence of two simple segments or as a single complex segment can in turn affect how the canonical syllable patterns of a language are analyzed.<sup>22</sup> Because issues such as these may create a potential confound in how we interpret associations between syllable structure complexity and segmental inventories, it is important that competing analyses be carefully evaluated.

Instrumental data can be used to support either a complex segment analysis or a sequential analysis in such a scenario. For example, if a phonetic sequence of homorganic nasal+stop has a durational pattern comparable to that of a simple voiceless stop in a language, this might be taken as evidence for a complex segment analysis (e.g., as shown for Fijian by Maddieson 1989a; though Ladefoged & Maddieson 1996 note that there is wide cross-linguistic variation in timing patterns in prenasalized consonants). There are a few studies on such issues in languages of the current sample. For example, Chitoran (1998) uses acoustic evidence to argue that Georgian harmonic clusters (e.g., [dg], [t<sup>h</sup>k<sup>h</sup>]) are better analyzed as sequences than as complex segments, as some have claimed. She shows that each member of a harmonic cluster has a release burst, and that the durational properties of these clusters word-internally do not differ significantly from identical

<sup>&</sup>lt;sup>22</sup> Of course, these issues may not prove so problematic in an Articulatory Phonology framework, or any model which does not force a discrete segmental analysis upon sound and syllable patterns.

sequences found across word boundaries. However, it is generally very rare in the language descriptions consulted here for authors to present acoustic or articulatory evidence supporting one analysis over another in these situations. In the absence of instrumental data, authors often rely on phonological criteria to support their analyses.

Sometimes authors base their analyses on distributional data. Erickson argues that phonetic C+[w] structures in Lao are in fact labialized consonants and not onset clusters. He observes that no corresponding C+[j] sequences (or palatalized consonants, for that matter) occur as onsets in the language, and that C+[w] structures are infrequent and limited in their distribution, occurring almost entirely before the low vowel /a/ and never before rounded vowels (2001: 135-8). These facts suggest a historical process by which the consonant in C+[u] sequences may have taken on the rounding of the high back vowel, a cross-linguistically common type of assimilation. Note that in this case, either analysis would put the language in the Moderately Complex category in the current study.

Similar criteria are used to posit a series of prenasalized consonants in Tukang Besi. If these structures were considered to be sequences, then they would be the only consonant clusters occurring in the language, which otherwise has canonical (C)V structure. Prenasalized consonants behave as a unit in reduplication processes; that is, words like *karambau* have *kara-karambau* as a reduplicated form, instead of *karamkarambau*. (Of course, this argument assumes a syllabification of *ka.ram.bau* in the scenario that [mb] is a sequence and not a complex segment). Additionally, native speakers put syllable breaks before the nasal+C sequences when dividing words into syllables (Donohue 1999: 30-31).

The Tukang Besi evidence is not strictly conclusive. The language could be analyzed as having (C)(C)V syllable structure which has very specific restrictions on  $C_2$ and  $C_1$ . In this case the ambiguous interpretation has important consequences for syllable structure complexity: one interpretation puts the language into the Simple category, while the other puts it into the Complex category. There is just one language in the Complex category, Lunda, which has biconsonantal onset patterns fitting the hypothetical (C)(C)V pattern for Tukang Besi. However, in Lunda other biconsonantal onsets, like C+glide sequences, also occur, and the nasal+C sequences may come about through morphological processes (4.9).

(4.9) Lunda (*Niger-Congo*; Democratic Republic of Congo)
/ku-n-ʒikwila/
INF-1.SG-uncover
[ku.nʒi.kwi.la]
'to uncover for me'

(Kawasha 2003: 24)

In Lunda onsets, nasals may combine with a wide variety of consonants, including all plosives, oral fricatives, /h/, /l/, and /w/. In Tukang Besi, the C in nasal+C structures is always an oral plosive or /s/, though other fricatives and sonorants occur in the language. There is persuasive evidence that nasal+C structures are sequences in Lunda. The nasal+C structures in Tukang Besi do not have much in common with those of Lunda in

terms of their behavior. Though the evidence for the unitary status of prenasalized consonants in Tukang Besi is not entirely conclusive, I follow the author's analysis here, coding these structures as complex segments and classifying the language as having Simple syllable structure.

A similar issue arises in interpreting a phonetic sequence of a mid or low vowel followed by a high offset. This can be analyzed as a diphthong, in which case the entire structure functions as a syllable nucleus, or a sequence of V+glide, in which case the glide is a member of the coda. Competing analyses for such structures can be found in Yakima Sahaptin. Structures represented orthographically as  $\langle aj \rangle$ ,  $\langle aw \rangle \langle uj \rangle$ , and so on, are described as diphthongs by Jansen (2010) and Rigsby & Rude (1996). However, Hargus & Beavert (2006) present evidence that the structures ending in the high front articulation may be better analyzed as V+/j/ sequences. Preceding /m/, these structures trigger a vowel epenthesis process that is also conditioned by other sonorant consonants, but not vowels, in the language (4.10).

## (4.10) Yakima Sahaptin (Sahaptian; United States)

(a) /?ínm/

[?ínɨm]

'excessively'

## (b) /tPjálm/

[tl'jálim]

'Cle Elum (place name)'

# (c) /talújm/ [talújɨm]

'nail'

(Hargus & Beavert 2006: 28)

This is evidence that the high front element in these structures behaves as a consonant. Though the /w/ component of such sequences is not reported to trigger the epenthesis process in (4.10), it is reported to pattern with /j/ in other morphophonemic contexts, and Hargus & Beavert (2006) treat it as a consonant in their analysis. This analysis has the effect of increasing the maximum coda pattern of the language to four, in which all fourconsonant codas begin with a glide, e.g., *sajlps* 'kidney'. However, due to other syllable patterns in the language, it does not affect the syllable structure complexity classification, which in either case is Highly Complex.

Kunjen presents an example of a language for which a sequential analysis rather than a complex segment analysis results in patterns which directly affect its syllable structure complexity classification. Sommer rejects a prenasalized stop analysis for structures such as [mb] and [ŋg] on the basis that reverse sequences occur and all component segments may occur separately (1969: 34). This analysis is what allows Kunjen to be classified as having Highly Complex syllable structure in the current study, as nasal+stop sequences are always present in the four-consonant codas in the language, which are also the only Highly Complex structures occurring (4.11).

(4.11) Kunjen (Pama-Nyungan, Australia)

/albmb/

'opossum'

(Sommer 1969: 33)

It should be noted that it was generally rare for ambiguous segmental analyses to affect the analysis of syllable structure to the point where a language might be classified in a different syllable structure complexity category. In fact the Tukang Besi and Kunjen examples discussed here are perhaps the most potentially problematic cases in the entire language sample.

## 4.2.2 Coding

After the above criteria were considered and segmental inventories determined, properties of the vowel and consonant inventories were coded as described here.

Vowel inventories were coded for all reported contrasts. First, the number of vowel quality distinctions was noted. Every vowel inventory was additionally coded for the presence or absence of contrastive vowel length, nasalization, and other less common contrasts, such as voicing and glottalization. Where such contrasts were present, it was noted whether the contrast was distinctive for all or some vowels.

I also noted the presence of diphthongs and/or tautosyllabic vowel sequences and recorded the number and specific forms of these structures. Because they are so often analyzed as phonological sequences which surface phonetically as diphthongs,

diphthongs present complications in establishing vowel phoneme inventory patterns (Maddieson 1984: 133). Recall that the purpose of considering patterns of diphthongs and tautosyllabic vowel sequences here is to establish the size of the full vocalic nucleus inventory for each language in order to test the hypothesis in (4.4). Therefore the diphthongs and tautosyllabic vowel sequences included in the inventories are not necessarily meant to be interpreted as phonologically unitary segments, but as occurring nucleus patterns.

In (4.12) I illustrate the coding with the vowel phoneme inventory of Pinotepa Mixtec, a language with Simple syllable structure.

(4.12) **Pinotepa Mixtec** (*Oto-Manguean*; Mexico)

V phoneme inventory: /i e a o u ĩ ẽ ã õ ũ ị ẹ ạ o u ĩ ẽ ặ õ ũ/ N vowel qualities: 5 Diphthongs or vowel sequences: None Contrastive length: None Contrastive nasalization: All

Other contrasts: Glottalization (All)

For each consonant inventory, the number of non-geminate consonants was recorded. Each consonant inventory was first coded for primary distinctions in voicing, place, and manner of articulation; here I use the term 'primary' to refer to those distinctions represented in the standard chart for non-pulmonic consonants in the International Phonetic Alphabet (IPA 2015).<sup>23</sup> The presence of a primary voiced/voiceless distinction was noted separately for obstruents and sonorants; voicing had to be the sole distinguishing feature for at least one pair of consonants in order for this distinction to be counted (e.g., /k/ and /g/, /m/ and /m/). All primary manners of articulation in the inventory were recorded, as were the primary places of articulation for all non-glide consonants. Additionally, I recorded the presence of elaborated articulations related to phonation, manner, and place, as defined by Lindblom & Maddieson (1988) and listed in Table 4.1 above. Note that there is some overlap in what I take to be primary articulations and the articulations classified as elaborations by Lindblom & Maddieson (e.g., labiodental, uvular); in the coding such articulations are included in both the place/ manner lists and in the list of elaborations.

In (4.13) I illustrate the coding with the consonant phoneme inventory of Lepcha, a language with Complex syllable structure.

(4.13) Lepcha (Sino-Tibetan; Bhutan, India, Nepal)

#### C phoneme inventory:

/p p<sup>h</sup> b t t<sup>h</sup> d t t<sup>h</sup> d c c<sup>h</sup> k k<sup>h</sup> g ? ts ts<sup>h</sup> f v s z  $\int$  3 h m n n n r l  $\beta$  j/

N consonant phonemes: 32

Geminates: N/A

Voicing contrasts: Obstruents

<sup>&</sup>lt;sup>23</sup> Note that I use different terminology than IPA in some cases: 'stop' instead of 'plosive', and 'palatoalveolar' instead of 'postalveolar'.

Places: Bilabial, Labiodental, Dental, Alveolar, Palato-alveolar, Retroflex, Palatal, Velar, Glottal

**Manners:** Stop, Affricate, Fricative, Nasal, Trill, Central approximant, Lateral approximant

N elaborations: 5

**Elaborations:** Voiced fricatives/affricates, Post-aspiration, Labiodental, Palatoalveolar, Retroflex

As noted by Maddieson, dental and alveolar places of articulation are not always reliably distinguished in reference materials (1984: 31-32). Sometimes authors even use the joint label 'dental/alveolar' as a cover term for a series of consonants in that general area in the vocal tract. In such cases, I characterize the place of the consonants in question as Dental/Alveolar (4.14).

(4.14) **Grebo** (*Niger-Congo*; Liberia)

C phoneme inventory: /p b t d c ӈ k g kp gb f s h m m n n ŋ ŋm l l w w j/ Places: Labial-velar, Bilabial, Dental/Alveolar, Palatal, Velar, Glottal

The current study considers only non-geminate consonant phonemes. Geminates are not always given the same treatment as consonants of 'normal' length in phonological descriptions, as they often occur in specific morphological contexts. While there are languages in which consonant gemination is contrastive within morphemes, there are many more in which gemination is contrastive at the lexical level but only in heteromorphemic contexts. As a result of this, discussions of gemination are often presented in the context of morphophonological processes, and comprehensive lists of geminate consonants may not be given and sometimes must be inferred. As the hypotheses in this chapter are concerned with phonation, place, and manner articulations, I do not consider issues of consonant gemination in any depth. However, I do note the reported presence of gemination in consonant inventories in the coding in Appendix B.

The phoneme inventory coding for each language in the sample, along with other notes on the consonant and vowel systems, can be found in Appendix B. In the following sections I present the results of the analyses of consonant and vowel inventories. Because only one of the hypotheses in the current chapter relates to vowel inventories, I present this study first (§4.3). A longer and more detailed study of consonant inventories is presented in §4.4.

#### 4.3 Results: Vowel inventories

In this section, I describe vowel inventory patterns in the language sample. The purpose of the study here is twofold: first, to test the hypothesis in (4.4) regarding vocalic nucleus inventory size and syllable structure, and second, to explore general features of vowel contrast with respect to syllable structure complexity. For the latter, there are no explicit hypotheses, but any patterns uncovered will be noted in the event that they might help shed light on the development of syllable structure complexity.

In §4.3.1, I present an analysis of vowel quality inventory sizes in the sample as a whole and with respect to the syllable structure complexity categories. I then move on to a more detailed analysis of vowel contrasts in the sample. In §4.3.2, I examine contrastive vowel length. In §4.3.3 I examine other contrasts in vowel inventories, including nasalization and phonation contrasts. In §4.3.4 I analyze diphthongs and tautosyllabic vowel sequences in the language sample. Finally, in §4.3.5 I combine the results of all the above analyses in order to test the hypothesis in (4.4) and determine whether there is a relationship between vocalic nucleus inventory size and syllable structure complexity in the sample. In §4.4.6 I briefly summarize the results of these analyses.

#### 4.3.1 Vowel quality inventory size

The distribution of vowel quality inventory sizes in the languages of the sample can be found in Figure 4.1.



**Figure 4.1.** Languages of sample distributed according to the number of distinctive vowel qualities in their phoneme inventories.

The average number of distinctive vowel qualities for languages in the sample is 5.9. The range is 2-13, with the extremes being Kabardian (two vowel qualities) and Eastern Khanty (13 vowel qualities). Over one-third (36) of the languages have systems with five contrastive vowel qualities. The next most common pattern is for languages to have six contrastive vowel qualities. These values are nearly identical to those reported for the 564-language sample in Maddieson (2013c).

The mean, median, and range of vowel quality inventory sizes for the languages in each category of syllable structure complexity can be found in Table 4.2.

	Syllable Structure Complexity			
Number of vowel qualities	Simple (N = 22 lgs)	Moderately Complex (N = 27 lgs)	Complex (N = 27 lgs)	Highly Complex (N = 24 lgs)
Mean	6	6.2	6.1	5.3
Median	5	6	5	5.5
Range	4-12	3-13	4-10	2-9

 Table 4.2. Vowel quality inventory sizes in each syllable structure complexity category.

There are some slight trends in the sample regarding the size of vowel quality inventories and syllable structure complexity. The ranges in vowel quality inventory size are somewhat narrower in the languages of the Complex and Highly Complex categories, and the largest vowel quality inventories are found in languages with Simple or Moderately Complex syllable structure. However, there are no clear trends with respect to mean or median vowel quality inventory size and syllable structure complexity. Statistical analysis shows no significant correlation between vowel quality inventory size and syllable structure complexity, measured either categorically (r(100) = -.123, p > .05) or as a sum of maximum syllable margin sizes (r(100) = -.063, p > .05).

#### 4.3.2 Contrastive vowel length

In this section, I examine patterns of contrastive vowel length in the sample. Here I include all languages reported to have contrastive vowel length for some or all vowel qualities. I also include five languages (Ewe, Fur, Maori, Maybrat, and Nimboran) which are reported to have tautosyllabic sequences of identical vowels, and two languages (Carib and Selepet) which are reported to have diphthongs consisting of identical vowels. In the latter groups of languages, other non-identical vowel sequences or diphthongs occur, and phonetically long vowels are often found in heteromorphemic contexts. Together, these facts are often used by authors to justify a sequential analysis rather than a long vowel analysis. I include these languages in the current analysis because the structures in question are reported to be produced as phonetically long vowels which may meaningfully contrast with short vowels (4.15a-b).

## (4.15) Maybrat (West Papuan; Indonesia)

(a) /puut/

[pu:t]

'we climb'

(b) /put/

[put]

'leech'

(Dol 2007: 29)

The distribution of contrastive vowel length in the languages of the sample according syllable structure complexity can be found in Table 4.3.

	Syllable Structure Complexity				
Vowel length	Simple (N = 22 lgs)	Moderately Complex (N = 27 lgs)	Complex (N = 27 lgs)	Highly Complex (N = 24 lgs)	
Contrastive	6	10	13	11	
Tautosyllabic sequences or diphthongs of identical Vs	1	5	1	0	
Non-contrastive	16	12	13	13	

**Table 4.3.** Contrastive vowel length in the sample. Note that Maori (in the Simple category) is reported to have contrastive vowel length for one vowel quality, but tautosyllabic sequences of identical vowels for other vowel qualities.<sup>24</sup> Therefore the numbers in the Simple column add up to 23, not 22.

Over half of the languages in the sample (54/100) do not have contrastive vowel

length. Vowel length distinctions are less common in the languages of the Simple

category than those of the other categories. In terms of geographic distribution, all six

macro-regions examined here have four or more languages with vowel length contrasts,

<sup>&</sup>lt;sup>24</sup> In Maori, nearly all possible combinations of two vowels can be found to occur tautosyllabically in normal speech. Bauer (1999: 524-8) uses this distribution to justify the analysis of all phonetically long vowels as identical vowel sequences. However, phonetic [a:] has a much higher frequency than would be expected if a sequential analysis were accepted, so Bauer analyzes this particular vowel quality as having contrastive length, while [i:], [ɛ:], etc. are taken to be sequences.

with this pattern being most common in North America (12 languages) and least common in Eurasia (four languages).

The above analysis does not distinguish between languages which have vowel length contrasts for all vowel qualities and those that have them for only some. In Figure 4.2 below, I present such an analysis, examining only those languages with contrastive vowel length, including those with tautosyllabic sequences or diphthongs of identical vowels.



**Figure 4.2.** Proportion of languages in each syllable structure complexity category which have contrastive vowel length for some or all vowel qualities (VQs).

In all categories, languages with vowel length contrasts are generally more likely to have these contrasts for all rather than just some vowel qualities. However, there is an interesting result with respect to vowel length contrasts in the Simple syllable structure category. Although languages with Simple syllable structure are overall less likely to have vowel length contrasts, if they do have a contrast they are also more likely than languages from the other categories to have this contrast for all vowel qualities. In fact, this pattern is without exception in the language sample. A possible interpretation of this pattern is that processes of vowel lengthening have recently phonologized in these languages.

Below I illustrate the prominent patterns in vowel length distinctions with the vowel inventories of two languages: Rotokas, which has Simple syllable structure and length contrasts for all qualities, and Central Dizin, which has Complex syllable structure but length contrasts only for a subset of vowels (4.16)-(4.17).

(4.16) **Rotokas** (*West Bougainville*; Papua New Guinea)

V phoneme inventory: /i e a o u i: e: a: o: u:/

(4.17) Central Dizin (*Afro-Asiatic*; Ethiopia)

**V** phoneme inventory: /i e ε i a o u i: e: a: o: u:/

#### 4.3.3 Other vowel contrasts

Here I present analyses of other contrastive properties present in the vowel inventories of the language sample, namely nasalization and phonation contrasts. See Table 4.4 for the distribution of languages in the sample with respect to contrastive vowel nasalization.

	Syllable Structure Complexity			
Vowel nasalization	Simple (N = 22 lgs)	Moderately Complex (N = 27 lgs)	Complex (N = 27 lgs)	Highly Complex (N = 24 lgs)
Contrastive	11	5	4	4
Non-contrastive	11	22	23	20

Table 4.4. Vowel nasalization contrasts in the sample.

Roughly one-quarter of the languages (24/100) have a vowel nasalization contrast for some or all vowel qualities. This feature is much more common in languages with Simple syllable structure, occurring in half of the languages in that category, as compared to fewer than 20% of the languages in the other categories; this trend is statistically significant in Fisher's exact test (p=.003). Contrastive vowel nasalization is also strongly associated with particular geographic regions in the current sample: all but four of the languages with this feature are found in Africa, North America, and South America. This finding closely mirrors the areal patterns noted by Hajek (2013) for his 244-language sample.

In Figure 4.3 I show the proportions of languages in each category having contrastive nasalization for some vowel qualities and for all vowel qualities.



**Figure 4.3.** Proportion of languages in each syllable structure complexity category which have contrastive vowel nasalization for some or all vowel qualities (VQs).

As compared to the analysis of vowel length contrasts in §4.3.2, there is no clear pattern in Figure 4.3 with respect to the presence of nasalization contrasts for some or all vowel qualities and syllable structure complexity. However, there is a strong areal patterning of this feature. In South America, most languages with distinctive vowel nasalization have this contrast for all vowels (5/7). In Africa, most languages with distinctive vowel nasalization have this contrast for just some vowels (5/7). See examples (4.18)-(4.19).

(4.18) Cubeo (Tucanoan; Colombia)

V phoneme inventory: /i e i a o u ĩ ẽ ĩ ã õ ũ/

(4.19) Toro So (Dogon; Burkina Faso, Mali)

V phoneme inventory: /i e  $\varepsilon$  a  $\circ o u \tilde{ } \tilde{ } \tilde{ } \tilde{ } a \tilde{ } \tilde{ } u /$ 

We now turn to an analysis of phonation contrasts in the vowel inventory data.

These are not common, but do occur in six languages in the sample, listed in Table 4.5 by the specific kind of phonation contrast and syllable structure complexity.

	Syllable Structure Complexity			
Other vowel contrasts	Simple	Moderately Complex	Complex	Highly Complex
Contrastive voicing	Ute			Tohono O'odham
Contrastive glottalization/ creaky voice	Pinotepa Mixtec Nuosu Yi	Pacoh	Mamaindê	

**Table 4.5.** Languages in sample with distinctive phonation contrasts in vowel inventories, according to syllable structure complexity.

In this very small data set, contrastive phonation in vowel inventories is more likely to be found in languages with Simple or Moderately Complex syllable structure. Nearly every language with a phonation contrast in its vowel inventory also has an additional contrast besides vowel quality: either vowel nasalization (two languages) or vowel length (three languages). The only exception to this trend is Nuosu Yi. I illustrate these patterns with the vowel phoneme inventories of Ute and Mamaindê (4.20)-(4.21).

(4.20) Ute (*Uto-Aztecan*; United States)

V phoneme inventory: /i œ a ɯ u i: œ: a: ɯ: u: i œ a ʉ ʉ//

#### (4.21) Mamaindê (Nambikuaran; Brazil)

V phoneme inventory: /i e a o u ĩ ẽ ã õ ũ ị ẹ ạ o u ĩ ặ ỹ/

#### 4.3.4 Diphthongs and vowel sequences

In this section I analyze other vocalic nucleus patterns in the sample, specifically patterns of diphthongs and tautosyllabic vowel sequences. This analysis excludes the diphthongs or vowel sequences made up of identical vowels that were included in the analysis of contrastive vowel length in §4.3.2. I group together diphthongs and vowel sequences here because the terms are often used interchangeably to refer to the same or very similar tautosyllabic structures, sometimes even within the same language reference. See Table 4.6 for the distribution of languages according to syllable structure complexity and the presence or absence of diphthongs or vowel sequences.

		Syllable Structure Complexity			
Diphthongs or vowel sequences	Simple (N = 22 lgs)	Moderately Complex (N = 27 lgs)	Complex (N = 27 lgs)	Highly Complex (N = 24 lgs)	
Present	6	15	8	8	
Absent	16	12	19	16	

**Table 4.6.** Languages of the sample, distributed according to syllable structure complexity and the presence or absence of diphthongs or tautosyllabic vowel sequences.

Languages with Moderately Complex syllable structure are much more likely than languages from the other categories to have diphthongs or vowel sequences (56%, compared to 27-33% in the other categories). Since these figures do not give a sense for the potential effect of diphthong and vowel sequences on vocalic nucleus inventory size, I present a more detailed analysis of the patterns in Table 4.7 below.

	Syllable Structure Complexity			
Diphthongs and/ or vowel sequences	Simple (N = 6 lgs)	Moderately Complex (N = 15 lgs)	Complex (N = 8 lgs)	Highly Complex (N = 8 lgs)
Mean	7.2	7.1	6.1	7.6
Median	5	6	4.5	6
Range	1-21	1-23	2-17	2-20

**Table 4.7.** Mean, median, and range values for number of diphthongs and vowel sequences in languages of sample, by syllable structure complexity.

There is a very wide range in the size of diphthong and tautosyllabic vowel sequence inventories in the languages of the sample. Extremely large inventories of diphthongs or vowel sequences, as illustrated by the 23-diphthong system of Selepet, are rare (4.22). Selepet has six vowel qualities, and nearly all possible combinations of vowels are reported to occur, either as diphthongs or sequences of identical vowels (those are treated in Table 4.3). The modal value for the 37 languages in Table 4.7 is just two diphthongs or vowel sequences, as illustrated for Telugu (4.23).

#### (4.22) Selepet (*Trans-New Guinea*; Papua New Guinea)

Diphthongs: /ie ia io io iu ei eu ai ae ao au oi oe oo ou oi oe ou ui ue ua uo uo/

(4.23) Telugu (Dravidian; India)

Diphthongs: /ai au/

## 4.3.5 Vocalic nucleus inventories and syllable structure complexity

Here I combine the results of the above analyses in order to determine whether there is any correlation between the size of vocalic nucleus inventories and syllable structure complexity. Specifically, I test the following hypothesis:

(4.24) H<sub>1</sub>: As syllable structure complexity increases, languages will have larger inventories of vocalic nuclei.

This hypothesis was motivated by observations in §3.3.4, where it was found that greater syllable structure complexity was associated with a higher likelihood of a language having complex vocalic nuclei, defined there as long vowels, diphthongs, and/ or tautosyllabic vowel sequences. It was assumed that the stronger presence of complex vocalic nuclei might correspond to overall larger vocalic nucleus inventories in languages with more complex syllable structure, revealing a relationship between vowel inventories and syllable structure complexity which has not been previously reported. However, the results in §4.3.2-4 show that certain vowel contrasts show strong patterns with respect to syllable structure complexity which may even out this expected effect. While vowel length contrasts are much more frequent in languages with Moderately Complex, Complex, and Highly Complex syllable structure, it is most common to find that vowel length is contrastive for *all* vowel qualities in languages with Simple syllable structure.

vowel systems of languages with Simple syllable structure. Here I examine vocalic nucleus inventories to see whether the hypothesized trend is borne out.

In this analysis, I include all distinctive vocalic nucleus patterns reported for each language, including all quality, length, nasalization, and phonation contrasts in addition to diphthong and tautosyllabic vowel sequence patterns. For example, the vocalic nucleus inventory of Budai Rukai is given below (4.25).

## (4.25) Budai Rukai (Austronesian; Taiwan)

Vocalic nucleus inventory: /i ə a u i: e: a: u: au ai ia ua/

In Table 4.8 I present the mean, median, and range values for vocalic nucleus inventory sizes in the language sample.

	Syllable Structure Complexity			
Vocalic nucleus inventory size	Simple (N = 22 lgs)	Moderately Complex (N = 27 lgs)	Complex (N = 27 lgs)	Highly Complex (N = 24 lgs)
Mean	12.8	13.6	11.6	10.7
Median	12	12	8	7.5
Range	5-31	3-31	5-35	3-30

**Table 4.8.** Mean, median, and range values for vocalic nucleus inventory sizes in sample, by syllable structure complexity.

Examining the mean and median values for each category of languages, we find that there is no linear trend relating vocalic nucleus inventory size to syllable structure complexity. Vocalic nucleus inventory sizes peak in the Moderately Complex category and fall from there with increasing syllable structure complexity. If anything, the trend by which larger mean and median values are found in the Simple and Moderately Complex categories than in the other categories is a result which goes against the predictions of the hypothesis in (4.24). Ultimately, there is no statistically significant correlation between vocalic nucleus inventory size and syllable structure complexity, measured either categorically (r(100) = -.125, p > .05) or as a sum of maximum syllable margin sizes (r(100) = -.127, p > .05).

Thus we find no support for the hypothesis in (4.24), but neither do we find strong support for the opposite effect, by which vocalic nucleus inventory size decreases with syllable structure complexity.

#### 4.3.6 Summary of vowel patterns in sample

While vocalic nucleus inventories may have different prototypical characteristics in languages with different syllable patterns, showing different rates and effects of length, nasalization, diphthongs, and other contrasts, their overall size appears to bear no relation to syllable structure complexity. However, the patterns associating specific contrastive properties of vowels with syllable structure complexity are worthy of noting. I summarize these findings in Table 4.9.
Positive trends (increases with syllable structure complexity)	Negative trends (decreases with syllable structure complexity)
Presence of vowel length contrast	Vowel length contrast in all vowels
	Presence of vowel nasalization contrast
	Presence of vowel phonation contrast

**Table 4.9.** Properties of vowel inventories showing some relationship to syllable structure complexity.

There is no obvious reason why the vowel patterns above should bear any direct relationship to syllable structure complexity. Nevertheless, it is important to note the patterns because they may hold information about the history of the languages in which they are spoken. Patterns of phonemic contrast may be a result of the phonologization of historical phonetic processes, which may themselves be relevant to the development of syllable patterns. I will return to this point in the general discussion of results in §4.5.

#### 4.4 Results: Consonant inventories

### 4.4.1 Consonant phoneme inventory size

Here I present a basic analysis of consonant phoneme inventory sizes in the language sample and test the hypothesis formulated in (4.5), reproduced as (4.26) below.

(4.26) H<sub>2</sub>: As syllable structure complexity increases, so does the size of consonant phoneme inventories. A positive correlation between these features has previously been established in Maddieson (2006, 2013a), which use a three-point system for categorizing syllable structure complexity. The hypothesis predicts that the trend will hold for the fourcategory system used in the current work. It also predicts that the effect will be found when syllable structure complexity is measured as a sum of maximum syllable margins, as suggested by Gordon (2016) for the modified 100-language WALS sample.

In Table 4.10 I present the mean, median, and range values for the consonant phoneme inventory sizes in the language sample, by category of syllable structure complexity.

	Syllable Structure Complexity			
C phoneme inventory size	Simple (N = 22 lgs)	Moderately Complex (N = 27 lgs)	Complex (N = 27 lgs)	Highly Complex (N = 24 lgs)
Mean	19	21.4	21.8	26
Median	16.5	21	21	23
Range	6-55	11-32	12-40	10-54

**Table 4.10.** Mean, median, and range values for non-geminate consonant phoneme inventory sizes in the language sample, by syllable structure complexity.

In Table 4.10, both mean and median values for consonant phoneme inventory size increase with syllable structure complexity. Languages in the Highly Complex category have on average about seven more consonants than languages in the Simple category. However, there is a wide range of inventory sizes in the language sample as a whole and within each category of syllable structure complexity, such that there is considerable overlap in this feature among the different categories. In fact, the largest

inventory in the sample is found in Hadza, a language with Simple syllable structure (4.27), and the third smallest inventory is found in Mohawk, a language with Highly Complex syllable structure (4.28).

(4.27) Hadza (Isolate; Tanzania)

N consonant phonemes: 55

(4.28) Mohawk (*Iroquoian*; Canada, United States) C phoneme inventory: /t k ? d̄<sub>3</sub> s h n l j w/

N consonant phonemes: 10

Despite this wide range of variation, there is a positive correlation between consonant phoneme inventory size and syllable structure complexity. When syllable structure complexity is measured categorically, the correlation is weak but significant (r(100) = .251, p = .01). The result is virtually identical when syllable structure complexity is measured as a sum of maximum syllable margins (r(100) = .250, p = .01). See Figures 4.4 and 4.5 for the distribution of languages according to these measures.



**Figure 4.4.** Correlation between syllable structure complexity categories and number of non-geminate consonant phonemes. Here syllable structure complexity is operationalized as follows: Simple = 1, Moderately Complex = 2, Complex = 3, Highly Complex = 4.



**Figure 4.5.** Correlation between syllable structure complexity as a sum of maximum syllable margin sizes and number of non-geminate consonant phonemes.

Thus the hypothesis in (4.26) is supported by the patterns in the current study, even though the sample is much smaller than those of previous works which reported similar findings. When Hadza is excluded as an outlier, the correlations between consonant phoneme inventory size and syllable structure complexity become stronger and more statistically significant (r(99) = .327, p < .001 for syllable structure complexity measured categorically, and r(99) = .310, p < .005 when it is measured as a sum of maximum syllable margins).

In (4.29)-(4.32) I illustrate typical consonant inventory sizes with a language from each category of syllable structure complexity in the sample.

(4.29) Savosavo (Solomons East Papuan; Solomon Islands)
Syllable Structure Complexity Category: Simple
C phoneme inventory: /p <sup>m</sup>b t <sup>n</sup>d <sup>n</sup>f k <sup>n</sup>g m n p ŋ s z r l β щ/
N consonant phonemes: 17

(4.30) **Kim Mun** (*Hmong-Mien*; Vietnam)

Syllable Structure Complexity Category: Moderately Complex C phoneme inventory: /p b t d c j k g f v θ s h m n ŋ ŋ l ʎ w j/ N consonant phonemes: 21

(4.31) **Basque** (Isolate; France, Spain)

Syllable Structure Complexity Category: Complex C phoneme inventory: /p b ț d c j k g ts ts tf f s s f x m n n l ß r r/ N consonant phonemes: 23

(4.32) **Tehuelche** (*Chon*; Argentina)

Syllable Structure Complexity Category: Highly Complex C phoneme inventory: /p b t d k g q G ? p' t' k' q' t∫ t∫ s ∫ x χ m n l r w j/ N consonant phonemes: 25

It was previously noted that the association between syllable structure complexity and consonant phoneme inventory size may reflect the overlapping geographical distributions of the two properties. Specifically, Simple syllable structure is most commonly found in equatorial regions, including Africa, New Guinea, and South America. Complex syllable patterns (as defined in that study) are most often found in northern North America, northern Eurasia, and northern Australia. The latter areas, besides Australia, are associated with large consonant inventories, and the former with small consonant inventories. Therefore the global positive correlation between syllable structure complexity and consonant inventory size may be a reflection of specific genealogical or areal trends within these regions. Maddieson (2006) rejected this scenario, finding that the pattern linking syllable structure complexity and consonant phoneme inventory size was significant within most of the geographical regions

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examined there. As the current language sample has a more balanced representation of syllable complexity, this issue is worth investigating again here.

Below, I examine whether the association between consonant inventory size and syllable structure complexity, with the added category of Highly Complex, can be found within geographical regions in the current sample. This analysis is necessarily impressionistic: because the already moderate sample size is split roughly evenly between six macro-regions, it is difficult to statistically test the patterns. In Figure 4.6, the median consonant inventory sizes are plotted against syllable structure complexity for the languages in each macro-region.



**Figure 4.6.** Median consonant phoneme inventory sizes by syllable structure complexity, for each macro-region represented in the sample.

The trends in Figure 4.6 are not all linear; this fact may reflect the small sample size for each region (16-17 languages each) as much as it does regional trends. However, we do find that in three regions — Africa, North America, and South America — there are general trends by which consonant phoneme inventory size increases with syllable

structure complexity. In Eurasia, consonant phoneme inventory size does increase from Moderately Complex to Highly Complex syllable structure, but there is a steep decline in this value in the Complex category. Southeast Asia & Oceania shows an increase in consonant phoneme inventory size from Simple to Complex syllable structure and then a sharp decline in the Highly Complex category, which admittedly is represented by only one language in that region (Semai). The only area showing a roughly flat trend is Australia & New Guinea, where the median consonant inventory size is 17-19 consonant phonemes regardless of syllable structure complexity. This pattern is consistent with previous observations that the languages of New Guinea and Australia are typologically very similar in the size of their consonant phoneme inventories (Maddieson 2013b).

While the patterns here are by no means conclusive, they do suggest that the relationship between consonant phoneme inventory size and syllable structure complexity may occur on regional scales in addition to a global scale, even when the Highly Complex category is included. For example, while South America has generally smaller consonant inventories than languages in other regions, it nevertheless shows increasing inventory size with increasing syllable structure complexity. It is also notable that none of the six regions show a clear negative association between consonant inventory size and syllable structure complexity.

### 4.4.2 Elaborations

Here I examine general patterns with respect to the presence of articulatory elaborations in the consonant phoneme inventories of the sample. Specifically, I test the hypothesis formulated in (4.6), and reproduced in (4.33).

(4.33) H<sub>3</sub>: As syllable structure complexity increases, so does the number of articulatory elaborations present in consonant phoneme inventories.

As discussed above, there are two motivations for this hypothesis. The first is the observation that many languages with famously complex syllable structure also tend to have several specific kinds of rare consonants in their phoneme inventories, corresponding to some of the elaborations in the typology put forth by Lindblom & Maddieson (1988). Additionally, the hypothesis is motivated by the findings of Maddieson et al. (2013). In the 700-language LAPSyD sample, it was found that languages with Complex syllable structure tend to have more consonants with elaborated articulations than languages with Simple or Moderately Complex syllable structure. While that study reported on numbers of elaborated consonant phonemes rather than the elaborations themselves, I expect the two patterns to be similar, and also for the trend to hold with the additional category of Highly Complex syllable structure.

First I briefly present an analysis similar to that conducted in Maddieson et al. (2013). Recall that the elaborations considered are those listed in Table 4.1. Here, as in the Maddieson et al. study, consonants having just one elaboration (e.g., Labialization

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for  $/k^{w}/)$  have been grouped together with consonants having more than one elaboration (e.g., Uvular, Labialization, and Ejective for  $/q^{w}/)$ . An example of this coding can be found in (4.34).

(4.34) Lakhota (Siouan; United States)

C phoneme inventory: /p p<sup>h</sup> b t t<sup>h</sup> k k<sup>h</sup> ? p' t' k'  $\widehat{tJ}$   $\widehat{tJ}$ <sup>h</sup>  $\widehat{tJ}$ ' s z  $\int \mathfrak{Z} \mathfrak{X} \mathfrak{Y} \mathfrak{h} \mathfrak{m} \mathfrak{n} \mathfrak{l} \mathfrak{w} \mathfrak{j}/\mathfrak{k}$ Elaborated consonants: /p<sup>h</sup> t<sup>h</sup> k<sup>h</sup> p' t' k'  $\widehat{tJ}$   $\widehat{tJ}$ <sup>h</sup>  $\widehat{tJ}$ ' z  $\int \mathfrak{Z} \mathfrak{Y}/\mathfrak{k}$ 

N elaborated consonants: 13

Table 4.11 shows the mean, median, and range in number of elaborated consonants for the languages of the sample.

	Syllable Structure Complexity			
N elaborated consonants	Simple (N = 22 lgs)	Moderately Complex (N = 27 lgs)	Complex (N = 27 lgs)	Highly Complex (N = 24 lgs)
Mean	6.1	6.9	7.2	11.8
Median	2.5	5	5	10
Range	0-38	0-16	1-24	0-37

**Table 4.11.** Mean, median, and range in number of elaborated consonants in phoneme inventories of languages of sample, by syllable structure complexity.

As expected, the mean and median numbers of elaborated consonant phonemes rise with increasing syllable structure complexity. Combining the mean trend in Table 4.11 with the mean trend in consonant inventory sizes in Table 4.10 from §4.4.1, we find the pattern in Figure 4.7. There is a slight increase in the mean number of basic consonants from the Simple category to the others, but the increasing consonant phoneme inventory size seems to be mostly a function of an increasing number of elaborated consonants.



**Figure 4.7.** Mean number of basic and elaborated consonants in phoneme inventories of languages of sample, by syllable structure complexity.

Now we turn to a direct test of the hypothesis in (4.33), which is concerned with articulatory elaborations themselves, rather than elaborated consonants. Table 4.12 lists the mean, median, and range values of the number of elaborations present in the languages of the sample according to syllable structure complexity.

	Syllable Structure Complexity			
N elaborations in C inventory	Simple (N = 22 lgs)	Moderately Complex (N = 27 lgs)	Complex (N = 27 lgs)	Highly Complex (N = 24 lgs)
Mean	2.5	2.9	2.6	3.9
Median	2	3	2	4
Range	0-10	0-8	1-6	0-7

**Table 4.12.** Mean, median, and range values for number of elaborations present in consonant inventories in each category of syllable structure complexity.

As predicted, the mean and median number of elaborations rises from the Simple category to the Highly Complex category, though the trend is not strictly linear. Nearly all of the languages in the sample have at least one elaboration in their consonant phoneme inventories.<sup>25</sup> Here, as in the analysis of consonant phoneme inventory size in §4.4.1, wide ranges may be observed in the number of elaborations present in the languages of the sample. The largest number of elaborations is found again in Hadza, a language with Simple syllable structure (4.35).

# (4.35) Hadza (Isolate; Tanzania)

#### C phoneme inventory:

 $p^{h} p b t^{h} t d k^{h} k g k^{hw} k^{w} g^{w} ? p' k' k'^{w} k | k! k || m n n n n n n n || \eta|| \eta!' n! || \eta||' n||$   $mp^{h} mb nt^{h} nd \eta k^{h} \eta g nts ndz \eta dz ts dz ts dz ts dz ts' ts' ts' ts' ts' ts' ts' ts' ts' h || n h/$ 

**Elaborations:** Voiced fricatives/affricates, Voiceless sonorants, Prenasalization, Post-aspiration, Lateral release, Ejective, Click, Labiodental, Palato-alveolar, Labialization

## N elaborations: 10

The largest numbers of consonant elaborations are found in languages with Simple and Moderately Complex syllable structure, and the range in number of elaborations is somewhat narrower for languages with Complex and Highly Complex syllable structure. Nevertheless, there is a positive correlation between the number of

<sup>&</sup>lt;sup>25</sup> There are just three exceptions to this pattern, all from the Southeast Asia & Oceania macro-region: Maori (Simple), Ilocano (Moderately Complex), and Semai (Highly Complex).

elaborations present in consonant inventories and syllable structure complexity in the language sample. This correlation is weak but statistically significant (r(100)=.215, p=.03 when syllable structure complexity is measured categorically, and r(100)=.242, p=.02 when it is measured as a sum of maximum syllable margins).

In (4.36)-(4.39) I illustrate typical numbers of consonant elaborations for each syllable structure complexity category.

(4.36) Yoruba (Niger-Congo; Benin, Nigeria)

Syllable Structure Complexity Category: Simple C phoneme inventory: /b t d J k g kp gb f s ∫ h m l r j w/ Elaborations: Labiodental, Palato-alveolar N elaborations: 2

(4.37) Kamasau (Torricelli; Papua New Guinea)

Syllable Structure Complexity Category: Moderately Complex C phoneme inventory: /b t d t͡j d͡ʒ k g ? mb nd nd͡ʒ ŋg φ β s ɣ m n ŋ ŋ r w j/ Elaborations: Voiced fricatives/affricates, Prenasalization, Palato-alveolar N elaborations: 3

(4.38) Aguacatenango Tzeltal (Mayan; Mexico)
Syllable Structure Complexity Category: Complex
C phoneme inventory: /p b t k ? p' t' k' ts t∫ ts' t∫' s ∫ h m n l r w j/

Elaborations: Ejective, Palato-alveolar

N elaborations: 2

#### (4.39) Itelmen (Chukotko-Kamchatkan; Russia)

Syllable Structure Complexity Category: Highly Complex C phoneme inventory: /p t k q ? p' t' k' q'  $\widehat{t}$   $\widehat{t}$   $\widehat{f}$   $\widehat{g}$  s z 4 x  $\chi$  m n  $\eta$  1 j/ Elaborations: Voiced fricatives/affricates, Ejective, Palato-alveolar, Uvular N elaborations: 4

The results presented here support the hypothesis that the number of articulatory elaborations present in consonant phoneme inventories is higher in languages with more complex syllable structure. An additional finding is that nearly every language in the sample has at least one consonant elaboration. In fact, the normal scenario, based on the data presented in Table 4.12, is for languages of all categories to have at least two elaborations. Considering these patterns, recall the fourth hypothesis of the current chapter, first presented in (4.7) and reproduced below as (4.40):

(4.40) H<sub>4</sub>: Languages with differing degrees of syllable structure complexity will exhibit different consonant contrasts in their phoneme inventories.

In light of the findings here, the predictions of the hypothesis in (4.40) can be refined with respect to its initial formulation in §4.1.4. We find that languages from all categories of syllable structure complexity tend more often than not to have two or three elaborations, and that the difference in the typical number of elaborations between the Simple and Highly Complex categories is not dramatic: the mean is 2.5 in the Simple category and 3.9 in the Highly Complex category. This small gap in the means does not leave room for an average of even two additional elaborations in languages of the Highly Complex category. But recall that the apparent prevalence of both uvular and ejective articulations in languages with more complex syllable structure, not to mention the frequent co-occurrence of these with other articulations such as secondary labialization, is in part what motivated the hypothesis in (4.40).

This suggests that the hypothesis in (4.40), if borne out by the data, may manifest in a different way than originally expected. It was expected that languages with more complex syllable structure would tend to have several kinds of articulations, corresponding to elaborations, that tend not to be found in languages with simpler syllable structure. Now it might more appropriate to expect that languages with more complex syllable structure tend to have not only *more* elaborations, but also *different kinds* of elaborations than languages with simpler syllable structure. There is also the possibility that the distribution of elaborations in the consonant inventories of the sample is dependent upon other factors (i.e., genealogical, areal, articulatory, acoustic/perceptual) and the higher rate of elaborations in languages with more complex syllable structure is completely random.

The hypothesis in (4.40) is in fact not limited to elaborated consonants, but explores these in addition to other consonant patterns, including basic distinctions in

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voicing, place, and manner. In the following three sections, I test this hypothesis. In §4.4.3 I examine phonation features in the consonant inventories of the sample. In §4.4.4 I examine place features, and in §4.4.5 I examine manner features. In §4.4.6 I summarize the results, relating them to the hypothesis in (4.40) and the discussion above regarding the specific ways in which consonant phoneme inventories differ in languages with different syllable structure complexity.

## **4.4.3 Phonation features**

In this section I present an analysis of phonation features in the consonant phoneme inventories of the language sample. In Table 4.13 I list the basic and elaborated phonation features which are considered. Note that I use the term 'basic' here to refer to distinctions made in the standard IPA chart of pulmonic consonants, but which are not included in Lindblom & Maddieson's (1988) list of elaborated articulations. Thus the list of basic features is equivalent to the list of primary articulatory features described in §4.2.2, minus any of those features considered by Lindblom & Maddieson to be elaborated.<sup>26</sup>

<sup>&</sup>lt;sup>26</sup> This distinction is more clearly apparent in Table 4.14 in §4.4.4.

Basic	Elaborated
voicing contrast in obstruents voicing contrast in sonorants	breathy voice creaky voice voiced fricatives/affricates voiceless sonorants pre-aspiration post-aspiration

**Table 4.13.** Basic and elaborated phonation features examined here. Here a 'voicing contrast in sonorants' is kept distinct from 'voiceless sonorants' to allow for the possibility that there are languages with voiceless but not voiced sonorants, thus having no voicing distinction in sonorants.

In Figure 4.8 I show the number of languages in the sample which have the given

phonation feature in their consonant inventories. Note that in the figure I have merged the

categories voicing contrast in sonorants and voiceless sonorants, as the latter group

overlaps with all of the languages of the former group.



**Figure 4.8.** Phonation features in consonant inventories, by number of languages in which they are present.

Roughly half of the phonation features examined here are found in ten or fewer languages. I briefly discuss those results here. None of the languages of the sample have *pre-aspiration. Breathy voice* is present in only three languages: Darai, Kharia, and Telugu. All of these languages are from the Indian subcontinent, where this feature is prevalent (Ladefoged & Maddieson 1996: 57-8). *Creaky voice* occurs in four languages in the language sample. Here, creaky voice always refers to consonants described as glottalized sonorants, which are often transcribed with an ejective or glottalization diacritic (e.g., /ut²/, /w²/). This feature is strongly associated with northern North America, occurring in Nuu-chah-nulth, Slave, and Thompson, but also occurs in one language from Southeast Asia & Oceania (Pacoh). Finally, there are five languages with *voiceless sonorants*: Nivkh, Kunjen, Grebo, Hadza, and Yi. The final three languages in that group belong to the Simple syllable structure category; this is perhaps suggestive of a trend, but that would have to be verified in a larger sample of languages.

There are three other phonation features — *voicing distinction in obstruents*, *voiced fricatives/affricates*, and *post-aspiration* — which occur in more than ten languages each. Figure 4.9 attempts to capture any trends that exist with respect to the presence of these features and syllable structure complexity. The figure shows the percentage of languages in each category of syllable structure which have the given phonation feature in their consonant inventories.



**Figure 4.9.** Percentage of languages in each category of syllable structure complexity having the given phonation feature in their consonant inventories. For the calculation of the *voiced fricatives/affricates* trend, four languages which have neither fricatives nor affricates have been excluded (see §4.4.5).

Two of the phonation features in Figure 4.9, *voiced fricatives/affricates* and *post-aspiration*, do not show linear trends with respect to syllable structure complexity. Voiced fricatives/affricates are present in about 50% of the languages of the sample, but somewhat less common in languages of the Complex category. Post-aspiration is very rare in languages with Simple syllable structure, peaks in the Moderately Complex category, and then has a falling trend from there. The other phonation feature, *voicing distinction in obstruents*, shows a generally falling trend from Simple to Highly Complex syllable structure.

While having a voicing distinction in obstruents is the norm for languages in all four categories of syllable structure, this feature is found with lowest frequency in languages with Highly Complex syllable structure. This trend is no doubt strongly influenced by the high representation of languages from the Americas in this category. See Figure 4.10 for a map of the geographical distribution of the languages *lacking* a voicing distinction in obstruents. It is very common for languages in the Americas to lack this feature. Most (8/9) of the languages without this feature in the Highly Complex category are from this region.



**Figure 4.10.** Areal distribution of languages in sample with no voicing distinction in obstruents.

Thus we find two phonation features whose occurrence has a negative linear relationship with syllable structure complexity. A *voicing distinction in obstruents* is less common in languages with Highly Complex syllable structure, though this trend may be driven by the high proportion of languages from the Americas in that category. In the small group of five languages with *voiceless sonorants*, three of these have Simple syllable structure. These results indicate that there are at least some kinds of consonants that are less common in languages with complex syllable structures than in languages with simpler syllable structures.

# 4.4.4 Place features

In this section I present an analysis of place features in the consonant phoneme inventories of the language sample. This analysis considers only the patterns of non-glide consonants. In Table 4.14 I list the place features considered.

Basic	Elaborated
labial-velar	labiodental
bilabial	palato-alveolar
dental	retroflex
alveolar	uvular
dental/alveolar	pharyngeal
alveolo-palatal	palatalization
palatal	labialization
velar	pharyngealization
glottal	velarization

 Table 4.14. Basic and elaborated place features examined here.

Figure 4.11 shows how many languages in the sample each place feature is found in. Note that in the figure I have merged languages which have dental, alveolar or dental/ alveolar articulations into one category of *dental/alveolar*. This is to distinguish languages reported to have only one of these places of articulation from those reported to have both dental and alveolar articulations (the *dental and alveolar* category in Figure 4.11).



**Figure 4.11.** Place features in consonant inventories, by number of languages in which they are present.

Several of the place features are nearly universal in the sample. All languages except for Mohawk have *bilabial* consonants, and all but Wutung have *velar* consonants. The presence of *dental/alveolar*, *dental and alveolar*, and *glottal* features are not universal in the sample, but the patterning of these features does not show any clear relationship to syllable structure complexity (see Figure 4.12).



**Figure 4.12.** Percentage of languages in each category of syllable structure complexity having *dental/alveolar*, *dental and alveolar*, and *glottal* place features.

There are six place features in the sample that are present in fewer than ten languages. *Alveolo-palatal* consonants are present in eight languages of the sample, five of which are spoken in Eurasia. Alveolo-palatals may be found in languages from all categories of syllable structure complexity. Secondary *palatalization* is present in seven languages from five macro-regions and in all categories of syllable structure complexity. The *labial-velar* feature occurs in six languages, five of which are spoken in Africa (Southern Bobo Madaré, Doyayo, Ewe, Grebo, and Yoruba). Half of the languages with labial-velar consonants have Simple syllable structure. The remaining rare place features are found only in languages with Highly Complex syllable structure. Secondary *pharyngealization* and *velarization* are present in one language each (Tashlhiyt and Albanian, respectively). *Pharyngeal* consonants are found in languages from areas which are famous 'hotspots' of complex syllable structure: the Pacific Northwest (Nuu-chahnulth, Thompson), the Caucasus (Kabardian), and the Atlas Mountains (Tashlhiyt).<sup>27</sup>

<sup>&</sup>lt;sup>27</sup> Here the term *pharyngeal* also includes epiglottal consonants.

The remaining six place features — *labiodental*, *palato-alveolar*, *retroflex*, *palatal*, *uvular*, and secondary *labialization* — are found in more than ten languages each. The patterning of these features with respect to syllable structure complexity is plotted in Figure 4.13.



**Figure 4.13.** Percentage of languages in each category of syllable structure complexity having the given place feature.

There are two features in Figure 4.13 which show clear positive trends with respect to syllable structure complexity. *Palato-alveolars* are strongly associated with Highly Complex syllable structure, though the presence of this feature also shows a gradual rise from the Simple to Complex categories. The trend with *uvulars* is especially striking. This feature is not present in a single language from the Simple category, yet its frequency of occurrence rises with syllable structure complexity to the point where half of the languages with Highly Complex syllable structure have consonants at this place of articulation. The geographical distribution of uvulars is show in Figure 4.14. While the prevalence of this feature in the Highly Complex syllable structure is boosted by its concentration in areas such as the Pacific Northwest and the Caucasus, it is notable that

uvulars co-occur with Highly Complex syllable structure in regions as far-flung as New Guinea, Northeast Asia, and Patagonia.



Figure 4.14. Areal distribution of languages in sample with uvular consonants.

The trends in the other place features plotted in Figure 4.13 are not so clear. The *retroflex* and *labialization* trends are fairly flat with respect to syllable structure complexity. The percentage of languages with the *labiodental* feature is consistent in all groups except for Moderately Complex, in which it is much more frequent. The *palatal* articulation has a slight negative trend with respect to syllable structure complexity.

The observation regarding the pattern of the *palatal* feature brings up an important issue of terminology and description. It is not uncommon for authors of language descriptions to use the term 'palatal' in classifying the place of a series of consonants, but then transcribe the consonants with the symbols used for palatoalveolars. Similarly, the terms 'alveolo-palatal' and 'alveo-palatal' may be used in prose descriptions, while palato-alveolar symbols are used in transcription. In her cross-

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linguistic study of palatalization, Bateman (2007) notes that there is often disagreement on the transcription conventions used for secondarily palatalized velars, fronted velars, and palatal consonants. It is understandable that there is some inconsistency and interchangeability in the use of these terms: the area of contact between the tongue body and the hard palate may be large and variable in consonants articulated in this region, making it difficult to select a place classification (Ladefoged & Maddieson 1996: 30-33). Since palato-alveolar and palatal places of articulation are not always reliably distinguished from one another or other similar articulations, we must consider the possibility that the trends with respect to these features in Figure 4.13 effectively cancel each other out. In such a scenario, there would be no trend with respect to consonant articulations in this region of the vocal tract and syllable structure complexity.

In order to clarify this issue, I examine five places in the general region of the hard palate: *palato-alveolar*, *palatal*, *palatalized alveolar and/or velar*, and *alveolo-palatal*. For each language, the number of places in which consonants are produced in this region is noted. For example, the sound system of Polish has consonants in three distinct places in this region: palato-alveolar, alveolo-palatal, and palatalized velar (4.41).

#### (4.41) **Polish** (*Indo-European*; Poland)

## C phoneme inventory:

/p b p<sup>j</sup> b<sup>j</sup> ț d k g k<sup>j</sup> g<sup>j</sup>  $\widehat{ts} \hat{dz} \hat{tf} \hat{dz} \hat{tc} \hat{dz} f v f^j v^j s z \int 3 c z x m m^j n n r l j w/$ 

Figure 4.15 shows the distribution of languages in the sample with respect to how many places are utilized in the region of the hard palate.



**Figure 4.15.** Number of place distinctions made in region of hard palate in languages with different syllable structure complexity. Place distinctions considered here are *palato-alveolar*, *palatal*, *palatalized alveolar and/or velar*, and *alveolo-palatal*. For each category of syllable structure complexity, I show the percentage of languages having one, two, three, or none of these places represented in their consonant inventories.

In all categories, most languages have at least one place articulation in the region of the hard palate. Crucially, the patterns in Figure 4.15 show that the percentage of languages having one or more articulations in the region of the hard palate increases steadily with syllable structure complexity. That is, the trend in Figure 4.13 favoring purported 'palatal' articulations in languages with simpler syllable structure does not cancel out the trend favoring purported 'palato-alveolar' articulations in languages with more complex syllable structure.

Below I present another analysis of the proliferation of place distinctions in a large region of the vocal tract. In this case, the number of place distinctions made in the post-velar region is considered. The distinctions considered here are the *uvular*, *labialized* 

*uvular*, *pharyngeal*, *pharyngealized*, and *glottal* places of articulation. See Figure 4.16 for how the number of post-velar distinctions patterns with respect to syllable structure.



**Figure 4.16.** Number of place distinctions made in post-velar region in languages with different syllable structure complexity. Place distinctions considered here are *uvular*, *labialized uvular*, *pharyngeal*, *pharyngealization*, and *glottal*. For each category of syllable structure complexity, I show the percentage of languages having 1, 2,  $\geq$ 3, or none of these places represented in their consonant inventories.

In all categories of syllable structure complexity, roughly similar proportions of languages have at least one post-velar place of articulation, usually glottal. However, in the Complex and Highly Complex categories, one-quarter and one-half of languages, respectively, have consonants at more than one place in the post-velar region. In fact, in the Highly Complex category, some languages have consonant systems which make use of four post-velar places (Kabardian, Nuu-chah-nulth, and Thompson), and one language (Tashlhiyt) has consonants at five post-velar places. Below I show the consonant phoneme inventory of Nuu-chah-nulth, which has consonants at *uvular*, *labialized uvular*, *pharyngeal*, and *glottal* places of articulation (4.42).

## (4.42) Nuu-chah-nulth (*Wakashan*; Canada)

C phoneme inventory: /p t k k<sup>w</sup> q q<sup>w</sup>  $\hat{s}$  ? p' t' k' k'<sup>w</sup>  $\hat{ts}$   $\hat{tf}$   $\hat{ts}$ '  $\hat{tf}$ '  $\hat{s}$   $\frac{4}{5} x x^{w} \chi \chi^{w}$ h h m n m' n' j w j' w'/

In this section we have found that there are several place features of consonants which have positive trends with respect to syllable structure complexity. The strongest trend is that of the *uvular* articulation, which does not occur in any language with Simple syllable structure, but is present in fully half of the languages with Highly Complex syllable structure. The presence of a *palato-alveolar* articulation, or at least one place in the region of the hard palate, is also positively associated with syllable structure complexity. Languages with more complex syllable structure tend to have more consonant place articulations in the post-velar region. Post-velar articulations *pharyngeal* and *pharyngealization*, as well as the *velarization* articulation, are found only in languages with Highly Complex syllable structure in the current sample.

## **4.4.5 Manner features**

Here the manner features in the consonant phoneme inventories of the language sample are analyzed. In Table 4.15 I list the manner features considered.

Basic	Elaborated
stop affricate fricative nasal flap/tap trill central approximant lateral affricate lateral fricative lateral flap lateral approximant	prenasalization nasal release lateral release ejective implosive click

**Table 4.15.** Basic and elaborated manner features examined here. 'Central approximants' include glides but also rhotic approximants such as /x/.

Figure 4.17 shows how many languages in the sample have each manner feature.

Because all instances of lateral release in the data were lateral affricates, I have merged

these features and only represent the elaborated category of lateral release in the table. I

have also merged *lateral flap* with *flap/tap*.



**Figure 4.17.** Manner features in consonant inventories, by number of languages in which they are present.

As with place features, there are several manner features which are nearly universal in the sample. *Stops* occur in every language. *Nasals* occur in all but three languages (Cubeo, Karajá, and Rotokas, all in the Simple category). There are four languages lacking *fricatives*: Alyawarra, Bardi, Mangarrayi, and Ungarinjin. All of these languages are spoken in Australia, a region where this rare typological feature is common (Maddieson 1984: 42). *Central approximants* are reported to be absent in eight languages, five of which have Simple syllable structure. However, in at least some of these languages, phonetic glides occur in complementary distribution with other sounds (e.g.,  $[\overline{d_3}]$ ~[j] in Ngäbere, Arosemena 1983: 107).

There are five manner features occurring in ten or fewer languages in the sample. *Clicks* and *nasal release* occur in one language each (Hadza and Alyawarra, respectively). *Implosives* are present in the consonant inventories of six languages from all categories of syllable structure complexity. This feature is predominantly found in Africa and Southeast Asia & Oceania. *Lateral fricatives* occur in nine languages, six of which have Highly Complex syllable structure. This feature is found almost entirely in North America and Eurasia in the current sample. *Lateral release*, which corresponds to lateral affricates, is only found in languages which also have lateral fricatives.

The remaining six manner features considered here occur in more than ten languages. The patterning of these features with respect to syllable structure complexity can be found in Figure 4.18.

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**Figure 4.18.** Percentage of languages in each category of syllable structure complexity having the given manner feature.

Again, several of the features in Figure 4.18 do not have clear patterns with respect to syllable structure complexity. Both *lateral approximants* and *trills* show a general rising trend with respect to syllable structure complexity, but then a fall in the Highly Complex category. *Affricates* show a rise between the Simple and Highly Complex categories, but this is punctuated by a large decline in the Complex category. Nevertheless, the pattern of this feature is dramatically different on the two extremes of the syllable structure complexity scale: in the Simple category, affricates are present in 45% of languages, and in the Highly Complex category, they are present in 83% of languages. There are three manner features in Figure 4.18, all represented by the solid trend lines, which show clearer trends with respect to syllable structure complexity: *ejectives, flaps/taps*, and *prenasalization*.

The percentage of languages with ejectives increases from 9% and 7% of languages with Simple and Moderately Complex syllable structure to 38% of languages with Highly Complex syllable structure. There is a heavy areal distribution of this feature; over half (10/16) of the languages with ejectives in the sample are found in the Americas. Outside the Americas, ejectives are also found to co-occur with Highly Complex syllable structure in the Caucasus region and Northeast Asia (see Figure 4.19).



Figure 4.19. Areal distribution of languages in sample with ejective consonants.

The flap/tap feature appears to have a negative relationship with syllable structure complexity. Central flaps/taps and lateral flaps show the same pattern with respect to syllable structure complexity in this sample, which is why the groups are merged here. Roughly two-thirds (64%) of languages with Simple syllable structure have flaps or taps, while around 40% of the languages with Complex and Highly Complex syllable do. Examining the geographical distribution of languages with flap or tap articulations, we find that this pattern with respect to syllable structure complexity can be found within most of the macro-regions in the sample (Figure 4.20).



Figure 4.20. Areal distribution of languages in sample with flap/tap consonants.

Flap and tap articulations differ from trill articulations in important ways. Flaps and taps are produced with a single rapid movement of the active articulator, usually the tongue tip, making brief contact with the passive articulator, usually the alveolar ridge. Trills in the coronal region often have the same configuration of articulators, but the vibration of the active articulator is driven by aerodynamic currents rather than a muscular movement (Ladefoged & Maddieson 1996: 217-32). However, taps and flaps can vary allophonically with trills in some languages, and authors may use the same terminology (e.g., 'vibrant') to describe both kinds of sounds. Since the trill and tap/flap patterns in Figure 19 go in opposite directions, we must allow for the possibility that the trend favoring taps/flaps in languages with simpler syllable structure is simply a coincidence reflecting certain analytical or terminological preferences in those language descriptions. In Figure 4.21 I combine these categories and plot all languages reported to have flaps/taps and/or coronal trills.



**Figure 4.21.** Percentage of languages in each category of syllable structure complexity reported to have flaps/taps and/or coronal trills.

While the trend in Figure 4.21 is less pronounced than that for flaps/taps in Figure 4.18, it still shows that there is a higher percentage of languages with these articulations in the Simple and Moderately Complex categories.

The proportion of languages with *prenasalization* contrasts in their consonant phoneme inventories decreases with syllable structure complexity. This trend is not clearly skewed toward any region in particular. Half (7/14) of these languages are from the region of Australia & Papua New Guinea, but the distribution of those languages among the categories of syllable structure complexity is even. The trend favoring prenasalization in languages with Simple syllable structure is not limited to a single region. The six languages with Simple syllable structure and prenasalization are from four different macro-regions: Africa (Hadza), Australia & New Guinea (Kewa, Savosavo), North America (Pinotepa Mixtec), and Southeast Asia & Oceania (Tukang Besi, Yi). While these sounds are found in diverse macro-regions, it is interesting to note that, like Simple syllable patterns, they are found in languages spoken in close proximity to the equator. See Figure 4.22 for a map of the geographical distribution of languages with prenasalization.



Figure 4.22. Areal distribution of languages in sample with prenasalized consonants.

In this section we have found both positive and negative trends with respect to specific manner of articulation features and syllable structure complexity. *Ejective* articulations are more likely to be present in the consonant inventories of languages as syllable structure complexity increases. Meanwhile, the percentage of languages having *flap/tap* and *prenasalized* articulations in their consonant inventories decreases with increasing syllable structure complexity. Additionally, two rare manner features — *lateral fricative* and *lateral release* — are strongly associated with Highly Complex syllable structure and those with Highly Complex syllable structure and those with Highly Complex syllable structure.
## 4.4.6 Summary of consonant patterns in sample

Three hypotheses were formulated in §4.1.4 with respect to consonant inventory patterns and syllable structure complexity. First, it was hypothesized that consonant phoneme inventory size would increase with syllable structure complexity. This relationship was upheld in the current sample and was found to be statistically significant when syllable structure complexity was measured categorically and when it was measured as a sum of maximum syllable margin size. Second, it was hypothesized that the number of elaborated articulations present in consonant phoneme inventories would increase with syllable structure complexity. This hypothesis was also borne out in the data. The correlation between syllable structure complexity and number of elaborations present was found to be positive and significant, though the difference in average number of elaborations was not dramatic between the categories at the two extremes of syllable structure complexity. Finally, it was hypothesized that languages with more complex syllable structure would have different kinds of consonants in their inventories than languages with simpler syllable structure. The results of the analyses in §4.4.3-5 suggest that this is the case, as there are specific consonant articulations which are more frequently present in languages of the Complex and Highly Complex categories. However, it was also found that there are consonant types which occur more frequently in languages with simpler syllable structures. Thus it can be said, more generally, that languages with different syllable patterns also tend to have different kinds of consonants.

The specific consonantal features found to have positive or negative trends with respect to syllable structure complexity are listed in Table 4.16. The features marked with

an asterisk (\*) and italicized font are those which show a strong trend but occur in fewer than ten languages.

Type of feature	<b>Positive trends</b> (increases with syllable structure complexity)	<b>Negative trends</b> (decreases with syllable structure complexity)
Phonation		Voicing distinction in obstruents Voiceless sonorants*
Place	Palato-alveolar Uvular More post-velar distinctions <i>Pharyngeal</i> *	Labial-velar*
Manner	Ejective Affricate Lateral fricative* Lateral release*	Flap/tap Prenasalization

**Table 4.16.** Features of consonantal systems associated positively or negatively with syllable structure complexity.

Because the current sample is limited to only 100 languages, and many of the features examined here are cross-linguistically rare to begin with, significance levels cannot be determined for some of the patterns in Table 4.16. However, three trends are found to be statistically significant. The increasing *palato-alveolar* trend is significant across all four categories of syllable structure complexity:  $\chi^2(3, N = 100) = 13.13$ , p = .004. The *uvular* trend is highly statistically significant across the four categories of syllable structure complexity:  $\chi^2(3, N = 100) = 19.63$ , p = .0002. The *prenasalization* trend is significant when the pattern in the Simple category is compared to that in the other three categories combined (p = .03 in Fisher's exact test). Finally, the trend in *ejectives* is not quite statistically significant when the combined pattern in the Highly

Complex and Complex categories is cross-tabulated against the combined pattern in the Simple and Moderately Complex categories (p = .07 in Fisher's exact test).

While a larger language sample would be required to determine the strength and significance of some of the specific trends, there is an important general observation to be made regarding the patterns uncovered here. This is that the three standard aspects of consonant articulation examined here — phonation, place, and manner — pattern differently with respect to syllable structure complexity. Simpler syllable structure is associated with the presence of certain phonation features, while more complex syllable structure is associated with the presence of certain place features. Both ends of the syllable structure complexity scale are associated with specific manner features, but very different kinds. The manners of articulation associated with more complex syllable structure belong to the class of obstruents (ejectives and affricates), while the manner features associated with simpler syllable structure either to the class of sonorants (flap/ tap), or arguably have a sonorant component (prenasalized consonants). These patterns may have important implications for uncovering the development of highly complex syllable structure, as well as for establishing a syllable structure-based phonological typology of languages. These issues will be discussed further in §4.5.

# 4.5 Discussion

## 4.5.1 Segmental inventory patterns and syllable structure complexity

In light of the findings presented in the current chapter, we revisit the first broad research question for the dissertation (4.43).

(4.43) Do languages with highly complex syllable structure share other phonetic and phonological characteristics such that this group can be classified as a linguistic type?

The results indicate that there are segmental patterns associated with highly complex syllable structure. The hypotheses predicting larger average consonant phoneme inventories and larger numbers of elaborated articulations in these languages were confirmed in the data here, as was the hypothesis that different kinds of consonants would occur in these languages than in languages with simpler syllable structure. In (4.44) I list those segmental patterns which are most characteristic of languages of the Highly Complex category.

## (4.44) Segmental patterns associated with Highly Complex category

Mean of 26 consonant phonemes Mean of 4 elaborations in consonant phoneme inventory Absence of voicing distinction in obstruents Absence of prenasalized consonants Absence of flap/tap consonants Presence of palato-alveolar consonants Presence of uvular consonants Presence of affricate consonants Presence of ejective consonants The terms 'absence' and 'presence' are used here not in a categorical sense, but to mean relative absence or presence of a property in the Highly Complex group as compared to the other syllable structure complexity groups. In the case of prenasalized consonants, the pattern is nearly categorical; these consonants occur in only one language with Highly Complex syllable structure (Menya).

Additionally, there are two segmental patterns which the languages in the Highly Complex, Complex, and Moderately Complex categories share in common, which set them apart from languages in the Simple category. These are listed in (4.45).

#### (4.45) Segmental patterns associated with non-Simple syllable structure

Presence of length contrast in vowels Absence of nasalization contrast in vowels

A handful of other segmental properties are associated with the Highly Complex category. These include the presence of pharyngeals, the presence of richly elaborated post-velar place distinctions, and the presence of lateral fricatives and affricates. However, all of these segment types were generally rare in the data set, making it difficult to draw strong conclusions from their patterning with respect to syllable structure complexity.

Recall the analyses in §3.4.1-2 which established two different distributions in the languages of the Highly Complex category. In eight languages — Cocopa, Georgian, Itelmen, Polish, Tashlhiyt, Thompson, Tohono O'odham, and Yakima Sahaptin — Highly

Complex structures were found to be a prevalent pattern. In five languages — Alamblak, Doyayo, Kunjen, Menya, and Wutung — Highly Complex structures were found to be a minor pattern. As discussed in Chapter 3, the languages within each of these groups share similar patterns with respect to the occurrence of Highly Complex structures at each syllable margin, restrictions on consonant combinations in these structures, and the relative frequency of these structures. The 11 languages which belong to neither group — Albanian, Camsá, Kabardian, Lezgian, Mohawk, Nuu-chah-nulth, Passamaquoddy-Maliseet, Piro, Qawasqar, Semai, and Tehuelche — have syllable patterns that vary with respect to the different features examined or which fall somewhere in between the patterns of the two extreme groups.

It is reasonable to expect that if highly complex syllable structure has other phonetic and phonological correlates, then languages which differ in the extent to which these syllable structures are prominent might also exhibit the other correlates to different degrees. In Table 4.17 the languages of the Highly Complex portion of the sample are divided into the three groups described above. The properties of vowel and consonant inventories associated with Highly Complex syllable structure and listed in (4.44) above are given in the columns. A check mark indicates that a language has the expected property; a shaded cell indicates that it does not. For consonant phoneme inventory size and number of elaborations, I have designated a value greater than or equal to the mean for the category to be the expected property.

_	V length contrast <b>present</b>	V nasal contrast <b>absent</b>	≥ <b>26</b> Cs	$\geq$ <b>4</b> elabs.	Voicing contrast in obstr. <b>absent</b>	Prenasal- ization <b>absent</b>	Flap/ tap <b>absent</b>	Palato- alveolar <b>present</b>	Uvular present	Affricate present	Ejective present		
	Languages with prevalent Highly Complex patterns												
Cocopa	√	√		√	√	√	√	√	√	√			
Georgian		√	√	$\checkmark$		√		√	√	√	$\checkmark$		
Itelmen		√		$\checkmark$		√	$\checkmark$	√	$\checkmark$	$\checkmark$	$\checkmark$		
Polish			$\checkmark$	$\checkmark$		$\checkmark$	$\checkmark$	$\checkmark$		V			
Tashlhiyt		√	√	$\checkmark$		√	√	$\checkmark$	$\checkmark$				
Thompson		√	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$		
T. O'odham	√	$\checkmark$				√		√		√			
Y. Sahaptin	√	√	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	√	$\checkmark$		
	Languages with intermediate Highly Complex patterns												
Albanian		√	$\checkmark$	$\checkmark$		√		√		√			
Camsá		√				√		√		√			
Kabardian	√	√	√	√		√	√	$\checkmark$	√	√	$\checkmark$		
Lezgian	√	√	$\checkmark$	$\checkmark$		√	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$	$\checkmark$		
Mohawk		√			√	√	√	$\checkmark$		√			
Nuu-chah-	√	√	√	√	√	√	√	√	√	√	$\checkmark$		
P Maliseet	√	√			√	√	√	√		√			
Piro	√	√			√	√		√		√			
Qawasqar		√			√	√	√		√	√	√		
Semai	√					√							
Tehuelche	√	√				√	√	√	√	√	√		
	Languages with minor Highly Complex patterns												
Alamblak		√				√		√		√			
Doyayo	√					√							
Kunjen		√		√	$\checkmark$	√	√						
Menya		√		$\checkmark$			√	√	√	√			
Wutung						√	√	√		√			

**Table 4.17.** Highly Complex languages, divided into three groups according to the prominence of their Highly Complex patterns. Check mark indicates that the given language has the expected segmental property; shaded cell indicates it does not.

The visual pattern in Table 4.17 indicates that the expectations are borne out. Languages which have Highly Complex syllable structure as a prevalent pattern also tend to have more of the established segmental correlates of Highly Complex syllable structure: 64/88 or 73% of the cells in that group have check marks, showing the expected pattern. Languages which have Highly Complex syllable structure as a minor pattern tend to have fewer of the segmental correlates: 21/55, or 38% of those cells show the expected pattern. The 'intermediate' languages are generally more like the first group in their segmental properties: 77/121, or 64% of these cells show the expected pattern. Just two languages of this group, Camsá and Semai, have segmental properties which are more similar to the languages of the 'minor' group than those of the 'prevalent' group.

Most of the correlates can be found in each group of languages with Highly Complex syllable structure. In the 'minor' group, there are two correlates which are not present in any of the languages: consonant phoneme inventories of 26 consonants or more, and ejectives. The presence of vowel length contrasts and uvular consonants are nearly absent in this group, occurring in one language each. I will not go into further detail here about the patterning of specific segmental properties within each of the three groups, which is apparent in Table 4.17. However, I will say that it is striking that the three subtypes of Highly Complex syllable structure, which were defined in §3.4.1-2 entirely by reference to their syllable patterns, show the predicted patterns with respect to the presence of segmental correlates of Highly Complex syllable structure.

Two languages of the sample, Yakima Sahaptin and Nuu-chah-nulth, have all of the established segmental correlates of Highly Complex syllable structure. Their segment

inventories might be considered prototypical of the Highly Complex category. I give the phoneme inventory of Yakima Sahaptin in (4.46).

### (4.46) Yakima Sahaptin (Sahaptian; United States)

## C phoneme inventory:

/p t k k<sup>w</sup> q q<sup>w</sup> ? p' t' k' k'<sup>w</sup> q' q'<sup>w</sup>  $\widehat{t!}$   $\widehat{ts}$   $\widehat{tf}$   $\widehat{ts'}$   $\widehat{ts'}$   $x^w \chi \chi^w h m n l w j/V$ **V phoneme inventory:** /i i a u i: a: u:/

The results of the analyses in this chapter also reveal tendencies in the segmental patterns of languages on the Simple end of the syllable structure complexity cline. In most cases these patterns are the opposite of those given in (4.44)-(4.45) for the Highly Complex category. However, some of the segmental patterns observed in this category are more extreme than others. In the case of uvulars, there is a complete absence of this consonant type in languages with Simple syllable structure. Ejectives are nearly absent in this category, occurring in only two languages (Hadza and Jemez). A handful of properties, including the presence of a vowel phonation contrast, the presence of voiceless sonorants, and the presence of labial-velar non-glide consonants seem to show patterns favoring Simple syllable structure, but occur in so few languages of the sample that strong conclusions cannot be drawn about them. Finally, languages with Simple syllable structure have the lowest mean number of consonant phonemes (19 consonants) and the lowest mean number of elaborations present in their phoneme inventories (2.5 elaborations) of all the categories examined here.

It is important to keep in mind that the findings reported here are tendencies, some of them subtle. Because most of the contrasts and articulations examined here occur in only a fraction of the language sample, and the sample is of moderate size to begin with, some of the results should be regarded cautiously until they can be confirmed on a larger scale. Languages in the sample also show wide ranges in the constituency of their segmental inventories, resulting in many exceptions to the general patterns. Hadza is in the Simple category, yet has the largest consonant inventory and number of elaborations of all the languages.<sup>28</sup> Mohawk and Passamaquoddy-Maliseeet are in the Highly Complex category, yet have very small consonant inventories and numbers of elaborations. However, it is encouraging for the wider implications of this study that several of the general findings, such as those regarding consonant phoneme inventory size and consonant elaborations, replicate the results of previous studies with much larger sample sizes. It is also notable that the distribution of features correlated with languages at either end of the syllable structure complexity cline does not appear to be random. The Highly Complex category is coherently associated with a group of consonant place features and manner features related to obstruents. The Simple category is coherently associated with phonation features for both consonants and vowels, and two manner

<sup>&</sup>lt;sup>28</sup> Borrowing may account for some of the sounds in the Hadza phoneme inventory. Bonny Sands (p.c.) notes that it's possible that some click articulations have been borrowed from other click languages, in the same way that some Bantu languages have borrowed clicks from neighboring Khoisan languages. Kirk Miller (p.c.) suggests that Hadza seems to have borrowed its initial prenasalized consonants and all voiced obstruents besides /b/. Even excluding clicks and non-bilabial voiced obstruents, the language would have an consonant inventory of 41 segments, still quite large. Both Sands and Miller agree that, apart from the presence of clicks, the phoneme inventory of Hadza is not atypical for an East African, particularly Cushitic, language.

features related to sonorants. This point will be discussed further in the following sections.

Having established segmental correlates of syllable structure complexity, we revisit the second research question of the dissertation (4.47).

(4.47) How does highly complex syllable structure develop over time?

The segment inventory of a language reflects, at least in part, sound changes which occurred at some point in the history of the language. Some typologically frequent speech sounds — for instance, voiceless stops at labial, dental/alveolar, and velar places of articulation — tend to persist within sound systems over the history of a language, and are not often observed to come about from other sounds as the result of allophonic processes (Bybee 2015a; see also discussion in §4.1.1). This tendency may reflect general biological constraints on the vocal tract and/or the perceptual robustness of these sounds. However, for many other sounds, there is evidence for how they tend to develop through phonetic mechanisms in language use.

In §4.5.2 I discuss reported processes of sound change which result in the consonantal patterns associated with Highly Complex syllable structure. In §4.5.3 I discuss reported processes resulting in the consonantal patterns associated with Simple syllable structure. In the following I include historical, comparative, and synchronic accounts of sound change processes. Although historical evidence is best because it involves more or less direct observation, the history of written language is such that there

are very few languages, language families, and regions for which such evidence exists. Including reports of synchronic and comparative processes greatly expands the range of data available, but it does come with the caveat that the reported patterns may have other possible analyses. Many of the synchronic processes reported here are from Allophon, a database of 820 phonetically-conditioned processes in 82 diverse languages (Bybee & Easterday under review).

In §4.5.4, I will compare the patterns reported in §4.5.2-3 and discuss their broad implications with respect to the research question in (4.47) and syllable structure typology more generally.

### 4.5.2 Articulations and contrasts characteristic of the Highly Complex category

In this section I present historical, comparative, and synchronic accounts of processes resulting in articulations and contrasts associated with the Highly Complex category, specifically palato-alveolars, uvulars, ejectives, affricates, and pharyngeals. As will be discussed in §4.5.4, all of these articulations commonly come about through the place assimilation of consonants to vowels and strengthening processes.

### 4.5.2.1 Palato-alveolars

Palato-alveolars are articulations made with the tongue blade in the area of the hard palate behind the alveolar ridge. These are known to develop from many different consonants. The most common conditioning environments for the development of these sounds are front, especially high front, vowels and palatal glides. Thus palato-alveolars

are often a product of the cross-linguistically common process of palatalization (Bhat 1978; Bateman 2007, Bybee & Easterday under review). Typically, the consonant undergoing palatalization precedes the conditioning vowel or glide. In a common type of process, palato-alveolars may develop out of alveolar consonants preceding a high front vowel, as in synchronic processes in Cantonese (4.48) and Logba (4.49).

### (4.48) **Cantonese** (*Sino-Tibetan*; China)

/t͡sy/ [t͡ʃy]

'live'

(Matthews & Yip 1994: 14; tone left unmarked here)

# (4.49) Logba (Niger-Congo; Ghana)

/onziɛ/

[onʒiɛ]

'owl'

(Dorvlo 2008: 18)

Palato-alveolars are also known to develop out of velar consonants. The usual situation involves a velar stop becoming a palato-alveolar affricate preceding a high front vowel or glide. A well-known example of this occurred in the late stages of Latin and early stages of Romance, when velar stops were fronted preceding front vowels, then

eventually became palato-alveolar affricates in some of the daughter languages, e.g. Latin [k]ivitate > Italian [t]ittà 'city' (Posner 1996: 113). Bhat (1978) lists many examples, mostly historical, of velar palatalization resulting in palato-alveolar affricates preceding front vowels. This process occurs synchronically in Nkore-Kiga (4.50).

(4.50) Nkore-Kiga (Niger-Congo; Uganda)

/kugija/ [kud͡ʒija] 'say, do'

(Taylor 1985: 202)

Synchronic instances of velar palatalization resulting in palato-alveolar affricates are relatively rare: in the Allophon database, there is only one phonetically-conditioned process fitting this description out of approximately 50 palatalization processes in 45 languages (Bybee & Easterday under review). Bateman (2007) reports a higher proportion of such processes in her survey of 58 languages with palatalization, though she additionally considers morphophonological processes. These facts suggest that the palato-alveolar outcome from velars typically follows a long chain of incremental palatalization in the history of a language.

More rarely, palato-alveolar consonants may develop from glide strengthening. This is the process by which a glide becomes more constricted in its articulation, sometimes becoming a fricative, affricate, or even a stop. This typically occurs in

syllable-initial position. A process of this sort has occurred recently in Argentinean Spanish, where the sound corresponding to palatal approximant /j/ in other major dialects is now realized as [ $\int$ ] or [3], among other variants, in syllable-initial position: e.g. Castilian Spanish a[j]er corresponds to Argentinean Spanish a[3]er~ a[ $\int$ ]er'yesterday' (Harris & Kaisse 1999: 118). There is evidence that glide strengthening comes about only after a long history of palatalization in a language: all 11 languages with synchronic palatal glide strengthening in the Allophon database were also found to have other synchronic palatalization processes and/or non-glide consonant phonemes in the palatal region (Bybee & Easterday under review).

Very rarely, palato-alveolars may develop out of labial consonants. Such a process can be found in Romanian; e.g. Standard Romanian /fjer/ corresponds to Moldavian /ʃer/ 'iron' (Bateman 2007: 108). Bateman argues that full palatalization of labial consonants is better analyzed as a strengthening of the palatal articulation following the labial, and subsequent weakening and deletion of the labial gesture. In her sample, labial palatalization always occurs in specific morphophonological contexts, and is always the outcome of a series of historical developments. Ohala (1978) argues for a perceptual basis for a similar phenomenon of full palatalization of labials in Southern Bantu, noting that labial-palatal sequences can be misperceived as palato-alveolar consonants.

Palato-alveolars may also develop out of alveolars with secondary palatalization, as in the example of free variation in Dan (4.51).

(4.51) **Dan** (*Mande*; Côte d'Ivoire, Guinea, Liberia)

/s<sup>j</sup>a/

[s<sup>j</sup>a]~[∫a]

'to indicate'

(Bearth & Zemp 1967: 17; tone left unmarked here)

Like the glide strengthening and velar fronting and affrication processes described above, the process in Dan appears to be the end result of a chain of palatalization processes. The presence of consonant phonemes with secondary palatalization implies that palatalization has a long history in the language.

Finally, palato-alveolars may develop out of free variation with other sounds having a palatal articulation. Ladefoged & Maddieson note that palatal stops are often produced with affrication due to the large surface area required for stop in this region, and as a result may vary with palato-alveolar affricates in a language (1996: 31-3).

The free variation of palatal stops with palato-alveolar affricates can be seen as a weakening of the abrupt stop release, and therefore a case of lenition. However, we find that the most common sound change processes leading to the development of palatoalveolar consonants are assimilation, usually anticipatory, to a high and/or front vowel or glide, and fortition of palatal glides. Both articulatory and perceptual accounts have been put forward to account for the high cross-linguistic frequency of these palatalization processes. Fronted velar stops and palato-alveolar affricates have acoustic similarities in their release bursts, which has led some to argue that this sound change is a result of

perceptual reanalysis (Guion 1998). In articulatory terms, palatalization which has a palato-alveolar outcome results from extreme temporal overlap of the tongue gestures used for the articulation of the consonant and the (high) front vowel (Bateman 2007). The high front tongue position is known to be particularly strong, in that it is likely to both affect and resist the effects of neighboring articulations, especially in syllable-initial position (Recasens & Espinosa 2009, Recasens 2014). This fact explains the prevalence of palatalization processes but may also contribute to the understanding of the mechanisms behind palatal glide strengthening (Bybee & Easterday under review).

# 4.5.2.2 Uvulars

Uvulars are articulations made with the tongue body in the region of the uvula. Direct historical accounts of the development of uvular consonants are few. This is probably largely due to the limited geographical distribution of uvulars, which tend to be found in regions where writing is a recent development, apart from the Eastern Mediterranean and Caucasus regions.<sup>29</sup> However, synchronic and comparative accounts may be found. Uvular stops, affricates, and nasals apparently always develop out of velar consonants.

In Yongning Na, uvular stops are marginally contrastive with velars in just two limited vocalic environments. Otherwise the distribution is predictable, with uvular allophones of the velar stops occurring in environments preceding low vowels (4.52).

<sup>&</sup>lt;sup>29</sup> In both Biblical Hebrew and Old Georgian the velar/uvular distinction already existed by the time that written records of the languages began (Rendsburg 1997, Butskhrikidze 2002).

This suggests a recent phonologization of uvular articulations in the language (Lidz 2010: 28).

(4.52) Yongning Na (Sino-Tibetan; China)

/k<sup>h</sup>a/

 $\left[q^{h} \alpha\right]$ 

'however many, several'

(Lidz 2010: 80; tone left unmarked here)

Adjacent back vowels may also condition such processes, as in the Uyghur example shown here (4.53).

(4.53) Uyghur (*Turkic*; China)

/tʃoŋ/

[t͡∫on]

'big'

(Hahn 1991: 76)

Fortescue describes the presence of uvular consonants as an areal feature of languages in the Bering Strait region. He reports that a common phonological pattern in the region is for uvular variants of velar stops to occur adjacent to back and/or low vowels, eventually phonemicizing as the conditioning vowels shift. Such processes appear to have occurred in the history of Nivkh, Ket, and many languages on the North American side of the region, and the pattern is still allophonic in Even and Yakut (1998: 72, 91).

The term 'back velar' is sometimes used interchangeably with the term 'uvular' in language references and can also be used more generally to describe the region behind the area of the velum that is typically used in velar articulations. Van den Berg states that in Hunzib, "strictly speaking, the uvulars are back velar consonants" (1995: 20). Similarly, references for languages spoken in the Pacific Northwest and California often describe a front velar/back velar place distinction in consonants (cf. Kinkade 1963 for Upper Chehalis, Harris 1981 for Comox, Golla 1970 for Hupa). It is somewhat easier to find synchronic processes which result in purported back or backed velars than those which result in uvulars. In the Allophon database, back(ed) velars are reported outcomes of allophonic processes in just three languages, but uvulars are never reported as an outcome (Bybee & Easterday under review). Like uvulars, allophonic back(ed) velars are produced in the environment of back and/or low vowels (4.54).

(4.54) Moro (Kordofanian; Sudan)

/kuku/

[kuku]

'boy's name'

(Black & Black 1971: 2)

The fact that synchronic processes resulting in back(ed) velars are crosslinguistically more common than those resulting in uvulars suggests that the sound change from velar to uvular may not often be direct but instead may come about slowly over the history of a language, like the palatalization and affrication of velar stops described above.

It should be noted that uvular trills occur in some languages, especially those of Western Europe. These are the source of the uvular fricatives and approximants which now function as rhotics in non-conservative varieties of Standard French and Standard German (Ladefoged & Maddieson 1996: 225). While it is likely judging from comparative Indo-European data that the uvular trill in conservative varieties of these and other languages arose from an apico-alveolar trill, there is much debate over the particular path(s) of development taken by this historical change (Schiller 1999).

Most of the processes described here for the development of uvulars would fall under the definition of assimilation. In gestural terms, the low and/or back tongue body configuration for the vowel articulation has the effect of pulling the consonant articulation away from the central part of the velum and towards the back velum or uvula. Unlike the case of palato-alveolars, there does not seem to be a strong directional tendency for this assimilation; it occurs both preceding and following the conditioning vowels in the examples given above. In the case of the Western European uvular trill, at least some accounts propose a weakening of the apical gesture and strengthening of the domed tongue body gesture for the rhotic (Schiller 1999), which could perhaps be analyzed as simultaneous processes of lenition and fortition.

## 4.5.2.3 Ejectives

Ejectives are consonants which involve a simultaneous closure by the glottis and a constriction in the oral vocal tract. During the consonant articulation, the closed glottis is raised, increasing the air pressure so that the release of the oral constriction is accompanied by a salient burst of air, though the specific phonetic properties of this articulation may vary widely cross-linguistically (Lindau 1984). Ejectives are often analyzed as sequences of obstruents and glottal stops, especially in phonological analyses which seek to maximize the economy of phoneme inventories. For example, Zuni has phonetic ejective stops and affricates, which are analyzed by Newman to be phonemic sequences (4.55).

(4.55) **Zuni** (Isolate; United States)

/k?o:∫i/

[k'o:∫i]

'Joshua cactus'

(Newman 1965: 16)

Again, due in part to their geographical distribution, direct historical accounts of the development of ejective phonemes are rare. However, comparative, morphological, and allophonic patterns in many languages show these sounds developing from the 'fusion' of sequences of obstruents and glottal stops. Haida dialects show evidence of such a process: Southern Haida /t'Ap?At/ corresponds to Alaskan Haida /t'əp'ət/ 'snap, break' (Fallon 2002: 312). In Nuu-chah-nulth, ejectives are produced when glottal stopinitial suffixes attach to obstruent-final stems (4.56).

(4.56) **Nuu-chah-nulth** (*Wakashan*; Canada)

/wik-?ap-we?in/ not-CAUS-3s.QT [wik'apwe?in]

'it hadn't been'

(Stonham 1999: 69)

In both the Haida and Nuu-chah-nulth examples, ejectives already occur as contrastive phonemes in the languages, indicating that these processes or something like them have operated in the languages for long periods of time. An example of the new emergence of ejectives in a language may be found in the history of Upper Necaxa Totonac. Comparative and language-internal evidence suggest a diachronic path by which uvular stops first became debuccalized, then fused with preceding fricatives to form cross-linguistically rare ejective fricatives in the language: e.g., Apapantilla /ʃqa:m/ corresponds to Upper Necaxa Totonac /ʃ'a:m/ 'corn husk' (Beck 2006: 6).

Ejectives may also occur as optional allophonic variants of voiceless stops in many languages. In many dialects of English, utterance-final voiceless stops may be realized as ejectives for emphatic affect: e.g., *Wha*[t']?? (Fallon 2002: 7-8, citing Taylor 1995: 224). A similar process in Pilagá, though optional, has a wider application. Vidal

(2001) notes that a characteristic phonetic feature of this language is the common occurrence of an optional glottal stop after almost any consonant, including sonorants. The closure of the glottis is most notable with voiceless obstruents, and may result in an ejective when these sequences occur in syllable-initial position (4.57).

(4.57) Pilagá (Guaicuruan; Argentina)

/qaepa/ [qaepa]~[q'aepa] 'evebrow'

(Vidal 2001: 36)

In nearly all languages for which the synchronic, morphophonological, or comparative evidence exists, ejectives come about from sequences of obstruents and glottal stops. In his typological study of ejectives, Fallon observes that fusion overwhelmingly occurs when the glottal stop follows the obstruent; there are just a few historical examples, always inferred from morphophonological data, in which the glottal stop may have preceded the obstruent (2002: 314). Therefore this process is overwhelmingly one of anticipatory assimilation. Fallon describes it as a temporal overlap of glottal and oral articulations: because plain voiceless consonants lack laryngeal features and glottal stops lack oral features, the anticipatory assimilation of the former to the latter is phonetically natural (ibid. 314).

## 4.5.2.4 Affricates

Affricates are plosive articulations which include a period of frication following the release of the occlusion. The stop and fricative portion of an affricate are often, but not always produced at the same place of articulation. The most frequent types of affricates, those produced in the palato-alveolar or dental/alveolar regions, are commonly attested to arise from stops in a process called assibilation (Hall & Hamann 2006, Telfer 2006). In a typical assibilation process, a dental/alveolar stop is realized as an affricate preceding a high front vowel.<sup>30</sup> This sound change is documented in the history of Romance, and is also a common allophonic process. For example, in West Greenlandic, voiceless alveolar stop /t/ has an allophone [ $\hat{ts}$ ] obligatorily preceding a high front vowel /i/ and optionally in word-final position (Fortescue 1984: 333). Assibilation processes may also be triggered by high vowels more generally, as in the Japanese example in (4.58).

(4.58) Japanese (Japonic; Japan)

/itɯ/

[itsɯ]

'when'

(Tsujimura 2013: 22)

<sup>&</sup>lt;sup>30</sup> Note that assibilation processes may often result in sibilant fricatives, in addition to affricates.

Because palato-alveolar consonants are so often affricates, some of the processes which commonly give rise to palato-alveolars may also produce affricates.<sup>31</sup> Dental/ alveolar or velar stops may be shifted to the palato-alveolar place of articulation and affricated adjacent to a (high) front vowel (see example 4.50 in §4.5.2.1). Due to the large contact area for stops in this region, affecting the extent to which the release can be abrupt, affricates may also come about through variation with a palatal stop, as in Piro, where /c/ varies freely between [c] and [ $\widehat{cc}$ ] (Hanson 2010: 17-18).

Additionally, affricates may arise from glide strengthening: e.g., Late Latin [j]*am* > Gallo-Romance  $[\widehat{d_3}]am$  'already' (Berns 2013: 132). A similar process, perhaps along the same cline, involves the strengthening of a palato-alveolar fricative to an affricate. In Sheko, the voiced palato-alveolar fricative [3] is in free variation with an affricate counterpart and a voiced palatal stop in most syllable-initial contexts (4.59).

(4.59) Sheko (Afro-Asiatic; Ethiopia)

/bāʒà/

[bāʒà]~[bād͡ʒà]~[bāɟà]

'work'

(Hellenthal 2010: 86)

<sup>&</sup>lt;sup>31</sup> This brings up the question of whether the higher proportions of palato-alveolars and affricates in the Highly Complex category are essentially an artifact of higher rates of palato-alveolar affricates (/tJ/ and /  $d_3$ /) in those languages. This is not the case. In all syllable structure complexity categories, most of the languages with affricates do not have them solely at the palato-alveolar place of articulation, and most of the languages with palato-alveolars do not have them solely for the affricate manner of articulation.

Other historical sources of affricates show them occasionally arising from consonant coalescence and stop intrusion. In the history of Romance, the deletion of unstressed vowels created consonant clusters which merged into affricates in some contexts: Classical Latin  $n\bar{a}tus >$  Gallo-Romance  $ne[t\bar{s}]$  'born' (Berns 2013: 128). Vowel deletion in Romance could also condition stop intrusion when occurring between a coronal sonorant and /s/, resulting in an affricate: Classical Latin *annos* > Gallo-Romance  $an[t\bar{s}]$  'years' (ibid.).

The environments conditioning the development of affricates are frequently similar to those conditioning the development of palato-alveolars: an adjacent, but usually following, high and/or front vowel, and/or syllable-initial position. Again, there are both acoustic/perceptual and articulatory accounts for these phenomena. Hall et al. (2006) argue that the turbulence occurring when a dental/alveolar stop is released into a high front vowel or glide can be reinterpreted as affrication. In articulatory terms, the highly constricted nature of the high front vowel configuration may contribute to a brief period of actual frication during and after the release of the stop. In either account, the stop is assimilating to properties of the following vowel. Lenition may play a more minor role in the development of affricates. The unconditioned variation between a palatal stop and palato-alveolar affricate can be, as discussed above, seen as a case of lenition of the stop release. The development of affricates out of coalescence processes is an effect of vowel deletion, a type of lenition. Finally, the development of affricates out of intrusive stops can be considered fortition, but is probably better understood as an effect of gestural retiming than insertion of a new gesture (Bybee 2015b: 43-44).

#### 4.5.2.5 More post-velar distinctions

Languages with Highly Complex syllable structure are more likely to have more than one post-velar articulation, defined here as uvular, pharyngeal(ized), and glottal articulations, than languages in the other categories examined. The development of uvular consonants has been described in §4.5.2.2 above. As described in §4.4.4, there is no apparent relationship between syllable structure complexity and the presence of glottal consonants. Therefore I focus here on the development of pharyngeals.

Pharyngeal consonants are articulated with a constriction, usually fricative or approximant, at the pharynx. The term is often used to describe consonants articulated at the pharynx or epiglottis, because there are very few languages in which this distinction is made (a notable exception is Aghul, Ladefoged & Maddieson 1996: 167-8).

In a typological study of post-velar consonants in 291 languages, Sylak-Glassman reports that languages with pharyngeals but no uvulars or glottals are extremely rare. Likewise, languages with uvulars and pharyngeals but no glottals are rare. He takes these distributions to suggest that pharyngeals are likely to develop from uvulars in languages in which both uvulars and glottals are already present (2014: 291).

Jacobsen (1969) uses comparative and morphophonological evidence to show that pharyngeals in Nuu-chah-nulth and Nitinaht very likely developed out of uvulars in the recent history of Nootkan. The pharyngeal consonants in these languages correspond to uvulars in Makah and other members of the family. This account is supported by the

more recent merger in Nuu-chah-nulth, briefly described in §4.2.1 above, in which ejective uvulars have merged with

/s/ in the present language.

Many authors have made similar observations regarding the relationship between glottals and pharyngeals in some Semitic languages. One proposal for the development of secondary pharyngealization in the family argues that these consonants were originally ejectives which gradually took on pharyngealization and lost the glottal closure (Zemánek 1996). In Neo-Aramaic, it has been proposed that pharyngeal [5] and glottal [7] were in complementary distribution at one historical stage (Hoberman 1985).

Jacobsen makes the following typological generalization regarding the development of pharyngeals:

"...[t]wo preconditions would be necessary to the development of pharyngeals: the presence of glottalized consonants, and of contrasting k- and q-series of consonants. Occasionally some languages meeting these specifications, such as early Nootka, must have experienced undue crowding of consonants at the back of the mouth and relieved this by moving some of them back to the pharynx."

(Jacobsen 1969: 152)

While it seems likely from the comparative, historical, and distributional evidence that pharyngeals develop out of uvulars and glottals, the specific phonetic motivations behind these developments are unclear. The paths posited for Nootkan and Semitic above seem to be quite general and unconditioned by specific vocalic or other environments. What Jacobsen describes in the passage above sounds more like an articulatory- or perceptually-motivated chain shift, as observed for vowel systems, than any typical process of consonantal sound change.

#### **4.5.3** Articulations and consonantal contrasts characteristic of the Simple category

In this section I present historical, comparative, and synchronic accounts of processes resulting in articulations and contrasts associated with the Simple category, specifically voiced obstruents, prenasalization, and flaps/taps. In contrast to the processes described in §4.5.2 above, the processes in this section can often be interpreted as lenition or sonorization.

### 4.5.3.1 Voicing distinction in obstruents

Voiced obstruents are less frequent in phoneme inventories than voiceless obstruents. Maddieson (1984) reports that most languages with a single series of stops by phonation type are reported to have voiceless stops. Voiced fricatives are much less frequent cross-linguistically than voiceless fricatives, and the presence of voiced fricatives and/or affricates in a language generally implies the presence of their voiceless counterparts (ibid.). In languages with contrastive voiceless and voiced series of obstruents, the extent to which vocal fold vibrations are sustained during the voiced articulations may vary widely from language to language (Ladefoged & Maddieson 1996: 50-3). Nevertheless, it seems that voicelessness is the 'default' phonation state for these sounds, such that any voicing distinction in obstruents arises through the introduction of voiced counterparts, however that manifests in phonetic terms.

Unsurprisingly, voiced obstruents are known to come about most often from voiceless obstruents through processes of voicing. Intervocalic voicing is a well-attested historical process by which voiced obstruents are known to emerge: e.g., Latin  $v\bar{v}ta >$ 

Portuguese *vida* 'life' (Posner 1996: 234). Similarly, English voiced fricatives were originally allophonic variants that occurred between voiced sounds (Millar & Trask 105-6). In another common process, voiceless obstruents may assimilate to the voicing of an adjacent sonorant: e.g., Roncalese Basque *alte* as compared to Standard Basque *alde* 'side' (Hualde 2003: 20). In Allophon, there are 47 synchronic processes of obstruent voicing, 18 of which occur intervocalically, and 21 of which occur adjacent to voiced consonants, usually sonorants. Other processes are reported to occur in specific segmental and/or word environments. For example, in Yimas, a voiceless bilabial stop /p/ is often realized as voiced preceding a high back vowel (4.60).

(4.60) Yimas (Lower Sepik-Ramu; Papua New Guinea)

/irpuʎik/ [irbuʎik] 'black ants'

(Foley 1991: 39)

Another much rarer source of voiced obstruents may be the denasalization of nasal stops. This happened historically in a diverse handful of languages of the Pacific Northwest, including Quileute, Lushootseed, and Makah (Thompson & Thompson 1972, Kinkade 1985). In Karitiâna, there is a synchronic process by which nasal consonants are realized as voiced stops word-initially; voiced stops occur in no other context in the language (4.61).

#### (4.61) Karitiâna (*Tupian*; Brazil)

/neso/

[deso]

'mountain'

(Storto 1999: 25)

Occasionally, there have been reports in the literature of obstruents becoming voiced in typologically unusual environments. Initial fricative voicing is historically attested in some Germanic languages (cf. English *sun* and German [*z*]*onne*, Standard Modern English *fall* and Southwest British English [*v*]*all*; Goblirsch 2003). Goblirsch attributes this to the generalization of an old pattern of inter-sonorant voicing of fricatives to the voicing of fricatives occurring in initial position after a pause. Yu describes a pattern for Lezgian which can be synchronically analyzed as word-final obstruent voicing: compare noun stem *rab* to suffixed form *rapuni* 'needle' (2004: 76). Using comparative and morphophonological evidence, he shows that the alternating consonants were historically voiced. Instead of a synchronic process of word-final voicing taking place in the language, it is likely that the corresponding word-internal alternants underwent a series of historical processes leading to their current devoiced forms.

In Apinayé, voiceless oral plosives may have voiced allophones in coda position. However, this is part of a larger distributional pattern of plosives in the language, by which voiceless allophones occur in the onsets of stressed syllables and voiced

allophones occur as free variants in more marginal positions, including the onsets of unstressed syllables (4.62a-b).

# (4.62) Apinayé (Macro-Ge; Brazil)

(a) /tep/
 ['tep]~['teb]
 'fish'
 (b) /pika/

[bɨˈka]~[pɨˈka]

'earth'

(Oliveira 2005: 44)

Obstruent voicing which occurs intervocalically or adjacent to voiced consonants is often described as assimilation, since the consonant takes on properties of surrounding sounds. However, in articulatory terms this may be considered a process of lenition: the gesture which opens the glottis for the voiceless period of the consonant is lost, perhaps as a result of shortened duration of the consonant and its increasing overlap with vocalic gestures (Bybee 2015b: 30). Indeed, Foley specifically refers to the process of /p/ voicing in Yimas as lenition (4.60). It is notable that a related process in the language involving /k/ has both voiced and spirantized the consonant in some contexts (1991: 39). Similarly, paths which started out as obstruent voicing in Romance have progressed into other forms of lenition, including spirantization: Latin *lupu* > Spanish  $lo[\beta ~ \beta]o$ . The sporadic voicing of voiceless stops in unstressed environments in Apinayé also make phonetic sense as lenition processes, since they occur in relatively weak environments. The denasalization processes described above, similarly, could be thought of as assimilation in that the consonants take on the nasality features of adjacent segments, or lenition, in that the velum lowering gesture is lost.

## 4.5.3.2 Prenasalization

Prenasalized consonants are phonetic sequences of homorganic nasals and consonants, usually stops. The timing pattern of prenasalized stops can be similar to that of nasal+plosive sequences across languages (Browman & Goldstein 1986), and indeed there are languages in which prenasalized stops derive from such sequences. In many Bantu languages, prenasalized consonants are often morphologically derived, but have the phonological behavior of single units (Tak 2006, see example 4.63).

(4.63) Kilega (Niger-Congo; Democratic Republic of the Congo)

/n-pene/ CL-goat [<sup>m</sup>pene] 'a goat'

(Tak 2006: 132)

Prenasalized portions of consonants may also arise as intrusive or transitional elements when consonants are found in the context of a nasalized vowel. In Tucano, there is a synchronic process by which a stop acquires prenasalization word-medially following a nasalized vowel (4.64).

(4.64) Tucano (Tucanoan; Brazil, Colombia)

/kõpe/ [kõ<sup>m</sup>pe] 'left'

(West 1980: 11; tone left unmarked here)

More often, synchronic processes yielding prenasalized consonants are reported to occur in specific utterance, word, or morpheme positions. In Sanchong Gelao, for example, initial voiceless stops in isolation forms may be prenasalized (4.65a-b).

(4.65) Sanchong Gelao (Tai-Kadai; China)

(a) /ta/

[<sup>n</sup>ta]

'moon/month'

(b) /zaw ta/
eight moon/month
[zaw ta]
'August'

(Shen 2003: 40, tone left unmarked here)

In Mian, voiced bilabial stop /b/ is prenasalized in the more general word-initial environment (Fedden 2007). In Hup, voiced obstruents are prenasalized morpheme-initially (4.66).

(4.66) Hup (*Nadahup*; Brazil, Colombia)

/du/ [<sup>n</sup>du]

'grandchild'

(Epps 2008: 54; tone left unmarked here)

It has been observed that phonemic prenasalized stops often behave phonologically like voiced stops, rather than nasals or sequences. (cf. Iverson & Salmons 1996 for Mixtec). Some languages with a prenasalized stop series lack other voiced stop series, such that the prenasalized stops effectively take their place (Maddieson 1984: 67-8). It has been proposed that prenasalization, though it is a manner feature, is an articulatory strategy for maintaining voicing on stops (Ohala 1983, Henton et al. 1992). Articulating a voiced stop is complicated by the fact that the increasing pressure in the oral cavity may approach the subglottal pressure, which reduces the amount of air flowing through the glottis and thus compromises the physiological requirements for voicing. Ohala notes that languages may "solve the problem" of voicing maintenance on stops by releasing air through the velic port during the initial part of the closure (1983: 200). This comes at little perceptual cost: the main auditory cues of voiced stops can be retained even with initial velic leakage (Ohala & Ohala 1991: 213). This too might explain why phonetic prenasalization often occurs domain-initially: voiced stops in these contexts may have a longer duration than their intervocalic counterparts (Flege & Brown 1982), and thus may be more prone to articulatory adjustments to extend the voicing.

# 4.5.3.3 Flaps/taps

Flaps and taps are rapid articulations which involve a movement of the active articulator to the passive articulator for a brief period of contact. Sometimes the terms 'flap' and 'tap' are used interchangeably. Ladefoged & Maddieson (1996) distinguish these articulations according to the angle of approach of the active articulator. Most flaps and taps, including the cross-linguistically most frequent ones, are produced by the tongue tip in the dental/alveolar region.

Flaps/taps may arise from sounds with various manners of articulation. In a welldocumented sound change, the Spanish trill descended from a geminate apico-alveolar
trill in Latin, while the Spanish tap descended from a trill of normal length (Hualde 2004: 17-18). There are many allophonic patterns in which trills vary with flaps in specific phonological environments, intervocalic and word-marginal contexts being two important ones. In Moro, voiced alveolar trill /r/ is realized as a flap [r] intervocalically (Black & Black 1971: 7). In Tigak, a word-initial alveolar trill varies freely with a flap (4.67).

(4.67) **Tigak** (*Austronesian*; Papua New Guinea)

/rik/ [rik]~[rik] 'they (subj. pr.)'

(Beaumont 1979: 14)

Trills may also vary with taps when occurring in a consonant cluster. For example, in Palantla Chinantec an apico-domal trill is realized as an apico-alveolar tap following another consonant in syllable onset (Merrifield 1963: 3).

Other sonorants may vary with flaps/taps as well. For example, in Dan, a lateral approximant is realized as a flap between alveolar stop and vowel (Bearth & Zemp 1967). In Car Nicobarese, a voiced alveolar lateral approximant is flapped in syllable final position (4.68).

(4.68) Car Nicobarese (Austro-Asiatic; India)

/tafu:l/ [tafu:J] 'six'

(Braine 1970: 45)

Alveolar stops and nasals in intervocalic contexts are common sources of flaps/ taps. This occurs in certain stress environments in American English (e.g., bu[r]er), and is a characteristic of rapid speech in some languages (e.g., Kadiwéu, Sandalo 1997). Such a process occurs in Pangasinan with voiced alveolar stops (4.69).

(4.69) Pangasinan (Austronesian; Philippines)

/madabok/ [marabok] 'dusty'

(Benton 1971: 18)

Processes resulting in flaps or taps are often sensitive to the height of surrounding vowels. In Apinayé, a voiceless alveolar stop is realized as a flap adjacent to mid front vowel /e/ (Oliveira 2005: 48). In Koiari, a lateral approximant is realized as a flap before front vowels (4.70).

#### (4.70) Koiari (*Trans-New Guinea*; Papua New Guinea)

/leketole/

[reketore]

'evening star'

(Dutton 1996: 6)

Due to the highly reduced duration and magnitude of tap and flap articulations in comparison to sounds they derive from, flapping is typically considered to be an unambiguous form of lenition. In an Articulatory Phonology model, flapping may come about through both the overlap of surrounding vowel gestures into the consonant and the reduction of the tongue tip or active articulator gesture.

### 4.5.4 Segmental patterns, sound change, and syllable structure complexity

In §4.4 it was noted that languages on opposite extremes of the syllable structure complexity cline tend to have different kinds of consonant articulations. Languages in the Highly Complex category are more likely to have certain consonant place features and manner features characteristic of obstruents. Languages in the Simple category are more likely to have certain phonation features, as well as certain manner features related to sonorants. This segmental distribution prompted an investigation into the common paths by which these specific articulations and contrasts are known to develop, since sound patterns often reflect processes of sound change. The reported historical, comparative, and synchronic evidence presented in §4.5.2-3 shows a similar divide according to the

kinds of processes that most commonly produce the segments characteristic of languages in the Highly Complex and Simple categories.

The consonant articulations and contrasts associated with the Highly Complex category tend to be brought about through processes of *assimilation* and *fortition*. Assimilation is very often to the place of an adjacent vowel: palato-alveolars and affricates typically assimilate to a high and/or front vowel and uvulars to a low and/or back vowel. In the case of ejectives, the assimilation is of an oral obstruent to a following glottal stop. In gestural terms, the assimilatory processes producing palato-alveolars and ejectives, in particular, involve a large amount of temporal overlap of the associated consonantal and vocalic gestures; for example, Bateman (2007) argues that it is the amount of temporal overlap of the high front tongue gesture of the vowel that distinguishes secondary palatalization from palatalization resulting in palato-alveolars. Affricates and palato-alveolars may also come about through fortition, and specifically processes of glide strengthening. Common conditioning environments for such processes are syllable-initial position and, again, adjacent high and/or front vowels. The syllableinitial position, like the high front tongue body configuration, is a strong environment for articulation. It is associated with a higher degree and duration of linguopalatal contact, higher tongue pressure against the palate, generally tighter consonant constriction, and greater synchronicity with vocalic gestures than syllable-final position (Byrd 1996b, Fougeron 1999, Keating et al. 2003, Goldstein et al. 2006).

By contrast, the consonant articulations and contrasts associated with the Simple category tend to come about through processes of *lenition*, in which the affected

consonants are weakened by a decrease in the magnitude or duration of associated gestures. Voiced obstruents often come about in intervocalic contexts or adjacent to voiced consonants, a process which involves the complete loss of the glottal opening gesture for voicelessness, perhaps as a result of the encroachment of glottal voicing gestures for surrounding sounds. Processes producing flaps and taps are cases of lenition which involve a reduction in the duration of the consonant gesture and sometimes an accompanying loss of the glottal opening gesture (when voiceless stops are flapped). Though prenasalization does not necessarily involve a decrease in the magnitude or duration of gestures, it has the effect of facilitating voicing. The sound changes described here fall under the definition of *sonorization*, the process by which consonants become more vowel-like. Additionally, some of the processes reported in §4.5.3 also occur in weak environments for articulation, such as intervocalic and unstressed positions, which are characteristic of lenition and sonorization processes.

Very generally speaking, languages with different syllable structure complexity are associated with different types of segmental patterns which are in turn associated with different kinds of sound change processes. Specifically, languages with more complex syllable patterns tend to have consonants which tend to come about through assimilation and fortition in strong environments, while languages with simpler syllable patterns tend to have consonants which tend to come about through patterns tend to have consonants which tend to come about through lenition in weak environments. These sound change processes differ not only in their standard classification, which considers abstract phonological features of the sounds involved, but also in the physical properties of gestural organization.

Of course, sound change may come about through very complex interactions of phonetic tendencies, morphosyntactic patterns, frequency, and social factors. Hualde notes that the phonetic mechanisms behind sound change are perhaps more readily transparent than "the psychological and social processes that lead to their conventionalization in specific environments and to the recategorization of sounds" (Hualde 2011: 2222). In a typological study such as the current project, it is not feasible to consider all of the additional factors which may have contributed to the sound patterns observed. However, it is encouraging that a consideration of phonetic factors alone has resulted in such coherent sound change patterns for both groups of languages examined.

With this we return to the second research question of the dissertation (4.71).

# (4.71) How does highly complex syllable structure develop over time?

It would seem that the development of highly complex syllable structure is likely to be accompanied by processes of sound change which are realized in articulatory terms as extreme gestural overlap and/or increased magnitude of gestures in strong positions. Specifically, the findings may suggest differences in patterns of temporal organization in the languages with more complex syllable structure, including more compressed timing relationships between consonants and vowels or glottal articulations. The question of whether these sound changes might be an earlier development, a later development, or a

secondary effect of the same processes which result in increased syllable structure complexity will be explored in Chapters 7 and 8.

The findings here suggest that there is more to be gained from the studies presented here than just a phonological characterization of languages with highly complex syllable structure. Languages with simple syllable structure, too, tend to be characterized by a set of phonological properties. The integrated findings regarding syllable structure complexity, phoneme inventories, and sound change evoke the holistic phonological typologies of the speech rhythm literature (Roach 1982, Dauer 1983, Auer 1993) and the Prague School (Isačenko 1939/1940). This raises the question of whether a holistic phonological typology defined by syllable structure complexity is tenable. This point will be revisited in the studies presented in Chapters 5, 6, and 7. In Chapter 5 I explore suprasegmental features in the sample. In Chapters 6 and 7 I examine phonetically conditioned processes occurring in the synchronic phonologies of the language sample. Chapter 6 examines processes of vowel reduction, and Chapter 7 examines specific kinds of consonant allophony.

I have left undiscussed here the vowel contrasts which were found to be associated with syllable structure complexity. Some of these contrasts will be revisited in later chapters. Vowel length will be touched upon in the context of stress and tone in Chapter 5, while phonation contrasts in vowels will be touched upon in the context of vowel reduction in Chapter 6.

#### CHAPTER 5:

#### SUPRASEGMENTAL PATTERNS

### **5.1 Introduction**

In this chapter I describe and present analyses of particular suprasegmental properties in the language sample. Specifically, the four hypotheses tested here relate the placement, segmental effects, and phonetic correlates of word stress to syllable structure complexity. The distribution of tone in the language sample is also briefly considered in relation to one of these hypotheses.

The chapter is organized as follows. In §5.1 I describe general properties of word stress and tone, discuss findings in the literature which relate these to syllable structure complexity, and introduce the hypotheses to be tested in the current study. In §5.2 I describe the methodology behind the data collection and coding. In §5.3 I present a brief analysis of the distribution of the presence of tone in the language sample. In §5.4 I present several analyses to test the hypotheses relating properties of word stress to syllable structure complexity. In §5.5 I discuss how the results address the main research questions of the dissertation regarding highly complex syllable structure, and how they relate more generally to the development of syllable structure complexity.

## 5.1.1 Word stress and tone

In Chapter 4, I presented a study of the segmental properties of the language sample. As discussed there, segments are the more or less discrete units which correspond

to contrastive consonant and vowel sounds in a language. In this chapter, the focus is instead on suprasegmental properties of the language sample. The term 'suprasegmental' refers to phonological properties of speech which are associated with domains larger than the segment; that is, the syllable, word, or larger units such as phonological phrases or utterances. In the current study, only two suprasegmental features are considered: word stress and tone. I describe some basic characteristics of these phenomena here.

Not all languages have word stress. In languages in which it occurs, word stress corresponds to the increased perceptual prominence of a syllable with respect to other syllables in a word. This prominence is acoustically salient and may be accompanied by increased duration, differences in fundamental frequency (usually relatively higher), higher intensity, and differences in spectral tilt (Gordon 2011). Articulatory properties associated with stress include increased duration of gestures, more extreme articulations (i.e., tighter constrictions for consonants and more open articulations for vowels) and less articulatory overlap between consonantal and vocalic gestures (Beckman & Edwards 1994, Fougeron 1999, de Jong et al. 1993). Many of the findings on acoustic and articulatory correlates of stress are based on studies of individual languages. Languages vary widely with respect to which phonetic properties cue stress. While English uses a combination of duration, intensity, and pitch (the perceptual analog of fundamental frequency) to signal stress, it is common for languages to rely on just one or two of these cues, or for one to be a stronger cue than the others. To illustrate with a language from the current sample: in Lelepa, duration, pitch, and intensity are all used to signal stress, but

do not necessarily co-occur, and length is noted to be a weaker correlate than the others (Lacrampe 2014: 58).

Stressed and unstressed syllables may differ in other phonetic and phonological properties as well. Processes conditioned at least in part by the stress environment, such as aspiration in stressed syllables and vowel reduction and flapping in unstressed syllables, may provide allophonic cues to stress. Stressed and unstressed syllables may also show phonological asymmetries. For instance, vowel quality or length contrasts in unstressed syllables may be reduced to a subset of those found in stressed syllables (van der Hulst 2010). From a perspective of sound change, such asymmetries reflect the phonologization of previous stress-conditioned allophonic processes and may suggest a long history of the effects of word stress in a language.

While languages with word stress may have both primary and secondary stress patterns, cross-linguistic studies, including the current study, often focus on the properties of primary stress. This is the strongest and most prominent stress in the word. Patterns of primary stress placement vary widely among languages. Sometimes these differences are described in terms of the function of stress. Patterns in which stress predictably falls on the same syllable with respect to a word edge, such as regular penultimate stress patterns, are said to be demarcative or delimitative in their function. That is, these patterns are thought to help the listener identify word boundaries in the speech stream. In other cases, stress may serve a distinctive function by signaling differences in meaning: e.g. English *récord* (noun) versus *recórd* (verb). However, it is rare for languages to have stress patterns which are entirely one or the other: most languages with delimitative stress have

exceptions to the these patterns, and most languages with distinctive stress do not have many lexical items which are differentiated solely by stress (Cruttenden 1997: 14-15).

Stress patterns may also be described in terms of the principles underlying the placement of primary stress. These may include the distance in number of syllables from a specific word or stem edge, the relative weight of syllables, or the structure of tonal sequences, or may be largely unpredictable (van der Hulst 2010). Issues of stress placement will be discussed in greater detail in §5.2.1.

There are several large-scale typological surveys of word stress systems. Hyman (1977) examines the placement of stress in fixed stress systems in 306 languages and shows that initial, penultimate, and final position are the most frequent locations used in these systems. In a 400-language survey of phenomena related to syllable weight, Gordon (2006) examines, among other issues, the cross-linguistic distribution of certain weight distinctions for stress placement. Goedemans & van der Hulst (2013a,b) report on word stress placement patterns in a sample of 510 languages. This database, StressTyp, was later updated to include over 750 languages and includes fine-grained classification procedures for stress placement patterns (Goedemans et al. 2017). Some general phonological databases also provide information on stress placement (e.g., LAPSyD, Maddieson et al. 2013).

Most large cross-linguistic studies and databases of word stress patterns are concerned with issues of stress placement. However, some of the other properties associated with stress have been investigated in smaller typological studies. Barnes (2002) examines the neutralization of contrasts in height, length, and other properties of

vowels in unstressed syllables in a diverse array of languages. Similarly, Crosswhite (2001) investigates common neutralization outcomes of unstressed vowel reduction in 40 languages. She finds that two strong cross-linguistic patterns are prominence reduction (centralization, laxing, or raising which reduces the vowel space in unstressed syllables) and vowel peripheralization (neutralization of vowel contrasts to a few peripheral qualities of the vowel space). In a diverse sample of 42 languages, Bybee et al. (1998) report on several properties associated with stress, including predictability of stress placement, lengthening of stressed vowels, unstressed vowel reduction, and consonantal changes conditioned by stress. The relationships between these patterns are used to support a model for the diachronic evolution of unpredictable word stress. This study will be discussed further below.

The analyses in this chapter are concerned primarily with the properties of word stress. However, tone is additionally considered in several of the analyses. Tone can be defined as the use of pitch to convey lexical or grammatical contrasts. Like word stress, not all languages have tone. Tone is typically described in terms of contrasts in pitch ranges or pitch contours, with each range or contour being meaningfully distinctive; however, specific tones in a language are often additionally associated with other phonetic correlates, including duration and phonation properties such as glottalization (Laver 1994: 477-81). Tone systems range from relatively simple, consisting of just two tone distinctions, to much more elaborated (e.g., six or seven tones in Cantonese, Bauer & Benedict 1997). There is also wide cross-linguistic variation in the distribution or function of tone within a language. In some languages, nearly all syllables in a word have

a lexically or morphologically defined tone. In others, the distribution of tone may be restricted to a single syllable or set of syllables in a word, or there may be limitations on the combinations of tones found in words (see Hyman 2009 for a discussion of commonly observed restrictions on tonal distribution).

Large-scale cross-linguistic studies of tone include Maddieson (2013d), which surveys the complexity of tonal systems (in number of distinctive tones) in 220 languages and relates the patterns to properties of segment inventories and syllable structure complexity. That study reports a strong geographical component to the distribution of tone languages: they are predominantly found in Africa and Southeast Asia, though they can also be found in parts of New Guinea and the Americas. Tone systems are altogether absent in the regions of Australia and most of Eurasia. Other general phonological surveys, such as LAPSyD (Maddieson et al. 2013) and the World Phonotactics Database (Donohue et al. 2013), include information on tonal systems.

Traditionally, linguists have assumed a prosodic typology in which three language types can be identified: stress languages, tone languages, and 'pitch accent' languages. The latter group is regarded as having properties of both stress and tone languages. In practice, the languages described by this term do not form a coherent group with respect to their accentual patterns. Hyman (2009) argues that there are no criteria by which such languages can be defined independently of stress or tone. In his view, languages which are traditionally called 'stress' or 'tone' languages just happen to have more prototypical features with respect to these criteria.

#### 5.1.2 Suprasegmentals and syllable structure complexity

As discussed in §1.4.1, a long-established line of research in linguistics has related properties of word stress to syllable structure complexity. The typology proposed by Pike (1945) distinguished two speech rhythm types: stress-timed languages and syllable-timed languages. Later refined to include a third category of mora-timing, this typology assumed isochrony, that is, equal timing between stresses, syllables, or morae, depending upon the language type. For example, in stress-timed languages, like English, the intervals between stressed syllables were proposed to have roughly equal durations. Syllable-timed languages, like Spanish, were proposed to have syllables of roughly equal durations. Isochrony was ultimately not confirmed (Roach 1982), but related research established that rhythm plays a strong role in speech perception and language acquisition (e.g., Cutler & Mehler 1993). Seeking to characterize measurable properties of speech rhythm, researchers proposed a number of co-occurring phonological features for each rhythm type (Dauer 1983, Auer 1993). Simple syllable structure was proposed to cooccur with syllable timing, and complex syllable structure with stress timing. Additionally, specific segmental properties and processes were suggested to co-occur with these types: stress timing, for instance, is associated with unstressed vowel reduction, contrastive vowel length, and more variable word stress patterns. Note that in this typology, syllable-timed languages may have word stress (e.g., Spanish); it is the different properties and effects of word stress which, in part, set these rhythm types apart from one another

A similar holistic phonological typology developed out of the Prague School tradition. Isačenko (1939/1940) proposed a typology of Slavic languages which distinguished between two types: 'consonantal' and 'vocalic' languages. As discussed in previous chapters, these groups of languages were defined according to properties of their phoneme inventories, syllable nuclei, and syllable structure complexity. Additionally, Isačenko considered prosodic features in this classification. Vocalic languages such as Slovene are said to be 'polytonic,' characterized by greater distinctions in 'musical intonation' in long syllables, along with simpler syllable structure and lower consonant-to-vowel ratios in the phoneme inventory. By contrast, consonantal languages such as Russian are said to be 'monotonic,' characterized by either dynamic or fixed stress systems, complex consonant clusters, and higher consonant-to-vowel ratios in the phoneme inventory (1939/1940: 67-9). Interestingly, the latter classification groups together languages like Russian, which has highly unpredictable word stress placement, and Polish, which has predominantly fixed placement of word stress.

More recent research paradigms have attempted to establish the acoustic correlates of speech rhythm. Metrics corresponding to the proportion of vocalic intervals and standard deviation of consonantal intervals in speech, when plotted against one another, are said to index traditional rhythm categories of stress timing and syllable timing (Ramus et al. 1999). These metrics have been suggested to relate directly to syllable structure complexity. When measured in a cross-linguistically diverse sample of languages carefully controlled for syllable structure complexity, the presence or absence of vowel reduction, and the presence or absence of contrastive vowel length, it was found

that syllable structure complexity is indeed significantly correlated with these indices (Easterday et al. 2011). However, it should be noted that there is debate in the literature as to the appropriateness and reliability of these and other metrics used to quantify the acoustic properties of speech rhythm (Wiget et al. 2010).

A few typological studies of moderate size have investigated relationships between stress patterns, syllable structure complexity, and phonological properties and processes. Auer (1993) examines a diverse array of phonological patterns which include syllable structure, stress, vowel harmony, tone, vowel epenthesis, vowel deletion, and consonant assimilation in a sample of 34 diverse languages. He finds a number of correlations and implications between the different measures. In that sample, higher syllable complexity is correlated with a higher presence of word stress and vowel reduction processes. However, the languages show a high degree of variation with respect to most of the measures and do not fall into narrowly defined types.

Schiering (2007) examines the distribution of ten phonetic and phonological parameters in a diversified sample of 20 languages. The parameters which most reliably cluster together are phonetic correlates of stress, segmental effects of stress, syllable complexity, and length contrasts. Specifically, languages with a high number of phonetic correlates of word stress are strongly associated with greater segmental effects of stress, are more loosely associated with high syllable structure complexity and length contrasts, and negatively associated with the presence of tone and vowel harmony. However, relatively few languages show clusters of all the properties suggested to be prototypical of any rhythm class, suggesting little evidence for discrete categories. Schiering argues

that the evidence instead points to a stress cline, in which gradual increases in the phonetic strength of stress are accompanied by increased segmental effects. He also raises the point that most of the proposed phonological correlates of linguistic rhythm are derived from the patterns of European languages, specifically English and Spanish. That the expected patterns were not held up in a diversified sample is an important finding.

Bybee et al. (1998) explore implicational relationships among the predictability of stress, vowel length as a phonetic correlate of stress, and stress-conditioned processes of vowel reduction and consonant allophony in 42 languages. They hypothesize that as increased vowel duration gradually becomes the primary correlate of predictable word stress, decreased vowel duration becomes an important property of unstressed syllables. As stress, signaled by vowel duration, becomes incrementally stronger in a language, it conditions segmental effects such as vowel quality reduction and consonant allophony. When eventually these effects culminate in vowel deletion, the predictable stress pattern of the language may be disrupted, yielding an unpredictable stress system and an even stronger reliance on duration as a signal for stress, continuing the cycle. The implicational relationships established in the study support this path of development: for example, languages with vowel lengthening also have vowel reduction, which the authors take to imply that vowel reduction becomes a defining property of unstressed syllables before vowel length becomes a defining property of stressed syllables. While the authors do not consider syllable structure, theirs is perhaps the only study of its kind in that it attempts to reconstruct from synchronic typological evidence a diachronic path along which stress systems and concomitant phonetic patterns may develop. Those phonetic patterns,

specifically vowel reduction resulting in eventual vowel deletion, are in turn relevant in the development of the consonant clusters associated with syllable structure complexity.

Comparing the findings of Bybee et al. (1998) and Schiering (2007) raises some points for further investigation. Bybee and colleagues do not report how their results relate to the syllable structure complexity of the languages examined. However, the diachronic path they propose is clearly relevant to the development of syllable structure complexity. Interestingly, though, Schiering (2007) did not find predictability of stress placement to be reliably correlated with segmental effects of stress or syllable structure complexity. Instead, he found that the relative strength of stress, in terms of number of phonetic correlates, was robustly associated with both segmental effects of stress and and syllable structure complexity.

Regarding relationships between tone and syllable structure complexity, some patterns have been noted in the literature. Specifically, Maddieson (2013d) established an inverse relationship between the elaboration of tonal contrasts and syllable structure complexity in a survey 471 languages. Additionally, languages lacking tone altogether were found to be much more likely to have complex syllable patterns. This concurs with findings by Auer (1993) and Schiering (2007).

### 5.1.3 The current study and hypotheses

The findings discussed above indicate that there are at least some associations between word stress, its correlates, placement, and segmental effects, and syllable structure complexity. However, none of the studies mentioned above, apart for the

acoustic study in Easterday et al. (2011), were conducted in a sample carefully chosen to equally represent differing degrees of syllable structure complexity. Languages with Simple or Highly Complex syllable structure were particularly rare in the samples of Auer (1993), Bybee et al. (1998), and Schiering (2007), owing to the methods of sample construction used and the relatively lower global frequencies of such languages. It is therefore appropriate to explore these issues in the current study, with the aim of addressing the main research questions of the dissertation (5.1)-(5.2):

(5.1) Do languages with highly complex syllable structure share other phonetic and phonological characteristics such that this group can be classified as a linguistic type?

(5.2) How does highly complex syllable structure develop over time?

In this chapter I seek to establish the suprasegmental properties, specifically those related to word stress, associated with highly complex syllable structure. In turn these findings will be used to inform a picture of the diachronic development of these structures.

The first two hypotheses follow from the research of Bybee et al. (1998), as well as observations of ongoing processes in the current sample and findings from a previous chapter in the dissertation. Bybee and colleagues found that the segmental effects of stress were stronger in languages with less predictable stress patterns, which in turn may come about through segmental effects of stress, namely unstressed vowel reduction and deletion. In the current sample, there are several examples of recent or ongoing processes which support this diachronic path. For example, in Imbabura Quechua, the regular penultimate stress pattern has recently been destabilized as a result of the reduction of validator suffixes: -tfari - > -tfa- 'doubt' and -mari - > -ma- 'emphatic firsthand information.' Cole (1982) reports that words with the short forms of these suffixes usually carry word-final stress (5.3).

#### (5.3) **Imbabura Quechua** (*Quechuan*; Ecuador)

∫amunga't͡ʃa ∫amu-n-ga-t͡ʃa come-3-FUT-DUB 'perhaps he will come'

(Cole 1982: 209)

The process in Imbabura Quechua may illustrate an early stage of the diachronic path proposed in Bybee et al. (1998), as it is limited to a (presumably frequent) set of grammatical constructions and the stress pattern of the language is still largely predictable. A process which may illustrate later stages of this diachronic path can be found in Lezgian. In this language, stress placement was until recently largely predictable within the stem, typically falling on the second syllable therein. Since stress is morphologically or lexically conditioned and its location cannot be predicted with respect to word boundaries, we can say that stress in Lezgian is already unpredictable to a degree. It has recently become more unpredictable with recent and ongoing processes of unstressed vowel deletion. The most productive such process involves the deletion of high vowels which follow voiceless obstruents in pretonic syllables (Haspelmath 1993: 36). The history of this process is long enough that it is reflected in the standard spelling for some lexical items. An example of a word which still shows variation in pronunciation is given in (5.4).

(5.4) Lezgian (*Nakh-Daghestanian*; Azerbaijan, Russia)

 $\widehat{t} \overline{J}^h i^{!} neba \sim {}^{!} \widehat{t} \overline{J}^h neba$ 

'secretly'

(Haspelmath 1993: 38)

As a result of this process, the stress placement, which was already somewhat unpredictable in that it was associated with its position in the stem and not the word, becomes even more unpredictable. Additionally, there is now a tendency in the language for post-tonic vowels to be deleted in certain consonantal environments. Haspelmath reports that this process is mostly restricted to inflectional suffixes, but there are a few cases where it seems to be more general (5.5).

(5.5) Lezgian (Nakh-Daghestanian; Azerbaijan, Russia)
di'dedilaj ~ di'dedlaj
'from mother'

(Haspelmath 1993: 40)

While the process in (5.5) does not currently affect word-final syllables, it is reasonable to imagine that the reductive processes conditioned by stress may continue to spread to new environments in the language, creating more complex syllable patterns as they phonologize. A natural outcome of such a scenario in any language, assuming it has affixation and/or polysyllabic stems, would be large maximum onset and coda structures. This would nicely account for the strong pattern in canonical syllable shapes discussed in §3.3.2 in which languages with a large maximum cluster at one syllable margin tend to have a similarly large maximum cluster in the other syllable margin.

With these points in mind, I formulate the following two hypotheses for the current study (5.6)-(5.7).

- (5.6) H<sub>1</sub>: As syllable structure complexity increases, so does the proportion of languages in which the placement of word stress is unpredictable.
- (5.7) H<sub>2</sub>: As syllable structure complexity increases, word stress has stronger phonetic and phonological effects in languages.

Any associations between unpredictable stress and the strength of its segmental effects must be accounted for by some specific property of the language. Bybee et al. (1998) propose that these effects will arise when vowel duration gradually becomes a phonetic correlate of stress. Schiering (2007), on the other hand, finds stronger segmental effects of stress in languages with more co-occurring phonetic correlates of stress. These observations lead to formulate two additional hypotheses (5.8)-(5.9).

- (5.8) H<sub>3</sub>: As syllable structure complexity increases, so does the likelihood that vowel duration is used as a phonetic correlate of word stress.
- (5.9) H<sub>4</sub>: As syllable structure complexity increases, word stress will be signaled by an increasing number of phonetic correlates.

These hypotheses will be tested in upcoming sections. It should be mentioned at the outset that prominence and accentual and tonal phenomena occurring at higher levels of phonological organization may contribute to stress patterns, segmental processes, and articulatory coordination in important ways (e.g., Fougeron & Keating 1997). However, the description of such patterns in standard language references is often impressionistic, inconsistent, or altogether absent. While the phenomena considered here are limited to stress and tonal patterns within the word, it is important to acknowledge that there are many additional factors which might affect the patterns observed.

### 5.2 Methodology

## 5.2.1 Patterns considered

In the current study, only primary stress patterns are considered. Furthermore, it is the dominant patterns which are considered and coded here; that is, patterns for which

there may be exceptions in a handful of words or grammatical constructions, but which are not obscured by these exceptions. After excluding such minor deviations, the stress pattern of each language was characterized according to the organizing principles underlying stress assignment. In doing so, it was useful to first make a distinction between stress patterns dependent upon phonological structure, on the one hand, and those dependent upon morphological or lexical structure, on the other hand.

Within languages in which stress placement depends upon phonological factors, several different kinds of phonological factors may determine stress assignment. In a fixed stress pattern, stress always falls on the same syllable of a word with respect to its relationship to a word boundary: stress may regularly fall on the initial syllable of a word, for example, or the antepenultimate syllable of a word. This pattern occurs regardless of what kind of morpheme (root/stem or affix) that syllable happens to belong to. For example, in Nakanai, stress falls predictably on the penultimate syllable of each word. Thus stress shifts as morphemes are added (5.10a-d).

# (5.10) Nakanai (Austronesian; Papua New Guinea)

- (a) 'abi 'get'
- (b) a'bia 'get it'
- (c) abi'tia

'got it'

(d) abimo'lia

'just get it'

(Johnston 1980: 258)

As mentioned above, in most languages, some exceptions to the dominant stress patterns are reported. To illustrate this with Nakanai, when deictic particles /-e/ 'here' and /-o/ 'there' are affixed to a word, the stress may remain static or shift to the final syllable (5.11a-d).

(5.11) Nakanai (Austronesian; Papua New Guinea)

- (a) o'muli 'eastward'
- (b) o'mulio

'eastward there'

(c) polo

'follow'

(d) polo'o

'follow there'

(Johnston 1980: 257)

Another stress pattern which is not morphologically or lexically conditioned but predictable from the phonological structure of a word is a weight-sensitive system. In such a system, stress falls on a heavy syllable, usually defined as one having a long vowel or a coda, or occasionally specific vowel qualities (Gordon 2006). Stress patterns which are sensitive to syllable weight are often additionally oriented towards one of the word edges (Goedemans & van der Hulst 2013b). For example, in Kabardian, stress falls on the final syllable of the word if it is heavy. If the final syllable is light, then stress falls on the penultimate syllable instead (5.12a-b).

(5.12) Kabardian (Northwest Caucasian; Russia, Turkey)

(a) le'za:'work (PST INTERROG)'

(b) 'mə∫e

'bear'

(Gordon & Applebaum 2010: 38)

There are some other less common scenarios in which stress placement is dependent upon phonological factors. In Southern Bobo Madaré, which is reported to have both word stress and tone, the tonal pattern of the word determines the stress placement. Stress falls on the first of two identical tones in disyllabic words (5.13a), and in phonological words with one or more high tones, stress falls on the first high tone (5.13b).

### (5.13) Southern Bobo Madaré (Mande; Burkina Faso)

(a) bārā

'work'

(b) nīmīsa lálo

'boy'

(Morse 1976: 110)

In languages in which the dominant stress pattern is determined by morphological factors, phonological factors may still play a role. For example, in Tehuelche, stress always falls on the initial syllable of a stem. In words without prefixation, stress is word-initial, but in words with prefixation, it is not. While stress is not predictable from the phonological form of the word, it is predictable within the stem itself (5.14a-c).

- (5.14) **Tehuelche** (*Chon*; Argentina)
- (a) 'qampen 'sheep'
- (b) 'je∫emk'en

je∫em-k'en

spring-NMLZ

'spring'

### (c) ?o'ma:nk

?o-ma:-n-k

NMLZ-kill-NMLZ-M

'assassin'

#### (Fernández Garay 1998: 107-8)

Similarly, syllable weight may factor into stress placement in languages in which stress is always associated with a root or stem, producing a phonologically predictable stress pattern within the root/stem (e.g., in Mamaindê in the current sample).

Other languages have stress placement which is morphologically conditioned, but much less predictable. In Yakima Sahaptin, all words carry one main stress. All roots have an unpredictable lexically-determined stress, such that there are near-minimal pairs for stress in the language (5.15a-c). Hargus & Beavert (2005) report that there are statistical preferences for stress placement in roots: it tends to fall in heavy syllables, to be trochaic when syllable weight is not a factor, and to have right directionality within the root. However, besides many exceptions to these patterns within roots themselves, there are additional complicating factors in stress assignment owing to affixation. Some affixes do not alter the stress pattern of the word (5.15d), but nearly half of the affixes in the language carry stress and cause stress to shift from or within the root. When stressed affixes are attached to a root, stress is preferentially assigned to a stressed suffix over a stressed prefix or root, and to a stressed prefix over a root (5.15e-f). Additionally, there are some suffixes which do not attract stress to themselves but which shift it to another position within the root (5.15g).

# (5.15) Yakima Sahaptin (Sahaptian; United States)

(a) <sup>'</sup>wjanawi-

'arrive'

(b) a'nawi-

'be hungry'

(c) k<sup>w</sup>'aja<sup>'</sup>wi

'mountain lion'

(d) pa'p'iχ∫a

pa-'p'iχ∫a

3.PL.NOM-remember

'they remember'

(e) 'papap'iχ∫a

'papa-'p'iχ∫a

**RECP-remember** 

'they remember each other'

(f) pitja'ła

'pitja-'ła

spear-AGT

'spearer'

(g) at Pa'wiłam 'beggar' (< a't P'awi- 'ask, beg for, request')

(Hargus & Beavert 2005: 66-7, 77, 92)

In some languages, the stress pattern is unpredictable in a different way: it is highly variable depending on context. Marmion (2010) describes word stress in Wutung as being present in words of two syllables or more, but being neither phonemic nor predictable. The stress pattern of a word may vary freely between speakers and within the same speaker (5.16a). Nevertheless, stress is perceptually salient and the variable location of its placement may have a strong effect on the realization of certain sequences (5.16b).

# (5.16) Wutung (Skou; Papua New Guinea)

(a) /hlapã/

['hlapã] ~ [hla'pã] 'night'

(b) /huwe/

 $[hu'w\theta] \sim ['hu:\theta]$ 

'stomach'

(Marmion 2010: 57, 91)

As the examples above show, there is a great deal of cross-linguistic variation in stress placement patterns. The stress patterns in the language sample must be categorized in a principled way in order to address the hypothesis in (5.6). In operationalizing stress predictability, I follow Schiering (2007), who in turn follows an earlier version of Goedemans & van der Hulst (2013a). In this system, three types of stress placement systems are distinguished: fixed stress location, weight-sensitive stress placement, and morphologically or lexically conditioned stress placement. On this scale, fixed stress systems have the highest predictability and morphologically or lexically conditioned stress systems have the lowest predictability. In testing the hypothesis in (5.6), the few stress placement patterns which don't fit into these categories, such as the toneconditioned system in Southern Bobo Madaré (5.13) and the variable system in Wutung (5.16), will be excluded. However, these systems will be included in other parts of the study, including the analyses of phonetic correlates of stress and stress-conditioned phonetic processes.

In order to address the hypothesis in (5.7) regarding the segmental effects of stress, phonetic processes reported to be conditioned by stress were collected. The processes considered include vowel reduction in unstressed syllables and consonant allophony in stressed or unstressed syllables. A reported process of regular vowel lengthening in stressed syllables was considered to be a phonetic correlate of stress (see below) and was not coded as a stress-conditioned process. Like segmental inventories, allophonic processes are always the result of analyses. In order to avoid some of the better-known pitfalls of synchronic phonological analysis (see §6.2 for more discussion of this point), I have limited the processes examined here to those conditioned solely by the phonological environment. That is, processes described as occurring within specific morphological or morphophonemic environments have been excluded.

Vowel reduction processes here include any process by which the vowel is deleted or reduced in quality, duration, or voicing. Other less common effects such as the loss of tonal contrasts have been considered as well. A reduction in vowel quality typically includes centralization, laxing, or raising towards a more 'neutral' or less sonorant vowel quality. However, in some languages, vowel reduction may involve a neutralization of contrasts which maximizes peripheral contrasts (Crosswhite 2001; see discussion in §6.2). Here I have included peripheralization as reduction when it is explicitly described as such in the reference. In some languages for which vowel duration is a correlate of word stress, the relatively shorter vowel duration in unstressed syllables is reported as vowel reduction. I have not included such cases here, but have included processes in which the reduced length of an unstressed vowel is shorter than what would normally be expected for unstressed vowels: for instance, extra shortening of unstressed vowels in pretonic position. I have included all vowel reduction processes in unstressed syllables regardless of whether stress is the sole conditioning environment; that is, the processes include those occurring in unstressed syllables but requiring additional conditioning factors such as word position or consonantal environment. Additional details on the collection and coding of unstressed vowel reduction processes can be found in §6.2, where I describe the methodology behind a more general study of vowel reduction in the language sample. Illustrative examples of some of the vowel reduction processes considered in the current chapter can be found in (5.17)-(5.19).

# (5.17) Bardi (Nyulnyulan; Australia)

Short vowels are reduced in quality in unstressed syllables.

/ˈgamad̪a/

[ˈkamsda]

'mother's mother'

(Bowern 2012: 88-90)

# (5.18) Apurinã (Arawakan; Brazil)

Vowels become devoiced in unstressed word-final position, especially in fast speech.

/mapo'щatsa/

[mapoˈɰat͡sa̯]

'caterpillar'

(Facundes 2000: 60-1)

# (5.19) Choctaw (Muskogean; United States)

A word-initial unstressed high front vowel /i/ may be deleted before a sequence of

/s/ or /J/ and another consonant.

/iskiti:'nih/

 $[iskiti:'nih] \sim [skiti:'nih]$ 

'it's small'

(Broadwell 2006: 19)

Processes of consonant allophony conditioned by word stress were also considered in the current study. I did not limit the data collection to specific kinds of processes, but included any phonetic process affecting consonants which was reported to be conditioned by the stress environment, either alone or in addition to other conditioning factors. Processes affecting consonants in unstressed syllables often include the voicing, flapping, or spirantization of stops, but less common processes such as spirantization of affricates, debuccalization, and deletion of consonants also occur. See (5.20)-(5.23) for examples of some of the patterns recorded.

# (5.20) Pinotepa Mixtec (Oto-Manguean; Mexico)

Plosives /t͡ʃ k kʷ/ in post-tonic syllables are voiced on occasion. /ˈtʃikarā/ [ˈtʃigarā] 'he is walking'

(Bradley 1970: 5)

### (5.21) Tukang Besi (Austronesian; Indonesia)

A voiced velar stop /g/may lenite to  $[\gamma]$  between unstressed vowels.

/nogui/guuduu/

[noyu'gudu]

'they make noise'

# (Donohue 1999: 27)

# (5.22) Cubeo (Tucanoan; Colombia)

Voiceless stops /p k/ may be realized as [h] directly following a stressed syllable. /'hapurabi/

['hahurabi]

'he is heard'

(Chacon 2012: 123)

# (5.23) Pech (Chibchan; Honduras)

In rapid speech, glottal fricative /h/ is often deleted following a stressed vowel and preceding an unstressed vowel.

/'kàhã/

['kầ̃:]

'town'

(Holt 1999: 24)

Processes affecting consonants in stressed syllables were less frequently reported. These processes often include aspiration or affrication of stops, glide strengthening, and lengthening; less frequent patterns include devoicing and place assimilation (5.24)-(5.26). (5.24) Maori (Austronesian; New Zealand)

A voiceless velar stop may be affricated preceding /a/ at the onset of a stressed syllable. /ˈkaraŋa/ [ˈkxaraŋa] 'call'

(Bauer 1999: 521-2)

# (5.25) Mangghuer (Mongolic; China)

Palatal glide /j/ may be spirantized word-initially and in syllables which are stressed.

/'ja/

['ja]

'what'

(Slater 2003: 31-2)

## (5.26) Nivkh (Isolate; Russia)

In stressed syllables, consonants followed by front vowels /i e/ may acquire secondary palatalization.

 $/k^{h}eq/$ 

['k<sup>hj</sup>eq]

'fox'

(Shiraishi 2006: 23)
As discussed above, segmental effects of stress in a language may become phonologized, which over time may result in phonological differences between unstressed and stressed syllables. In particular, unstressed syllables may show a limited range of contrasts in consonants, consonant combinations, vowel qualities, vowel length, and tone (van der Hulst 2010). In addition to considering phonetic processes conditioned by stress, I have coded languages for stress-related phonological asymmetries. In some cases, the asymmetry between stressed and unstressed syllables is limited to just one contrastive feature. For example, in Burushaski, vowel length contrasts are limited to stressed syllables in underived lexical items (Anderson 1997: 1028). However, in some languages there are dramatic phonological differences between stressed and unstressed syllables. Such systems are common in some of the language families of Southeast Asia, where words often have a sesquisyllabic pattern: a stressed main syllable preceded by a presyllable which is unstressed and highly limited in its phonological composition (Matisoff 1973, Michaud 2012; similar patterns may be found in some language families of Meso-America, including Oto-Manguean). For example, presyllables in Sre are limited to three shapes: a sequence of an unaspirated, unimploded obstruent,  $\frac{1}{2}$ , and an optional liquid or nasal coda; the sequence /?a/; or a syllabic nasal. By contrast, main syllables show the full range of consonant and vowel contrasts, and may have tautosyllabic consonant clusters. See (5.27a-c) for examples.

- (5.27) Sre (*Austro-Asiatic*; Vietnam)
- (a) sən'djaŋ'steep side of a valley'
- (b) ?a'suh'to blow on a fire'

(c) m'poŋ

'door'

(Olsen 2014: 32, 46, 48)

As discussed in §5.1.2, there may be associations between specific phonetic correlates of stress and the extent to which stress has segmental effects in a language (Bybee et al. 1998, Schiering 2007). This observation motivated the hypotheses in (5.8)-(5.9). In coding for this study, three phonetic correlates of stress — vowel duration, pitch, and intensity — were noted wherever described in language references. In older language references, in particular, phonetic descriptions of stress are often impressionistic, if they are included at all. More recent works sometimes give instrumental evidence for the phonetic correlates of stress. In coding for the phonetic correlates of stress, I differentiated between reports which were impressionistic and those which were based on instrumental measurements. Where sources disagreed on phonetic correlates of stress, I gave preference to descriptions based on instrumental measurements, if available.

As mentioned above, relationships between the presence and complexity of tonal systems and syllable structure complexity have been established in the literature

(Maddieson 2013d). Because none of the hypotheses in the current chapter are directly related to tone, I do not present a detailed analysis of the patterns here. Degrees of complexity within tonal systems (cf. Maddieson 2013d), for example, are not considered. I also do not distinguish between 'prototypical' tonal systems, in which most syllables bear tone and tonal combinations are relatively free, and systems in which tonal patterns are relatively more restricted (cf. Hyman 2009). However, it is important to consider the presence of tone in the languages of the sample. Since tone makes use of pitch contrasts and pitch is often a correlate of word stress, there is the potential that word stress may manifest in phonetically different ways depending on the presence or absence of a tonal system (Gordon 2011). This in turn could be reflected in any associations observed between phonetic correlates of stress and syllable structure complexity in the sample.

#### 5.2.2 Coding

The information gathered on word stress and tonal patterns in the sample was coded as follows. First, the presence or absence of tone and word stress were noted. If a language was noted as having word stress, the dominant stress placement pattern was coded as one of the following: Fixed, meaning stress falls in a predictable location with respect to word boundaries; Weight-Sensitive, meaning stress placement is sensitive to factors such as vowel length, presence of a coda, and/or vowel quality but can be determined from the phonological, and not morphological, structure of a word; and Morphologically or Lexically Conditioned, in which a description of the stress pattern must refer to the morphology. As mentioned above, this classification is meant to

correspond to a three-point scale representing the predictability of stress placement (cf. Schiering 2007).

The presence of phonetic processes reported to be conditioned by stress were coded, and the type of process noted. These include Vowel Reduction, Consonant Allophony in Unstressed Syllables, and Consonant Allophony in Stressed Syllables. Regular processes of vowel lengthening in stressed syllables were taken to indicate that vowel duration was a phonetic correlate of stress. Differences in the phonological properties of stressed and unstressed syllables were also noted and coded as: Vowel Quality Contrasts, Vowel Length Contrasts, Consonant Contrasts, Tonal Contrasts, and Other. Phonetic correlates of stress were coded as Vowel Duration, Pitch, and Intensity. Here the category Pitch includes both level pitch (usually higher than in unstressed syllables) and pitch contours associated with stressed syllables. Each reported correlate was additionally coded for whether it was based on impressionistic observations or instrumental evidence.

In (5.28) I illustrate the coding for Kadiwéu, a language with Complex syllable structure.

(5.28) Kadiwéu (Guaicuruan; Brazil)

Tone: No Word stress: Yes Stress placement: Weight-Sensitive **Phonetic processes conditioned by stress:** Consonant Allophony in Unstressed Syllables

Differences in phonological properties of stressed and unstressed syllables: (None)

Phonetic correlates of stress: Intensity (impressionistic)

The coding for each language in the sample can be found in Appendix B.

In the following sections I present analyses to test the hypotheses in (5.6)-(5.9). Because the analysis of tone is brief, I present it first before moving on to the study of word stress in the sample.

# 5.3 Results: Tone

The distribution of tone in the languages of the sample with respect to syllable structure complexity can be found in Table 5.1.

	Syllable Structure Complexity			
N languages with tone:	Simple (N = 22 lgs)	Moderately Complex (N = 27 lgs)	Complex (N = 27 lgs)	Highly Complex (N = 24 lgs)
Present	11	11	11	5
Absent or not reported	11	16	16	19

**Table 5.1.** Languages of sample distributed according to presence of tone.

Tone is present in 38 languages of the sample. The proportion of languages reported to have tone decreases with syllable structure complexity: half of the languages

in the Simple category have tone, while only one-fifth of the languages in the Highly Complex category do. This is in line with the findings of Maddieson (2013d). As observed in that work, there is a strong areal component to the distribution of tone: 23 of the languages with tone in the current study are located in the macro-regions of Africa and Southeast Asia & Oceania. Within these regions, languages of all syllable structure complexity types can be found to have tone. Tone is least common in the macro-regions of Eurasia (one language, Ket), South America, and Australia & Papua New Guinea (three languages each).

The issue of tone will be revisited in §5.4.1, then further in §5.4.5 in an analysis of phonetic correlates of stress.

### 5.4 Results: Stress

The analyses in this section examine properties of stress in the language sample. This section is organized as follows. §5.4.1 presents a general description of the presence of stress in the sample. Stress placement patterns are analyzed in §5.4.2. Phonetic processes conditioned by stress are examined in §5.4.3 and subsections therein. Phonological asymmetries between stressed and unstressed syllables are analyzed in §5.4.4. In §5.4.5 the phonetic correlates of stress in the sample are examined. The results of the analyses of word stress properties are summarized in §5.4.6.

## 5.4.1 Presence of word stress and syllable structure complexity

The distribution of word stress in the languages of the sample can be found in Table 5.2. In this analysis I have excluded two languages: for Grebo and Qawasqar, there are conflicting reports regarding the presence or absence of stress.

	Syllable Structure Complexity					
N languages with word stress:	SimpleModerately ComplexComplexHighly Complex(N = 21 lgs)(N = 27 lgs)(N = 27 lgs)(N = 23 lgs)					
Present	18	18	23	22		
Absent or not reported	3	9	4	1		

**Table 5.2.** Languages of sample distributed according to presence of word stress. Grebo (Simple category) and Qawasqar (Highly Complex category) have been excluded due to conflicting reports.

Most of the languages in the sample (81 languages) are reported to have word stress. The percentage of languages having word stress increases from the Moderately Complex category (67%) to the Highly Complex category (96%). However, this trend is broken by the pattern in the Simple category, which has a high percentage of languages with word stress (86%).

In Table 5.3, I combine the patterns from Tables 5.1 and 5.2 to show how both

tone and word stress are distributed in the languages of the sample.

	Syllable Structure Complexity				
N languages with:	Simple (N = 21 lgs)	Moderately Complex (N = 27 lgs)	Complex (N = 27 lgs)	Highly Complex (N = 23 lgs)	
Word stress only	11	14	15	18	
Tone only	3	7	3	1	
Both tone and word stress	7	4	8	4	
Neither		2	1		

**Table 5.3.** Languages of sample distributed according to presence of word stress and/or tone. Grebo (Simple category), and Qawasqar (Highly Complex category) have again been excluded due to conflicting reports regarding the presence of word stress.

The pattern in the first row in Table 5.3 indicates that similar percentages of languages with Simple, Moderately Complex, and Complex syllable structure have word stress but no tonal contrasts (percentages range from 52%-56%). By contrast, 78% of languages in the Highly Complex category have word stress but no tone. This result could reflect the fact that there is little geographic overlap between areas where tonal systems are common and areas where Highly Complex syllable patterns are common.

There were three languages in the sample for which neither word stress nor tone were reported to be present: Oksapmin, Kharia, and West Greenlandic. In the case of West Greenlandic, instrumental evidence has been presented to support the analysis of the language as having no stress (Jacobsen 2000).

## **5.4.2 Stress assignment**

In this section I present an analysis addressing the hypothesis formulated in §5.1.3 as (5.6) and reproduced here as (5.29).

(5.29) H<sub>1</sub>: As syllable structure complexity increases, so does the proportion of languages in which the placement of word stress which is unpredictable.

The distribution of the languages with word stress in the sample according to their dominant stress placement patterns can be found in Table 5.4. In this analysis, two languages (Toro So and Menya) have been excluded because the descriptions of stress patterns were too minimal to allow for classification. Thus the current analysis includes 79 languages.

	Syllable Structure Complexity				
Word stress placement pattern:	Simple (N = 17 lgs)	Moderately Complex (N = 18 lgs)	Complex (N = 23 lgs)	Highly Complex (N = 21 lgs)	
Fixed	6	10	13	9	
Weight-sensitive	4	3	2	4	
Morphologically or Lexically Conditioned	6	2	7	7	
Variable or other	1	3	1	1	

**Table 5.4.** Languages of sample with word stress distributed according to their dominant stress placement patterns. Toro So (Simple category) and Menya (Highly Complex category) have been excluded due to insufficient descriptions of stress patterns in the references available.

The patterns classified as 'Variable or other' in Table 5.4 are those whose stress placement is determined by phonological factors other than location with respect to the word edge or weight, or whose stress patterns may vary according to speaker or situational context, like the examples in (5.13) and (5.16) in §5.2.1. Excluding these languages, I plot the patterns of the remaining 73 languages in Figure 5.1. This figure shows the percentage of languages in each category of syllable structure complexity having the given stress placement pattern.



**Figure 5.1.** Percentage of languages for which word stress patterns could be identified exhibiting each of the given stress placement patterns, by syllable structure complexity.

Recall that the three categories for stress placement used here can be used as measures for the predictability of stress placement, with fixed systems being most predictable and morphologically or lexically conditioned systems being least predictable. Interpreting the patterns in Figure 5.1, we find that the percentage of languages with less predictable stress placement — that is, morphologically or lexically conditioned stress systems and weight-sensitive stress systems combined — does indeed increase from the Moderately Complex to the Highly Complex category. However, the linear trend is again broken by the pattern in the Simple category. In comparison to the other categories, the Simple category has the highest percentage of languages with the least predictable stress pattern (6/14, 43%) and the lowest percentage of languages with the most predictable stress pattern (also 6/14, 43%). Thus, while the hypothesis in (5.29) is supported within

the set of languages with non-Simple syllable structure, we do not find general support for the hypothesis.

Recall from §5.2.1 the discussion of patterns of stress placement determined by morphological factors. In some languages, stress is morphologically determined but predictable; for example, in Tehuelche, stress falls predictably upon the initial syllable in the stem (5.14). In other languages, stress placement may be lexically determined and/or sensitive to morphological factors, but these factors are so complex that stress is largely unpredictable; this was the case for stress in Yakima Sahaptin (5.15). There are also languages in which morphologically conditioned stress placement is intermediate between these extremes. For example, in Choctaw, accent is predictable for all underived verbs and deverbal nouns, but unpredictable in underived nouns and some other contexts (Broadwell 2006). In Table 5.5, I have distributed the 22 languages with morphologically or lexically conditioned stress by the predictability of those systems. Systems like that of Tehuelche are classified as having stress which is predictable within the stem. Systems like that of Yakima Sahaptin are classified as having stress which is unpredictable. Systems somewhere in between, like that of Choctaw, are given an intermediate classification. The classification of languages into these categories is subjective to some extent.

	Syllable Structure Complexity				
Languages with morphologically or lexically conditioned	Simple	Moderately Complex	Complex	Highly Complex	
stress placement	(N = 6 lgs)	(N = 2 lgs)	(N = 7 lgs)	(N =7 lgs)	
Predictable within stem	2	1	2	2	
Intermediate	3	1	2	2	
Unpredictable	1		3	3	

**Table 5.5.** Languages with morphologically or lexically conditioned word stress patterns, distributed according to predictability of those patterns and syllable structure complexity.

Examining morphologically or lexically conditioned stress systems in more detail in Table 5.5, there may be some evidence for the hypothesis that the predictability of stress placement decreases as syllable structure complexity increases. Unpredictable morphologically or lexically conditioned systems are almost exclusively found in languages from the Complex and Highly Complex categories. However, the small sample size makes it difficult to draw strong conclusions from these patterns.

While we do not find strong support for the hypothesis in (5.29), there are suggestions of associations between unpredictable word stress and highly complex syllable structure. This point will be revisited in §5.4.6, after other phonetic and phonological properties of stress in the sample have been examined.

#### 5.4.3 Phonetic processes conditioned by word stress

In this section, processes conditioned by word stress in the language sample are analyzed as a first step in testing the hypothesis in (5.7), reproduced in (5.30).

(5.30) H<sub>2</sub>: As syllable structure complexity increases, word stress has stronger phonetic and phonological effects in languages.

In Table 5.6, the presence of unstressed vowel reduction, processes affecting consonants in unstressed syllables, and processes affecting consonants in stressed syllables is noted. In this analysis, all 81 languages reported to have word stress have been included.

	Syllable Structure Complexity				
Languages with:	Simple (N = 18 lgs)	Moderately Complex (N = 18 lgs)	Complex (N = 23 lgs)	Highly Complex (N =22 lgs)	Total
Unstressed vowel reduction	6	14	15	14	49
Processes affecting Cs in unstressed syllables	7	4	8	3	22
Processes affecting Cs in stressed syllables	5	3	4	3	15

**Table 5.6.** Languages with word stress exhibiting the given phonetic processes conditioned by word stress.

The patterns in Table 5.6 indicate that languages in the Simple category are much less likely to have phonetic vowel reduction processes as an effect of word stress. Meanwhile, the number of languages with consonant processes conditioned by stress decreases as syllable structure complexity increases. In Figure 5.2 I show the percentage of languages in each category which are reported to have word stress-conditioned processes. Because the trends with respect to consonant processes in stressed and unstressed syllables are so similar, I collapse them here to show the percentage of languages having any stress-conditioned consonant processes.



**Figure 5.2.** Percentage of languages with word stress in each category of syllable structure complexity exhibiting stress-conditioned vowel reduction or consonant processes.

Only one of the trends shows support for the hypothesis. Unstressed vowel reduction processes are reported less frequently for languages with Simple syllable structure than those in the other categories. However, the trend with respect to processes affecting consonants goes in the opposite direction predicted by the hypothesis. These unexpected findings prompt a more detailed analysis of both vowel reduction processes and consonant processes conditioned by stress in the sample.

## 5.4.3.1 Unstressed vowel reduction

General vowel reduction patterns in the sample will be examined in much greater detail in Chapter 6, so I present only a brief analysis of unstressed vowel reduction here. Here I only consider those languages reported to have *unstressed* vowel reduction, and focus on the outcomes of those processes. The outcomes which are considered here are reduction in duration, reduction in quality, devoicing, and deletion. A language may have several unstressed vowel reduction processes yielding different outcomes; each such process and outcome has been considered in the analysis here. The results are shown in Figure 5.3. For each category of syllable structure complexity, the percentage of languages with unstressed vowel reduction resulting in the given outcome is shown.



**Figure 5.3.** Percentage of languages with unstressed vowel reduction having the given outcome of vowel reduction in each category of syllable structure complexity.

The patterns for the outcomes of unstressed vowel reduction shown in Figure 5.3 again set the Simple category apart from the others. Unstressed vowel reduction is much less likely to involve vowel deletion or a reduction in quality in languages of the Simple category than in languages from the other categories. Further, there are dominant trends in the outcomes of unstressed vowel reduction in the Moderately Complex, Complex, and Highly Complex categories: in each of those categories, there is at least one outcome that occurs in over 50% of languages with unstressed vowel reduction. In the Simple category, none of the outcomes examined here occur in more than one-third of the

languages with unstressed vowel reduction; that is, outcomes tend to be more variable in this group (admittedly, it is a small sample, consisting of only six languages).

#### 5.4.3.2 Processes affecting consonants in unstressed syllables

We now turn to an examination of processes affecting consonants in unstressed syllables. In the current sample, these processes occur in 22 languages and form a heterogeneous group, with most of the process types occurring in just one or two languages. In Table 5.7, I list the more frequent processes separately and group together the minor trends under the label of 'Other.' In examining the table, note that a language may have more than one process affecting consonants in unstressed syllables; therefore the numbers going down the columns may add up to more than the totals in the column headings.

		Syllable Structure Complexity			
Processes affecting consonants in unstressed syllables:	Simple (N = 7 lgs)	Moderately Complex (N = 4 lgs)	Complex (N = 8 lgs)	Highly Complex (N =3 lgs)	Total
Deletion	1		3	1	5
Voicing	1	1	1	1	4
Spirantization	2	1			3
Flapping		1	1		2
Other	7	5	4	2	18

**Table 5.7.** Processes affecting consonants in unstressed syllables in sample, by syllable structure complexity.

Because the data set consists of only 22 languages and the total number of

languages with each kind of process is so small, it is difficult to draw conclusions from

the patterns in Table 5.7. However, one interesting pattern is that languages with simpler syllable structure seem to be associated with not only a higher number but also a higher diversity of processes affecting consonants in unstressed syllables. Seven languages in the Simple category have such processes. In this group, the more common processes of deletion, voicing, and spirantization occur. However, there are also seven different kinds of 'Other' processes represented in this group: devoicing, aspiration, lengthening, glottalization, debuccalization, secondary palatalization, and change in place of articulation. By comparison, the Complex category has eight languages in which processes affect consonants in unstressed syllables, but there is less diversity exhibited by the processes in this group overall. Three of the more common processes occur in this group: voicing, deletion, and flapping. Only three types of 'Other' processes occur: aspiration, lengthening, and a process by which a stop becomes a glide.

## 5.4.3.3 Processes affecting consonants in stressed syllables

Processes affecting consonants in stressed syllables are less common than those affecting consonants in unstressed syllables.<sup>32</sup> In the current sample, 15 languages were reported to have such patterns. The processes examined here form quite coherent groups: all but six of the processes can be classified as glide strengthening, aspiration, lengthening, or affrication. See Table 5.8 for their distribution in the sample. Note again that a language may have more than one process affecting consonants in stressed

<sup>&</sup>lt;sup>32</sup> Ian Maddieson (p.c.) points out that this lower number could be an artifact of analysis, in which consonant realization in stressed syllables may be more likely to be taken as the basic form of the phoneme.

syllables; therefore the numbers going down the columns may add up to more than the totals in the column headings.

		Syllable Structure Complexity			
Processes affecting consonants in stressed syllables:	Simple (N = 5 lgs)	Moderately Complex (N = 3 lgs)	Complex (N = 4 lgs)	Highly Complex (N =3 lgs)	Total
Glide strengthening	3	2	1		6
Aspiration	2	1	1		4
Lengthening	4				4
Affrication	2	1			3
Other			3	3	6

**Table 5.8.** Processes affecting consonants in stressed syllables in sample, by syllable structure complexity.

As in the previous analysis, it is difficult to draw strong conclusions from such a small data set. However, there are some patterns worth noting. First, the Simple category is associated with generally higher rates of the most common processes affecting consonants in stressed syllables (glide strengthening, aspiration, lengthening, and affrication). Some of the languages in the Simple category have more than one such process: for example, Pinotepa Mixtec is reported to have both aspiration and glide strengthening in stressed syllables. Second, here the minor ('Other') trends in the current analysis are found in languages with more complex syllable structure: these are as varied as palatalization (Nivkh, Complex), voicing and implosion (Mamaindê, Complex), 'more fortis' articulation (Kunjen, Highly Complex), labialization (Thompson, Highly Complex), and devoicing (Tohono O'odham Highly Complex). These results are in

contrast to the results of the previous analysis, in which the minor patterns were more strongly associated with languages in the Simple and Moderately Complex categories.

#### 5.4.3.4 Implicational relationships between phonetic processes conditioned by stress

Because the number of languages with unstressed vowel reduction is higher in the sample than the number of languages with processes affecting consonants in unstressed syllables, which in turn is higher than the number of languages with processes affecting consonants in stressed syllables, we might expect to find implicational relationships among some of these processes. That is, it might be the case that the presence of one kind of stress-conditioned phonetic process in a language implies the presence of another kind of process. Any such implications might shed light on the diachronic development of segmental effects of word stress.

In Table 5.9 I present the distribution of languages with word stress in the sample according to the presence or absence of unstressed vowel reduction and stressconditioned processes affecting consonants. Here processes affecting consonants in stressed syllables and those affecting consonants in unstressed syllables have been collapsed.

Unstressed V	Stress-conditioned C processes:				
reduction:	Present	Absent			
Present	19	30			
Absent	9	23			

**Table 5.9.** Languages with word stress, distributed according to presence or absence of unstressed vowel reduction and stress-conditioned processes affecting consonants.

The trend in Table 5.9 is not significant in a chi-squared test. This finding is inconsistent with that of Bybee et al. (1998), who established an implicational universal by which the presence of consonant changes conditioned by stress in a language implies the presence of vowel reduction in unstressed syllables. However, that study examined a subset of specific consonant changes, and had a very different sample composition with respect to syllable complexity patterns. The results in the present study are not entirely surprising, given the fact that vowel reduction and stress-conditioned consonant processes have opposite trends with respect to syllable structure complexity (see Figure 5.3 in §5.4.3.1). Languages with unstressed vowel reduction outnumber those with stressconditioned consonant allophony in the Moderately Complex, Complex, and Highly Complex categories; the opposite pattern is found in the Simple category. However, even when languages from the Simple category are excluded, the pattern in the other categories is not found to be statistically significant in Fisher's exact test. Therefore, while most of the languages with stress-conditioned consonant allophony have unstressed vowel reduction, the pattern is not a strong one.

The two trends for stress-conditioned processes affecting consonants run parallel to one another with respect to syllable structure complexity, so it is more likely that we might find an implicational relationship between them. In Table 5.10, the languages with word stress in the sample are distributed according to the presence or absence of processes affecting consonants in unstressed and stressed environments, respectively.

Stressed C	Unstressed C processes:			
processes:	Present	Absent		
Present	9	6		
Absent	13	53		

**Table 5.10.** Languages with word stress, distributed according to presence or absence of processes affecting consonants in unstressed and stressed environments.

The distribution in Table 5.10 indicates that the presence of processes affecting consonants in stressed environments tends to imply the presence of processes affecting consonants in unstressed environments: this is true of 9/15 languages with consonant processes in stressed environments. Though this trend is not universal, it is significant (p = .003 in Fisher's exact test). It could very well be reflective of the pattern by which processes of weakening are cross-linguistically more frequent than processes of strengthening (Lavoie 2015, Bybee 2015b).

#### 5.4.4 Phonological properties of stressed and unstressed syllables

Another way to approach the hypothesis in (5.30) regarding the segmental effects of word stress is to examine asymmetries in the phonological properties of stressed and unstressed syllables. These patterns may reflect the phonologization of stress-conditioned phonetic processes, such as those described in the previous sections, and may indicate that word stress has a long history of segmental effects in a language.

The phonological differences in stressed and unstressed syllables considered here are differences in vowel quality contrasts, vowel length contrasts, tonal contrasts, and consonant contrasts. The contrasts examined here are not necessarily categorical: authors may report exceptions in a few lexical items or describe the pattern as an overwhelming tendency. For example, the phoneme /ə/ in Eastern Kewa is described as occurring most often in unstressed syllables (Franklin & Franklin 1978: 18). Included in the definition of vowel quality contrasts here are regular processes of vowel reduction which have the effect of neutralizing vowel quality contrasts: for example, when some or all vowels are realized as /ə/ in unstressed syllables. Regular unstressed vowel reduction processes with such dramatic neutralizing effects on quality were actually quite rare in the sample, being reported for only two languages: Thompson and Tohono O'odham. Therefore there is very little overlap between the reduced vowel quality contrasts examined here and the phonetic unstressed vowel reduction processes reported in §5.4.3.1.

Relatively few languages within the sample were reported to have phonological differences between stressed and unstressed syllables, as I have defined them here: in total, only ten languages had such patterns. I show their distribution with respect to syllable structure complexity in Table 5.11.

	Syllable Structure Complexity				
Languages with phonological differences between	Simple	Simple Moderately Complex		Highly Complex	
stressed and unstressed syllables:	(N = 18 lgs)	(N = 18 lgs)	(N = 23 lgs)	(N =22 lgs)	
Present	1	3	3	3	
Absent or not reported	17	15	20	19	

**Table 5.11.** Languages with word stress exhibiting phonological differences between stressed and unstressed syllables.

The pattern in Table 5.11 lends support to the hypothesis that languages with more complex syllable structure are more likely to show segmental effects of word stress. However, this trend, like several of the trends discussed above, does not increase incrementally with syllable structure complexity, but instead serves to set the Simple category apart from the others. Only one language in the Simple category is reported to have phonological differences between stressed and unstressed syllables. The rest of the languages with these differences are distributed evenly among the Moderately Complex, Complex, and Highly Complex categories.

As mentioned in §5.2.1, languages may show varying degrees of phonological differences between stressed and unstressed syllables. In Table 5.12 I list the languages reported to have phonological differences between stressed and unstressed syllables. In the first row are languages in which stressed and unstressed syllables differ in only one of the phonological properties examined here. In the second and third rows are languages whose stressed and unstressed syllables differ in more than one phonological property.

	Syllable Structure Complexity				
Phonological differences between stressed and	Simple	Moderately Complex	Complex	Highly Complex	
unstressed syllables:	(N = I Ig)	(N = 3  lgs)	(N = 3  lgs)	(N = 3 lgs)	
1 property	Kewa	Khanty	Bardi Burushaski	Thompson	
2 properties				Semai Tohono O'odham	
3 or more properties		Lao Pacoh	Sre		

**Table 5.12.** Number of phonological differences between stressed and unstressed syllables in the sample, by syllable structure complexity.

There does not appear to be a trend, within this very small data set, by which the number of phonological differences between stressed and unstressed syllables increases incrementally with syllable structure complexity. The languages with the most phonological differences between stressed and unstressed syllables are from the Moderately Complex and Complex categories. Lao, Pacoh, and Sre are all spoken in the Southeast Asia & Oceania macro-region and described as having sesquisyllabic word patterns.

The specific phonological differences between stressed and unstressed syllables observed in the sample can be found in Table 5.13. Note that because languages may have more than one such difference the numbers going down the columns may add up to more than the totals in the column headings.

Phonological differences between stressed and	Simple	Moderately Complex	Complex	Highly Complex	Total
unstressed syllables:	(N = 1 lg)	(N = 3 lgs)	(N = 3 lgs)	(N =3 lgs)	
Vowel quality contrasts	1	3	1	3	8
Vowel length contrasts		2	3	2	7
Tonal contrasts		1	1		2
Consonant contrasts		2	1		3

**Table 5.13.** Phonological differences between stressed and unstressed syllables in the sample, by syllable structure complexity.

Again, it is difficult to draw conclusions about patterns from the very limited data set in Table 5.13. It does appear that differences in vowel length contrasts between stressed and unstressed syllables may bear some relation to syllable structure complexity: 5/7 languages with this phonological property are in the Complex or Highly Complex categories. The distribution of languages also shows that phonological differences of any kind in stressed versus unstressed syllables are rarer for languages in the Simple category than the others.

## **5.4.5** Phonetic correlates of stress

In this section, I analyze the phonetic correlates of stress reported for languages of the sample with word stress. Specifically, I test the hypotheses in (5.8)-(5.9), reproduced in (5.31)-(5.32).

- (5.31) H<sub>3</sub>: As syllable structure complexity increases, so does the likelihood that vowel duration is used as a phonetic correlate of word stress.
- (5.32) H<sub>4</sub>: As syllable structure complexity increases, word stress will be signaled by an increasing number of phonetic correlates.

The phonetic correlates of stress examined here are vowel duration, pitch, and intensity. Altogether, phonetic correlates could be determined for 60 languages, roughly three-fourths of the languages reported to have word stress. In Table 5.14 I show the number of languages from each syllable structure complexity category which are reported to have each correlate of word stress. Note that languages may have more than one

phonetic correlate of stress, so the numbers going down the columns are not expected to add up to the totals in the column headers.

	Syllable Structure Complexity				
Phonetic correlates of word stress:	Simple (N = 15 lgs)	Moderately Complex (N = 11 lgs)	Complex (N = 17 lgs)	Highly Complex (N = 17 lgs)	
Vowel Duration	9	7	8	13	
Pitch	12	6	8	8	
Intensity	7	7	13	12	

**Table 5.14.** Reported correlates (impressionistic or instrumentally confirmed) of word stress in languages of sample, by syllable structure complexity. 19 languages with word stress have been excluded here because phonetic correlates of stress are not described. One additional language (Ungarinjin) has also been omitted, but is reported to have *decreased* duration as a correlate of stress for one vowel, /a/.

In order to better illustrate the trends in Table 5.14, in Figure 5.4 I plot the

percentage of languages in each syllable structure category reported to have each

correlate of word stress.



**Figure 5.4.** Percentage of languages for which phonetic correlates of stress are reported which exhibit given phonetic correlate of word stress, by syllable structure complexity.

We find some support for the hypothesis in (5.31). The percentage of languages using vowel duration as a phonetic correlate of word stress rises from the Simple to the Highly Complex categories, and the highest proportion of such languages is found in the Highly Complex category. However, this trend is not universal: the Complex category actually has the lowest proportion of languages using vowel duration as a phonetic correlate of stress. The other two correlates of stress, pitch and intensity, also show trends with respect to syllable structure complexity. The percentage of languages in which intensity is a phonetic correlate of word stress increases with syllable structure complexity. By contrast, the percentage of languages in which pitch is used as a correlate of word stress decreases with syllable structure complexity.

These results are somewhat surprising in light of previous findings in this and the previous chapter. In §5.3 it was found that tonal contrasts are more frequently found in languages of the Simple category than in the others. Since tonal contrasts are signaled by pitch and tone is most frequently found in the Simple category, we might expect pitch to be used as a phonetic correlate of stress less frequently in this category than the others. Similarly, in §4.3.2, it was found that vowel length contrasts are more common in the Moderately Complex, Complex, and Highly Complex categories. Since vowel length is contrastive in more of those languages, we might expect vowel duration to be used less frequently as a phonetic correlate of stress in these languages, as compared to languages in the Simple category. The trends observed in Figure 5.4 go against both of these predictions; furthermore, the trends are prominent. An analysis of the phonetic correlates of stress within languages with tone and vowel length contrasts shows that such

assumptions about contrasts and phonetic correlates of stress are not entirely justified. Of the 15 languages with tonal contrasts for which the phonetic correlates of stress are described, six use pitch as a correlate of stress and nine do not. Of the 22 languages with contrastive vowel length for which phonetic correlates of stress are described, 15 use vowel duration as a correlate of stress and seven do not.

The distributions in Table 5.14 and Figure 5.4 show how each individual correlate of word stress patterns with respect to syllable structure complexity. We now turn to a test of the hypothesis in (5.32), which predicts that increasing syllable structure complexity will be accompanied by an increased number of phonetic correlates of word stress. In other words, we expect that the proportion of languages with two or three of the correlates examined here will increase across the four syllable structure complexity categories. The observed distribution can be found in Figure 5.5.



**Figure 5.5.** Percentage of languages exhibiting given number of phonetic correlate of word stress in each syllable structure complexity category.

While the rate of co-occurrence of all three phonetic correlates of stress is slightly higher in the Highly Complex portion of the sample, there are no strong trends in Figure 5.5. Therefore we do not find support for the hypothesis in (5.32).

The patterns described above are for all reported phonetic correlates of stress, regardless of whether they are based on impressions or instrumental evidence. Instrumental evidence for phonetic correlates of stress was reported for 18 languages in the sample: five from the Simple category, five from the Complex category, and eight from the Highly Complex category. I show these patterns in Figure 5.6.





The patterns in the small set of languages for which phonetic correlates of stress are instrumentally confirmed mirror to some extent the results in Figure 5.4. The use of pitch as a phonetic correlate of stress generally decreases with syllable structure complexity, and the use of intensity increases with syllable structure complexity. However, vowel duration shows a level trend across the categories of syllable structure complexity here, further limiting the extent to which there is evidence for the hypothesis in (5.31).

### 5.4.6 Summary of word stress patterns

Four hypotheses were formulated in §5.1.4 with respect to word stress and syllable structure complexity. The first was that the proportion of languages with unpredictable word stress placement would increase with syllable structure complexity. The results of the analysis in §5.4.2 did not confirm this on a broad scale: languages with morphologically or lexically conditioned word stress were in fact most common in the Simple syllable structure category. However, a finer-grained analysis of patterns within morphologically or lexically conditioned stress systems indicated that the most unpredictable patterns within that group were almost exclusively found in languages of the Complex and Highly Complex categories. A second hypothesis predicted that word stress would have stronger segmental effects in languages as syllable structure complexity increased. The analyses in §5.4.3-4 provided mixed support for this hypothesis. Processes of unstressed vowel reduction, and outcomes of these processes resulting in reduction in quality and deletion, were much more common in languages with Moderately Complex, Complex, and Highly Complex syllable structure than those with Simple syllable structure. Languages with non-Simple syllable structure were also more likely to have phonological differences between stressed and unstressed syllables. However, the proportion of languages with stress-conditioned processes affecting consonants was found to decrease with syllable structure complexity. Finally, a study of

the phonetic correlates of word stress in §5.4.5 tested the hypotheses that increasing syllable structure complexity would be accompanied by increasing use of vowel duration as a correlate of stress, as well as an increased number of phonetic correlates of stress. One of these hypotheses was weakly supported in the sample. The proportion of languages in which vowel duration signals stress increases from the Simple to Highly Complex category, but this trend is not strictly linear, nor is it supported by instrumental evidence.

The specific properties of word stress and tone found to have positive or negative trends with respect to syllable structure complexity are listed in Table 5.15. An asterisk (\*) and italicized font indicate that the trend is based on a small data set (fewer than ten languages).

Type of property	<b>Positive trends</b> (increases with syllable structure complexity)	<b>Negative trends</b> (decreases with syllable structure complexity)
Presence of stress and tone	Word stress and no tone	Tone
Stress placement	Unpredictable morphological or lexical conditioning (*)	
Segmental effects of word stress	Unstressed vowel reduction Reduction in vowel quality Vowel deletion Phonological asymmetries between stressed and unstressed syllables <i>Asymmetry in vowel length contrasts</i> <i>in</i> <i>stressed and unstressed syllables</i> (*)	C processes in unstressed syllables C processes in stressed syllables Diversity in unstressed C processes
Phonetic correlates of stress	Vowel duration (impressionistic) Intensity	Pitch

**Table 5.15.** Properties of word stress associated positively or negatively with syllable structure complexity.

Some of the patterns shown in Table 5.15 do not have an incremental trend with respect to syllable structure complexity. For instance, the trends in unstressed vowel reduction, reduced quality or deletion outcomes of vowel reduction, and phonological asymmetry between stressed and unstressed syllables are not gradual. Instead they set the Simple category apart from the other three categories, which all have similar patterns with respect to these properties. The vowel reduction trend is significant: when the pattern in the Simple category is cross-tabulated against those for the other three categories combined, the result is statistically significant:  $\chi^2(1, N = 81) = 7.144$ ,

p = 0.008. Another statistically significant pattern in the data is the trend in the use of pitch as a phonetic correlate of stress: this is significant when the pattern in the Simple category is cross-tabulated against those for the other three categories combined  $(\chi^2(1, N = 60) = 4.434, p = 0.04)$ . Other patterns are too subtle to show a significant effect in chi-squared tests, or occur in very small data sets.

For the most part, the results of the analyses in this chapter lend only weak support to the hypotheses. However, some of the unexpected patterns in the data, such as the opposing patterns with respect to unstressed vowel reduction and stress-conditioned consonant allophony and syllable structure complexity, indicate that stress may nevertheless play an important and complex role in the diachronic development of syllable structure. In light of the results here, it is necessary to rethink the hypotheses and the relationships between word stress, its effects, and syllable structure complexity. These issues will be explored in the following section.

### 5.5 Discussion

## 5.5.1 Suprasegmental patterns and highly complex syllable structure

Having conducted analyses to test hypotheses relating suprasegmental properties to syllable structure complexity, we return to the research questions of the dissertation. The first is reproduced in (5.33).

(5.33) Do languages with highly complex syllable structure share other phonetic and phonological characteristics such that this group can be classified as a linguistic type?

While there was mixed support for the hypotheses tested here, the analyses revealed that there are suprasegmental patterns more strongly associated with the Highly Complex category than the other categories. In (5.34) I list the suprasegmental patterns which are most characteristic of languages of the Highly Complex category.

### (5.34) Suprasegmental patterns associated with Highly Complex category

Presence of stress and absence of tone Absence of stress-conditioned processes affecting consonants Presence of vowel duration as a phonetic correlate of stress Absence of pitch as a phonetic correlate of stress

As mentioned in the discussion of segmental patterns in §4.5.1, the terms 'absence' and 'presence' are used here not in a categorical sense. Instead these are meant to correspond to the relative absence or presence of a property in the Highly Complex group as compared to the other syllable structure complexity groups.

The analyses conducted here also revealed, in several cases, suprasegmental patterns which are shared in common among the languages in the Highly Complex,

Complex, and Moderately Complex categories. The patterns serve to set these languages apart from languages in the Simple category. They are listed in (5.35).

#### (5.35) Suprasegmental patterns associated with non-Simple syllable structure

Presence of unstressed vowel reduction Presence of unstressed vowel quality reduction Presence of unstressed vowel deletion

Presence of phonological asymmetries between stressed and unstressed syllables

Other properties of word stress associated with the Highly Complex category include: the presence of morphologically or lexically conditioned stress patterns which are unpredictable within those domains; an asymmetry in vowel length contrasts in stressed and unstressed syllables; and perhaps the use of a combination of vowel duration, pitch, and intensity to signal stress. However, these patterns were determined on the basis of small data sets, so it is difficult to make generalizations about them.

In §4.5.1 I showed how the segmental patterns associated with the Highly Complex group were distributed among the languages in that group. The resulting distribution showed that languages in which Highly Complex syllable patterns are more prominent also had more of those associated segmental patterns. In Table 5.16 I illustrate how the suprasegmental patterns most strongly associated with the Highly Complex portion of the sample are distributed among the languages. The languages are again divided into three groups according to the prominence of their Highly Complex syllable

patterns, as established in §3.4.1-2. The suprasegmental properties associated with Highly Complex syllable structure and listed in (5.34) above are given in the columns. A check mark indicates that a language has the expected property; a shaded cell indicates that it does not.
	Word stress <b>present</b>	Tone <b>absent</b>	Stress- conditioned C allophony <b>absent</b>	V duration as correlate of stress <b>present</b>	Pitch as correlate of stress <b>absent</b>
	Lang	guages with pr	evalent Highly	Complex pat	terns
Cocopa	$\checkmark$	$\checkmark$		$\checkmark$	
Georgian	$\checkmark$	$\checkmark$	√	(nr)	(nr)
Itelmen	$\checkmark$	$\checkmark$	√		$\checkmark$
Polish	V	$\checkmark$	√	√	
Tashlhiyt	√	√	√	√	$\checkmark$
Thompson	V	√		√	
Tohono O'odham	V	√		√	
Y. Sahaptin	$\checkmark$	√	√		
	Langu	ages with inte	rmediate High	ly Complex pa	atterns
Albanian	$\checkmark$	$\checkmark$	√	√	√
Camsá	√	√	√	√	√
Kabardian	√	√	√	√	
Lezgian	V	√	√	√	$\checkmark$
Mohawk	V		√		
Nuu-chah-nulth	√	√	√	√	$\checkmark$
Passamaquoddy-Maliseet	V		√	√	$\checkmark$
Piro	V	√	√		
Qawasqar	(disagree)	V			
Semai	$\checkmark$	$\checkmark$	√	(nr)	(nr)
Tehuelche	$\checkmark$	$\checkmark$	√	(nr)	(nr)
	Languages with minor Highly Complex patterns				
Alamblak	$\checkmark$	$\checkmark$	√	(nr)	(nr)
Doyayo					
Kunjen	√	√		√	√
Menya	V		√	(nr)	(nr)
Wutung	√			√	√

**Table 5.16.** Highly Complex languages, divided into three groups according to the prominence of their Highly Complex patterns. Expected suprasegmental properties are given in columns. A check mark indicates that the given language has the expected property; a shaded cell indicates it does not. Note that for Qawasqar (intermediate) there is disagreement over whether the language has word stress. *(nr)* indicates that phonetic correlates of stress were not reported for the language.

The pattern in Table 5.16 indicates that the predictions are largely upheld.

Languages which have Highly Complex syllable structure as a prevalent pattern tend to have more of the suprasegmental properties associated with Highly Complex syllable structure: 28/40 or 70% of the cells in that group are checked, indicating that the expected pattern was found. The 'intermediate' languages actually have a slightly higher percentage of the expected properties: 40/55, or 73% of those cells have check marks. These groups are in contrast with the languages which have Highly Complex syllable structure as a minor pattern: 12/25, or 48% of those cells show the expected pattern. Similar patterns are obtained when the unreported phonetic correlates (marked *(nr)* in the table) are excluded.

The patterns in Table 5.16 show that languages which have Highly Complex syllable structure as a minor pattern tend to have fewer of the suprasegmental properties associated with this group. As with the similar analysis of segmental patterns in §4.5.1, this is striking, given that the divisions in the Highly Complex group were defined solely by reference to their syllable patterns. We find again here that stronger Highly Complex syllable patterns in a language tend to be accompanied by a stronger presence of the phonetic and phonological correlates. These findings lend further support to the idea that highly complex syllable structure is a linguistic type whose prototype is characterized by a coherent set of phonological features.

Despite the pattern in Table 5.16, the results in the current study suggest that highly complex syllable structure is not as reliably associated with suprasegmental

features as it is with segmental features. With that in mind, we revisit the second research question of the dissertation (5.36).

#### (5.36) How does highly complex syllable structure develop over time?

The strongest patterns in the word stress data examined here serve to set apart the Simple category from the other three categories of syllable structure complexity. Therefore it is difficult to relate these results to the development of Highly Complex patterns specifically. This is further complicated by the fact that the hypotheses tested here were weakly supported, or not supported at all. This prompts us to reexamine some of the assumptions underlying these hypotheses.

The hypotheses were rooted in findings from previous studies which related properties of stress to specific effects of stress independently of syllable structure complexity (Bybee et al. 1998, Schiering 2007), though the relevance of these findings to syllable structure complexity seems clear enough. However, as noted above, the size and construction of the language samples used in the previous studies and the current one are quite different. It would be fruitful, then, to examine some of those associations established in the previous studies to see if they hold in the current sample, without reference to syllable structure complexity.

Analyses of the relationships between stress placement, vowel duration as a correlate of stress, and the various segmental effects of stress turned up one statistically significant pattern in the sample. There is an association between the presence of

morphologically or lexically conditioned stress and the presence of stress-conditioned allophonic variation in consonants (Table 5.17). This relationship is statistically significant ( $\gamma^2(1, N = 79) = 4.863, p = 0.027$ ).

Morphologically or	Stress-conditioned C processes:			
conditioned stress placement	Present	Absent		
Present	12	10		
Absent	16	41		

**Table 5.17.** Languages with word stress, distributed according to presence or absence of stress-conditioned consonant allophony and morphologically or lexically conditioned stress placement.

Other associations — i.e., between stress predictability and unstressed vowel reduction, stress predictability and vowel duration as a correlate of stress, and segmental effects of stress and vowel duration as a correlate of stress — were not found to be statistically significant in the current sample. This could be an effect of the composition of the current sample, in which the representation of syllable patterns which are relatively rare cross-linguistically is artificially high. For example, vowel reduction was found to be much rarer in languages of the Simple category, which represent 22/100 languages here. Another factor affecting the results could be differences in the references consulted. Bybee and colleagues state that very few of the references consulted in that study made mention of the phonetic correlates of stress (1998: 278). They had to rely instead upon descriptions of reported vowel lengthening processes in order to determine whether vowel duration was a correlate of stress. Many of the language descriptions consulted in

the current chapter have been written in the last 20 years, during which time the reporting of phonetic correlates of stress has become standard procedure.

Schiering (2007) found a strong positive association between the strength of stress in number of phonetic correlates and the extent to which stress has segmental effects in the languages of his sample. I conducted a similar analysis with the data here, calculating the correlation between the number of phonetic correlates reported to signal stress and the number of types of stress-conditioned segmental processes occurring, the three possibilities being unstressed vowel reduction, consonant allophony in unstressed syllables, and consonant allophony in stressed syllables. This analysis revealed a moderate but highly statistically significant positive correlation between the phonetic strength of stress and the extent of the segmental effects of stress (r(60) = .364, p < .005).

We find that a few strong associations between properties of stress and its segmental effects occur in the current study, replicating results from previous studies. It is puzzling then, given other associations established in the literature between these features and syllable structure complexity, that we did not find strong patterns linking properties of stress and syllable structure complexity in the current sample. This suggests that the role of stress in the development of highly complex syllable structure is more subtle than originally expected.

## 5.5.2 Word stress and the development of syllable structure patterns

Though the patterns established here relating word stress properties to syllable structure complexity are unexpected and difficult to interpret, it is nevertheless important to attempt to relate them to the development of syllable structure patterns more generally.

The pattern by which languages in the Simple category are less likely to have unstressed vowel reduction is expected from a diachronic point of view. If such patterns become prevalent enough in a language to become phonologized, this could eventually lead to a language developing more complex syllable patterns, at which point it would no longer belong to the Simple category. A related point is that languages with Simple syllable structure show highly variable outcomes with respect to both unstressed vowel reduction and stress-conditioned consonant allophony. By comparison, languages with more complex syllable patterns consistently show two strong outcomes with respect to unstressed vowel reduction: deletion and reduction in vowel quality. These trends could be interpreted as indicative of relative phonologization of stress-conditioned allophonic processes. That is, the more consistent outcomes of unstressed vowel reduction in languages with non-Simple syllable structure could point to a longer history of segmental effects of stress in those languages. We would expect this to be the case for languages in the Moderately Complex, Complex, and Highly Complex categories more so than languages in the Simple category.

The decrease in the number of languages having stress-conditioned consonant allophony as syllable structure complexity increases was quite unexpected. This pattern is especially interesting in light of the findings in Chapter 4, in which certain consonant

articulations were found to be associated with different ends of the syllable structure complexity cline. One diachronic interpretation of this pattern could be that consonant articulations associated with more complex syllable structure have their origin in stressconditioned allophonic processes in languages with simpler syllable structure. While parallel processes of vowel reduction occur, making the syllable structure more complex, these consonantal processes may phonologize and eventually result in new contrastive phonemes. However, such a speculative scenario is difficult to examine in the current data set. None of the stress-conditioned processes examined here result in uvulars or ejectives. Processes resulting in the other articulations associated with high syllable complexity are relatively rare: out of the 55 stress-conditioned consonant processes collected here, only six result in palato-alveolar and/or affricate articulations. These do all occur in languages from the Simple and Moderately Complex categories.

A few possibilities come to mind for why languages in the Highly Complex category do not show the highest rates of stress-conditioned segmental processes. One is that there *are* higher rates of vowel reduction in these languages, but the coarse-grained analyses in this chapter did not capture this fact. The analysis here considered only the presence or absence of unstressed vowel reduction patterns, but not the number of such patterns in each of the languages. This issue will be explored in further depth in Chapter 6, which presents a detailed analysis of all phonetic vowel reduction patterns in the language sample. Another possibility is that in languages of the Highly Complex category, segmental effects of stress have already operated in the languages for long periods of time and had dramatic effects on the phonology. In such a scenario, pre- and

post-tonic vowels will have been largely reduced, leaving few vowels outside of stems to be affected by phonetic unstressed vowel reduction. Likewise, the absence or highly reduced nature of unstressed vowels would make consonant allophony in unstressed syllables unlikely. In other words, languages with Highly Complex syllable patterns may not show extreme segmental effects of stress because these processes have essentially progressed to completion within these languages. Such a scenario is, however, extremely speculative and not likely given the phonological facts of most of the languages in this group. While there are a few languages in which most unstressed vowels are highly reduced (e.g., Thompson), there are many more in which this is not the case.

A simpler, more plausible, and more satisfactory explanation for the patterns observed in this chapter is that word stress simply does not have the universally strong effect on syllable structure development that it was thought to have when the hypotheses of this study were formulated. Concurrent with that is the observation that there are many ways in which stress systems and syllable patterns may change independently of one another. Schiering notes the following issue in positing motivations for speech rhythm types:

"[P]roblems translating these observations to cross-linguistic data from a worldwide sample arise because at each step of the diachronic scenario for each phonological parameter of linguistic rhythm, multiple evolutionary scenarios may in principle be at work."

(Schiering 2007: 353)

Schiering gives several examples of how unpredictable word stress placement patterns may come about independently of vowel reduction. For example, in Turkish,

unpredictable stress patterns can be found in loanwords and in a grammaticalized construction in which the phrasal stress pattern has been reanalyzed as an irregular word stress pattern. In the current sample, there are similar patterns in which irregular stress patterns have been introduced by the recent grammaticalization of formerly independent words which retain their stress patterns (e.g., in Quechua, example 5.3). Bybee et al. (1998) also present several historically attested alternative paths by which stress placement patterns may change independently of vowel reduction. By the same token, processes of vowel reduction which have the effect of altering syllable patterns do not have to be conditioned by stress. For example, in Nkore-Kiga, a language which does not have word stress, high vowels may be deleted in certain consonantal contexts word-medially (Taylor 1995: 202-5). And consonant allophony, of course, may be conditioned by many other environmental factors besides stress.

The findings here indicate that the properties and effects of word stress are just a few components of the "phonetics-phonology constellation" (Schiering 2007: 354) characterizing highly complex syllable structure. In fact, in comparing the results of this chapter to those of the previous chapter, an important finding might be that general properties of gestural organization in speech could be just as relevant as the effects of word stress in the development of highly complex syllable structure. This point will be reconsidered in the following chapters, which examine more generally the properties of vowel reduction and certain kinds of consonant allophony in the sample as they relate to syllable structure complexity.

#### **CHAPTER 6:**

## **VOWEL REDUCTION AND SYLLABLE STRUCTURE COMPLEXITY**

#### 6.1 Introduction and hypothesis

In this and the following chapter, I address the two broad research questions of the dissertation by expanding the phonological survey of syllable structure complexity beyond segmental and suprasegmental properties, considering instead the dynamic, ongoing patterns of sound change that occur in languages with different kinds of syllable structure. Specifically, the study in the current chapter investigates the properties of vowel reduction in languages with different syllable structure complexity. The purpose of looking at vowel reduction, in particular, is that it is a known pathway by which complex syllable patterns develop.

Vowel reduction, specifically the weakening of vowels in unstressed syllables, has long been proposed to co-occur with complex syllable structure in the rhythm typology literature (Auer 1993). Vowel reduction is also known from historical and comparative evidence to cause changes in canonical syllable structure. For example, as discussed in §3.2.3, a comparison of the syllable patterns of Toro So with those of related dialect Tommo So suggests that deletion of final vowels has recently changed the canonical syllable patterns of the latter: what was previously a (C)V pattern is now (C)V(C) (Plungian 1995). Vowel reduction can also be responsible for producing the tautosyllabic consonant clusters associated with complex syllable structure: recall the process of vowel devoicing in Ute, also described in §3.2.3. Devoiced vowels have resulted in some

patterns in this previously CV language which can be synchronically analyzed as sequences of consonants and glottal fricatives (Givón 2011). Below I illustrate the potential effects of the most extreme form of vowel reduction, vowel deletion, with an example also mentioned in §5.1.3. A recent process deleting pretonic high vowels in certain consonantal environments has dramatically changed the canonical syllable patterns of Lezgian. Where only simple onsets used to occur, now onsets of two or three consonants are common. The change is ongoing (6.2a), but its directionality is apparent when modern invariant forms are compared to conservative standard spelling (6.2b).

- (6.2) Lezgian (Nakh-Daghestanian; Azerbaijan, Russia)
- (a)  $[t \tilde{J}^{h} i' neba] \sim [t \tilde{J}^{h} neba]$ 'secretly'

(b)	Standard spelling	Modern form	gloss
	xizan	/xzan/	'family'
	šutq 'unun	/ʃ <sup>w</sup> t <sup>h</sup> q'unun/	'press out'

(Haspelmath 1993: 36-8)

Instrumental evidence indicates that this deletion process continues to be highly productive in the language (Chitoran & Babaliyeva 2007). This acoustic study also shows that the vowel deletion does not occur spontaneously, but is the end product of an incremental reduction cline. Initial stages of this process include devoicing and reduced duration of the affected vowel before it has reduced to the point that one might consider it to be deleted. Further, there is evidence that this process involves not only reduction of the vowel gesture, but also its overlap with that of the preceding consonant: the articulatory characteristics of the vowel may persist as a secondary articulation of the preceding consonant (note the labialization in the second example in 6.2b).

A major goal in the current work is to identify paths by which highly complex syllable structure, and the large consonant clusters associated with it, develop over time. The evidence from Lezgian, which itself now has syllable structure that puts it in the Highly Complex category in this study, as well as languages with similar patterns, indicates that vowel reduction is at least one source for the development of complex tautosyllabic consonant clusters in a language. The continued productivity of this particular process in Lezgian also suggests that vowel reduction patterns may continue to persist even after they have altered the syllable patterns of a language.

As noted in §5.1.3, there is additionally a tendency in the language for post-tonic vowels to be deleted in certain consonantal environments (6.3).

(6.3) Lezgian (Nakh-Daghestanian; Azerbaijan, Russia)

di'dedilaj ~ di'dedlaj

'from mother'

(Haspelmath 1993: 40)

Haspelmath reports that the process in (6.3) is mostly restricted to inflectional suffixes; though there are other contexts in which it occurs, the precise phonological conditioning is difficult to specify. The processes illustrated by (6.2) and (6.3) are structurally similar: both are conditioned by stress and the consonantal environment, and affect predominantly high vowels. An interesting question to consider here is whether the processes illustrated share a common motivation. That is, though they are distinct patterns, the similarities in their conditioning and outcomes may reflect an increasing general phonetic tendency towards reduction of high vowels, and/or their overlap with consonantal gestures, in unstressed syllables in the language.

The observations above suggest several points for further investigation. First of all, because vowel reduction processes may persist in a language after they have altered canonical syllable patterns, it is reasonable to hypothesize that languages with complex syllable structure will be more likely to have ongoing vowel reduction processes than those with simpler syllable structure. The impressionistic descriptions of the phonetic characteristics of languages with highly complex syllable structure in §1.4.3, in which unstressed syllables are described as being "squeezed together" and unstressed vowels as being obscure or dropped entirely, suggest that this hypothesis has merit. Second, following the observations regarding the two processes in Lezgian, we might expect vowel reduction to also be more prevalent within languages with complex syllable patterns. This could manifest in a higher number of distinct vowel reduction patterns within those languages. Finally, it is reasonable to suppose that the generally higher prevalence of vowel reduction in languages with more complex syllable structure may be accompanied by more extreme outcomes of these processes, given that the syllable patterns may have come about through similarly extreme outcomes of vowel reduction at

some point in the history of those languages. The analysis in §5.4.3.1, in which it was shown that vowel deletion was frequently an outcome of unstressed vowel reduction in languages from the non-Simple categories, would support this idea. With these points in mind, I present the hypothesis for the current chapter (6.4).

(6.4) H<sub>1</sub>: As syllable structure complexity increases, languages will show stronger effects of vowel reduction, in terms of both prevalence of processes and final outcomes of processes.

In the study presented here, I test this hypothesis by analyzing the overall prevalence of vowel reduction in the sample. I also analyze the specific characteristics of the affected vowels, conditioning environments, and outcomes associated with vowel reduction in the sample. Trends in these components of vowel reduction patterns may shed light on the diachronic development of highly complex syllable structure, as well as inform our understanding of synchronic phonetic tendencies in these languages.

Recall that an unexpected finding in Chapter 5 was that the proportion of languages with stress-conditioned vowel reduction did not increase linearly with syllable structure complexity, but instead was found to occur in similarly high percentages of languages with Moderately Complex, Complex, and Highly Complex syllable structure as compared to the Simple category. This issue will be revisited in greater depth in the current chapter, but it is important to note that the analyses here are not limited to vowel reduction conditioned by stress. Since vowel reduction with any kind of conditioning

environment may be relevant to the development of syllable structure complexity, the scope of this chapter is much broader than what was presented in the analysis in §5.4.3.

#### 6.2 Methodology

## 6.2.1 Patterns considered

The term *vowel reduction* is most often used in the literature to refer to a process which affects vowel quality, typically in unstressed or otherwise weak phonological environments. A prototypical manifestation of this is the movement of unstressed vowels closer to the 'neutral' central area of the vowel space, e.g., English Rosa's roses ['1002<u>9</u>z '1002<u>i</u>z]. Crosswhite, who defines vowel reduction more narrowly as "[t]he neutralization of two (or more) phonemic vowels when unstressed (2000: 1)," distinguishes two types of vowel reduction in terms of their perceptual outcomes: prominence reduction and contrast enhancement. In prominence-reducing vowel reduction, phonemic contrasts are neutralized to low-sonority vowels, specifically vowels in the mid central region and high vowels (see English example above). This has the effect of restricting the entire vowel space in unstressed syllables to a smaller (usually higher and/or more central) region. In contrast-enhancing vowel reduction, vowel contrasts in unstressed syllables are neutralized in such a way as to preserve the peripheral contrasts in the vowel space. For example, in Luiseño, mid vowels are raised to their high counterparts in unstressed syllables: 'to their high counterparts in unstressed syllables: 'to the syllables' because  $2 + \frac{1}{2} + \frac{1}{2}$ 'limping' (Munro & Benson 1973: 19). This has the effect of reducing the five-vowel system /i e a o u/ to a three-vowel system /i a u/ in unstressed syllables. While many

language-specific studies of vowel reduction exist in the literature (e.g. Lindblom 1963 for Swedish, Padgett and Tabain 2005 for Russian), large-scale typological studies of the phenomenon are rare and limited specifically to this issue of neutralization of phonemic contrasts (Crosswhite 2001, 2004).

The current study does not limit itself to phonemic neutralization or reduction of vowel quality in its examination of vowel reduction processes. As indicated by the discussion of the Lezgian vowel reduction pattern above, vowel deletion is an incremental process which may involve many different forms of reduction. While the cline to vowel deletion in English typically involves vowel quality reduction (e.g., *potato*  $[p^{h}out^{h}errou] > [p^{h}t^{h}errou]$ ), the Lezgian example shows that other weakening effects such as devoicing and shortening may be involved in this process (Chitoran & Babaliyeva 2007). Thus a principled way to approach the current study is to consider any case of vowel weakening to be potentially informative in piecing together the development of highly complex syllable structure.

The vowel reduction processes examined in the current study encompass any kind of lenition, that is, weakening, of a vowel. In determining what constitutes a weakening of a vowel, I appeal to phonological models in which sound change is understood in terms of articulatory gestures (Browman & Goldstein 1992, Mowrey & Pagliuca 1995). From this point of view, a vowel reduction would involve a decrease in the magnitude or duration of vocalic gestures, and/or overlap of vocalic gestures by gestures associated with neighboring sounds, which may have similar outcomes. Thus vowel reduction may involve reduced tongue body displacement, which would produce a reduction in quality,

but it could also involve reduction or loss of the glottalic gesture (devoicing), temporal reduction of the vocalic gestures (shortening), and other effects. We therefore define *vowel reduction* as any process resulting in (a) the reduction in duration, quality, voicing, or any other property of a vowel, or (b) the vowel no longer having any acoustic manifestation. While the latter phenomenon is typically described as vowel 'deletion,' it is important to note that gestural overlap with adjacent sounds may result in a vowel no longer being audible, but still having an articulatory trace (cf. Browman & Goldstein 1990 for consonant deletion).

Another complication with the label *vowel reduction* is that it may be used for many different kinds of processes, including those limited to specific morphological paradigms and cases of idiosyncratic reduction which occur only in highly frequent words or phrases. In fact both such patterns were frequently found in the language sample (6.5-6):

## (6.5) **Burushaski** (Isolate; Pakistan)

When the causative prefix is attached to a verb stem, long vowels in the stem frequently shorten, and  $\epsilon$ / tenses and raises to /i/. -delas > adilas 'make jump'

(Anderson 1997: 1030)

(6.6) Koiari (*Trans-New Guinea*; Papua New Guinea)

The phrase *ego tonitoniva*, 'very long,' is often produced as *ego tontoniva* in rapid speech.

(Dutton 1996: 7)

Such examples are certainly important in enriching our understanding of vowel reduction, attesting to the strong effect that usage-based factors such as analogy, frequency, and automation can have on the sound system of a language, and illustrating the complex intertwining of phonological and morphosyntactic patterns that occur in natural language use and a speaker's representation of the language (Bybee 2001). However, the analysis of such patterns presents complications. The interpretation of patterns limited to morphological paradigms may be complicated by such factors as inversion or telescoping (Vennemann 1972, Hyman 1975), in which the chain of developments is obscured or reversed. An example of a synchronic misinterpretation of this sort was discussed in §4.5.3.1 for Lezgian: Yu (2004) shows that an apparent synchronic process of word-final obstruent voicing in the language is not plausible based on morphophonological and comparative evidence, and that it is more likely that a sequence of processes has devoiced the corresponding word-internal alternants. Similarly, reduction in highly frequent forms, also known as special reduction, has been found in the research to not be entirely comparable to other productive processes of vowel reduction, being more extreme in its effects (Bybee et al. 2016). For these reasons, vowel reduction patterns limited to specific morphological paradigms and highly frequent forms

will be omitted from the current study. Instead, only cases of phonetically or

*phonologically conditioned vowel reduction* are considered, on the basis that these are at least somewhat transparent in their conditioning environments and effects, and productive in the languages for which they are reported. In (6.7)-(6.10), I illustrate some of the processes considered in the analysis.

## (6.7) **Pech** (*Chibchan*; Honduras)

In rapid speech, vowels in unstressed syllables are sometimes voiceless between voiceless consonants.

/sikì̃ko/

[sikiko]

'church'

(Holt 1999: 18)

# (6.8) Kim Mun (*Hmong-Mien*; Vietnam)

Long vowels are shortened and produced with level tone in non-word-final syllables.

(a) /gja:ŋ<sup>35</sup>/

[gja:ŋ<sup>35</sup>]

'tree'

(b)  $/gja:\eta^{35}\theta:n^{52}/$ 

[gjaŋ<sup>33</sup>0ın<sup>52</sup>]

'tree trunk'

(Clark 2008: 117)

## (6.9) Alamblak (*Sepik*; Papua New Guinea)

A tense mid front vowel /e/ may be realized as lax  $[\varepsilon]$  in unstressed syllables.

/'metet/

['metɛt]

'she is a woman'

(Bruce 1984: 38)

# (6.10) Karok (Isolate; United States)

An unaccented word-initial short vowel preceding two consonants may be lost following a pause.

/i∫puk/

[∫puk]

'money'

(Bright 1957: 53)

A few types of phonetically- or phonologically-conditioned vowel reduction processes were excluded from the current study. An extremely common type of process in the language sample involved a centralization, laxing, or raising of vowel quality solely as an effect of a specific consonantal environment, as illustrated by (6.11) below:

(6.11) Maybrat (*West Papuan*; Indonesia)

A high front vowel /i/ may be realized as high central half-close unrounded vowel [ï] when preceding the velar stop /k/. /manik/ [manïk]

'oil'

(Dol 2007: 15)

Such processes are not clear examples of vowel reduction, and may be better analyzed as place assimilation of the vowel to the consonant. These were excluded from the present study. In cases in which a reduction in vowel quality was conditioned by another factor in addition to the consonantal environment, such as word position or stress environment, the process *was* included as a case of vowel reduction. Processes involving a reduction in voicing, length or other vocalic properties solely as an effect of the consonantal environment were included in the present analysis, but were generally rare.

As mentioned in §5.2.1, where word stress is described as having longer vowel duration as a phonetic correlate, authors sometimes describe the relatively shorter length of all unstressed syllables as vowel reduction. Such patterns have not been included here as vowel reduction. What have been included are vowel shortening processes in which

the reduced length of an unstressed vowel is shorter than what would normally be expected for unstressed vowels, for instance, extra shortening of unstressed vowels in pretonic position as compared to other unstressed positions.

Finally, processes of vowel harmony which might involve vowel laxing or raising were excluded from the present analysis. Also excluded were cases of vowel reduction or deletion conditioned by an adjacent vowel (e.g., hiatus avoidance), and vowel coalescence or merger.

## 6.2.2 Determining what constitutes a process

In any analysis of dynamic processes within or across languages, potential methodological problems arise from issues of how and where to draw the lines which divide the holistic sound pattern of the language into discrete processes. In the current study, it was important to strike a balance between capturing similarities in patterns of vowel reduction and recognizing potentially important differences in those patterns. This sometimes required a reinterpretation of the patterns as they were reported in the descriptive materials.

Where more than one vowel was found to reduce in the same way in the same environment, these patterns were grouped together as a single process. Patterns were coded as separate processes when differences in the conditioning environments or outcomes were reported for different affected vowels or groups of vowels. For example, the pattern in (6.12) below was split into two processes due to the slightly different

conditioning environments reported for the two affected high vowels (other aspects of the processes have been ignored here to simplify the exposition):

(6.12) Cocama (*Tupian*; Peru)

(a) The high back vowel /u/ may be produced as [o] word-finally.

/itimu/

[itimo]

'liana sp.'

(b) The high front vowel /i/ may be produced as [e] word-finally following an approximant consonant.

/tsuwi/

[tsuwe]

'tail'

(Vallejos Yopán 2010: 109-10)

Issues of regularity and speech style were also considered to be important factors in differentiating processes. In the example below (6.13), a pattern of vowel lengthening in Doyayo has been split into two processes based on differences in its regularity in two similar conditioning environments. Patterns like these were not very common in the data:

(6.13) Doyayo (Niger-Congo; Cameroon)

(a) A long vowel is optionally shortened preceding a coda of two or three consonants.

(b) A long vowel is obligatorily shortened preceding a coda of four consonants.

(Wiering and Wiering 1994: 22)

Some patterns in the language sample involved the optional reduction *or* deletion of a vowel or group of vowels in some specific conditioning environment. In such cases, the pattern was coded as a single process with two optional outcomes: reduction (in whatever way specified by the source) or deletion, as in the Lelepa example below (6.14):

(6.14) Lelepa (Austronesian; Vanuatu)

In word-final position following a consonant, high vowels /i u/ and mid back vowel /o/ may be deleted or devoiced.

/nati/ [nati] ~ [nati] ~ [nat] 'banana'

(Lacrampe 2014: 15, 64-5)

# 6.2.3 Coding

As with most typological studies of moderate to large size, the data collection for this study relies on patterns reported in reference grammars and other descriptive materials. Written references, which are often heavily reliant on elicited data, are of course a poor substitute for multi-modal corpora of natural language use. The written word is also a particularly poor medium for the study of speech sound patterns. Typological studies of phonological processes are further complicated by issues of analysis. The direction of a process relies on the analysis of the author and their judgments of what a likely process is, based on the synchronic evidence at hand in the language. Characterizations of variation may be phonetically imprecise and based on impressions rather than instrumental measures, and the degree of detail and patterns attended to may reflect the interest and/or native language biases of the author. In addition to these potential issues, there are many other complications of descriptive and typological work relating to the speech styles and variation represented in language reference materials, as discussed in Chapter 2.

It is expected that the group of vowel reduction processes collected from the sources will reflect some or all of the above problems. However, in a sample of 100 diverse languages ranging from highly endangered languages with a handful of speakers to well-documented languages with institutional status, described by hundreds of researchers from various backgrounds, we expect strong cross-linguistic trends to rise above the 'noise' of the aforementioned complications.

Each process of vowel reduction was coded for three structural factors: the vowels affected, the features of the environment reported to cause the reduction, and the outcome of the reduction process. I describe specifics of the coding procedure here.

The *affected vowels* were coded according to their phonetic descriptions in the references consulted and the corresponding IPA symbols. Where the affected vowels formed a coherent natural class with respect to the vowel inventory of the language this was also noted (e.g. *long vowels, high vowels, all vowels*).

The conditioning environment was coded to reflect what phonetic or phonological factors contributed to the occurrence of the process: consonantal environment, word environment, word stress environment, and/or phrase (or utterance) environment. In coding the conditioning environment, sometimes a reinterpretation of the process as reported was required. Where word and phrase/utterance environments were confounded, the phrase/utterance domain was considered to be the conditioning factor: for instance, in cases in which an author reported that word-final vowels are reduced at the end of an utterance. Where both word and phrase/utterance environments clearly contributed to the process, then both were coded as conditioning factors: for instance, when word-final vowels are deleted phrase-medially but not phrase-finally. Similarly, when word stress and word position were potentially confounded, then the stress environment was considered the sole conditioning factor. An example of this would be when an author reported that the antepenultimate vowel of a word is reduced preceding a stressed syllable, but the language was also reported to have fixed penultimate word stress.

The *outcome* was coded according to the nature of the reduction vis-à-vis the phonetic definitions of the affected vowels. Outcomes included reduction in vowel duration, reduction in vowel quality (usually laxing or centralization), devoicing, deletion, and other rarer effects such as tone leveling or glottalization of the vowel. Following findings in the literature reported in §6.2.1, an outcome of vowel peripheralization was considered to be a reduction in vowel quality if explicitly described by the author as being a process of vowel reduction.

Insofar as such information was reported, processes were also coded for factors of regularity (e.g., regular or optional application), speech style (e.g., normal, rapid, or casual speech), and sociolinguistic variation (e.g., age of speakers).

All vowel reduction processes considered in this chapter can be found in Appendix B.

## 6.3 Results

Here I present a quantitative analysis of vowel reduction processes occurring in the language sample. These analyses test the hypothesis formulated in §6.1 and reproduced below (6.15).

(6.15) H<sub>1</sub>: As syllable structure complexity increases, languages will show stronger effects of vowel reduction, in terms of both prevalence of processes and final outcomes of processes.

In §6.3.1-2, the relative prevalence of vowel reduction processes is examined with respect to syllable structure complexity. In §6.3.3-5, analyses are presented showing how trends in the affected vowels (§6.3.3), conditioning environments (§6.3.4), and outcomes of vowel reduction processes (§6.3.5) differ among languages with different syllable structure complexity. In §6.3.6 I present a holistic analysis of the reduction processes in the sample. In §6.3.7 I summarize the patterns observed and discuss how they support the hypothesis in (6.15).

#### 6.3.1 Languages with vowel reduction

Out of the 100 languages in the sample, 73 were found to have vowel reduction processes as defined in §6.2.1. Table 6.1 shows the distribution of languages in the sample with respect to syllable structure complexity and the presence or absence of vowel reduction processes.

	Syllable Structure Complexity				
N languages with:	SimpleModerately ComplexC(N = 22 lgs)(N = 27 lgs)(N		Complex (N = 27 lgs)	Highly Complex (N = 24 lgs)	
Vowel reduction	13	19	20	21	
No vowel reduction	9	8	7	3	

**Table 6.1.** Languages of the sample distributed according to syllable structure complexity and presence or absence of vowel reduction processes, as reported in sources.

In all four categories of syllable structure complexity, languages are more likely than not to have reported vowel reduction processes. As syllable structure complexity increases, so does the proportion of languages showing vowel reduction. Comparing the analysis here with the one given for unstressed vowel reduction in §5.4.3, we find a departure from the previous patterns. In that study, it was found that the percentage of languages with unstressed vowel reduction peaked in the Moderately Complex category and could be found in similarly high percentages of languages in the Complex and Highly Complex categories, setting these three categories apart from the Simple category but not each other. Here we find that when additional conditioning environments are considered, languages in the Highly Complex category are more likely (88%) than languages in the Complex and Moderately Complex (74% and 70%, respectively) to have reported vowel reduction patterns. Thus in this initial analysis of the presence of vowel reduction in languages of the sample, we find support for the hypothesis that languages with more complex syllable structure will show stronger effects of vowel reduction.

## 6.3.2 Number of distinct vowel reduction processes present

Here I analyze the number of distinct vowel reduction processes present in the languages of the sample. Below I present the median and range in number of vowel reduction processes within each category of syllable structure complexity. These results can be found in Table 6.2.

	Syllable Structure Complexity			
N distinct vowel reduction processes:	Simple (N = 22 lgs)	Moderately Complex (N = 27 lgs)	Complex (N = 27 lgs)	Highly Complex (N = 24 lgs)
Median	1	1.5	1	2
Range	0-3	0-5	0-7	0-6

**Table 6.2.** Languages of sample distributed according to syllable structure complexity and median and range in number of distinct vowel reduction processes, as reported in sources consulted.

The trends in Table 6.2 indicate that languages with differing syllable structure complexity also differ with respect to the number of distinct vowel reduction processes occurring. Though the trend in the median number of vowel reduction processes is not particularly informative, the languages in the Simple category have the narrowest range in number of processes, while languages in the other categories have broader ranges. Figure 6.1 shows the percentage of languages in each category which have zero, one, two, and three or more distinct vowel reduction processes.



**Figure 6.1.** Percentage of languages in each syllable structure complexity group with given number of distinct vowel reduction processes.

Roughly speaking, as syllable structure complexity increases, so does the likelihood that a language has more than one vowel reduction process operating in its phonological system. In fact, languages at the far end of the syllable structure complexity scale, those in the Highly Complex category, are much more likely to have two or more vowel reduction processes (75%) than to have one or none (25%).

The analysis in the previous section revealed that the proportion of languages having any vowel reduction processes increases as syllable structure complexity increases. The results presented here point to a greater prevalence of vowel reduction in languages with more complex syllable structure, in that larger numbers of distinct processes tend to be present in these languages. This lends further support to the hypothesis being tested in this study. The data can also be interpreted as pointing to greater variability in vowel reduction patterns in languages with more complex syllable structure. Recalling the criteria presented in §6.2.3 for determining what constitutes a distinct process, the trends here reflect a higher degree of variation in affected vowels, conditioning environments, outcomes, and regularity of vowel reduction patterns in languages with more complex syllable structure.

In Table 6.3, the 169 vowel reduction processes collected from the language sample are distributed according to the syllable structure complexity of the languages in which they occur. In the following sections, trends in the affected sounds, conditioning environments, and outcomes of these processes will be analyzed.

	Syllable Structure Complexity			
	Simple (N = 22 lgs)	Moderately Complex (N = 27 lgs)	Complex (N = 27 lgs)	Highly Complex (N = 24 lgs)
N reported vowel reduction processes:	18	46	49	56

**Table 6.3.** Distinct vowel reduction processes in sample, distributed according to the syllable structure complexity of the languages in which they occur.

#### **6.3.3 Affected vowels**

As described in §6.2.3, the vowels affected by each vowel reduction process in the data were coded according to their phonetic descriptions in the references consulted, and where appropriate, according to their natural class with respect to the composition of the language's vowel inventory. In Table 6.4, the vowel reduction processes in the data are distributed according to the vowels or groups of vowels affected.

	Syllable Structure Complexity			
Affected vowels	Simple (18 processes)	Moderately Complex (46 processes)	Complex (49 processes)	Highly Complex (56 processes)
all vowels	11	10	17	22
high vowels	4	16	11	5
low vowel /a/ or /a/		6	4	2
mid central vowel /ə/				11
short vowels		4	5	3
long vowels	3	5	5	5
other		5	7	8

**Table 6.4.** Vowel reduction processes in sample, distributed according to affected vowels and syllable structure complexity of languages in which they occur.

The categories of affected vowels listed in Table 6.4 capture the clearest patterns in the data set as a whole. For the sake of simplicity, the category of *high vowels* includes processes which affect all or some high vowels in the language, along with processes targeting just one high vowel, such as /i/ or /u/. The *other* category is fairly heterogeneous, and includes processes affecting groups such as non-high vowels, front and high vowels, high and mid vowels, /e/, and so on.

For languages in all four categories of syllable structure complexity, vowel reduction processes affecting *all vowels* are frequent; in fact, this is the dominant trend for every category except for Moderately Complex. What is more interesting about the data presented in Table 6.4 are the secondary and outlier trends with respect to affected vowels and syllable structure complexity. *High vowels* are much less likely to be affected by vowel reduction processes in languages with Highly Complex syllable structure as

compared to languages in the other syllable structure complexity categories (this pattern is statistically significant, p = .005 in Fisher's exact test).<sup>33</sup> Vowel reduction processes in languages with Simple syllable structure do not target *short vowels* in those languages which have vowel length distinctions, but they do target *long vowels*. This is an unusual trend compared to the patterns in the languages with more complex syllable structure, though it could also be a random effect due to the small number of vowel reduction processes in the Simple category. Finally, perhaps the most interesting feature of the data presented above is that reduction processes in which *schwa* is the sole affected vowel occur only in languages of the Highly Complex category. Even more strikingly, this is the second most frequent trend for vowel reduction processes in that group of languages.

It is important to always bear in mind that any reported phonemic inventory is a product of an author's analysis. The symbol [ə] is conventionally used as cover symbol for any neutral vowel in the mid central region of the vowel chart (Laver 1994: 280), and phonetic descriptions of such neutral vowels are often impressionistic and unaccompanied by instrumental data in reference materials. To complicate matters, a common outcome of vowel reduction is a vowel produced somewhere in the mid central region. Thus, proving that /ə/ is indeed a contrastive sound, and not a reduced variant of another vowel, is not always a straightforward process in a phonemic analysis of a language. With these caveats in mind, we consider the distribution of languages in the sample which are demonstrated through the analysis of minimal pairs, stress patterns, or other methods to have contrastive /ə/ in their vowel phoneme inventories, with respect to

<sup>&</sup>lt;sup>33</sup> The Lezgian processes used to illustrate vowel reduction processes in §6.1 are in fact some of the very few processes targeting high vowels in the Highly Complex category.

the presence or absence of vowel reduction processes affecting /ə/ specifically (Table

6.5).

	Syllable Structure Complexity			
V reduction processes affecting /ə/	Simple (N = 3 lgs)	Moderately Complex (N = 7 lgs)	Complex (N = 6 lgs)	Highly Complex (N = 8 lgs)
Present				6
Absent	3	7	6	2

**Table 6.5**. Languages in sample reported to have phonemic /ə/, distributed according to syllable structure complexity and presence or absence of vowel reduction processes affecting /ə/ specifically. The trend in Highly Complex languages is highly significant when compared against the combined trend in the Simple, Moderately Complex, and Complex languages (p < .001 in Fisher's exact test).

Contrastive /ə/ is reported in the vowel phoneme inventories of 24 languages in the sample. It occurs in segmental inventories of languages from all four categories of syllable structure complexity, though it is somewhat less frequent in languages with Simple syllable structure. The 11 vowel reduction processes affecting /ə/, as shown in Table 6.4 above, occur in six diverse languages of the Highly Complex sample: Alamblak (*Sepik*), Albanian (*Indo-European*), Itelmen (*Chukotko-Kamchatkan*), Kabardian (*Northwest Caucasian*), Passamaquoddy-Maliseet (*Algic*), and Thompson (*Salishan*). This trend, in which vowel reduction processes affect /ə/ only in languages with Highly Complex syllable structure, is highly statistically significant (p < .001).

The implications of the results reported for affected vowels will be further discussed in §6.4. In the next section, the environments conditioning vowel reduction processes in the sample are analyzed.

# **6.3.4** Conditioning environments

As described in §6.2.3, the conditioning environment of each vowel reduction process in the language sample was coded to reflect whether the consonantal environment, position in the word, position with respect to word stress, and/or position in the phrase/utterance contributed to the occurrence of the process. The results of this analysis can be found in Table 6.6.

	Syllable Structure Complexity				
<b>Conditioning</b> environments	Simple (18 processes)	Moderately Complex (46 processes)	Complex (49 processes)	Highly Complex (56 processes)	Totals
Single environment		1			5
Consonantal	2	5	7	10	24
Word stress	3	5	11	13	32
Word position	2	5	2	1	10
Phrase/utterance	1	5	2	1	9
Unclear	—	1		4	5
Combination of environments					
Word stress and consonantal	1	3	8	12	24
<i>Word stress</i> and word position	3	10	6	8	27
Word stress and phrase/utter. position	1	3	4	3	11
Consonantal and word position and word stress		5	7	2	14
Other combinations	5	4	2	2	13

Table 6.6. Conditioning environments of vowel reduction processes in sample.

75 of the vowel reduction processes in the language sample are reported to be conditioned by a single aspect of the environment as defined above. For five processes, not enough information about the process was given to categorize the conditioning environment. The remaining 89 processes are conditioned by a combination of environments, typically *word stress* in addition to something else. The most common conditioning environments are *word stress* alone (32 processes) and the *word stress* environment in combination with *word position* (27 processes).

The main patterns in Table 6.6 are summarized in Figure 6.2, which depicts the overall effect of each of the four environments in conditioning vowel reduction processes in languages with different syllable structure complexity. Here the environments are counted regardless of whether they occur alone or in combination with others in conditioning a process.





The trends in Figure 6.2 show *word stress* and *consonantal* environments conditioning a higher percentage of vowel reduction processes as syllable structure
complexity increases. *Word position* and *phrase/utterance position* show the opposite effect: these environments condition a higher percentage of processes as syllable structure complexity decreases. Chi-squared tests show that of these four trends, only the *word position* trend is significant at the level of p < .05 ( $\chi^2(3, N = 169) = 11.248, p = .01$ ). Another notable aspect of the distributions is that in the Simple category, there are no strong tendencies in the conditioning environments for vowel reduction: all four environments examined here condition roughly similar percentages of processes.

Recall from the analyses in §5.4.1 that roughly one-fifth of the languages in the sample are not reported to have word stress. In Figure 6.3 I only include vowel reduction processes from the 81 languages reported to have word stress. The trend shows the percentage of those processes which are conditioned by the stress environment in each category of syllable structure complexity.





The trend in word stress-conditioned vowel reduction in Figure 6.3 is similar to the one in Figure 6.2 in that it shows the percentage of such processes rising with syllable

structure complexity, but here the most marked rise is between the Simple and Moderately Complex categories. In §5.4.3 it was found that vowel reduction as a segmental effect of stress occurred in a much smaller percentage of languages from the Simple category than languages from the other three categories: only 33% of the languages with word stress in the Simple category had unstressed vowel reduction. Here we find a similar pattern: though 50% of the vowel reduction processes in the Simple category are conditioned by stress, this category is still set apart in that it shows a lower percentage of stress-conditioned vowel reduction processes than the other categories. Cross-tabulating the pattern in the Simple category against the pattern of the other three categories combined yields a significant result (p = .05 in Fisher's exact test). This indicates that not only does stress condition vowel reduction in more languages with non-Simple syllable structure, but it also conditions more processes overall in those languages. This is confirmed when examining the ratio of the number of stressconditioned vowel reduction processes to the number of languages with stressconditioned vowel reduction in each category (Table 6.7).

	Syllable Structure Complexity				
	Simple	Moderately Complex	Complex	Highly Complex	
N V reduction processes conditioned by stress	8	27	36	40	
N lgs. with V reduction conditioned by stress	6	14	15	14	
ratio	1.3	1.9	2.4	2.9	

**Table 6.7.** Ratio of number of stress-conditioned vowel reduction processes to the number of languages with unstressed vowel reduction in each category of syllable structure complexity.

The pattern in Table 6.7 indicates that in languages with word stress-conditioned vowel reduction, the average number of processes conditioned by word stress, either solely or in addition to other phonological factors, gradually increases with syllable structure complexity.

The implications of the results reported for conditioning environments will be further discussed in §6.4. In the next section, the outcomes of vowel reduction processes in the sample are analyzed.

### 6.3.5 Outcomes

Here we examine the reported outcomes of vowel reduction processes in the data. These were reduction in vowel duration, reduction in vowel quality, devoicing, deletion, and a few other effects. The other effects included cases where the vowel forms a syllabic consonant with an adjacent consonant, and two much rarer outcomes, tone leveling and glottalization of the vowel. As with the conditioning environments, sometimes a process involved a combination of outcomes. As described in §6.2.3, processes reported to

involve the optional reduction or deletion of a vowel or group of vowels in some specific environment were coded as having several outcomes (deletion and whatever other reduction was specified by the author). See Table 6.8 for the distribution of processes according to outcome and syllable structure complexity in the data.

	Syllable Structure Complexity				
Outcome of vowel reduction processes	Simple (18 processes)	Moderately Complex (46 processes)	Complex (49 processes)	Highly Complex (56 processes)	Totals
Single outcome from process					
Reduction in duration	2	4	9	9	24
Reduction in quality	1	17	19	20	57
Devoicing	7	4	5	4	20
Syllabic consonant	1	2	1	2	6
Tone leveling or loss			2		2
Glottalization of vowel	1	1			2
Deletion	2	15	9	14	40
Unspecified reduction	1			1	2
Several outcomes from process					
Reduction or deletion	3	1	3	6	13
Other combinations		2	1		3

Table 6.8. Outcomes of vowel reduction processes in sample.

The most common outcomes for vowel reduction in the data are *reduction in quality* (57 processes) and *deletion* (40 processes). Processes involving a combination of outcomes are rare, and most of these are of the kind in which a vowel is optionally reduced or deleted. The major patterns in Table 6.8 are shown in Figure 6.4. Here the outcomes are counted regardless of whether they occur alone or in combination with others.



**Figure 6.4.** Relative frequency of different outcomes of vowel reduction processes (expressed as percentage of total processes in each category of syllable structure complexity). Here outcomes are counted regardless of whether they occur alone or in combination with other outcomes.

For outcomes of vowel reduction processes, it is again the languages with Simple syllable structure which differ significantly in their behavior from the other languages in the sample. Languages with Simple syllable structure are significantly less likely than languages with more complex syllable structure to have processes resulting in a *reduction in quality* (p = .02 in Fisher's exact test), and significantly more likely to have processes resulting in *devoicing* (p = .002 in Fisher's exact test).

Another interesting pattern in the data is the general predominance of vowel deletion. This is the second most common outcome of vowel reduction in all four categories of syllable structure complexity. As discussed in §6.1, vowel deletion is one of the known diachronic sources of the tautosyllabic consonant clusters which are a defining

feature of syllable complexity. Indeed, the hypothesis tested here predicts not only a greater prevalence of vowel reduction in languages with more complex syllable structure, but also a greater prevalence of extreme outcomes of vowel reduction, including vowel deletion.

Recall from the analyses in §5.4.3.1 that vowel deletion was a much more common outcome of unstressed vowel reduction in languages of the Moderately Complex, Complex, or Highly Complex groups than in languages of the Simple group. When all kinds of vowel reduction (i.e., not just stress-conditioned) are considered, we find that there is not a clear trend with respect to vowel deletion and syllable structure complexity. Table 6.8 and Figure 6.4 do not show an increasing frequency of vowel deletion with syllable structure complexity, as predicted by the hypothesis. However, these analyses do not consider the specific effects of vowel deletion, which can vary dramatically in the structures they produce (6.16)-(6.17):

## (6.16) **Fur** (*Fur*; Sudan)

In 3-syllable words with the structure  $(C_1)V_1C_2V_2C_3V_3$ , where  $C_2$  is /l/ or /c/,  $C_3$  is /l/, /c/, or a nasal /m n p ŋ/, and  $V_1$  and  $V_2$  are identical,  $V_2$  may optionally be deleted.

- (a) /tirima/
  - [tirima] ~ [tirma]

'sprouted grain'

(b) /kurso/

'heap of millet ears'

(c) /jawil/

'sky'

(Jakobi 1990: 27, 29, 60-61; tone left unmarked)

(6.17) Albanian (*Indo-European*; Albania, Serbia and Montenegro)

In rapid speech, mid central vowel /ə/ is optionally deleted when occurring between two consonants, of which  $C_1$  is not /s z ʒ/.

(a) /dəlirə/

[dlirə]

'pure'

(b) /məsuesja/

[msuesja]

'the teacher'

(Klippenstein 2010: 21-22, 27)

In Fur (6.16a), the optional vowel deletion results in simple codas of the form /l/ or /c/, both of which are invariable structures attested in the canonical syllable patterns of the language (6.16b-c). That is, no tautosyllabic clusters or non-canonical patterns are formed as a result of this process. By contrast, in the Albanian process, the optional

deletion of /ə/ may result in tautosyllabic clusters which are canonical, e.g. /br/ or /ps/ onsets, or non-canonical, e.g. onsets like /dl/ or /ms/ (6.17a-b).

In Table 6.9, the 40 languages in the sample reported to have processes of vowel reduction resulting in changes to syllable patterns are distributed according to the specific structural outcome(s) of these processes. Most of these are processes of vowel deletion, but I also include processes which result in syllabic consonants.

	Syllable Structure Complexity			
Structure resulting from vowel deletion	Simple (5 languages)	Moderately Complex (13 languages)	Complex (9 languages)	Highly Complex (13 languages)
Canonical simple onset		Alyawarra Carib Cocama Kamasau		
Canonical simple coda		Alyawarra Fur Telugu	Bardi Chipaya Ket Lelepa Pech Mamaindê	Albanian Kabardian Nuu-chah-nulth Tehuelche Thompson
Canonical tautosyllabic cluster		Darai Ngäbere	Ket Lelepa Pech	Albanian Itelmen Lezgian Nuu-chah-nulth Qawasqar Passamaquoddy- Maliseet Tehuelche Thompson Tohono O'odham
Non-canonical simple coda	Nakanai Tukang Besi	Cocama Nkore-Kiga	Lakhota Lunda	Camsá
Non-canonical tautosyllabic cluster	Grebo	Choctaw Karok Khanty		Albanian Nuu-chah-nulth Qawasqar
Syllabic consonant	Nuosu Yi	Alyawarra Kamasau	Mamaindê	Doyayo Kabardian Polish Thompson
Syllable deleted	Cubeo		Sre	Tehuelche
Unclear		Selepet		

**Table 6.9.** Languages in sample with vowel deletion, distributed according to syllable structure complexity and structural outcome of vowel deletion processes. For some languages, vowel deletion results in several different structural outcomes.

In most of the languages (29/40) in Table 6.9, vowel deletion processes result in a

structure which is attested in the canonical syllable pattern of the language, whether it be

a simple onset, simple coda, or tautosyllabic cluster. In 14 languages, vowel deletion results in non-canonical syllable patterns, including otherwise unattested simple codas and tautosyllabic clusters. In seven languages, vowel reduction results in a syllabic consonant. In three languages vowel reduction is part of a wider-reaching process which deletes an entire syllable, and in one language (Selepet) the structural effect is unclear from the description.

Arguably, the most extreme effect of vowel deletion is to create non-canonical tautosyllabic clusters. Because there were so few instances of this in the data, it is difficult to draw any conclusions from the distribution of these patterns with respect to syllable structure complexity. The number of languages with vowel deletion producing non-canonical syllable patterns in general (either codas or tautosyllabic clusters) does not increase with syllable structure complexity; if anything, such processes are more strongly associated with languages in the Simple and Moderately Complex categories. However, a notable pattern in Table 6.9 is the relatively higher number of languages in the Highly Complex category for which vowel deletion results in tautosyllabic clusters, either canonical or non-canonical. In the Highly Complex category, 9/13 languages have this outcome from vowel deletion, as compared to 9/27 of the languages from the other three categories combined. Though this trend is not statistically significant, it is striking in that tautosyllabic clusters come about though vowel deletion more often in languages which already have large tautosyllabic clusters. In this respect, there is some support here for the hypothesis that final outcomes of vowel reduction processes are more extreme in languages with more complex syllable structure.

Additionally, as previously discussed in §3.3.5, there is a trend by which the number of languages with vowel reduction processes resulting in syllabic consonants increases with syllable structure complexity. This trend is minor at best, being based on the patterns of just seven languages. However, taken at face value it also lends some support to the hypothesis tested here: vowel reduction resulting in syllabic consonants may alter the syllable patterns of languages in more extreme ways than, say, vowel deletion resulting in canonical simple codas.

### 6.3.6 Holistic analysis of vowel reduction processes

The quantitative analyses presented in §6.3.3-5 do not necessarily inform a holistic understanding of the vowel reduction processes in the sample, since they treat the affected vowels, conditioning environments, and outcomes separately. Here I present a summary of vowel reduction to complement the analyses presented above. I characterize in general terms the most characteristic kinds of vowel reduction processes which occur in each group of languages in the sample, as defined by syllable structure complexity in (6.18)-(6.21). This breakdown allows us to examine how the different affected vowels, conditioning environments, and outcomes tend to cluster together into coherent processes in the sample. The number of processes which fit the general description is given in parentheses. For each syllable structure category I give one or two prototypical examples of vowel reduction.

## (6.18) Summary of vowel reduction processes in Simple category (N = 18)

- Vowels devoiced at word or phrase/utterance margins (6)
- Long vowels shortened/glottalized in various environments (3)
- Word- or phrase/utterance-final vowels deleted (2)
- Vowels devoiced in other environments (2)
- Other (5)
- (a) **Apurinã** (*Arawakan*; Brazil)

Vowels become devoiced in unstressed word-final position, especially in fast speech.

/tõːˈgat͡ʃi/

[tõːˈgat͡ʃi̯]

'cough'

(Facundes 2000: 60-1)

## (6.19) Summary of vowel reduction processes in Moderately Complex category

(N = 46)

- Vowels, often high or short, deleted in unstressed syllables (13)
- High vowels reduced in quality when unstressed and/or at word or phrase/ utterance margins (8)
- Vowels deleted or devoiced in specific consonantal environments (7)
- Low central vowel /a/ reduced in quality when unstressed and/or at word or phrase/utterance margins *(6)*

- Long vowels shortened/glottalized in various environments (5)
- Other (7)
- (a) **Khanty** (*Uralic*; Russia)

Vowels in word-final syllables are under-articulated, reduced, devoiced, or deleted.

/kəswəytəyəsət/

[kəswəytəyəst]

'run-ITER-PST.3-3.PL'

(Filchenko 2007: 56)

## (b) **Mangghuer** (*Mongolic*; China)

High vowels /i u/ realized as lax in unstressed syllables.

/tçawtun'tu/

[fcawton'tu]

'dream (DAT)'

(Slater 2003:35)

# (6.20) Summary of vowel reduction processes in Complex category (N = 49)

- Vowels reduced in quality in unstressed syllables (19)
- Unstressed vowels deleted, often in specific consonantal environments (9)
- Long vowels shortened in various environments (5)

- Devoicing of vowels in environment of voiceless consonants and/or unstressed domain-final environments *(5)*
- All vowels shortened in specific unstressed contexts (3)
- Other (8)
- (a) **Ungarinjin** (*Worrorran*; Australia)

Low central vowel /a/ is realized as [ə] when unstressed.

/'bara\_bara/

['barə<sub>barə</sub>]

'story'

(Rumsey 1978: 17-18)

### (b) **Pech** (*Chibchan*; Honduras)

Unstressed vowels are usually deleted between any consonant and a following /r/. /'kúhparằ/

[ˈkúhprầ̀]

'you and I having bought it'

(Holt 1999: 23)

## (6.21) Summary of vowel reduction processes in Highly Complex category (N = 56)

- Vowels reduced in quality in unstressed syllables (16)
- Unstressed /ə/ deleted, often in specific consonantal environments (9)
- Unstressed vowels deleted, often in specific consonantal environments (7)

- Long vowels shortened in various environments (5)
- Unstressed vowels devoiced in specific consonantal and word or phrase/ utterance environments (4)
- All vowels shortened in specific consonantal environments (3)
- Other (12)

## (a) **Thompson** (*Salishan*; Canada)

High vowels /i u/ are nearly always realized as [ə] when preceding the main

stress, except for when /u/ occurs between two velar consonants.

 $/sq'^wu'te^xw/$ 

[sq'<sup>w</sup>ə<sup>'</sup>tełx<sup>w</sup>]

'(other) side of the house'

(Thompson & Thompson 1992: 32)

## (b) **Kabardian** (*Northwest Caucasian*; Russia, Turkey)

Unstressed /ə/ preceding a stressed syllable is often deleted, so long as it does not produce an initial consonant cluster.

/bəsə'məf'/

[bəsˈməf']

'good host'

(Gordon & Applebaum 2010: 42)

The characteristic patterns of vowel reduction vary widely in the different syllable structure complexity categories. There are two general patterns which occur in all groups of languages: shortening of long vowels in various environments, and vowel devoicing in specific consonantal or domain environments.

Some processes are unique to languages in a particular category of syllable structure complexity: for instance, unstressed /ə/ deletion occurs only in languages with Highly Complex syllable structure. Other general processes may occur with different specifications in languages with different syllable structure complexity. For example, unstressed vowel deletion primarily affects high and short vowels in languages with Moderately Complex syllable structure. In languages with Complex or Highly Complex syllable structure, unstressed vowel deletion tends to affect all unstressed vowels, but is also typically conditioned by the consonantal environment.

This treatment of vowel reduction processes in the data upholds several of the trends uncovered by the various quantitative analyses. For instance, the stronger effect of word and phrase/utterance positions in languages with simpler syllable structure is reflected here by general vowel reduction tendencies in the Simple and Moderately Complex categories. Several vowel reduction patterns in these groups are conditioned by the margins of word and phrase/utterance domains. Similarly, the word stress environment is prominent in conditioning many of the vowel reduction patterns in languages with Moderately Complex, Complex, and Highly Complex syllable structure, and we also see that a very common outcome of such processes is reduction in vowel quality.

### 6.3.7 Summary of vowel reduction patterns

In §6.1 I formulated a hypothesis based on observations of recent and ongoing processes of vowel reduction causing changes to syllable structure patterns in some languages. The hypothesis predicted that languages with more complex syllable structure would show stronger effects of vowel reduction. Specifically, it was predicted that as syllable structure complexity increased, vowel reduction processes would be both more prevalent and have more extreme outcomes. These predictions were largely upheld by the analyses above. The analyses in §6.3.1-2 showed that both the percentage of languages with vowel reduction processes and the number of vowel reduction processes per language increases with syllable structure complexity. While the analysis of outcomes of vowel reduction in §6.3.5 did not show a steady increase in vowel deletion outcomes across the four categories of syllable structure complexity, it showed support for the hypothesis in another way. Vowel deletion processes resulting in tautosyllabic clusters were found to occur in a higher percentage of languages from the Highly Complex category than from the other categories, and this was by far the most common outcome of vowel deletion in this group of languages.

The specific properties of vowel reduction found to have positive or negative trends with respect to syllable structure complexity are listed in Table 6.10. An asterisk (\*) and italicized font indicate that the trend is based on a small data set (fewer than ten languages).

Type of property	<b>Positive trends</b> (increases with syllable structure complexity)	<b>Negative trends</b> (decreases with syllable structure complexity)
Vowel reduction	Presence of processes Number of distinct processes	
Affected vowels	Short vowels /ə/ (*)	High vowels
Conditioning environments	Word stress position Number of distinct processes conditioned by stress	Word position <i>Phrase/utterance position (*)</i>
Outcomes	Reduction in quality Deletion resulting in tautosyllabic clusters	Devoicing

**Table 6.10.** Properties of vowel reduction associated positively or negatively with syllable structure complexity.

As with findings in previous chapters, some of the patterns shown in Table 6.10 do not show a gradual trend with respect to syllable structure complexity. Some trends, such as an increasing percentage of processes targeting schwa and decreasing number of processes targeting high vowels, are associated with the Highly Complex category specifically and serve to set this category apart from the other three. Both of these trends are statistically significant. Similarly, the Simple category is set apart from the other three in that it is characterized by higher rates of devoicing and lower rates of reduction in quality (both statistically significant trends), as well as having no vowel reduction processes affecting short vowels. The only trend that is gradual with respect to syllable structure complexity and also statistically significant is that by which word position conditions fewer processes as syllable complexity increases. In the next section I discuss the implications of these results for our understanding of highly complex syllable structure as a language type and for the development of syllable structure complexity more generally.

#### 6.4 Discussion

#### 6.4.1 Vowel reduction patterns and highly complex syllable structure

Here I discuss the implications of the study of vowel reduction for the central research questions of the dissertation. The first question is reproduced below.

(6.22) Do languages with highly complex syllable structure share other phonetic and phonological characteristics such that this group can be classified as a linguistic type?

The study of vowel reduction presented here adds several new findings in answer to (6.22). The properties of phonetically and phonologically conditioned vowel reduction which are more strongly associated with the Highly Complex category than the others are listed in (6.23).

#### (6.23) Properties of vowel reduction associated with Highly Complex category

Presence of vowel reduction processes Presence of two or more vowel reduction processes Presence of higher numbers of stress-conditioned vowel reduction processes Absence of vowel reduction processes affecting high vowels Presence of vowel reduction processes affecting /ə/ Absence of processes conditioned by word/phrase/utterance position Presence of vowel deletion resulting in tautosyllabic clusters

As mentioned in previous chapters, the terms 'absence' and 'presence' are used here not in a categorical sense. Instead these are meant to correspond to the relative absence or presence of a property in the Highly Complex group as compared to the other syllable structure complexity groups. The pattern by which /ə/ is specifically targeted for reduction is categorical, in that it does not occur in the other categories.

As with the previous studies in this dissertation, the results of the analyses here also point to characteristics which set apart the languages of the Highly Complex, Complex, and Moderately Complex categories from those of the Simple category. I list those in (6.24).

### (6.24) Properties of vowel reduction associated with non-Simple syllable structure

Presence of processes affecting short vowels Presence of processes conditioned by word stress Presence of processes of quality reduction Absence of processes of devoicing In previous chapters I showed how the segmental and suprasegmental patterns associated with the Highly Complex group were distributed among the languages in that group. The resulting distribution showed that languages in which Highly Complex syllable patterns are more prominent also had more of those associated patterns. In Table 6.11 I show a similar breakdown for how the vowel reduction patterns most strongly associated with the Highly Complex portion of the sample are distributed among those languages. The languages are again divided into three groups according to the prominence of their Highly Complex syllable patterns, as established in §3.4.1-2. The vowel reduction properties associated with Highly Complex syllable structure and listed in (6.23) above are given in the columns. A check mark indicates that a language has the expected property; a shaded cell indicates that it does not.

	V reduction <b>present</b>	≥ 2 V reduction processes <b>present</b>	≥ 2 Stress- conditioned vowel reduction processes <b>present</b>	V reduction affecting only high vowels <b>absent</b>	V reduction affecting /ə/ present	Processes conditioned by word/ phrase/utter. position <b>absent</b>	Vowel deletion resulting in tautosyllabic clusters <b>present</b>
		Lar	guages with p	revalent High	ly Complex	patterns	
Cocopa	√	√	$\checkmark$	√		√	
Georgian				√		√	
Itelmen	√	√		√	√	√	√
Polish	√	√		$\checkmark$		$\checkmark$	
Tashlhiyt	√			V		$\checkmark$	
Thompson	√	$\checkmark$	$\checkmark$		V	$\checkmark$	
Tohono O'odham	√	√	√	√			√
Yakima Sahaptin	√	√		√		√	
	Languages with intermediate Highly Complex patterns						
Albanian	√	√	√	√	√		√
Camsá	√	√	√	√			
Kabardian	1	√	√	√	V		
Lezgian	√	√	√			√	$\checkmark$
Mohawk	√			√			
Nuu-chah-nulth	√	√	√	√			√
PassMaliseet	1	√	√	√	√	√	$\checkmark$
Piro	√	√	√	√			
Qawasqar	√	√		√			√
Semai	1			√		√	
Tehuelche	√	√	√	√		√	√
	Languages with minor Highly Complex patterns						
Alamblak	√	1	$\checkmark$		$\checkmark$	$\checkmark$	
Doyayo	√	√		√		√	
Kunjen	√	√					
Menya				√		√	
Wutung				√		√	

**Table 6.11.** Highly Complex languages, divided into three groups according to the prominence of their Highly Complex patterns. Expected properties are given in columns. A check mark indicates that the given language has the expected property; a shaded cell indicates it does not.

As in the similar analyses in §4.5 and §5.5, we find that languages which have Highly Complex syllable structure as a prevalent pattern tend to have more of the vowel reduction properties associated with this category: 34/56 (61%) of the cells in that group are checked, as compared to 15/35 (43%) of those for languages which have Highly Complex syllable structure as a minor pattern. Here again the 'intermediate' languages pattern more like the prevalent group (50/77, or 65% of the cells show the expected pattern). Like the similar patterns reported for segmental and suprasegmental features, these results lend support to the idea that highly complex syllable structure is a linguistic type which can be defined by a coherent set of prototypical features, in this case, certain types of dynamic vowel reduction patterns.

The larger amount of gray space in Table 6.11 as compared to the similar breakdowns of segmental and suprasegmental patterns in §4.5 and §5.5 indicates that the properties of vowel reduction are generally less consistent correlates of highly complex syllable structure than segmental and suprasegmental properties. This brings us to the second research question of the dissertation:

#### (6.25) How does highly complex syllable structure develop over time?

There are several results from the current study of vowel reduction which may prove relevant in addressing the diachronic development of highly complex syllable structure. The hypotheses were motivated by the observation that vowel reduction, specifically in the form of vowel deletion, is a documented source of tautosyllabic consonant clusters. It should therefore be an important contributing factor to the development of the long consonant clusters characteristic of languages with highly complex syllable structure. If increasing syllable structure complexity represents a diachronic cline, then an increase in syllable structure complexity would at some point entail the gradual emergence of previously unattested (non-canonical) tautosyllabic clusters. In the data examined here, evidence of such a scenario is extremely rare as a result of synchronic vowel reduction processes which are notable enough to be reported as productive patterns by authors of language references. Vowel deletion produces new (non-canonical) tautosyllabic clusters in only six languages of the sample: one language with Simple syllable structure (Grebo), two languages with Moderately Complex syllable structure (Choctaw and Karok) and three with Highly Complex syllable structure (Albanian, Nuu-chah-nulth, and Qawasqar). Of these, detailed distributional and phonetic data on the resulting clusters is available only for Albanian. In that language, at least, vowel deletion resulting in tautosyllabic clusters is shown to be quite prevalent, producing dozens of distinct canonical and non-canonical onset sequences (Klippenstein 2010; orthographic evidence indicates that non-canonical onset sequences are recent). Nevertheless, the current data set is too small from which to draw strong conclusions regarding general observable patterns of syllable structure emergence (but see further discussion of this point in Chapter 8). This is an area in which more comprehensive phonetic, distributional, and frequency data for the languages of the sample would prove extremely informative.

What we do find in the vowel reduction data is evidence of persistent articulatory routines. While vowel deletion is an important process in all syllable structure complexity groups, we find that it is more likely to produce tautosyllabic clusters, either canonical or non-canonical, in the Highly Complex group. That is, *vowel deletion is more likely to* create clusters in languages which already have a prevalence of consonant clusters. This is in line with the reported findings for Lezgian, in which the process of pretonic high vowel deletion continues to persist in the language even after it has altered the syllable structure patterns of the language (Chitoran & Babaliyeva 2007). This observation is not surprising from a usage-based perspective, in which phonological structure is sensitive to cognitive factors such as frequency effects and analogy (Bybee 2001); that is, a high frequency of complex syllable patterns in a language could facilitate the maintenance of novel complex syllable patterns which come about through vowel deletion. It also suggests long-term stability in highly complex syllable structure, a view which is not necessarily afforded by abstract theoretical treatments seeking to account for its problematic nature (Bagemihl 1991, Rowicka 1999).

Several other findings in the data tentatively suggest paths of development for highly complex syllable structure. Vowel deletion targeting /ə/ is present only in languages of the Highly Complex portion of the sample. Disregarding the many issues of a phonemic analysis designating /ə/ as contrastive, this pattern may point to another persistent articulatory routine. Mid central vowel [ə], or something very much like it, is a common outcome of vowel reduction processes: while the precise outcome of quality reduction isn't always specified by authors, [ə] was reported to be the specific outcome in

16 of the 63 processes involving quality reduction analyzed here. Similarly, contrastive / a/ is known to derive historically from reduced vowels in some cases. This seems to be transparently the case for several languages in the sample (e.g., Pacoh, Alves 2000). The presence of /a/ deletion exclusively in languages of the Highly Complex category could point to a cline in which (1) vowel reduction processes initially affect vowel quality, (2) the reduced vowel quality becomes phonologized, and (3) the reductive tendencies in the language continue to affect the sound that has already been reduced, eventually leading to its deletion.<sup>34</sup> Such a hypothetical path of reduction may then be responsible for the pattern by which high vowels are commonly affected by vowel reduction in the Simple, Moderately Complex, and Complex categories but not the Highly Complex category: processes may have by that stage already affected the quality of high vowels in environments of reduction. Although only speculation here, these possibilities will be explored in greater detail in Chapter 8.

### 6.4.2 Implications for development of syllable structure complexity

We now turn to a discussion of how the results of the study might have implications for the development of syllable structure complexity more generally. A concrete finding from the current study which may bear on the development of different syllable structure types pertains to common conditioning environments for vowel reduction. Word position and phrase/utterance position are highly relevant conditioning environments in languages with simpler syllable structures, while word stress is the

<sup>&</sup>lt;sup>34</sup> Indeed, this does seem to be the process occurring in American English with respect to /ə/ deletion.

strongest conditioning environment in languages with more complex syllable structure. However, an additional important observation is that a robust minority of vowel reduction processes in the sample are not conditioned by stress at all: these include 48 vowel reduction processes (28% of the total) in 41 languages from all syllable structure complexity categories. Furthermore, the outcomes of such processes may have an effect on syllable structure: four result in syllabic consonants and 13 result in vowel deletion. In one such process in Itelmen, vowel reduction or deletion may occur in both stressed and unstressed syllables. In (6.26), this process is shown occurring in a stressed syllable and resulting in a canonical tautosyllabic onset cluster. The language has fixed initial stress, according to Bobaljik (2006: 6).

#### (6.26) **Itelmen** (*Chukotko-Kamchatkan*; Russia)

Mid central vowel /ə/ may be realized as a high back unrounded vowel [uɪ] or drop entirely in some contexts where the consonantal environment has no effect. /'kəmmanəkit/ ['kəmmanəkit] ~ ['kuımmanəkıt] ~ ['kmanəkıt]

'I-CAUS'

(Georg & Volodin 1999: 13)

There are also 11 languages in the sample (again from all syllable complexity categories) which have word stress and vowel reduction processes, but no vowel reduction processes conditioned by word stress. As discussed in §5.5.2, an important consideration in

interpreting findings in the speech rhythm literature is the fact that stress systems and syllable patterns may change independently of one another. The presence of the set of vowel reduction patterns discussed above suggests that non-stress-conditioned vowel reduction is an important, if secondary, source by which syllable patterns may be altered over time.

Though 18/22 languages in the Simple category have word stress, this category is still set apart from the rest in that word stress is much less likely to condition vowel reduction in these languages. As mentioned in Chapter 5, this observation has also been made in the speech rhythm literature: syllable-timed languages do not necessarily lack stress, but stress does not have strong effects in those languages (Auer 1993). In the current study it was additionally found that the number of distinct processes conditioned by word stress within languages with word stress increases with syllable structure complexity. This finding clarifies one of the more puzzling results from Chapter 5, where it was found that the overall percentage of languages with stress-conditioned vowel reduction did not increase across the Moderately Complex, Complex, and Highly Complex categories. In light of the results in this chapter, we can say that while the number of languages with unstressed vowel reduction does not increase across these categories, the effects of stress within those languages does increase. In that sense, at least, there is now stronger evidence for the hypothesis in Chapter 5 regarding the segmental effects of stress, which did not have much support in the analyses in that chapter: stress conditions a higher number of distinct vowel reduction patterns as syllable structure increases.

This raises the question of how word stress, specifically, and vowel reduction, more generally, differs in languages with Simple syllable structure. With respect to word stress, recall from Chapter 5 that besides segmental effects, there were few properties of stress which set the Simple category apart from the others. Languages in that category were more likely than the others to have pitch as a phonetic correlate of stress and less likely than the others to have intensity as a correlate. However, it is unclear how either of those properties would correspond to lower rates of unstressed vowel reduction in those languages. Turning to the more general question of how vowel reduction differs in languages with Simple syllable structure, one possibility is the presence and effects of tone. In §5.3 it was found that half of the languages in the Simple category had tonal contrasts, a proportion that was higher than in the other three categories. Tonal contrasts signal changes in lexical or grammatical meaning, and are typically carried by vowels. It is worth investigating whether the presence of tone makes vowel reduction less likely to occur: in such a scenario, the greater functional load carried by vowels in those languages might make them less susceptible to reduction processes. In Table 6.12, the languages of the sample are distributed according to the presence or absence of tone and vowel reduction processes.

	Vowel reduction processes			
Tone	Present	Absent		
Present	24	14		
Absent	49	13		

**Table 6.12.** Languages of sample, distributed according to presence or absence of tone and vowel reduction processes. ( $\chi^2(2, N = 100) = 3.012, p = .08$ )

Though a higher proportion of languages with tone do not have vowel reduction processes (14/38, as compared to 13/62 non-tonal languages), this trend is not statistically significant. A similar analysis of the vowel deletion patterns with respect to the presence or absence of tone also yields a non-significant result. Thus it does not seem likely that the greater presence of tone motivates the lower rates of vowel reduction in the Simple category.<sup>35</sup>

The properties most strongly associated with vowel reduction in the languages of the Simple category are those having to do with outcomes: a higher rate of devoicing outcomes and a lower rate of reduced quality outcomes set this category apart from the others. The devoicing outcome bears a relationship to the conditioning environments associated with vowel reduction in the Simple category. Throughout the four syllable structure complexity categories, devoicing is most often conditioned by the word or phrase/utterance environment (19/30 devoicing processes). The higher rate of devoicing in the Simple category is clearly related to the higher rate of domain-conditioned processes in this category: 6/8 devoicing processes are conditioned by word or phrase/ utterance environments. However, the general motivations behind the higher rate of domain-conditioned processes in the Simple category are not entirely clear.<sup>36</sup> It could be

<sup>&</sup>lt;sup>35</sup> The analysis of tone presented in §5.3 does not consider complexity of tonal systems in number of tone contrasts, nor does it distinguish between 'prototypical' and restricted tonal systems. It is possible that there could be a relationship between the presence of tone and absence of vowel reduction when such patterns are considered.

<sup>&</sup>lt;sup>36</sup> Incidentally, the prominence of vowel devoicing processes in the Simple category is consistent with the findings in §4.3.3 that phonation contrasts in vowels most often occur in these languages (though this observation is tentative, as the previous analysis was based only only six languages).

that in languages in which domains are necessarily vowel-final, as in the Simple category, domain-final devoicing will be more prominent.

Because most of the vowel reduction processes reported in the sources are not accompanied by instrumental data, it is difficult to comment on the relative extremity of different forms of reduction, such as devoicing or reduction in quality, in comparison to vowel deletion. In an Articulatory Phonology model, processes such as vowel reduction come about through an increase in overlap or decrease in magnitude of articulatory gestures (Browman & Goldstein 1992). A similar proposal posits that phoneticallyconditioned sound change originates in temporal or substantive reduction of gestures (Mowrey & Pagliuca 1995). Both models predict that the cline to vowel deletion would necessarily include reduced vowel length, either as a result of overlap of surrounding consonantal gestures into the vowel articulation, or as a temporal reduction of the vocalic gesture itself. The acoustic findings reported by Chitoran & Babaliyeva (2007) for Lezgian support this: they show that the vowel reduction patterns in that language involve devoicing and decreased vowel duration before eventual deletion. They also show evidence for gestural overlap in that vocalic properties are retained as secondary palatalization or labialization on the preceding vowel.

The findings of the current study indicate that decreased vowel duration occurs as an outcome of vowel reduction in a roughly equal proportion of processes in each syllable structure complexity category. However, the qualitative analysis of the process types in §6.3.6 shows that there are important differences between the categories: while shortening of long vowels occurs in all four categories, shortening of all vowels in

specific consonantal or unstressed contexts occurs as a strong pattern only in languages with Complex and Highly Complex syllable structure. Since such processes would have a more detrimental effect on short vowels than long vowels from an articulatory point of view, an argument could be made that these are further examples of relatively extreme vowel reduction in languages with more complex syllable structure.

While there are still unanswered questions regarding particulars of the distribution of vowel reduction properties in the sample, the results of this study show that vowel reduction remains relevant, and indeed becomes even more prevalent, as syllable structure complexity increases. Furthermore, the results indicate that though rates of vowel reduction as an effect of word stress increase with syllable structure complexity, other sources of vowel reduction are relevant in both the language sample as a whole and in the languages of the Highly Complex category. This suggests that vowel reductive tendencies in general increase with syllable structure complexity. This point will be revisited in Chapter 8, after presenting a brief study of consonant allophony in Chapter 7.

#### **CHAPTER 7:**

#### **CONSONANT ALLOPHONY**

#### 7.1 Introduction and hypotheses

In this chapter, I explore ongoing patterns of consonant allophony in the language sample which may shed light on some of the associations between syllable structure complexity and segmental and suprasegmental properties observed in preceding chapters. While the purpose of the study of vowel reduction in Chapter 6 was in part to observe directly the processes which cause syllable patterns to become more complex, the study in this chapter approaches the issue of the development of syllable structure complexity more obliquely.

Recall that in Chapter 4, several segmental correlates of highly complex syllable structure were established. Specifically, palato-alveolar, uvular, ejective, and affricate articulations were found to be most frequent in languages in the Highly Complex category. As discussed in §4.5.4, these articulations are often observed to come about through processes of assimilation (especially consonant-to-vowel) and fortition. By contrast, the articulations associated with the Simple category (voiced obstruents, prenasalization, and flaps/taps) are often observed to come about through processes of lenition and sonorization. This observation brings up the question of whether the segmental properties associated with the Highly Complex category, and the sound change processes they imply, precede, follow, or accompany the development of complex syllable patterns in those languages, which are directly caused by vowel reduction.

In §5.4.3 it was found that for languages with word stress, the percentage of languages with stress-conditioned consonant allophony roughly decreases with syllable structure complexity: 50% of the languages with word stress in the Simple category have such processes, but only 23% of the languages with word stress in the Highly Complex category do. An opposite pattern is found for stress-conditioned vowel reduction. Refer to Figure 5.2, reproduced here as Figure 7.1:



**Figure 7.1.** Percentage of languages with word stress in each category of syllable structure complexity which exhibit stress-conditioned vowel reduction or consonant processes.

As discussed in Chapter 5, the pattern with respect to stress-conditioned consonant processes was an unexpected finding, in that it follows from the speech rhythm literature and related work (Bybee et al. 1998, Schiering 2007) that segmental effects of stress will *increase* with syllable structure complexity. While that was the case with unstressed vowel reduction (see also §6.3.4), it was not so for consonant allophony in stressed or unstressed syllables.

While it proved to be an unexpected result in Chapter 5, the pattern in Figure 7.1 provides valuable information for formulating a hypothesis regarding when the segmental

properties associated with the Highly Complex category develop in relation to the development of the syllable patterns themselves. If the syllable structure complexity scale represents a diachronic cline, then the patterns in Figure 7.1 suggest that in languages with word stress, consonant allophony precedes vowel reduction, or is at least more prevalent than vowel reduction in early stages of syllable structure change. This suggests that we might expect to find allophonic processes resulting in the articulations associated with the Highly Complex category more often in languages with simpler syllable structure. As these processes become more prevalent and regular over the history of a language, they may phonologize and become part of the segment inventory of the language, ceasing to be productive. If accompanied by vowel reduction, this diachronic scenario could result in languages with complex syllable structure being more likely to have those specific consonant articulations as contrastive phonemes. By the same token, we might expect allophonic processes resulting in those articulations to be more common in languages with simpler syllable structure.

The scenario above is speculative and, moreover, based solely on the findings for stress-conditioned segmental processes discussed in Chapter 5. However, it motivates a hypothesis which is testable in the language sample (7.1).

(7.1) H<sub>1</sub>: As syllable structure complexity increases, allophonic processes resulting in palato-alveolars, uvulars, ejectives, and affricates will become less prevalent.

This hypothesis predicts that allophonic processes resulting in articulations associated with Highly Complex syllable structure will be most prevalent in languages of the Simple category.

As mentioned above, the articulations associated with the Highly Complex category typically come about through processes of consonant-to-vowel assimilation and fortition. Along the same lines of reasoning that motivated the hypothesis in (7.1), we might predict assimilatory and strengthening processes in general to be more prevalent in languages with simpler syllable structure. This motivates a second hypothesis (7.2).

(7.2) H<sub>2</sub>: As syllable structure complexity increases, allophonic processes of consonantto-vowel assimilation and fortition will become less prevalent.

Even if these hypotheses are borne out in the data, they may not support the diachronic scenario described above. After all, the trend in Figure 7.1 shows the percentage of languages with stress-conditioned consonant allophony decreasing in general with syllable structure complexity. The patterns predicted by (7.1)-(7.2), if borne out, must be disambiguated in some way from other patterns of consonant allophony in order to be taken as support for any diachronic path. Therefore I predict that allophonic processes resulting in the articulations associated with the Simple category — voiced obstruents, prenasalization, and flaps/taps — will show a different trend with respect to syllable structure complexity, I predict that allophonic processes resulting in lenition or
sonorization more generally will follow a similar pattern, either remaining level or increasing in prominence with increasing syllable structure complexity. Since my predictions for the processes associated with the Simple category are not specific, I do not formulate hypotheses for them here. However, these patterns will be considered in the analyses that follow.

#### 7.2 Methodology

#### 7.2.1 Patterns considered

As with the study of vowel reduction in Chapter 6, only phonetically or phonologically conditioned processes affecting consonants are considered here. I proceed here with the same disclaimers regarding author biases and judgments about the details and directionality of the processes reported in language references.

In order to test the hypothesis in (7.1), allophonic processes resulting in the consonant articulations found to be positively associated with the Highly Complex category were considered. These include *palato-alveolar*, *uvular*, *ejective*, and *affricate* outcomes. The *uvular* category includes articulations described as post-velar or back velar. I did not consider processes producing the articulations found to be associated with the Highly Complex category on the basis of fewer than ten data points; that is, processes resulting in *lateral fricatives*, *lateral affricates*, and *pharyngeals* were not considered. However, there were almost no examples of such processes in the language sample.

Some examples of allophonic processes resulting in articulations associated with Highly Complex syllable structure can be found in (7.3)-(7.5).

(7.3) Chipaya (Uru-Chipaya; Bolivia)

Dental fricative /s/ is realized as [ $\int$ ] when occurring between high vowels. /s<code>qisi</code>/

[s̪qi∫i]

'leather'

(Cerrón-Palomino 2006: 48-9)

# (7.4) **Bashkir** (*Turkic*; Russia)

Voiceless velar fricative /x/ is optionally realized as post-velar  $[\chi]$  in words with only back vowels.

/xafa/

[xafa]

'worry'

(Poppe 1964: 11)

#### (7.5) Semai (*Austro-Asiatic*; Malaysia)

Voiceless palatal stop /c/ is slightly affricated [cccc] in syllable onsets. /mɑ̃cɔ̃:t/ [mɑ̃cc̃ɔ̃:t] 'small'

(Philips 2007: 5)

In order to test the hypothesis in (7.2), allophonic processes resulting in consonant assimilation to an adjacent vowel were considered. Only processes conditioned by adjacent vowels which have the effect of causing the consonant to become more like the vowel in articulatory terms (as denoted by articulatory descriptions or IPA transcriptions) were considered here: e.g., a velar consonant produced with labialization adjacent to rounded vowels. I limited the processes examined here to those involving *palatalization*, *labialization*, or *velarization*. The term *palatalization* here includes any processes resulting in a consonant moving closer to the palatal region, except for those resulting in palato-alveolars, which are considered in the group of processes described above. This category includes processes resulting in fronting of velars or uvulars, secondary palatalization, and the production of palatal consonants. See (7.6)-(7.8) for examples. (7.6) Lepcha (*Sino-Tibetan*; Bhutan, India, Nepal)
Velar stops /k g/ are slightly palatalized [k<sup>i</sup> g<sup>i</sup>] before front vowels /i e/.
/kit/
[k<sup>i</sup>it]
'snatch'

(Plaisier 2007: 21)

(7.7) Karok (Isolate; United States)

Voiceless velar fricative /x/ is labialized  $[x^w]$  after a back (rounded) vowel.

 $/\theta uxxa\theta/$ 

 $[\theta u x^w x^w a \theta]$ 

'mother's sister'

(Bright 1957: 8)

(7.8) **Lezgian** (*Nakh-Daghestanian*; Azerbaijan, Russia)

Lateral approximant /l/ is velarized [1] syllable-finally following a back vowel.

 $/p^{h}tul/$ 

[p<sup>h</sup>tuł]

'grandchild'

(Haspelmath 1993: 35, 37)

Additionally, processes of fortition were considered in addressing the hypothesis in (7.2). In defining fortition, I follow Bybee (2015b) in considering fortition to be an increase in the magnitude of a gesture. Here I apply that definition only to changes in manner of articulation, and include processes which result in a consonant being produced with greater constriction relative to its original articulation (again as denoted by an explicit articulatory description or the change in articulation implied by the IPA transcriptions used). Though gemination and consonant lengthening are commonly described as fortition and involve an increase in the duration of gestures, I have excluded them from the present analysis because the segmental analyses in Chapter 4 did not consider consonant length. The processes here fall into two categories: *glide* strengthening, in which a glide becomes more constricted in its articulation, and other increased constriction, in which any other kind of consonant becomes more constricted in its articulation. While I did not include processes involving the total assimilation of a consonant to another consonant, other kinds of increases in constriction which involved consonantal conditioning were included. However, this was a minor conditioning environment in comparison to vocalic and domain environments. See (7.9)-(7.11) for examples.

(7.9) **Cocama** (*Tupian*; Peru)

Palatal approximant /j/ is optionally realized as voiced alveolar fricative [z] intervocalically. /pijaki/ [pizaki]

'toucan'

(Vallejos Yopán 2010: 99-100)

(7.10) Kewa (Trans-New Guinea; Papua New Guinea)

Velar and labial fricatives /x  $\phi$ / occur as affricates utterance-initially.

/xaa/

[kxaa]

'smell'

(Franklin & Franklin 1978: 24)

## (7.11) Albanian (Indo-European; Albania, Serbia and Montenegro)

Fricatives /f v  $\theta$   $\delta$ / have occasional stop allophones word-finally and before consonants.

/kaf∫on/

[kap∫on]

'it bites'

(Newmark 1957: 16)

The processes resulting in the consonant articulations strongly associated with the Simple category which are considered here include *voiced obstruents*, *prenasalization*, and *flap/tap consonants*. The trends associating *voiceless sonorants* and *labial-velar* articulations with the Simple category were based on the patterns of fewer than ten languages, so these were excluded from the current analysis. See (7.12)-(7.14) for examples of the processes collected.

(7.12) Mohawk (Iroquoian; Canada, United States)

Alveolar fricative /s/ is voiced word-initially preceding a vowel and intervocalically.

/onisela/

[onizela]

'shelf'

(Bonvillain 1973: 30-1)

# (7.13) Darai (Indo-European; Nepal)

Intervocalically, voiced bilabial stop /b/ may be realized as [mb].

/kabo/

[kambo]

'house post'

(Kotapish & Kotapish 1973: 27)

## (7.14) Kadiwéu (Guaicuruan; Brazil)

The voiced alveolar stop /d/ is realized as a tap [r] intervocalically in rapid speech. /d͡ʒit͡ʃiditike/ [d͡ʒit͡ʃiritike] 'I swing it'

(Sandalo 1997: 16)

Finally, I considered several specific types of lenition in this study. I take lenition to be an articulatory weakening; that is, a decrease in the magnitude or duration of a gesture (Browman & Goldstein 1992b, Mowrey & Pagliuca 1995). The processes considered here are prototypical types of lenition or sonorization, processes in which a consonant becomes more vowel-like in its articulation: *spirantization of stops/affricates, debuccalization*, and *consonants becoming glides or vowels*. Spirantization is defined here as any process which involves a stop or affricate becoming a fricative. Debuccalization involves the loss of the oral constriction of a consonant. Examples of such processes are given in (7.15)-(7.17).

# (7.15) **Pech** (*Chibchan*; Honduras)

Voiced bilabial stop /b/ is realized as fricative [β] intervocalically. /tibiebiska/ [tiβieβiska] 'type of grass'

(Holt 1999: 16)

# (7.16) Hausa (Afro-Asiatic; Niger, Nigeria)

Voiceless bilabial fricative  $/\phi/$  is realized as glottal [h] preceding back round vowels /u o/.

/haiqu/

[haihu]

'give birth'

(Jaggar 2001: 7)

## (7.17) Ingessana (Eastern Sudanic; Sudan)

Voiced stops /b J/ are weakened to approximants intervocalically.

/kaɟan/

[kajan]

'bring-3.SG.NOM.CONT.P'

(Stirtz 2011: 24-5)

As with the vowel reduction study in Chapter 6, patterns of consonant allophony were considered to be one process if a sound or group of sounds was affected in the same way in the same conditioning environment. Patterns which were similar but differed along any of those parameters were coded as separate processes.

# 7.2.2 Coding

The types of consonant allophony examined here are to varying extents defined by what sounds are affected and how. For this reason, the conditioning environment was the only aspect of the processes that was coded in detail. Conditioning environments were coded for the presence of four factors: segmental environment, stress environment, domain (word/phrase/utterance) environment, and free variation.

# 7.3 Results

## 7.3.1 Distribution of processes in the language sample

Here I present analyses showing how the different groups of allophonic processes are represented in the language sample. But first, it should be noted that 90/100 languages in the sample had at least one of the process types examined here. The ten languages without any such processes are fairly evenly distributed among the four categories of syllable structure complexity: three languages each in the Simple and Moderately Complex categories, and two languages each in the Complex and Highly Complex categories. This is a very different distribution from the pattern of stress-conditioned consonant allophony established in Chapter 5 and shown in Figure 7.1. This suggests that

stress is not nearly so strong a conditioning factor for consonant allophony as it is for vowel reduction, a point which I will return to in §7.3.7.2.

In total, 295 allophonic processes fitting the descriptions of the process types given in §7.2 were collected and coded for analysis. Table 7.1 shows how these processes are distributed in the language sample.

	Syllable Structure Complexity			
	Simple (N = 22 lgs)	Moderately Complex (N = 27 lgs)	Complex (N = 27 lgs)	Highly Complex (N = 24 lgs)
N languages with process types considered here	18	24	25	22
N processes collected	64	86	91	54

**Table 7.1.** Distribution of allophonic consonant processes considered in the current study among categories of syllable structure complexity.

Below I present several analyses in order to directly address the hypotheses in

(7.1) and (7.2), reproduced below:

- (7.18) H<sub>1</sub>: As syllable structure complexity increases, allophonic processes resulting in palato-alveolars, uvulars, ejectives, and affricates will become less prevalent.
- (7.19) H<sub>2</sub>: As syllable structure complexity increases, allophonic processes of consonantto-vowel assimilation and fortition will become less prevalent.

As a first test of these hypotheses, in Figure 7.2 I show the percentage of languages in each category of syllable structure complexity which have allophonic processes resulting in (i) articulations associated with the Highly Complex category (palato-alveolar, uvular/back velar, ejective, affricate), (ii) consonant-to-vowel assimilation (other palatalization/fronting, labialization, and velarization), and (iii) fortition (glide strengthening or increased constriction).



**Figure 7.2.** Percentage of languages in each category which have allophonic processes resulting in articulations associated with the Highly Complex category, fortition, or other consonant-to-vowel assimilation.

The pattern in the figure shows support for the hypothesis in (7.18): as syllable structure complexity increases, the percentage of languages with allophonic processes resulting in the articulations associated with Highly Complex syllable structure decreases. The patterns show only mixed support for the hypothesis in (7.19). While the percentage of languages with allophonic fortition processes decreases with syllable structure complexity as predicted, this is not the case for the trend with respect to C-to-V place assimilation.

As discussed above, additional support for the hypotheses may be found if allophonic processes resulting in articulations associated with the Simple category, and processes of lenition or sonorization more generally, exhibit a different pattern altogether with respect to syllable structure complexity. In Figure 7.3, I show the percentage of languages in each category of syllable structure complexity which have allophonic processes resulting in (i) articulations associated with the Simple category (voiced obstruents, prenasalization, and flapping), and (ii) lenition or sonorization (spirantization, debuccalization, and consonants becoming glides or vowels).



**Figure 7.3.** Percentage of languages in each category which have allophonic processes resulting in articulations associated with the Simple category or lenition/sonorization.

Neither of the trends in Figure 7.3 are level or rising, as they were tentatively predicted to be in §7.1. In fact, neither shows a coherent linear trend with respect to syllable structure complexity. However, since the patterns differ markedly from the falling trends in Figure 7.2, they can be taken as lending some support to the hypotheses.

The analyses above consider only the presence of processes within languages, and not the individual processes. In the following figures, I show how the process types pattern in terms of the percentage of the total number of allophonic processes they represent in each syllable structure complexity category.



**Figure 7.4.** Percentage of processes in each category which result in articulations associated with the Highly Complex category, fortition, or other consonant-to-vowel assimilation.

This analysis lends some further support for the hypothesis that allophonic processes yielding articulations associated with Highly Complex syllable structure are more prevalent in languages with Simple syllable structure than the others. The trend with respect to fortition, similarly, peaks in the Simple category and then has a level lower rate for the other categories. The trend for consonant-to-vowel assimilation, which did not show a falling pattern in Figure 7.2, is fairly level here. Thus we again find some support for the hypothesis in (7.18), and somewhat less support for the hypothesis in (7.19).

Examining the patterns of processes resulting in articulations associated with the Simple category and more general processes of lenition or assimilation (Figure 7.5), we find that the trends are again quite different from those in Figure 7.4.



**Figure 7.5.** Percentage of processes in each category which result in articulations associated with the Simple category or lenition/sonorization.

In sum, the analyses in this section show that allophonic processes producing articulations associated with the segmental inventories of languages with Highly Complex syllable structure are distributed differently among the languages of the sample than processes producing articulations associated with Simple syllable structure. Similarly, processes of fortition and processes of lenition or sonorization are distributed differently among the language sample with respect to syllable structure complexity.

In the following sections, each group of processes will be examined in more detail.

#### 7.3.2 Processes resulting in articulations associated with Highly Complex category

In this section I examine allophonic processes in the language sample which result in the articulations most strongly associated with the Highly Complex category: palatoalveolar, uvular, and affricate. Recall that no allophonic processes resulting in ejective articulations were found in the language sample.





**Figure 7.6.** Percentage of languages in each syllable structure complexity category with allophonic processes resulting in articulations associated with the Highly Complex category.

We find that the percentage of languages with allophonic processes resulting in palato-alveolar articulations is roughly similar for the Simple, Moderately Complex, and Complex categories and drops sharply in the Highly Complex category. The percentage of languages with processes resulting in affricates shows an opposite trend, being highest in the Simple category but much lower in the other three categories. The trend with uvulars shows a very different pattern, peaking in the Complex category; however, processes yielding uvular articulations were quite rare in the language sample, comprising only eight processes from seven languages. Thus it would seem that the processes producing palato-alveolar and especially affricate articulations drive the trend by which this group of processes is found more frequently in languages with simpler syllable structure. In Table 7.3 I examine the conditioning environments for the processes resulting in palato-alveolars and affricates. In order to simplify the presentation, I do not break the processes down by syllable structure complexity.

	Allophonic processes yielding:			Total for	
Conditioning environment	Palato- alveolar (34 processes)	Uvular (8 processes)	Affricate (39 processes)	(66 processes)	
Segmental	28 (82%)	8 (100%)	22 (56%)	47 (71%)	
Domain	3 (9%)		5 (13%)	6 (9%)	
Stress	2 (6%)		7 (18%)	7 (11%)	
Free variation	3 (9%)		9 (23%)	10 (15%)	

**Table 7.3.** Conditioning environments for allophonic processes producing palatoalveolars, uvulars, and affricates. Note that a process may have more than one conditioning environment, so the sum of each of the columns may add up to more than the total in the column header. Note also that the total figures for the entire group take into account the fact that several processes have palato-alveolar affricate outcomes.

We see that segmental factors are by far the strongest conditioning environment for this group of processes. The segmental conditioning environments are almost always vocalic for these processes, suggesting a high degree of consonant-to-vowel assimilation. What sets the processes producing palato-alveolar and affricate articulations apart from those producing uvular articulations is a greater variety of conditioning environments in the former two groups. In the group of processes which produce affricates, the effect of the segmental environment is somewhat weaker, while stress and free variation play a stronger role.

#### 7.3.3 Other processes resulting in consonant-to-vowel assimilation

Here I examine more closely the allophonic processes resulting in palatalization, labialization, and velarization in the sample. In Figure 7.7 I show the percentage of languages in each category which have such processes.



**Figure 7.7.** Percentage of languages in each syllable structure complexity category with allophonic processes resulting in articulations associated with C-to-V place assimilation.

Recall that in the analyses shown in Figures 7.2 and 7.4, the assimilation processes did not show the expected trend with respect to syllable structure complexity; that is, these processes were not more prevalent in languages with simpler syllable structure. Here the only trend that approximates the expected pattern is that of labialization processes. Labialization is more common in the Simple and Moderately Complex categories than the others. The palatalization trend in Figure 7.7 is similar to the one in Figure 7.6 for palato-alveolars. This is unsurprising, given that these are very similar process types. Velarization is represented by only four processes from as many languages, all from the Complex and Highly Complex categories. In Table 7.4 I show the conditioning patterns for these process types. Again, in order to simplify the presentation, I do not break down the processes by syllable structure complexity.

	Allophonic processes yielding:			Total for	
Conditioning environment	Palatalization (24 processes)	Labialization (12 processes)	<b>Velarization</b> (4 processes)	(40 processes)	
Segmental	24 (100%)	12 (100%)	3 (75%)	39 (98%)	
Domain	2 (8%)	1 (8%)	1 (25%)	4 (10%)	
Stress	3 (13%)	1 (8%)		4 (10%)	
Free variation			1 (25%)	1 (3%)	

**Table 7.4.** Conditioning environments for allophonic processes resulting in palatalization, labialization, and velarization. Note that a process may have more than one conditioning environment, so the sum of each of the columns may add up to more than the total in the column header.

Again, the processes types examined here are predominantly conditioned by the segmental environment. Velarization processes have the highest percentages of non-

segmental conditioning environments, but because there are only four processes in this

group it is difficult to draw generalizations about that. Stress is strongest as a

conditioning factor in the palatalization group.

## 7.3.4 Other processes resulting in fortition

Here I examine processes resulting in glide strengthening and other increased constriction. The percentage of languages having these process types in each syllable structure category is given in Figure 7.8.



**Figure 7.8.** Percentage of languages in each syllable structure complexity category with allophonic processes resulting in articulations associated with strengthening.

Recall from the trends in Figures 7.2 and 7.4 that the prevalence of fortition processes in general was found to decrease with syllable structure complexity. Judging from the pattern in Figure 7.8 it would appear that the trend was driven by the other increased constriction processes rather than glide strengthening.

In Table 7.5 I show how the fortition processes pattern with respect to

conditioning environments.

	Allophonic pro		
Conditioning environment	Glide strengthening (29 processes)	Other increased constriction (34 processes)	<b>Total for group</b> (63 processes)
Segmental	16	20	36
	(55%)	(59%)	(57%)
Domain	11	12	23
	(38%)	(351%)	(37%)
Stress	6 (21%)		6 (10%)
Free variation	3	7	10
	(10%)	(21%)	(16%)

**Table 7.5.** Conditioning environments for allophonic processes resulting in glide strengthening and other increased constriction. Note that a process may have more than one conditioning environment, so the sum of each of the columns may add up to more than the total in the column header.

We find a very different pattern in this group of processes than in the previous groups examined. While the segmental environment is still the strongest conditioning factor for both process types, the domain environment is involved in conditioning roughly one-third of the fortition processes. This is most often word-initial or syllableinitial position. Stress is only a conditioning factor for glide strengthening processes.

#### 7.3.5 Processes resulting in articulations associated with Simple category

The percentage of languages in each category which have allophonic processes resulting in articulations associated with the Simple category — voiced obstruent, flap/ tap, and prenasalization — can be found in Figure 7.9.



**Figure 7.9.** Percentage of languages in each syllable structure complexity category with allophonic processes resulting in articulations associated with lower syllable complexity.

Recall from the analysis in Figure 7.5 that this group of processes showed an erratic pattern with respect to syllable structure complexity. The pattern here which most closely resembles the one for the group of processes as a whole is the flap/tap process type. The percentage of voiced obstruent articulations generally rises with syllable structure complexity, though it falls again in the Highly Complex category. There were only three processes resulting in prenasalization, all of which fall into the Moderately Complex and Complex categories. An important pattern to glean from this figure is that none of the processes resulting in the specific articulations associated with the Simple category are found to generally decrease in prevalence as syllable structure complexity increases. That is, none of these processes show a pattern similar to what was observed for palato-alveolars, affricates, palatalization, labialization, or increased constriction.

In Table 7.6 I show how these processes pattern with respect to conditioning environments.

	Allophonic processes yielding:			
Conditioning environment	Voiced obstruent (45 processes)	Prenasalizatio n (3 processes)	Flap/tap (24 processes)	Total for group (72 processes)
Segmental	35 (78%)	3 (100%)	16 (67%)	54 (75%)
Domain	8 (18%)	1 (33%)	5 (21%)	14 (19%)
Stress	6 (13%)		2 (8%)	8 (11%)
Free variation	2 (4%)		4 (17%)	6 (8%)

**Table 7.6.** Conditioning environments for allophonic processes resulting in voiced obstruents, prenasalization, and flaps/taps. Note that a process may have more than one conditioning environment, so the sum of each of the columns may add up to more than the total in the column header.

While the segmental environment is the strongest conditioning factor in this group of processes, there is again a secondary effect of domain environment for all types. Stress as a conditioning environment is strongest for the processes resulting in voiced obstruents; in 5/6 of these processes, voicing occurs in an unstressed environment. The two flap/tap processes conditioned by stress occur specifically in unstressed environments.

# 7.3.6 Other processes resulting in lenition or sonorization

Other processes resulting in lenition or sonorization, specifically those with outcomes of spirantization, debuccalization, or consonants becoming glides or vowels, are examined here. See Figure 7.10 for the percentage of languages in each syllable structure complexity category which have such processes.



**Figure 7.10.** Percentage of languages in each syllable structure complexity category with allophonic processes resulting in articulations associated with sonorization.

Recall that lenition/sonorization processes as a group did not show a coherent trend with respect to syllable structure complexity in Figures 7.3 and 7.5. In the analysis here, we find that spirantization processes generally become more prevalent from the Simple to Complex categories. Similarly, processes by which a consonant becomes a glide or vowel generally decrease from the Moderately Complex to Highly Complex categories.

The conditioning environments for the various lenition and sonorization processes can be found in Table 7.7.

	Allophonic processes yielding:			Total for
Conditioning environment	<b>Spirantization</b> (39 processes)	Debuccalizatio n (11 processes)	C > glide, V (22 processes)	group (72 processes)
Segmental	24	4	18	46
	(62%)	<i>(36%)</i>	(82%)	(64%)
Domain	6	4	4	14
	(15%)	<i>(36%)</i>	(18%)	(19%)
Stress	1 (3%)	1 (9%)		2 (3%)
Free variation	10	2	1	13
	(26%)	(18%)	(5%)	(18%)

**Table 7.7.** Conditioning environments for allophonic processes resulting in spirantization, debuccalization, and consonants becoming glides or vowels. Note that a process may have more than one conditioning environment, so the sum of each of the columns may add up to more than the total in the column header.

Though this is the second-largest group of processes examined in this chapter, it

has the fewest (and lowest percentage of) processes conditioned by the stress

environment. Domain environments, typically syllable- or word-final position, are

relatively prominent in this group of processes. This group also has the highest

percentage of processes occurring in free variation of any of the other groups examined in

this chapter.

In the following section I summarize the trends found for individual process types as they relate to syllable structure complexity.

## 7.3.7 Summary of results

#### 7.3.7.1 Allophonic processes associated with syllable structure complexity

The analyses in §7.3.2-6 indicate that there are associations between the allophonic processes examined here and syllable structure complexity. I list these associations in Table 7.8 below.

Processes more prominent as syllable complexity <i>decreases</i>	<i>No linear relationship</i> between process and syllable complexity	Processes more prominent as syllable complexity <i>increases</i>
Palato-alveolarization Affrication Labialization Palatalization Other increased constriction C > glide, vowel	Uvular Voiced obstruent Flapping/tapping Prenasalization (*) Debuccalization	Velarization (*) Glide strengthening Spirantization

**Table 7.8.** Associations between allophonic processes and syllable structure complexity. (\*) indicates that the trend is based on very few (<5) processes.

There are six process types which become more prevalent in the languages of the sample as syllable structure complexity decreases. Two of these process types have outcomes which result in articulations associated with the Highly Complex category: *palato-alveolars* and *affricates*. Another three process types — those resulting in *palatalization*, *labialization*, and *other increased constriction* — are forms of consonant-to-vowel assimilation and fortition, respectively. These kinds of sound changes were proposed to be common sources of the articulations associated with Highly Complex syllable structure in §4.5.4. Thus we find that 5/6 of the process types examined here which are more prevalent in languages with simpler syllable structure have outcomes which are associated in some way with segmental properties of highly complex syllable structure. This finding is in line with the hypotheses of this chapter.

There is a very different pattern for process types which show no linear relationship to syllable structure complexity. Three of these process types have as outcomes articulations associated with the Simple category: those resulting in *voiced obstruents*, *flaps/taps*, and *prenasalization*, though it should be noted that the last of these was generally a rare process in the language sample. Additionally, the occurrence of *debuccalization*, a form of lenition/sonorization, shows no linear relationship with syllable structure complexity. Lenition and sonorization were proposed to be common sources of the articulations associated with Simple syllable structure in §4.5.4. These results lend further support to the hypotheses, as they show that some of the allophonic outcomes associated with segmental properties of the Highly Complex and Simple categories may have different distributions with respect to syllable structure complexity.

There are a few unexpected trends. For example, the process type by which a *consonant becomes a glide or vowel* generally increases in prevalence as syllable structure complexity decreases. That is, though it is a sonorization process, it patterns with the assimilatory and strengthening processes producing articulations associated with the Highly Complex category. Similarly, the occurrence of Highly Complex-associated articulation *uvularization* shows no linear relationship with syllable structure complexity. Finally, there are three process types whose prevalence increases with syllable structure complexity. One process results in *velarization*, a type of consonant-to-vowel assimilation. However, this trend is based on only four processes. *Glide strengthening*, a type of fortition, slightly increases with syllable structure complexity. Finally, the

prevalence of *spirantization*, a type of lenition, generally increases with syllable complexity.

#### 7.3.7.2 Conditioning factors in consonant allophony

There are also loose associations in the data between process types, conditioning environments, and syllable structure complexity. Most of the processes analyzed were conditioned by the segmental environment. However, there are some interesting patterns with respect to the secondary trends. For four of the process types whose occurrence have no linear trend with respect to syllable structure complexity — *voiced obstruent, flap/tap, prenasalization*, and *debuccalization* — the second strongest conditioning factor is the domain environment. Most frequently, such processes occurred in word-medial, word-final, or syllable-final environments (12/19 processes). By comparison, for two of the process types which are more prevalent in languages with simpler syllable structure — *affricate* and *palatalization* — the second strongest conditioning factor is the stress environment. There are also two processes producing *palato-alveolars* which are conditioned by stress, but stress is generally not a strong conditioning environment for that process type.

The latter pattern mentioned above reflects a general trend in the data by which processes of the types examined here are more likely to be conditioned by stress in languages with Simple syllable structure. In Figure 7.11 I show the percentage of processes in each syllable structure complexity category which are conditioned by stress in the current analysis.



**Figure 7.11.** Percentage of languages with consonant process types examined here conditioned by word stress.

Note that the pattern in Figure 7.11 is much less pronounced than the analogous one in Figure 7.1 (also that the scale has been reduced to 0-40% for Figure 7.11). That is because the pattern in Figure 7.1 includes languages with *any* reported processes of stress-conditioned consonant allophony in the sample, including the very common processes of aspiration and consonant lengthening. The consonant processes considered here are limited to those relevant to the hypotheses, and do not include aspiration or lengthening. In general, stress is not a strong conditioning environment for the process types examined here, but where it is strong is in the Simple category.

In Table 7.9, I show the number of processes conditioned by stress in each category, and the number of languages with stress-conditioned processes. In the bottom row I give the ratio of processes to languages.

	Syllable Structure Complexity			
	Simple	Moderately Complex	Complex	Highly Complex
N allophonic C processes conditioned by stress	12	5	8	1
N lgs. with allophonic C processes conditioned by stress	5	3	5	1
ratio	2.4	1.7	1.6	1.0

**Table 7.9.** Ratio of number of stress-conditioned vowel reduction processes to the number of languages with unstressed vowel reduction in each category of syllable structure complexity.

We find that in languages with stress-conditioned consonant processes of the types examined here, the average number of such processes per language decreases with syllable structure complexity. That is, languages with Simple syllable structure are not only more likely to have stress-conditioned consonant allophony, but stress also conditions more processes in those languages. This result is essentially the reverse of the pattern found in §6.3.4 for stress-conditioned vowel reduction. In that analysis, it was found that in languages with unstressed vowel reduction, the average number of such processes increased with syllable structure complexity.

In Table 7.10, I show the distribution of stress-conditioned processes by process type and syllable structure complexity.

	Syllable Structure Complexity			
Process type	Simple (12 processes)	Moderately Complex (5 processes)	Complex (8 processes)	Highly Complex (1 process)
Affrication	5	2		
Palato-alveolar	2			
Uvular				
Palatalization	1		2	
Labialization				1
Velarization				
Glide strengthening	3	1	2	
Other increased constriction				
Voiced obstruent	2	1	3	
Prenasalization				
Flap/tap		1	1	
Spirantization	1			
Debuccalization				
C > glide, vowel	1			

**Table 7.10.** Processes of consonant allophony conditioned by stress. Note that because some processes have several outcomes (e.g., palato-alveolar and affricate), numbers going down the columns do not necessarily add up to the header totals.

Nine of the process types examined here occur with stress conditioning. For all but three of those (*palatalization*, *labialization*, and *flap/tap*), the stress-conditioned processes predominantly occur in languages in the Simple and Moderately Complex categories. We find that when only stress-conditioned processes are considered, the glide strengthening pattern falls more in line with the predictions of the hypotheses: these processes are most prevalent in the Simple category.

#### 7.4 Discussion

In §7.1, two hypotheses were formulated regarding expected patterns of consonant allophony in the sample. Following from observations of stress-conditioned consonant allophony in Chapter 5, it was thought that the articulations found to be associated with segment inventories of languages in the Highly Complex category in Chapter 4 might have their origin in allophonic processes at some earlier stage in the languages, perhaps even before the complex syllable patterns developed. It was therefore hypothesized that allophonic processes resulting in these articulations, or associated sound changes such as consonant-to-vowel assimilation and fortition, would be most prevalent in languages with simpler syllable structures. By contrast, it was expected that allophonic processes producing articulations established in Chapter 4 to be associated with Simple syllable structure, and other kinds of lenition or sonorization, would show a different trend, perhaps increasing in prevalence with syllable structure complexity or remaining constant across the categories.

The results here point to some support for the hypotheses, but also a more complex situation than what was predicted. There are eight process types which have outcomes associated with segmental properties of the Highly Complex category, or general consonant-to-vowel assimilation or fortition. 5/8 of these processes — *palato-alveolar, affricate, palatalization, labialization,* and *other increased constriction* — show the pattern predicted by the hypotheses. Meanwhile, there are six process types which have outcomes associated with segmental properties of the Simple category, or general lenition or sonorization. 5/6 of them show the patterns indirectly predicted by the

hypotheses, that is, they show non-decreasing, but often also non-linear, trends with respect to syllable structure complexity.

Loose associations between conditioning environments and the patterns observed lend further support to the hypotheses by indicating that the patterns described above may not be random, but instead have coherent motivations. Most of the processes in the data set have segmental conditioning. The process types which rise in prevalence with decreasing syllable structure complexity tend to have stress as the second most frequent conditioning environment. The process types whose occurrence shows no linear trend with respect to syllable structure complexity tend to have a domain-medial or final environment as the second most frequent conditioning environment.

Three of the process types which are more prevalent in languages with simpler syllable structure — those resulting in *palato-alveolars*, *affricates*, and *palatalization* — share in common occasional stress-conditioning and frequent high and/or front vowel conditioning environments. This is a similar situation for *glide strengthening*, which as it turns out patterns with these process types if only stress conditioning is considered. Thus it seems that most of the assimilation and fortition types which fall in line with the predictions of the hypothesis correspond to those which are heavily conditioned by stress and high or front vowels.

I discuss possible diachronic implications of these patterns in the following section.

#### 7.4.1 Consonant allophony and the development of syllable structure complexity

In §7.1 it was stated that if the hypotheses regarding consonant allophony were borne out in the data, this might illuminate elements of the diachronic path by which highly complex syllable structure develops. Specifically, it was thought that comparing these patterns against the vowel reduction patterns established in Chapter 6 might reveal information about the relative order of certain processes of change in the development of this language type.

The results reveal a greater prevalence of some process types associated with the segmental properties of the Highly Complex category as syllable structure complexity decreases. Palato-alveolars, affricates, palatalization, labialization, and increased constriction are most commonly outcomes of allophonic processes in languages of the Simple category. If we very liberally assume that all of these allophonic processes are heading towards phonemicization and that all of these languages are heading towards higher syllable complexity, that would indicate that some of the articulations associated with the Highly Complex category may start to develop quite some time before complex syllable patterns develop out of vowel deletion. An additional scenario is suggested by the opposing patterns with respect to prevalence of stress-conditioned consonant allophony and stress-conditioned vowel reduction. Stress conditions more processes affecting consonants in languages with simpler syllable structure and more processes affecting vowels in languages with more complex syllable structure. If syllable structure complexity is a diachronic cline, the stress-conditioned patterns could indicate that in early processes of syllable structure change, stress has stronger effects on consonants than

on vowels. Additionally, both of these scenarios could suggest that the processes affecting consonants develop concurrently with the initial stages of vowel reduction in languages. In this scenario, we might expect a large amount of overlap between languages with the relevant consonant allophony and languages with vowel reduction.

I tested this scenario in the current language sample. In Table 7.11 I show the languages in the Simple category reported to have vowel reduction and/or the relevant processes of consonant allophony (i.e., processes resulting in palato-alveolars, affricates, palatalization, labialization, or increased constriction). In Table 7.12 I show the same analysis for stress-conditioned processes only.

V reduction	<b>Relevant C allophony</b>			
processes	Present	Absent		
Present	11	2		
Absent	6	3		

**Table 7.11.** Languages of Simple category, distributed according to presence or absence of vowel reduction processes and consonant allophony resulting in palato-alveolars, affricates, palatalization, labialization, or increased constriction.

stress-conditioned	stress-conditioned relevant C allophony			
V reduction processes	Present	Absent		
Present	2	2		
Absent	2	12		

**Table 7.12.** Languages of Simple category with word stress, distributed according to presence or absence of stress-conditioned vowel reduction processes and consonant allophony resulting in palato-alveolars, affricates, palatalization, or increased constriction.

The pattern in Table 7.11 comes closest to approximating the proposed relationship. Though the presence of vowel reduction tends to imply the presence of the relevant consonant processes (9/11 languages with vowel reduction) and vice versa (11/17 languages with consonant allophony), the pattern in Table 7.11 is not statistically significant in Fisher's exact test. Table 7.12 does not show the expected relationship and the distribution is not statistically significant in Fisher's exact test.

Of course, the above scenario is grossly overgeneralized. We should not expect all processes resulting in specific kinds of consonant allophony to be part of a larger process of syllable structure change in a language, least of all processes of palatalization and affrication, which are extremely prevalent cross-linguistically (Bhat 1978, Bateman 2007, Bybee & Easterday under review). Nevertheless, the tendencies in the data with respect to these processes, and the differences between their patterns and patterns of prototypical lenition processes, make it tempting to draw connections between consonant allophony and syllable structure complexity. Even if the relationship is largely coincidental, it is very interesting that the group of processes which are more prevalent at the simpler end of the syllable structure complexity scale tend to result in some of the segmental articulations associated with more complex syllable structure.

Most of the lenition and sonorization process types do not follow any linear trend with respect to syllable structure complexity. An interesting question is why the outcomes of such processes — e.g., prenasalization, flapping, voiced obstruents — correspond to segmental contrasts more often in languages with simpler syllable structure. One clue to this could be in the conditioning environments. Intervocalic conditioning environments
were found almost exclusively in processes of these types: 14/27 of voiced obstruent processes and 14/24 of processes resulting in flaps/taps occur in intervocalic contexts. Again, in an oversimplified scenario, this may indicate that such patterns, though prevalent in all categories, are more likely to phonologize in languages in which intervocalic environments are more consistently present, as in the Simple category.

While the analyses in this chapter do not contribute any definitive results with respect to the role of processes of consonant allophony in the development of highly complex syllable structure, they perhaps provide a few helpful clues. These results will be revisited in the next chapter, in which the results of the studies in Chapters 3-7 are summarized and given a diachronic interpretation.

### **CHAPTER 8:**

# HIGHLY COMPLEX SYLLABLE STRUCTURE: CHARACTERISTICS, DEVELOPMENT, AND STABILITY

### 8.1 Introduction

In this chapter I consider the findings from the studies in preceding chapters and discuss how they address the broad research questions of the dissertation. In §8.3 I revisit the first research question, summarizing the evidence for establishing highly complex syllable structure as a linguistic type and discussing how it relates to other holistic language types proposed in the literature. In §8.4 I return to the second research question and discuss how findings from the dissertation inform our understanding of the directionality, tendencies, and mechanisms behind the development of highly complex syllable structure, specifically, and syllable complexity, more generally. In §8.5 I discuss patterns which suggest that highly complex syllable structure may have long-term stability within languages and language families. Finally, in §8.6 I suggest some areas for further research.

Before I move on to those discussions, I present one more brief analysis of the data. A few of the previous analyses dealt with the issue of morphology and syllable complexity. In §3.3.6, the morphological composition of maximum cluster shapes and syllabic consonants was analyzed. It was found that as syllable structure complexity increases, so does the likelihood that the maximum onset and coda patterns of a language display heteromorphemic patterns. Similarly, within most of the syllable structure

complexity categories, as syllable structure complexity increases, so does the likelihood that syllabic consonants can be found in grammatical morphemes. While the scope of the dissertation does not allow for a detailed investigation of morphological issues, I present one further analysis in §8.2 to contribute to our understanding of the role of morphology in the development of highly complex syllable structure and its definition as a language type.

### 8.2 Syllable structure complexity and morphology

In §1.4.2, several holistic typologies of language were discussed in which syllable structure complexity is proposed to co-occur with specific morphological properties. Two of the language types proposed by Skalička (1979), agglutination and introflection, are supposed to have complex consonant clusters. In one of these, agglutination, it is proposed that languages will have a high amount of verbal inflection and more than one inflectional affix per word. However, Skalička's typology is largely impressionistic and, besides the latter specification, does not provide a method for quantifying the degree of agglutination. Shosted (2006) considers correlations between the potential number of distinct syllable types in a language and inflectional synthesis of the verb. The latter property is defined, following Bickel & Nichols (2013), as the number of grammatical categories marked on the maximally inflected verb form. Though Shosted's results were statistically insignificant, the relationship between the two properties was found to be slightly positive among the 32 languages of his sample. These results, along with Skalička's proposal and the findings in §3.3.6 regarding morphological patterns of

clusters and syllabic consonants, prompt me to investigate the relationship between syllable structure complexity and degree of synthesis in the language sample.

In morphological typology, synthesis refers to the relative number of morphemes per word in a language. In the morphological typology proposed by Sapir (1921), the term synthetic refers to languages with a few morphemes per word, setting this type apart from analytic and polysynthetic languages, which have one morpheme per word and many morphemes per word, respectively. Noting the impressionistic nature of these definitions, Greenberg (1954) proposed a quantitative method by which to measure synthesis. This index of synthesis is the average number of morphemes per word in running text. The index does not consider fusion, in which more than one grammatical meaning is fused into a single morpheme (e.g., English 3rd Person Singular Present -s). It also does not address some forms of non-concatenative morphology, such as vowel or consonant gradation. However, it does capture the relative degree to which affixation and compounding (conflated here) occur in language use. For that reason it is appropriate for the current study. Recall that a prediction made in previous chapters was that large wordmarginal consonant clusters may come about when reduction processes affect vowels in unstressed affixes. I expect that this source of large consonant clusters will be reflected in uniformly higher morpheme/word ratios in the Highly Complex category.

I conducted an analysis to establish the morpheme/word ratios of the languages in the sample. Texts with interlinear glossing were not readily available for all languages, so ultimately this analysis included only 61 of the languages in the sample. The macroregion of Africa is severely underrepresented in this analysis, as texts with interlinear

glosses were more difficult to come by for these languages. Only five languages represent Africa, while the other macro-regions are represented by 10-13 languages each.

It should be noted that the texts analyzed here represent a variety of genres. Where third-person narratives or traditional folktales were available, these were given preference for analysis; however, the texts also include some first-person narratives, dialogues, and formal written prose. In conducting the morpheme counts, I took the interlinear glossing at face value, though I acknowledge that the conventions of morphological analysis used by the various researchers may reflect differences in level of abstraction from the 'surface' forms. Zero morphemes were not counted. On average, the section of text analyzed for each language was about 300 words in length. However, this figure ranges widely from 69 words (for Pech) to 573 words (for Ungarinjin). When fewer than 200 words were analyzed for a language, this typically indicates that no additional texts were available. References for the texts used, as well as raw word and morpheme counts for each language, can be found in Appendix B.

The means and ranges for morpheme/word ratios for each syllable structure complexity category can be found below.

	Syllable Structure Complexity			
Morphemes per word in text	Simple (13 lgs)	Moderately Complex (14 lgs)	Complex (19 lgs)	Highly Complex (15 lgs)
Mean	1.6	1.6	1.7	2.0
Range	1.0-2.3	1.1-2.4	1.0-2.8	1.1-2.6

**Table 8.1.** Mean and range values for morpheme/word ratios in running text in languages of sample.

The mean morpheme/word value for the entire sample was 1.7. As expected, the Highly Complex category has the highest average number of morphemes per word. Though the range of values observed in the Highly Complex category is similar to the others, the mean shows that more of the languages are distributed towards the high end of the range, indicating a tendency towards, if not a uniformity of, higher morpheme/word ratios in this group. In the 61 languages examined here, there is a statistically significant positive correlation between the morpheme/word ratio and syllable structure complexity. That is, synthesis generally increases with syllable structure complexity in the sample. This correlation is moderate when syllable structure complexity is measured categorically (r(61) = .306, p = .02) and weaker when it is measured as a sum of maximum syllable margins (r(61) = .262, p = .04).

Though this analysis is very general and glosses over many important issues of morphological analysis, it adds further evidence to the idea that morphology plays an important role in the development of syllable structure complexity. In a sense, this is intuitively understood: many languages with highly complex syllable patterns, including Itelmen, Georgian, Kabardian, Cocopa, and the Salishan languages, have been described as polysynthetic in various descriptions. However, the analysis here establishes a quantitative basis for the relationship and suggests that the presence of a relatively high degree of synthesis is often a prerequisite for the development of highly complex syllable structure. Incidentally, the language in the Highly Complex category with the lowest morpheme/word ratio — Wutung, with a ratio of 1.1 — is a language in which Highly

Complex syllable patterns are extremely non-prototypical for that group, being restricted to a single tautomorphemic onset, /hmbl/.

Having further established a role for morphology in patterns of syllable complexity, we now turn to a summary of the evidence for highly complex syllable structure as a linguistic type.

### 8.3 Highly complex syllable structure as a linguistic type

Here I evaluate the results of the dissertation as they relate to the first central research question (8.1).

(8.1) Do languages with highly complex syllable structure share other phonetic and phonological characteristics such that this group can be classified as a linguistic type?

In Chapters 3-7, I presented analyses of the patterns of syllable structure, segmental inventories, suprasegmental properties, vowel reduction, and consonant allophony in a diverse cross-linguistic sample carefully constructed to be equally representative of different degrees of syllable complexity. More often than not, the analyses revealed associations between these features and syllable structure complexity. Below I summarize the patterns which were found to set the Highly Complex category apart from the others in the language sample. Trends found to be statistically significant are marked with an asterisk (\*).

## Syllable patterns characteristic of the Highly Complex group (Chapter 3)

- A large maximum cluster at one syllable margin tends to imply a large cluster at the other margin. (§3.3.2)
- Obligatory syllable margins (usually onset) frequent in this group. (§3.3.3)
- Syllabic consonants most likely to be present in this group. (§3.3.5)
- Heteromorphemic patterns in maximum syllable margins most likely in this group. (§3.3.6)
- Syllabic consonants more likely to be found in grammatical morphemes in this group. (§3.3.6)
- Consonant clusters characterized by perceptually salient release, aspiration, variable transitional vocalic elements. (§3.4.3)

### Segmental patterns characteristic of the Highly Complex group (Chapter 4)

- Largest consonant phoneme inventories (average 26 Cs) in this group.\*
   (§4.4.1)
- Highest average number of articulatory elaborations in consonant phoneme inventory in this group.\* (§4.4.2)
- Absence of voicing distinction in obstruents, prenasalized consonants,\* and flap/tap articulations most likely in this group. (§4.4.3, §4.4.5)
- Presence of palato-alveolar,\* uvular,\* affricate, and ejective articulations most likely in this group. (§4.4.4, §4.4.5)

## Suprasegmental patterns characteristic of the Highly Complex group

## (Chapter 5)

- Combination of presence of word stress and absence of tone most likely in this group. (§5.4.1)
- Stress-conditioned processes affecting consonants least likely to be present in this group. (§5.4.3)
- Vowel duration most likely and pitch\* least likely to be an impressionistic phonetic correlates of stress in this group. (§5.4.5)

# Vowel reduction patterns characteristic of the Highly Complex group (Chapter 6)

- Vowel reduction most prominent in this group (most likely to be present and most likely to involve two or more distinct processes). (§6.3.1, §6.3.2)
- Vowel reduction processes least likely to affect high vowels in this group.\*
   (§6.3.3)
- Vowel reduction processes affecting /ə/ specifically occur only in this group.\*
   (§6.3.3)
- In languages with word stress, word stress conditions the highest average number of vowel reduction processes in this group.\* (§6.3.4)
- Vowel reduction processes conditioned by word\* or phrase/utterance position least common in this group. (§6.3.4)

• Vowel deletion most likely to produce tautosyllabic clusters in this group. (§6.3.5)

# Consonant allophony patterns characteristic of the Highly Complex group (Chapter 7)

- Languages in this group least likely to have allophonic processes resulting in fortition or articulations associated with the Highly Complex category.
   (§7.3.1)
- Allophonic processes resulting in palatalization or palato-alveolar articulations least frequent in this group. *(§7.3.3)*

# Other morphological patterns characteristic of the Highly Complex group (Chapter 8)

Highest degree of synthesis (average morpheme/word ratio) in this group.\*
 (§8.2)

The evidence does indicate that languages on the extreme end of syllable complexity scale share a number of other phonetic and phonological properties in common besides canonical syllable patterns. Most often, these characteristic properties are strong or weak tendencies which set this group apart from languages with simpler syllable structure. However, in a few cases, the properties are categorical; for instance, vowel reduction patterns affecting only /ə/ were found only in the Highly Complex portion of the sample. Moreover, it is often clear from the data that the bundle of features listed above is not a random assortment of phonological properties that just happen to align in this group of languages. In some cases, properties were found to show a gradual linear trend with syllable complexity: e.g., the positive trend with respect to the presence of uvular articulations (§4.4.5), or the negative trend with respect to phrase/utterance position in vowel reduction conditioning ( $\S6.3.4$ ). In many cases, the trends serve to set the Simple category apart from the three more complex categories: e.g., the absence of phonological asymmetries between stressed and unstressed syllables, or the presence of stress-conditioned consonant allophony. The effect of these interacting patterns is that there are two more or less coherent bundles of phonological tendencies which strongly characterize the languages at either end of the syllable complexity scale. Languages with intermediate syllable patterns (Moderately Complex or Complex) pattern with one or the other of these extremes in many properties, but rarely show different trends altogether, at least not in such a way as to form their own coherent pattern. Additionally, selective statistical testing showed that many of the trends listed above were found to be significant.

Other evidence pointing to highly complex syllable structure as a linguistic type is in the fact that languages in which these syllable patterns are strong tend to have more of the accompanying phonological features listed above. In §3.4.2, I identified two groups of languages in the Highly Complex category based on the size, distribution, combinatorial restrictions, and relative frequency of their Highly Complex syllable patterns. A group of eight genealogically and geographically diverse languages —

Cocopa, Georgian, Itelmen, Polish, Tashlhiyt, Thompson, Tohono O'odham, and Yakima Sahaptin — were found to have Highly Complex structures as a prevalent pattern in these respects. Another group of five genealogically but less geographically diverse languages — Alamblak, Doyayo, Kunjen, Menya, and Wutung — were found to have Highly Complex structures as a minor pattern according to these criteria. In observing the distribution of other phonological correlates of Highly Complex syllable structure in Chapters 4-6, it was found that these were more strongly associated with languages having Highly Complex structure as a prevalent pattern than those having it as a minor pattern. Languages in which Highly Complex patterns were intermediate tended to behave more like the prevalent group in this respect (see §4.5.1, §5.5.1, §6.4.1 for more details).

As a linguistic type, highly complex syllable structure has properties which are reminiscent of several other language types proposed in holistic typologies of language. The co-occurrence of syllable structure complexity and vowel reduction, especially unstressed vowel reduction, aligns this group of languages with the stress-timed type often discussed in the speech rhythm literature (Dauer 1983, Auer 1993, Schiering 2007). Yet these language types do not completely overlap: in particular, the virtual lack of stress-conditioned consonant allophony and unexpectedly high percentage of fixed stress systems sets languages with highly complex syllable structure apart from prototypical stress-timed languages. Similarly, highly complex syllable structure shares some characteristics in common with the agglutination type proposed by Skalička (1979), in that syllable complexity co-occurs with a high amount of synthesis (which I liberally take

as a proxy for inflection here) and rich consonant systems. Here too the types do not overlap completely, in part because Skalička narrowly defined agglutination so as to approximate an ideal language type. This typology does specify that agglutination is characterized by looser fusion between gramemes and the stem, which would not be reflective of the patterns in the current data, in which large heteromorphemic tautosyllabic consonant clusters often occur. Finally, highly complex syllable structure is aligned with aspects of the consonantal type in the typology proposed by Isačenko (1939/1940), and with more casual uses of the term in phonological descriptions of languages. Specifically, the co-occurrence of syllable complexity, rich consonant systems, the presence of specific contrasts such as secondary palatalization, and fixed or lexicallydetermined stress in languages with highly complex syllable structure make this type reminiscent of consonantal languages. One major point of departure from this typology is that languages with highly complex syllable structure were found in the current study to be more likely to have syllabic consonants, a feature proposed by Isačenko to co-occur with vocalic languages.

In sum, the patterns in the data here suggest that highly complex syllable structure is a linguistic type characterized by phonetic, phonological, and morphological patterns which are sometimes categorical but are most often tendencies. Highly complex syllable structure is a holistic language type that shares some features in common with stresstimed languages, agglutination, and consonantal languages, but is also defined by a set of features which are not characteristic of any of those types. In the following section I discuss how the properties of highly complex syllable structure and the other patterns

established in this dissertation can be used to address the second research question regarding the historical development of this type.

### 8.4 The development of highly complex syllable structure

In this section, I discuss how the findings of the dissertation address the second research question, reproduced below (8.2).

(8.2) How does highly complex syllable structure develop over time?

I approach the issue of the development of highly complex syllable structure from several different angles. First, in §8.4.1 I discuss the issue of assumptions about directionality in syllable structure change, presenting patterns from the current sample which seem to indicate that change more often tends to be in the direction of increased complexity. In §8.4.2 I discuss how the cross-linguistic patterns established in the preceding chapters might suggest paths of language change associated with the development of this type. In §8.4.3 I compare the phonological and morphological properties of pairs of related languages differing in their syllable structure complexity in order to determine whether the cross-linguistically established patterns are present at the local level. In §8.4.4 I discuss a historically attested case of syllable structure change and how it relates to the findings of this dissertation. In §8.4.5 I discuss issues of language contact and the transfer of prosodic properties from one language to another as a potential

source for the development of highly complex syllable structure. Finally, in §8.4.6 I present some ideas for how such processes might get started in a language.

### 8.4.1 Directionality of syllable structure change

Up until this point in the dissertation, it has been assumed when discussing the phonetic and phonological correlates of syllable structure complexity that the findings might point to how highly complex syllable structure develops out of simpler syllable patterns. In many cases I have referred to the four-category syllable structure complexity scale used in this study as corresponding to a diachronic cline. This assumption is, in part, supported by documented evidence of such a cline: for example, we can be certain from historical records that the present syllable patterns of Lezgian, which have been mentioned several times previously in the dissertation, arose out of simpler patterns. However, since the focus has been on processes which create syllable complexity, the opposite scenario, in which the phonetic and phonological correlates might be interpreted to reflect how simple syllable structure develops out of more complex patterns, has been largely neglected.

There is ample evidence within the language sample for syllable structure change going in the direction of increased complexity. The analysis of outcomes of vowel deletion in §6.3.5 provides many such examples. Seven languages were found to have vowel deletion resulting in non-canonical simple codas: in Nakanai, Tukang Besi, Lunda, and Camsá, such processes create codas in languages that otherwise do not have them; and in Cocama, Nkore-Kiga, and Lakhota, the processes add new consonants to the

inventory of simple codas in the language. Additionally, seven languages have vowel deletion processes resulting in non-canonical tautosyllabic clusters: in Grebo, Choctaw and Karok, these processes create clusters in syllable margins which are otherwise simple; in Khanty and Nuu-chah-nulth, these processes create larger clusters than what the language canonically has; and in Albanian and Qawasqar, these processes create clusters which are the same size as canonical clusters but of non-canonical shapes.

Apart from the cases above involving synchronic vowel deletion, there are at least nine other languages in the sample for which historical and comparative evidence points to syllable structure recently having become more complex. Several of these were mentioned in §3.2.3 in the discussion of languages whose patterns fell near the edges of the syllable structure complexity categories as defined in this study. Ute and Toro So are classified as having Simple syllable structure, but both have canonical simple codas which have recently arisen as a result of vowel devoicing and deletion. In some languages, speech style and sociolinguistic variation suggest that syllable structure has recently become more complex. In Pech, onset clusters /pr, tr, kr, br/ appear to be a recent development as a result of syncope of historical or underlying vowels, as the vowels may "reappear" in slow speech (Holt 1999: 20). Similarly, in Oksapmin, biconsonantal onset clusters are realized with an intervening schwa for some older speakers, but are produced as clusters by most younger speakers (Loughnane 2009: 65-67). The dialect of Karajá considered here has Simple syllable structure, but other dialects are reported to have biconsonantal onset clusters as the result of optional schwa deletion (Ribeiro 2012: 75). Bruce notes that close transition in consonant clusters in

Alamblak corresponds to /i/ in related language Sumariup (1984: 69-70). He takes this as likely evidence of recent vowel deletion in Alamblak, since the remaining occurrences of /i/ in the language are weak with respect to stress placement and susceptible to elision. Writing conventions can also point to the directionality of the change. As mentioned in \$3.4.3, changing writing conventions in Menya may suggest that the clusters in that language are a product of recent vowel reduction and deletion (Whitehead 2004: 9, 226). In Lezgian, the process of high vowel syncope which has recently made syllable patterns more complex is well-documented by orthographic evidence (Haspelmath 1993: 36-8). Finally, in Tzeltal Aguacatenango, syllable patterns have recently become more complex as a result of loanwords becoming nativized. Native maximum onsets in the language are of the form /s  $\int h/ + C_2$ , with the initial consonant corresponding to a prefix. Kaufman reports that these prefixes may now be attached to Spanish loanwords with initial consonant clusters, resulting in triconsonantal onsets (Kaufman 1971: 14).

It is far rarer to find clear cases of ongoing simplification of syllable structure patterns in the language sample. Variable processes of cluster-simplifying vowel epenthesis and consonant deletion were not systematically collected for all languages of the sample; however, they were noted wherever observed.<sup>37</sup> There are three languages in the sample for which syllable structure seems to be unambiguously undergoing simplification. The case of Jemez was discussed in §3.2.3. In this language, which has canonical simple codas, processes of coda deletion operate in all environments except for

<sup>&</sup>lt;sup>37</sup> Note that cases of (morpho)phonological epenthesis are not considered in this discussion. Recall from the discussion of methods in §3.2.1 that processes of vowel epenthesis which were reported to be invariable were considered to be part of the canonical syllable pattern of the language.

utterance-finally (Yumitani 1998: 22-4). The resulting extremely low frequency of phonetic codas is what justified the inclusion of this language in the Simple category. In Passamaquoddy-Maliseet, apostrophes are now used in the practical orthography to represent consonants which were once pronounced but are now absent from clusters (e.g., *'tomakéyu* is the modern spelling of what was once *ktomakéyu* 's/he is poor,' Leavitt 1996: 16). It is known from historical transcriptions and the pronunciation of older speakers that these were originally clusters and have recently undergone simplification. In Chipaya, historical records indicate that triconsonantal onsets used to occur as a result of the affixation of personal prefix *x*-. At present such forms are reported to be obsolete and completely unproductive, though speakers do passively accept them (Cerrón-Palomino 2006: 66).

There are also several ambiguous cases of active syllable structure simplification in the language sample. In the Vietnam dialect of Kim Mun, Clark observes central vowel insertion between the consonants in one of the biconsonantal onset patterns, /kl/ (Clark 2008: 127). However, this report is based on one token in the speech of one informant, and it is not made clear whether this may be a frequent variant of the cluster. In Qawasqar, triconsonantal onsets, including /qsq/ and /qst/, are reported to be unstable in rapid speech: e.g., *qsqar* > *sqar*, 'urine' (Clairis 1985: 393). However, in this language rapid speech may also produce clusters through vowel deletion — e.g. *seqwe* > *sqwe* 'future marker' — so it is unclear that syllable structure complexity is changing significantly in either direction in this language. Finally, as discussed in §3.2.3, Piro also presents an ambiguous case of syllable structure change. Matteson (1965: 24) states that

the very low frequency of triconsonantal onsets had decreased in comparison to a count made a decade previously. However, Hanson, writing nearly half a century later, writes that "words beginning with three consonants in a sequence are very common" (2010: 27).

Taking all of the above patterns into account, we have 22 languages in which synchronic, historical, or comparative evidence suggests that syllable structure has recently become more complex. By comparison, there are three languages in which similar evidence strongly suggests that syllable patterns have become simpler. For one language (Vietnam Kim Mun), a very weak case could be made for simplification. Finally, Qawasqar and Piro present ambiguous cases in which syllable structure change does not show a preference for directionality, or there are conflicting reports regarding this phenomenon.

Interestingly, two of the three strong cases for ongoing syllable structure simplification — Jemez and Passamaquoddy-Maliseet — are endangered or in obsolescence. This outcome is consistent with observations by Romaine (2010) and Cook (1989) regarding the effect of obsolescence on phonological structure, though it should be noted that some obsolescing languages, including Cocama, Choctaw, and Karok, have processes of vowel reduction which produce more complex consonant clusters.

There are many historically documented cases of syllable structure simplification. Historical and modern varieties of English provide many such examples: e.g., simplification of /kn/ and /gn/ onsets in Middle English (Minkova 2003), coda deletion and simplification in African American Vernacular English (Rickford 1999), and coda simplification and debuccalization in Singapore English (Deterding 2007). However, as a

gradient, phonetically motivated process, simplification of syllable structure seems to be much rarer than an increase in syllable structure complexity, at least in the current sample. That is, the reported phonetic patterns in the language sample suggest that syllable structure change is more often in the direction of increased complexity. This is a puzzling result when the cross-linguistic distribution of syllable complexity is considered. If the phonetic processes are indicative of a uniform trend towards complex syllable structure, we would perhaps expect the global proportions of languages with Complex and Highly Complex syllable patterns to be much higher than they are. I do not discount that the distribution of phonetic processes discussed above could reflect common biases in phonological analysis, or perhaps more rapid processes of phonologization of vowel epenthesis and consonant deletion patterns as compared to vowel deletion, for whatever reason. Perhaps ongoing research on listener/researcher bias in identifying syllable patterns (Kwon et al. 2017) could shed some light on these issues.

### 8.4.2 Clues from the cross-linguistic patterns

We know from historically documented processes of syllable structure change in specific languages that unstressed vowel deletion is a common source of the consonant clusters associated with highly complex syllable structure. Snapshots of 'before' and 'after' states of syllable patterns in a language are useful because they illustrate the direct and dramatic effect of unstressed vowel deletion on syllable structure. However, such reports might overlook the relationship between these processes and other parts of the phonology and grammar. If the reductive patterns which eventually manifest as vowel

deletion have a long history in a language, effects that they have long before vowel deletion becomes prevalent may not be recognized as directly related to the process of syllable structure change. Examination of the cross-linguistic trends may reveal these subtle patterns and allow us to 'fill in' other cross-linguistically common steps in the process which might not otherwise be apparent when looking at specific case studies. Trends in syllable patterns, segmental inventories, suprasegmental properties, and processes of vowel reduction and consonant allophony established in this study suggest some potential links in the chain of developments leading to the emergence of highly complex syllable structure. I discuss these here.

An interesting finding in the analysis of syllable structure in §3.3.2 was that large maximum clusters in one syllable margin tended to imply similarly large maximum clusters in the other syllable margin. As mentioned in that analysis, this is not an expected distribution if we consider onsets and codas to be independent structures. From a diachronic point of view, this suggests that complex onset and coda patterns may not be independent in terms of their development, especially in situations of extreme vowel reduction and loss. This relates to the findings regarding the morphological complexity of highly complex clusters (§3.3.6) and the higher degrees of synthesis observed in these languages (§8.2). Assuming morphologically or lexically conditioned stress, in a language with a high degree of synthesis and both prefixation and suffixation, we would expect processes of unstressed vowel deletion to create large heteromorphemic consonant clusters at both word edges. Also related to these issues are the findings that syllabic consonants are more frequently found in the Highly Complex portion of the sample, and

that they are most frequently found to belong or correspond to grammatical morphemes in that group. Such patterns may reflect similar sources of unstressed vowel reduction in affixes, though perhaps with different temporal effects on articulation.

The analysis of segmental patterns in Chapter 4 similarly revealed that languages in the Highly Complex category are more likely to have specific consonant articulations than other languages in the sample. In particular, palato-alveolar, uvular, ejective, and affricate articulations were strongly associated with this category. A survey of historical and synchronic processes known to produce these articulations revealed that these tend to come about through processes of assimilation and fortition, which often correspond to the temporal overlap of consonant and vowel (or glottal) articulations, or strengthening of gestures in certain domain or vocalic environments. The tendency of languages in the Highly Complex category to have such sounds suggests that such processes were once prevalent enough in the languages' histories to phonologize into segmental patterns. Further, the presence of such segments in a language becomes more likely with increasing syllable structure complexity, which suggests that these processes may be interconnected in some way with the development of complex syllable patterns.

The analysis of suprasegmental patterns in Chapter 5 yielded some unexpected results, in that the Highly Complex category was not found to be strongly associated with lexically- or morphologically- conditioned word stress. Additionally, languages with Highly Complex syllable structure were not found to be more likely to have unstressed vowel reduction than languages in the Moderately Complex or Complex categories. The latter result was elucidated in the study of vowel reduction in Chapter 6. There it was

found that in languages with unstressed vowel reduction, the average number of distinct processes of that kind increased with syllable complexity. This suggests a sort of 'snowball effect' in which vowel reduction patterns conditioned by stress may gradually become more prevalent in a language even as syllable patterns are affected in their path. What causes this increasing reductive tendency is not entirely clear. It was expected that such extreme effects of stress would be more likely in languages with morphologicallyor lexically-conditioned (unpredictable) stress, as previously found in the literature (Bybee et al. 1998, Schiering 2007). However, most of the stress systems in the Highly Complex group were not unpredictable. Further, 5/7 languages with unpredictable stress in the Highly Complex group were found to have the average number of vowel reduction processes for that group: just two processes. Meanwhile, some languages with fixed stress were found to have a higher than average number of vowel reduction processes (e.g., Piro with 3, O'odham with 5).

One diachronic account for this unexpected mismatch between the vowel reduction patterns and the stress patterns could be that languages with Highly Complex syllable structure are likely to have had unpredictable stress systems at an earlier point in their histories. In such a scenario, a language with relatively simple syllable structure and lexically- or morphologically-determined stress patterns and a high degree of synthesis develops a pattern of unstressed vowel reduction. As vowels are reduced and deleted, stress shifts accordingly with respect to word edges. Say in such a scenario that stress is stem-initial and the language has phonologically short, unstressed grammatical prefixes. If vowel reduction deleted all vowels in prefixes in such a language, it could eventually

have the effect of causing the stress system to become a fixed initial system rather than an unpredictable system. Such processes, if cross-linguistically common, could account for the unexpectedly high rate of fixed stress systems in the Highly Complex group.

There are a few other cross-linguistic findings that may relate to the diachronic development of syllable structure complexity. In Chapter 6 it was found that deletion of /ə/ was a common process type in the Highly Complex category. In fact, though phonemic /ə/ could be found in languages from all categories of syllable structure complexity, this sound was specifically targeted for further reduction only in languages in the Highly Complex category. Since [ə] is often the outcome of vowel reduction, processes deleting /ə/ may be indicative of a long history of vowel reduction in a language.

Finally, the analyses in Chapter 7 sought in part to determine the distribution of allophonic processes producing articulations associated with the Highly Complex category, as well as other specific processes of consonant-to-vowel assimilation and fortition. It was found that processes producing palato-alveolars, affricates, palatalization, and increased constriction, specifically, were more prevalent in languages with Simple syllable structure. Further, stress was much more likely to condition such processes in languages of the Simple category than in others. When this trend is plotted against the trend for stress-conditioned vowel reduction, the resulting pattern indicates that as syllable structure complexity increases, stress decreasingly affects consonants and increasingly affects vowels. If the syllable structure complexity scale is considered to be a diachronic cline, what this suggests is that, during the development of syllable structure

complexity, stress affects consonants first and vowels later. Though the results in Chapter 7 did not paint so straightforward a picture, what this suggests in terms of syllable complexity and segmental inventories is that consonant articulations associated with the Highly Complex group may develop before the syllable patterns associated with these languages.

As mentioned in previous chapters, there is always the risk when conducting typological studies that strong cross-linguistic trends may be an epiphenomenon emerging from several distinct smaller-scale patterns. Many of the analyses in this dissertation have shown that is not the case, as the patterns can be found in diverse groups of languages. However, it is important to see if the diachronic paths which have been inferred from the cross-linguistic trends are plausible at a local level before positing them to be common paths of syllable structure change. In the following section I conduct such a study.

### 8.4.3 Comparisons of related pairs of languages in sample

Recall in §2.1.3 that the language sample was constructed so as to include pairs of related languages with differing degrees of syllable structure complexity. Here we compare these pairs to see if the cross-linguistic associations between syllable structure complexity and phonological and morphological patterns hold at the local level, in which case the diachronic paths discussed above may be more plausible. Where relevant, I also mention historical and comparative evidence that may further shed light on the mechanisms behind the divergent patterns.

### 8.4.3.1 Uto-Aztecan: Ute and Tohono O'odham

Ute and Tohono O'odham both belong to the Uto-Aztecan family of languages, a family with large geographic spread in the western region of the United States and Mexico. Ute is a member of the Numic branch of the Northern division of the family, which also includes Shoshone, Northern Paiute, and Chemehuevi. At time of contact with Spanish and Anglo settlers, it was indigenous to the mountains of western Colorado and eastern Utah (Givón 2011). Tohono O'odham is a member of the Tepiman branch, which includes closely related Pima, as well as the Tepehuan languages of northern Mexico. It is spoken in southern Arizona and northern Sonora (Zepeda 1983).

Ute has been classified in the Simple category in the current language sample, though its syllable patterns are technically Moderately Complex (see discussion in §3.2.3). Tohono O'odham has Highly Complex syllable structure as a prevalent pattern. A summary of the phonological properties of these languages, as they relate to the studies of the dissertation, can be found in Table 8.2.

	Ute	Tohono O'odham
Syllable patterns	Simple	Highly Complex (prevalent)
Maximum syllable margins	Onset: 1; Coda: 1	Onset: 4; Coda: 4
Syllabic consonants		obstruents
C phoneme inventory	/p t k ? t͡j ß s ɣ m n r w j/	/p b ț d d k g ? t͡j d̄ʒ s s h m n ŋ ŋ ľ ß j/
N C phonemes	13	20
Articulations/contrasts associated with <i>Simple</i> category	Flap/tap	Flap/tap Voicing distinction in obstruents
Articulations/contrasts associated with <i>Highly</i> <i>Complex</i> category	Palato-alveolar Affricate	Palato-alveolar Affricate
Word stress present?	Yes	Yes
Stress placement	Fixed	Fixed
N V reduction processes	3	5
Vs affected by reduction	all	all, short
V reduction environments	Consonant, Stress, Word	Consonant, Stress, Word, Phrase
V reduction outcomes	Devoicing	Devoicing, Quality, Deletion
C allophony resulting in S articulations, lenition/sonorization	Obstruent voicing Flapping Spirantization	_
C allophony resulting in HC articulations, C-to-V assimilation, fortition	Labialization Palatalization	

Table 8.2. Comparison of phonological properties of Ute and Tohono O'odham.

This segmental patterns of this pair of Uto-Aztecan languages largely conforms to the cross-linguistic patterns established in previous chapters for Simple and Highly Complex syllable structure. Tohono O'odham has syllabic obstruents, while Ute has no syllabic consonants at all. The consonant phoneme inventory of Tohono O'odham is larger than Ute's by seven consonants. However, both languages have consonant articulations which are associated with both the Simple and Highly Complex categories: both have flap/tap, palato-alveolar, and affricate articulations. Additionally, Tohono O'odham has a voicing distinction in affricates. Voiced affricates make up much of the difference in consonant phoneme inventory size between the languages.

The suprasegmental and allophonic patterns of Ute and Tohono O'odham are also somewhat in line with the predictions. Both languages have word stress and vowel reduction, but the number of distinct reductive patterns in Tohono O'odham is greater. While both languages have both domain- and stress-conditioned vowel reduction, the number and extremity in outcomes is greater for Tohono O'odham, and processes also target short vowels in this language. Finally, Ute is found to have a number of different kinds of allophonic processes affecting consonants. These include consonant-to-vowel assimilation, but also processes of lenition and sonorization. Tohono O'odham has none of the types examined here.

Finally, the morphological patterns of the two languages show mixed results. Ute has a much higher morpheme/word ratio than Tohono O'odham: 2.3 as compared to 1.4. In Tohono O'odham, all of the maximum syllable onset and coda patterns are heteromorphemic, and syllabic obstruents always correspond to grammatical particles (determiners and conjunctives, specifically).

Of the two languages examined here, Ute has syllable patterns which are more typical of general Uto-Aztecan patterns. Of the seven Uto-Aztecan languages included in the survey by Maddieson (2013a), four languages have Moderately Complex syllable structure, two Complex syllable structure, and the other language was Tohono O'odham.

This suggests that the Tohono O'odham syllable patterns are a novel, perhaps relatively recent development in the family. Comparing the consonant allophony processes of Ute against the consonant phoneme inventory of Tohono O'odham, and the details of vowel reduction processes in the former versus the latter, it does seem plausible that the phonological patterns of Tohono O'odham may have evolved from a system that once looked like Ute.

### 8.4.3.2 Arawakan: Apurinã and Piro

Apurinã and Piro both belong to the Arawakan family of languages, a large language family with wide geographical spread throughout Central America and the northern half of South America. Apurinã and Piro both belong to the small Purus branch of Arawakan, also known as South-Western Arawak. Apurinã is said to be Piro's closest linguistic relative (Facundes 2002). Apurinã is spoken along the tributaries of the Purús River in the southern part of Amazonas state in Brazil, while Piro is spoken in the Madre de Dios region of Peru (Aikhenvald 1999).

Apurinã has Simple syllable structure, while Piro has been classified as having Highly Complex syllable structure as an intermediate pattern (see discussion in §3.2.3 about complications for classifying syllable patterns in Piro). A summary of the phonological properties of these languages can be found in Table 8.3.

	Apurinã	Piro	
Syllable patterns	Simple	Highly Complex (intermediate)	
Maximum syllable margins	Onset: 1; Coda: 0	Onset: 3; Coda: 0	
Syllabic consonants		(conflicting reports)	
C phoneme inventory	/p t k t͡s t͡ʃ s∫h m n ŋ r j ɰ/	/p t c k t͡s t͡ʃ s ʃ ç ĥ̃ m n l r w j/	
N C phonemes	14	16	
Articulations/contrasts associated with <i>Simple</i> category	Flap/tap	Flap/tap	
Articulations/contrasts associated with <i>Highly</i> <i>Complex</i> category	Palato-alveolar Affricate	Palato-alveolar Affricate	
Word stress present?	Yes	Yes	
Stress placement	Weight-sensitive	Fixed	
N V reduction processes	1	3	
Vs affected by reduction	all	all, /a/	
V reduction environments	Stress, Word	Stress, Word, Phrase/Utterance	
V reduction outcomes	Devoicing	Devoicing, Quality	
C allophony resulting in S articulations, lenition/sonorization	_	Obstruent voicing Flapping	
C allophony resulting in HC articulations, C-to-V assimilation, fortition	Palatalization	Affricate Increased constriction	

**Table 8.3.** Comparison of phonological properties of Apurinã and Piro.

As mentioned in §3.3.5, there are conflicting reports as to whether Piro has syllabic consonants. Matteson (1965) describes the syllable template as having complex onsets, but also describes the consonants which are not directly preceding the nucleus as being syllabic allophones of the consonants. In Chapter 3 I took the onset cluster analysis. In any case, it does not affect the analysis of the language as having Highly Complex syllable structure.

The segmental patterns of Apurinã and Piro show mixed results with respect to the predicted patterns. The consonant phoneme inventory of Piro is larger than that of Apurinã by two consonants. Both languages have two articulations associated with the Highly Complex category (palato-alveolar and affricate) and one articulation associated with the Simple category (flap/tap). Comparing the inventories we see that Piro has one more obstruent in the general palatal region than Apurinã.

In terms of suprasegmentals and allophonic patterns, we find that both languages have word stress and vowel reduction. Piro has more distinct vowel reduction patterns than Apurinã, as predicted. Piro has reduction in quality outcomes as predicted. However, both languages have vowel reduction in stress and domain contexts. As for consonant allophony, the pattern is the opposite of what is predicted: both languages have assimilation/fortition processes, while only Piro has lenition/sonorization processes.

The morpheme/word ratio is 2.1 for both Apurinã and Piro, which is unsurprising given how closely the languages are related. In Piro, maximum onset clusters are heteromorphemic, though biconsonantal onsets may show tautomorphemic or heteromorphemic patterns. If the syllabic consonant analysis is taken, syllabic consonants would occur in both grammatical and lexical morphemes.

Of the two languages compared here, the syllable patterns of Apurinã are more closely aligned with the general patterns of the Arawakan family. Of the six Arawakan languages included in the survey in Maddieson (2013a), five of them have Moderately

Complex syllable structure, none have Complex syllable structure, and the other language is Apurinã. Since Piro and Apurinã are very closely related, this suggests that the highly complex patterns of Piro may have developed relatively recently in history. Comparing cognate forms in Apurinã and Piro given in Facundes (2002: 88-9), missing vowels in the Piro forms correspond to /i e i a o/ in the Apurinã forms, suggesting that the historical vowel deletion processes responsible for creating consonant clusters in Piro were quite general.

### 8.4.3.3 Trans-New Guinea: Koiari and Menya

Koiari and Menya both belong to the Trans-New Guinea family of languages, which is spoken in and around the Highlands region of the island of New Guinea. Koiari is a member of the small Koiarian branch of the family, which consists of six languages. It is spoken in the southeastern peninsular region of New Guinea just inland of Port Moresby (Dutton 1996). Menya is a member of the Angan branch, which consists of about a dozen languages. It is spoken in the Tauri Valley in the eastern region of the Highlands (Whitehead 2004).

Koiari has Simple syllable structure, while Menya has Highly Complex syllable structure, albeit as a minor pattern in the language. A summary of the phonological properties of these languages can be found in Table 8.4.

	Koiari	Menya
Syllable patterns	Simple	Highly Complex (minor)
Maximum syllable margins	Onset: 1; Coda: 0	Onset: 3; Coda: 1
Syllabic consonants		nasals
C phoneme inventory	/b t d k g $\varphi$ ß s h m n l j/	$/p \ t \ k \ q \ ^m b \ ^n d \ ^n g \ ^{\aleph} G \ \widehat{tJ} \ ^p \widehat{d_3} \ h \ m \ n \ n \ \eta \ w \ j/$
N C phonemes	13	17
Articulations/contrasts associated with <i>Simple</i> category	Voicing distinction in obstruents	Voicing distinction in obstruents Prenasalization
Articulations/contrasts associated with <i>Highly</i> <i>Complex</i> category	_	Palato-alveolar Uvular Affricate
Word stress present?	Yes	Yes
Stress placement	Morph. or lexconditioned	(unclear)
N V reduction processes		
Vs affected by reduction		
V reduction environments	_	_
V reduction outcomes		
C allophony resulting in S articulations, lenition/sonorization	Flapping	Flapping Spirantization
C allophony resulting in HC articulations, C-to-V assimilation, fortition	Increased constriction Glide strengthening	_

**Table 8.4.** Comparison of phonological properties of Koiari and Menya.

We find that, with a few exceptions, the patterns of this pair of languages are reflective of the cross-linguistic patterns established for Simple and Highly Complex syllable structure. The segmental properties of Koiari and Menya differ in many of the ways predicted by the cross-linguistic patterns established in previous chapters. Menya has syllabic consonants while Koiari does not. The consonant phoneme inventory of Menya is larger than Koiari's by four phonemes, and includes palato-alveolar, uvular, and affricate articulations, all of which are cross-linguistically more closely associated with complex syllable patterns. The phoneme inventory of Koiari has a voicing distinction in obstruents, which is cross-linguistically more associated with simpler syllable patterns. However, Menya also has two consonant types which are associated with simpler syllable patterns: a voicing distinction in obstruents and prenasalization.

In terms of suprasegmental features and processes, there are not many patterns reported for either language. Both languages have word stress, but neither are reported to have active processes of vowel reduction. In line with the cross-linguistic patterns, both have processes of consonant allophony resulting in lenition or sonorization. Also in line with the cross-linguistic patterns, Koiari has two strengthening processes.

The morphological properties of the two languages also conform to the general patterns established in the dissertation. Koiari has a morpheme/word ratio of 1.5, while Menya has a morpheme/word ratio of 2.5. In Menya, syllabic nasals may occur in both grammatical and lexical morphemes. While it is unclear from the data provided whether the largest maximum onsets in Menya occur in heteromorphemic contexts, biconsonantal onsets show both tautomorphemic and heteromorphemic patterns.

Of these two languages, the syllable patterns of Koiari are more in line with general syllable patterns in the Trans-New Guinea family. Within the Koiarian branch, Barai also has simple syllable patterns (Olson 1973). Elsewhere in the family, Simple and Moderately Complex syllable patterns seem to dominate in most of the branches. For example, the other Trans-New Guinea languages of the sample, Kewa (Engan branch)

and Selepet (Finisterre-Huon branch) also have Simple and Moderately Complex syllable structure, respectively. However, Menya is not alone in Trans-New Guinea in terms of its phonological characteristics. While it does not seem that other Angan languages have consonant clusters quite like those found in Menya, some are similar to Menya in other aspects of their phonology. Kapau has a small consonant system, but has a velar/backed velar (uvular) distinction in its stop series, as well as complex onsets (Alan Healey 1981). Ampeeli has a relatively large consonant system for the region (21 consonants), which includes palato-alveolar, labialized palato-alveolar, and labialized velar series. Syllabic nasals frequently occur in Ampeeli, creating word patterns such as san.tn.n.pa 'striped' and hm.hm?.ma.fa 'you fill a bigger container from a smaller one' (Cochran et al. 1981: 86-7). In the preface to a volume titled *Angan Languages Are Different*, Alice Healey writes that all of the languages in this group "are characterized by phonological complexity unusual in this country" (1981: 4). Common properties of these languages include phonetic and phonemic labialization and palatalization, long strings of consonants with severe co-occurrence restrictions, and extremely complex morphophonemics.

The Angan and Koiarian branches are not posited to be closely related within Trans-New Guinea, so perhaps it is inappropriate to draw strong conclusions about diachrony from this pair of languages. It should be noted that Angan seems to have an outsider status in Trans-New Guinea. Wurm and colleagues remark on the "aberrant" nature of Angan languages within the Trans-New Guinea family and suggest that the characteristics of this branch suggest a "strong super-imposition upon an older, probably

unrelated language type" (1977: 310). This seems to imply a contact or substrate origin for some of the phonological differences that these languages exhibit.

### 8.4.3.4 Niger-Congo: Yoruba and Doyayo

Yoruba and Doyayo both belong to the Niger-Congo family of languages, a huge language family which is spread throughout most of sub-Saharan Africa. There are several taxonomic systems by which the languages in this family are classified and related to one another, some of them conflicting. In my discussion here, I follow the classification system proposed by Williamson (1989). In this classification, both Yoruba and Doyayo belong to different genera within the Volta-Congo subfamily of Niger-Congo. Yoruba, native to Nigeria and now a major language of West Africa, belongs to the Defoid genus. Doyayo belongs to a poorly attested subgroup of the Adamawa genus, and is spoken in the North Region of Cameroon (Wiering & Wiering 1994).

Yoruba has Simple syllable structure and Doyayo has Highly Complex syllable structure as a minor pattern. A summary of the phonological properties of these languages, as they relate to the studies of the dissertation, can be found in Table 8.5.
	Yoruba	Doyayo	
Syllable patterns	Simple	Highly Complex (minor)	
Maximum syllable margins	Onset: 1; Coda: 0	Onset: 1; Coda: 4	
Syllabic consonants	nasals	nasals (variants)	
C phoneme inventory	/b t d j k g $\widehat{kp}$ gb f s $\int h m l$ c j w/	/p t k kp b b d d g gb f v s z h m n ŋ l c w j/	
N C phonemes	17	22	
Articulations/contrasts associated with <i>Simple</i> category	Voicing distinction in obstruents Flap/tap	Voicing distinction in obstruents Flap/tap	
Articulations/contrasts associated with <i>Highly</i> <i>Complex</i> category	Palato-alveolar		
Word stress present?	(disagreement)	(not reported)	
Stress placement	_	_	
N V reduction processes		3	
Vs affected by reduction	_	all, long	
V reduction environments		Consonant	
V reduction outcomes	_	Reduced length, Syllabic C	
C allophony resulting in S articulations, lenition/sonorization	—	Spirantization	
C allophony resulting in HC articulations, C-to-V assimilation, fortition			

**Table 8.5.** Comparison of phonological properties of Yoruba and Doyayo.

The segmental patterns of Yoruba and Doyayo do not fall squarely with the predictions. Doyayo does have a consonant phoneme inventory which is larger than Yoruba's by five consonants. However, both languages have syllabic consonants and consonant articulations associated with the Simple category. Further, Yoruba, but not

Doyayo, has a consonant articulation (palato-alveolar) which is typically associated with the Highly Complex category.

There is not much to compare in terms of the suprasegmental properties and allophonic patterns of the two languages. Doyayo does have vowel reduction, as predicted, and has three such processes; however, the conditioning environment and outcomes are not what is prototypical for the Highly Complex category. Doyayo also has one of the processes of consonant lenition examined here.

Morpheme/word ratios could not be calculated for Yoruba or Doyayo due to lack of available texts. All coda clusters in Doyayo are heteromorphemic, as is common for languages in the Highly Complex category. In Yoruba, syllabic nasals correspond to grammatical morphemes. In Doyayo, syllabic nasals are optional variants of vowel+/n/ sequences in certain phonological contexts in lexical items.

Of the two languages, Yoruba has syllable patterns which most closely resemble the typical patterns of Niger-Congo, which show a range of patterns but tend most often to be Moderately Complex (Maddieson 2013a). Because its closest linguistic relatives are so poorly attested, it is difficult to put the syllable patterns of Doyayo into context. It is clear that the development of syllable complexity is inextricably linked to the morphology of the language: all consonant clusters in the language are heteromorphemic (Wiering & Wiering 1994: 40).

# 8.4.3.5 Indo-European: Darai and Albanian

Darai and Albanian both belong to the Indo-European family of languages, a large family which is spread throughout much of Eurasia. Darai is a member of the large Indic genus of the family which is located in South Asia. It is spoken along the Narayani and Madi Rivers in Nepal (Dhakal 2012). Albanian constitutes its own branch within Indo-European. The Tosk dialect included in this study is spoken south of the Shkumbin River in Albania and northern Greece, and corresponds closely to the standard form of the language.

Darai has Moderately Complex syllable structure, while Albanian has Highly Complex syllable structure as an intermediate pattern in the language. A summary of the phonological properties of these languages can be found in Table 8.6.

	Darai	Albanian	
Syllable patterns	Moderately Complex	Highly Complex (intermediate)	
Maximum syllable margins	Onset: 2; Coda: 1	Onset: 4; Coda: 3	
Syllabic consonants			
C phoneme inventory	$\begin{array}{l} /p \ b \ t \ d \ t \ d \ k \ g \ p^h \ b^h \ t^h \ d^h \ t^h \ d^h \ k^h \\ g^h \ \widehat{ts} \ \widehat{dz} \ \widehat{ts}^h \ \widehat{dz}^h \ \widehat{ts}^h \ \widehat{dz}^h \ s \ h \ m \ n \ n \ r \ l \ \beta \ j/ \end{array}$	/p b t d c ɟ k g t͡s d͡z t͡ʃ d͡ʒ f v θ ð s z ∫ ʒ h m n ɲ l ł ɾ r j/	
N C phonemes	29	29	
Articulations/contrasts associated with <i>Simple</i> category	Voicing distinction in obstruents	Voicing distinction in obstruents Flap/tap	
Articulations/contrasts associated with <i>Highly</i> <i>Complex</i> category	Affricate	Palato-alveolar Affricate	
Word stress present?	Yes	Yes	
Stress placement	Fixed	Morph or lexdetermined	
N V reduction processes	1	2	
Vs affected by reduction	/u/	/ə/	
V reduction environments	Consonant	Consonant, Stress, Word	
V reduction outcomes	Deletion	Deletion	
C allophony resulting in S articulations, lenition/sonorization	Prenasalization Spirantization Debuccalization	_	
C allophony resulting in HC articulations, C-to-V assimilation, fortition	Palato-alveolar Affricate Palatalization Increased constriction	_	

Table 8.6. Comparison of phonological properties of Darai and Albanian.

In segmental terms, Darai and Albanian do not fit the predicted patterns very well. Their consonant phoneme inventories are the same size. Both have consonant articulations which are characteristic of Simple and Highly Complex syllable structure. Albanian has two articulations characteristic of the Highly Complex category (palatoalveolar and affricate), while Darai has only one. The size and composition of the Darai inventory are consistent with areal features of languages of the Indian subcontinent, which typically include distinctions such as voiced aspirate and retroflex stop series.

The suprasegmental patterns and allophonic processes show more conformity to the cross-linguistic patterns. Both languages have word stress and vowel reduction. While both languages have vowel deletion, such processes are conditioned by stress only in Albanian. In terms of the allophonic consonant process types examined here, all of the assimilation and fortition processes in the comparison are found in Darai, in line with predictions. Additionally, processes of lenition/sonorization are reported for Darai but not Albanian.

The morpheme/word ratio could only be calculated for Darai: it was 1.6. The morphological patterns of maximum onset and coda clusters in the languages fit with the trends of the overall language sample: biconsonantal onsets in Darai are always tautomorphemic, while Albanian shows both patterns (heteromorphemic maximum onsets but tautomorphemic maximum codas).

Of the two languages compared here, the syllable patterns of Albanian are perhaps more in line with typical Indo-European patterns. This language family is associated with high syllable complexity; to my knowledge there are no languages in the family with Simple syllable structure and very few with Moderately Complex syllable structure. While the patterns of Albanian may not be atypical within the European region, they are considerably more complex than probably most of the languages in the family, which are concentrated in the Indic branch. The syllable patterns of Albanian are known to have developed long after the split between this branch and the Indic branch. In a

reconstruction of Proto-Albanian, Orel posits that a stress shift prompted by contact with Latin in the late stages of the language conditioned processes of vowel reduction and deletion which created at least some of the unusual onset patterns of Albanian. Unstressed initial vowels were deleted preceding sonorants in a process which later spread to other consonantal contexts: Early Proto-Albanian \**ambi* > Albanian *mbi* 'on, upon,' Early Proto-Albanian *en-grāja*: > Albanian *ngroh* ~ *ngrof* 'to warm' (Orel 2000: 22).

# 8.4.3.6 Austronesian: Maori and Lelepa

Maori and Lelepa both belong to the Austronesian family of languages, another huge language family which has a wide distribution in Southeast Asia and Oceania. Both languages belong to the Oceanic genus, the largest branch of Austronesian which has many subgroups. Lynch et al. (2002) propose that Polynesian, the subgroup which Maori belongs to, and the Vanuatu languages to which Lelepa belongs fall within the same linkage group in the Oceanic genus. Maori is the indigenous language of New Zealand. Lelepa is one of the many indigenous languages of Vanuatu and is spoken on the islands of Lelepa and Efate in central Vanuatu (Lacrampe 2014).

Maori has Simple syllable structure, while Lelepa has Complex syllable structure. A summary of the phonological properties of these languages can be found in Table 8.7.

	Maori	Lelepa	
Syllable patterns	Simple	Complex	
Maximum syllable margins	Onset: 1; Coda: 0	Onset: 3; Coda: 2	
Syllabic consonants		liquids, nasals	
C phoneme inventory	/p t k ф h m n ŋ r w/	$/\widehat{kp}^w \ p \ t \ k \ f \ s \ \widehat{\eta m}^w \ m \ n \ \eta \ l \ r \ w \ j/$	
N C phonemes	10	14	
Articulations/contrasts associated with <i>Simple</i> category	Flap/tap	_	
Articulations/contrasts associated with <i>Highly</i> <i>Complex</i> category	_	_	
Word stress present?	Yes	Yes	
Stress placement	Morph or lexdetermined	Fixed	
N V reduction processes	1	6	
Vs affected by reduction	all	all	
V reduction environments	Word, Utterance	Consonant, Stress, Word	
V reduction outcomes	Devoicing	Quality, Devoicing, Deletion	
C allophony resulting in S articulations, lenition/sonorization		Obstruent voicing Spirantization	
C allophony resulting in HC articulations, C-to-V assimilation, fortition	Affricate Palatalization Glide strengthening	Uvular	

 Table 8.7. Comparison of phonological properties of Maori and Lelepa.

The segmental patterns of Maori and Lelepa largely follow the predictions based on cross-linguistic observations. Though both languages have relatively small consonant phoneme inventories, Lelepa's is larger than Maori's by four consonants. Lelepa has syllabic nasals and liquids, while Maori has no syllabic consonants. Maori has one consonant articulation associated with the Simple category, while Lelepa has no articulations associated with the Simple or Highly Complex categories. It should be noted here, however, that the Polynesian subgroup is believed to have undergone a dramatic loss of consonants as compared to other branches of Oceanic as the language family dispersed (Trudgill 2004). Therefore the consonant phoneme inventory of Maori is unusually small for the Oceanic group in general.

The suprasegmental patterns and allophonic processes of Maori and Lelepa correspond quite well to the prototypical patterns for the Simple and Highly Complex categories, respectively. Both languages have word stress and vowel reduction, with Lelepa having six distinct patterns and Maori only one. Domain environment conditions vowel reduction in Maori, while stress and consonantal environment additionally condition vowel reduction in Lelepa. The outcomes of vowel reduction in Lelepa are more extreme, as is typical for languages with more complex syllable structure. As for consonant allophony, Maori has assimilation and fortition processes. Lenition/ spirantization processes occur in Lelepa, as does an assimilation process producing uvulars. But note that this is not out of line with the cross-linguistic patterns: processes producing uvulars were found to occur only in languages with Moderately Complex or Complex syllable structure in §7.3.2.

Lelepa has a morpheme/word ratio of 1.4, but this index could not be calculated for Maori. In Lelepa, maximum onset and coda clusters are tautomorphemic, though biconsonantal onsets may show both patterns (see example 3.24 in §3.3.6). Syllabic liquids and nasals in Lelepa occur as positional variants in certain phonological environments. It is unclear whether these variants occur in grammatical morphemes.

Of the two languages examined here, Maori has syllable patterns which are more characteristic of typical Austronesian, and especially Oceanic, patterns. Four of the seven Austronesian languages included in the current study have Simple syllable structure. Lelepa has syllable patterns which are quite unusual for the family. Languages of Vanuatu are generally well-known for having unusual phonological features (cf. Maddieson 1989b on linguolabial consonants in Vanuatu). While the syllable patterns of Lelepa are not typical for languages of Vanuatu, they are more typical in comparison to an immediately adjacent language. In South Efate, Thieberger reports invariable complex onsets in forms such as *nskau* 'reef' and *tkau* 'hook' (Thieberger 2004: 63, 74). In fast speech there is an ongoing process of unstressed medial vowel deletion, the vowels of which can still be recovered in careful speech: e.g., tesa > tsa 'child' (ibid. 75). Thieberger states that this pattern was noted as early as 1926, and may reflect a long process of change that sets South Efate apart from its northern neighbors. Further south in the archipelago, Erromangan has complex onsets and a rich system of intervocalic clusters: *nrvat* 'four,' *wemplan* 'butterfly' (Crowley 1998: 20-2). The author suggests these came about through unstressed vowel reduction; there is also a productive process of word-initial vowel reduction in language.

# 8.4.3.7 Summary of patterns

Comparing pairs of related languages with differing syllable patterns, we find a fair amount of variation in the extent to which their phonological patterns conform to the 'prototypical' patterns of languages in the Simple and Highly Complex categories

established earlier in the dissertation. Some patterns were more consistent than others: 5/6 of the pairs followed the predicted pattern by which the language with more complex syllable structure had a larger consonant phoneme inventory. The pairs also typically fell in line with the predictions regarding syllabic consonants, consonant allophony, and morphological properties.

Patterns within segment inventories were less predictable: languages often had articulations associated with both ends of the syllable structure scale. It is actually not appropriate to expect some of these segmental patterns, such as the lack of a voicing distinction in obstruents in languages with more complex syllable structure, to be categorical. While languages with Highly Complex syllable structure are less likely to have a voicing distinction in obstruents than languages with Simple syllable structure. languages from all groups were more likely than not to have this distinction in the analysis in §4.4.3. Similarly, while the percentage of languages with affricates is higher in the Highly Complex category than the Simple category, in general at least half of languages from all categories had these sounds (§4.4.5), so it is not reasonable to expect that languages in the Simple category are likely to lack them. Nevertheless, even disregarding those articulations, there are unexpected patterns in the comparisons above: e.g., the presence of prenasalization in Menya (Highly Complex) but not Koiari (Simple), and the presence of palato-alveolars in Yoruba (Simple) but not in Doyayo (Highly Complex).

Word stress is relevant in 5/6 pairs, and it is notable that in each of these pairs, both members are reported to have word stress. This suggests that stress was relevant in

the incipient stages of syllable structure change in the languages that eventually developed more complex syllable structure. A comparison of stress placement does not reveal strong trends. Sometimes the language with more complex syllable structure had more predictable stress placement patterns than its counterpart, sometimes not. The question of stress predictability and syllable structure change is still very much a puzzle in light of this data.

The related pairs are most reflective of the cross-linguistic trends in their vowel reduction patterns. In all pairs except for Trans-New Guinea, vowel reduction is more prevalent in the language with more complex syllable structure. The effects of vowel reduction are also more extreme in the languages with more complex syllable structure in 3/4 languages for which vowel reduction is reported for both members of the pair. The Indo-European and Austronesian pairs follow the cross-linguistic trend by which languages with more complex syllable structure have stress-conditioned vowel reduction and languages with simpler syllable structure have other (usually domain) conditioning environments. In Uto-Aztecan and Arawakan, stress conditions vowel reduction in both members of the pair.

Some of the diachronic implications taken from the cross-linguistic trends in the sample find support in the pairs of languages examined here. Word stress and a high degree of morphological synthesis are relevant factors in the development of highly complex syllable structure. Vowel reduction persists and is in fact more prevalent and extreme in the members of the pairs which have higher syllable complexity. The size of consonant segment inventories is consistently associated with syllable structure

complexity, and the allophonic patterns producing articulations associated with Highly Complex syllable structure were largely found in the languages with simpler syllable structure, as expected. However, the specifics of segmental patterns did not generally match up as expected with syllable complexity. This suggests that phonologization of the consonant allophony processes observed in languages with simpler syllable structure may proceed in a different manner than expected, or that mechanisms of phonemicization are highly language-specific and proceed differently in different languages. Clearly there are many potential factors at play in the development of consonant phoneme inventories. An additional complication is that the pairs of related languages compared above may represent a variety of time depths, and that where the time depth is considerable (as with Darai and Albanian), there is a greater likelihood that the phenomena examined here have been influenced by other language-internal and -external factors.

In the following section, I revisit the historically attested case of Lezgian in order to compare it with the findings here.

## 8.4.4 The case of Lezgian

To my knowledge there are no cases of languages shifting from Simple syllable patterns to Highly Complex syllable patterns for which all stages of the process are historically documented. However, Lezgian presents a historically documented situation of dramatic syllable structure change in one syllable margin in the language.

Lezgian has recently undergone a process of high vowel syncope preceding stressed syllables, which changed its earlier canonical syllable structure of CV(C)(C) to

today's (C)(C)CV(C)(C) pattern. As discussed in §6.1, processes of syncope continue to this day in the language. Transcriptions by Petr K. Uslar in 1896 suggest at first glance that pretonic high vowel syncope had not yet taken place: cf. Uslar's transcription  $\chi iper$ and modern transcription  $\chi per$  'sheep (pl.)' (Haspelmath 1993: 36). However, Haspelmath (1993: 56) states that Uslar may have used the high vowel transcriptions to represent the residual palatalization and labialization left on the preceding consonant by the deletion process. These remnants of the reduction process can still be observed in some modern forms (as also noted by Chitoran & Babaliyeva 2007). Haspelmath notes that where modern spelling represents the pretonic high vowel, there is usually still palatalization or labialization on the consonant in pronunciation (8.3).

(8.3) Lezgian (*Nakh-Daghestanian*; Azerbaijan, Russia)

Standard spelling	Phonemic form	gloss
čükwer	$\widehat{tJ}^{\rm hw}\chi^{\rm w}er$	'pear'
kifer	k <sup>hj</sup> fer	'plaits'

(Haspelmath 1993: 37)

Perhaps this is not such a clear case of historical attestation of all stages of a shift to Highly Complex syllable structure after all. However, another comment of Haspelmath's hints at the implications this process has for the segmental patterns of the language: "The preservation of palatalization and labialization after vowel syncope means that theoretically one would have to add more than a dozen palatalized and labialized-palatalized obstruent phonemes to the consonant inventory. This is not done here because the change of vowel syncope is very recent and more research is needed to determine precisely all its implications."

(Haspelmath 1993: 38)

To put Haspelmath's quote in context, the consonant phoneme inventory of Lezgian numbers 54 consonants and already has a number of labialized consonants (8.4).

# (8.4) Consonant phoneme inventory of Lezgian

/p p<sup>h</sup> b t t<sup>h</sup> d t<sup>w</sup> t<sup>wh</sup> k k<sup>h</sup> g k<sup>w</sup> k<sup>wh</sup> g<sup>w</sup> q q<sup>h</sup> q<sup>w</sup> q<sup>wh</sup> ? p' t' t'<sup>w</sup> k' k'<sup>w</sup> q' q'<sup>w</sup> ts ts<sup>h</sup> ts<sup>w</sup> ts<sup>wh</sup> tf tf<sup>h</sup> ts' ts'<sup>w</sup> tf' f s z s<sup>w</sup> z<sup>w</sup>  $\int \Im x \chi \kappa \chi^w \kappa^w h m n l r j w/$ 

In addressing how highly complex syllable structure develops out of relatively simple syllable structure, the Lezgian example provides the following: (i) the process was conditioned by stress, (ii) similar processes operate in the language to this day, (iii) the original process affected high vowels, (iv) consonant allophony associated with this process apparently followed, rather than preceded, the vowel reduction (similarly, any segments which are phonemicized from these patterns will follow the vowel reduction), and (v) since Lezgian has very few prefixes, the process has only created tautomorphemic clusters up to now.

The first two properties are consistent with the cross-linguistic patterns established in this dissertation. The third property is also consistent with the finding that

vowel reduction is more likely to affect high vowels in languages with non-Highly Complex patterns (§6.3.3). The fourth property is not consistent with the patterns suggested by the cross-linguistic data here, which imply that stress may condition consonant allophony before it conditions vowel reduction in a language. Finally, the last pattern is not consistent with the strong role that morphology is expected to play in the development of highly complex syllable structure.

Thus it seems that the case of Lezgian confirms some of the diachronic implications derived from the cross-linguistic patterns in previous chapters, but also diverges with respect to a few of these implications. I will return to this point in §8.4.6. In the following section I turn to a discussion of language contact as a factor in syllable structure change.

#### 8.4.5 Language contact and syllable structure complexity

As mentioned in the introductory chapters of this dissertation, complex syllable structure, and especially highly complex syllable structure, is limited in its geographical distribution. The Pacific Northwest area of North America and the Caucasus region, in particular, are famous 'hotspots' for syllable complexity; in these regions, groups of unrelated languages may be found to have similarly remarkably complex syllable structure (Chirikba 2008, Thompson & Kinkade 1990). As defined in the current study, languages with highly complex syllable patterns may be found in every geographical macro-region (see Figure 8.1). However, despite attempts to make the language sample as

geographically balanced as possible, most of the languages in the Highly Complex category can be found in geographical proximity to others in the category.



Figure 8.1. Geographical distribution of languages in Highly Complex portion of sample.

In Figure 8.1, there are the expected clusters of languages in the Pacific Northwest and Caucasus regions. Smaller clusters of unrelated languages include: Tohono O'odham and Cocopa in the Sonoran Desert region, Passamaquoddy-Maliseet and Mohawk in the northeastern region of the United States, and Qawasqar and Tehuelche in Patagonia. Even three of the languages with Highly Complex syllable structure as a minor pattern — Alamblak, Menya, and Wutung — are found in relative geographic proximity to one another in New Guinea. In most of these regions, there is historical and linguistic evidence of long-term cultural contact (e.g., between the Tepiman and Yuman language families in the Sonoran Desert region, Shaul & Hill 1998). Recall also from the discussions in §8.4.3 that some of the complex members of the pairs were posited (Menya) or known (Lelepa) to be in contact with other languages with similarly complex syllable patterns.

That syllable structure complexity has been described as a feature of linguistic areas such as the Pacific Northwest and the Caucasus suggests that such patterns can spread from one language to another in situations of heavy language contact and bilingualism. Yet we know from observations of loanword adaptation that novel syllable structures are not easily borrowed; one of the major cross-linguistic loci of epenthesis processes is precisely in this context (Hall 2011). This raises the question of how syllable patterns, especially highly complex ones that are cross-linguistically rare to begin with, converge in languages in situations of contact.

It has been noted that in situations of language contact, prosodic and suprasegmental phenomena are more likely to diffuse than phonemes (chapters in Aikhenvald & Dixon 2001b). There is a growing body of empirical evidence for this observation. Mennen (2004) found that Dutch-Greek bilinguals who acquired Greek in adulthood transferred peak alignment patterns from Dutch into their Greek speech. Native speakers of Tswana were found not to apply phrase-final lengthening in their English speech, in accordance with their L1 patterns, setting the intonational properties of their speech apart from those of South African English and Afrikaans English speakers (Coetzee & Wissing 2007). Simonet (2011) reports that Spanish-Majorcan Catalan bilinguals tend to transfer utterance-final pitch accents from their L1 to their L2. In a study of English-Mexican Spanish bilinguals in Los Angeles, Robles-Puente (2014) found that both speakers who had moved to Los Angeles in childhood and those who had

been born in Los Angeles to immigrant parents retained Mexican Spanish intonational contours in their Spanish and English speech.

As discussed in previous chapters, the component of speech prosody which has been most often associated with syllable complexity is speech rhythm. Instrumental investigations providing evidence for the influence of L1 rhythmic patterns on L2 (and sometimes vice versa) are becoming more prevalent in the literature. White & Mattys (2007) measured acoustic correlates of rhythm in native and non-native English, Dutch, Spanish, and French speech. They found that L1 has an effect on L2 which is observable in the rhythm metrics VarcoV (standard deviation of vocalic interval duration divided by the mean vocalic duration) and %V (proportion of vocalic intervals). In L2 speech, the values for these metrics usually fell somewhere between the values measured for native speech in each of the languages. A comparison of the Pairwise Variability Index (PVI) metric in the speech of Spanish monolinguals and speakers of Hispanic English revealed a Spanish substrate influence on the speech of the latter (Carter 2005). Further, the rhythmic properties of Hispanic English were found to be quite uniform across speakers regardless of generation, which the author suggests may be indicative of long-term persistence of the substrate influence. Robles-Puente (2014) found that English-Spanish bilinguals who had been in Los Angeles since childhood or were raised there by immigrant parents showed Spanish-like rhythm in both languages. Finally, the effect may go the other way as well: Afrikaans-Spanish bilinguals who had been living in a Spanishdominant environment (in Patagonia) for at least two-thirds of their lives were found to

show more Spanish-like values for the nPVI-V metric in their Afrikaans speech than nonbilingual Afrikaans speakers (Coetzee et al. 2015).

Because the rhythm metrics mentioned in the research above correspond to durational properties of consonant and vowel intervals, they may reflect timing patterns which relate directly to syllable structure complexity. There is at least one case in which the instrumentally-confirmed rhythmic properties of a language correspond to a historically documented process of contact-induced syllable structure change. This is the case of Moroccan Arabic.

Dialects of Arabic spoken in North Africa, also known as Western Arabic, have often been said to have phonetic and rhythmic properties which differ markedly from those of the dialects spoken in the Middle East (Eastern Arabic dialects). In a perceptual experiment, native speakers of various dialects of Arabic were able to correctly identify Arabic speakers as coming from North Africa or the Middle East 98% of the time (Barkat et al. 1999). In this task, speakers mentioned that the perceptual characteristics of Western Arabic which helped them make this identification were that it sounded "faster" than Eastern Arabic and had a "jerky" or "halting" sound (Ghazali et al. 2002). All varieties of Arabic have been described as stress-timed in the literature; however, the salient perceptual differences between Western and Eastern Arabic have prompted instrumental investigations into the nature of rhythmic timing in the various dialects. An analysis of the acoustic properties of Western (specifically Moroccan, Algerian, Tunisian) and Eastern (specifically Egyptian, Jordanian, Syrian) dialects of Arabic revealed extreme differences in their values for metrics used to quantify speech rhythm properties (Hamdi

et al. 2004). Western Arabic dialects had values for  $\Delta C$  (standard deviation in consonant intervals) and %V (proportion of vocalic intervals) which were even more extreme than those found for the 'prototypical' stress-timed language English. The  $\Delta C$  and %V values for Eastern Arabic dialects put these languages closer to French, which is said to have syllable timing. Of the three Western Arabic dialects, Moroccan Arabic had the most extreme high  $\Delta C$  and low %V values. The authors attributed this pattern to the frequent deletion of short vowels in this dialect, which creates consonant clusters and syllabic consonants, and also to the generally shorter duration noted for both phonologically long and short vowels in this dialect as compared to Eastern Arabic dialects.

Chtatou (1997) notes that the phonetics, phonology, morphology, and lexicon of Moroccan Arabic have been heavily influenced by contact with the Amazigh (Berber) languages indigenous to the region, including Tamazight, Tarifit, and Tashlhiyt, with influences being likened to heavy substrate effects. In the most recently Arabized regions, Moroccan Arabic may be so phonetically different from other Western dialects of Arabic that speakers of the other dialects have trouble understanding it (ibid. 105). Some of the phonetic differences can be attributed to patterns of vowel reduction resulting in complex consonant clusters. Recall from previous examples in the dissertation that Tashlhiyt has highly complex syllable structure due to the prevalence of syllabic consonants in the language, which may result in long word-marginal strings of consonants or even words without vowels. In accordance with the phonetic patterns of local Amazigh dialects, Moroccan Arabic varieties are characterized by rampant vowel reduction resulting in tautosyllabic clusters or syllabic consonants, depending on the analysis. This is apparent

when comparing Classical Arabic (CA) forms to their Moroccan Arabic (MA) equivalents: e.g., CA /na.di.ma/ > MA /n.dm/ 'to regret;' CA /ta.qa:.ba.la/ > MA /t.qa:.bl/ 'to meet' (Chtatou 1997: 110). We see from comparison with Eastern dialects of Arabic that this pattern is unique to Moroccan Arabic. Other dialects have kept most of the vowels of Classical Arabic, though vowel quality changes may have occurred (8.5):

(8.5) Comparison of forms in Classical Arabic, Eastern dialects, and Moroccan Arabic
CA *katabtu* > Egyptian Arabic *katabt* > MA *ktbt* 'I wrote'
CA *taktubu* > Saudi Arabic *tiktib* > MA *ka tktb* 'you (M) write'
CA *taskunu* > Iraqi Arabic *tiskin* > MA *ka tskn* 'you (M) live'

(Chtatou 1997: 111-12)

This pattern of vowel deletion is extremely productive and applied quite generally to loanwords. The most common pattern in syllable structure adaptation in lexical items from Classical Arabic is the deletion of short vowels and the preservation of long ones, as in the word for 'to meet' given above. Similar patterns may be observed in the adaptation of French loanwords into Moroccan Arabic: e.g., Fr. *direction* > MA *drksjum* 'direction;' Fr. *tracteur* > MA *trktu:r* 'tractor' (1997: 116; note that the final stressed vowel has been retained). Sayahi (2005) describes a number of patterns by which vowel-initial Spanish loanwords into Moroccan Arabic are made to have more complex syllable structure: e.g., Sp. *equipo* > MA *lkipo* 'team;' Sp. *espia* > MA *spia* 'spy;' Sp. *enfermero* > MA *frmiro* 'nurse.'

The phenomenon described above is quite interesting, because reported instances of nativization of syllable patterns in the literature tend to involve the simplification of patterns; e.g. English *technostress* > Japanese *tekunosutoresu* (Kay 1995: 69). Similarly, when languages with complex syllable structure borrow words from languages with simpler syllable structure, segmental patterns are often nativized, but syllable patterns are usually retained; e.g. Japanese *tsunami* [tsunami] > English [su]*nami*; English *Hamlet* > Russian [g]*am*[l<sup>i</sup>]*et*. Both Moroccan Arabic and Amazigh varieties have phonological words which are similar in shape to the Classical Arabic, French, and Spanish source words given above; e.g., Tashlhiyt tifunasin 'cows,' Moroccan Arabic hadak 'DEM.' Thus it is not readily apparent why loanwords would be borrowed in such a way as to create such complex onsets. This is a case in which morphosyntactic patterns of the language may have some effect on the phonological adaptation of loanwords. In Moroccan Arabic, as in Tashlhiyt, the inflectional morphology of the language relies in part on nonconcatenative processes which can be lexically determined and dependent upon the phonological form of words, many of which have complex clusters and also tend to be monosyllabic (Heath 2007). Perhaps loanword adaptation is in part affected by analogy to such patterns. Nevertheless, as we know from the historical and comparative evidence, those very patterns originated in highly productive patterns of vowel reduction which were carried over from Amazigh.

The case of Moroccan Arabic suggests that native properties of speech rhythm, including vowel reduction and tendencies toward longer consonant intervals and shorter vowel intervals in speech, may be transferred by speakers to an L2 much in the same way

that intonational contours are transferred. In situations of intense cultural contact and high rates of bilingualism and multilingualism, it is easy to imagine rhythmic properties being transferred in this way among unrelated languages with the effect that similar syllable patterns may be found in them.

## 8.4.6 Development of highly complex syllable structure: conclusions and questions

Syllable structure has long been known to become more complex through processes of vowel reduction. The associations between syllable complexity and other phonetic, phonological, and morphological properties described in this dissertation suggest that the path to highly complex syllable structure additionally tends to include other specific processes and properties in addition to vowel reduction or deletion.

It is clear from the cross-linguistic trends, the comparison of related pairs of languages, and the case study of Lezgian that stress-conditioned vowel reduction, in particular, is almost always relevant in the development of highly complex syllable structure. The findings here also point to the persistence and increasing prevalence of vowel reduction as syllable structure becomes more complex. Morphology too is more often than not a factor, though the Lezgian example shows that this does not always have to be the case.

Consonant inventory size is additionally strongly associated with syllable complexity, and specific consonantal articulations with either end of the syllable complexity scale. However, the cross-linguistic patterns were not strongly upheld in the comparisons of related languages. Meanwhile, the comparison of related pairs of

languages largely showed the expected patterns with respect to a higher prevalence of consonant allophony in the languages with simpler patterns, but in the Lezgian example, C-to-V place assimilation occurs concurrently with, or shortly following, vowel reduction. Perhaps the inconsistent patterns with respect to consonant phonemes and consonant-affecting processes are related to the speed with which vowel reduction affects syllable structure patterns, or even the specific kind of vowel reduction operating within a language (e.g., quality, devoicing, reduction in duration). That is, the same underlying mechanisms for vowel reduction may also condition consonant processes that lead to larger inventories, albeit in complex and varied ways. Without detailed historical accounts, it is difficult to identify the specific patterns that consonant changes may take as part of a larger process of syllable structure change. The consistent differences in consonant phoneme inventory size in languages with simpler and more complex syllable structure suggest that there is a relationship there.

Another important consideration in the development of highly complex syllable structure is the issue of contact and transfer of rhythmic properties from one language to another. It is not clear whether we should expect many correlates of highly complex syllable structure to occur when syllable complexity is increased as a result of rhythmic transfer from one language to another in situations of intense contact. Perhaps this is another case where consonantal patterns may deviate from the predictions derived from the cross-linguistic patterns.

A question that still remains open is how, specifically, the diachronic path leading to highly complex syllable structure gets started in a language. In light of the findings and

discussions above, I have one specific hypothesis which is based on observations of vowel reduction patterns in languages with Simple syllable structure. Recall from the summary of vowel reduction processes in §6.3.6 that the most common process type in the Simple category is the devoicing of vowels at word or phrase/utterance margins. In the comparison of pairs in §8.4.3, 3/4 languages with the simpler syllable patterns (Ute, Apurinã, and Maori) have vowel devoicing as an outcome of vowel reduction. This proportion, though derived from a tiny group of languages, is larger than the overall proportion of languages in the Simple category which have devoicing as an outcome of vowel reduction (6/13). That is, in language families in which both extreme syllable patterns occur, such that there is the phonological and morphological potential for languages with simpler syllable patterns to follow a similar path as their more complex relatives, devoicing is likely to be an outcome of vowel reduction in the languages with simpler patterns. This is interesting, because vowel reduction resulting in devoicing may be a more likely source of incipient syllable structure change than other forms of reduction. This is because devoiced vowels, especially in domain-marginal contexts, may be easily lost or restructured as glottal fricatives or aspiration. In Apurinã, it has been noted that stops become aspirated preceding a devoiced unstressed vowel (8.6).

- (8.6) Apurinã (Arawakan; Brazil)
  - /ka'jati/

[ka'jat<sup>h</sup>i]

'paca (large rodent)'

(Facundes 2000: 60-1)

The Apurinã example suggests that the properties of the devoiced vowel are becoming associated with the consonant, providing an ideal context for sound change, and in this case, syllable structure change.<sup>38</sup> As described in §3.2.3, a similar process of vowel devoicing in Ute has already affected the syllable patterns in that language. If domain-marginal vowel devoicing occurs in a language with word stress, perhaps such devoicing processes could disrupt the rhythmic patterns of the language, leading eventually to a stronger role of stress and associated segmental effects. This topic would be a good avenue for further research.

In Figure 8.2 I show how highly complex syllable structure and its associated properties might develop out of simpler syllable structure and its properties, according to the findings in this dissertation.

<sup>&</sup>lt;sup>38</sup> On the other hand, the aspiration analysis may simply be another way of noting the devoiced vowel.



**Figure 8.2.** Proposed path of development for highly complex syllable structure out of simpler syllable patterns.

In the discussions above I explored how highly complex syllable structure might arise over time in special phonological, morphological, and even sociolinguistic contexts. While there are still open questions regarding the details of these paths, I believe that the evidence shows that the processes involved are quite natural and common patterns of language change, a fact that stands in stark contrast to the frequent description of highly complex structures as marked or dispreferred. In the following section I discuss the longterm stability of these structures.

#### 8.5 Highly complex syllable structure: a stable and motivated pattern

Recall from the discussion of the literature in Chapter 1 that many of the properties of highly complex syllable structure — the size and composition of clusters, the presence of syllabic obstruents, its association with morphological complexity — are cross-linguistically rare and/or theoretically problematic. Abstract theoretical accounts for the structures rarely touch upon practical aspects of these 'dispreferred' patterns such as their maintenance and stability in speech communities in the long term. I discuss some of these issues here.

## 8.5.1 Synchronic stability of highly complex syllable structure

In Chapter 6 it was found that 21/24 of the languages in the Highly Complex category had processes of vowel reduction. The 14 languages in this category with stress-conditioned vowel reduction had on average three such processes as ongoing synchronic patterns. Altogether, processes of vowel deletion or reduction were found to alter syllable patterns in 13 of the languages in this category, either by turning onsets into codas, producing tautosyllabic clusters, or producing syllabic consonants. As mentioned in that chapter, what the cross-linguistic data suggests is that vowel reduction has strongest effects on syllable structure in languages in which such processes have previously altered the canonical syllable patterns.

Because highly complex syllable patterns are so cross-linguistically rare and 'dispreferred,' we might expect to see in these languages more instances of simplification of syllable patterns than instances of syllable structure becoming more complex. As the

discussion of directionality in §8.4.1 suggests, this does not seem to be the case. In that discussion, I mentioned incipient processes of variable epenthesis and historical processes of cluster simplification. Here I present additional information on the stability of highly complex syllable structure by discussing regular (phonologized) processes of epenthesis and active processes of cluster simplification.

An analysis of the languages in the Highly Complex category revealed that nine languages have regular phonological processes of epenthesis which break up consonant clusters. There are two kinds of epenthesis patterns which are characteristic of the languages of this group: processes which break up sequences of sounds which are identical or highly similar (e.g., sequences of sibilants), and processes which break up sequences of two sonorants or a sonorant and obstruent. I give an example of the latter process type in (8.7).

# (8.7) Yakima Sahaptin (Sahaptian; United States)

(a) /?ínm/

[?ínɨm]

'excessively'

(b) /tPjálm/

[tl'jálim]

'Cle Elum (place name)'

(c) /talújm/

[talújɨm]

'nail'

(Hargus & Beavert 2006: 28)

Similar processes can also be found in Kabardian and Doyayo, among others. What is interesting about such patterns is that they do not target the long sequences of obstruents which are prototypical of highly complex syllable structure.

An analysis of active (variable) processes of consonant deletion resulting in cluster simplification turned up similar results. There are ten languages with such patterns. Interestingly, such processes typically affect sonorants or glottal fricatives in these languages. While the affected sound in the example in (8.8) is transcribed as a voiced fricative, it patterns phonotactically with sonorants in Georgian (Shosted & Chikovani 2006: 261).

# (8.8) Georgian (Kartvelian; Georgia)

/vprtsk<sup>h</sup>vni/ [øprtsk<sup>h</sup>vni] ~ [prtsk<sup>h</sup>vni] 'I peel'

(Shosted & Chikovani 2006: 261)<sup>39</sup>

<sup>&</sup>lt;sup>39</sup> Elsewhere in the dissertation I have followed Aronson (1991) in transcribing the voiced labial fricative of Georgian as bilabial  $\beta$ ; however, some researchers classify it as a labiodental  $\nu$ . I use  $\nu$  in this example to preserve Shosted & Chikovani's transcription.

Again, the prototypical syllable patterns of these languages are not strongly affected by such processes. It should also be noted that four of the languages with processes like these have Highly Complex structures as a minor pattern (Alamblak, Kunjen, Menya, and Wutung).

The distribution of processes of epenthesis and consonant deletion, as compared to the distribution of vowel reduction processes, suggests that despite theoretical issues of analysis, highly complex syllable structure is neither problematic for speakers, nor synchronically unstable in speech communities. The phonetic processes responsible for creating these syllable patterns appear to be both remarkably persistent and more prevalent than processes which 'repair' them, at least in languages which have Highly Complex syllable structure as a prevalent pattern.

# 8.5.2 Diachronic stability of syllable complexity

Complex syllable structure may show long-term stability within language families and regions. This is apparent in examining the geographical distribution of maximum syllable structure patterns. In constructing the language sample for the current study, it was impossible to find the Simple pattern within Eurasia, and very difficult to find such patterns in North America, such that 2/3 languages from this region in the Simple portion of the sample actually have Moderately Complex patterns. If we assume that the complex syllable patterns of these regions developed at some point out of simpler patterns, then the geographical distributions suggest that, once it develops, syllable complexity tends to

persist for long periods of time. Similarly, a recent study of maximum syllable shapes in four proposed linguistic areas found that the patterns were more closely associated with language families than with regions, though there was limited evidence for convergence in parts of the Caucasus and Pacific Northwest (Napoleão de Souza 2017). The author's interpretation of the findings was that syllable structure patterns may be a generally stable phonological property of languages, persisting for long periods of time within language families. If one considers only the universal preference for CV structures, these distributional facts are unexpected. We might expect that strong cognitive or physiological pressures favoring CV over all other syllable types would manifest crosslinguistically in such a way that languages with canonical (C)V patterns could be found in any language family or region.

From a diachronic point of view, the observed patterns may relate to the way that vowel reduction, vowel epenthesis, and consonant deletion tend to operate within languages. Vowel deletion may cause canonical syllable patterns to change from fairly simple to quite complex in a relatively short period of time, such that a language which previously had only simple onsets may, just a few generations later, have a wide variety of highly complex clusters (e.g., Lezgian). The opposite scenario, in which highly complex syllable patterns in a language are uniformly simplified by epenthesis in a short period of time, seems very unlikely. Cross-linguistically, epenthesis processes tend to target specific phonotactic environments or sequences of sounds (Hall 2011). While such processes might simplify some specific syllable shapes in a language, they might leave many others unaffected, such that the overall syllable pattern of the language is still

complex (cf. the Yakima Sahaptin example in 8.7). Unless vowel epenthesis becomes a completely general process, or occurs in multiple iterations with different consonant sequences (both of which seem unlikely given cross-linguistic patterns), it is hard to imagine such a process dramatically changing the syllable patterns of a language in a short period of time. This also seems unlikely from an articulatory point of view, given that the widespread temporal adjustments to gestural organization required of such a scenario would run against general tendencies towards increased overlap and reduction of gestures (Browman & Goldstein 1992). Similarly, processes of cluster reduction, as noted above, often target specific sequences, and it is hard to imagine these operating so generally as to obliterate both word-marginal and word-internal clusters in a language to the point where they dramatically affect canonical syllable patterns.

It seems that in the case of syllable structure, a high degree of complexity may be introduced quite rapidly into the system, but once there, it is difficult to completely remove. Historical processes suggest this is the case. In the Middle English (ME) period, a series of vowel epenthesis processes targeted certain consonant sequences in the language which had been present in Old English (OE): e.g., OE *niht* > ME *nyhyt* 'night;' OE *myln* > ME *milne* 'mill' (Jones 1989: 167, 170). Similarly, some codas were lost through sonorization processes: e.g., West Saxon OE  $h\bar{e}g$  > ME *hei* 'hay' (ibid. 150). Meanwhile, cluster simplification processes reduced /kn/ and /gn/ onsets (Minkova 2003). Despite these changes to syllable patterns, which were quite widespread judging from orthographic evidence, onset clusters such as /pl/ and /fr/, and codas such as /nd/, were not affected by such processes: cf. OE *ploga* 'plough,' OE *frēond* 'friend.' Thus

while syllable complexity was simplified at the level of specific sequences in the language, and simple syllable shapes perhaps became more frequent, the canonical syllable patterns of the language were not strongly affected. By comparison, later processes of vowel deletion added considerably to the complexity of coda patterns in the language, yielding what are today the maximum tautosyllabic clusters in the language:  $si[ks\theta s]$ , te[ksts], and so on.

#### 8.5.3 Phonetic properties of highly complex syllable patterns and long-term stability

Researchers often remark upon the salient phonetic characteristics of highly complex syllable patterns. In §3.4.3 I presented a variety of phonetic descriptions of consonant (usually obstruent) clusters in languages from the Highly Complex portion of the sample. The accounts describe the clusters in these languages as being characterized by 'open transition,' 'transitional vocoids,' 'overtones,' 'strong aspirated release,' 'audible intervals,' and so on. These phonetic properties are described for sequences analyzed as clusters and those analyzed as syllabic obstruents, and all share properties typical of intrusive vowels as defined by Hall (2006). In my previous discussion of these patterns, I concluded that such transitions are a prominent characteristic of Highly Complex syllable structure and constitute a phonetic correlate of this language type. I propose that these salient phonetic characteristics, which derive from temporal properties of gestural organization, facilitate the long-term maintenance and stability of highly complex syllable patterns which most models of the syllable predict to be dispreferred.

There is a small body of research which relates the temporal properties of gestural organization of obstruent sequences to perceptual recoverability. Consonant clusters have been found to be characterized by less overlap between gestures when occurring in wordinitial position than in other positions (cf. Byrd 1996a for English). In a perceptual recoverability account, word-initial position may correspond to utterance-initial position in discourse. If a word-initial sequence of obstruents, especially stops, occurs in utterance-initial position, there is no vowel preceding the first consonant which could provide acoustic cues as to its place of articulation. A release of the first stop would cue acoustic information on its place of articulation, while heavy overlap with the following consonant would obscure such acoustic cues. Perception of the first stop would be additionally facilitated if a vocalic transition is present, since this allows for a greater distribution of acoustic cues in time (Ridouane & Fougeron 2011: 294). In this view, gestural organization strategies resulting in a temporal lag between word-initial obstruents may have a perceptual motivation; that is, overlap between consonant gestures may be suppressed in order to preserve phonetic cues.

Perceptual recoverability has been suggested as a motivation behind timing patterns observed in clusters in Korean (Silverman & Jun 1994), Tsou (Wright 1996), Georgian (Chitoran et al. 2002), and Tashlhiyt (Ridouane & Fougeron 2011). Some of these studies have shown that it is not just word onset position, but also the relative place of articulation of the consonants in sequence which contribute to observed temporal lag, which somewhat weakens the original argument for perceptual recoverability. Indeed, most of the phonetic descriptions of highly complex clusters in §3.4.3 do not refer

specifically to word-initial or even onset environments, but instead mention specific sequences of consonants. In Cocopa, for example, transitional elements can be found in at least some word-final consonant sequences (8.9).

# (8.9) Cocopa (Yuman; United States) k<sup>a</sup>myúx<sup>i</sup>4<sup>j</sup> 'I hope that somehow you will'

(Crawford 1966: 47)

Additionally, Chitoran & Cohn (2009) note that in Georgian onsets, the timing lag between consonant gestures is larger than what is needed for the release burst to be perceptually recoverable. They further suggest that timing differences between consonant sequences in Georgian reflect phonologized patterns of language-specific gestural organization.

Considering that obstruent clusters in languages with highly complex syllable structure come about through vowel reduction, and that place characteristics of the original vowel may be retained in release bursts (cf. descriptions of clusters in Lezgian and Tohono O'odham in §3.4.3), it seems more likely that perceptual recoverability is an effect of, rather than a motivation for, the gestural organization of clusters in these languages. I suggest that the gestural timing and perceptual properties of such sequences may facilitate the long-term maintenance of highly complex syllable patterns by making
them less susceptible to complete overlap resulting in consonant deletion (Browman & Goldstein 1990).

# **8.6 Topics for further research**

In this dissertation I have shown that highly complex syllable structure is a holistic linguistic type associated with a number of phonetic, phonological, and morphological correlates. Additionally, the cross-linguistic patterns identified here may point to general tendencies in the diachronic development of these structures. However, there are many ways in which the studies here can be expanded. Some of the results also suggest lines of research outside of the range of standard phonological typology.

An issue which should be explored in more depth is that of type frequency of syllable patterns. This issue was touched upon only briefly in the discussion of the prevalence of highly complex patterns in Chapter 3. A finer-grained analysis of frequency patterns may refine our understanding of how processes of vowel reduction and consonant allophony work their way through the language as syllable structure changes. Similarly, the treatment of morphology was necessarily brief and general in the current study, but there is ample ground for further research here. Relevant topics may include the type (e.g., prefixing, suffixing, infixing, templatic, etc.) and function (inflection, compounding, lexical class changing derivation, lexical affixation, etc.) of morphological patterns which occur in tautosyllabic clusters of different degrees of complexity. Additionally, it would be interesting to establish a cross-linguistic range for the distribution of morphologically simple and complex tautosyllabic clusters or syllable

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inventories, as the results here point to a great deal of variation with respect to such distributions even within the Highly Complex portion of the sample. Though such studies have been conducted for a handful of European languages (Dressler & Dziubalska-Kołaczyk 2006, Dressler et al. 2010, inter alia), a truly global examination of these issues could better inform our understanding of the development of complexity in syllable systems.

Another issue which deserves more attention is that of language contact and syllable structure complexity. While linguistic areas such as the Pacific Northwest and the Caucasus region are well known for unusual syllable complexity, possibly as an effect of contact, some patterns noted above suggest that this phenomenon may be relatively frequent at an even smaller scale. The situation of Lelepa and its neighbors is especially striking because it shows emerging complexity at a very local level in a situation of contact, but within a larger family which is famous for its simple syllable patterns (Oceanic). A global survey of similar small-scale clusters of syllable patterns may reveal important information about the role of contact in the development of phonological complexity.

Finally, the results of the current study suggest that there are properties of gestural organization associated with both synchronic characteristics of highly complex syllable patterns and diachronic stages of their development. Synchronically, the obstruent clusters associated with these syllable patterns are characterized by open transitions between consonantal gestures which may in many cases have their source in processes of vowel reduction. Diachronically, the contrastive consonant articulations associated with

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these languages may originate in patterns of increased overlap of consonantal and vocalic gestures and strengthening of consonantal gestures at some point in the history of these languages, perhaps even before the development of complex syllable patterns. There is a growing literature of instrumental investigations of gestural organization in the syllable patterns of diverse languages. Many of these studies are relevant to the issues examined here concerning properties of consonant clusters (cf. Goldstein et al. 2007 for Georgian and Tashlhiyt, Hermes et al. 2013 for Italian, Marin 2014 for Romanian, Butler 2015 for Khmer and Bunong, Marin et al. 2017 for seven European languages) and syllabic consonants (cf. Hermes et al. 2011 for Tashlhiyt, Pouplier & Beňuš 2011 for Slovak). The findings in the current study reveal a prevalence of vowel reduction in languages with more complex syllable patterns and suggest a prevalence of consonant-to-vowel coarticulation and strengthening in languages with simpler syllable patterns. In light of these findings, it would be interesting to instrumentally investigate general patterns of gestural organization as they pertain to those specific issues in languages with differing syllable complexity.

# APPENDICES

Appendix A: Language sample

Appendix B: Data

Appendix C: Language sample from Maddieson (2013a)

# Appendix A: Language sample

In Tables A1-4 I present information on the language sample used in the dissertation. Languages are organized first by macro-region, then alphabetically by language family and genera.

KEY TO READING TABLE:

**ISO 693-3:** ISO 693-3 code for language used in survey.

Language: Dialect is given in parentheses where relevant.

Syllable Structure: S = Simple MC = Moderately Complex C = Complex HC = Highly Complex

Macro-region: Following Dryer (1989: 268; 1992: 83, 133-5).

*Africa* = continent of Africa, including Semitic languages of southwest Asia.

*Australia & New Guinea* = Australian continent and Melanesia, excluding Austronesian languages of Melanesia.

*Eurasia* = Eurasian landmass, excluding Semitic and languages from families of southeast Asia as defined below, and including the Munda languages of Austro-Asiatic.

*North America* = North American continent, including languages of Mexico, Mayan and Aztecan languages in Central America, and some branches of Chibchan-Paezan.

*South America* = South American continent, including languages of Central America except Mayan and Aztecan languages, and some Chibchan-Paezan branches.

*Southeast Asia & Oceania* = Southeast Asian region, including all Sino-Tibetan, Tai-Kadai, Hmong-Mien, and Austro-Asiatic languages excluding Munda, and Oceania region (Austronesian languages).

**Family** and **Genus:** Following genealogical classifications listed in the World Atlas of Language Structures Online (Dryer & Haspelmath 2013).

**Speaker Population:** Population figure for language (or specific dialect) given in Ethnologue 19 (Lewis et al. 2016). An asterisk indicates that another source was used for population estimate; these can be found beneath the table.

Date: Date given in Ethnologue 19 (Lewis et al. 2016) for speaker population figure.

Development Status: Following Ethnologue 19 (Lewis et al. 2016).

*Institutional* = language has wide use in the home and community and official status at educational, provincial, national, and/or international levels.

**Developing** = language is used in the home, community, and sometimes broader contexts, and in initial stages of developing a system of writing and standardization.

*Vigorous* = language is used in the home and community by speakers of all generations, but has not yet developed a system of graphization or standardization.

*In Trouble* = language is currently in the process of losing intergenerational transmission, with the community shifting to other languages for daily use, but there are still speakers of child-bearing age. *Dying* = language has lost intergenerational transmission entirely, and all fluent speakers are above child-bearing age.

ISO 639-3	Language	Syll. Struc.	Macro- region	Family	Genus	Speaker Pop.	Date	Develop- ment Status
hts	Hadza	S	Africa	(isolate)		950	2013	In Trouble
dts	Toro So	S	Africa	Dogon	Dogon	50,000	1998	Institutional
bbo	Southern Bobo Madaré	S	Africa	Mande	Western Mande	181,000	2009	Developing
yor	Yoruba	S	Africa	Niger-Congo	Defoid	19,043,700	1993	Institutional
grj	Grebo (Southern)	S	Africa	Niger-Congo	Kru	65,000	2012	Vigorous
SVS	Savosavo	S	Aus & New Guinea	Solomons East Papuan	Savosavo	2,420	1999	Vigorous
kew	Kewa (Eastern)	S	Aus & New Guinea	Trans-New Guinea	Engan	45,000	2000	Developing
kbk	Koiari	S	Aus & New Guinea	Trans-New Guinea	Koiarian	1,700	2000	Vigorous
roo	Rotokas	S	Aus & New Guinea	West Bougainville	West Bougainville	4,320	1981	Developing
tow	Jemez	S	N America	Kiowa-Tanoan	Kiowa-Tanoan	1,790	2007	In Trouble
mio	Mixtec (Jicaltepec)	S	N America	Oto-Manguean	Mixtecan	20,000	1990	Vigorous
ute	Ute	S	N America	Uto-Aztecan	Numic	920	2007	In Trouble
ura	Urarina	S	S America	(isolate)		3,000	2002	Developing
wba	Warao	S	S America	(isolate)		28,100	2007	Vigorous
apu	Apurinã	S	S America	Arawakan	Purus	2,780	2006	In Trouble
kpj	Karajá	S	S America	Macro-Ge	Karajá	2,500	2007	In Trouble
cub	Cubeo	S	S America	Tucanoan	Tucanoan	6,260	2008	Developing
khc	Tukang Besi (North)	S	SE Asia & Oceania	Austronesian	Celebic	120,000	1995	Vigorous
mri	Maori	S	SE Asia & Oceania	Austronesian	Oceanic	158,640	2013	In Trouble
nak	Nakanai	S	SE Asia & Oceania	Austronesian	Oceanic	13,000	1981	Developing
dru	Rukai (Budai)	S	SE Asia & Oceania	Austronesian	Rukai	10,500	2002	Developing
iii	Yi (Nuosu)	S	SE Asia & Oceania	Sino-Tibetan	Burmese-Lolo	2,000,000	2004	Institutional

**Table A1.** Portion of language sample with Simple syllable structure.

ISO 639-3	Language	Syll. Struc.	Macro- region	Family	Genus	Speaker Pop.	Date	Develop- ment Status
hau	Hausa	MC	Africa	Afro-Asiatic	West Chadic	26,929,000	1991	Institutional
fvr	Fur	MC	Africa	Fur	Fur	745,800	2004	Developing
cgg	Nkore-Kiga	MC	Africa	Niger-Congo	Bantoid	1,580,000	2002	Institutional
ewe	Ewe	MC	Africa	Niger-Congo	Kwa	4,184,000	2013	Institutional
knc	Kanuri	MC	Africa	Saharan	Western Saharan	3,290,500	1985	Institutional
aly	Alyawarra	MC	Aus & New Guinea	Pama-Nyungan	Central Pama- Nyungan	1,660	2006	Developing
kms	Kamasau	MC	Aus & New Guinea	Torricelli	Marienberg	960	2003	In Trouble
spi	Selepet	MC	Aus & New Guinea	Trans-New Guinea	Finisterre- Huon	7,000	1988	Developing
ayz	Maybrat	MC	Aus & New Guinea	West Papuan	North-Central Bird's Head	20,000	1987	Developing
mjg	Mangghuer	MC	Eurasia	Altaic	Mongolic	152,000	2000	In Trouble
khr	Kharia	MC	Eurasia	Austro-Asiatic	Munda	241,580	2001	Developing
tel	Telugu	MC	Eurasia	Dravidian	South-Central Dravidian	74,244,300	2001	Institutional
dry	Darai	MC	Eurasia	Indo-European	Indic	11,700	2011	In Trouble
kca	Khanty (Eastern)	MC	Eurasia	Uralic	Ugric	2,000	2007	In Trouble
kyh	Karok	MC	N America	(isolate)		12	2007	Dying
kal	West Greenlandic	MC	N America	Eskimo-Aleut	Eskimo	44,000	2007	Institutional
cho	Choctaw	MC	N America	Muskogean	Muskogean	10,400	2010	In Trouble
SCS	Slave (Hare)	MC	N America	Na-Dene	Athapascan	710	2007	In Trouble
car	Carib	MC	S America	Cariban	Cariban	7,358	2001	In Trouble
gym	Ngäbere	MC	S America	Chibchan	Guaymiic	171,840	2000	Developing
qvi	Quechua (Imbabura)	MC	S America	Quechuan	Quechuan	150,000	2007	Developing
cod	Cocama	MC	S America	Tupian	Tupi-Guaraní	250	2007	Dying
pac	Pacoh	МС	SE Asia & Oceania	Austro-Asiatic	Katuic	32,500	2002	In Trouble
ilo	Ilocano	MC	SE Asia & Oceania	Austronesian	Northern Luzon	7,016,400	2000	Institutional
mji	Kim Mun (Vietnam)	MC	SE Asia & Oceania	Hmong-Mien	Hmong-Mien	374,500	2000	Vigorous
yue	Cantonese	MC	SE Asia & Oceania	Sino-Tibetan	Chinese	62,967,910	2013	Institutional
lao	Lao	MC	SE Asia & Oceania	Tai-Kadai	Kam-Tai	3,253,700	2005	Institutional

 Table A2. Portion of language sample with Moderately Complex syllable structure.

ISO 639-3	Language	Syll. Struc.	Macro- region	Family	Genus	Speaker Pop.	Date	Develop- ment Status
mpi	Kotoko (Makary)	С	Africa	Afro-Asiatic	Biu-Mandara	16,000	2004	In Trouble
mdx	Dizi (Central)	С	Africa	Afro-Asiatic	Dizoid	33,900	2010	Institutional
tbi	Ingessana	С	Africa	Eastern Sudanic	Eastern Jebel	67,200	2000	Vigorous
lun	Lunda	С	Africa	Niger-Congo	Bantoid	403,000	2010	Institutional
dyo	Diola-Fogny	С	Africa	Niger-Congo	Northern Atlantic	397,100	nd	Developing
mpc	Mangarrayi	С	Aus & New Guinea	Mangarrayi-Maran	Mangarrayi	12	2006	Dying
nir	Nimboran	С	Aus & New Guinea	Nimboran	Nimboran	2,000	1987	Dying
bej	Bardi	С	Aus & New Guinea	Nyulnyulan	Nyulnyulan	160	2006	Dying
opm	Oksapmin	C	Aus & New Guinea	Oksapmin	Oksapmin	8,000	1991	Developing
ung	Ungarinjin	С	Aus & New Guinea	Worrorran	Worrorran	57	2006	In Trouble
eus	Basque	С	Eurasia	(isolate)		545,800	2012	Institutional
bsk	Burushaski	С	Eurasia	(isolate)		96,800	2004	Vigorous
niv	Nivkh (West Sakhalin)	С	Eurasia	(isolate)		15*	2014	Dying
bak	Bashkir	С	Eurasia	Altaic	Turkic	1,245,990	2010	Institutional
ket	Ket	С	Eurasia	Yeniseian	Yeniseian	210	2010	Dying
pay	Pech	С	N America	Chibchan	Paya	990	1993	Dying
tzh	Aguacatenango Tzeltal	С	N America	Mayan	Mayan	372,000	2000	Developing
lkt	Lakhota	С	N America	Siouan	Core Siouan	2,200	1997	In Trouble
kbc	Kadiwéu	С	S America	Guaicuruan	Kadiweu	1,590	2006	In Trouble
apn	Apinayé	С	S America	Macro-Ge	Ge-Kaingang	1,260	2003	Developing
wmd	Mamaindê	С	S America	Nambikuaran	Nambikuaran	330	2007	In Trouble
cap	Chipaya	С	S America	Uru-Chipaya	Uru-Chipaya	1,200	1995	Developing
kpm	Sre (Kơho)	С	SE Asia & Oceania	Austro-Asiatic	Bahnaric	166,000	2009	Developing
lpa	Lelepa	С	SE Asia & Oceania	Austronesian	Oceanic	400	1989	Vigorous
slz	Ma'ya	C	SE Asia & Oceania	Austronesian	S. Halmahera - W. New Guinea	4,000	2001	In Trouble
lep	Lepcha	С	SE Asia & Oceania	Sino-Tibetan	Lepcha	69,800	2001	Vigorous
cdm	Chepang	С	SE Asia & Oceania	Sino-Tibetan	Mahakiranti	48,500	2011	In Trouble

**Table A3.** Portion of language sample with Complex syllable structure.

ISO 639-3	Language	Syll. Struc.	Macro- region	Family	Genus	Speaker Pop.	Date	Develop- ment Status
shi	Tashlhiyt	HC	Africa	Afro-Asiatic	Berber	3,896,000	2004	Developing
dow	Doyayo	HC	Africa	Niger-Congo	Adamawa	18,000	1985	Developing
kjn	Kunjen	НС	Aus & New Guinea	Pama-Nyungan	Northern Pama-Nyungan	20	1991	Dying
amp	Alamblak	НС	Aus & New Guinea	Sepik	Sepik Hill	1,530	2000	Developing
wut	Wutung	НС	Aus & New Guinea	Skou	(uncertain)	900	2003	Vigorous
mcr	Menya	HC	Aus & New Guinea	Trans-New Guinea	Angan	20,000	1998	Developing
itl	Itelmen	НС	Eurasia	Chukotko- Kamchatkan	Southern Chukotko- Kamchatkan	80	2010	Dying
als	Albanian (Tosk)	HC	Eurasia	Indo-European	Albanian	1,841,400	2012	Institutional
pol	Polish	HC	Eurasia	Indo-European	Slavic	40,248,740	2013	Institutional
kat	Georgian	HC	Eurasia	Kartvelian	Kartvelian	4,347,320	1993	Institutional
lez	Lezgian	HC	Eurasia	Nakh-Daghestanian	Lezgic	616,760	2010	Institutional
kbd	Kabardian	HC	Eurasia	Northwest Caucasian	Northwest Caucasian	1,628,500	2010	Developing
pqm	Passamaquoddy- Maliseet	HC	N America	Algic	Algonquian	590	2011	In Trouble
coc	Сосора	HC	N America	Hokan	Yuman	350	1998	In Trouble
moh	Mohawk	HC	N America	Iroquoian	Northern Iroquoian	3,540	1999	In Trouble
yak	Sahaptin (Yakima)	НС	N America	Penutian	Sahaptian	5**	2006	Dying
thp	Thompson	HC	N America	Salishan	Interior Salish	130	2014	In Trouble
ood	Tohono O'odham	HC	N America	Uto-Aztecan	Tepiman	14,094	2007	In Trouble
noo	Nuu-chah-nulth	НС	N America	Wakashan	Southern Wakashan	130	2014	Dying
kbh	Camsá	HC	S America	(isolate)		4,000	2008	Developing
alc	Qawasqar	HC	S America	Alacalufan	Alacalufan	12	2006	Dying
pib	Piro	HC	S America	Arawakan	Purus	4,000	2000	Developing
teh	Tehuelche	HC	S America	Chon	Chon Proper	5***	2012	Dying
sea	Semai	НС	SE Asia & Oceania	Austro-Asiatic	Aslian	10,000	2007	Institutional

Table A4. Portion of language sample with Highly Complex syllable structure.

\* Population figure from Botma & Shiraishi (2014).
\*\* Population figure from Hargus & Beavert (2006).
\*\*\* Population figure from *aoNEK FILMS* (2012), includes semi-speakers.

# **Appendix B: Data**

In this appendix I present the coded data used for the various studies in the dissertation. The languages are listed alphabetically by ISO 639-3 code.

## [alc] QAWASQAR Alacalufan, Alacalufan (Chile)

References consulted: Aguilera (2001), Clairis (1977, 1985), Viegas Barros (1990)

Sound inventory C phoneme inventory:  $p p^h p' t t^h t' q q^h q' ts ts' s f x h m n l r w j/$ N consonant phonemes: 21 Geminates: N/A Voicing contrasts: None Places: Bilabial, Alveolar, Velar, Uvular, Glottal Manners: Stop, Affricate, Fricative, Nasal, Flap/Tap, Central approximant, Lateral approximant Elaborations: Post-aspiration, Ejective, Uvular N elaborations: 3 N elaborated consonants: 11 V phoneme inventory: /e a o/ N vowel qualities: 3 Diphthongs or vowel sequences: Diphthongs /aw ow/ Contrastive length: None Contrastive nasalization: None Other contrasts: N/A **Notes:** Clairis gives minimal pairs for  $/p^{h} t^{h}$ , gives  $/q^{2} q^{h}$  but not  $/k k^{\prime}$ . /e o/ vary quite widely. /e/ is [ə] 65.9% of the time word-medially. Clairis and Viegas Barros both consider glides and high vowels to be in complementary distribution, but have chosen glides as lexical representation. Syllable structure **Complexity Category:** Highly Complex Canonical syllable structure: (C)(C)(C)(C)(C)(C)(C)(C) (Clairis 1985: 391-401) Size of maximum onset: 4 Size of maximum coda: 3 **Onset obligatory:** No Coda obligatory: No Vocalic nucleus patterns: Short vowels, Diphthongs

Syllabic consonant patterns: N/A

Size of maximum word-marginal sequences with syllabic obstruents: N/A

**Predictability of syllabic consonants:** N/A

**Morphological constituency of maximum syllable margin:** Tautomorphemic (Onset), Both patterns (Coda)

Morphological pattern of syllabic consonants: N/A

**Onset restrictions:** All consonants except /r/ occur in simple onsets. In biconsonantal onsets, C<sub>1</sub> may be /f q q' s t/ and C<sub>2</sub> may be /f s t t' j w q/. Triconsonantal onsets have same restrictions for C1; include /qsq, qst, sqw/. Example given of four-consonant onset is /qsqj/.

**Coda restrictions:**  $f j l m n r s w/do not appear in simple codas. In biconsonantal codas, C<sub>1</sub> is <math>f j l m n p q r t w s/and C_2$  is /s q/. Triconsonantal codas include /lqs, rqs, qsq/.

**Notes:** Clairis notes that large clusters are "unstable in rapid speech", e.g. qsqar > sqar, 'urine' but that rapid speech can also produce clusters, e.g., future marker seqwe > sqwe (1985: 393).

[alc] QAWASQAR Alacalufan, Alacalufan (Chile) (cont.)

## **Suprasegmentals**

# Tone: No

**Word stress:** Disagreement (Clairis 1977 claims stress, Clairis 1985 claims not, that it varies across different tokens of same word or doesn't occur at all).

# **Vowel reduction processes**

**alc-R1:** Low vowel /a/ and mid front vowel /e/, and to a lesser extent mid back vowel /o/, are frequently realized as [ə] (Clairis 1985: 382-4; conditioning environment not described).

alc-R2: A word-initial vowel is often syncopated in rapid speech (Clairis 1985: 393).

**alc-R3:** An interconsonantal vowel is often syncopated in rapid speech. Apparently only some consonants condition this process, but particulars are not described (Clairis 1985: 393).

## **Consonant allophony processes**

**alc-C1:** Voiceless uvular stop [q] varies freely with affricated variant [qx]. (Clairis 1985: 378) **alc-C2:** Bilabial stop may be realized as a fricative. (Aguilera 2001) **alc-C3:** Voiceless alveolar fricative [s] may be realized as [h] word-finally. (Clairis 1985: 372) **alc-C4:** Aspirated uvular stop [q<sup>h</sup>] and velar fricative [x] vary freely with [h]. (Clairis 1985: 377-8)

## **Morphology**

(adequate texts unavailable)

References consulted: Bevington (1974), Klippenstein (2010), Newmark (1957), Newmark et al. (1982)

#### Sound inventory

C phoneme inventory: /p b t d c j k g ts dz tj dz f v  $\theta$  ð s z j z h m n n l ł r r j/ N consonant phonemes: 29 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Dental, Alveolar, Palato-alveolar, Palatal, Velar, Glottal Manners: Stop, Affricate, Fricative, Nasal, Flap/Tap, Trill, Central approximant, Lateral approximant N elaborations: 4 Elaborations: Voiced fricatives/affricates, Labiodental, Palato-alveolar, Velarization V phoneme inventory: /i y  $\varepsilon \ni a \ni u$ / N vowel qualities: 7 Diphthongs or vowel sequences: Diphthongs /ie ua ye ue/ Contrastive length: None Contrastive nasalization: None Other contrasts: N/A Notes: Vowel length and nasalization contrasts occur in Gheg dialect.

#### Syllable structure

Complexity Category: Highly Complex

Canonical syllable structure: (C)(C)(C)(C)(C)(C)(C)(C) (Newmark 1957: 24-9, Klippenstein 2010)

Size of maximum onset: 4

Size of maximum coda: 3

**Onset obligatory:** No **Coda obligatory:** No

Vocalic nucleus patterns: Short vowels, Diphthongs

Syllabic consonant patterns: N/A

Size of maximum word-marginal sequences with syllabic obstruents: N/A

Predictability of syllabic consonants: N/A

**Morphological constituency of maximum syllable margin:** Tautomorphemic (Coda), Heteromorphemic (Onset)

## Morphological pattern of syllabic consonants: N/A

**Onset restrictions:** Apparently no restrictions for simple onsets. Biconsonantal onsets quite varied, include /t fc tk 3b fl tr pj zv mp rj/, with voicing mismatches typically avoided. Triconsonantal onsets include / fpr, skl, skt, pft, 3vl, ndr, mbl/, Four-consonant onsets include /t fmpl, zmbr/.

**Coda restrictions:** In simple codas, apparently /c, h/ do not occur. Biconsonantal codas include /jt, rp, rf, mp, ls, fk, ps, tk, k $\theta$ ,  $\overline{tsk}$ ,  $\overline{3d}$ /. Triconsonantal codas always end in a voiceless sibilant plus /t/, include / pft, kst/.

Notes: Klippenstein (2010) shows that there are some onset clusters not listed by Newmark which occur.

# **Suprasegmentals**

Tone: No Word stress: Yes Stress placement: Morphologically or Lexically Conditioned Phonetic processes conditioned by stress: Vowel Reduction

Differences in phonological properties of stressed and unstressed syllables: (None)

**Phonetic correlates of stress:** Vowel duration (impressionistic), Intensity (impressionistic) **Notes:** In words without inflection, stress is final if that syllable is closed or ends in non-mid vowel, while stress falls on penultimate if final syllable ends in mid vowel (even if penultimate ends in mid vowel). (Trommer 2013). While vowel quality factors into stress assignment, it appears that there is no difference in the vowel quality contrasts in stressed and unstressed syllables.

# Vowel reduction processes

**als-R1:** For many speakers in ordinary speech, unstressed  $|\partial|$  is not pronounced when word-final following a consonant (Newmark et al. 1982: 11; for older speakers in southern Tosk region, vowel is retained but pronounced as [I] in this context).

**als-R2:** In rapid speech, mid central vowel  $|\partial|$  is optionally deleted when occurring between two consonants, of which C<sub>1</sub> is not /s z 3/. This deletion rarely occurs when both C<sub>1</sub> and C<sub>2</sub> are voiced (Klippenstein 2010: 21-2).

## **Consonant allophony processes**

**als-C1**: Fricatives /f  $\theta$  v  $\delta$ / have occasional homorganic stop allophones pre-juncture and preceding a consonant. (Newmark 1957)

#### Morphology

(adequate texts unavailable)

[aly] ALYAWARRA Pama-Nyungan, Central Pama-Nyungan (Australia)

**References consulted:** Yallop (1977)

#### Sound inventory

C phoneme inventory: /p t t f c k  $p^m t^n t^n t^n t^n w$  h n n n n n l l k r w j y/ N consonant phonemes: 27 Geminates: N/A Voicing contrasts: None Places: Bilabial, Dental, Alveolar, Retroflex, Palatal, Velar Manners: Stop, Nasal, Trill, Central approximant, Lateral approximant N elaborations: 2 Elaborations: Nasal release, Retroflex V phoneme inventory: /i a u i u u/ N vowel qualities: 3 Diphthongs or vowel sequences: Diphthongs /ai au/ Contrastive length: Some **Contrastive nasalization:** None Other contrasts: N/A Notes: /y/ doesn't occur in W. Arrente, but is retained in Alyawarra (Yallop 1977: 12). /i, u/ distinctive in length.

#### Syllable structure

Complexity Category: Moderately Complex Canonical syllable structure: (C)(C)V(C) (Yallop 1977: 41-5) Size of maximum onset: 2 Size of maximum coda: 1 Onset obligatory: No Coda obligatory: No Vocalic nucleus patterns: Short vowels, Long vowels Syllabic consonant patterns: Nasal Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: Varies with VC sequence Morphological constituency of maximum syllable margin: Tautomorphemic (Onset) Morphological pattern of syllabic consonants: N/A Onset restrictions: C<sub>1</sub> may be a plosive, nasal-released plosive, or nasal. C<sub>2</sub> is always /w/.

**Coda restrictions:** Nasals, laterals, and trills most common; less commonly, plosives and nasal-released plosives may occur. There are no word-final codas.

**Notes:** The sequence / $\eta$ kw/ seems to occur invariably as an onset cluster in the word  $\eta$ kwala 'sugar, sweetness'; however this is only true phrase-initially. In connected speech when following another word, words without an initial vowel always occur with a linking vowel (quality determined by initial consonant), which alters the syllable structure (Yallop 1977: 28-30). Since the 3-C onset seems to be a very marginal pattern, I take the canonical syllable structure of the language to be consistent with the (C)(C)V(C) pattern reported by Yallop later in the text.

#### **Suprasegmentals**

Tone: No

Word stress: Yes

Stress placement: Fixed

**Phonetic processes conditioned by stress:** Vowel Reduction, Consonant Allophony in Stressed Syllables **Differences in phonological properties of stressed and unstressed syllables:** (None)

**Phonetic correlates of stress:** Vowel duration (impressionistic), Pitch (impressionistic), Intensity (impressionistic)

Notes: Duration is a correlate of stress for only some syllables.

[aly] ALYAWARRA Pama-Nyungan, Central Pama-Nyungan (Australia) (cont.)

# **Vowel reduction processes**

**aly-R1:** High vowels /i u/ tend to be centralized and preceded by a glide in word-initial (unstressed) position (Yallop 1977: 25).

**aly-R2:** Low short vowel /a/ is reduced to mid when occurring word-initially or -finally (and therefore unstressed) (Yallop 1977: 25).

**aly-R3:** Low short vowel /a/ is often dropped word-initially (and therefore unstressed) before a single consonant (Yallop 1977: 28).

**aly-R4:** In normal connected speech, short unstressed vowels are often elided altogether before continuants (Yallop 1977: 27).

**aly-R5:** When low short vowel /a/ is dropped in word-initial, unstressed position before a sequence of consonants, the first may become syllabic (results in syllabic nasals, Yallop 1977: 19)

#### **Consonant allophony processes**

aly-C1: Palatal stop /c/ is often realized as affricate [cc]. (Yallop 1977: 21)

**aly-C2**: Lateral approximants may be realized as fricatives following a sequence of /ij/ or /aj/ and preceding a plosive. (Yallop 1977: 19)

**aly-C3**: A trill may be realized as palato-alveolar fricative [**3**] following a dental or alveolar consonant. (Yallop 1977: 19)

#### **Morphology**

(adequate texts unavailable)

[amp] ALAMBLAK Sepik, Sepik Hill (Papua New Guinea)

References consulted: Bruce (1984), SIL (2004)

## Sound inventory

C phoneme inventory: /p b t d k g t  $\int dz d \phi s \int x m n p r w j$ / N consonant phonemes: 18 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Alveolar, Palato-alveolar, Velar Manners: Stop, Affricate, Fricative, Nasal, Flap/Tap, Central approximant N elaborations: 2 Elaborations: Voiced fricatives/affricates, Palato-alveolar V phoneme inventory: /i e i  $\vartheta$  a o u/ N vowel qualities: 7 Diphthongs or vowel sequences: Diphthongs /ai ii ui oi au/ Contrastive length: None Contrastive nasalization: None Other contrasts: N/A Notes: For affricates, SIL OPD gives only /dz/. /i/ included in Bruce 1984, but not SIL OPD.

## Syllable structure

Complexity Category: Highly Complex Canonical syllable structure: (C)(C)(C)(C)(C)(C) (Bruce 1984, SIL 2004) Size of maximum onset: 3 Size of maximum coda: 3 Onset obligatory: No Coda obligatory: No Vocalic nucleus patterns: Short vowels, Diphthongs Syllabic consonant patterns: Nasal Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: Predictable from word/consonantal context Morphological constituency of maximum syllable margin: Tautomorphemic (Onset), Both patterns (Coda)

Morphological pattern of syllabic consonants: Lexical items

**Onset restrictions:** No restrictions on simple onsets. Biconsonantal onsets include /sk tw gw fw kr pk/. Triconsonantal onsets include /tkm, tkb, prt, tkm, krp, brb, mxt/.

**Coda restrictions:** It seems there are some restrictions on simple codas, including /b g w j/. Biconsonantal codas include /nt, rt, sr, rs, gt/. Triconsonantal codas include /nptf ndt mbt/.

**Notes:** SIL OPD lists some larger onsets, e.g. /kmbr/, and vowelless words, e.g. /kpt/. Unclear whether forms listed in SIL OPD have alternate forms with epenthetic vowel or if these are fully regular patterns. Syllabification in Bruce (1984) does give three-obstruent onset (*jak*'<u>tkb</u>ətkikibət 'to get and mash', p. 60). Analysis of syllable structure dependent on analysis/status of high central vocoid /i/. Bruce discusses possible history of this vowel and development of some of these clusters (1984: 69-70).

## **Suprasegmentals**

Tone: No Word stress: Yes Stress placement: Weight-Sensitive Phonetic processes conditioned by stress: Vowel Reduction Differences in phonological properties of stressed and unstressed syllables: (None) Phonetic correlates of stress: Not described [amp] ALAMBLAK Sepik, Sepik Hill (Papua New Guinea) (cont.)

## **Vowel reduction processes**

**amp-R1:** Tense high front vowel /i/ is optionally realized as lax [I] when occurring after a palatal glide /j/ in an unstressed syllable (Bruce 1984: 37).

**amp-R2:** A tense mid front vowel /e/ may be realized as lax [ $\epsilon$ ] in unstressed syllables (Bruce 1984: 38). **amp-R3:** Mid back rounded vowel /o/ is shortened when preceded by a velar consonant and followed by an alveolar consonant (Bruce 1984: 39).

**amp-R4:** Mid central vowel /ə/ may be realized as high central vowel [i] preceding a consonant-initial stressed syllable (Bruce 1984: 41).

#### **Consonant allophony processes**

**amp-C1:** Alveolars may be realized as palatal or palato-alveolar following a palatal consonant (including glides). (Bruce 1984: 29)

**amp-C2**: Fricatives are voiced when occurring after a voiced non-nasal and before a voiced consonant. (Bruce 1984: 25)

**amp-C3:** A labiovelar approximant is realized as a vocalic offglide [°] following a mid or low vowel and preceding a peripheral consonant. (Bruce 1984: 28)

#### <u>Morphology</u>

**Text:** "The spirit who turned into an animal" (Bruce 1984: 323-331) **Synthetic index:** 2.5 morphemes/word (1264 morphemes, 502 words) [apn] APINAYÉ Macro-Ge, *Ge-Kaingang* (Brazil)

References consulted: Burgess & Ham (1968), Ham (2009), Oliveira (2005)

#### Sound inventory

C phoneme inventory: /p <sup>m</sup>b t <sup>n</sup>d k <sup>n</sup>g ? fc <sup>p</sup>d 3 v s m n p η r j/ N consonant phonemes: 17 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Labiodental, Alveolar, Palato-alveolar, Velar, Glottal Manners: Stop, Affricate, Fricative, Nasal, Flap/Tap, Central approximant N elaborations: 4 Elaborations: Voiced fricatives/affricates, Prenasalization, Labiodental, Palato-alveolar V phoneme inventory: /i e ε a A ɔ r o tu u ĩ ẽ ã Ã õ ữ ữ/ N vowel qualities: 10 Diphthongs or vowel sequences: Diphthongs /ao uə/ Contrastive length: None Contrastive nasalization: Some Other contrasts: N/A Notes: Ham (2009) has /z/ instead of /j/. Burgess & Ham (1968) present a very different consonant

inventory, counting voiced plosives as predictable, and no glides. /f/ occurs in loanwords. Discussion of typological unusualness of, and attested central vowel contrasts in other Jê languages (Oliveira 2005: 61-2). Nasal contrasts for /i e a  $\Lambda$  o  $\mu$  u/. Diphthongs are not frequent and few instances have been attested.

#### Syllable structure

Complexity Category: Complex Canonical syllable structure: (C)(C)(C)V(C) (Oliveira 2005: 67-71) Size of maximum onset: 3 Size of maximum coda: 1 Onset obligatory: No Coda obligatory: No Vocalic nucleus patterns: Short vowels, Diphthongs Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: Tautomorphemic (Onset) Morphological pattern of syllabic consonants: N/A

**Onset restrictions:** Biconsonantal onsets limited to sequences of plosive + nasal, approximant, or flap. In triconsonantal onsets, first consonant is a plosive, and others are limited to nasals, approximants, or flap. Each segment in a tautosyllabic sequence must be produced at a different place of articulation, and with a different manner of articulation.

**Coda restrictions:** Limited to voiceless plosives or sonorants. Prenasalized stops and  $/\eta$  do not occur.

**Suprasegmentals** 

Tone: No

Word stress: Yes

Stress placement: Morphologically or Lexically Conditioned

**Phonetic processes conditioned by stress:** Vowel Reduction, Consonant Allophony in Unstressed Syllables, Consonant Allophony in Stressed Syllables

**Differences in phonological properties of stressed and unstressed syllables:** (None)

Phonetic correlates of stress: Vowel duration (impressionistic), Intensity (impressionistic)

[apn] APINAYÉ Macro-Ge, *Ge-Kaingang* (Brazil) (cont.)

# **Vowel reduction processes**

**apn-R1:** Vowels of unstressed syllables preceding the nucleus of a stress group are very short (Burgess and Ham 1968: 12).

**apn-R2:** Vowels may be realized as devoiced utterance-finally, though nasalized vowels are devoiced less frequently than oral vowels (Ham 2009: 7).

# **Consonant allophony processes**

**apn-C1:** Palatal glide /j/ is realized as alveolo-palatal [z] in the onset of a stressed syllable. (Ham 2009: 5) **apn-C2:** /j/ may be realized as [z] when occurring as the second consonant in an onset and directly preceding a vowel. (Oliveira 2005)

**apn-C3:** Voiceless velar stop /k/ is palatalized preceding a front vowel. (Oliveira 2005: 50)

apn-C4: Plosives and are optionally voiced in syllable codas. (Oliveira 2005: 44)

**apn-C5:** Plosives are optionally voiced in the onset of unstressed syllables. (Oliveira 2005: 44) **apn-C6**: Voiceless bilabial stop /p/ is prenasalized when occurring word-finally after a nasalized vowel. (Oliveira 2005: 46)

**apn-C7**: Voiceless alveolar stop /t/ is realized as a flap when occurring between two mid front vowels. (Oliveira 2005: 48)

# Morphology

**Text:** "Sun and Moon" (first 8 pages, Oliveira 2005: 304-311) **Synthetic index:** 1.1 morphemes/word (445 morphemes, 409 words) [apu] APURINÃ Arawakan, Purus (Brazil)

References consulted: Facundes (2000)

# Sound inventory

C phoneme inventory: /p t k ts tf s f h m n n r j u/ N consonant phonemes: 14 Geminates: N/A Voicing contrasts: None Places: Bilabial, Alveolar, Palato-alveolar, Palatal, Velar, Glottal Manners: Stop, Affricate, Fricative, Nasal, Flap/Tap, Central approximant N elaborations: 1 Elaborations: Palato-alveolar V phoneme inventory: /i e i a o i: e: i: a: o: ĩ ẽ i ã õ ĩ: ẽ: i: ã: õ:/ N vowel qualities: 5 Diphthongs or vowel sequences: Vowel sequences /io ei ai ao oi/ Contrastive length: All Contrastive nasalization: All Other contrasts: N/A Notes: /h/ occur only word-initially. /o/ varies between [o] and [u].

## Syllable structure

Category: Simple Canonical syllable structure: (C)V (Facundes 2000: 87-90) Size of maximum onset: 1 Size of maximum coda: N/A Onset obligatory: No Coda obligatory: N/A Vocalic nucleus patterns: Short vowels, Long vowels, Vowel sequences Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: N/A Morphological pattern of syllabic consonants: N/A Onset restrictions: All consonants occur. Notes: It is possible to analyze diphthongs as coda glides.

#### **Suprasegmentals**

Tone: No Word stress: Yes Stress placement: Weight-Sensitive Phonetic processes conditioned by stress: Vowel Reduction, Consonant Allophony in Unstressed Syllables Differences in phonological properties of stressed and unstressed syllables: (None) Phonetic correlates of stress: Pitch (impressionistic), Intensity (impressionistic)

#### **Vowel reduction processes**

**apu-R1:** Vowels become devoiced in unstressed word-final position, especially in fast speech (Facundes 2000: 60-1). This process also causes aspiration of a preceding stop.

#### **Consonant allophony processes**

**apu-C1**: Voiceless velar stop is palatalized preceding mid front vowels. (Facundes 2000: 76) **apu-C2**: Plosives are voiced following a nasalized vowel. (Facundes 2000: 73)

[apu] APURINÃ Arawakan, Purus (Brazil) (cont.)

Morphology Text: "Apurina text sample" (Facundes 2000: 625-642) Synthetic index: 2.1 morphemes/word (714 morphemes, 347 words) [ayz] MAYBRAT West Papuan, North-Central Bird's Head (Indonesia)

**References consulted:** Dol (2007)

#### Sound inventory

C phoneme inventory: /p t k f s x m n r w j/ N consonant phonemes: 11 Geminates: N/A Voicing contrasts: None Places: Bilabial, Labiodental, Alveolar, Velar Manners: Stop, Fricative, Nasal, Trill, Central approximant N elaborations: 1 Elaborations: Labiodental V phoneme inventory: /i e a o u/ N vowel qualities: 5 Diphthongs or vowel sequences: Vowel sequences/ii ie ia io ea eo ai ae ao au oi oa oo ua uo uu/ Contrastive length: None **Contrastive nasalization:** None Other contrasts: N/A Notes: /o/ is described as lower than /e/. // occur in some words as 'optional' phoneme, e.g. /te/~/əte/ 'below'. It can't take stress but is counted for syllabification (Dol 2007: 15-18).

#### Syllable structure

Complexity Category: Moderately Complex Canonical syllable structure: (C)V(C) (Dol 2007: 34-8) Size of maximum onset: 1 Size of maximum coda: 1 Onset obligatory: No Coda obligatory: No Vocalic nucleus patterns: Short vowels, Vowel sequences Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: N/A Morphological pattern of syllabic consonants: N/A Onset restrictions: All consonants except /p/, /w/, and /j/ occur. Notes: Initial consonant sequences are posited in Dol's analysis as a result of morphology, but these are

invariably broken up by an epenthetic schwa, such that phonetic onset clusters never occur. On the basis of both perceptual and acoustic evidence, Dol takes *phonetic* structure of syllable to be canonical (2007: 35-7).

Suprasegmentals Tone: No Word stress: Yes Stress placement: Fixed Phonetic processes conditioned by stress: (None) Differences in phonological properties of stressed and unstressed syllables: (None) Phonetic correlates of stress: Vowel duration (impressionistic) Notes: Duration a correlate in monosyllabic words that receive stress in connected speech.

#### **Vowel reduction processes**

(none reported)

# [ayz] MAYBRAT West Papuan, North-Central Bird's Head (Indonesia) (cont.)

# **Consonant allophony processes**

**ayz-C1:** Plosives and /x/ vary with voiced variants freely. (Dol 2007: 21-2) **ayz-C2**: Trill varies freely with flap in non-word-initial environments. (Dol 2007: 24)

## **Morphology**

Text: "Siwa and his brother Mafif" (Dol 2007: 284-291) Synthetic index: 1.5 morphemes/word (689 morphemes, 453 words) [bak] BASHKIR Altaic, *Turkic* (Russia)

References consulted: Berkson et al. (2016), Matthew Carter (p.c.), Poppe (1964)

#### Sound inventory

C phoneme inventory: /p b t d k g q  $\theta \delta s \int \chi \mathbf{E} h \mathbf{m} \mathbf{n} \eta \mathbf{l} \mathbf{r} \mathbf{w} \mathbf{j}$ / N consonant phonemes: 21 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Dental, Alveolar, Palato-Alveolar, Velar, Uvular, Glottal Manners: Stop, Fricative, Nasal, Flap/Tap, Central approximant, Lateral approximant N elaborations: 2 Elaborations: Voiced fricatives/affricates, Palato-alveolar, Uvular V phoneme inventory: /i y I y æ ɑ u ʊ u/ N vowel qualities: 9 Diphthongs or vowel sequences: None Contrastive length: None Contrastive nasalization: None Other contrasts: N/A Notes: /?  $(\mathbf{\hat{s}} \mathbf{\hat{f}}) \mathbf{f} \mathbf{v} \mathbf{z} \mathbf{3}$ / occur only in loans. Vowels are from Carter & Robbins (2016) acoustic study. /ut/ is

# Syllable structure

Complexity Category: Complex Canonical syllable structure: (C)V(C)(C) (Poppe 1964: 12-18) Size of maximum onset: 1 Size of maximum coda: 2 Onset obligatory: No Coda obligatory: No Vocalic nucleus patterns: Short vowels, Long vowels, Diphthongs, Vowel sequences Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: Tautomorphemic (Coda) Morphological pattern of syllabic consonants: N/A

the 'canonical' phoneme but quality is closer to  $[\Lambda]$ . /e  $\sigma$ / occur only in loanwords from Russian.

**Coda restrictions:** All consonants except /b d g  $\mu$  h/ may occur as simple codas. Biconsonantal codas apparently have /r l/ as C<sub>1</sub> and a stop as C<sub>2</sub> (patterns inferred from examples).

### <u>Suprasegmentals</u>

Tone: No Word stress: Yes Stress placement: Fixed Phonetic processes conditioned by stress: Vowel Reduction Differences in phonological properties of stressed and unstressed syllables: (None) Phonetic correlates of stress: Intensity (impressionistic)

#### **Vowel reduction processes**

**bak-R1:** High and mid vowels are lowered and centralized in pre-stressed position (Carter and Robbins 2015).

[bak] BASHKIR Altaic, *Turkic* (Russia) (cont.)

# **Consonant allophony processes**

**bak-C1:** Velar fricative /x/ and nasal [ŋ] may be realized as uvulars adjacent to back vowels. (Poppe 1964: 11)

**bak-C2:** Lateral approximant [1] is velarized adjacent to back vowels (Poppe 1964: 10).

**bak-C3:** Voiced bilabial stop [b] may be realized as a fricative in fast speech (Poppe 1965: 8)

**bak-C4:** A labiovelar approximant is realized as a vocalic offglide syllable-finally and word-finally. (Poppe 1965: 9)

#### **Morphology**

(adequate texts unavailable)

[bbo] BOBO MADARÉ, SOUTHERN

References consulted: Morse (1976), Sanou (1978)

#### Sound inventory

C phoneme inventory: /kp gb p b t d k g f v s z h m n n n n n l r w j/ N consonant phonemes: 21 Geminates: N/A Voicing contrasts: Obstruents Places: Labial-velar, Bilabial, Labiodental, Dental, Palatal, Velar, Glottal Manners: Stop, Fricative, Nasal, Flap/Tap, Lateral approximant, Central Approximant N elaborations: 2 Elaborations: Voiced fricatives/affricates, Labiodental V phoneme inventory: /i e ε ə a ɔ o u ĩ ẽ ã ɔ̃ ũ/ N vowel qualities: 8 Diphthongs or vowel sequences: None Contrastive length: None Contrastive nasalization: Some Other contrasts: N/A Notes: Phonetically long vowels analyzed as sequences (Morse 1976: 100-105). /ə/ is very reduced: in

normal conversation, it sounds more like open transition than a vowel, but it does bear tone. Morse analyzes it as phoneme because in most cases it is unclear which vowel might have been reduced to produce this sound (Morse 1976: 42-5).

<u>Syllable structure</u>

Complexity Category: Simple Canonical syllable structure: (C)V (Morse 1976: 112-114) Size of maximum onset: 1 Size of maximum coda: N/A Onset obligatory: No Coda obligatory: N/A Vocalic nucleus patterns: Short vowels Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: N/A Morphological pattern of syllabic consonants: N/A Onset restrictions: All consonants occur. Notes: Occasionally CCV syllables occur in loanwords. The only cases of closed syllables are in a few French loans in well-educated speech (Morse 1976: 113).

# **Suprasegmentals**

Tone: Yes Word stress: Yes Stress placement: Other (tone) Phonetic processes conditioned by stress: Consonant Allophony in Unstressed Syllables Differences in phonological properties of stressed and unstressed syllables: (None) Phonetic correlates of stress: Not described

## **Vowel reduction processes**

bbo-R1: High front vowels /i ĩ/ are partially devoiced following /s/ (Morse 1976: 28-9).

## **Consonant allophony processes**

**bbo-C1:** Bilabial stops are affricated preceding a high front vowel. (Morse 1976: 20)

**bbo-C2:** A flap [r] is realized with palato-alveolar fricative release  $[r^3]$  preceding a high front vowel. (Morse 1976: 25)

**bbo-C3:** Voiced stops /b/ and /g/ are realized as fricatives in intervocalic environments. (Morse 1976: 22) **bbo-C4:** Alveolar and velar stops and fricatives, and /n/, are fronted preceding high and/or front vowels. (Morse 1976: 20-23)

bbo-C5: Stops, fricatives, nasals, and laterals are labialized preceding back vowels. (Morse 1976: 20)

# **Morphology**

(adequate texts unavailable)

[bcj] BARDI

#### Nyulnyulan, Nyulnyulan (Australia)

References consulted: Bowern (2012)

#### Sound inventory

C phoneme inventory: /p t t c g m n η ŋ ŋ l [ ʎ r ų j w/ N consonant phonemes: 17 Geminates: N/A Voicing contrasts: None Places: Bilabial, Alveolar, Retroflex, Palatal, Velar Manners: Stop, Nasal, Trill, Central approximant, Lateral approximant N elaborations: 1 Elaborations: Retroflex V phoneme inventory: /i a ɔ u i: a: u:/ N vowel qualities: 4 Diphthongs or vowel sequences: None Contrastive length: Some Contrastive nasalization: None Other contrasts: N/A Notes: /e/ is marginally phonemic.

Syllable structure

Complexity Category: Complex Canonical syllable structure: (C)V(C)(C) (Bowern 2012: 94-104) Size of maximum onset: 1 Size of maximum coda: 2 Onset obligatory: No Coda obligatory: No Vocalic nucleus patterns: Short vowels, Long vowels Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: Both patterns (Coda) Morphological pattern of syllabic consonants: N/A

**Coda restrictions:** Chart on p. 102 indicates that all consonants except /b/ may occur as a simple coda. Biconsonantal codas consist of /l/, / $\chi$ / or /r/ followed by a nasal which is homorganic with the following stop.

[bcj] BARDI

Nyulnyulan, Nyulnyulan (Australia)

Suprasegmentals

Tone: No Word stress: Yes Stress placement: Fixed Phonetic processes conditioned by stress: Vowel Reduction, Consonant Allophony in Unstressed Syllables

**Differences in phonological properties of stressed and unstressed syllables:** Vowel Length Contrasts (see notes)

(cont.)

**Phonetic correlates of stress:** Vowel duration (instrumental), Pitch (instrumental), Intensity (instrumental) **Notes:** Duration is a correlate of stress for short vowels, and is slight. There are cases where post-tonic vowels are not neutralized, and examples where intensity peak does not coincide with the pitch peak. Stress is always word-initial; because some consonant contrasts do not occur word-initially, stressed syllables are associated with fewer consonant contrasts: trill /r/ and palatal lateral / $\Delta$ / do not occur, while apico-dental and apico-alveolar (retroflex) consonants are neutralized in favor of retroflex series. Long vowels are rarely attested in unstressed positions. I take the consonant pattern to be reflective of general tendencies towards word-initial neutralization in Australian languages, but the vowel length pattern to be truly an effect of stress, since it is explicitly described in those terms.

## **Vowel reduction processes**

**bcj-R1:** Short vowels are reduced in quality in unstressed syllables (centralized and lowered or raised to [ə] or [3], Bowern 2012: 88).

**bcj-R2:** For some speakers, the vowel in an open medial syllable of a trisyllabic word is deleted, especially when it is /i/ and the third syllable is heavy (Bowern 2012: 91).

**bcj-R3:** High front vowels /i u/ are rhoticized and reduced between a stop and a glide (Bowern 2012: 91). **bcj-R4**: Word-final vowels are often partially or fully devoiced (Bowern 2012: 92; in some dialects these vowels are omitted entirely).

**bcj-R5:** A vowel in a syllable following a stressed syllable is characterized by both shortening and centralization, particularly when that syllable is open (Bowern 2012: 111; some sources consistently note this as vowel loss).

## **Consonant allophony processes**

**bcj-C1:** Glide /j/ may be realized as [J] following a trill and preceding a vowel, while also following a stressed syllable. (Bowern 2012: 80-1)

**bcj-C2:** Stops are voiced intervocalically. (Bowern 2012: 76)

bcj-C3: A trill is realized as a flap intervocalically. (Bowern 2012: 81)

bcj-C4: Stops are realized with weak closure intervocalically. (Bowern 2012: 78)

## <u>Morphology</u>

**Text:** "Goolamana," "Story about Mirrdiidi people" (Bowern 2012: 704-710) **Synthetic index:** 2.0 morphemes/word (307 morphemes, 151 words)

## [bsk] BURUSHASKI Isolate (Pakistan)

References consulted: Anderson (1997), Yoshioka (2012)

#### Sound inventory

C phoneme inventory: /p b t d t d k g q p<sup>h</sup> t<sup>h</sup> t<sup>h</sup> k<sup>h</sup> q<sup>h</sup> ts tç dz fs dz ts<sup>h</sup> tc<sup>h</sup> fs<sup>h</sup> s z c s y h m n η r l w щ ј/ N consonant phonemes: 36 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Dental, Alveolar, Retroflex, Alveolo-palatal, Velar, Uvular, Glottal Manners: Stop, Affricate, Fricative, Nasal, Flap/Tap, Central approximant, Lateral approximant N elaborations: 4 Elaborations: Voiced fricatives/affricates, Post-aspiration, Retroflex, Uvular V phoneme inventory: /i ɛ ʌ o u i: ɛ: ʌ: o: u:/ N vowel qualities: 5 Diphthongs or vowel sequences: Diphthongs /Ai Au/ Contrastive length: All **Contrastive nasalization:** None Other contrasts: N/A Notes: /u/ is an advanced velar approximant.

#### Syllable structure

Complexity Category: Complex Canonical syllable structure: (C)(C)V(C)(C) (Anderson 1997: 1024-5; Yoshioka 2012: 18-24) Size of maximum coda: 2 Size of maximum coda: 2 Onset obligatory: No Coda obligatory: No Vocalic nucleus patterns: Short vowels, Long vowels, Diphthongs Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: Tautomorphemic (Onset, Coda) Morphological pattern of syllabic consonants: N/A Onset restrictions: All consonants may occur as a simple onset, though /ŋ/ and /j/ do not occur wordinitially. Biconsonantal onsets occur with /p b p<sup>h</sup> t d t<sup>h</sup> q/ as C<sub>1</sub> and /r j/ as C<sub>2</sub>. Anderson also gives example

of /qy/ onset in Standard Burushaski.

**Coda restrictions:** Any consonant except /w j/ can occur as simple coda, though voiced stops and affricates and some fricatives are not found word-finally. In biconsonantal codas,  $C_1$  is a voiceless fricative and  $C_2$  is /k/, or  $C_1$  is a sonorant and  $C_2$  is /k s c ts tc fs/.

**Notes:** Yoshioka states that all word-initial Cr onsets are from loan words and onomatopoeia, but Anderson gives examples that appear to be native (e.g. *pra:q* 'completely').

[bsk] BURUSHASKI Isolate (Pakistan)

(cont.)

**Suprasegmentals** 

Tone: No Word stress: Yes Stress placement: Morphologically or Lexically Conditioned Phonetic processes conditioned by stress: Vowel Reduction, Consonant Allophony in Unstressed

Syllables Differences in phonological properties of stressed and unstressed syllables: Vowel Quality Contrasts

**Phonetic correlates of stress:** Pitch (impressionistic)

**Notes:** Stress is marked by pitch or pitch contour. Long vowels are only found in stressed syllables. Language is described as having pitch accent by Yoshioka. Vowel length is found only in stressed syllables in underived lexical items (Anderson 1028).

# **Vowel reduction processes**

**bsk-R1:** High vowels /i u/ are realized as lax in unstressed syllables (Anderson 1997: 1029).

**bsk-R2:** Mid front vowel /e/ fluctuates with [ε] in unstressed syllables (Anderson 1997: 1029). **Notes:** In Yasin dialect, unstressed /o/ frequently raises to [u] (Anderson 1997: 1038).

## **Consonant allophony processes**

**bsk-C1:** Voiceless velar stop [k] varies freely with uvular [q] preceding /a/. (Anderson 1997: 1025) **bsk-C2:** Voiced velar fricative varies freely with a velar affricate and a voiced uvular stop syllable-initially. (Anderson 1997: 1025)

**bsk-C3:** Aspirated stops may be realized as affricates or fricatives syllable-initially. (Anderson 1997: 1025) **bsk-C4**: Alveolo-palatal [dz] varies freely with fricative variant. (Anderson 1997: 1025) **bsk-C5**: Velar fricative /x/ may be realized as [h] preceding /u/. (Anderson 1997: 1025)

## **Morphology**

(adequate texts unavailable)

[cap] CHIPAYA Uru-Chipaya, Uru-Chipaya (Bolivia)

References consulted: Cerrón-Palomino (2006), Olson (1967)

#### Sound inventory

C phoneme inventory: /p p<sup>h</sup> p' t t<sup>h</sup> t' k k<sup>h</sup> k' k<sup>w</sup> q q<sup>h</sup> q' q<sup>w</sup> ts ts<sup>h</sup> ts' tf tf<sup>h</sup> tf' ts ts<sup>h</sup> ts' s s s x x<sup>w</sup>  $\chi \chi^w$ mnnnl f Lrwj/ N consonant phonemes: 40 Geminates: N/A Voicing contrasts: None Places: Bilabial, Dental, Alveolar, Palato-alveolar, Retroflex, Velar, Uvular Manners: Stop, Affricate, Fricative, Nasal, Trill, Central approximant, Lateral approximant N elaborations: 6 Elaborations: Post-aspiration, Ejective, Palato-alveolar, Retroflex, Uvular, Labialization V phoneme inventory: /i e a o u i: e: a: o: u:/ N vowel qualities: 5 Diphthongs or vowel sequences: None **Contrastive length:** All Contrastive nasalization: None Other contrasts: N/A Notes: /2/ occurs in restricted sociolinguistic contexts in one morpheme (Cerrón-Palomino 2006: 55).

# Syllable structure

Complexity Category: Complex Canonical syllable structure: (C)(C)V(C)(C) (Cerrón Palomino 2006: 63-66). Size of maximum onset: 2 Size of maximum coda: 2 Onset obligatory: No Coda obligatory: No Vocalic nucleus patterns: Short vowels, Long vowels Syllabic consonant patterns: Obstruent (Conflicting reports) Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: Tautomorphemic (Onset), Both patterns (Coda) Morphological pattern of syllabic consonants: N/A

**Onset restrictions:** No restrictions on simple onsets. Biconsonantal onsets have /s  $\S$   $\S$ / as C<sub>1</sub>. Only presently attested triconsonantal onset is /x\$t<sup>h</sup>/, pronounced [h\$t<sup>h</sup>].

Coda restrictions: No restrictions on simple codas. Biconsonantal codas end in /s/.

**Notes:** Triconsonantal onsets used to be more common, as they are derived from a combination of prefixes and a stem-initial consonant; however, these forms are now completely unproductive and "almost

obsolete". Speakers passively accept /xst<sup>h</sup>/ in two forms,  $xst^ha$ : 'give it to me!' and  $xst^ha$ : give it to me, please!'. (Cerron Palomino 2006: 66). Because this is explicitly described as a marginal and rapidly obsolescing pattern, I classify this language as having Complex syllable structure, though note that it has recently shifted from having Highly Complex syllable structure.

#### **Suprasegmentals**

Tone: No Word stress: Yes Stress placement: Fixed Phonetic processes conditioned by stress: Vowel Reduction Differences in phonological properties of stressed and unstressed syllables: (None) Phonetic correlates of stress: Not described

# [cap] CHIPAYA Uru-Chipaya, Uru-Chipaya (Bolivia) (cont.)

## **Vowel reduction processes**

**cap-R1:** Low central vowel /a/ is realized as [ə] in unstressed open syllables (Olson 1967: 301). **cap-R2:** Short vowels /i e a o u/ are devoiced when preceded by an aspirated consonant and followed by a voiceless consonant (usually a non-sibilant fricative) (Cerrón-Palomino 2006: 62).

cap-R3: Short vowels are truncated (deleted) before a pause (Cerrón-Palomino 2006: 67).

**Notes:** Vowel devoicing is one of the most salient phonetic properties of the language (Cerrón-Palomino 2006: 62). Historical elision of pre-stress vowels is responsible for some of the onset sequences in Chipaya (Cerrón-Palomino 2006: 65).

## **Consonant allophony processes**

**cap-C1:** Voiceless dental fricative is realized as a palato-alveolar when occurring between two high vowels. (Cerrón-Palomino 2006: 48-9)

**cap-C2:** Labiovelar approximant [w] may be realized as a fricative intervocalically, especially when the surrounding vowels are /i/. (Cerrón-Palomino 2006: 55)

cap-C3: A trill is realized as a flap syllable-finally. (Cerrón-Palomino 2006: 54)

**cap-C4:** A palato-alveolar affricate is realized as a fricative word-finally (Cerrón-Palomino 2006: 49) **cap-C5:** Velar and uvular stops vary freely with fricative variants (Cerrón-Palomino 2006: 38)

## <u>Morphology</u>

**Text:** "Tata Sabaya y el Sajama" (Cerrón Palomino 2006: 286-291) **Synthetic index:** 2.1 morphemes/word (342 morphemes, 161 words) [car] CARIB

#### Cariban, Cariban (Suriname)

**References consulted:** Courtz (2008), Hoff (1968), Peasgood (1972)

#### Sound inventory

C phoneme inventory: /p b t d k g ? s h m n ŋ r w j/ N consonant phonemes: 15 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Alveolar, Retroflex, Velar, Glottal Manners: Stop, Fricative, Nasal, Flap/Tap, Velar, Glottal N elaborations: 1 **Elaborations:** Retroflex V phoneme inventory: /i e i a u o/ N vowel qualities: 6 Diphthongs or vowel sequences: Diphthongs /ei ui oi ii ai ou au/ Contrastive length: None Contrastive nasalization: None Other contrasts: N/A Notes: Hoff shows phonemic length contrast in a very limited set of lexical items in 1968. Peasgood has vowel length distinction. Courtz and Yamada take vowel length to be prosodic.

#### Syllable structure

Category: Moderately Complex Canonical syllable structure: (C)V(C) (Courtz 2008: 22-7) Size of maximum onset: 1 Size of maximum coda: 1 Onset obligatory: No Coda obligatory: No Vocalic nucleus patterns: Short vowels, Diphthongs Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: N/A Morphological pattern of syllabic consonants: N/A Onset restrictions: All consonants occur. Coda restrictions: Only nasals and plosives occur.

**Notes:** "Underlying" stop-C onsets are realized with epenthesized [i] or stop isn't pronounced at all when occurring sentence-initially. Author interprets most word-initial instances of /i/ as "auxiliary vowels" needed to pronounce syllables that have lost their original vowel; e.g. /inta/ (Courtz 2008: 26).

#### **Suprasegmentals**

Tone: No Word stress: Yes Stress placement: Weight-Sensitive Phonetic processes conditioned by stress: Vowel Reduction, Consonant Allophony in Unstressed Syllables Differences in phonological properties of stressed and unstressed syllables: (None)

**Phonetic correlates of stress:** Vowel duration (impressionistic), Pitch (impressionistic)

[car] CARIB Cariban, Cariban (Suriname) (cont.)

## **Vowel reduction processes**

car-R1: A word-medial vowel is devoiced preceding syllable-initial /s/ (Peasgood 1972: 38).

car-R2: An unstressed word-initial high central vowel /i/ is deleted (Courtz 2008: 40).

**car-R3:** An unstressed word-initial high front vowel /i/ is deleted unless it precedes /t/. The high and front features of the deleted vowel perseverate into the following consonant (Courtz 2008: 41).

# **Consonant allophony processes**

**car-C1:** A voiceless alveolar fricative is realized as palato-alveolar adjacent to /i/. (Courtz 2008: 32) **car-C2:** Voiceless stops are realized as voiced following an unstressed CV sequence or following a nasal. (Courtz 2008: 31)

## **Morphology**

**Text:** "Kurupi's haircut" (first 10 pages; Courtz 2008: 150-159) **Synthetic index:** 1.8 morphemes/word (619 morphemes, 353 words) [cdm] CHEPANG Sino-Tibetan, Mahakiranti (Nepal)

**References consulted:** Caughley (1969, 1982)

# Sound inventory

C phoneme inventory: /p b t d k g ?  $\widehat{tJ} d\widehat{z} \int h m n \eta l r w j/$ N consonant phonemes: 18 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Dental, Palato-alveolar, Velar, Glottal Manners: Stop, Affricate, Fricative, Nasal, Trill, Central approximant, Lateral approximant N elaborations: 2 Elaborations: Voiced fricatives/affricates, Palato-alveolar V phoneme inventory: /i e  $\vartheta$  a o u/ N vowel qualities: 6 Diphthongs or vowel sequences: None Contrastive length: None Contrastive nasalization: None Other contrasts: N/A Notes: Stress may have conditioned vowel split historically (Caughley 1982: 39).

#### Syllable structure

Complexity Category: Complex Canonical syllable structure: C(C)(C)V(C)(C) (Caughley 1982: 37-8) Size of maximum onset: 3 Size of maximum coda: 2 Onset obligatory: Yes Coda obligatory: No Vocalic nucleus patterns: Short vowels Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: Tautomorphemic (Onset, Coda) Morphological pattern of syllabic consonants: N/A

**Onset restrictions:** Biconsonantal onsets are /k g p b s t d  $\hat{t} \int d\hat{z} / + /h/$ , or /m  $\eta$  n l r/ + /j/. In triconsonantal onsets, C<sub>1</sub> is /k g/, C<sub>2</sub> is /l r/, and C<sub>3</sub> is /j/.

**Coda restrictions:** Simple codas limited to nasals and plosives. Biconsonantal codas are  $j/j + \eta h$ ? k/ or / m n r l w  $\eta / + h$ ?/.

**Notes:** Onset and coda patterns given above are inferred from complicated table in Caughley (1982: 38), but seem accurate based on examples in reference. Glottals in onsets and codas have varying realizations which include strong aspiration, lengthening, or breathy/voiceless equivalent of adjacent segment (37-36).

#### **Suprasegmentals**

Tone: Yes

Word stress: Yes

Stress placement: Fixed

Phonetic processes conditioned by stress: (None)

# Differences in phonological properties of stressed and unstressed syllables: (None)

# Phonetic correlates of stress: Not described

**Notes:** Caughley mentions briefly a "pitch length stress pattern" but it's not clear if this is referring to stressed syllables or feet (it seems like the latter) (1969: 25). Syllables with voiceless final consonants often appear more strongly stressed. Pitch is contrastive in restricted environments for certain syllable types, indicating that Chepang may be in an intermediate stage between an earlier non-tonal stage of the language and incipient stages of full tonal development (Chepang 1982: 38-9).
[cdm] CHEPANG Sino-Tibetan, Mahakiranti (Nepal) (cont.)

#### **Vowel reduction processes**

cdm-R1: Vowels are shortened in syllables closed by voiceless consonants (Caughley 1969: 21).

#### **Consonant allophony processes**

**cdm-C1:** A voiceless alveolar fricative is realized as palato-alveolar preceding front vowels. (Caughley 1969: 10)

**cdm-C2:** A labiovelar approximant is realized as fricated preceding front vowels. (Caughley 1969: 14) **cdm-C3:** Velar stops and the velar nasal are backed preceding back vowels. (Caughley 1982: 4) **cdm-C4:** Velar stops are fronted preceding front vowels. (Caughley 1969: 4)

## **Morphology**

**Text:** "The origin of the drum" (first 4 pages; Caughley 1982: 245-248) **Synthetic index:** 2.1 morphemes/word (678 morphemes, 321 words) [cgg] NKORE-KIGA

Niger-Congo, Bantoid (Uganda)

References consulted: Taylor (1985)

## Sound inventory

C phoneme inventory: /p b t d k g t  $\widehat{f}$  d  $\widehat{d}$  f v s z  $\int \mathfrak{z}$  h m n n r r w j/ N consonant phonemes: 22 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Labiodental, Dental, Palato-alveolar, Velar, Glottal Manners: Stop, Affricate, Fricative, Nasal, Trill, Central approximant N elaborations: 3 Elaborations: Voiced fricatives/affricates, Labiodental, Palato-alveolar V phoneme inventory: /I  $\varepsilon$  a o  $\cup$  I:  $\varepsilon$ : a: o:  $\cup$ :/ N vowel qualities: 5 Diphthongs or vowel sequences: None Contrastive length: All Contrastive nasalization: None Other contrasts: None

**Notes:** /t/ missing in list of phonemes, but is described in Taylor (1985: 199). Velar nasal  $[\eta]$  not phonemic. Taylor (1985: 202) describes vowels as being "voiced or unvoiced," but does not elaborate on whether this is predictable or contrastive. In any case, this distinction is not indicated in the phonemic transcriptions of the language, so I do not code for a voicing distinction in vowels here.

## Syllable structure

Category: Moderately Complex Canonical syllable structure: (C)(C)V(C) (Taylor 1985: 205-7) Size of maximum onset: 2 Size of maximum coda: 1 Onset obligatory: No Coda obligatory: No Vocalic nucleus patterns: Short vowels, Long vowels Syllabic consonant patterns: Nasal Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: Predictable from word/consonantal context Morphological constituency of maximum syllable margin: Tautomorphemic (Onset) Morphological pattern of syllabic consonants: Both Onset restrictions: [ŋ] allophone of /n/ never occurs as single initial consonant. C<sub>1</sub> in onset clusters seems

**Onset restrictions:** [ŋ] allophone of /n/ never occurs as single initial consonant.  $C_1$  in onset clusters seems to be limited to /b  $\widehat{tJ}$  g h j m n n r  $\int s$  t/.  $C_2$  is always semivowel /w/ or /j/.

## Coda restrictions: Nasals /m n/ and allophone [ $\eta$ ]

**Notes:** Word-initially, a nasal consonant preceding another consonant is syllabic. The author's description of syllabification word-medial nasal+C sequences is conflicted: the syllable boundary is first described as coming between the two segments (Taylor 1985: 205), but later the author describes the syllable/hesitation pause in speech to come *before* the nasal (206-7). The author states that for *omuhanda* 'way', a syllabification of *o-mu-handa* is preferred to *o-mu-han-da*, but also says that "both opinions have some phonetic support". It appears that the second solution is rejected on the grounds that a syllable may not end with a consonantal sound, but it is not clear why this strict interpretation of canonical syllable structure is taken. Therefore I analyze the language as having optional codas restricted to nasal consonants.

[cgg] NKORE-KIGA

Niger-Congo, *Bantoid* (Uganda) (cont.)

Suprasegmentals Tone: Yes Word stress: No

#### **Vowel reduction processes**

**cgg-R1:** High vowels /I U/ are deleted between two instances of  $ft_{j}$ ,  $f_{j}$ , s, or h. All examples show this occurring word-medially (Taylor 1995: 202-3).

**cgg-R2:** High back vowel /u/ is deleted when preceded by a fricative / $\int 3$  s/ and followed by dental plosive /t/ (Taylor 1995: 205).

## Consonant allophony processes

**cgg-C1:** Velar stops are realized as palato-alveolar affricates preceding front vowels. (Taylor 1985: 200) **cgg-C2:** An alveolar approximant is realized as a voiced alveolar stop following an alveolar nasal. (Taylor 1985: 201)

**cgg-C3:** A voiced bilabial stop is realized as a labiodental fricative when occurring intervocalically. (Taylor 1985: 200)

#### **Morphology**

[cho] CHOCTAW Muskogean, Muskogean (United States)

References consulted: Broadwell (2006)

#### Sound inventory

C phoneme inventory: /p b t k ? t∫ f s ∫ h m n l ł w j/ N consonant phonemes: 16 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Labiodental, Alveolar, Palato-alveolar, Velar, Glottal Manners: Stop, Affricate, Fricative, Nasal, Central approximant, Lateral fricative, Lateral approximant N elaborations: 2 Elaborations: Labiodental, Palato-alveolar V phoneme inventory: /i a u i: a: u: ĩ ã ũ/ N vowel qualities: 3 Diphthongs or vowel sequences: None Contrastive length: Some Contrastive nasalization: Some Other contrasts: N/A Notes: Short vowels also have nasal counterparts.

Syllable structure

Category: Moderately Complex Canonical syllable structure: (C)V(C) (Broadwell 2006: 18-21). Size of maximum onset: 1 Size of maximum coda: 1 Onset obligatory: No Coda obligatory: No Vocalic nucleus patterns: Short vowels, Long vowels Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: N/A Morphological pattern of syllabic consonants: N/A Onset restrictions: All consonants except /2/ occur. Coda restrictions: All consonants except /b 4 w j tî/ occur.

**Suprasegmentals** 

Tone: Yes Word stress: Yes Stress placement: Morphologically or Lexically Conditioned Phonetic processes conditioned by stress: Vowel Reduction Differences in phonological properties of stressed and unstressed syllables: (None) Phonetic correlates of stress: Pitch (impressionistic) Notes: Language has a pitch accent system: final syllable of each word has high or rising pitch, while some

**Notes:** Language has a pitch accent system: final syllable of each word has high or rising pitch, while some stems have additional high pitch on penultimate or antepenultimate syllable. (Ulrich) Pitch is very minimally contrastive in the language (Broadwell 2006: 17).

## **Vowel reduction processes**

**cho-R1:** A word-initial (and unstressed) high front vowel /i/ may be deleted before a sequence of /s/ or /J/ and another consonant, in casual speech (Broadwell 2006: 19).

**cho-R2:** A long high front vowel /i:/ is often lowered to [e:] when occurring word-finally (Broadwell 2006: 30).

## [cho] CHOCTAW Muskogean, Muskogean (United States) (cont.)

## **Consonant allophony processes**

**cho-C1:** A voiceless velar stop is voiced intervocalically. (Broadwell 2006: 15) **cho-C2:** A voiceless velar stop may be realized as a voiced fricative intervocalically (Broadwell 2006: 15)

#### **Morphology**

**Text:** "My first days in school," "Life at the orphanage" (Broadwell 2006: 355-360) **Synthetic index:** 2.1 morphemes/word (552 morphemes, 263 words) [coc] COCOPA Hokan, Yuman (Mexico, United States)

**References consulted:** Bendixen (1980), Crawford (1966)

#### Sound inventory

C phoneme inventory: /p t f k k<sup>w</sup> q q<sup>w</sup> ?  $\widehat{t}$  s  $\frac{1}{3}$  s  $\int \frac{1}{2} x x^{w} m n n^{j} l l^{j} r w j/$ N consonant phonemes: 24 Geminates: N/A Voicing contrasts: None Places: Bilabial, Alveolar, Palato-alveolar, Retroflex, Velar, Uvular, Glottal Manners: Stop, Affricate, Fricative, Nasal, Flap/Tap, Central approximant, Lateral fricative, Lateral approximant N elaborations: 5 Elaborations: Palato-alveolar, Retroflex, Uvular, Palatalization, Labialization V phoneme inventory: /i a u i: a: u:/ N vowel qualities: 3 Diphthongs or vowel sequences: Diphthongs /iw uj aj aw i:w uj aj a:w/. Vowel sequences /ia i:a a:a ua u:a/ Contrastive length: All Contrastive nasalization: None Other contrasts: N/A Notes: /e/ occurs only in loanwords from Spanish, English.

#### Syllable structure

**Complexity Category:** Highly Complex **Canonical syllable structure:** (C)(C)(C)(C)(C)(C)(C) (Crawford 1966: 35-48; Bendixen 1980: 218-19) **Size of maximum onset:** 4 **Size of maximum coda:** 3 **Onset obligatory:** No **Coda obligatory:** No

**Vocalic nucleus patterns:** Short vowels, Long vowels, Diphthongs, Vowel sequences **Syllabic consonant patterns:** Nasal, Liquid, Obstruent

**Size of maximum word-marginal sequences with syllabic obstruents:** 5 (initial), 3 (final) **Predictability of syllabic consonants:** Predictable from word/consonantal context

**Morphological constituency of maximum syllable margin:** Heteromorphemic (Onset, Coda) **Morphological pattern of syllabic consonants:** Grammatical items (Nasal, Liquid, Obstruent), Both (Liquid)

**Onset restrictions:** Biconsonantal onsets include stop-fricative, fricative-fricative clusters. Triconsonantal onsets include /sxt psk<sup>w</sup> xps/. Four-consonant onsets include /stfx? pstf? fxlm/. Only glottal stops may be contiguous with other stops.

**Coda restrictions:** Contiguous stops may not be identical in coda clusters. Biconsonantal codas include sonorant+obstruent, obstruent+obstruent, with no contiguous stops:  $/Jk \ sx \ kp \ lp \ n^{j}x \ ms/$ . Triconsonantal codas include sonorant+obstruent+obstruent, or three obstruents: /qsk  $\ ssk \ rsk/$ .

**Notes:** Obstruent-sonorant and sonorant-obstruent onsets reported by Crawford, but Bendixen states these are predictably split by epenthesis (1980: 219-20). Crawford claims there are different combinatory patterns occurring in onsets of stressed and unstressed syllables (1966: 35-37), but the description is confusing and the examples don't clarify. Both stressed and unstressed syllables have, e.g., /psk<sup>w</sup>/ onsets. Both Crawford and Bendixen propose that fricatives may occur as syllable nuclei, though Bendixen states this occurs only in fastest rates of speech (1980: 34).

[coc] COCOPA

**Suprasegmentals** 

Tone: No

Word stress: Yes

Stress placement: Morphologically or Lexically Conditioned

**Phonetic processes conditioned by stress:** Vowel Reduction, Consonant Allophony in Unstressed Syllables

Differences in phonological properties of stressed and unstressed syllables: (None)

**Phonetic correlates of stress:** Vowel duration (impressionistic), Pitch (instrumental), Intensity (instrumental)

**Notes:** Bendixen instrumentally confirms intensity/amplitude for standard word stress; Crawford reports (without instrumental evidence) duration and pitch as correlates. Bendixen reports these (instrumentally) for emphatic stress. Stress only targets syllables containing vowels (Crawford 28).

#### Vowel reduction processes

**coc-R1:** Vowels in unstressed syllables are somewhat less tense than those of stressed syllables (Crawford 1966: 22).

**coc-R2:** A stressed vowel is shortened when preceded by /w/ and a morpheme boundary (Bendixen 1980: 67).

**Notes:** Short /i/ is relatively rare in unstressed syllables (Crawford 1966: 32). In formal oration, unstressed syllables are barely audible (Bendixen 1980: 332-3).

## **Consonant allophony processes**

coc-C1: A voiceless velar stop is fronted preceding /i/. (Crawford 1966: 15)

**coc-C2:** Stops may be voiced following a long vowel word-finally when the following word begins with a nasal. (Bendixen 1980: 99-100)

#### **Morphology**

[cod] COCAMA Tupian, *Tupi-Guarani* (Peru)

References consulted: Vallejos Yopán (2010), Vallejos (p.c.)

#### Sound inventory

C phoneme inventory: /p t k ts tf x m n r w j/ N consonant phonemes: 11 Geminates: N/A Voicing contrasts: None Places: Bilabial, Alveolar, Palato-alveolar, Velar Manners: Stop, Affricate, Fricative, Nasal, Flap/Tap, Central approximant N elaborations: 1 Elaborations: Palato-alveolar V phoneme inventory: /i e i a u/ N vowel qualities: 5 Diphthongs or vowel sequences: None Contrastive length: None Contrastive nasalization: None Other contrasts: N/A

Syllable structureCategory: Moderately ComplexCanonical syllable structure: (C)(C)V(C) (Vallejos 2010: 112-15)Size of maximum onset: 2Size of maximum coda: 1Onset obligatory: NoCoda obligatory: NoVocalic nucleus patterns: Short vowelsSyllabic consonant patterns: N/ASize of maximum word-marginal sequences with syllabic obstruents: N/APredictability of syllabic consonants: N/AMorphological constituency of maximum syllable margin: Tautomorphemic (Onset)Morphological pattern of syllabic consonants: N/A

**Onset restrictions:** All consonants occur in simple onsets; in complex onsets  $C_1$  is limited to /p t k r n/ and  $C_2$  to glides /w/ and /j/.

Coda restrictions: Only /w/, /j/, and /n/ occur.

**Notes:** "Underlying" stop-C onsets are realized with epenthesized [i] or stop isn't pronounced at all when occurring sentence-initially. Author interprets most word-initial instances of i/i as "auxiliary vowels" needed to pronounce syllables that have lost their original vowel; e.g. /inta/ (Courtz 2008: 26).

Suprasegmentals Tone: No Word stress: Yes Stress placement: Fixed Phonetic processes conditioned by stress: Vowel Reduction Differences in phonological properties of stressed and unstressed syllables: (None) Phonetic correlates of stress: Not described [cod] COCAMA Tupian, Tupi-Guaraní (Peru) (cont.)

## Vowel reduction processes

**cod-R1:** The high back vowel /u/ is produced as lax or [o] word-finally (and following stressed syllable) (Vallejos Yopán 2010: 109).

**cod-R2:** The high front vowel /i/ is produced as lax or [e] word-finally (and following a stressed syllable) following an approximant segment (Vallejos Yopán 2010: 109).

**cod-R3:** The mid vowel /e/ is slightly centralized word-medially, especially in fast pronunciation (Vallejos Yopán 2010: 110).

**cod-R4:** In words of more than three syllables, the vowel of the antepenultimate syllable (preceding the stressed syllable) is deleted (Vallejos Yopán 2010: 110-11).

**cod-R5:** Unstressed high vowels /i u/ are deleted word-initially preceding homorganic approximant /j/ or / w/ when the following syllable is stressed (Vallejos Yopán 2010: 111-12).

#### **Consonant allophony processes**

**cod-C1:** Alveolar affricate is realized as palato-alveolar preceding a high front vowel. (Vallejos Yopán 2010: 101)

**cod-C2:** A palatal glide may be realized as [z] word-initially and intervocalically. (Vallejos Yopán 2010: 99)

**cod-C3:** A labiovelar glide may be realized as a fricative intervocalically. (Vallejos Yopán 2010: 99) **cod-C4:** An alveolar nasal is realized as palatal preceding a palatal glide. (Vallejos Yopán 2010) **cod-C5:** Stops are voiced following a nasal. (Vallejos Yopán 2010: 98)

**cod-C6:** An alveolar affricate may be realized as a fricative preceding a non-high vowel. (Vallejos Yopán 2010: 100)

## **Morphology**

**Text:** "Bite of snake" (first 10 pages, Vallejos 2010: 883-892) **Synthetic index:** 1.5 morphemes/word (489 morphemes, 329 words) [cub] CUBEO

References consulted: Chacon (2012), Morse & Maxwell (1999)

#### Sound inventory

C phoneme inventory: /p b t d k t͡j h r w ð j/ N consonant phonemes: 11 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Alveolar, Palato-alveolar, Velar, Glottal Manners: Stop, Affricate, Fricative, Flap/Tap, Central approximant N elaborations: 1 Elaborations: Palato-alveolar V phoneme inventory: /i e ɨ a o u ĩ ẽ ĩ ã õ ũ/ N vowel qualities: 6 Diphthongs or vowel sequences: Vowel sequences /ea oa ue ao au ei ui/ and many more Contrastive length: None Contrastive nasalization: All Other contrasts: N/A

**Notes:** Morse & Maxwell give /x/ instead of /h/, don't have / $\check{Q}$ /. Chacon states [ $\check{Q}$ ] often allophone of /j/, but does contrast with /j/ word-initially preceding /a/ in a highly frequent stem ('make'). However, Chacon also gives minimal pairs for / $\check{Q}$ /, but the phoneme has very limited distribution. Morse & Maxwell give / $\epsilon$ / instead of /e/.

Syllable structureComplexity Category: SimpleCanonical syllable structure: C(V) (Chacon 2012: 163-7)Size of maximum onset: 1Size of maximum coda: N/AOnset obligatory: NoCoda obligatory: N/AVocalic nucleus patterns: Short vowels, Vowel sequencesSyllabic consonant patterns: N/ASize of maximum word-marginal sequences with syllabic obstruents: N/APredictability of syllabic consonants: N/AMorphological constituency of maximum syllable margin: N/AMorphological pattern of syllabic consonants: N/AOnset restrictions: All consonants occur.Notes: The third yowel in a sequence, if /i/, is acoustically similar to [i] (Chacon 2012: 52).

## **Suprasegmentals**

Tone: Yes Word stress: Yes Stress placement: Morphologically or Lexically Conditioned Phonetic processes conditioned by stress: Vowel Reduction, Consonant Allophony in Unstressed Syllables, Consonant Allophony in Stressed Syllables

Differences in phonological properties of stressed and unstressed syllables: (None)

**Phonetic correlates of stress:** Vowel duration (instrumental), Pitch (instrumental), Intensity (instrumental) **Notes:** Duration is the most consistent correlate of stress, intensity is less clear. "Kubeo tones are best seen as word-level contours, since they impose a particular pitch contour on a large section of an entire word, not only on individual syllables" (Chacon 134). Tones only occur on primary stressed syllables and syllables to the right of that. [cub] CUBEO Tucanoan, Tucanoan (Colombia) (cont.)

## **Vowel reduction processes**

**cub-R1:** Vowels in unstressed syllables are shorter, or may be deleted entirely (Chacon 2012: 109, 123; instrumental evidence pp. 155-9). Other segments in unstressed syllables can additionally be deleted. **Notes:** In sequences of three vowels analyzed as tautosyllabic by author, third vowel, if /i/, may be realized as [j] (Chacon 2012: 52).

## **Consonant allophony processes**

**cub-C1:** A palatal glide may be realized as a palato-alveolar affricate, especially in word-initial stressed syllables, but also word-initially in unstressed syllables. (Chacon 2012: 67)

**cub-C2:** A labiovelar glide may be realized as a fricative preceding non-front vowels. (Chacon 2012: 63) **cub-C3:** A voiced alveolar stop is realized as an alveolar flap intervocalically. (Chacon 2012: 63)

**cub-C4:** A voiced alveolar stop is realized as a retroflex flap following any vowel and preceding a front vowel. (Chacon 2012: 6)

**cub-C5:** Voiceless bilabial and velar stops are sometimes realized as a glottal fricative when occurring in a post-stress syllable. (Chacon 2012: 123)

## **Morphology**

[dow] DOYAYO

#### Niger-Congo, Adamawa (Cameroon)

References consulted: Wiering & Wiering (1994)

#### Sound inventory

C phoneme inventory: /p t k kp b b d d g gb f v s z h m n ŋ l r w j/ N consonant phonemes: 22 Geminates: N/A Voicing contrasts: Obstruents Places: Labial-velar, Bilabial, Labiodental, Alveolar, Velar, Glottal Manners: Stop, Fricative, Nasal, Flap/Tap, Central approximant, Lateral approximant N elaborations: 3 Elaborations: Voiced fricatives/affricates, Implosive, Labiodental V phoneme inventory: /i e ε a ɔ o u i: e: ε: a: ɔ: o: u: ĩ ẽ ẽ ã ɔ̃ õ ũ ĩ: ẽ: ã: ɔ̃: ũ:/ N vowel qualities: 7 Diphthongs or vowel sequences: None Contrastive length: All Contrastive nasalization: Some Other contrasts: N/A Notes: There is a nasal contrast for all but /e e: o o:/.

#### Syllable structure

Complexity Category: Highly Complex Canonical syllable structure: (C)V(C)(C)(C)(C) (Wiering & Wiering 1994: 21-23, 37-43) Size of maximum onset: 1 Size of maximum coda: 4 Onset obligatory: No Coda obligatory: No Vocalic nucleus patterns: Short vowels, Long vowels Syllabic consonant patterns: Nasal Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: Varies with CV sequence Morphological constituency of maximum syllable margin: Heteromorphemic (Coda) Morphological pattern of syllabic consonants: N/A Onset restrictions: All consonants but /ŋ/ may occur in onset. Coda restrictions: All consonants but /p f d kp  $\overline{g}$ b  $\beta$  h/ may occur as simple codas. Biconsonantal coda

combinations are quite extensive, include /rk, pt, ts, kt,  $\beta r$ /. Triconsonantal codas include /brt/ (phonetically [ $\beta rt$ ]), /glt/ (phonetically [ $\gamma lt$ ]), and more. Four-consonant codas include /blts/, /gldz/, /mnts/, / $\eta rdz$ /, and more. In largest clusters, C<sub>1</sub> is limited to /b g m  $\eta$ /, C<sub>2</sub> to /l r n/, C<sub>3</sub> to /d t/, and C<sub>4</sub> to /s z/. C<sub>3</sub> and C<sub>4</sub> must match in voicing. /b g/ usually realized as fricatives in clusters.

#### **Suprasegmentals**

Tone: Yes Word stress: Not reported

#### **Vowel reduction processes**

**dow-R1:** A long vowel is optionally shortened preceding a coda of two or three consonants (Wiering and Wiering 1994: 22).

**dow-R2:** A long vowel is obligatorily shortened preceding a coda of four consonants (Wiering and Wiering 1994: 22).

**dow-R3:** Following any stop other than /b/, a sequence of vowel plus alveolar nasal consonant is realized as a syllabic nasal (Wiering and Wiering 1994: 24).

# [cub] CUBEO Tucanoan, Tucanoan (Colombia) (cont.)

## **Consonant allophony processes**

**dow-C1:** Voiced bilabial and velar stops are spirantized initially in a voiced consonant cluster. (Wiering & Wiering 1994: 31-2)

# **Morphology**

### [dru] RUKAI (BUDAI DIALECT) Austronesian, Rukai (Taiwan)

#### References consulted: Chen (2006)

#### Sound inventory

**C** phoneme inventory: /p b t d d k g  $\widehat{ts}$  v  $\theta$   $\widehat{\delta}$  s m n  $\eta$  r l ] w j/ N consonant phonemes: 20 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Labiodental, Dental, Alveolar, Retroflex, Velar Manners: Stop, Affricate, Fricative, Nasal, Trill, Central approximant, Lateral approximant N elaborations: 3 Elaborations: Voiced fricatives/affricates, Labiodental, Retroflex V phoneme inventory: /i ə a u i: e: a: u:/ N vowel qualities: 4 Diphthongs or vowel sequences: Diphthongs /au ai ia ua/ **Contrastive length:** All Contrastive nasalization: None Other contrasts: N/A Notes: Long vowels are contrastive in monosyllabic words and first syllable of disyllabic words, but not in penultimate position.

#### Syllable structure

Complexity Category: Simple Canonical syllable structure: (C)V (Chen 2006: 211-18) Size of maximum onset: 1 Size of maximum coda: N/A Onset obligatory: No Coda obligatory: N/A Vocalic nucleus patterns: Short vowels, Long vowels, Diphthongs Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: N/A Onset restrictions: All consonants occur.

**Notes:** Most Formosan languages have canonical (C)V(C) structure; related language Paiwan also has (C)V(C). In Budai Rukai, a small number of sonorant codas such as nasals and laterals were attested in fast speech, but reconfirmation by author revealed (C)V forms for these (Chen 2006: 213).

## **Suprasegmentals**

Tone: No Word stress: Yes Stress placement: Weight-Sensitive Phonetic processes conditioned by stress: Vowel Reduction Differences in phonological properties of stressed and unstressed syllables: (None) Phonetic correlates of stress: Vowel duration (instrumental), Pitch (instrumental) Notes: Pitch is a strong cue for stress in long and short vowels; duration a stronger cue for long vowels and is somewhat sensitive to word position of stress.

## [dru] RUKAI (BUDAI DIALECT) Austronesian, *Rukai* (Taiwan) (cont.)

### **Vowel reduction processes**

dru-R1: Long vowels are shortened when occurring in non-main stress position (Chen 2006: 257).

## **Consonant allophony processes**

**dru-C1:** Voiceless alveolar fricative and affricate are realized as palato-alveolar preceding a high front vowel. (Chen 2006: 230)

**dru-C2:** A voiced labiodental fricative may be realized as a stop word-initially preceding schwa. (Chen 2006: 227)

**dru-C3:** A voiced labiodental fricative may be realized as a glide word-initially preceding a non-schwa vowel. (Chen 2006: 227)

## **Morphology**

[dry] DARAI

**References consulted:** Dhakal (2012), Kotapish & Kotapish (1978), Paudyal (2003), Netra P. Paudyal (p.c.)

Sound inventory

C phoneme inventory: /p b t d t d k q p<sup>h</sup> b<sup>h</sup> t<sup>h</sup> d<sup>h</sup> t<sup>h</sup> d<sup>h</sup> t<sup>h</sup> d<sup>h</sup> t  $\widehat{dz}$  t  $\widehat{dz}$  t  $\widehat{dz}$  h s f m n n r l  $\beta$  j/ N consonant phonemes: 29 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Dental, Alveolar, Retroflex, Velar, Glottal Manners: Stop, Affricate, Fricative, Nasal, Trill, Central approximant, Lateral approximant N elaborations: 4 Elaborations: Breathy voice, Voiced fricatives/affricates, Post-aspiration, Retroflex V phoneme inventory: /i e ə a o u ĩ ẽ ẽ ã õ ũ/ N vowel qualities: 6 Diphthongs or vowel sequences: Diphthongs /iu eu au əu ou ei ai ui əi oi/ Contrastive length: None **Contrastive nasalization:** All Other contrasts: N/A **Notes:** Kotapish & Kotapish 1973 also report /r/. Paudval gives  $\Lambda$  / instead of  $\lambda$ . All six vowels are marginally contrastive for nasality (Dhakal 2012: 7).

#### Syllable structure

Complexity Category: Moderately Complex Canonical syllable structure: (C)(C)V(C) (Dhakal 2012: 17-20) Size of maximum onset: 2 Size of maximum coda: 1 Onset obligatory: No Coda obligatory: No Vocalic nucleus patterns: Short vowels, Diphthongs Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: Tautomorphemic (Onset) Morphological pattern of syllabic consonants: N/A

**Onset restrictions:**  $C_1$  may be any consonant except /ŋ/.  $C_2$  is always a glide / $\beta$ / or /j/. **Coda restrictions:** All consonants except for glides and glottal fricative /h/ are attested. Nucleus:

Notes: Syllables lacking onsets are attested but very rare (Dhakal 2012: 19).

#### <u>Suprasegmentals</u>

Tone: No Word stress: Yes Stress placement: Fixed Phonetic processes conditioned by stress: Vowel Reduction Differences in phonological properties of stressed and unstressed syllables: Not described Phonetic correlates of stress: Not described [dry] DARAI Indo-European, *Indic* (Nepal) (cont.)

#### **Vowel reduction processes**

**dry-R1:** High back vowel /u/ may be deleted preceding a sequence of /wa/ and another consonant (Kotapish & Kotapish 1973: 49).

### **Consonant allophony processes**

**dry-C1:** Alveolar affricates and voiceless alveolar fricative are realized as palato-alveolar preceding a front vowel. (Kotapish & Kotapish 1978: 26)

**dry-C2:** A voiceless aspirated velar fricative is realized as affricate [kx] following a vowel and preceding a schwa. (Kotapish & Kotapish 1978: 26)

**dry-C3:** An alveolar flap is realized with palato-alveolar fricative release word finally. (Kotapish & Kotapish 1978: 24)

**dry-C4:** Bilabial stops are realized as palatalized word-initially preceding /e/. (Kotapish & Kotapish 1978: 27)

**dry-C5:** A voiced bilabial stop is realized as prenasalized intervocalically. (Kotapish & Kotapish 1978: 27) **dry-C6:** A voiceless bilabial stop is spirantized intervocalically or between a vowel and a consonant. (Kotapish & Kotapish 1978: 17)

**dry-C7:** A voiceless alveolar fricative varies with a glottal fricative preceding alveolar sonorants. (Kotapish & Kotapish 1978)

#### **Morphology**

Text: "Jackal and Hen" (Dhakal 2012: 180-192) Synthetic index: 1.6 morphemes/word (734 morphemes, 472 words) [dts] TORO SO Dogon, Dogon (Burkina Faso, Mali)

References consulted: Bendor-Samuel et al. (1989), Hantgan (2012), Plungian (1995)

#### Sound inventory

C phoneme inventory: /p b t d k g d3 s h m n n η η l r w j/ N consonant phonemes: 17 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Dental/Alveolar, Palato-Alveolar, Palatal, Velar, Glottal Manners: Stop, Affricate, Fricative, Nasal, Flap/Tap, Lateral Approximant, Central Approximant N elaborations: 2 Elaborations: Voiced fricatives/affricates, Palato-alveolar V phoneme inventory: /i e ε a ɔ o u ĩ ẽ ã ɔ̃ ũ/ N vowel qualities: 7 Diphthongs or vowel sequences: None Contrastive length: None Contrastive nasalization: Some Other contrasts: N/A

**Notes:** Authors state status of  $[\eta]$  uncertain. I have included it since Plungian (1995) and Hantgan (2012) indicate it is contrastive but limited in its distribution. Plungian lists 25 consonants, including geminate /m: n: l:/ and prenasalized stops, which seem to be unique to Tommo So. Hantgan lists 19 but includes /ʃ/ and / 3/ as phonemes, even though these don't occur in any examples and author states that they are predictable variants of alveolar fricatives. Hantgan gives / $\gamma$ / instead of /h/. Long vowels interpreted as sequences.

#### Syllable structure

Complexity Category: Simple Canonical syllable structure: (C)V(C) (Bendor-Samuel et al. 1989: 172, Hantgan 2012, Plungian 1995) Size of maximum onset: 1 Size of maximum coda: 1 Onset obligatory: No Coda obligatory: No Vocalic nucleus patterns: Short vowels Syllabic consonant patterns: Nasal Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: Phonemic, Predictable from word/consonantal context Morphological constituency of maximum syllable margin: N/A Morphological pattern of syllabic consonants: Both Onset restrictions: All consonants occur. Notes: Bendor-Samuel et al. (1989) state syllable structure is canonically (C)V. Plungian (1995) states

**Notes:** Bendor-Samuel et al. (1989) state syllable structure is canonically (C)V. Plungian (1995) states that /w j m ŋ/ occur word-finally. Hantgan states that epenthesis occurs to ensure all syllables are of type CV in Ibi So dialect (2012: 26, 33), but then states coda consonants occur before the Perfective suffix if the verb root contains a low back vowel (2012: 47). Some word-final nasals and glides in Hantgan are transcribed with tone, indicating syllabicity, but some are not (also occasionally word-final /r/ appears). I consider this language to be a marginal case of Simple syllable structure. Plungian states (for Tommo So) that biconsonantal combinations with nasals or approximants (as C<sub>2</sub>?) are phonologically possible, but almost always split by a schwa (e.g. /dabla/ > [dabala]). Plungian also reports that coda consonants /w j m  $\eta$ / may occur (1995: 6).

[dts] TORO SO

Dogon, Dogon (Burkina Faso, Mali)

(cont.)

**Suprasegmentals** 

Tone: Yes Word stress: Yes Stress placement: Not described Phonetic processes conditioned by stress: Not described Differences in phonological properties of stressed and unstressed syllables: Not described Phonetic correlates of stress: Not described Notes: Lexical accent exists but is not well described.

#### Vowel reduction processes

**Notes:** Some speakers of related dialect Tommo-So, especially younger ones, reduce high vowels /i u/ in word-final position, or delete them entirely (Plungian 1995: 6; nature of reduction is not described). Tommo-So has rampant reduction of final and medial vowels, which sets this dialect apart from others (Plungian 1995: 8).

#### **Consonant allophony processes**

(none reported)

#### Morphology

**Text:** "Texte en dialecte tommo-so" (Plungian 1995: 40-43) \*\*\*\*Tommo-So dialect\*\*\*\* **Synthetic index:** 1.2 morphemes/word (339 morphemes, XX words) [dyo] DIOLA-FOGNY Niger-Congo, Northern Atlantic (Gambia, Senegal)

References consulted: Lavergne (1979), Sapir (1965)

## Sound inventory

C phoneme inventory: /p b t d c j k g f s h m n n η η l ι w j/ N consonant phonemes: 19 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Labiodental, Alveolar, Palatal, Velar, Glottal Manners: Stop, Fricative, Nasal, Central approximant, Lateral approximant N elaborations: 1 Elaborations: Labiodental V phoneme inventory: /i ι e ε 9 a o o o u i: r: e: ε: 9: a: o: o: o: u:/ N vowel qualities: 10 Diphthongs or vowel sequences: Diphthongs /eo iu Ie oa eI/ Contrastive length: All Contrastive nasalization: None Other contrasts: N/A Notes: Diphthongs are rare.

#### Syllable structure

Complexity Category: Complex Canonical syllable structure: (C)V(C)(C) (Sapir 1965: 6-9) Size of maximum coda: 2 Onset obligatory: No Coda obligatory: No Vocalic nucleus patterns: Short vowels, Long vowels, Diphthongs Syllabic consonant patterns: Nasal Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: Predictable from word/consonantal context Morphological constituency of maximum syllable margin: Tautomorphemic (Coda) Morphological pattern of syllabic consonants: Grammatical items Onset restrictions: All consonants occur. Coda restrictions: For simple codas, all consonants except /d/ may occur. For complex codas, C<sub>1</sub> is a nasal, C<sub>2</sub> a stop.

#### **Suprasegmentals**

Tone: No Word stress: Yes Stress placement: Fixed Phonetic processes conditioned by stress: Vowel Reduction, Consonant Allophony in Unstressed Syllables, Consonant Allophony in Stressed Syllables Differences in phonological properties of stressed and unstressed syllables: None Phonetic correlates of stress: Not described

#### **Vowel reduction processes**

**dyo-R1:** High-mid central vowel /9/ is lowered to the quality of English [ə] when unstressed (Sapir 1965: 6).

## [dyo] DIOLA-FOGNY Niger-Congo, Northern Atlantic (Gambia, Senegal) (cont.)

## **Consonant allophony processes**

**dyo-C1:** Velar stops are realized as post velar preceding /u/. (Sapir 1965: 5) **dyo-C2:** A voiceless velar stop is realized as palatal preceding a front vowel (some speakers). (Sapir 1965)

#### **Morphology**

#### [eus] BASQUE (CENTRAL/STANDARD) Isolate (France, Spain)

References consulted: Hualde (2003), Saltarelli et al. (1988)

#### Sound inventory

C phoneme inventory: /p b t d c  $\frac{1}{1}$  k g  $\frac{1}{12}$  ts t f f s s f x m n n l f r r/ N consonant phonemes: 23 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Labiodental, Dental, Alveolar, Palato-alveolar, Palatal, Velar Manners: Stop, Affricate, Fricative, Nasal, Flap/Tap, Trill, Lateral approximant N elaborations: 2 Elaborations: Labiodental, Palato-alveolar V phoneme inventory: /i e a o u/ N vowel qualities: 5 Diphthongs or vowel sequences: None Contrastive length: None **Contrastive nasalization:** None Other contrasts: N/A **Notes:** /c  $\frac{1}{2}$  are recently phonemic; Saltarelli et al. give these as  $\frac{1}{2} \frac{d^j}{x}$ . (x/may be very retracted. Zuberoan dialect also has /y/ and phonemic nasalized vowels.

## Syllable structure

Complexity Category: Complex Canonical syllable structure: (C)(C)V(C)(C) (Saltarelli et al. 1988: 277-81; Hualde 2003: 33-7) Size of maximum onset: 2 Size of maximum coda: 2 Onset obligatory: No Coda obligatory: No Vocalic nucleus patterns: Short vowels Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: Tautomorphemic (Onset, Coda) Morphological pattern of syllabic consonants: N/A

**Onset restrictions:** All consonants except for /r r/ occur as simple onsets. Biconsonantal onsets consist of obstruent C<sub>1</sub> /p b t d k g f/ and C<sub>2</sub> /l r r/.

**Coda restrictions:** All consonants except /b d g p f m x/ occur as simple codas. Complex codas have /x s  $\int$ /, a liquid, or a nasal as C<sub>1</sub> and a plosive, affricate, or fricative as C<sub>2</sub>. Stops or affricates are not allowed in word-internal codas.

**Notes:** Saltarelli et al. state that complex codas occur utterance-finally only; however, Hualde (2003) gives examples of nasal+fricative and liquid+fricative codas occurring word-internally, and a wide range of coda clusters occurring word-finally.

## **Suprasegmentals**

Tone: No Word stress: Yes Stress placement: Fixed Phonetic processes conditioned by stress: (None) Differences in phonological properties of stressed and unstressed syllables: Nonee Phonetic correlates of stress: Pitch (instrumental) Notes: The Bizcaian dialects have pitch accent system. Saltarelli et al. describe five different accentual systems for dialects of Basque (1988: 282-3).

## [eus] BASQUE (CENTRAL/STANDARD) Isolate (France, Spain) (cont.)

#### **Vowel reduction processes**

**Notes:** There are processes of unstressed vowel reduction and even deletion of post-tonic vowels in the High Navarrese dialects (Hualde & Urbina 2003: 56-7).

## **Consonant allophony processes**

**eus-C1:** A palatal lateral approximant is realized as a palatal fricative by some speakers. (Hualde 2003: 29) **eus-C2:** Fricatives are realized as voiced preceding a voiced consonant. (Hualde 2003: 24) **eus-C3:** A voiced stop may be realized as a fricative or approximant intervocalically. (Hualde 2003: 19)

## **Morphology**

Text: "Text 4" (Hualde & Urbina 2003: 906-912) Synthetic index: 1.6 morphemes/word (462 morphemes, 284 words) [ewe] EWE Niger-Congo, Kwa (Ghana, Togo)

References consulted: Ameka (1991), Duthie (1996), Jalloh (2005), Stahlke (1971)

#### Sound inventory

C phoneme inventory: /p ţ d k g kp gb ts dz φ β f v s z x fi m n ŋ ŋ r l w/ N consonant phonemes: 24 Geminates: N/A Voicing contrasts: Obstruents Places: Labial-velar, Bilabial, Labiodental, Dental, Alveolar, Palatal, Velar, Glottal Manners: Stop, Affricate, Fricative, Nasal, Trill, Central approximant, Lateral approximant N elaborations: 1 Elaborations: Labiodental V phoneme inventory: /i e ε ə a ɔ o u ĩ ẽ ẽ õ ã õ õ ũ/ N vowel qualities: 8 Diphthongs or vowel sequences: Vowel sequences /uu aa ao oo/ Contrastive length: None Contrastive nasalization: All Other contrasts: N/A Notes: Here I've selected the most common/generally distributed allophone as the phoneme name, but the

following pairs are in complementary distribution (phoneme label listed first):  $[\eta] \sim [\gamma], [m] \sim [b], [n] \sim [d], [n] \sim [j], [l] \sim [\tilde{l}], [\tilde{ts}] \sim [\tilde{tf}], [dz] \sim [dz], and [w] \sim [\gamma].$  Duthie (1996: 10-18) gives description of allophonic variation. /r/ occurs only as C<sub>2</sub> in an onset cluster. /e/ now merging with /ɛ/ (Duthie 1996: 19).

#### Syllable structure

**Complexity Category:** Moderately Complex Canonical syllable structure: (C)(C)V(C) (Amela 1991: 38-9) Size of maximum onset: 2 Size of maximum coda: 1 **Onset obligatory: No** Coda obligatory: No Vocalic nucleus patterns: Short vowels, Vowel sequences Syllabic consonant patterns: Nasal Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: Phonemic Morphological constituency of maximum syllable margin: Tautomorphemic (Onset) Morphological pattern of syllabic consonants: Both **Onset restrictions:**  $C_1$  may be any consonant except r/r.  $C_2$  may be l r w/or [j], allophone of palatal nasal. Coda restrictions: Nasals only. **Notes:** Sequences such as  $/\eta k/$  in  $\eta keke$  'day' analyzed a belonging to different syllables, with  $[\eta]$  being syllabic (1991: 39).

#### **Suprasegmentals**

Tone: Yes Word stress: Not reported

#### **Vowel reduction processes**

(none reported)

#### **Consonant allophony processes**

ewe-C1: Alveolar affricates and fricatives are realized as palato-alveolar preceding /i/. (Jalloh 2005: 9)

(cont.)

Morphology (adequate texts unavailable)

[fvr] FUR Fur, Fur (Sudan)

References consulted: Jakobi (1990), Kutsch Lojenga & Waag (2004), Noel (2008)

#### Sound inventory

C phoneme inventory: /b t d ł k g f s m n n n l r w j/ N consonant phonemes: 16 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Labiodental, Dental, Alveolar, Palatal, Velar Manners: Stop, Fricative, Nasal, Flap/Tap, Central approximant, Lateral approximant N elaborations: 1 Elaborations: Labiodental V phoneme inventory: /i I E Ə A O U U/ N vowel qualities: 8 Diphthongs or vowel sequences: Vowel sequences /ii II EE aa DO UU UU IA iD iE AI AI UA UD UE/ Contrastive length: None Contrastive nasalization: None Other contrasts: N/A **Notes:** /h/ occurs in only two lexical items and is variable in one of them, so I have omitted it here. /f/ is classified by Jakobi as voiceless bilabial stop by phonological criteria, but its actual realization is [f] in most contexts. [j] alternates with [z]. Noel give  $/d_3/$  instead of /t/. Vowel system is from Kutsch Lojenga and Waag (2004); Jakobi and Noel each give 5 vowels, /a  $\varepsilon$  i  $\sigma$  u/. Long vowels are analyzed as sequences by Jakobi.

#### Syllable structure

Complexity Category: Moderately Complex Canonical syllable structure: (C)V(C) (Jakobi 1990: 53-8) Size of maximum onset: 1 Size of maximum coda: 1 Onset obligatory: No Coda obligatory: No Vocalic nucleus patterns: Short vowels Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: N/A Morphological pattern of syllabic consonants: N/A Onset restrictions: All consonants occur. Onset [j] occurs only as allophone of /i/ (as analyzed by author). Coda restrictions: All consonants except voiced obstruents /b d į g/ and [z] (allophone of /j/) may occur.

#### <u>Suprasegmentals</u>

Tone: Yes Word stress: Not reported

#### **Vowel reduction processes**

**fvr-R1:** In 3-syllable words with the structure  $(C_1)V_1C_2V_2C_3V_3$ , where  $C_2$  is /l/ or /r/,  $C_3$  is /l/, /r/, or nasal / m n  $\mu$  n/, and  $V_1$  and  $V_2$  are identical,  $V_2$  may optionally be deleted (Jakobi 1990: 60-61).

## **Consonant allophony processes**

fvr-C1: A palatal glide is realized as [z] word-initially. (Jakobi 1990: 19)

[fvr] FUR Fur, Fur (Sudan) (cont.)

Morphology Text: "A Fur text" (Jakobi 1990: 125-127) Synthetic index: 1.2 morphemes/word (234 morphemes, 202 words)

#### [grj] GREBO (SOUTHERN) Niger-Congo, Kru (Liberia)

References consulted: Innes (1966, 1981), Newman (1986)

#### Sound inventory

#### Syllable structure

Complexity Category: Simple Canonical syllable structure: (C)V (Innes 1981: 130, 1966: 15-16) Size of maximum onset: 1 Size of maximum coda: N/A Onset obligatory: No Coda obligatory: N/A Vocalic nucleus patterns: Short vowels Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: N/A Morphological pattern of syllabic consonants: N/A

**Notes:** CCV shapes occur in loans; C<sub>2</sub> is always [1] or [w] (Innes 1981: 130, 1966: 15-16). Innes reports that some words of the form CVCV contract to CCV in rapid speech; this is when the medial consonant is / d/ or /n/, and it results in C+[1] clusters (e.g., *pone* > *plē* 'rat', 1981: 130). Newman reports that there are many such words for which **only** ClV forms occur and there are no corresponding CVCV forms, but he gives examples which Innes lists alternating forms for. Because Innes provides evidence, I adopt his analysis. Newman also reports that C<sub>2</sub> in such clusters is generally pronounced as an 'r-like tap' rather than a lateral (1986: 177).

### **Suprasegmentals**

Tone: Yes

Word stress: Disagreement (Innes reports stress; Newman 1986 reports he could not verify this)

#### **Vowel reduction processes**

**grj-R1:** In words of the form CVCV in rapid speech,  $V_1$  is deleted if  $C_1$  is a non-alveolar stop or /f, m, hm,  $\eta$ / and  $C_2$  is /d/ or /n/;  $C_2$  is realized phonetically as [l] when this process occurs (Innes 1981: 130, 1966: 15-16).

# **Consonant allophony processes**

(none reported)

# <u>Morphology</u>

[gym] NGÄBERE Chibchan, *Guaymiic* (Panama)

References consulted: Arosemena (1983), Kopesec & Kopesec (1974)

#### Sound inventory

C phoneme inventory: /b t k g k<sup>w</sup> g<sup>w</sup> t  $\int dz$  ð s h m n n n  $\eta \eta^w l$  c/ N consonant phonemes: 18 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Dental, Alveolar, Palato-alveolar, Velar, Glottal Manners: Stop, Affricate, Fricative, Nasal, Flap/Tap, Lateral approximant N elaborations: 3 Elaborations: Voiced fricatives/affricates, Palato-alveolar, Labialization V phoneme inventory: /i e a ɔ o ɤ u ɯ ĩ ẽ ã ɔ̃ ɤ̃ õ 때 ũ/ N vowel qualities: 8 Diphthongs or vowel sequences: None Contrastive length: None **Contrastive nasalization:** All Other contrasts: N/A Notes: I can't tell if Kopesec's <d> refers to /d/ or to some affricated variety. Alphonse (1956) says there is a sound identical to Spanish /d/.

#### Syllable structure

Complexity Category: Moderately Complex Canonical syllable structure: (C)(C)V (Arosemena & Melquíades 1983: 109-15) Size of maximum onset: 2 Size of maximum coda: N/A Onset obligatory: No Coda obligatory: N/A Vocalic nucleus patterns: Short vowels Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: Tautomorphemic (Onset) Morphological pattern of syllabic consonants: N/A Onset restrictions: In complex onsets, C<sub>1</sub> is limited to stops, fricatives and /m ŋ/. C<sub>2</sub> is limited to /r l/.

#### **Suprasegmentals**

Tone: No Word stress: Yes Stress placement: Unpredictable/Variable Phonetic processes conditioned by stress: Vowel Reduction Differences in phonological properties of stressed and unstressed syllables: Not described Phonetic correlates of stress: Vowel duration (impressionistic) Notes: Duration a correlate of stress only in words with 3 or more syllables. Arosemena uses term *intensidad* but this seems to correspond to 'prominence'. Kopesec & Kopesec state that stress fluctuates

within speakers and speech style/rate and that many different patterns occur (1974: 21-2).

[gym] NGÄBERE Chibchan, *Guaymiic* (Panama) (cont.)

## **Vowel reduction processes**

**gym-R1:** A low central vowel /a/ is realized as medial [ə] when occurring before a pause (Kopesec & Kopesec 1974: 28)

**gym-R2:** All vowels are realized as post-glottalized preceding a pause (Kopesec & Kopesec 1974: 29) **gym-R3:** In words where more than one CV syllable occur, a(n unstressed?) vowel preceding a CV syllable may be deleted and thus create a CCV pattern with open transition between the consonants (Arosemena 1983: 110).

## **Consonant allophony processes**

gym-C1: A voiceless alveolar stop is voiced intervocalically. (Arosemena 1983: 15)

**gym-C2:** Stops, non-glottal fricatives, and the voiceless palato-alveolar affricate are prenasalized following a nasalized vowel. (Arosemena 1983: 18)

**gym-C3:** Voiced plain bilabial and velar stops are spirantized in relaxed speech. (Kopesec & Kopesec 1974)

**gym-C4:** A voiced palato-alveolar affricate is realized as a palatal glide following a vowel and preceding / e/. (Arosemena 1983: 16)

**gym-C5:** A labialized velar nasal is realized as a nasalized labiovelar glide intervocalically. (Kopesec & Kopesec 1974: 27)

## **Morphology**

[hau] HAUSA

Afro-Asiatic, West Chadic (Niger, Nigeria)

**References consulted:** Hunter (1980), Jaggar (2001), Möhlig (1983), Newman (1997, 2000), Schuh & Bagari (1999)

#### Sound inventory

C phoneme inventory: /b t d  $k^{j} q^{j} k q k^{w} q^{w}$ ?  $2^{j} \delta d k^{\prime j} k^{\prime} k^{\prime w} \hat{ts}$   $\hat{t} \int d_{\bar{z}} \phi s z \int h m n l r r j w/d_{\bar{z}}$ N consonant phonemes: 31 Geminates: /b: t: d: k<sup>j</sup>: g<sup>j</sup>: k: g: k<sup>w</sup>: g<sup>w</sup>: ?: ?<sup>j</sup>: b: d: k<sup>j</sup>: k': k<sup>w</sup>: ts': tf: d3: \$ as z: f: h: m: n: l: r: r: j: w:/ (All) Voicing contrasts: Obstruents Places: Bilabial, Alveolar, Palato-alveolar, Velar, Glottal Manners: Stop, Affricate, Fricative, Nasal, Flap/Tap, Central approximant, Lateral approximant N elaborations: 7 Elaborations: Voiced fricatives/affricates, Ejective, Implosive, Palato-alveolar, Retroflex, Palatalization, Labialization V phoneme inventory: /i e a o u i: e: a: o: u:/ N vowel qualities: 5 Diphthongs or vowel sequences: Diphthongs /ai au/ Contrastive length: All Contrastive nasalization: None Other contrasts: N/A **Notes:** [fs'] varies with [s']. All consonants may occur word-medially as geminates (Jaggar 28). This seems

to be morphophonemic. Here I've excluded palatalized labial  $\langle \Phi^j \rangle$ , as it is described as "lexically infrequent and i often replaced by its plain counterpart" (Newman 1997: 539).

#### Syllable structure

Complexity Category: Moderately Complex Canonical syllable structure: CV(C) (Newman 1997:543, 2000: 403-405) Size of maximum onset: 1 Size of maximum coda: 1 Onset obligatory: Yes Coda obligatory: No Vocalic nucleus patterns: Short vowels, Long vowels, Diphthongs Syllabic consonant patterns: Nasal Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: Phonemic Morphological constituency of maximum syllable margin: N/A Morphological pattern of syllabic consonants: Both Onset restrictions: Any consonant may occur. Coda restrictions: Any consonant may occur, except for  $/\Phi^{j}/$  (in the speech of those who have it).

Suprasegmentals Tone: Yes Word stress: No

#### **Vowel reduction processes**

hau-R1: Long vowels preceding a coda are shortened (Jaggar 2001: 23).

**hau-R2:** In normal conversational speech, medial short high vowels /i u/ (those not preceding a pause) are laxed or centralized, with rounding or lack of rounding determined by the environment (Jaggar 2001: 9-10, Schuh & Bagari 1999:90).

**hau-R3:** In normal conversational speech, medial short non-high vowels /e a o/ (those not preceding a pause) are neutralized to [ə] (Jaggar 2001: 9-10, Schuh & Bagari 1999:90).

## [gym] NGÄBERE Chibchan, *Guaymiic* (Panama) (cont.)

## **Consonant allophony processes**

hau-C1: Alveolar stops and fricatives are realized as palato-alveolar before front vowels. (Jaggar 2001: 25)
hau-C2: Velars are labialized before back rounded vowels. (Jaggar 2001: 8)
hau-C3: Velars are palatalized before front vowels. (Jaggar 2001: 8)

## **Morphology**

## [hts] HADZA Isolate (Tanzania)

References consulted: Kirk Miller (p.c.), Sands (2013), Sands et al. (2012), Bonny Sands (p.c.)

### Sound inventory

**C** phoneme inventory:  $/p^h p b t^h t d k^h k g k^{hw} k^w g^w$ ? p' k' k'w k| k! k|| m n p ŋ ŋ<sup>w</sup> ŋ|' ŋ| ŋ!' ŋ! ŋ!' ŋ||  ${}^{m}p^{h}mb^{n}t^{h}nd^{n}k^{h}q^{n}ts^{n}ds^{n}ds^{n}ds^{n}ts^{n}ds^{n}ts^{n}ds^{n}ts^{n}ds^{n}ts^{n}ds^{n}ts^{n}ds^{n}ts^{n}ds^{n}ts^{n}ds^{n}ts^{n}ds^{n}ts^{n}ds^{n}ts^{n}ds^{n}ts^{n}ds^{n}ts^{n}ds^{n}ts^{n}ds^{n}ts^{n}ds^{n}ts^{n}ds^{n}ts$ N consonant phonemes: 55 Geminates: N/A Voicing contrasts: Obstruents, Sonorants Places: Bilabial, Labiodental, Dental, Alveolar, Palato-alveolar, Velar, Glottal Manners: Stop, Affricate, Fricative, Nasal, Central approximant, Lateral affricate, Lateral fricative, Lateral approximant N elaborations: 10 Elaborations: Voiced fricatives/affricates, Devoiced sonorants, Prenasalization, Post-aspiration, Lateral release, Ejective, Click, Labiodental, Palato-alveolar, Labialization V phoneme inventory: /i e a o u ĩ ũ/ N vowel qualities: 5 Diphthongs or vowel sequences: None Contrastive length: None **Contrastive nasalization:** Some Other contrasts: N/A Notes: All voiced obstruents borrowed except for /b/, medial prenasalized plosives, and nasals apart from / m/ and /n/; however, sources unknown (Kirk Miller, p.c.). If we take this analysis to be accurate, then language has 49 consonant phonemes instead of 55. Vowel nasalization is marginally contrastive (Sands 2013: 38). Svllable structure **Complexity Category:** Simple Canonical syllable structure: (C)V (Tucker et al. 1977: 309; Sands et al. 1996; Sands 2013) Size of maximum onset: 1 Size of maximum coda: N/A

**Onset obligatory:** Yes

Coda obligatory: N/A

Vocalic nucleus patterns: Short vowels

Syllabic consonant patterns: N/A

Size of maximum word-marginal sequences with syllabic obstruents: N/A

Predictability of syllabic consonants: N/A

Morphological constituency of maximum syllable margin:  $\ensuremath{\mathrm{N/A}}$ 

Morphological pattern of syllabic consonants: N/A

Onset restrictions: All consonants occur.

**Notes:** Sands (2013) analyzes syllable structure as CV, where C includes prenasalized obstruents and V may be a nasal vowel. Kirk Miller (p.c.) analyzes syllable structure as CV(N), without nasal vowels. Miller also notes that onsets are obligatory, with predictable /h/ occurring in otherwise vowel-initial syllables.

#### **Suprasegmentals**

Tone: Yes

Word stress: No

**Notes:** Prominence may shift syllables according to context. Thus this may be a pitch accent language, but there is not enough information to characterize the stress pattern.

## [hts] HADZA Isolate (Tanzania) (cont.)

## **Vowel reduction processes**

**hts-R1:** Final vowels frequently become voiceless, especially when preceded by /?/ or other voiceless stops. This devoicing can extend to penultimate vowels, such that the final two syllables of a word in utterance-final position can become whispered. (Sands et al. 1996: 177; Tucker et al. 1977: 309)

## **Consonant allophony processes**

**hts-C1:** An ejective velar stop is realized as an affricate [kx'] by some speakers. (Sands 2013: 41) **hts-C2:** An alveolar lateral approximant is realized as a flap intervocalically. (Sands 2013: 41)

#### **Morphology**

## [iii] YI (NUOSU) Sino-Tibetan, Burmese-Lolo (China)

References consulted: Gerner (2013), Maoji (1997), Merrifield (2012)

#### Sound inventory

C phoneme inventory: /p p<sup>h</sup> b <sup>m</sup>b t t<sup>h</sup> d <sup>n</sup>d k k<sup>h</sup> g <sup>n</sup>g ts ts<sup>h</sup> dz <sup>n</sup>dz <sup>n</sup>dz ts<sup>h</sup> dz <sup>n</sup>dz <sup>n</sup>dz ts<sup>h</sup> c z x y h m m n n n n l l/ N consonant phonemes: 43 Geminates: N/A Voicing contrasts: Obstruents, Sonorants Places: Bilabial, Labiodental, Dental, Alveolar, Retroflex, Alveolo-palatal, Velar, Glottal Manners: Stop, Affricate, Fricative, Nasal, Lateral approximant N elaborations: 6 Elaborations: Voiced fricatives/affricates, Devoiced sonorants, Prenasalization, Post-aspiration, Labiodental, Retroflex V phoneme inventory: /i ε i a ɔ o ɯ u i ̯u/ N vowel qualities: 8 Diphthongs or vowel sequences: None Contrastive length: None Contrastive nasalization: None Other contrasts: Creaky voice (some) Notes: /n/ represents alveolo-palatal nasal. Pei-Shan dialect additionally has a series of palato-alveolars derived from velars:  $t_1 t_1^h d_3 d_3 \int 3/ (Maoji 1997: 68-9)$ . /i u/ have contr. creaky voice counterparts.

#### Syllable structure

Complexity Category: Simple Canonical syllable structure: (C)V (Gerner 2013: 30-2) Size of maximum onset: 1 Size of maximum coda: N/A Onset obligatory: No Coda obligatory: N/A Vocalic nucleus patterns: Short vowels Syllabic consonant patterns: Nasal, Liquid Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: Varies with CV sequence Morphological constituency of maximum syllable margin: N/A Morphological pattern of syllabic consonants: N/A

## **Suprasegmentals**

Tone: Yes Word stress: Not reported

#### **Vowel reduction processes**

**iii-R1:** When nasals and lateral approximants co-occur with central vowel /i/, these sequences are in free variation with syllabic consonants (Gerner 2013: 31).

#### **Consonant allophony processes**

(none reported)

#### **Morphology**

**Text:** "Why do men have their livestock stay close to home?" (Gerner 2013: 525-530) **Synthetic index:** 1.0 morphemes/word (465 morphemes, 455 words)
[ilo] ILOCANO Austronesian, Northern Luzon (Philippines)

References consulted: Rubino (1997)

## Sound inventory

C phoneme inventory: /p b t d k g ?  $\widehat{ts}$  s m n n r l j w/ N consonant phonemes: 16 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Dental, Alveolar, Velar, Glottal Manners: Stop, Affricate, Fricative, Nasal, Flap/Tap, Central approximant, Lateral approximant N elaborations: 0 Elaborations: N/A V phoneme inventory: /i e a u/ N vowel qualities: 4 Diphthongs or vowel sequences: None Contrastive length: None Contrastive nasalization: None Other contrasts: N/A Notes: /u/ marginally phonemic in some Spanish loans (otherwise [u] is an allophone of /o/). Vowel+glide sequences not analyzed as diphthongs.

## Syllable structure

Complexity Category: Moderately Complex Canonical syllable structure: CV(C) (Rubino 1997: 28-9) Size of maximum onset: 1 Size of maximum coda: 1 Onset obligatory: Yes Coda obligatory: No Vocalic nucleus patterns: Short vowels Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: N/A Morphological pattern of syllabic consonants: N/A Onset restrictions: All consonants occur. Coda restrictions: All consonants occur except /h 2/.

## **Suprasegmentals**

Tone: No Word stress: Yes Stress placement: Weight-Sensitive Phonetic processes conditioned by stress: Vowel Reduction Differences in phonological properties of stressed and unstressed syllables: None Phonetic correlates of stress: Vowel duration (impressionistic), Intensity (impressionistic) Notes: Duration a correlate of stress in open syllables.

## Vowel reduction processes

**ilo-R1:** Low central vowel /a/ and high vowels /i u/ are produced with more neutral (laxed for high vowel, higher for /a/) artiulation in unstressed syllables (Rubino 1997: 16-17). **ilo-R2:** High back vowel /u/ is lowered to [o] word-finally (and unstressed) (Rubino 1997: 17).

#### [ilo] ILOCANO Austronesian, Northern Luzon (Philippines) (cont.)

# **Consonant allophony processes**

ilo-C1: Alveolar stops and the voiceless alveolar fricative are realized as palato-alveolar preceding a palatal glide. (Rubino 1997: 11)

ilo-C2: A voiceless velar stop is realized as affricated [kx] intervocalically. (Rubino 1997: 11) ilo-C3: A voiceless velar stop is realized as a glottal stop preceding a consonant. (Rubino 1997: 11)

## **Morphology**

(adequate texts unavailable)

[itl] ITELMEN Chukotko-Kamchatkan, Southern Chukotko-Kamchatkan (Russia)

**References consulted:** Bobaljik (2006), Jonathan Bobaljik (p.c.), Georg & Volodin (1999), Volodin (1976), Volodin & Zhukova (1968)

#### Sound inventory

C phoneme inventory: /p t k q ? p' t' k' q'  $\hat{t}$   $\hat{t}$   $\hat{f}$   $\hat{b}$  s z  $\frac{1}{2}$  x  $\gamma$  m n  $\eta$  1 j/ N consonant phonemes: 23 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Alveolar, Palato-alveolar, Velar, Uvular, Glottal Manners: Stop, Affricate, Fricative, Nasal, Central approximant, Lateral fricative, Lateral approximant N elaborations: 4 Elaborations: Voiced fricatives/affricates, Ejective, Palato-alveolar, Uvular V phoneme inventory: /i e ə a o u/ N vowel qualities: 6 Diphthongs or vowel sequences: None Contrastive length: None **Contrastive nasalization:** None Other contrasts: N/A **Notes:**  $/r p \Lambda / occur in Russian, Koryak loans. Some sources have /2/ as a suprasegmental phenomenon,$ but Georg & Volodin consider it a segment.

#### Syllable structure

**Complexity Category:** Highly Complex Canonical syllable structure: (C)(C)(C)(C)(C)(C)(C)(C)(C)(C)(C)(C) (Georg & Volodin 1999: 38-44) Size of maximum onset: 7 Size of maximum coda: 5 **Onset obligatory:** No Coda obligatory: No Vocalic nucleus patterns: Short vowels Syllabic consonant patterns: Nasal, Liquid Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: Predictable from word/consonantal context Morphological constituency of maximum syllable margin: Heteromorphemic (Onset, Coda) Morphological pattern of syllabic consonants: Lexical items (Liquid), Both (Nasal, Liquid) Onset restrictions: Apparently all consonants may occur as simple onsets. It seems almost any biconsonantal onset may occur. In triconsonantal onsets, generally any consonant may be added to a permissible biconsonantal onset, so long as one of the consonants is a voiceless stop or sonorant, but consecutive sequences of three voiceless stops, fricatives, or sonants are not allowed within lexical morphemes. There are many examples of 4-consonant onsets, which are combinations of two permissible biconsonantal onsets. Examples include /ttxn, ksxw, ktxl/. Five-consonant onsets include /kpłkn, kskgz/. Six-consonant onsets include /tksxqz/. The one example of a seven-consonant onset given is /kstk'łkn/. **Coda restrictions:** There seem to be restrictions on simple codas; examples not given for /p', t', z, j/ in this environment. Biconsonantal codas include /mx 4q sx/. Triconsonantal codas include /p4h m4x/. Fourconsonant codas include /nt[px mpłx łtxt]/. Five-consonant codas include /nxłxt] mstxt]/. Notes: Combinability of consonants within clusters is subject to few constraints. "Das häufige Auftreten komplexer Konsonantengruppen gehört zu den auffällingsten Zügen der itelmenischen Phonologie." "The frequent occurrence of complex consonant clusters is one of the most notable traits of Itelmen phonology." (Georg & Volodin 1999:38)

[itl] ITELMEN

#### Suprasegmentals

Tone: No Word stress: Yes Stress placement: Fixed Phonetic processes conditioned by stress: (None) Differences in phonological properties of stressed and unstressed syllables: Not described Phonetic correlates of stress: Intensity (impressionistic)

## Vowel reduction processes

**itl-R1:** Vowels occurring in closed syllables 'cluttered with consonants' ( $_nCVC_n$ ) are less clear and reduced in quality (Volodin 1976: 73).

itl-R2: Mid central vowel  $|\partial|$  may be realized as a high back unrounded vowel [ $\mathbf{u}$ ] or drop entirely in some contexts where the consonantal environment has no effect (Georg & Volodin 1999: 13).

#### **Consonant allophony processes**

itl-C1: A voiceless labiodental fricative varies freely with a velarized variant. (Georg & Volodin 1999: 15) itl-C2: Some stops and affricates are labialized preceding a rounded vowel (Georg & Volodin 1999: 16) itl-C3: A voiceless bilabial stop is spirantized intervocalically. (Georg & Volodin 1999: 14-15) itl-C4: A voiceless bilabial fricative is realized as an approximant preceding a consonant. (Georg & Volodin 1999)

## **Morphology**

Text: "Süddialekt" (Georg & Volodin 1999: 250-262) Synthetic index: 2.0 morphemes/word (876 morphemes, 438 words) [kal] WEST GREENLANDIC

References consulted: Fortescue (1984), Hagerup (2011), Jacobsen (2000)

#### Sound inventory

C phoneme inventory: /p t k q v s y ß m n ŋ N l j/ N consonant phonemes: 14 Geminates: N/A Voicing contrasts: None Places: Bilabial, Alveolar, Velar, Uvular Manners: Stop, Fricative, Nasal, Central approximant, Lateral approximant N elaborations: 3 Elaborations: Voiced fricative/affricates, Labiodental, Uvular V phoneme inventory: /i a u iĭ aĭ uĭ/ N vowel qualities: 3 Diphthongs or vowel sequences: Diphthong /ai/ Contrastive length: All Contrastive nasalization: None Other contrasts: N/A

**Notes:**  $\frac{1}{5}$  found only in central dialect region and is described as rapidly receding and merging with  $\frac{1}{5}$ , with merger complete in younger speakers. Jacobsen states that  $\frac{1}{1}$  is marginal.  $\frac{1}{1}$  occurs in loanwords.  $\frac{1}{3}$  much more common than other long vowels. Other historical diphthongs have merged into long vowels.

#### Syllable structure

Category: Moderately Complex Canonical syllable structure: (C)V(C) (Fortescue 1984: 338-9) Size of maximum onset: 1 Size of maximum coda: 1 Onset obligatory: No Coda obligatory No Vocalic nucleus patterns: Short vowels, Long vowels, Diphthongs Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: N/A Morphological pattern of syllabic consonants: N/A Onset restrictions: All consonants occur. Coda restrictions: All(?) consonants occur. Notes: Final geminates occur in syncopated exclamations.

Suprasegmentals Tone: No Word stress: No

#### **Vowel reduction processes**

**kal-R1:** Short high vowels /i u/ are produced as lax word-finally (Hagerup 2011: 56-63). **kal-R2:** Short high vowels /i u/ tend to be devoiced between voiceless consonants in open syllables (Fortescue 1984: 335).

**kal-R3:** Long vowels are realized as shorter when preceding long consonants than they are preceding singleton consonants (Jacobsen 2000: 65).

## [kal] WEST GREENLANDIC

Eskimo-Aleut, Eskimo (Greenland) (cont.)

## **Consonant allophony processes**

**kal-C1:** A voiceless alveolar stop is affricated preceding a high front vowel. (Fortescue 1984: 333) **kal-C2:** Some stops and fricatives are realized with secondary palatalization adjacent to a high front vowel. (Fortescue 1984: 333)

kal-C3: A voiceless alveolar fricative is somewhat voiced intervocalically. (Fortescue 1984: 334)

kal-C4: A uvular stop may be realized as a fricative intervocalically. (Fortescue 1984: 333)

kal-C5: A voiced velar fricative is realized as a glide intervocalically. (Fortescue 1984: 334)

kal-C6: A velar nasal may be realized as a nasalized vowel intervocalically. (Fortescue 1984: 334)

## **Morphology**

(adequate texts unavailable)

[kat] GEORGIAN

Kartvelian, Kartvelian (Georgia)

**References consulted:** Aronson (1990, 1991), Chitoran (1998), Hewitt (1995), Jun et al. (2006), Shosted & Chikovani (2006), Skopeteas & Féry (2010), Vicenek (2010), Vogt (1958)

#### Sound inventory

C phoneme inventory: /b p<sup>h</sup> d t<sup>h</sup> q k<sup>h</sup> p' t' k' q' dz  $fs^h dz$   $ff^h$   $fs^2$   $ff' \beta z s z \int u \chi h m n r l/$ N consonant phonemes: 28 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Dental, Alveolar, Palato-alveolar, Velar, Uvular, Glottal Manners: Stop, Affricate, Fricative, Nasal, Flap/Tap, Lateral approximant N elaborations: 5 Elaborations: Voiced fricatives/affricates, Post-aspiration, Ejective, Palato-alveolar, Uvular V phoneme inventory: /i e a o u/ N vowel qualities: 5 Diphthongs or vowel sequences: None Contrastive length: None Contrastive nasalization: None Other contrasts: N/A **Notes:** [ $\beta$ ] alternates with [ $\beta$ ]. Vicenik gives instrumental evidence that /b d g/ are voiced. Shosted & Chikovani have v/v for the glide, as well as velars instead of v/y/v. Robins & Waterson have a velarized

lateral instead of a plain lateral approximant.

**Onset restrictions:** All consonants occur as simple onsets. Biconsonantal onsets include stop+stop, stop+affricate, stop+fricative, stop+sonorant, affricate+stop, affricate+fricative, affricate+sonorant, fricative+stop, and so on. Triconsonantal onsets include stop+stop+stop+stop+sonorant, stop+affricate+stop, stop+sonorant+stop, fricative+stop+sonorant etc. stem-initially, and more when prefixes are involved. All larger onsets include sonorants such that there are no obstruent strings of more than three; e.g. /p'rts'k' $\beta$ , ts'q'rt, brts'q'/. Seven-consonant onsets include /g $\beta$ ts' $\beta$ rtn/. Eight-consonant onsets include /g $\beta$ prtsk $\beta$ n/.

**Coda restrictions:** All(?) consonants but /h/ occur in simple codas. Biconsonantal codas include /rt bs nd ds ls bt mt pt/. Triconsonantal codas include /gns  $\chi$ ls/. Five-member codas include /ntjxls, rts'q' $\beta$ s, rt'k'ls/.

#### [kat] GEORGIAN

Kartvelian, Kartvelian (Georgia) (cont.)

**Notes:** Vogt lists 740 onset clusters (of up to six members) and 244 stem-final clusters (of up to four members); however, he does not include morphologically complex clusters. True word-final clusters seem to be much more restricted than stem-final clusters, which are always followed by a vowel, which resyllabifies the cluster. However it does seem to be the case that sonorants are required in all onsets of more than three consonants and all codas of three consonant or more. A subset of clusters are known as 'harmonic' and consist of a non-velar stop or affricate followed by a homogeneous velar or uvular consonant. These have been analyzed as single segment, but Chitoran (1998) shows through instrumental analysis that they have phonetic and timing characteristics of sequences.

### **Suprasegmentals**

Tone: No Word stress: Yes Stress placement: Fixed Phonetic processes conditioned by stress: (None) Differences in phonological properties of stressed and unstressed syllables: (None) Phonetic correlates of stress: Not described

#### **Vowel reduction processes**

(none reported)

#### **Consonant allophony processes**

**kat-C1:** The uvular ejective stop may vary with an ejective uvular affricate variant. (Aronson 1991) **kat-C2:** A uvular ejective stop may vary with an ejective uvular fricative. (Shosted & Chikovani 2006)

## **Morphology**

**Text:** "The destiny of Kartli" (Hewitt 1995: 655-663) **Synthetic index:** 2.4 morphemes/word (594 morphemes, 246 words) [kbc] KADIWÉU Guaicuruan, Kadiwéu (Brazil)

References consulted: Braggio (1981), Sandalo (1997)

## Sound inventory

C phoneme inventory: /p b t d k g q  $\widehat{t}$   $\widehat{d}_{3}$  s m n l w j/ N consonant phonemes: 15 Geminates: /b: d: g: m: n: l: w: j:/ (Some) Voicing contrasts: Obstruents Places: Bilabial, Dental, Palato-Alveolar, Velar, Uvular Manners: Stop, Affricate, Fricative, Nasal, Central approximant, Lateral approximant N elaborations: 3 Elaborations: Voiced fricatives/affricates, Palato-alveolar, Uvular V phoneme inventory: /i e a o i: e: a: o:/ N vowel qualities: 4 Diphthongs or vowel sequences: None Contrastive length: All Contrastive nasalization: None Other contrasts: N/A Notes: Sandalo gives geminate counterparts of /m n l w j/ in the phoneme inventory. Sandalo analyzes /в/ as a uvular stop, but since it is realized as a fricative in most positions. I use this symbol.

## Syllable structure

Complexity Category: Complex Canonical syllable structure: (C)(C)V (Sandalo 1997: 17-18) Size of maximum onset: 2 Size of maximum coda: N/A Onset obligatory: No Coda obligatory: N/A Vocalic nucleus patterns: Short vowels, Long vowels, Diphthongs Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: Tautomorphemic (Onset) Morphological pattern of syllabic consonants: N/A

**Onset restrictions:** All consonants may occur in simple onsets. In biconsonantal onets,  $C_2$  is always / $\mu$ /,  $C_1$  may be stop or nasal (perhaps others too).

**Notes:** Sandalo's analysis has /ʁ d d:/ occurring as codas in clitics, but apparently these never surface as such phonetically, being deleted preceding consonants and resyllabilited as onsets preceding vowels (1997: 16).

## Suprasegmentals

Tone: No Word stress: Yes Stress placement: Weight-Sensitive Phonetic processes conditioned by stress: Consonant Allophony in Unstressed Syllables Differences in phonological properties of stressed and unstressed syllables: (None) Phonetic correlates of stress: Intensity (impressionistic)

## Vowel reduction processes

**kbc-R1:** Long vowels are optionally reduced to short vowels preceding a voiceless stop onset of a following syllable. Example given shows that following stop is lengthened (Sandalo 1997: 17).

## [kbc] KADIWÉU Guaicuruan, Kadiwéu (Brazil) (cont.)

## **Consonant allophony processes**

**kbc-C1:** A voiced uvular fricative may be realized as a stop word-initially. (Sandalo 1997: 16) **kbc-C2:** A voiced alveolar stop is realized as a flap intervocalically. (Sandalo 1997: 16) **kbc-C3:** A voiced palato-alveolar affricate is realized as a fricative by some speakers (Sandalo 1997: 15-16)

## <u>Morphology</u>

(adequate texts unavailable)

[kbd] KABARDIAN Northwest Caucasian, Northwest Caucasian (Russia, Turkey)

**References consulted:** Applebaum (2013), Colarusso (2006), Gordon & Applebaum (2010), Kuipers (1960), Matasović (2010)

#### Sound inventory

C phoneme inventory: /p b t d k<sup>w</sup> g<sup>w</sup> q q<sup>w</sup> ? ?<sup>w</sup> p' t' k<sup>w</sup> q' q<sup>w</sup> ts dz tf d3 ts' tf' f v s z ł h c z f 3 x x<sup>w</sup> γ χ κ χ<sup>w</sup> κ<sup>w</sup> h h f ł' c' m n r w j/ N consonant phonemes: 48 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Labiodental, Dental, Alveolar, Palato-alveolar, Alveolo-palatal, Velar, Uvular, Pharyngeal, Glottal Manners: Stop, Affricate, Fricative, Nasal, Trill, Central approximant, Lateral fricative, Ejective N elaborations: 7 Elaborations: Voiced fricatives/affricates, Ejective, Labiodental, Palato-alveolar, Uvular, Pharyngeal, Labialization V phoneme inventory: /ə a aː/ N vowel qualities: 2 Diphthongs or vowel sequences: Diphthongs /aw iə/

N vowel qualities: 2 Diphthongs or vowel sequences: Diphthongs /aw, jə/ Contrastive length: Some Contrastive nasalization: None Other contrasts: N/A

**Notes:** /h/ is marginal; exists in the speech of older generations, mostly in Arabic loans (Matasovic 10). Colarusso has /c  $\frac{1}{2}$ / or /t  $\frac{1}{2}$ / for /t $\frac{1}{2}$ /. Colarusso doesn't have /y/. Other accounts posit two short vowels ( $\frac{1}{2}$ ) and five long vowels (a: e: i: o: u:). There is a length contrast for /a/: /a:/ is low open, /a/ is central open.

#### Syllable structure

**Complexity Category:** Highly Complex **Canonical syllable structure:** (C)(C)(C)(C)(C) (Colarusso 2006: 4-20; Matasović 2010: 13; Applebaum 2013) Size of maximum onset: 3 Size of maximum coda: 2 **Onset obligatory:** No Coda obligatory: N/A Vocalic nucleus patterns: Short vowels, Long vowels Syllabic consonant patterns: Nasal, Liquid, Obstruent Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: Predictable from word/consonantal context (Nasal, Liquid), Varies with VC sequence (Nasal, Liquid, Obstruent) Morphological constituency of maximum syllable margin: Tautomorphemic (Coda), Both patterns (Onset) Morphological pattern of syllabic consonants: Unclear Onset restrictions: All consonants occur as simple onsets. Biconsonantal onsets consist mostly of stop+fricative, e.g. /th be<sup>w</sup> pc/, but also rarely include two stops, e.g. /pq/. These clusters tend to be

stop+fricative, e.g. /th  $b x^w p c$ /, but also rarely include two stops, e.g. /pq/. These clusters tend to be regressive, and clusters with labial first element are especially frequent. Examples of triconsonantal onsets include /bzw zby pct/.

**Coda restrictions:** Unclear whether there are restrictions on simple codas. Biconsonantal codas include /bz wf pł rt/.

**Notes:** Colarusso analyzes initial sequence in *zbyác* 'I covered/thatched it' as *z.byác*, but gives no articulatory/perceptual evidence for this (2006: 17). This analysis seems to be influenced by formal 'universal' models of syllable structure. Matasović describes such sequences as onset clusters (2010: 13). Applebaum (2013) gives examples of complex codas.

[kbd] KABARDIAN Northwest Caucasian, Northwest Caucasian (Russia, Turkey) (cont.)

**Suprasegmentals** 

Tone: No Word stress: Yes Stress placement: Weight-Sensitive Phonetic processes conditioned by stress: Vowel Reduction Differences in phonological properties of stressed and unstressed syllables: (None) Phonetic correlates of stress: Vowel duration (instrumental), Pitch (instrumental), Intensity (instrumental) Notes: Duration and intensity are correlates of stress for most speakers.

## Vowel reduction processes

kbd-R1: Low vowel /a/ is realized as higher [v] when unstressed (Applebaum 2013: 98-9).
kbd-R2: Frequently a sequence of a short high vowel and a consonant is replaced by a syllabic consonant (results in syllabic nasals, liquids, and obstruents; Kuipers 1960: 24, 42-3).
kbd-R3: Word-final /ə/ is deleted after a stressed syllable (Kuipers 1960: 34, 42).
kbd-R4: Unstressed /ə/ preceding a stressed syllable is often deleted, so long as it does not produce an initial consonant cluster (Gordon & Applebaum 2010: 42).

**Consonant allophony processes** 

**kbd-C1:** Voiceless plosives may have affricated release preceding a vowel. (Kuipers 1960: 17) **kbd-C2:** Labiovelar and palatal glides are realized with slight glottal friction word-initially. (Kupers 1960: 22)

**kbd-C3:** Stops are voiced preceding a voiced stop or fricative. (Matasović 2010)

**kbd-C4:** Voiceless ejective palato-alveolar affricate and fricative are realized as voiced word-medially. (Kuipers 1960: 19)

## **Morphology**

Text: "Nart story" (Applebaum 2013: 223-231) Synthetic index: 2.5 morphemes/word (571 morphemes, 229 words) [kbh] CAMSÁ Isolate (Colombia)

**References consulted:** Fabre (2002), Howard (1967, 1972), Juajibioy Chindoy (1962), Monguí Sánchez (1981)

Sound inventory

C phoneme inventory: /p b t d k q ts  $\widehat{fs}$  t  $\widehat{fs}$  s  $\int x m n n l r \Lambda w j/$ N consonant phonemes: 22 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Alveolar, Palato-alveolar, Retroflex, Velar Manners: Stop, Affricate, Fricative, Nasal, Flap/Tap, Central approximant, Lateral approximant N elaborations: 2 Elaborations: Palato-alveolar, Retroflex V phoneme inventory: /i e i a o u/ N vowel qualities: 6 **Diphthongs or vowel sequences:** Diphthongs /ai oi ui ia io ie ua ue/ **Contrastive length:** None **Contrastive nasalization:** None Other contrasts: N/A Notes: Monguí Sánchez give a very different consonant phoneme inventory than the others. Juajibioy Chindoy concurs with Howard and the others, but additionally lists affricate /pf/. Howard lists <ë> for what others list as /i/; Monguí Sánchez gives /ə/ for this vowel.

#### Syllable structure

Complexity Category: Highly Complex Canonical syllable structure: (C)(C)(C)(C)(C)V (Howard 1967: 81-5, Howard 1972: 84-9) Size of maximum onset: 4 Size of maximum coda: N/A Onset obligatory: No Coda obligatory: N/a Vocalic nucleus patterns: Short vowels, Diphthongs Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: Heteromorphemic (Onset) Morphological pattern of syllabic consonants: N/A Onset restrictions: Biconsonantal onsets are most commonly two voiceless consonants at different places of articulation, e.g. /xt st fts sb tjt, tk tm jl nj/. Many combinations occur, but liquids and glides are restricted to C<sub>2</sub> position. In triconsonantal onsets, C<sub>1</sub> is /b t s j n/ and apparently / $\phi$ /, C<sub>2</sub> is /d t k tj fts x j s

restricted to C<sub>2</sub> position. In triconsonantal onsets, C<sub>1</sub> is /b t s  $\int$  n/ and apparently / $\phi$ /, C<sub>2</sub> is /d t k t $\int$  ts x  $\int$  m j/, and C<sub>3</sub> is /b k j m n r/. Examples include /stx ndm  $\phi$ xn stfb sfts/. 4-consonant onsets include /  $\phi$ stx/.

**Notes:** "Consonant clusters are very common in Camsá" (Howard 1967: 81). Howard (1967) gives canonical syllable structure as (C)(C)(C)V, but updates it to (C)(C)(C)(C)V in Howard (1972), saying onsets may consist of four consonants when subject is 1st person plural (/ $\phi$ -/). Some biconsonantal onsets (stop+stop, C+nasal sequences at different places of articulation) appear with brief transitional vocoid [°] between consonants; similarly there are affects on length of fricatives in first versus second position of biconsonantal onsets, and sometimes an associated vocoid or offlgide with those (1967: 82).

[kbh] CAMSÁ Isolate (Colombia) (cont.)

<u>Suprasegmentals</u>

Tone: No Word stress: Yes Stress placement: Fixed Phonetic processes conditioned by stress: Vowel Reduction Differences in phonological properties of stressed and unstressed syllables: (None) Phonetic correlates of stress: Vowel duration (impressionistic)

## Vowel reduction processes

**kbh-R1:** Word-final vowels occurring after a penultimate stress are optionally devoiced or deleted. This may occur in isolation but generally occurs in the middle of a clause (Howard 1967: 86). **kbh-R2:** Word-medial vowels are 'practically eliminated,' with syllables between the first syllable and the stressed syllable being 'squeezed together' (Howard 1967: 86-7).

**Notes:** "Words are pronounced rapidly with vowels practically eliminated word medially. A degree of emphasis is placed on the vowel of the first syllable with the following syllables squeezed together before the stressed syllable." (Howard 1967: 86-7).

## **Consonant allophony processes**

**kbh-C1:** A palatal glide is realized as a voiced palato-alveolar affricate following an alveolar nasal. (Howard 1967)

**kbh-C2:** An alveolar flap is realized as [z] word-initially. (Howard 1967: 78)

**kbh-C3:** A voiceless alveolar fricative is realized as voiced adjacent to a voiced alveolar stop. (Howard 1967: 78)

kbh-C4: A voiced bilabial stop may be spirantized in all environments. (Howard 1967: 77)

## **Morphology**

(adequate texts unavailable)

[kbk] KOIARI

#### Trans-New Guinea, Koiarian (Papua New Guinea)

References consulted: Dutton (1996)

#### Sound inventory

**C** phoneme inventory: /b t d k g  $\phi \beta$  s h m n l j/ N consonant phonemes: 13 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Alveolar, Velar, Glottal Manners: Stop, Fricative, Nasal, Lateral approximant, Central approximant N elaborations: 1 Elaborations: Voiced fricatives/affricates V phoneme inventory: /i e a o u/ N vowel qualities: 5 Diphthongs or vowel sequences: None **Contrastive length:** None Contrastive nasalization: None Other contrasts: N/A **Notes:**  $[\beta]$  alternates with [w], with [w] occurring before back vowels; perhaps it would be better analyzed as /w/.

## <u>Syllable structure</u>

Complexity Category: Simple Canonical syllable structure: (C)V (Dutton 1996: 7) Size of maximum onset: 1 Size of maximum coda: N/A Onset obligatory: No Coda obligatory: N/A Vocalic nucleus patterns: Short vowels Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: N/A Morphological pattern of syllabic consonants: N/A

#### **Suprasegmentals**

Tone: No Word stress: Yes Stress placement: Morphologically or Lexically Conditioned Phonetic processes conditioned by stress: Consonant Allophony in Stressed Syllables Differences in phonological properties of stressed and unstressed syllables: (None) Phonetic correlates of stress: Vowel duration (impressionistic), Pitch (impressionistic)

#### **Vowel reduction processes**

(none reported)

#### **Consonant allophony processes**

**kbk-C1:** A voiced bilabial fricative is realized as a glide preceding non-front vowels. (Dutton 1996) **kbk-C2:** A voiceless bilabial fricative may be realized as [p] word-initially preceding a back vowel. (Dutton 1996)

kbk-C3: An alveolar lateral approximant is realized as a flap preceding front vowels. (Dutton 1996)

[kbk] KOIARI Trans-New Guinea, *Koiarian* (Papua New Guinea) (cont.)

Morphology Text: "Maruba" (Dutton 1996: 72-76) Synthetic index: 1.5 morphemes/word (488 morphemes, 318 words) [kca] KHANTY (EASTERN DIALECT) Uralic, Ugric (Russia)

References consulted: Filchenko (2007), Andrey Filchenko (p.c.)

Sound inventory

C phoneme inventory: /p t c k q t͡ʃ s ɣ m n ŋ ŋ ŋ r l ʎ L w j/ N consonant phonemes: 19 Geminates: N/A Voicing contrasts: None Places: Bilabial, Alveolar, Palato-alveolar, Palatal, Velar, Uvular Manners: Stop, Affricate, Fricative, Nasal, Trill, Central approximant, Lateral approximant N elaborations: 4 Elaborations: Voiced fricatives/affricates, Palato-alveolar, Uvular V phoneme inventory: /i y e ø œ æ i ə ə a ɔ o u/ N vowel qualities: 13 Diphthongs or vowel sequences: None Contrastive length: None Contrastive nasalization: None Other contrasts: N/A

**Notes:** /r/ is described as an 'alveolar-palatal trill'. /k q  $\chi$   $\eta$ / are described as 'cacuminal' (retroflex?). /t / occurs in Upper Yugan dialect only. /ə ə Ø ɔ/ are 'reduced' vowels, produced as lax, weak, and short, commonly occurring in unstressed syllables.

Syllable structure

Complexity Category: Moderately Complex Canonical syllable structure: (C)V(C)(C) (Filchenko 2007: 53-7) Size of maximum onset: 1 Size of maximum coda: 2 Onset obligatory: No Coda obligatory: No Vocalic nucleus patterns: Short vowels Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: Heteromorphemic (Coda) Morphological pattern of syllabic consonants: N/A

**Onset restrictions:** C<sub>1</sub> may be any consonant except  $/\eta$ /. C<sub>2</sub> is always a glide  $/\beta$ / or /j/.

Coda restrictions: All consonants except for glides and glottal fricative /h/ are attested.

**Notes:** Canonical syllable structure includes coda clusters. These come about through derivation or inflection, and vowel epenthesis is employed "robustly and productively" such that most are not realized as coda clusters. However, derived coda clusters with a sonorant preceding a homorganic stop are more likely to be retained (e.g. *lol-t* 'crack, dent'-PL). Description suggests that occurrence of clusters is a matter of probability, and there is an "extremely low probability of consonant clusters at the morphemic edges, word-initial, and word-final position" (Filchenko 2007: 55). I therefore analyze this language as having Moderately Complex syllable structure.

[kca] KHANTY (EASTERN DIALECT)

## Uralic, Ugric (Russia) (cont.)

#### **Suprasegmentals**

Tone: No Word stress: Yes Stress placement: Weight-Sensitive Phonetic processes conditioned by stress: Vowel Reduction Phonetic correlates of stress: Not described Differences in phonological properties of stressed and unstressed syllables: Vowel Quality Contrasts

(see notes)

**Notes:**  $/ \Im \Im \Im$  o/ commonly occur in unstressed syllables, and their occurrence in a word may complicate typical patterns of stress assignment (if initial syllable in bisyllabic word has reduced vowel, stress shifts to next syllable).

#### **Vowel reduction processes**

**kca-R1:** Word-final vowels, particularly  $|\partial|$  and  $|\phi|$ , are under-articulated, reduced, devoiced, or deleted (Filchenko 2007: 56).

#### **Consonant allophony processes**

**kca-C1:** Voiceless velar stop and voiced velar fricative are realized as uvulars adjacent to back vowels. (Filchenko 2007: 41)

**kca-C2:** A labiovelar approximant may be realized as a bilabial stop following /m/. (Filchenko 2007: 44-45)

**kca-C3:** A voiced velar fricative may be realized as a velar stop adjacent to /t k q  $\hat{t}$ /. (Filchenko 2007) **kca-C4:** A voiced velar fricative may be realized as a velar stop intervocalically. (Filchenko 2007) **kca-C5:** Labial and dorsal consonants are palatalized preceding front vowels. (Filchenko 2007: 37) **kca-C6:** A voiced velar fricative is realized as a labiovelar approximant following /u/. (Filchenko 2007: 45-6)

## <u>Morphology</u>

**Text:** "A bear in the river" (Filchenko 2007: 582-588) **Synthetic index:** 1.9 morphemes/word (649 morphemes, 342 words) [ket] KET Yeniseian, Yeniseian (Russia)

References consulted: Georg (2007), Vajda (2000)

#### Sound inventory

C phoneme inventory: /b t d k q s h m n ŋ l j/ N consonant phonemes: 12 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Alveolar, Velar, Uvular, Glottal Manners: Stop, Fricative, Nasal, Central approximant, Lateral approximant N elaborations: 1 Elaborations: Uvular V phoneme inventory: /i e i ə a o u/ N vowel qualities: 7 Diphthongs or vowel sequences: None Contrastive length: None Contrastive nasalization: None Other contrasts: N/A

#### Syllable structure

**Complexity Category:** Complex **Canonical syllable structure:** (C)(C)V(C)(C)(C) (Georg 2007: 80-4)

Size of maximum onset: 2

Size of maximum coda: 3

**Onset obligatory:** No

Coda obligatory: No

Vocalic nucleus patterns: Short vowels

Syllabic consonant patterns: Nasal

Size of maximum word-marginal sequences with syllabic obstruents:  $\ensuremath{\mathrm{N/A}}$ 

Predictability of syllabic consonants: Predictable from word/consonantal context

**Morphological constituency of maximum syllable margin:** Heteromorphemic (Onset), or Both patterns (Coda)

## Morphological pattern of syllabic consonants: Grammatical items

**Onset restrictions:** Apparently all consonants occur in simple onsets. Onset clusters have  $/b \ k \ d/as \ C_1$  and apparently any (?) consonant as  $C_2$ .

**Coda restrictions:** All consonants except /h/ occur as simple codas. Biconsonantal codas seem fairly unrestricted, though most end in /s/ (nominalizing suffix), /n/, or / $\eta$ / (plural suffixes). Other biconsonantal codas such as /tl/, / $\eta$ l/, /nt/, /kt/, and /qt/ may occur within roots. Triconsonantal codas always have a continuant as the second member and /s/ as the third member.

**Notes:** Canonical syllable structure differs here from Georg's reported patterns, which include twoconsonant codas. In discussion on p. 84 he gives example of triconsonantal coda, which may occur when the nominalizer suffix -s is added to a coda ending in a continuant. All examples of biconsonantal onsets have stops as  $C_2$  but it would seem based on patterns reported that any stem-initial C could occur in this position. What is written as /?/ in Georg's transcriptions marks Tone 2 and shouldn't be analyzed as a consonant.

#### **Suprasegmentals**

**Tone:** Yes **Word stress:** No **Notes:** Falling tones are 'acoustically close to a dynamic stress'. [ket] KET Yeniseian, Yeniseian (Russia) (cont.)

## **Vowel reduction processes**

**ket-R1:** An unstressed high front vowel /i/ in the sequence VCiCV is syncopated, if no non-permitted consonant cluster results (Georg 2007: 214; "stress" here refers to tonal contour).

**ket-R2:** Vowels with second tone lose their tone except in absolute final position in phrase (Vajda 2000: 15-16).

**ket-R3:** In post-tonal (non-initial) syllables and the second syllable of a disyllabic pitch contour, there is free variation between vowels and higher counterparts (Vajda 2000: 11).

## **Consonant allophony processes**

**ket-C1:** A voiceless alveolar fricative is sometimes realized as a palato-alveolar fricative or affricate preceding front vowels. (Georg 2007: 78)

**ket-C2:** A voiceless velar stop is realized as a voiced velar fricative intervocalically. (Georg 2007: 75) **ket-C3:** A consonant is voiced preceding another consonant. (Georg 2007: 75)

**ket-C4:** A voiced alveolar stop is realized as a flap intervocalically in some dialects. (Georg 2007: 76) **ket-C5:** Voiced bilabial stop, voiceless velar and uvular stops are spirantized intervocalically. (Georg 2007: 75-8)

## <u>Morphology</u>

**Text:** "Two brothers" (Vajda 2004: 92-97) **Synthetic index:** 2.3 morphemes/word (602 morphemes, 267 words) [kew] KEWA (EASTERN)

References consulted: Franklin (1971), Franklin & Franklin (1962, 1978)

#### Sound inventory

C phoneme inventory: /mb t nd c k  $\phi$  s x m n n l r w j/ N consonant phonemes: 15 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Alveolar, Palatal, Velar Manners: Stop, Fricative, Nasal, Flap/Tap, Lateral Flap/Tap, Central Approximant N elaborations: 1 Elaborations: Prenasalization V phoneme inventory: /i e ə a o u/ N vowel qualities: 6 Diphthongs or vowel sequences: None Contrastive length: None Contrastive nasalization: None Other contrasts: N/A Notes: Palatal consonants are present in Eastern Kewa only, and do not occur before high vowels (Franklin & Franklin 1978: 21). /e/ reported in 1971, 1978 references, but not 1962 references. /a/ produced slightly longer, but has no short counterpart.

#### Syllable structure

Complexity Category: Simple Canonical syllable structure: (C)V (Franklin 1971: 11-12) Size of maximum onset: 1 Size of maximum coda: N/A Onset obligatory: No Coda obligatory: No Coda obligatory: N/A Vocalic nucleus patterns: Short vowels Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: N/A Morphological pattern of syllabic consonants: N/A

## **Suprasegmentals**

Tone: Yes Word stress: Yes Stress placement: Morphologically or Lexically Conditioned Phonetic processes conditioned by stress: (None) Differences in phonological properties of stressed and unstressed syllables: Vowel Quality Contrasts Phonetic correlates of stress: Vowel duration (impressionistic), Pitch (impressionistic) Notes: Pitch as a correlate of stress here indicates that perceptual or auditory height of a tone may be conditioned by stress placement.

Vowel reduction processes

(none reported)

## **Consonant allophony processes**

**kew-C1:** A voiceless alveolar fricative is realized as palato-alveolar preceding a high vowel. (Franklin 1971: 24)

**kew-C2:** A voiceless bilabial or velar fricative may be realized as an affricate utterance-initially. (Franklin 1971: 24)

kew-C3: Fricatives may be voiced in fast speech. (Franklin 1971: 24)

## <u>Morphology</u>

Text: "East Kewa" (lines 1-13, 32-58, Franklin & Franklin 1978: 483-487) Synthetic index: 1.4 morphemes/word (399 morphemes, 278 words) [khc] TUKANG BESI (NORTH DIALECT) Austronesian, Celebic (Indonesia)

References consulted: Donohue (1999)

## Sound inventory

C phoneme inventory: /p t k g ? <sup>m</sup>p <sup>m</sup>b <sup>n</sup>t <sup>n</sup>d <sup>n</sup>k <sup>n</sup>g b d  $\beta$  s h <sup>n</sup>s m n n r l/ N consonant phonemes: 22 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Dental, Alveolar, Velar, Glottal Manners: Stop, Fricative, Nasal, Trill, Lateral Approximant N elaborations: 3 Elaborations: Voiced fricatives/affricates, Prenasalization, Implosive V phoneme inventory: /i ɛ a o ɯ/ N vowel qualities: 5 Diphthongs or vowel sequences: None Contrastive length: None **Contrastive nasalization:** None Other contrasts: N/A Notes: There are also palatal phonemes loaned from Indonesian/Trade Malay. Author presents distributional/reduplication/syllabification evidence for analyzing prenasalized stops as unitary rather than sequences in reduplication processes.

Syllable structure

Complexity Category: Simple Canonical syllable structure: (C)V (Donohue 1999: 30-1) Size of maximum onset: 1 Size of maximum coda: N/A Onset obligatory: No Coda obligatory: N/A Vocalic nucleus patterns: Short vowels Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: N/A Morphological pattern of syllabic consonants: N/A

#### **Suprasegmentals**

Tone: No Word stress: Yes Stress placement: Fixed Phonetic processes conditioned by stress: Consonant Allophony in Unstressed Syllables Differences in phonological properties of stressed and unstressed syllables: (None) Phonetic correlates of stress: Pitch (impressionistic) Notes: Donohue speculates that TB has an incipient pitch accent system that's developing through the

regularization of phonetic properties of older non-contrastive stress system (1999: 34).

#### **Vowel reduction processes**

**khc-R1:** In casual speech, any word-final vowel can delete or become voiceless after a voiceless consonant (Donohue 1999: 23).

[khc] TUKANG BESI (NORTH DIALECT) Austronesian, Celebic (Indonesia) (cont.)

## **Consonant allophony processes**

**khc-C1:** Non-implosive bilabial stops may be realized as affricates preceding /a/, /o/. (Donohue 1999: 16) **khc-C2:** Voiceless glottal fricative is realized as voiceless bilabial fricative preceding /u/. (Donohue 1999: 19)

**khc-C3:** A voiceless velar stop is realized as fronted preceding /i/. (Donohue 1999: 19)

**khc-C4:** An alveolar trill may be realized as an alveolar, lateral, or retroflex flap intervocalically in some dialects and in casual speech. (Donohue 1999: 18)

**khc-C5:** An alveolar lateral approximant my be realized as a lateral or retroflex flap following a non-front vowel in some dialects and in casual speech. (Donohue 1999: 18)

**khc-C6:** A voiced velar stop is spirantized in lax environments, including between two unstressed vowels. (Donohue 1999: 27)

**khc-C7:** An implosive bilabial stop is realized as a fricative intervocalically. (Donohue 1999: 16) **khc-C8:** Non-implosive bilabial stops may be spirantized preceding non-high back vowels. (Donohue 1999: 16)

## <u>Morphology</u>

**Text:** "The heron and the monkey" (Donohue 1999: 516-520) **Synthetic index:** 1.5 morphemes/word (605 morphemes, 398 words) [khr] KHARIA Austro-Asiatic, Munda (India)

References consulted: Peterson (2010)

#### Sound inventory

**Notes:** Palatal stops often realized as affricates. The retroflex consonants are most often realized as postalveolars. /t/ is marginally phonemic, but there is a minimal pair distinguishing it from /d/. [?] is also described as extremely marginal, does not seem to contrast with anything and is predictable in its distribution. / $\epsilon$  J/ raise to /e o/ when lengthened. Status of diphthongs /ae ao ou oi ui/ doubtful to Peterson, as they do not occur before codas in the native vocabulary. Therefore he analyzes these as V+glide. Other authors consider nasalization to be marginally phonemic, but Peterson does not (2011: 27).

## Syllable structure

Complexity Category: Moderately Complex Canonical syllable structure: (C)V(C) (Peterson 2011: 32-3) Size of maximum onset: 1 Size of maximum coda: 1 Onset obligatory: No Coda obligatory: No Vocalic nucleus patterns: Short vowels, Diphthongs Syllabic consonant patterns: Nasal Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: Predictable from word/consonantal context Morphological constituency of maximum syllable margin: N/A Morphological pattern of syllabic consonants: Lexical items Onset restrictions: C<sub>1</sub> may be any consonant except /t/ and /n/. Coda restrictions: /s/ and /h/ do not occur in native codas. Voicing, aspiration, and dental/retroflex contrasts neutralized in coda.

#### **Suprasegmentals**

Tone: No

## Word stress: No

**Notes:** Word-level rising prosodic pattern defines the phonological word, but any syllable may be more prominent with respect to intensity.

## **Vowel reduction processes**

(none reported)

#### **Consonant allophony processes**

**khr-C1:** A voiced velar stop is realized as a glottal stop syllable-finally. (Peterson 2010: 29)

[khr] KHARIA Austro-Asiatic, Munda (India) (cont.)

Morphology Text: "The nine totems" (first 8 pages, Peterson 2011: 439-446) Synthetic index: 1.5 morphemes/word (604 morphemes, 399 words)

[kjn] KUNJEN (OYKANGAND) Pama-Nyungan, Northern Pama-Nyungen (Australia)

**References consulted:** Sommer (1969, 1981)

#### Sound inventory

C phoneme inventory: /p t t c k p<sup>h</sup> t<sup>h</sup> t<sup>h</sup> c<sup>h</sup> k<sup>h</sup> f ð y m n n n n r 1 l w j/ N consonant phonemes: 23 Geminates: N/A Voicing contrasts: None Places: Bilabial, Labiodental, Dental, Alveolar, Palatal, Velar Manners: Stop, Fricative, Nasal, Trill, Central approximant, Lateral approximant N elaborations: 4 Elaborations: Voiced fricatives/affricates, Devoiced sonorants, Post-aspiration, Labiodental V phoneme inventory: /I e a o u/ N vowel qualities: 5 Diphthongs or vowel sequences: None **Contrastive length:** None **Contrastive nasalization:** None Other contrasts: N/A Notes: Prenasalized stops interpreted as a cluster on the basis of occurrence of reverse sequences and separate occurrence of component segments (1969: 34).

#### Syllable structure

Complexity Category: Highly Complex Canonical syllable structure: (C)VC(C)(C)(C) (Summer 1969: 33-35; Sommer 1981; Dixon 1970) Size of maximum onset: 1 Size of maximum coda: 4 Onset obligatory: No Coda obligatory: Yes Vocalic nucleus patterns: Short vowels Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: Tautomorphemic (Coda) Morphological pattern of syllabic consonants: N/A Onset restrictions: Unclear. Coda restrictions: Simple codas unrestricted. Biconsonantal codas include nasal-nasal, lateral-stop, lateral-fricative, stop-nasal, rhotic-stop, rhotic-nasal, rhotic-glide, glide-glide. Triconsonantal codas h

lateral-fricative, stop-nasal, rhotic-stop, rhotic-nasal, rhotic-glide, glide-glide. Triconsonantal codas have liquid as  $C_1$  followed by stop-nasal or nasal-stop sequence, or stop-nasal-stop sequence in which first two members are homorganic. Four-consonant codas consist of /l I j/ followed by homorganic sequence of stop, nasal, and stop, e.g. /lbmb/.

**Notes:** This language is typologically unusual in that it is claimed to have no onsets. Sommer (1970, 1981) argues for this analysis using evidence from phonological processes in the language. Consonant-initial syllables are reported to occur in a few lexical items when these are sentence-initial: Sommer (1969: 16, 33) indicates that this is optional and limited to words which occur with high frequency in that environment, but Sommer (1981) suggests that this is an invariant pattern. Dixon (1970) disagrees with Sommer's analysis; in work with Olgolo he observed many invariant word-final vowels in the language. He analyzes the language as having V(C)(C) structure in initial syllables and CV(C)(C) syllables following that, with the limitation that a stem-final syllable can have at most one final consonant (1970: 274). Sommer criticizes Dixon for using data from the more distantly related Olgolo rather than from closely related Olgol to argue against patterns in Oykangand. Dixon also analyzes the language as having a series of pre-stopped nasals; this would affect the canonical syllable structure proposed by Sommer. Sommer argues for his sequential analysis of these structures in (1981: 242 fl)

(cont.)

#### **Suprasegmentals**

Tone: No Word stress: Yes Stress placement: Morphologically or Lexically Conditioned Phonetic processes conditioned by stress: Consonant Allophony in Stressed Syllables Differences in phonological properties of stressed and unstressed syllables: Not described Phonetic correlates of stress: Vowel duration (instrumental), Intensity (impressionistic)

## **Vowel reduction processes**

**kjn-R1:** In fast speech, vowels tend toward an indeterminate central position resembling [ə] but maintain their rounding characteristics (Sommer 1969: 41). **kjn-R2:** High front vowel is realized as lax in unstressed, non-word-initial position (Sommer 1969:41).

## **Consonant allophony processes**

**kjn-C1:** Unaspirated voiceless stops are voiced preceding a nasal. (Sommer 1969: 39) **kjn-C2:** Unaspirated voiceless stops are sometimes voiced following a liquid. (Sommer 1969: 39)

## **Morphology**

(adequate texts unavailable)

[kms] KAMASAU Torricelli, Marienberg (Papua New Guinea)

References consulted: Sanders & Sanders (1980)

#### Sound inventory

C phoneme inventory: /b t d t) d3 k g ? mb nd μd3 ng φ β s γ m n n ŋ r w j/ N consonant phonemes: 23 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Alveolar, Palato-alveolar, Velar, Glottal Manners: Stop, Affricate, Fricative, Nasal, Flap/Tap, Central approximant N elaborations: 3 Elaborations: Voiced fricatives/affricates, Prenasalization, Palato-alveolar V phoneme inventory: /i e i a o u/ N vowel qualities: 6 Diphthongs or vowel sequences: Vowel sequences /iu ia ie io ui ua ue uo ai au ao ei eu ea eo oi ou/ Contrastive length: None Contrastive nasalization: None Other contrasts: N/A

Syllable structureComplexity Category: Moderately ComplexCanonical syllable structure: (C)(C)V(C) (Sanders & Sanders 1980: 116-121)Size of maximum onset: 2Size of maximum coda: 1Onset obligatory: NoCoda obligatory: NoVocalic nucleus patterns: Short vowels, Vowel sequencesSyllabic consonant patterns: NasalSize of maximum word-marginal sequences with syllabic obstruents: N/APredictability of syllabic consonants: Varies with CV sequenceMorphological constituency of maximum syllable margin: Both patterns (Onset)Morphological pattern of syllabic consonants: N/AOnset restrictions: C1 may be a plosive, /mb/, /s/, /r/, or nasal. C2 is always /j/, /w/, or /r/.Coda restrictions: All consonants except /w j/ may occur. CCVVC syllables are always closed by /?/.

Suprasegmentals Tone: No Word stress: Yes Stress placement: Unpredictable/Variable Phonetic processes conditioned by stress: Vowel Reduction Differences in phonological properties of stressed and unstressed syllables: (None) Phonetic correlates of stress: Not described

#### Vowel reduction processes

**kms-R1:** The vowel in a word-initial syllable preceding a stressed syllable has a tendency to be reduced, being deleted or overlapped with a preceding (nasal) consonant to produce a syllabic consonant (Sanders & Sanders 1980: 114-115).

**kms-R2:** A low central vowel /a/ occurs as mid in an unstressed syllable (Sanders & Sanders 1980: 122).

## **Consonant allophony processes**

(none reported)

Morphology Text: "Amu2 Text" (Sanders & Sanders 1994: 85-94) Synthetic index: 1.4 morphemes/word (639 morphemes, 455 words) [knc] KANURI Saharan, Western Saharan (Chad, Niger, Nigeria, Sudan)

References consulted: Cyffer (1998), Hutchison (1981)

#### Sound inventory

C phoneme inventory: /b t d k g <sup>m</sup>b <sup>n</sup>d <sup>n</sup>g  $\widehat{t}$   $\widehat{dz}$  f s z  $\int h m n r l w j/$ N consonant phonemes: 21 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Labiodental, Alveolar, Palato-alveolar, Velar, Glottal Manners: Stop, Affricate, Fricative, Nasal, Flap/Tap, Central approximant, Lateral approximant N elaborations: 4 Elaborations: Voiced fricatives/affricates, Prenasalization, Labiodental, Palato-alveolar V phoneme inventory: /i е ә а л о и/ N vowel qualities: 7 Diphthongs or vowel sequences: None **Contrastive length:** None Contrastive nasalization: None Other contrasts: None Notes: Vowel sequences /aa ii uu ai au ia iu oi/ appear to be variable realizations in predictable contexts in which an intervocalic /g/may be weakened or entirely lost.

## Syllable structure

Category: Moderately Complex Canonical syllable structure: (C)V(C) (Hutchison 1981: 15-17, Cyffer 1998) Size of maximum onset: 1 Size of maximum coda: 1 Onset obligatory: No Coda obligatory: No Vocalic nucleus patterns: Short vowels, Vowel sequences Syllabic consonant patterns: Nasal Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: Predictable from word/consonantal context Morphological constituency of maximum syllable margin: N/A Morphological pattern of syllabic consonants: Lexical items Onset restrictions: None.

**Coda restrictions:** only sonorant consonants /l r m n/ occur (Hutchison 1981: 15) **Notes:** Hutchison states that onsetless syllables occur only in borrowings (1981: 15), but both Hutchison and Cyffer (1998) give examples of V-initial nouns, verbs, and demonstratives which seem unlikely to be borrowed (e.g., verb paradigm for 'come', demonstratives  $\dot{a}d\dot{a}$  and  $\dot{a}nj\dot{a}$ ).

## **Suprasegmentals**

Tone: Yes Word stress: No

#### **Vowel reduction processes**

(none reported)

## **Consonant allophony processes**

**knc-C1:** A voiceless alveolar fricative is realized as palato-alveolar preceding front vowels. (Cyffer 1998: 20)

**knc-C2:** A voiceless alveolar fricative is realized as a palatal stop when occurring after a consonant and before a front vowel. (Cyffer 1998: 21)

**knc-C3:** A voiceless labiodental fricative is realized as labial preceding a back rounded vowel. (Cyffer 1998: 23)

**knc-C4:** Voiceless consonants are voiced when occurring after a sonorant and preceding a vowel. (Cyffer 1998: 22)

knc-C5: A voiced velar stop is spirantized intervocalically. (Cyffer 1998: 22)

**knc-C6:** A voiced bilabial stop may be realized as a labiovelar glide when occurring after a vowel or liquid. (Cyffer 1998: 22)

**knc-C7:** A voiceless alveolar fricative may be realized as a palatal glide when occurring after a sonorant and preceding a front vowel. (Cyffer 1998: 21)

**knc-C8:** Velar stops are realized as corresponding glides when adjacent to front and back vowels, respectively. (Cyffer 1998: 22)

## **Morphology**

(adequate texts unavailable)

[kpj] KARAJÁ Macro-Ge, Karajá (Brazil)

References consulted: Ribeiro (2012)

Sound inventory

C phoneme inventory: /b d d k θ h r l w/ N consonant phonemes: 9 Geminates: N/A Voicing contrasts: None Places: Bilabial, Dental, Alveolar, Velar, Glottal Manners: Stop, Fricative, Flap/Tap, Central approximant, Lateral approximant N elaborations: 1 Elaborations: Implosive V phoneme inventory: /i I e ε ± ± 9 a o o o u ĩ 9 ã õ/ N vowel qualities: 12 Diphthongs or vowel sequences: None Contrastive length: None Contrastive nasalization: Some Other contrasts: N/A

**Notes:** The voiced stops /b d/ do not contrast with nasals, have nasals as variants. Author argues that [t] dz [t] are predictable variants of /d d k  $\theta$ / adjacent to [+ATR] vowels, and gives morphophonemic alternation evidence for this analysis (Ribeiro 2012: 116-121). The process occurs only within words, not across word boundaries. Schwa [a] is argued by author to be non-phonemic synchronically, and to come about through dissimilation. Nasalization is distinctive for /i a a/.

#### Syllable structure

Complexity Category: Simple Canonical syllable structure: (C)V (Ribeiro 2012: 75-6) Size of maximum onset: 1 Size of maximum coda: N/A Onset obligatory: No Coda obligatory: N/A Vocalic nucleus patterns: Short vowels Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: N/A Morphological pattern of syllabic consonants: N/A Onset restrictions: All consonants occur. Coda restrictions: N/A Notes: In Southern and Northern Karajá dialects, CCV syllables may occur as a result of schwa deletion between a stop (specifically /b/, /k/, or /d/) and the alveolar flap /r/. In these dialects, words consisting of

**Notes:** In Southern and Northern Karaja dialects, CCV syllables may occur as a result of schwa deletion between a stop (specifically /b/, /k/, or /d/) and the alveolar flap /r/. In these dialects, words consisting of CCV syllables behave phonologically as bimoraic, reflecting minimal phonological word patterns in Karajá (Ribeiro 2012: 75-6).

#### <u>Suprasegmentals</u>

Tone: No Word stress: Yes Stress placement: Fixed Phonetic processes conditioned by stress: (None) Differences in phonological properties of stressed and unstressed syllables: (None) Phonetic correlates of stress: Pitch (impressionistic) [kpj] KARAJÁ Macro-Ge, *Karajá* (Brazil) (cont.)

**Vowel reduction processes** 

(none reported)

## **Consonant allophony processes**

**kpj-C1:** A voiceless velar stop and voiced alveolar stop are realized as palato-alveolar affricates and a voiceless interdental fricative is realized as a palato-alveolar fricative adjacent to +ATR vowels. (Ribeiro 2012)

## **Morphology**

(adequate texts unavailable)

[kpm] SRE Austro-Asiatic, *Bahnaric* (Vietnam)

References consulted: Ladefoged & Maddieson (1997), Manley (1972), Olsen (2014)

#### Sound inventory

C phoneme inventory: /p b t d c j k g ? p<sup>h</sup> t<sup>h</sup> c<sup>h</sup> k<sup>h</sup> b d s h m n n ŋ m<sup>h</sup> n<sup>h</sup> n<sup>h</sup> r r<sup>h</sup> l l<sup>h</sup> w j/ N consonant phonemes: 30 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Alveolar, Palatal, Velar, Glottal Manners: Stop, Fricative, Nasal, Trill, Central approximant, Lateral approximant N elaborations: 3 Elaborations: Post-aspiration, Implosive V phoneme inventory: /i e ε i a α ɔ o 𝔅 u i: e: ɛ: i: a: α: ɔ: 𝔅: o: u:/ N vowel qualities: 10 Diphthongs or vowel sequences: None Contrastive length: All Contrastive nasalization: None Other contrasts: N/A

**Notes:** Ladefoged & Maddieson (1996:116) suspect the aspirated nasal are actually voiceless. Olsen argues that aspirated trill, lateral approximants are units, using morphological evidence. Manley doesn't list these, but does have /j<sup>h</sup> w<sup>h</sup>/ instead. Olsen shows VOT for aspirated sonorants is 2-3 times longer than for unaspirated stops, concluding that this indicates aspiration rather than voicelessness. [i] varies with [ui]. /a/ occurs in subdialects A & B, but not C. /e o a/ almost always occur long. Long vowels are associated with pitch fall or rise; Manley analyzes pitch, not length as the conditioned feature (Manley 15).

#### **Syllable structure**

Complexity Category: Complex Canonical syllable structure: C(C)(C)V(C)(C) (Olsen 2014: 30-40, Manley 1972: 23-7) Size of maximum onset: 3 Size of maximum coda: 2 Onset obligatory: Yes Coda obligatory: No Vocalic nucleus patterns: Short vowels, Long vowels Syllabic consonant patterns: Nasals Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: Unpredictable Morphological constituency of maximum syllable margin: Tautomorphemic (Onset, Coda) Morphological pattern of syllabic consonants: Lexical Onset restrictions: All consonants may occur in simple onsets, though presyllable onsets are limited to unaspirated, unimploded obstruents. Biconsonantal onsets have a liquid or glide as C<sub>2</sub>. Triconsonantal onsets are limited to a stop or /s m/ as C<sub>1</sub>, /r l/ as C<sub>2</sub>, and /w j/ as C<sub>3</sub>.

**Coda restrictions:** In presyllables, simple codas are limited to liquids and /n/. In main syllables, simple coda may be liquid, nasal, glide, or glottal. Biconsonantal codas are glide + /? h/.

Notes: This language has presyllables/main syllable distinction.

[kpm] SRE Austro-Asiatic, *Bahnaric* (Vietnam)

(cont.)

**Suprasegmentals** 

Tone: Yes Word stress: Yes Stress placement: Fixed Phonetic processes conditioned by stress: Vowel Reduction Differences in phonological properties of stressed and unstressed syllables: Vowel Quality Contrasts, Vowel Length Contrasts, Consonant Contrasts, Tonal Contrasts Phonetic correlates of stress: Intensity (impressionistic) Notes: Duration and pitch seem to be interdependent correlates of tone. Main syllable vowels have "attendant pitch length" (Olsen 32).

## **Vowel reduction processes**

**kpm-R1:** Long vowels decrease in duration if not occurring word-finally, particularly if unstressed (Olsen 2014: 33).

kpm-R2: Presyllables tend to weaken or disappear in many environments (Olsen 2014: 31).

#### **Consonant allophony processes**

**kpm-C1:** An alveolar trill is realized as a flap when occurring as second consonant of onset and preceding a vowel. (Olsen 2014: 24)

## Morphology

**Text:** "Traditional village work" (Olsen 2014: 106-107) **Synthetic index:** 1.0 morphemes/word (90 morphemes, 89 words)
#### [kyh] KAROK Isolate (United States)

References consulted: Bright (1957), Sandy (2014)

#### Sound inventory

C phoneme inventory: /p t k ?  $\widehat{tJ} \beta f \theta s \int x h m n r j/$ N consonant phonemes: 16 Geminates: N/A Voicing contrasts: None Places: Bilabial, Labiodental, Dental, Alveolar, Palato-alveolar, Velar, Glottal Manners: Stop, Affricate, Fricative, Nasal, Flap/Tap, Central approximant N elaborations: 2 Elaborations: Labiodental, Palato-alveolar V phoneme inventory: /i a o u i: e: a: o: u:/ N vowel qualities: 5 Diphthongs or vowel sequences: Diphthong /ui/, perhaps more Contrastive length: Some Contrastive nasalization: None Other contrasts: N/A Notes: /ʃ/ only marginally contrastive with /s/ (Bright 1957: 17). No length distinction in /e:/.

#### Syllable structure

Category: Moderately Complex Canonical syllable structure: CV(C) (Bright 1957: 11) Size of maximum onset: 1 Size of maximum coda: 1 Onset obligatory: Yes Coda obligatory: No Vocalic nucleus patterns: Short vowels, Long vowels, Diphthongs Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: N/A Morphological pattern of syllabic consonants: N/A Onset restrictions: All consonants occur. Coda restrictions: All consonants occur.

 Suprasegmentals

 Tone: Yes

 Word stress: Yes

 Stress placement: Other (tone and weight)

 Phonetic processes conditioned by stress: Vowel Reduction, Consonant Allophony in Unstressed Syllables

 Differences in phonological properties of stressed and unstressed syllables: Not described

 Phonetic correlates of stress: Not described

 Notes: Sandy argues that stress placement is predictable and phonologically conditiond by requireme

**Notes:** Sandy argues that stress placement is predictable and phonologically conditiond by requirements of tone, which in turn is determined by syllable weight/structure. Stress coincides with tone-bearing mora (Sandy 2014: 40).

[kyh] KAROK Isolate (United States) (cont.)

#### **Vowel reduction processes**

kyh-R1: An unstressed low central vowel /a/ without tone is realized as [ə] (Bright 1957: 11).

**kyh-R2:** An unaccented word-initial short vowel preceding two consonants may be lost following a pause (Bright 1957: 53).

**kyh-R3:** Long vowels in post-tonic syllables followed by a pause are realized with lower pitch and glottalization (Bright 1957: 13).

**kyh-R4:** Syllables with short vowels may be realized with whispered voice in post-tonic position preceding a pause (Bright 1957: 13)

#### **Consonant allophony processes**

**kyh-C1:** A voiceless velar fricative is realized with uvular trill release when occurring before a front vowel. (Bright 1957).

**kyh-C2:** A voiceless velar fricative is realized as labialized when occurring after a back vowel. (Bright 1957: 8)

#### **Morphology**

**Text:** "How salmon was given to mankind" (Angulo & Freeland 1971: 202-4) **Synthetic index:** 2.4 morphemes/word (614 morphemes, 252 words) [lao] LAO Tai-Kadai, Kam-Tai (Laos, Thailand)

References consulted: Enfield (2004, 2007), Erickson (2001), Morev et al. (1979)

#### Sound inventory

**C phoneme inventory:** /p p<sup>h</sup> b t t<sup>h</sup> d t<sup>w</sup> k k<sup>h</sup> k<sup>w</sup> k<sup>wh</sup> ? ?<sup>w</sup> t c t c t s s<sup>w</sup> h m n n η η η<sup>w</sup> l l<sup>w</sup> υ j/ N consonant phonemes: 28 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Labiodental, Alveolar, Alveolo-palatal, Velar, Glottal Manners: Stop, Affricate, Fricative, Nasal, Central approximant, Lateral approximant N elaborations: 3 Elaborations: Post-aspiration, Labiodental, Labialization V phoneme inventory: /i e ɛ ə a ɔ o ɯ u iː eː ɛː əː aː ɔː oː ɯː uː/ N vowel qualities: 9 Diphthongs or vowel sequences: Diphthongs /ia ua ua/ Contrastive length: All Contrastive nasalization: None Other contrasts: N/A Notes: /v/ varies between fricative and approximant, but approximant more common. Labialized consonants don't occur before rounded vowels. Because there are no Cj sequences in the language, the CG

analysis is rejected for these (Erickson 2001: 138). Diphthong /au/ occurs in Northern varieties.

#### Syllable structure

Complexity Category: Moderately Complex Canonical syllable structure: CV(C) (Enfield 2007: 33-5; Morev et al. 1979: 20) Size of maximum onset: 1 Size of maximum coda: 1 Onset obligatory: Yes Coda obligatory: No Vocalic nucleus patterns: Short vowels, Long vowels, Diphthongs Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: N/A Morphological pattern of syllabic consonants: N/A Onset restrictions: All consonants occur. Coda restrictions: Limited to /p t k ? m n ŋ w j/.

#### <u>Suprasegmentals</u>

Tone: Yes Word stress: Yes Stress placement: Fixed Phonetic processes conditioned by stress: (None) Differences in phonological properties of stressed and unstressed syllables: Vowel Quality Contrasts, Vowel Length Contrasts, Consonant Contrasts, Tonal Contrasts Phonetic correlates of stress: Not described

Vowel reduction processes (none reported)

<u>Consonant allophony processes</u> (none reported) [lao] Tai-Kadai, Kam-Tai (Laos, Thailand) LAO

(cont.)

Morphology Text: "A grammar of Lao" (Enfield 2007: 488-497) Synthetic index: 1.1 morphemes/word (381 morphemes, 362 words)

[lep] LEPCHA

Sino-Tibetan, Lepcha (Bhutan, India, Nepal)

References consulted: Plaisier (2007), Sprigg (1966)

#### Sound inventory

C phoneme inventory: /p p<sup>h</sup> b t t<sup>h</sup> d t t<sup>h</sup> d c c<sup>h</sup> k k<sup>h</sup> g ? ts ts<sup>h</sup> f v s z  $\int$  3 h m n p ŋ r l  $\beta$  j/ N consonant phonemes: 32 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Labiodental, Dental, Alveolar, Palato-alveolar, Retroflex, Palatal, Velar, Glottal Manners: Stop, Affricate, Fricative, Nasal, Trill, Central approximant, Lateral approximant N elaborations: 5 Elaborations: Voiced fricatives/affricates, Post-aspiration, Labiodental, Palato-alveolar, Retroflex V phoneme inventory: /i e  $\ni$  a  $\ni$  0  $\bowtie$  u/ N vowel qualities: 8 Diphthongs or vowel sequences: None Contrastive length: None Contrastive nasalization: None Other contrasts: N/A Notes: [e] varies with [ $\epsilon$ ]. / $\vartheta$ / approaches [ $\Lambda$ ] or [ $\mathfrak{w}$ ] in some contexts.

#### Syllable structure

Complexity Category: Complex Canonical syllable structure: C(C)(C)V(C) (Plaisier 2007: 30-32) Size of maximum onset: 3 Size of maximum coda: 1 Onset obligatory: Yes Coda obligatory: No Vocalic nucleus patterns: Short vowels Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: Tautomorphemic (Onset) Morphological pattern of syllabic consonants: N/A Onset restrictions: All consonants occur in simple onsets. Biconsonantal onsets have /j r l/ as C<sub>2</sub>. Triconsonantal onsets have /k g p b f m l t<sup>h</sup>/ as C<sub>1</sub>, /r l/ as C<sub>2</sub>, and /j/ as C<sub>3</sub>. Coda restrictions: Limited to /p t k m n ŋ r l/.

#### Suprasegmentals

Tone: Yes Word stress: Yes Stress placement: Weight-Sensitive Phonetic processes conditioned by stress: (None) Differences in phonological properties of stressed and unstressed syllables: Not described Phonetic correlates of stress: Vowel duration (impressionistic), Intensity (impressionistic) Notes: Duration a correlate of stress in open syllables. Pitch seems to be correlate not of stress but weak tonal system.

#### **Vowel reduction processes**

(none reported)

# [lep] LEPCHA Sino-Tibetan, Lepcha (Bhutan, India, Nepal) (cont.)

### **Consonant allophony processes**

**lep-C1:** A voiceless alveolar fricative is realized as palato-alveolar preceding a high front vowel. (Plaisier 2007: 27)

**lep-C2:** Velar stops are realized as palatalized preceding a front vowel. (Plaisier 2007: 21)

lep-C3: An alveolar trill varies (apparently?) freely with a flap. (Plaisier 2007: 28)

# **Morphology**

**Text:** "The story of the jackal" (Plaisier 2007: 165-168) **Synthetic index:** 1.7 morphemes/word (249 morphemes, 144 words) [lez] LEZGIAN Nakh-Daghestanian, Lezgic (Azerbaijan, Russia)

References consulted: Chitoran & Babaliyeva (2007), Haspelmath (1993), Kodzasov (1990), Yu (2004)

# Sound inventory

C phoneme inventory: /p p<sup>h</sup> b t t<sup>h</sup> d t<sup>w</sup> t<sup>wh</sup> k k<sup>h</sup> g k<sup>w</sup> k<sup>wh</sup> q<sup>w</sup> q q<sup>h</sup> q<sup>w</sup> q<sup>wh</sup> ? p' t' t'<sup>w</sup> k' k'<sup>w</sup> q' q'<sup>w</sup> ts ts<sup>h</sup>  $\widehat{ts^w} \widehat{ts^{wh}} \widehat{tf} \widehat{tf^h} \widehat{ts'} \widehat{ts'^w} \widehat{tf'} f s z s^w z^w \int \Im x \chi u \chi^w u^w h m n l r j w/$ N consonant phonemes: 54 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Labiodental, Dental, Palato-alveolar, Velar, Uvular, Glottal Manners: Stop, Affricate, Fricative, Nasal, Trill, Central approximant, Lateral approximant N elaborations: 7 Elaborations: Voiced fricatives/affricates, Post-aspiration, Ejective, Labiodental, Palato-alveolar, Uvular, Labialization V phoneme inventory: /i y e æ a u æ: a:/ N vowel qualities: 6 Diphthongs or vowel sequences: None Contrastive length: Some Contrastive nasalization: None Other contrasts: N/A **Notes:** Kodzasov has  $\beta$  instead of w. /æ: a:/ are rather marginally contrastive with other vowels. Some dialects have /ɯ/.

#### Syllable structure

**Complexity Category:** Highly Complex Canonical syllable structure: (C)(C)(C)(C)(C) (Haspelmath 1993: 40-46) Size of maximum onset: 3 Size of maximum coda: 2 **Onset obligatory: No** Coda obligatory: No Vocalic nucleus patterns: Short vowels Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: Tautomorphemic (Onset, Coda) Morphological pattern of syllabic consonants: N/A Onset restrictions: Biconsonantal onsets include sequences of voiceless obstruents or voiceless obstruent+sonorant. Triconsonantal onsets consist of three voiceless obstruents or two voiceless obstruents and an /r/ or /l/, include /krtj, t<sup>hw</sup>rp, jtk, kk'l tjxr kst ktk/. Coda restrictions: Biconsonantal codas have no restrictions, include /rd, st, mp, xt, lt, rk/. Notes: Syllable structure has undergone changes recently and used to be canonically (C)V (Haspelmath 1993: 46). <u>Suprasegmentals</u>

Tone: No Word stress: Yes Stress placement: Morphologically or Lexically Conditioned Phonetic processes conditioned by stress: Vowel Reduction Differences in phonological properties of stressed and unstressed syllables: Not described Phonetic correlates of stress: Vowel duration (instrumental)

# [lez] LEZGIAN Nakh-Daghestanian, *Lezgic* (Azerbaijan, Russia) (cont.)

#### **Vowel reduction processes**

**lez-R1:** High vowels /i y u/ are devoiced and shortened, or deleted when occurring pre-tonically between voiceless obstruents, if both are not fricatives. Process occurs even if there is an intervening /r/ before the second obstruent (Haspelmath 1993: 36-40; Chitoran & Babaliyeva 2007).

**lez-R2:** High vowels /i y u/ are optionally devoiced and shortened, or deleted when occurring between an obstruent and a sonorant followed by a stressed vowel (Haspelmath 1993: 36-40; Chitoran & Babaliyeva 2007).

**lez-R3:** Mid front vowel /e/ is produced with higher quality in pre-stress syllables, especially when followed by /i/ in the next syllable (Haspelmath 1993: 32).

# **Consonant allophony processes**

**lez-C1:** A labiovelar approximant varies freely with a labial fricative variant. (Haspelmath 1993) **lez-C2:** An alveolar lateral approximant is velarized syllable-finally following a back vowel. (Haspelmath 1993)

#### **Morphology**

**Text:** "Who is stealing the melons?", "The magpie and the wolf" (Haspelmath 1993: 448-456) **Synthetic index:** 1.7 morphemes/word (249 morphemes, 144 words)

[lkt] LAKHOTA Siouan, Core Siouan (United States)

**References consulted:** Ingham (2003), Lakota Language Consortium (2008), Mirzayan (2010), Rood & Taylor (1996)

#### Sound inventory

C phoneme inventory:  $p p^h b t t^h k k^h$ ? p' t' k' tî tî<sup>h</sup> tî' s z ( 3 x y h m n l w j/ N consonant phonemes: 26 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Alveolar, Palato-alveolar, Velar, Glottal Manners: Stop, Affricate, Fricative, Nasal, Central approximant, Lateral approximant N elaborations: 4 Elaborations: Voiced fricatives/affricates, Post-aspiration, Ejective, Palato-alveolar V phoneme inventory: /i e a o u ĩ ã ũ/ N vowel qualities: 5 Diphthongs or vowel sequences: None Contrastive length: None **Contrastive nasalization:** Some Other contrasts: N/A Notes: Rood & Taylor call /x y/ velar; Mirzayan call these post-velar. /b/ has limited distribution but is unpredictable in some words. Nasal contrast of /i a u/. Only diphthong, /au/, used solely by men in greeting hau.

#### Syllable structure

**Complexity Category:** Complex Canonical syllable structure: (C)(C)V(C) (Taylor & Rood 1996: 446-7, Mirzayan 2010: 39, Ingaham 2003:5) Size of maximum onset: 2 Size of maximum coda: 1 **Onset obligatory:** No Coda obligatory: No Vocalic nucleus patterns: Short vowels, Diphthongs, Vowel sequences Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: Tautomorphemic (Onset) Morphological pattern of syllabic consonants: N/A **Onset restrictions:** Apparently any consonant may function as simple onset. Biconsonatal onsets include sequences of two plosives, plosive+fricative, fricative+plosive, obstruent+voiced continuant sequences, and sequences of two voiced continuants. **Coda restrictions:** Limited to  $/s \int h l b g / word-internally, and <math>/n m / word-finally$ . Notes: Syllabification usually follows morpheme boundaries

# Suprasegmentals

Tone: No

Word stress: Yes

Stress placement: Fixed

Phonetic processes conditioned by stress: Vowel Reduction

Differences in phonological properties of stressed and unstressed syllables: (None)

**Phonetic correlates of stress:** Vowel duration (instrumental), Pitch (impressionistic), Intensity (impressionistic)

**Notes:** Duration is a significant correlate in certain segmental contexts. Intensity reported by Ullrich et al ('greater loudness'), but not instrumentally confirmed.

# [lkt] LAKHOTA Siouan, Core Siouan (United States) (cont.)

#### **Vowel reduction processes**

**lkt-R1:** In rapid speech any unstressed word-final vowel may be dropped. This process is very frequent but more common in certain morphosyntactic constructions (Mirzayan 2010: 155-6, Taylor & Rood 1996: 447).

# **Consonant allophony processes**

**lez-C1:** A labiovelar approximant varies freely with a labial fricative variant. (Haspelmath 1993) **lez-C2:** An alveolar lateral approximant is velarized syllable-finally following a back vowel. (Haspelmath 1993)

# **Morphology**

**Text:** "Hunting eggs in the spring" (Ingham 2003: 95-96) **Synthetic index:** 1.3 morphemes/word (282 morphemes, 215 words) [lpa] LELEPA Austronesian, Oceanic (Vanuatu)

**References consulted:** Lacrampe (2014)

# Sound inventory

C phoneme inventory: /kp<sup>w</sup> p t k f s mm n n l r w j/ N consonant phonemes: 14 Geminates: N/A Voicing contrasts: None Places: Labial-velar, Bilabial, Labiodental, Alveolar, Velar Manners: Stop, Fricative, Nasal, Trill, Central approximant, Lateral approximant N elaborations: 2 Elaborations: Labiodental, Labialization V phoneme inventory: /i e a o u a:/ N vowel qualities: 5 Diphthongs or vowel sequences: Diphthongs /ej aj aw ow/ Contrastive length: Some Contrastive nasalization: None Other contrasts: N/A Notes: Length distinction for /a/ only.

#### Syllable structure

Complexity Category: Complex Canonical syllable structure: (C)(C)(C)V(C)(C) (Lacrampe 2014: 41-8) Size of maximum onset: 3 Size of maximum coda: 2 Onset obligatory: No Coda obligatory: No Vocalic nucleus patterns: Short vowels, Long vowels, Diphthongs Syllabic consonant patterns: Nasal, Liquid Size of maximum word-marginal sequences with syllabic obstruents: N/A

Predictability of syllabic consonants: Predictable from word/consonantal context Morphological constituency of maximum syllable margin: Tautomorphemic (Onset, Coda) Morphological pattern of syllabic consonants: Lexical items

**Onset restrictions:** All consonants may occur in simple onsets. In biconsonantal onsets,  $C_1$  is a plosive, nasal, or fricative and  $C_2$  is usually a liquid but an also be a fricative, stop, or glide. Triconsonantal onsets are /fsr, psr/).

**Coda restrictions:** Any consonant may occur in simple codas. The specific patterns for biconsonantal codas are unclear, but they include /lf, rk, ŋs nt ŋk lp/ and appear to be limited to sonorant+obstruent. **Notes:** Syllable structure is in process of becoming more complex in this language, with rampant vowel reduction producing many codas and clusters, though many clusters are also invariant.

#### **Suprasegmentals**

Tone: No Word stress: Yes Stress placement: Fixed Phonetic processes conditioned by stress: Vowel Reduction Differences in phonological properties of stressed and unstressed syllables: (None) Phonetic correlates of stress: Vowel duration (impressionistic), Pitch (impressionistic), Intensity (impressionistic)

Notes: These correlates of stress do not necessarily co-occur; length especially is reduced in rapid speech.

#### [lpa] LELEPA Austronesian, Oceanic (Vanuatu) (cont.)

# **Vowel reduction processes**

**Ipa-R1:** Mid front vowel /e/ is optionally reduced to [ə] when occurring in open unstressed syllables (Lacrampe 2014: 34).

**lpa-R2:** Low central vowel /a/ is reduced to [v] in unstressed syllables (Lacrampe 2014: 34-5). **lpa-R3**: After a consonant, word-final high vowels /i u/ and mid back vowel /o/ may be deleted or devoiced (Lacrampe 2014: 15, 64-5).

**lpa-R4:** After a consonant, word-final mid front vowel /e/ and low vowel /a/ are reduced in quality, devoiced, or deleted (Lacrampe 2014: 15, 64-5).

**lpa-R5:** A vowel filling the nucleus of a syllable preceding the syllable receiving primary stress is reduced in quality, when the word is three syllables or fewer and the stressed syllable has an onset (Lacrampe 2014: 66; process does not occur if it produces an unattested consonant cluster).

**Ipa-R6:** A vowel filling the nucleus of a syllable preceding the syllable receiving primary stress is deleted, when the word is four or more syllables, the stressed syllable is CV, and the reduced syllable is CV or V (Lacrampe 2014: 66-7; process does not occur if it produces an unattested consonant cluster). **Notes:** Processes R3-R6 are said to be more common in the speech of younger speakers.

#### **Consonant allophony processes**

**lpa-C1:** A voiceless velar stop is realized as uvular following a back vowel or /a/. (Lacrampe 2014: 19) **lpa-C2:** Stops and fricatives are optionally voiced intervocalically. (Lacrampe 2014: 17) **lpa-C3:** A voiceless velar fricative may be spirantized following a back vowel or /a/. (Lacrampe 2014: 20)

# <u>Morphology</u>

**Text:** "Text 1" (Lacrampe 2014: 495-500) **Synthetic index:** 1.4 morphemes/word (586 morphemes, 406 words) [lun] LUNDA

Niger-Congo, Bantoid (Democratic Republic of Congo)

References consulted: Kawasha (2003)

#### Sound inventory

C phoneme inventory: /p b t d k g  $\widehat{t} \int d\widehat{z} f v s z \int (z h m n n n n l w j/z)$ N consonant phonemes: 22 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Labiodental, Alveolar, Palato-alveolar, Velar, Glottal Manners: Stop, Affricate, Fricative, Nasal, Central approximant, Lateral approximant N elaborations: 3 Elaborations: Voiced fricatives/affricates, Labiodental, Palato-alveolar V phoneme inventory: /i e a o u i z e z a z o z u z/ N vowel qualities: 5 Diphthongs or vowel sequences: None Contrastive length: All Contrastive nasalization: None Other contrasts: N/A Notes: Reasoning for not considering nasal+C sequences to be prenasalized stops given (2003: 24). Vowel length contrastive in just a few cases.

#### Syllable structure

Complexity Category: Complex Canonical syllable structure: (C)(C)(C)V (Kawasha 2003: 20-21) Size of maximum onset: 3 Size of maximum coda: N/A Onset obligatory: No Coda obligatory: N/A Vocalic nucleus patterns: Short vowels, Long vowels Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: Both patterns (Onset) Morphological pattern of syllabic consonants: N/A

**Onset restrictions:** Simple onsets are apparently unrestricted. In biconsonantal onsets, any non-glide consonant may occur as  $C_1$  if followed by a bilabial glide /w/ as  $C_2$ . Nasal + consonant sequences also occur as biconsonantal onsets. Triconsonantal onsets have a nasal as  $C_1$ , any non-nasal, non-glide consonant as  $C_2$ , and a glide (bilabial) as  $C_3$ .

**Notes:** Kawasha discusses onset restrictions in terms of glides, of which there are two (/w j/) in the language, but in examples only /w/ occurs in clusters.

<u>Suprasegmentals</u> Tone: Yes Word stress: Not reported

#### **Vowel reduction processes**

**lun-R1**: A word-final high vowel /i/ is realized as "voiceless and muted" when following semi-vowels /w j/, glottal consonant /h/, or nasal /m/ in continuous speech. Examples show that this is syncope, not devoicing (Kawasha 2003: 37-8).

[lun] LUNDA

# **Consonant allophony processes**

(none reported)

# <u>Morphology</u>

(adequate texts unavailable)

[mcr] MENYA Trans-New Guinea, Angan (Papua New Guinea)

References consulted: Whitehead (1992, 2004)

#### Sound inventory

C phoneme inventory: /p t k q <sup>m</sup>b <sup>n</sup>d <sup>n</sup>g <sup>N</sup>G t  $\int p d t$  h m n n n n n v j/ N consonant phonemes: 17 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Dental, Palato-alveolar, Velar, Uvular, Glottal Manners: Stop, Affricate, Fricative, Nasal, Central approximant N elaborations: 4 Elaborations: Voiced fricatives/affricates, Prenasalization, Palato-alveolar, Uvular V phoneme inventory: /i e  $\Rightarrow$  a o u/ N vowel qualities: 6 Diphthongs or vowel sequences: Vowel sequences /u $\Rightarrow$  io ue u $\Rightarrow$  ua ai uau/ (perhaps more) Contrastive length: None Contrastive nasalization: None Other contrasts: N/A Notes: /q/ most frequent consonant phoneme in this language.

#### Syllable structure

Complexity Category: Highly ComplexCanonical syllable structure: (C)(C)(C)V(C) (Whitehead 2004: 226; SIL OPD)Size of maximum onset: 3Size of maximum coda: 1Onset obligatory: NoCoda obligatory: NoVocalic nucleus patterns: Short vowels, Vowel sequencesSyllabic consonant patterns: NasalSize of maximum word-marginal sequences with syllabic obstruents: N/APredictability of syllabic consonants: Predictable from word/consonantal contextMorphological constituency of maximum syllable margin: Tautomorphemic (Onset)Morphological pattern of syllabic consonants: Both

**Onset restrictions:** No restrictions on simple onsets. Biconsonantal onsets include /tq, pk, pq/, at least, with suggestions of nasals occurring as well (2004: 9). Triconsonantal onsets include /tpq, ptq/ (/q/ typically produced as  $[\mu]$  or  $[\gamma]$  after a plosive in clusters).

#### Coda restrictions: Nasals /m n/ occur.

**Notes:** Non-homorganic consonants are separated by extremely short vocalic segments which are inconsistently produced and represented, "more and more not being written" (Whitehead 2004: 226). Quality seems to be conditioned by vowel harmony and/or surrounding consonants. When three plosives come together, there is a greater likelihood of one vowel being written but inconsistency as to which one (2004: 9).

# Suprasegmentals

Tone: Yes Word stress: Yes Stress placement: Not described Phonetic processes conditioned by stress: (None) Differences in phonological properties of stressed and unstressed syllables: Not described Phonetic correlates of stress: Not described Notes: Tone and stress described as interdependent in language, with tone being phonemic but having low

**Notes:** Tone and stress described as interdependent in language, with tone being phonemic but having lo functional load (Whitehead 2004: 226).

[mcr] MENYA Trans-New Guinea, Angan (Papua New Guinea) (cont.)

### **Vowel reduction processes**

(none reported)

#### **Consonant allophony processes**

**mcr-C1:** A voiceless dental stop is in free variation with a flap and a lateral approximant in intervocalic position. (Whitehead 2004: 9) **mcr-C2:** A voiceless uvular stop varies with voiced uvular or velar fricatives in intervocalic position. (Whitehead 2004: 9)

# **Morphology**

**Text:** "Hunting expedition" (first 20 pages, Whitehead 2004: 238-257) **Synthetic index:** 2.5 morphemes/word (745 morphemes, 301 words) [mdx] DIZIN, CENTRAL Afro-Asiatic, Dizoid (Ethiopia)

References consulted: Allan (1976), Beachy (2005), Breeze (1988)

#### Sound inventory

C phoneme inventory: /p b t d k g p' t' k' ts t  $\hat{f}$  d  $\hat{d}$  ts' t  $\hat{f}$   $\hat{g}$  s z  $\int$  3 h m n ŋ r l w j/ N consonant phonemes: 27 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Alveolar, Palato-alveolar, Velar, Glottal Manners: Stop, Affricate, Fricative, Nasal, Flap/Tap, Central approximant, Lateral approximant N elaborations: 3 Elaborations: Voiced fricatives/affricates, Ejective, Palato-alveolar V phoneme inventory: /i e  $\varepsilon i \alpha$  o u i: e:  $\alpha$ : o: u:/ N vowel qualities: 7 Diphthongs or vowel sequences: None Contrastive length: Some Contrastive nasalization: None Other contrasts: N/A

**Notes:** /?/ is posited to avoid underlying syllabic nasals, otherwise its occurrence is completely predictable. I do not include it.  $\langle fg \ fg' \ g \ z/$  occur only in Western Dizin (Beach 2005). Allan gives 24 consonant phonemes, lists an inventory that is quite divergent from Beachy, Breeze.

#### Syllable structure

Complexity Category: Complex Canonical syllable structure: (C)V(C)(C)(C) (Beachy 2005: 38-46) Size of maximum onset: 1 Size of maximum coda: 3 Onset obligatory: No Coda obligatory: No Vocalic nucleus patterns: Short vowels, Long vowels Syllabic consonant patterns: Nasal Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: Phonemic Morphological constituency of maximum syllable margin: Tautomorphemic (Coda)

Morphological pattern of syllabic consonants: Both

**Onset restrictions:** All consonants except /p/ may occur (though /p/ occurs as onset in loanwords). **Coda restrictions:** For simple codas, all consonants except /?, k',  $d_3$ / may occur. Biconsonantal coda combinations are fairly free, though not all possible combinations occur and most follow a rising sonority contour according to a standard six-point hierarchy. In tri-consonantal codas, C<sub>1</sub> is /j/, C<sub>2</sub> is /n/, and C<sub>3</sub> is /t, d, s,  $\int$ /.

**Notes:** Syllabic nasal nuclei occur only in syllables with predictable obligatory onset of [?] and optional coda of /t/ (Beachy 2005: 41).

#### **Suprasegmentals**

Tone: Yes Word stress: Yes

Stress placement: Fixed

Phonetic processes conditioned by stress: Vowel Reduction

**Differences in phonological properties of stressed and unstressed syllables:** Not described **Phonetic correlates of stress:** Not described

[mdx] DIZIN, CENTRAL Afro-Asiatic, *Dizoid* (Ethiopia) (cont.)

# **Vowel reduction processes**

**mdx-R1:** Short high vowels /i u/ are sometimes realized as voiceless when word-final (Beachy 2005: 35-6).

**mdx-R2:** The phoneme  $\epsilon$  is optionally realized as [ə], but no conditioning environment given (Beachy 2005: 37).

#### **Consonant allophony processes**

**mdx-C1:** A voiceless alveolar fricative is realized as voiced preceding /d/. (Beachy 2005: 26) **mdx-C2:** Voiced bilabial and velar stops are realized as fricatives word-finally. (Beachy 2005: 17) **mdx-C3:** A voiceless bilabial stop varies with a bilabial fricative and a labiodental fricative word-internally and word-finally. (Beachy 2005: 17)

#### **Morphology**

**Text:** "A lion and a fox" (Beachy 2005: 154-158) **Synthetic index:** 1.9 morphemes/word (485 morphemes, 251 words) [mio] PINOTEPA MIXTEC Oto-Manguean, *Mixtecan* (Mexico)

References consulted: Bradley (1971), Costello (2014)

#### Sound inventory

C phoneme inventory: /p t t<sup>j</sup> k k<sup>w</sup> ? <sup>m</sup>b <sup>n</sup>d <sup>n</sup>d<sup>j</sup> <sup>n</sup>g t s f m n n l r w j/ N consonant phonemes: 20 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Dental, Alveolar, Palato-alveolar, Velar, Glottal Manners: Stop, Affricate, Fricative, Nasal, Flap/Tap, Central approximant, Lateral approximant N elaborations: 4 Elaborations: Prenasalization, Palato-alveolar, Palatalization, Labialization V phoneme inventory: /i e a o u ĩ ẽ ã õ ũ ị e a o u ĩ ẽ ã õ ũ/ N vowel qualities: 5 Diphthongs or vowel sequences: None **Contrastive length:** None Contrastive nasalization: All Other contrasts: Glottalization (All) **Notes:** Author calls /?/ a 'semiconsonant'.  $/\phi s^{j}$  occur only in Spanish loans. /x/ occurs in diminutive speech style.

#### Syllable structure

Complexity Category: Simple Canonical syllable structure: (C)V (Bradley 1970: 14) Size of maximum onset: 1 Size of maximum coda: N/A Onset obligatory: No Coda obligatory: N/A Vocalic nucleus patterns: Short vowels Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: N/A Morphological pattern of syllabic consonants: N/A

Onset restrictions: All consonants occur.

**Notes:** Bradley describes glottal stop as a semiconsonant which may attach to a vowel to form a complex nucleus and thus a 'checked' syllable (1970: 14). Costello analyzes syllable template as (C)V(C) with glottal stop as the only acceptable coda (2014: 24-5). Both authors note that checked syllables/glottal codas occur only in stressed/tonic syllables. Since the glottal stop has a very limited distribution and does not behave like a prototypical coda, I consider this language to have Simple syllable structure. The analysis of the glottal stop as a laryngeal feature of the syllable has been proposed for other Mixtecan languages as well (e.g., Juchitán Zapotec, Marlett & Pickett 1987).

#### **Suprasegmentals**

Tone: Yes

Word stress: Yes

Stress placement: Fixed

**Phonetic processes conditioned by stress:** Vowel Reduction, Consonant Allophony in Unstressed Syllables, Consonant Allophony in Stressed Syllables

**Differences in phonological properties of stressed and unstressed syllables:** Not described **Phonetic correlates of stress:** Vowel duration (impressionistic), Intensity (impressionistic)

# [mdx] DIZIN, CENTRAL Afro-Asiatic, *Dizoid* (Ethiopia) (cont.)

#### **Vowel reduction processes**

**mio-R1:** A final unstressed vowel decays at the end of a terminal contour, following a pause (Bradley 1970: 13).

# **Consonant allophony processes**

**mio-C1:** Prenasalized dental stop may be realized as palato-alveolar in a post-tonic syllable immediately following the tonic syllable. (Bradley 1970: 6) **mio-C2:** Labiovelar and palatal glides are fricated in tonic syllables. (Bradley 1970: 8) **mio-C3:**  $/t\int k k^w$ / may be realized as voiced in post-tonic syllables. (Bradley 1970: 5)

**mio-C4:**  $/k^{w}/$  is occasionally voiced in pretonic syllables. (Bradley 1970: 5)

# **Morphology**

(adequate texts unavailable)

[mjg] MANGGHUER Altaic, Mongolic (China)

**References consulted:** Slater (2003)

#### Sound inventory

C phoneme inventory:  $/p^h p t^h t k^h k q^h q ts^h ts tc^h tc ts^h ts fs c s \chi m n n l t w j/$ N consonant phonemes: 26Geminates: N/AVoicing contrasts: NonePlaces: Bilabial, Labiodental, Alveolar, Retroflex, Alveolo-palatal, Velar, UvularManners: Stop, Affricate, Fricative, Nasal, Central approximant, Lateral approximantN elaborations: 4Elaborations: Post-aspiration, Labiodental, Retroflex, UvularV phoneme inventory: /i e a o u/N vowel qualities: 5Diphthongs or vowel sequences: NoneContrastive length: NoneContrastive nasalization: NoneOther contrasts: N/A $Notes: /tc^h tc c/ are described as being post-alveolar most often, but symbols indicate alveolo-palatal.$ 

Absence of contrastive vowel length is unusual for a Mongolic language.

#### Syllable structure

Complexity Category: Moderately Complex Canonical syllable structure: (C)(C)V(C) (Slater 2003: 54-72) Size of maximum coda: 1 Onset obligatory: No Coda obligatory: No Vocalic nucleus patterns: Short vowels Syllabic consonant patterns: Liquid Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: Phonemic Morphological constituency of maximum syllable margin: Tautomorphemic (Onset) Morphological pattern of syllabic consonants: Lexical items Onset restrictions: C<sub>1</sub> may be any consonant except /ŋ/, but may not be identical to C<sub>2</sub>. C<sub>2</sub> must be glide /j/ or /w/. Coda restrictions: Restricted to /J ŋ n j w/.

#### **Suprasegmentals**

Tone: No

Word stress: Yes

Stress placement: Fixed

**Phonetic processes conditioned by stress:** Vowel Reduction, Consonant Allophony in Unstressed Syllables, Consonant Allophony in Stressed Syllables

Differences in phonological properties of stressed and unstressed syllables: (None)

Phonetic correlates of stress: Pitch (impressionistic), Intensity (impressionistic)

**Notes:** Different outcomes for /i/ and /e/. /i/ generally realized as somewhat central, but may move towards quality [i], especially in stressed syllables. /e/ is  $[\varepsilon]$ ~ $[\partial]$  in most contexts, but  $[\partial]$  generally appears in stressed syllables without onset clusters or codas. I'm not coding this as vowel reduction because it seems there is free variation even within stressed syllables.

[mjg]	MANGGHUER	Altaic, Mongolic (China)	(cont.)
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#### **Vowel reduction processes**

**mjg-R1:** High vowels /i u/ realized as lax in unstressed syllables (Slater 2003:35). **mjg-R2:** High vowels /i u/ and mid front vowel /e/ are often devoiced following a voiceless consonant. This typically occurs in medial unstressed syllables and is most regular following a voiceless fricative (Slater 2003: 36).

# **Consonant allophony processes**

**mjg-C1:** A palatal glide is realized as a fricative in the onset of a stressed syllable. (Slater 2003: 31-2) **mjg-C2:** A retroflex approximant is realized as fricative [**z**] in the onset of a stressed syllable. (Slater 2003: 30)

**mjg-C3:** A retroflex approximant is realized as an alveolar flap intervocalically before an unstressed vowel. (Slater 2003: 31)

# **Morphology**

Text: "Rabbit's trick" (Slater 2003: 343-350) Synthetic index: 1.5 morphemes/word (547 morphemes, 377 words) [mji] KIM MUN (VIETNAM DIALECT) Hmong-Mien, Hmong-Mien (Vietnam)

**References consulted:** Clark (2008)

# Sound inventory

C phoneme inventory: /p b t d c j k g f v θ s h m n ŋ ŋ l ʎ w j/ N consonant phonemes: 21 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Labiodental, Dental, Alveolar, Palatal, Velar, Glottal Manners: Stop, Fricative, Nasal, Central approximant, Lateral approximant N elaborations: 2 Elaborations: Voiced fricatives/affricates, Labiodental V phoneme inventory: /i e ε e a ɔ o u a:/ N vowel qualities: 8 Diphthongs or vowel sequences: None Contrastive length: Some Contrastive nasalization: None Other contrasts: N/A Notes: Length contrastive for /a/ only.

Syllable structure

Complexity Category: Moderately Complex Canonical syllable structure: (C)(C)V(C) (Clark 2008: 123-7) Size of maximum onset: 2 Size of maximum coda: 1 Onset obligatory: No Coda obligatory: No Vocalic nucleus patterns: Short vowels, Long vowels Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: Tautomorphemic (Onset) Morphological pattern of syllabic consonants: N/A

**Onset restrictions:** Simple onsets unrestricted. For complex onsets,  $C_1$  must be /p b t k g/, and  $C_2$  must be /l w j/.

**Coda restrictions:** Restricted to nasals, glides, and /p t/. **Notes:** It is possible Vietnam Kim Mun is in the process of losing onset clusters, as vowel epenthesis sometimes occurs in /kl/ sequences (Clark 2008: 127).

#### **Suprasegmentals**

Tone: Yes Word stress: Not reported

#### **Vowel reduction processes**

**mji-R1:** Long vowels are shortened and produced with level tone in non-word-final syllables (Clark 2008: 117).

# **Consonant allophony processes**

(none reported)

Morphology (adequate texts unavailable) [moh] MOHAWK

References consulted: Bonvillain (1973), Michelson (1981, 1988)

#### Sound inventory

C phoneme inventory: /t k ?  $d_3$  s h n l j w/ N consonant phonemes: 10 Geminates: N/A Voicing contrasts: None Places: Alveolar, Palato-alveolar, Velar, Glottal Manners: Stop, Affricate, Fricative, Nasal, Central approximant, Lateral approximant N elaborations: 2 Elaborations: Voiced fricatives/affricates, Palato-alveolar V phoneme inventory: /i I e  $\tilde{\Lambda}$  a o  $\tilde{u}$ / N vowel qualities: 7 Diphthongs or vowel sequences: None Contrastive length: None **Contrastive nasalization:** None Other contrasts: xxxx **Notes:**  $/\Lambda u/$  are nasalized. Peripheral phonemic vowel /I/ occurs in two basic words (Bonvillain 1973: 43). Bonvillain states vowel length is predictable.

#### Syllable structure

Complexity Category: Highly Complex Canonical syllable structure: (C)(C)(C)(C)(C)(C)(C)(C) (Bonvillain 1973: 21-23; Michelson 1981, 1988: 12) Size of maximum onset: 4 Size of maximum coda: 3 Onset obligatory: No Coda obligatory: No Vocalic nucleus patterns: Short vowels, Vowel sequences Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: Heteromorphemic (Onset, Coda) Morphological pattern of syllabic consonants: N/A Onset restrictions: All consonants may occur in simple onsets. Biconsonantal onsets are /nj tj kj kw ts ks

st kt sk tk sh th kh/. Triconsonantal onsets always have /j s w h/ as a member, e.g. /tsj, ksk, kts, shw, shr, khn/. Four-consonant onsets are /shnj khnj/.

**Coda restrictions:** All consonants except  $/d_3/$  may occur in simple codas. Biconsonantal codas include /ks ?s ts/. Triconsonantal codas are rare and highly restricted, include /?ks ?ts kst/.

**Notes:** Michelson writes that vowel epenthesis predictably breaks up triconsonantal onsets (1981), but lists many surface word-initial onsets in 1988 (p. 12).

# **Suprasegmentals**

Tone: Yes Word stress: Yes Stress placement: Fixed Phonetic processes conditioned by stress: (None) Differences in phonological properties of stressed and unstressed syllables: (None) Phonetic correlates of stress: Pitch (impressionistic) Notes: Some co-occurrence of length with stress: all long vowels stressed, but not all stressed vowels long; lengthening is thus dependent on accent. [moh] MOHAWK Iroquoian, Northern Iroquoian (Canada, United States) (cont.)

# **Vowel reduction processes**

**moh-R1:** The length of a long vowel may be somewhat diminished in keeping with phrasal and sentence contours (Bonvillain 1973: 46).

#### **Consonant allophony processes**

**moh-C1:** A voiceless alveolar fricative is realized as palato-alveolar preceding /i/, by some speakers. (Bonvillain 1973: 31)

**moh-C2:** A labiovelar glide is realized as a labiodental fricative preceding /h/. (Bonvillain 1973: 34)

**moh-C3:** A voiceless alveolar fricative is realized as voiced intervocalically. (Bonvillain 1973) **moh-C4:** A voiceless alveolar fricative is realized as voiced word-initially preceding a vowel. (Bonvillain 1973)

**moh-C5:** Voiceless stops /t k/ are realized as voiced preceding a vowel with an optional intervening glide. (Bonvillain 1973: 28)

# **Morphology**

(adequate texts unavailable)

[mpc] MANGARRAYI

References consulted: Merlan (1989)

#### Sound inventory

C phoneme inventory: /b d d j g ? m n η ŋ ŋ l l J J w j/ N consonant phonemes: 17 Geminates: N/A Voicing contrasts: None Places: Bilabial, Alveolar, Retroflex, Palatal, Velar, Glottal Manners: Stop, Nasal, Central approximant, Lateral approximant N elaborations: 1 Elaborations: Retroflex V phoneme inventory: /i e a o u/ N vowel qualities: 5 Diphthongs or vowel sequences: None Contrastive length: None Contrastive nasalization: None Other contrasts: N/A Notes: Voiced stop symbols used for single stop series.

Syllable structure

**Complexity Category:** Complex **Canonical syllable structure:** CV(C)(C) (Merlan 1989: 186-96) Size of maximum onset: 1 Size of maximum coda: 2 **Onset obligatory: Yes** Coda obligatory: No Vocalic nucleus patterns: Short vowels Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: Both patterns (Coda) Morphological pattern of syllabic consonants: N/A **Onset restrictions:** All consonants except for rhotics /1 J/ may occur. Coda restrictions: Any consonant may occur as simple coda. Biconsonantal codas consist of a non-nasal sonorant /1 ] J J/ followed by a stop or nasal, or nasal followed by glottal stop (e.g. /ŋ?/, p. 182). Notes: V syllables result from the reduction of irrealis prefix forms wa- and ja- to a- (p. 196).

# Suprasegmentals

Tone: No Word stress: Yes Stress placement: Fixed Phonetic processes conditioned by stress: (None) Differences in phonological properties of stressed and unstressed syllables: (None) Phonetic correlates of stress: Pitch (impressionistic), Intensity (impressionistic)

Vowel reduction processes (none reported)

# [mpc] MANGARRAYI Mangarrayi-Maran, Mangarrayi (Australia)

(cont.)

# **Consonant allophony processes**

**mpi-C1:** Velar stops are realized as palato-alveolar affricates preceding /i/. (Allison 2012)

# <u>Morphology</u>

(adequate texts unavailable)

[mpi] KOTOKO, MAKARY Afro-Asiatic, *Biu-Mandara* (Central African Republic)

References consulted: Allison (2012), Mahamat (2005)

#### Sound inventory

**C** phoneme inventory: /p b t d k g <sup>m</sup>b <sup>n</sup>d <sup>n</sup>g b d k' tî dz ts' tî' f s z î h m n r l w j/ N consonant phonemes: 27 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Labiodental, Alveolar, Palato-alveolar, Velar, Glottal Manners: Stop, Affricate, Fricative, Nasal, Flap/Tap, Central approximant, Lateral approximant N elaborations: 6 Elaborations: Voiced fricatives/affricates, Prenasalization, Ejective, Implosive, Labiodental, Palatoalveolar V phoneme inventory: /i e i a o u/ N vowel qualities: 6 Diphthongs or vowel sequences: None Contrastive length: None **Contrastive nasalization:** None Other contrasts: N/A Notes: Mahamat (2005) does not give /mb nd ng/. Allison gives reasoning for differences (2012: 17-20).

# Syllable structure

Complexity Category: Complex Canonical syllable structure: (C)(C)(C)V(C) (Allison 2012: 23-24) Size of maximum onset: 3 Size of maximum coda: 1 Onset obligatory: No Coda obligatory: No Vocalic nucleus patterns: Short vowels Syllabic consonant patterns: Nasal Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: Predictable from word/consonantal context Morphological constituency of maximum syllable margin: Tautomorphemic (Onset) Morphological pattern of syllabic consonants: Lexical items Onset restrictions: Apparently no restrictions on simple onsets. In biconsonantal onsets, the most common

**Onset restrictions:** Apparently no restrictions on simple onsets. In biconsonantal onsets, the most common pattern is for  $C_1$  to be a stop or fricative, and  $C_2$  to be /r l w j/. /sk/, /sk'/, and /ft/ onsets also occur. The only triconsonantal onset is /skw/.

Coda restrictions: Only sonorants /m n l r w j/ occur.

#### **Suprasegmentals**

Tone: Yes Word stress: Not reported

#### **Vowel reduction processes**

(none reported)

# Consonant allophony processes

(none reported)

#### **Morphology**

(adequate texts unavailable)

[mri] MAORI Austronesian, Oceanic (New Zealand)

**References consulted:** Bauer (1999)

#### Sound inventory

C phoneme inventory:  $/p t k \phi h m n \eta r w/$ N consonant phonemes: 10 Geminates: N/A Voicing contrasts: None Places: Bilabial, Alveolar, Velar, Glottal Manners: Stop, Fricative, Nasal, Flap/tap, Central approximant N elaborations: 0 Elaborations: N/A V phoneme inventory: /i ɛ a ɔ u aː/ N vowel qualities: 5 Diphthongs or vowel sequences: Vowel sequences /ii ɛɛ ɔɔ uu aɛ ai aɔ au ɔa ɔɛ ɔi ɔɔ ɔu ɛa ɛi ɛɔ ɛu ua uɛ ui uo ia ie io iu/. Contrastive length: Some **Contrastive nasalization:** None Other contrasts: N/A **Notes:**  $|\phi|$  is variable in realization, was likely |f| in pat.

#### Syllable structure

Complexity Category: Simple Canonical syllable structure: (C)V (Bauer 1993: 533-8) Size of maximum onset: 1 Size of maximum coda: N/A Onset obligatory: No Coda obligatory: N/A Vocalic nucleus patterns: Short vowels, Long vowels, Diphthongs Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: N/A Morphological pattern of syllabic consonants: N/A

# Suprasegmentals Tone: No Word stress: Yes Stress placement: Morphologically or Lexically Conditioned Phonetic processes conditioned by stress: Consonant Allophony in Unstressed Syllables, Consonant Allophony in Stressed Syllables Differences in phonological properties of stressed and unstressed syllables: (None) Phonetic correlates of stress: Vowel duration (impressionistic), Pitch (impressionistic), Intensity (impressionistic) Notes: Intensity is optionally a correlate of stress. Pitch here is a pitch fall. Secondary stress marked only by length.

#### **Vowel reduction processes**

mri-R1: The final vowel of words spoken in isolation is frequently devoiced (Bauer 1999: 546).

# [mri] MAORI Austronesian, Oceanic (New Zealand) (cont.)

# **Consonant allophony processes**

**mri-C1:** Stops may vary freely with affricates in stressed syllables. (Bauer 1999: 545) **mri-C2:** A voiceless alveolar stop may be affricated preceding an unstressed, devoiced vowel; sometimes this process involves palatalization of the stop too. (Bauer 1999) **mri-C3:** In stressed syllables, /w/ may be produced with closer approximation. (Bauer 1999: 545)

# **Morphology**

(adequate texts unavailable)

[nak] NAKANAI Austronesian, Oceanic (Papua New Guinea)

References consulted: Johnston (1980)

#### Sound inventory

C phoneme inventory: /p b t d k g β s h m r l/ N consonant phonemes: 12 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Alveolar, Velar, Glottal Manners: Stop, Fricative, Nasal, Trill, Lateral approximant N elaborations: 1 Elaborations: Voiced fricatives/affricates V phoneme inventory: /i e a o u/ N vowel qualities: 5 Diphthongs or vowel sequences: None Contrastive length: None Contrastive nasalization: None Other contrasts: N/A

Syllable structureComplexity Category: SimpleCanonical syllable structure: (C)V (Johnston 1980: 254-6)Size of maximum onset: 1Size of maximum coda: N/AOnset obligatory: NoCoda obligatory: N/AVocalic nucleus patterns: Short vowelsSyllabic consonant patterns: N/ASize of maximum word-marginal sequences with syllabic obstruents: N/APredictability of syllabic consonants: N/AMorphological constituency of maximum syllable margin: N/AMorphological pattern of syllabic consonants: N/AOnset restrictions: All consonants occur.

Suprasegmentals Tone: No Word stress: Yes Stress placement: Fixed Phonetic processes conditioned by stress: Consonant Allophony in Stressed Syllables Differences in phonological properties of stressed and unstressed syllables: (None) Phonetic correlates of stress: Pitch (impressionistic)

#### Vowel reduction processes

**nak-R1:** High front vowel /i/ may be realized as [I] utterance-finally following /s/ and /t/. Sometimes the articulation of [I] in this position is 'so lenis as to be inaudible' (Johnston 1980: 253). **nak-R2:** High back rounded vowel /u/ is not realized utterance-finally following /m/ (Johnston 1980: 254).

#### **Consonant allophony processes**

**nak-C1:** In stressed syllables, [t] varies with affricate [ts] preceding /i/. (Johnston 1980: 252) **nak-C2:** An alveolar trill varies with a flap in all environments. (Johnston 1980: 253)

Morphology Text: "Text 1," "Text 2" (Johnston 1980: 262-266) Synthetic index: 1.2 morphemes/word (498 morphemes, 406 words) [nir] NIMBORAN Nimboran, Nimboran (Indonesia)

References consulted: Anceaux (1965), May & May (1981), May (1997)

#### Sound inventory

C phoneme inventory: /p t k b <sup>m</sup>b d <sup>n</sup>d <sup>n</sup>g s h m n  $\eta$  ] w j/ N consonant phonemes: 16 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Dental, Retroflex, Velar, Glottal Manners: Stop, Fricative, Nasal, Central approximant, Lateral flap N elaborations: 2 Elaborations: Prenasalization, Retroflex V phoneme inventory: /i e u a o u/ N vowel qualities: 6 Diphthongs or vowel sequences: Vowel sequences /ii ee uu ai au ei ao ou/ Contrastive length: None Contrastive nasalization: None Other contrasts: N/A Notes: // is used for retroflexed lateral flap. Prenasalized stops given by May with distributional justification. Extrasystematical phonemes  $\beta$  and x occur in one lexical item each (Anceaux 1965: 9).

Anceaux gives /i/ instead of /u/. Long vowels are analyzed as vowel clusters.

#### Syllable structure

Complexity Category: Complex Canonical syllable structure: (C)(C)(C)V(C) (Anceaux 1965: 31-6; May 1997: 12-19; May & May 1981: 12) Size of maximum onset: 3 Size of maximum coda: 1 Onset obligatory: No Coda obligatory: No Vocalic nucleus patterns: Short vowels, Vowel sequences Syllabic consonant patterns: Obstruent (Conflicting reports) Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: Tautomorphemic (Onset) Morphological pattern of syllabic consonants: N/A

**Onset restrictions:** All consonants may occur as simple onsets. In biconsonantal onsets, all consonants except for /w j/ may occur as  $C_1$ . If  $C_1$  is nasal or stop, then  $C_2$  is /l/, /j/, or /w/. Biconsonantal onsets /nt/, / sp/, /sw/, /sk/, /hm/, /hn/ additionally occur. Triconsonantal onset patterns are limited to /skw/, /skl/, /skj/, / <sup>n</sup>glw/ and /blw/.

**Coda restrictions:** Limited to  $/m n \eta p/$ . For a few speakers, a word-final vowel sequence /ii/may be realized as [ik].

**Notes:** May notes that triconsonantal onsets with /w/ or /j/ as third member could be alternatively interpreted as biconsonantal onsets followed by a vowel sequence starting with /u/ or /i/; however he adopts the former analysis due to syllable peak patterns observed in the language (May 1997: 17-18). May & May note that the initial fricative in /skl/ onsets may be syllabic ([s,kl]), based on speaker reaction to syllable division in words with this cluster (1981: 29); however, reconsideration of the data in May 1997 leads to the triconsonantal analysis.

[nir] NIMBORAN

#### Nimboran, Nimboran (Indonesia) (cont.)

**Suprasegmentals** 

Tone: No

Word stress: Yes

Stress placement: Morphologically or Lexically Conditioned

**Phonetic processes conditioned by stress:** Vowel Reduction, Consonant Allophony in Unstressed Syllables

**Differences in phonological properties of stressed and unstressed syllables:** Not described **Phonetic correlates of stress:** Pitch (impressionistic), Intensity (impressionistic)

**Notes:** Vowel quality correlate for /ʉ/, /a/ may vary in very complex combinations of word, syllable, stress, and vowel contexts.

#### **Vowel reduction processes**

**nir-R1:** High front vowel /i/ is lowered when unaccented and preceding a word-final /n/ (Anceaux 1965: 10).

**nir-R2:** The low central vowel /a/ is in free variation with a higher variant if it precedes a consonant and an accented vowel (Anceaux 1965: 13).

**nir-R3:** Mid back rounded vowel /o/ is realized as higher and unrounded when occurring word-finally and without accent (Anceaux 1965: 14).

#### **Consonant allophony processes**

**nir-C1:** Sequences of alveolar stops, fricative, and nasal and /i/ vary with palatalized variants of the consonants when /i/ is unstressed. (May & May 1981: 18)

**nir-C2:** A voiceless bilabial stop is voiced preceding a voiced consonant. (May 1997: 30) **nir-C3:** A voiceless bilabial stop varies with a fricative syllable-initially. (May & May 1981: 16) **nir-C4:** A voiceless bilabial stop is spirantized intervocalically. (May & May 1981: 16)

#### **Morphology**

**Text:** "Sample text" (May 1997: 172-177) **Synthetic index:** 1.7 morphemes/word (334 morphemes, 198 words)

# [niv] NIVKH, WEST SAKHALIN DIALECTIsolate (Russia)

References consulted: Gruzdeva (1998), Kreinovich (1979), Shiraishi (2006)

#### Sound inventory

C phoneme inventory: /p p<sup>h</sup> t t<sup>h</sup> c c<sup>h</sup> k k<sup>h</sup> q q<sup>h</sup> φ β s z x y χ s h m n n η l r r w j/ N consonant phonemes: 28 Geminates: N/A Voicing contrasts: Obstruents, Sonorants Places: Bilabial, Dental, Palatal, Velar, Uvular, Glottal Manners: Stop, Fricative, Nasal, Trill, Central approximant, Lateral approximant N elaborations: 4 Elaborations: Voiced fricatives/affricates, Devoiced sonorants, Post-aspiration, Uvular V phoneme inventory: /i e i a o u/ N vowel qualities: 6 Diphthongs or vowel sequences: None Contrastive length: None Contrastive nasalization: None Other contrasts: N/A Notes: The uvular/velar distinction is 'nearly allophonic'. Gruzdeva posits a 3-way stop contrast between voiced, voiceless, and aspirated stops. I take Shiraishi's analysis here.

#### Syllable structure

Complexity Category: Complex Canonical syllable structure: (C)(C)V(C)(C)(C) (Shiraishi 2006: 29-30) Size of maximum onset: 2 Size of maximum coda: 3 Onset obligatory: No Coda obligatory: No Vocalic nucleus patterns: Short vowels Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: Both patterns (Onset, Coda) Morphological pattern of syllabic consonants: N/A Onset restrictions: Apparently no restrictions on simple onsets. Biconsonantal onsets may not have plosive or /j/ as C<sub>2</sub>.

**Coda restrictions:** Simple codas apparently unrestricted. Biconsonantal codas include/sk/, /ys/, /wk/, /p $\phi$ /. Examples of triconsonantal codas include /ntq/ and /nt $\chi$ /.

Notes: Gruzdeva (1998, for Amur and E. Sakhalin dialects) also lists /lms/, /lmr/, and /vdr/ codas.

#### **Suprasegmentals**

Tone: No Word stress: Yes Stress placement: Fixed Phonetic processes conditioned by stress: Consonant Allophony in Stressed Syllables Differences in phonological properties of stressed and unstressed syllables: (None) Phonetic correlates of stress: Pitch (impressionistic)

#### **Vowel reduction processes**

(none reported)

**Notes:** in related Amur dialect, stress shift from 2nd to 1st syllable contributed to loss and reduction of vowels and distinct phonological character of this dialect.

# [nir] NIMBORAN Nimboran, Nimboran (Indonesia) (cont.)

# **Consonant allophony processes**

**niv-C1:** A voiceless alveolar trill may be produced with palato-alveolar fricative release or vary with a voiceless palato-alveolar fricative. (Shiraishi 2006: 26)

**niv-C2:** Consonants become palatalized preceding front vowels, especially when stressed. (Shiraishi 2006: 23)

niv-C3: Non-aspirated plosives are realized as voiced following sonorants. (Shiraishi 2006: 25)

# **Morphology**

**Text:** "A frog and a rat" (Gruzdeva 1998: 58-61) **Synthetic index:** 1.7 morphemes/word (408 morphemes, 240 words)
[noo] NUU-CHAH-NULTH Wakashan, Southern Wakashan (Canada)

References consulted: Carlson et al. (2001), Kim (2003), Rose (1981), Stonham (1999)

## Sound inventory

C phoneme inventory: /p t k k<sup>w</sup> q q<sup>w</sup>  $\Gamma$  ? p' t' k' k'<sup>w</sup> ts tf tł ts' tf' tł' s ł f x x<sup>w</sup>  $\chi$   $\chi$ <sup>w</sup> h h m n m' n' j w j' w'/ N consonant phonemes: 35 Geminates: N/A Voicing contrasts: None Places: Bilabial, Alveolar, Palato-alveolar, Velar, Uvular, Pharyngeal, Glottal Manners: Stop, Affricate, Fricative, Nasal, Central approximant, Lateral affricate, Lateral fricative N elaborations: 7 Elaborations: Creaky voice, Lateral release, Ejective, Palato-alveolar, Uvular, Pharyngeal, Labialization V phoneme inventory: /i a u i: a: u:/ N vowel qualities: 3 Diphthongs or vowel sequences: None Contrastive length: All Contrastive nasalization: None Other contrasts: N/A Notes: Stonham reports 39 consonants, including /q' q'<sup>w</sup> h<sup>w</sup> 4<sup>w</sup>/. Davidson has /q' q'<sup>w</sup>/ but Kim shows these have merged with  $\Gamma$  in present language. /o e/ appear phonemically only in loanwords, vocative

constructions, and expressions for speech act.

### Syllable structure

Complexity Category: Highly Complex Canonical syllable structure: CV(C)(C)(C)(C) (Kim 2003: 161-6; Stonham 1999: 47-55) Size of maximum onset: 1 Size of maximum coda: 4 Onset obligatory: Yes Coda obligatory: No Vocalic nucleus patterns: Short vowels, Long vowels Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: Heteromorphemic (Coda) Morphological pattern of syllabic consonants: N/A

Onset restrictions: All consonants may occur as simple onsets.

**Coda restrictions:** Glottal(ized) and pharyngeal consonants do not occur as simple codas. Biconsonantal codas include /tsk, ks, tq, mts/. Triconsonantal codas include /tsftq thts m $\chi$ s p4ts qtfs/. Four-consonant codas are rare; C<sub>1</sub> must be a nasal, or the sequence /qh/ must occur: /mtqf hsqh nkqh thqh/. Sonorants do not follow obstruents in coda clusters, but there seem to be few manner/place restrictions on obstruent sequences.

**Notes:** Kim and Stonham both report canonical CV(C)(C)(C) structure, but Stonham lists a few cases of 4-consonant codas (1999: 48). Sequences of identical consonants occur only across morpheme boundaries.

[noo] NUU-CHAH-NULTH

## **Suprasegmentals**

Tone: No Word stress: Yes Stress placement: Weight-Sensitive Phonetic processes conditioned by stress: Vowel Reduction Differences in phonological properties of stressed and unstressed syllables: (None) Phonetic correlates of stress: Vowel duration (impressionistic), Intensity (impressionistic) Notes: Pitch may vary independently of the correlates of stress.

### Vowel reduction processes

noo-R1: Word-final short vowels are deleted (Rose 1981: 25).

**noo-R2:** Preceding a word-final coda, the rightmost vowel may be deleted if it is in a third or later syllable, is not obligatorily long, and is not already flanked by an consonant clusters. If rightmost vowel doesn't fit these conditions, then the rightmost vowel which is capable of deleting will do so, given it is in third or later syllable (Rose 1981: 25).

**noo-R3**: A vowel two syllables leftward of a deleted vowel is optionally deleted, if it is not in an inflectional suffix and is in a third or later syllable of the word (Rose 1981: 25).

noo-R4: Word-final long vowels are shortened (Rose 1981: 27).

**Notes:** Interaction of processes in noo-R1, noo-R2, and noo-R3 may produce long consonant sequences, but only when fricatives are present between any occurring stops (Rose 1981: 26).

# **Consonant allophony processes**

noo-C1: A consonant is labialized following /u/ and preceding another vowel. (Stonham 1999: 27)

### **Morphology**

**Text:** "What mosquitoes are made of" (Stonham 1999: 133-143) **Synthetic index:** 2.6 morphemes/word (545 morphemes, 212 words) **[ood] TOHONO O'ODHAM** Uto-Aztecan, *Tepiman* (Mexico, United States)

**References consulted:** Dolores & Mathiot (1991), Fitzgerald (1994), Hale (1959), Hill & Zepeda (1992), Saxton (1963, 1982)

#### Sound inventory

C phoneme inventory: /p b t d d k q ? t  $\int dz$  s s h m n n n  $\int \beta j$ N consonant phonemes: 20 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Dental, Retroflex, Palatal, Velar, Glottal Manners: Stop, Affricate, Fricative, Nasal, Central approximant, Lateral flap N elaborations: 3 Elaborations: Voiced fricatives/affricates, Palato-alveolar, Retroflex V phoneme inventory: /i i a o u i: i: a: o: u: i/ N vowel qualities: 5 Diphthongs or vowel sequences: Diphthongs / ii iu io ia ii iu io ia ui ui uo ua oi oi ou oa ai ai au oa/ **Contrastive length:** All Contrastive nasalization: None Other contrasts: Voicing (Some) **Notes:**  $|\vec{l}|$  is a retroflex lateral flap. /o/ is often realized as [5]. 'Extra-short' (voiceless) vowels sometimes represented in the orthography with a breve, but it is unclear whether these are the same vowels predicted by the rules below, or other vowels altogether. Dolores & Mathiot (1991: 236) state that /i/ is phonemic.

### Syllable structure

**Complexity Category:** Highly Complex Canonical syllable structure: C(C)(C)(C)(C)(C)(C)(C)(C) (Saxton 1982: 100-102, Hale 1959: 24-30, Hill & Zepeda 1992) Size of maximum onset: 4 Size of maximum coda: 4 **Onset obligatory:** Yes Coda obligatory: No Vocalic nucleus patterns: Short vowels, Long vowels, Vowel sequences Svllabic consonant patterns: Obstruents Size of maximum word-marginal sequences with syllabic obstruents: N/A (grammatical particles are independent, not phonologically bound to adjacent word) Predictability of syllabic consonants: Unpredictable Morphological constituency of maximum syllable margin: Heteromorphemic (Onset, Coda) Morphological pattern of syllabic consonants: Grammatical Onset restrictions: All consonants may occur as simple onsets. Biconsonantal onsets are varied and governed by several complex patterns, but include all stop+spirant, spirant+unvoiced stop, nasal+homorganic nonnasal sequences, in addition to others, e.g. /sk st bp mp dt dz k ng/. Triconsonantal onsets have complex combination of biconsonantal patterns, include /snk/, 4-consonant onsets also have complex combination of biconsonantal patterns, include /nds2/. Coda restrictions: Biconsonantal codas include /gs dk ms/. Triconsonantal codas include /kpn gsp tpk bstf/. 4-consonant codas include /ftfktf tfspk/.

**Notes:** Saxton gives maximal onset of three consonants; however, Hale gives example of 4-consonant onset. Hale gives specific rules for consonant combinations, but these are difficult to interpret and include medial clusters. Description of phonetic characteristics is for clusters, not vowels that undergo predictable devoicing in certain environments. "Except in the case of a few words that drop an initial /v/ or /h/ [...] there are no words that possess an initial vowel in O'odham" (Dolores & Mathiot 1991: 238).

[ood] TOHONO O'ODHAM

## **Suprasegmentals**

Tone: No Word stress: Yes

Stress placement: Fixed

**Phonetic processes conditioned by stress:** Vowel Reduction, Consonant Allophony in Stressed Syllables **Differences in phonological properties of stressed and unstressed syllables:** Vowel Quality Contrasts, Vowel Length Contrasts

**Phonetic correlates of stress:** Vowel duration (impressionistic), Pitch (impressionistic), Intensity (impressionistic)

Notes: Dolores & Mathiot (1991) report that there is no stress, but others report it does occur.

### **Vowel reduction processes**

**ood-R1:** Unstressed short vowels are devoiced when occurring word-finally (Hale 1959: 17-21). **ood-R2:** Unstressed vowels are devoiced between a vowel or velar consonant and a voiceless consonant (Hale 1959: 17-21).

**ood-R3:** An unstressed vowel following a word-initial CV, at a sentence boundary, is devoiced (Saxton 1982: 103). e.g. sentence-final  $/k\acute{oi}/ > [k\acute{oi}]$ 

**ood-R4:** An unstressed vowel is deleted when flanked by consonants that form a permitted consonant cluster (Saxton 1982: 103).

**ood-R5:** Unstressed vowels are reduced to [a], except for a noncentral vowel following a consonant that is not /t,  $\hat{t}$ /(Saxton 1982: 104).

### **Consonant allophony processes**

(none reported)

### **Morphology**

**Text:** "The coyote and the jackrabbit" (Saxton 1982: 263-266) **Synthetic index:** 1.4 morphemes/word (353 morphemes, 250 words) [opm] OKSAPMIN Oksapmin, Oksapmin (Papua New Guinea)

References consulted: Loughnane (2009)

## Sound inventory

C phoneme inventory: /t k k<sup>w</sup> <sup>m</sup>b <sup>n</sup>d <sup>η</sup>g <sup>η</sup>g<sup>w</sup> φ s x x<sup>w</sup> m n l w j/ N consonant phonemes: 16 Geminates: N/A Voicing contrasts: Obstruent Places: Bilabial, Alveolar, Velar Manners: Stop, Fricative, Nasal, Central approximant, Lateral approximant N elaborations: 2 Elaborations: Prenasalization, Labialization V phoneme inventory: /i e ə a o u/ N vowel qualities: 6 Diphthongs or vowel sequences: None Contrastive length: None Contrastive nasalization: None Other contrasts: N/A Notes: The Lawrences also propose /əi u/ for vowel inventory.

### Syllable structure

Complexity Category: Complex Canonical syllable structure: (C)(C)V(C) (Loughnane 2009: 63-73) Size of maximum onset: 2 Size of maximum coda: 1 Onset obligatory: Yes Coda obligatory: No Vocalic nucleus patterns: Short vowels Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: Both patterns (Onset) Morphological pattern of syllabic consonants: N/A Onset restrictions: Any consonant may occur as a simple onset. In biconsonantal onsets, C<sub>1</sub> may be any

consonant except for a glide /w j/ or labialized stop or fricative / $k^w {}^ng^w x^w$ /, and C<sub>2</sub> may be /j w l x/. /sk/ onsets also occur.

Coda restrictions: All consonants occur except for prenasalized stops.

**Notes:** The biconsonantal onset patterns described above include what Loughnane considers to be 'marginal' clusters: those that are realized for some speakers as clusters and for other speakers with a very short or full schwa vowel between the consonants (Loughnane 2009: 64-5). Since these are regular patterns for some speakers I include them here.

Suprasegmentals Tone: No Word stress: No

Vowel reduction processes

(none reported)

[opm]	OKSAPMIN	Oksapmin, Oksap	omin (Papua New Guinea)	(cont.)
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### **Consonant allophony processes**

**opm-C1:** A voiceless bilabial fricative is realized as a bilabial stop preceding a syllable boundary followed by a consonant. (Loughnane 2009: 33)

opm-C2: A voiceless bilabial fricative is realized as a stop word-finally. (Loughnane 2009: 33)

**opm-C3:** A voiceless velar fricative is realized as voiceless palatal fricative syllable-initially preceding a high front vowel or syllable-finally following a high front vowel. (Loughnane 2009)

**opm-C4:** A voiceless velar fricative is realized as a voiced palatal fricative following /i/ and preceding another vowel. (Loughnane 2009)

opm-C5: Voiceless fricatives are voiced intervocalically. (Loughnane 2009)

## **Morphology**

**Text:** "Echidna, laxjan bird, and bat" (Loughnane 2009: 493-502) **Synthetic index:** 1.7 morphemes/word (843 morphemes, 482 words) [pac] PACOH Austro-Asiatic, Katuic (Vietnam)

References consulted: Alves (2000, 2006)

## Sound inventory

C phoneme inventory: /p b t d c j k ? p<sup>h</sup> t<sup>h</sup> k<sup>h</sup> m n ŋ ŋ ç h r l w j w<sup>2</sup> j<sup>2</sup>/ N consonant phonemes: 23 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Alveolar, Palatal, Velar, Glottal Manners: Stop, Fricative, Nasal, Trill, Central approximant, Lateral approximant N elaborations: 2 Elaborations: Creaky voice, Post-aspiration V phoneme inventory: /i ę ɛ æ i ə ə a ɒ ɔ o u i: e: ɛ: æ: i: ə: ə: a: ɒ: ɔ: o: u:/ N vowel qualities: 12 Diphthongs or vowel sequences: Diphthongs /iə iə uə iə iə uə/ Contrastive length: All Contrastive nasalization: None Other contrasts: Glottalization (some) Notes: /ç/ ranges from alveolar to palatal fricative. The vowels transcribed as creaky voice differ in [RTR]

value ([+RTR]), which manifests as both lower vowel quality and glottalic or 'slight degree of raspiness'. This distinction is common in Mon-Khmer language and generally has phonation effects such as "breathiness, creakiness, or raspiness" (Alves 2006: 14).

## Syllable structure

Complexity Category: Moderately Complex Canonical syllable structure: C(C)V(C) (Alves 2006: 17-21) Size of maximum onset: 2 Size of maximum coda: 1 Onset obligatory: No Coda obligatory: No Vocalic nucleus patterns: Short vowels, Long vowels Syllabic consonant patterns: Nasal, Liquid Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: Phonemic Morphological constituency of maximum syllable margin: Tautomorphemic (Onset) Morphological pattern of syllabic consonants: Lexical items Onset restrictions: Simple onsets unrestricted. For complex onsets, C<sub>1</sub> must be a stop, and C<sub>2</sub> must be /l r/. Coda restrictions: In main syllables, apparently all consonants occur. In presyllables, only sonorants occur.

### **Suprasegmentals**

Tone: No Word stress: Yes Stress placement: Fixed Phonetic processes conditioned by stress: (None) Differences in phonological properties of stressed and unstressed syllables: Vowel Quality Contrasts, Vowel Length Contrasts, Consonant Contrasts Phonetic correlates of stress: Vowel duration (impressionistic), Intensity (impressionistic)

## [pac] PACOH Austro-Asiatic, *Katuic* (Vietnam) (cont.)

### **Vowel reduction processes**

## (none reported)

**Notes:** Alves (2000) notes that only [ə] occurs as a vocalic nucleus in closed presyllables; however, this does not appear to be a currently productive process. Likewise syllabic nasals and liquids can only occur in presyllables with glottal-stop onsets. "Clearly, some kind of phonetic reduction is resulting in the loss of vowel distinctions in closed presyllables and in the complete loss of vowels in presyllables with nasals as the sonorant peaks ..." (2000: 22)

## **Consonant allophony processes**

**pac-C1:** A labiovelar approximant is realized as a labiodental fricative word-initially. (Alves 2006: 11) **pac-C2:** Velar consonants are labialized following /u/ or /o/. (Alves 2006: 12)

## **Morphology**

**Text:** "The Old Days" and "Pacoh Fellows and Girls" (Watson 1980: 86-7, 182-4) **Synthetic index:** 1.1 morphemes/word (557 morphemes, 520 words) [pay] PECH Chibchan, Paya (Honduras)

References consulted: Holt (1986, 1999)

## Sound inventory

C phoneme inventory: /p b ț k k<sup>w</sup> ? § ∫ h m n r r l j w/ N consonant phonemes: 16 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Dental, Palato-alveolar, Velar, Glottal Manners: Stop, Fricative, Nasal, Flap/Tap, Trill, Central approximant, Lateral approximant N elaborations: 2 Elaborations: Palato-alveolar, Labialization V phoneme inventory: /i e a o u i: e: a: o: u: ĩ ẽ ã õ ũ ĩ: ẽ: ã: õ: ũ: / N vowel qualities: 5 Diphthongs or vowel sequences: Diphthongs /aj aw ej/ Contrastive length: All Contrastive nasalization: All Other contrasts: N/A

### Syllable structure

**Complexity Category:** Complex **Canonical syllable structure:** (C)(C)V(C)(C) (Holt 1999: 20-21)

Size of maximum onset: 2

Size of maximum coda: 2

**Onset obligatory:** No

Coda obligatory: No

Vocalic nucleus patterns: Short vowels, Long vowels, Diphthongs

Syllabic consonant patterns: N/A

Size of maximum word-marginal sequences with syllabic obstruents:  $\ensuremath{\mathrm{N/A}}$ 

Predictability of syllabic consonants: N/A

**Morphological constituency of maximum syllable margin:** Tautomorphemic (Coda), Both patterns (Onset)

## Morphological pattern of syllabic consonants: N/A

**Onset restrictions:** Apparently none for simple onsets. C<sub>2</sub> is /r/ in biconsonantal onsets.

**Coda restrictions:** In simple codas, all consonants except /p t k<sup>w</sup> b/ occur. Biconsonantal codas have /r/as the first member, and only occur medially.

**Notes:** /pr, tr, kr, br/ onsets appear to be a recent development as a result of syncope of historical or underlying vowels. These vowels "often reappear in extremely slow, careful speech" (Holt 1999: 20).

## **Suprasegmentals**

Tone: Yes

Word stress: Yes

Stress placement: Morphologically or Lexically Conditioned

**Phonetic processes conditioned by stress:** Vowel Reduction, Consonant Allophony in Unstressed Syllables

**Differences in phonological properties of stressed and unstressed syllables:** Not described **Phonetic correlates of stress:** Not described

**Notes:** Pitch only hinted to be a correlate of stress (Holt 1986: 238). Stress is apparently predictable on the basis of underlying tone (1999: 19). Holt describes tone system as being relatively simple, with tones associated with certain marked syllables and distributed to unmarked syllables through assimilation or prosodic patterns (so patterns somewhat predictable?).

[pay] PECH Chibchan, Paya (Honduras) (cont.)

### **Vowel reduction processes**

pay-R1: In closed syllables, long vowels are realized as relatively short (Holt 1999: 18).
pay-R2: Short vowels are usually open and lax in closed syllables and when unstressed (Holt 1999: 18).
pay-R3: In rapid speech, unstressed high front vowel /i/ is sometimes realized as [ə] (Holt 1999: 18).
pay-R4: In rapid speech, vowels in unstressed syllables are sometimes voiceless between voiceless consonants (Holt 1999: 18).

**pay-R5:** Unstressed vowels are usually deleted between any consonant and a following /c/ (Holt 1999: 23). **pay-R6**: An unstressed interconsonantal vowel is often lost between two stressed syllables (Holt 1999: 23). **pay-R7:** The length of a long vowel can metathesize with that of a following consonant (usually  $/\int/$  or /k/), shortening the vowel and lengthening the following consonant (unclear if following C is in same syllable) (Holt 1999: 24-5).

## **Consonant allophony processes**

**pay-C1:** A voiceless palato-alveolar fricative may be realized as an affricate preceding a vowel. (Holt 1999: 16)

**pay-C2:** Glides may be realized as pre-stopped [<sup>d</sup>j <sup>g</sup>w] when occurring word-initially. (Holt 1999: 16) **pay-C3:** A voiceless velar stop is realized as voiced following a long vowel. (Holt 1999: 15-16) **pay-C4:** A voiced velar stop is spirantized intervocalically. (Holt 1999: 16)

## **Morphology**

**Text:** "Sample text" (Holt 1999: 79-80) **Synthetic index:** 2.8 morphemes/word (196 morphemes, 69 words)

## [pib] PIRO Arawakan, Purus (Peru)

References consulted: Hanson (2010), Lin (1997), Matteson (1965), Parker (1989), Urquía Sebastián & Marlett (2008)

#### Sound inventory

C phoneme inventory: /p t c k  $\widehat{ts} \widehat{t} \int c \widehat{h} m n l r w j/$ N consonant phonemes: 16 Geminates: N/A Voicing contrasts: None Places: Bilabial, Alveolar, Palato-alveolar, Palatal, Velar, Glottal Manners: Stop, Affricate, Fricative, Nasal, Flap/Tap, Central approximant, Lateral approximant N elaborations: 1 Elaborations: Palato-alveolar V phoneme inventory: /i e i a o/ N vowel qualities: 5 Diphthongs or vowel sequences: None **Contrastive length:** None **Contrastive nasalization:** None Other contrasts: N/A **Notes:** Urquia Sebastian reports /cc/ intead of /c/; Hanson notes these vary freely.  $/\tilde{h}/$  has very wide range of variation (Hanson 2010: 20-23). Matteson gives /ut/ for Hanson's /i/. Urguia Sebastian, Matteson report

vowel length distinctions for all vowel qualities but Lin, Hanson say no.

### Syllable structure

Complexity Category: Highly Complex Canonical syllable structure: C(C)(C)V (Hanson 2010: 25; Matteson 1965: 22-32; Matteson & Pike 1958; Lin 1997: 404-6; Lin 1993) Size of maximum onset: 3 Size of maximum coda: N/A Onset obligatory: Yes Coda obligatory: N/A Vocalic nucleus patterns: Short vowels, Long vowels Syllabic consonant patterns: Nasal (Conflicting), Liquid (Conflicting), Obstruent (Conflicting) Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: Heteromorphemic (Onset) Morphological pattern of syllabic consonants: N/A

constraints, though most identical clusters do not occur, and combinations of obstruents with similar place/ manner rare. Examples of occurring biconsonantal onsets include /pt mw çp jw ks tm mt sm ms nn kn tl/. Triconsonantal onsets include /pcr nkn wt[k ntsp nt[k mtn/.

**Notes:** Hanson notes that word-internal nasals are often (but inconsistently) treated as ambisyllabic, but never treated as only codas (2010: 25). No other explicit examples of 3-obstruent clusters, but all triconsonantal clusters are morphologically complex and have consonantal prefix as first constituent (including pronominal prefixes /n-/, /t-/, /p-/, /r-/, /w-/). Matteson states that C<sub>1</sub> may not be a fricative or affricate, but that there are no general restrictions on C<sub>2</sub> and C<sub>3</sub> (1965: 29-30). Combinatory restrictions on place/manner would still seem to allow three-obstruent codas. Additionally, Matteson states that the frequency of triconsonantal onsets was lower in 1965 than a count made a decade before. Therefore it could be that syllable structure in the language is simplifying. I classify it as having Highly Complex syllable structure, while acknowledging that such patterns may be marginal in the language.

[pib] PIRO Arawakan, Purus (Peru) (cont.)

Suprasegmentals Tone: No Word stress: Yes Stress placement: Fixed Phonetic processes conditioned by stress: Vowel Reduction Differences in phonological properties of stressed and unstressed syllables: (None) Phonetic correlates of stress: Pitch (impressionistic)

# Vowel reduction processes

**pib-R1:** A vowel in an utterance-final syllable may be wholly or partly voiceless (Matteson 1965: 23). **pib-R2:** Short low vowel /a/ may be realized as a neutral vowel in an utterance-final syllable (Matteson 1965: 23).

**pib-R3:** Unstressed vowels are 'somewhat more centralized but without any significant reduction' (Hanson 2010: 16).

## **Consonant allophony processes**

**pib-C1:** A voiceless palatal stop varies freely with affricated variant [cç]. (Hanson 2010: 17) **pib-C2:** A labiovelar approximant is realized as a bilabial fricative when occurring before front vowels. (Hanson 2010)

**pib-C3:** An alveolar lateral approximant may be realized as a stop following a nasal consonant. (Hanson 2010: 24)

pib-C4: Stops are realized as voiced intervocalically. (Hanson 2010: 17)

**pib-C5:** An alveolar lateral approximant is realized as an alveolar flap following a front or high central vowel. (Hanson 2010: 24)

## **Morphology**

**Text:** "The anteater and the jaguars" (Hanson 2010: 379-386) **Synthetic index:** 2.1 morphemes/word (539 morphemes, 257 words) [pol] POLISH Indo-European, *Slavic* (Poland)

**References consulted:** Gussman (2007), Jassem (2003), Newlin-Łokowicz (2012), Nowak (2006), Rocławski Zydorowicz (2010)

### Sound inventory

C phoneme inventory: /p b p<sup>j</sup> b<sup>j</sup> t d k q k<sup>j</sup> q<sup>j</sup> ts dz t dz t dz t dz f v f<sup>j</sup> sv<sup>j</sup> s z  $\int z z x m m<sup>j</sup> n n r l j w/$ N consonant phonemes: 35 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Labiodental, Dental, Alveolar, Palato-alveolar, Alveolo-palatal, Velar Manners: Stop, Affricate, Fricative, Nasal, Trill, Central approximant, Lateral approximant N elaborations: 4 Elaborations: Voiced fricatives/affricates, Labiodental, Palato-alveolar, Palatalization V phoneme inventory: /i  $\varepsilon i a \circ u \tilde{\varepsilon} \tilde{\sigma}/$ N vowel qualities: 6 Diphthongs or vowel sequences: None Contrastive length: None **Contrastive nasalization:** Some Other contrasts: N/A Notes: Jassem and Gussman differ quite a bit in their C inventories. Palatalized labials are often realized a sequences of Cij before vowels that are not /i/. Some of the consonants Gussman listed have been omitted here because they are predictable  $(/s^j z^j x^j)$  or occur only in loanwords  $(/f^j z^j)$ , etc.).  $(\varepsilon z)$  have nasalized

counterparts, which may be perhaps better analyzed as diphthongs:  $\tilde{z}^{w}$ ,

### Syllable structure

Complexity Category: Highly Complex **Canonical syllable structure:** (C)(C)(C)(C)(C)(C)(C)(C)(C)(C) (Gussman 2007: 200-224; Jassem 2003: 103; Zydorowicz 2010, Bargiełowna 1950) Size of maximum onset: 5 Size of maximum coda: 5 **Onset obligatory:** No Coda obligatory: No Vocalic nucleus patterns: Short vowels Svllabic consonant patterns: Nasal, Liquid Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: Varies with CV sequence Morphological constituency of maximum syllable margin: Heteromorphemic (Onset, Coda) Morphological pattern of syllabic consonants: N/A **Onset restrictions:** Biconsonantal onsets quite varied, include /kt fts tf nd jm dz pf dv dr pl qw sm mn wd/. Triconsonantal onsets include /sxl [kw p[t bzm<sup>j</sup> x[t tkf<sup>j</sup>/. Four-consonant onsets include /pstr pst [ fstr drgn fks [ vzql/. Five-consonant onsets like /spstr/ may occur in phonological words. **Coda restrictions:** Biconsonantal codas include /ctc st kt st rf wn nts lk wf/. Triconsonantal codas

include /nft lcn jsk psk stf rtf xtr/. Four-consonant codas include /nstf tstf rstf/, have strict limitations on final three consonants.

**Notes:** The examples presented in Bargiełowna (1950: 21) suggest that 5-C codas may occur in rare cases when phonemic nasalized vowel precedes 4-C cluster, e.g. *przestępstw* [p]este<u>mpstf</u>].

[pol] POLISH Indo-European, *Slavic* (Poland) (cont.)

**Suprasegmentals** 

Tone: No Word stress: Yes Stress placement: Fixed Phonetic processes conditioned by stress: Vowel Reduction Differences in phonological properties of stressed and unstressed syllables: (None) Phonetic correlates of stress: Vowel duration (instrumental), Pitch (instrumental), Intensity (instrumental) Notes: The pitch correlate here is a pitch slope.

## **Vowel reduction processes**

**pol-R1:** Non-high vowels  $\epsilon \mathfrak{z} \mathfrak{a}$  are more reduced in F1 and F2 domains in non-stressable positions (Nowak 2006: 378-9).

**pol-R2:** In rapid speech, syllabic nasals and liquids may occur as optional variants of vowel-consonant sequences (occurs more often in grammatical elements; Rubach 1974).

# **Consonant allophony processes**

pol-C1: An alveolar trill is realized as a flap in rapid speech. (Rocławski 1976: 132)

## **Morphology**

(adequate texts unavailable)

[pqm] PASSAMAQUODDY-MALISEET Algic, Algona

**References consulted:** Leavitt (1996), LeSourd (1993)

### Sound inventory

C phoneme inventory: /p t k k<sup>w</sup>  $\widehat{tJ}$  s h m n l w j/ N consonant phonemes: 12 Geminates: N/A Voicing contrasts: None Places: Bilabial, Alveolar, Palato-alveolar, Velar, Glottal Manners: Stop, Affricate, Fricative, Nasal, Central approximant, Lateral approximant N elaborations: 1 Elaborations: Palato-alveolar V phoneme inventory: /i  $\varepsilon$  a o o:/ N vowel qualities: 5 Diphthongs or vowel sequences: None Contrastive length: Some Contrastive nasalization: None Other contrasts: N/A

**Notes:** Aspirated stops /p<sup>h</sup> t<sup>h</sup> k<sup>h</sup>/ occur word-initially as a result of some morphophonemic contrasts and contrast with stop+/h/ (Sherwood 1986). LeSourd argues that preaspirated stops are clusters (1996: 38-41). /o/ here is intermediate between [o] and [u]. /ə/ is never lengthened under stress, but is contrastive word-initially. According to LeSourd, vowel length is predictable in both dialects, except for /o/ and /o:/ before /w/.

### Syllable structure

Complexity Category: Highly Complex Canonical syllable structure: (C)(C)(C)(C)(C)(C)(C) (LeSourd 1993: 58-61, 121-160) Size of maximum onset: 3 Size of maximum coda: 3 Onset obligatory: No Coda obligatory: No Vocalic nucleus patterns: Short vowels, Long vowels Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: Tautomorphemic (Onset, Coda) Morphological pattern of syllabic consonants: N/A Onset restrictions: All consonants occur as simple onsets. Biconsonantal onset combinations are fairly unrestricted and include /pt tp.pf[ sk<sup>w</sup> hs/ Triconsonantal onsets are usually of the form CsC: /psk psk

unrestricted and include /pt tp ptJ sk<sup>w</sup> hs/. Triconsonantal onsets are usually of the form CsC: /psk psk<sup>w</sup> ksp ksk<sup>w</sup>/, though /nkh/, /nsp/ occur in some stems.

**Coda restrictions:** All(?) consonants occur as simple codas (/h/ does not occur word-finally). Biconsonantal codas similar in form to onsets and are fairly unrestricted:  $/pt\hat{f} tk^w tfk kp sk^w ts st hk^w$ . Triconsonantal codas usually of form CsC, include /psk<sup>w</sup> ksk<sup>w</sup> nsk wsk/. [pol] POLISH Indo-European, *Slavic* (Poland) (cont.)

**Suprasegmentals** 

Tone: Yes Word stress: Yes Stress placement: Weight-Sensitive Phonetic processes conditioned by stress: Vowel Reduction Differences in phonological properties of stressed and unstressed syllables: (None) Phonetic correlates of stress: Vowel duration (impressionistic) Notes: Duration a correlate of stress in open syllables. Language described as having pitch accent: a stressed syllable may bear high or low pitch/contour (LeSourd 1993: 62).

# **Vowel reduction processes**

**pqm-R1:** Unstressed/unstressable /ə/ is omitted more often than not after sequences of /h/C, /ss/, or between non-syllabic sonorants, except in slow or deliberate speech (LeSourd 1996: 36). **pqm-R2:** Unstressable vowels which are not eliminated by phonological syncope are often subject to phonetic reduction or deletion (LeSourd 1996: 104).

## **Consonant allophony processes**

**pqm-C1:** Voiceless stops may be voiced intervocalically. (LeSourd 1993: 37) **pqm-C2:** Velar stops may be spirantized intervocalically. (LeSourd 1993: 37)

## **Morphology**

**Text:** "A sample text" (Leavitt 1996: 55-58) **Synthetic index:** 2.1 morphemes/word (262 morphemes, 125 words)

### [qvi] QUECHUA (IMBABURA) Quechuan, Quechua (Ecuador)

References consulted: Carpenter (1982), Cole (1982)

#### Sound inventory

C phoneme inventory: /p b t d k g ts tf  $\phi \beta$  s z f z x m n n l r w j/ N consonant phonemes: 22 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Alveolar, Palato-alveolar, Palatal, Velar Manners: Stop, Affricate, Fricative, Nasal, Flap/Tap, Central approximant, Lateral approximant N elaborations: 2 Elaborations: Voiced fricatives/affricates, Palato-alveolar V phoneme inventory: /i a u/ N vowel qualities: 3 Diphthongs or vowel sequences: None Contrastive length: None **Contrastive nasalization:** None Other contrasts: N/A Notes: Carpenter gives series of aspiated stops, but Cole shows these have fricativized in Imbabura Quechua. /b d g  $\beta$  z/ are not indigenous but are now fully integrated/nativized (e.g., occur in suffixes). /r/ contrasts with flap in some dialect areas.

### Syllable structure

Complexity Category: Moderately Complex Canonical syllable structure: (C)V(C) (Cole 1982: 203-5) Size of maximum onset: 1 Size of maximum coda: 1 Onset obligatory: No Coda obligatory: No Vocalic nucleus patterns: Short vowels Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: N/A Morphological pattern of syllabic consonants: N/A Onset restrictions: All consonants occur. Coda restrictions: In native words, restricted to voiceless fricatives, liquids, and semivowels.

#### **Suprasegmentals**

Tone: No Word stress: Yes Stress placement: Fixed Phonetic processes conditioned by stress: Vowel Reduction Differences in phonological properties of stressed and unstressed syllables: Not described Phonetic correlates of stress: Pitch (impressionistic), Intensity (impressionistic)

## Vowel reduction processes

**qvi-R1:** Vowels /i a u/ appear in lax form when unstressed (Jake 1983: 17; Cole 1982: 203 reports this for word-final unstressed vowels only).

# [qvi] QUECHUA (IMBABURA) Quechuan, Quechua (Ecuador) (cont.)

# **Consonant allophony processes**

**qvi-C1:** A voiced alveolar flap is realized as retroflex fricative [z] word-initially. (Cole 1982: 202) **qvi-C2:** A voiceless velar fricative may be realized as [g] preceding a voiced consonant. (Cole 1982: 201) **qvi-C3:** Voiceless stops and affricates are voiced following a nasal. (Cole 1982: 200)

# <u>Morphology</u>

**Text:** "Minkaymanta" (Carpenter 1982: 442-55) \*\*\*\*Ecuadorian dialect\*\*\*\* **Synthetic index:** 2.1 morphemes/word (206 morphemes, 97 words) [roo] ROTOKAS West Bougainville, *West Bougainville* (Papua New Guinea)

References consulted: Firchow & Firchow (1969), Firchow et al. (1973), Robinson (2006, 2011)

#### Sound inventory

C phoneme inventory: /p t k g β r/ N consonant phonemes: 6 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Alveolar, Velar Manners: Stop, Fricative, Flap/Tap N elaborations: 1 Elaborations: Voiced fricatives/affricates V phoneme inventory: /i e a o u i: e: a: o: u:/ N vowel qualities: 5 Diphthongs or vowel sequences: None Contrastive length: All Contrastive nasalization: None Other contrasts: N/A

**Notes:** Consonant phoneme representations are given as most characteristic allophonic realization. The contrast between voiceless, voiced, and nasal stops appears to have collapsed in Central Rotokas, producing this system, but these contrasts can still be found in Aita Rotokas (Robinson 2006).

### Syllable structure

Complexity Category: Simple Canonical syllable structure: (C)V (Robinson 2011: 28-9) Size of maximum coda: N/A Onset obligatory: No Coda obligatory: No Coda obligatory: N/A Vocalic nucleus patterns: Short vowels, Long vowels Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: N/A Morphological pattern of syllabic consonants: N/A Onset restrictions: All consonants occur.

## <u>Suprasegmentals</u>

Tone: No Word stress: Yes Stress placement: Weight-Sensitive Phonetic processes conditioned by stress: (None) Differences in phonological properties of stressed and unstressed syllables: Not described Phonetic correlates of stress: Not described Notes: Firchow and Firchow (1969: 271) hint at interrelationship between length and stress, but do not elaborate.

**Vowel reduction processes** 

(none reported)

# [roo] ROTOKAS West Bougainville, *West Bougainville* (Papua New Guinea) (cont.)

### **Consonant allophony processes**

**roo-C1:** A voiceless alveolar stop may be realized as an affricate preceding /i/. (Robinson 2011: 28) **roo-C2:** A voiced alveolar flap varies freely with [n], [l], [d]. (Firchow & Firchow 1969: 274) **roo-C3:** A voiced bilabial fricative varies freely with a voiced bilabial stop. (Firchow & Firchow 1969: 274)

**roo-C4:** A voiceless alveolar stop may be realized as a fricative preceding /i/. (Robinson 2011: 28) **roo-C5:** A voiced velar stop may be spirantized medially. (Firchow & Firchow 1969: 274)

## **Morphology**

Text: "Matevu (version 2)" (Robinson 2011: 293-304) Synthetic index: 2.2 morphemes/word (642 morphemes, 293 words) [scs] SLAVE (HARE DIALECT) Na-Dene, Athapascan (Canada)

References consulted: Rice (1989, 2005)

#### Sound inventory

C phoneme inventory: /p t t<sup>h</sup> k k<sup>h</sup> k<sup>w</sup> ? t' k' îs te tî tî ts' te' tî ' f s z ł ţ ( ʒ x y h m n r j w ?w/ N consonant phonemes: 31 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Labiodental, Alveolar, Palato-alveolar, Velar, Glottal Manners: Stop, Affricate, Fricative, Nasal, Flap/Tap, Central approximant, Lateral affricate, Lateral fricative N elaborations: 8 Elaborations: Creaky voice, Voiced fricatives/affricates, Post-aspiration, Lateral release, Ejective, Labiodental, Palato-alveolar, Labialization V phoneme inventory: /i e ɛ a o u ĩ ɛ̃ õ/ N vowel qualities: 6 Diphthongs or vowel sequences: None Contrastive length: None **Contrastive nasalization:** Some Other contrasts: N/A **Notes:** The distinction between |e| and  $|\varepsilon|$  is contrastive in Hare. Nasal vowels are said to be derived by rules in Rice (1989), but Rice (2005) lists them as phonemic.

#### Syllable structure

Category: Moderately Complex Canonical syllable structure: (C)V(C) (Rice 1989: 143-53) Size of maximum onset: 1 Size of maximum coda: 1 Onset obligatory: No Coda obligatory: No Vocalic nucleus patterns: Short vowels, Long vowels Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: N/A Morphological pattern of syllabic consonants: N/A Onset restrictions: All consonants occur. Coda restrictions: Only [? h j] occur, though others occur 'underlyingly'.

## **Suprasegmentals**

Tone: Yes Word stress: Yes Stress placement: Morphologically or Lexically Conditioned Phonetic processes conditioned by stress: (None) Differences in phonological properties of stressed and unstressed syllables: (None) Phonetic correlates of stress: Vowel duration (impressionistic), Pitch (impressionistic), Intensity (impressionistic) Notes: Predictable stress-like properties occur, falling on V immediately preceding stem of verb or stem

vowel of noun. A high tone on a vowel already bearing a high tone for some other reason gives the syllable extra prominence by increasing the pitch (Rice 2005: 362).

### **Vowel reduction processes**

(none reported)

### **Consonant allophony processes**

scs-C1: Velar fricatives are labialized preceding a rounded vowel. (Rice 1989)

**scs-C2:** Plain velar stops and the voiceless velar fricative are realized as palatal preceding a front vowel. (Rice 1989: 31)

scs-C3: Ejectives and plain consonants may be voiced intervocalically. (Rice 1989: 31)

**scs-C4:** Voiceless palato-alveolar affricate may vary freely with [[]. (Rice 1989: 35)

scs-C5: A voiceless velar fricative varies freely with a glottal fricative. (Rice 1989: 32)

**scs-C6:** A voiced velar fricative may be realized as a labiovelar approximant preceding a round vowel. (Rice 1989: 32)

# **Morphology**

(adequate texts unavailable)

[sea] SEMAI

References consulted: Dentan (2003), Diffloth (1976a, b), Philips (2007), Sloan (1988)

#### Sound inventory

C phoneme inventory: /p b t d c j k g ? m n ŋ ŋ ç h r l w j/ N consonant phonemes: 19 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Alveolar, Palatal, Velar, Glottal Manners: Stop, Fricative, Nasal, Flap/Tap, Central approximant, Lateral approximant N elaborations: 0 Elaborations: N/A V phoneme inventory: /i ɛ ə ɑ ɔ u i: e: ɛ: i: ɑ: ɔ: o: u: ĩ ɛ̃ ə̃ ɑ̃ ɔ̃ ū̃ ĩ: ɛ̃: ī: ɑ̃: ɔ̃: ū̃:/ N vowel qualities: 9 Diphthongs or vowel sequences: None Contrastive length: Some Contrastive nasalization: Some Other contrasts: N/A Notes: /e: i: o:/ occur only long; there is contrastive nasalization for all but these.

#### <u>Syllable structure</u>

Complexity Category: Highly Complex

Canonical syllable structure: C(C)V(C) (Diffloth 1976a, 1976b; Sloan 1988; Philips 2007)

Size of maximum onset: 2

Size of maximum coda: 1

**Onset obligatory:** Yes

Coda obligatory: No

Vocalic nucleus patterns: Short vowels, Long vowels

Syllabic consonant patterns: Nasal, Liquid, Obstruent

Size of maximum word-marginal sequences with syllabic obstruents: 4 (initial)

Predictability of syllabic consonants: Predictable from word/consonantal context

Morphological constituency of maximum syllable margin: Tautomorphemic (Onset)

Morphological pattern of syllabic consonants: Grammatical items

**Onset restrictions:** All consonants may occur in simple onsets. Examples of biconsonantal onsets include / dn, gh, cr/.

Coda restrictions: All consonants except voiced stops may occur.

**Notes:** Philips (2007) reports CVC maximum for both major and minor syllables, with optional elision of /  $\mathfrak{I}/\mathfrak{I}$  minor syllable. However, both Diffloth and Sloan report that some roots have two initial consonants before the main vowel. Sloan's data (from Diffloth) includes reduplicated (expressive) forms, in which  $C_1(V)C_2VC_3 > C_1C_3C_1C_2VC_3$ , e.g. dnph > dhdnph. Sloan takes canonical major syllable to be C(C)V(V) (C), with minor syllables being of the shape C or CC, where obstruents such as /p/ or /c/, as well as more sonorous consonants, may occur (1988: 320-1). This results in word-initial sequences such as /sts/, /krk/, / pnpr/, and larger strings as in <u>kckmr?exc</u> 'short, fat arms', syllabified /kc.km.r.?exc/. It appears that the longest string of obstruents word-initially is 4: /gpgh/. Much like syllables without vowels in Tashlhiyt, Semai minor syllables "are clearly heard and perceived as distinct syllables" (1988: 320). Because the unusual syllable patterns of this language produce strings of 3 obstruents or greater word-initially, I classify this language as Highly Complex.

[sea] SEMAI

Austro-Asiatic, Aslian (Malaysia) (cont.)

Suprasegmentals Tone: No Word stress: Yes Stress placement: Fixed Phonetic processes conditioned by stress: (None) Differences in phonological properties of stressed and unstressed syllables: Vowel Quality Contrasts, Vowel Length Contrasts Phonetic correlates of stress: Not described

## **Vowel reduction processes**

**sea-R1:** Preceding glottal consonants, some long vowels (/e: i: o:/) are produced as short (Philips 2007: 10-11).

## **Consonant allophony processes**

sea-C1: Palatal stops have affricated release syllable initially. (Philips 2007: 5)

## <u>Morphology</u>

(adequate texts unavailable)

### [shi] TASHLHIYT Afro-Asiatic, Berber (Morocco)

**References consulted:** Coleman (2001), Dell & Elmedlaoui (2002), Gordon & Nafi (2012), Louali & Puech (1999), Ridouane (2002, 2007, 2008, 2014)

#### Sound inventory

C phoneme inventory: /b t d t<sup>c</sup> d<sup>c</sup> k q k<sup>w</sup> q<sup>w</sup> f s s<sup>c</sup> (  $\chi \chi^w$  н h z z<sup>c</sup> 3 в в<sup>w</sup> f m n w l l<sup>c</sup> r r<sup>c</sup> j/ N consonant phonemes: 34 Geminates: /b: t: d: t<sup>c</sup>: d<sup>c</sup>: k: g: k<sup>w</sup>: g<sup>w</sup>: q: q<sup>w</sup>: f: s: s<sup>c</sup>: ∫: χ: χ<sup>w</sup>: H: h: z: z<sup>c</sup>: 3: 3:<sup>c</sup> B: B<sup>w</sup>: f: m: n: w: l: l<sup>c</sup>: r: r<sup>s</sup>: j:/ (All, including some that don't have singleton counterparts) Voicing contrasts: Obstruents Places: Bilabial, Labiodental, Dental, Palato-alveolar, Velar, Uvular, Pharyngeal, Glottal Manners: Stop, Fricative, Nasal, Trill, Central approximant, Lateral approximant N elaborations: 7 Elaborations: Voiced fricatives/affricates, Labiodental, Palato-alveolar, Uvular, Pharyngeal, Labialization, Pharyngealization V phoneme inventory: /i a u/ N vowel qualities: 3 Diphthongs or vowel sequences: None Contrastive length: None Contrastive nasalization: None Other contrasts: N/A **Notes:** All consonants have short/long counterparts except for /q:  $q^w$ :  $z^{s}$ , which are analyzed by Ridouane as long.  $/n^{\varsigma} \int^{\varsigma}/ are extremely marginal, according to Ridouane.$ 

### Syllable structure

**Complexity Category:** Highly Complex Canonical syllable structure: (C)V(C) (Dell & Elmedlouai 2002, Ridouane 2008) Size of maximum onset: 1 Size of maximum coda: 1 **Onset obligatory:** No Coda obligatory: No Vocalic nucleus patterns: Short vowels, Long vowels Syllabic consonant patterns: Nasal, Liquid, Obstruent Size of maximum word-marginal sequences with syllabic obstruents: ? (words without vowels) Predictability of syllabic consonants: Predictable from word/consonantal context Morphological constituency of maximum syllable margin: N/A Morphological pattern of syllabic consonants: Both **Onset restrictions:** None for simple onsets. Coda restrictions: Unclear. Notes: Dell & Elmedlaoui propose (C)V(C) structure with consonantal nuclei allowed. Puech & Louali (1999) present experimental acoustic and perceptual data which suggest biconsonantal onsets, at least;

(1999) present experimental acoustic and perceptual data which suggest biconsonantal onsets, at least; Ridouane (2008) argues against this using a variety of phonetic experiments and phonological processes. Regardless of the analysis of syllable structure, the phonetic patterns have long sequences of consonants (including obstruents) word-initially, medially, and finally, and therefore fits our definition of Highly Complex. [shi] TASHLHIYT Afro-Asiatic, Berber (Morocco) (cont.)

 Suprasegmentals

 Tone: No

 Word stress: Yes (but see notes)

 Stress placement: Fixed

 Phonetic processes conditioned by stress: (None)

 Differences in phonological properties of stressed and unstressed syllables: (None)

 Phonetic correlates of stress: Vowel duration (instrumental), Intensity (instrumental)

 Notes: Most claim prominence and accent are features of higher-level prosodic units, but Gordon & Nafi show phonetic correlates at word level. Pitch is a significant correlate of phrasal, but not word, stress.

# **Vowel reduction processes**

shi-R1: Vowels are shortened preceding a geminate consonant (Dell & Elmedlouai)

**Consonant allophony processes** 

(none reported)

Morphology Text: "The north wind and the sun" (Ridouane 2014: 219) Synthetic index: 1.9 morphemes/word (144 morphemes, 76 words) [slz] MA'YA

References consulted: Remijsen (2002), Van der Leeden (1993)

#### Sound inventory

**C** phoneme inventory: /p b t d q G p<sup>j</sup> b<sup>j</sup> t<sup>j</sup> d<sup>j</sup> k<sup>j</sup> q<sup>j</sup> f f<sup>j</sup> s s<sup>j</sup> m m<sup>j</sup> n n<sup>j</sup> 1 l<sup>j</sup> r w w<sup>j</sup> j/ N consonant phonemes: 26 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Labiodental, Alveolar, Velar, Uvular Manners: Stop, Fricative, Nasal, Flap/Tap, Central approximant, Lateral approximant N elaborations: 3 Elaborations: Labiodental, Palatalization, Uvular V phoneme inventory: /i e a o u/ N vowel qualities: 5 Diphthongs or vowel sequences: None Contrastive length: None **Contrastive nasalization:** None Other contrasts: N/A Notes: Van der Leeden gives discussion of 14 'principal consonants' and 12 palatalized consonants (1993: 36-7).

### Syllable structure

Complexity Category: Complex Canonical syllable structure: (C)(C)V(C) (van der Leeden 1993: xxix, 34–8) Size of maximum onset: 2 Size of maximum coda: 1 Onset obligatory: No Coda obligatory: No Vocalic nucleus patterns: Short vowels Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: Both patterns (Onset) Morphological pattern of syllabic consonants: N/A

release between constituents) and those produced with 'closed transition' (release between constituents). Open transition clusters have a nasal or stop as  $C_1$  and a stem-initial consonant as  $C_2$ . Examples include / km/, /ms/. Close transition clusters have any consonant but /r w j/ as  $C_1$  and /n l l<sup>j</sup> w/ as  $C_2$ .

## Coda restrictions: /m n f k s/ occur.

**Notes:** Author presents many word-initial clusters and remarks on their frequency but states canonical syllable pattern is (C)V(C) and that CCV and CCVC syllables should not be considered canonic (van der Leeden 1993: xxix).

[shi] TASHLHIYT Afro-Asiatic, Berber (Morocco) (cont.)

Suprasegmentals

Tone: Yes Word stress: Yes Stress placement: Morphologically or Lexically Conditioned Phonetic processes conditioned by stress: (None) Differences in phonological properties of stressed and unstressed syllables: (None)

**Phonetic correlates of stress:** Vowel duration (instrumental), Intensity (instrumental) **Notes:** Effect size of correlates of stress: duration > V quality > intensity. Remijsen argues for 3-way tonal system and stress accent system which results in apparent contour tones. Accent is contrastive in polysyllabic words, either on the penultimate or final syllable, and tonal contrasts limited to final syllable (2002: 597).

### Vowel reduction processes

**slz-R1:** Vowels with glide tone 21 are shortened and leveled in pitch (to tone 1) in 'sentence-final' syllables (Van der Leeden 1993: 62).

### **Consonant allophony processes**

**slz-C1:** A voiceless alveolar fricative is realized as palato-alveolar when occurring between two high front vowels. (van der Leeden 1993: 23)

**slz-C2:** A voiceless bilabial or alveolar stop is realized as voiced syllable- or word-finally. (van der Leeden 1993: 18-19)

**slz-C3:** A voiceless bilabial or alveolar stop is realized as voiced preceding a voiced stop. (van der leeden 1993: 18-19)

## <u>Morphology</u>

**Text:** "Marriage customs" (van der Leeden 1993: 88-91) **Synthetic index:** 1.3 morphemes/word (564 morphemes, 449 words) [spl] SELEPET

Trans-New Guinea, *Finisterre-Huon* (Papua New Guinea)

**References consulted:** McElhanon (1970)

#### Sound inventory

C phoneme inventory:  $p^{m}b t \frac{n}{d} k^{n}g s h m n \eta l r w j/$ N consonant phonemes: 15 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Dental, Alveolar, Velar, Glottal Manners: Stops, Fricative, Nasal, Flap/Tap, Central approximant, Lateral approximant N elaborations: 1 Elaborations: Prenasalization V phoneme inventory: /i e a ɔ o u/ N vowel qualities: 6 Diphthongs or vowel sequences: Diphthongs /ii ie ia io io iu ei eu ai ae ao au oi oe oo uu oi oe ou ui ue ua uo uo uu/ Contrastive length: None Contrastive nasalization: None Other contrasts: N/A **Notes:** Prenasalization in voiced stops is weak in initial position, but always prenasalized intervocalically, so I take this variant to be phoneme label. No significant difference in length between simple and complex nuclei.

# Syllable structure

Complexity Category: Moderately Complex Canonical syllable structure: (C)V(C) (McElhanon 1970: 14-18) Size of maximum coda: 1 Onset obligatory: No Coda obligatory: No Vocalic nucleus patterns: Short vowels, Vowel sequences Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: N/A Morphological pattern of syllabic consonants: N/A Onset restrictions: All consonants occur. Coda restrictions: Only voiceless stops and nasals occur.

## **Suprasegmentals**

Tone: Not reported Word stress: Yes Stress placement: Fixed Phonetic processes conditioned by stress: Vowel Reduction Differences in phonological properties of stressed and unstressed syllables: (None) Phonetic correlates of stress: Intensity (impressionistic)

# **Vowel reduction processes**

**spl-R1**: Unstressed syllables or vowels in postnuclear slope (in phrases) tend to elision nearer the nucleus (McElhanon 1970: 6).

**spl-R2:** Length of syllables or vowels decreases nearer the nucleus in the prenuclear slope (in phrases) (McElhanon 1970: 6).

# [spl] SELEPET Trans-New Guinea, *Finisterre-Huon* (Papua New Guinea) (cont.)

## **Consonant allophony processes**

**spl-C1:** A palatal glide may be realized as a palatal alveolar fricative  $[z^{j}] \sim [s^{j}]$  word-initially preceding /i/. (McElhanon 1970)

**spl-C2:** A palatal glide may be realized as a palatal alveolar fricative  $[z^{j}] \sim [s^{j}]$  when following a consonant. (McElhanon 1970)

# **Morphology**

(adequate texts unavailable)

[svs] SAVOSAVO Solomons East Papuan, Savosavo (Solomon Islands)

References consulted: Wegener (2008)

### Sound inventory

C phoneme inventory:  $p^{m}b t^{n}d^{n} + k^{n}g m n p \eta s z r l \beta w/$ N consonant phonemes: 17 Geminates: N/A Voicing contrasts: Obstruent Places: Bilabials, Alveolar, Palatal, Velar Manners: Stop, Fricative, Nasal, Trill, Central Approximant, Lateral Approximant N elaborations: 2 Elaborations: Voiced fricatives/affricates, Prenasalization V phoneme inventory: /i e a o u/ N vowel qualities: 5 Diphthongs or vowel sequences: Dipththong /ai/ Contrastive length: None Contrastive nasalization: None Other contrasts: None Notes: Prenasalized stops have both plain voiced and prenasalized allophones, but latter much more frequent. /ai/ combination is diphthong in some cases, disyllabic vowel sequence in others (Wegener 2008: 22).

## Syllable structure

Complexity Category: Simple Canonical syllable structure: (C)V (Wegener 2008: 23-4) Size of maximum onset: 1 Size of maximum coda: N/A Onset obligatory: No Coda obligatory: N/A Vocalic nucleus patterns: Short vowels Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: N/A Morphological pattern of syllabic consonants: N/A

### **Suprasegmentals**

Tone: No Word stress: Yes Stress placement: Morphologically or Lexically Conditioned Phonetic processes conditioned by stress: (None) Differences in phonological properties of stressed and unstressed syllables: (None) Phonetic correlates of stress: Vowel duration (impressionistic), Pitch (instrumental), Intensity (instrumental) Notes: Only pitch and intensity instrumentally confirmed as correlates of stress, and then only qualitatively with PRAAT. Pitch only sometimes a correlate of stress (p. 24).

## Vowel reduction processes

(none reported)

## Consonant allophony processes

svs-C1: An alveolar trill may be realized as a flap in rapid speech. (Wegener 2010: 17)

# (cont.)

**Morphology** 

Text: "Koi polupolu" (lines 1-46, Wegener 2008: 331-336) Synthetic index: 1.6 morphemes/word (630 morphemes, 396 words) [tbi] INGESSANA Eastern Sudanic, *Eastern Jebel* (Sudan)

References consulted: Bender (1983), Crewe (1975), Stirtz (2011)

### Sound inventory

C phoneme inventory: /p b t d t d c j k g f s m n ŋ ŋ l r w ð j/ N consonant phonemes: 21 Geminates: /f: s: m: n: ŋ: ŋ: l: r:/ (Some) Voicing contrasts: Obstruents Places: Bilabial, Labiodental, Dental, Alveolar, Palatal, Velar Manners: Stop, Fricative, Nasal, Flap/Tap, Central approximant, Lateral approximant N elaborations: 1 Elaborations: Labiodental V phoneme inventory: /i ε ə a ɔ u i: ε: ə: a: ɔ: u:/ N vowel qualities: 6 Diphthongs or vowel sequences: Vowel sequences /εɔ aε aɔ ɔε ɔa iə iu əi əu ui uə/ Contrastive length: All Contrastive nasalization: None Other contrasts: N/A Notes: Geminate /f s n ŋ ŋ l r (trill)/ occur in intervocalic position.

### Syllable structure

Complexity Category: Complex Canonical syllable structure: (C)V(C)(C) (Stirtz 2011: 36-43) Size of maximum onset: 1 Size of maximum coda: 2 Onset obligatory: No Coda obligatory: No Vocalic nucleus patterns: Short vowels, Long vowels, Vowel sequences Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: Both patterns (Coda) Morphological pattern of syllabic consonants: N/A Onset restrictions: Apparently none. Coda restrictions: For simple codas, all consonants except /?, k', d͡ʒ/ may occur. Biconsonantal codas occur only word-finally. C<sub>1</sub> is /r, l/, or nasal. C<sub>2</sub> is an obstruent.

#### <u>Suprasegmentals</u>

Tone: Yes Word stress: Yes Stress placement: Unpredictable/Variable Phonetic processes conditioned by stress: (None) Differences in phonological properties of stressed and unstressed syllables: (None) Phonetic correlates of stress: Intensity (impressionistic) Notes: In connected speech, stress patterns subject to 'largely unpredictable rhythmic variation' (Crewe 1975: 12-13).

**Vowel reduction processes** 

(none reported)

# [tbi] INGESSANA Eastern Sudanic, Eastern Jebel (Sudan) (cont.)

## **Consonant allophony processes**

**tbi-C1:** Voiced bilabial and palatal stops are realized as approximants intervocalically. (Stirtz 2011: 25) **tbi-C2:** Voiced bilabial and palatal stops and glides are realized as the corresponding vowel when occurring word-finally. (Stirtz 2011)

## **Morphology**

**Text:** "The goat and the fox," "The Nyeerma and the fox" (Stirtz 2011: 319:326) **Synthetic index:** 1.5 morphemes/word (503 morphemes, 339 words)

### [teh] TEHUELCHE Chon, Chon Proper (Argentina)

References consulted: Fernández Garay (1998), Fernández Garay & Hernández (2006)

#### Sound inventory

C phoneme inventory: /p b t d k g q G ? p' t' k' q' t f t f' s  $\int x \chi m n l r w j$ / N consonant phonemes: 25 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Dental, Palato-alveolar, Velar, Uvular, Glottal Manners: Stop, Affricate, Fricative, Nasal, Trill, Central approximant, Lateral approximant N elaborations: 3 Elaborations: Ejective, Palato-alveolar, Uvular V phoneme inventory: /e a o e: a: o:/ N vowel qualities: 3 Diphthongs or vowel sequences: None Contrastive length: All Contrastive nasalization: None Other contrasts: N/A

#### Syllable structure

Complexity Category: Highly Complex

**Canonical syllable structure:** (C)(C)(C)(C)(C)(C) (Fernández Garay 1998: 93-103; Fernández Garay & Hernández 2006: 13-14)

Size of maximum onset: 2

Size of maximum coda: 3

**Onset obligatory:** No

Coda obligatory: No

Vocalic nucleus patterns: Short vowels, Long vowels

Syllabic consonant patterns: Nasal, Obstruent

Size of maximum word-marginal sequences with syllabic obstruents: 3 (initial), >3 (final) Predictability of syllabic consonants: Phonemic, Predictable from word/consonantal context, or Varies with CV sequence

**Morphological constituency of maximum syllable margin:** Both patterns (Onset, Coda) **Morphological pattern of syllabic consonants:** Grammatical items

**Onset restrictions:** Biconsonantal onsets include /pl/, /k, q/+obstruent, and /m/+consonant.

**Coda restrictions:** There are no apparent restrictions for biconsonantal codas, which include  $/m\int p\int t\int ?r lk' rtf rn/$ . Triconsonantal clusters include at least /?(p mnk rnk ?nk/.

**Notes:** Canonical patterns listed above are for the root morpheme and word levels (Fernández Garay & Hernández explicitly state that triconsonantal clusters occur word-finally, but don't include this shape in their list). In addition to clusters, Fernández Garay (1998) and Fernández Garay & Hernández (2006) posit syllables of the shape C and CC, which may consist of obstruents (and some other Cs) and correspond to grammatical morphemes. These can be added at word margins to the canonical clusters to form larger sequences of consonants at the "phrase" level, an example being k-tfa2fp-f-kn > /ktfa2fpfk'n/ 'it is being washed' (2006: 13). Examples throughout the description show maxima of three consonants word/phrase-initially and six consonants is made possible by the development of epenthetic vowels." These *supporting vowels* play the role of "lubricator" in sequences of consonants and are described as having a neutral vowel quality corresponding to the neutralization of all other vowels (2006: 13). However, in the (1998) reference they are transcribed alternately as [ə] and [u], seemingly as a response to the consonantal environment.

[teh] TEHUELCHE Chon, Chon Proper (Argentina) (cont.)

Suprasegmentals

Tone: No Word stress: Yes Stress placement: Morphologically or Lexically Conditioned Phonetic processes conditioned by stress: Vowel Reduction Differences in phonological properties of stressed and unstressed syllables: Not described Phonetic correlates of stress: Not described

## Vowel reduction processes

**teh-R1:** Mid front vowel /e/ is realized as [ə] when unstressed (Fernandez Garay 1998: 82). **teh-R2:** Vowels may be elided in word-internal and word-final (unstressed) syllables. Entire unstressed syllables may delete as well (Fernandez Garay 1998: 104-5).

## **Consonant allophony processes**

**teh-C1:** A palatal glide may be realized as a voiced palato-alveolar fricative by some speakers (Fernández Garay 1998: 73)

**teh-C2:** Uvular stops and fricatives are fronted preceding a front vowel. (Fernández Garay 1998: 77-78) **Notes:** There is a great deal of unpredictable allophonic variation due to the obsolescence of the language.

## **Morphology**

**Text:** "Monologo 2," "Monologo 4" (Fernandez Garay and Hernandez 2006: 269-286) **Synthetic index:** 1.7 morphemes/word (412 morphemes, 249 words)
[tel] TELUGU

References consulted: Kelley (1963), Kostić et al. (1977), Krishnamurti (1998)

#### Sound inventory

C phoneme inventory: /p b ț d ț d k g p<sup>h</sup> b<sup>h</sup> d<sup>h</sup> t<sup>h</sup> d<sup>h</sup> k<sup>h</sup> g<sup>h</sup> t  $\widehat{f}$  t  $\widehat{dz}$  d  $\widehat{z}$  h f s s c x m n η r l ] w j/ N consonant phonemes: 32 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Dental, Alveolar, Retroflex, Alveolo-palatal, Velar Manners: Stop, Affricate, Fricative, Nasal, Trill, Central approximant, Lateral approximant N elaborations: 5 Elaborations: Breathy voice, Voiced fricatives/affricates, Post-aspiration, Labiodental, Retroflex V phoneme inventory: /i e a o u i: e: æ: a: o: u:/ N vowel qualities: 6 Diphthongs or vowel sequences: Diphthongs /ai au/ Contrastive length: Some **Contrastive nasalization:** None Other contrasts: N/A Notes: Vowel length distinction for all but /æ:/, which is always long. Place distinctions in consonant inventory from Kostić et al. (1977:191).

## Syllable structure

Complexity Category: Moderately Complex Canonical syllable structure: (C)V(C) (Kostić et al. 1977: 199) Size of maximum onset: 1 Size of maximum coda: 1 Onset obligatory: No Coda obligatory: No Vocalic nucleus patterns: Short vowels, Long vowels, Diphthongs Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: N/A Morphological pattern of syllabic consonants: N/A Onset restrictions: All consonants occur.

**Coda restrictions:** None? Speaker judgment data suggests that word-medial geminate clusters (e.g. *pennu*) are typically syllabified as onset of syllable, while other word-medial CC clusters (e.g. *gampa*) are split across syllables (Sailaja 1999).

# Suprasegmentals

Tone: No Word stress: Yes Stress placement: Fixed Phonetic processes conditioned by stress: Vowel Reduction, Consonant Allophony in Unstressed Syllables, Consonant Allophony in Stressed Syllables Differences in phonological properties of stressed and unstressed syllables: (None) Phonetic correlates of stress: Not described [tel] TELUGU Dravidian, South-Central Dravidian (India) (cont.)

#### **Vowel reduction processes**

**tel-R1:** A short vowel is lost between two consonants which have the same place of articulation, or of which  $C_1$  is an apical and  $C_2$  is an apical or laminal, or between dentals and affricates (Kostić et al. 1977: 9).

**tel-R2:** Long vowels /i: a: o: u:/ in word-final (and unstressed) position may be reduced to the length of a short vowel (Kostić et al. 1977: 11-52).

**tel-R3:** [ə] is reported to be an allophone or perhaps free variant of /a, e/ but no further description is given as to its distribution (Kostić et al. 1977).

## **Consonant allophony processes**

**tel-C1:** A voiceless aspirated stop may be realized as an affricate [kx] in a stressed syllable. (Kostić et al. 1977: 105)

tel-C2: Stops are partially fricated in unstressed position. (Kostić et al. 1977: 89)

tel-C3: Stops are realized as fricatives intervocalically. (Krishnamurti 1998: 207)

tel-C4: A bilabial stop is realized as a labial glide intervocalically. (Krishnamurti 1998: 207)

tel-C5: A bilabial stop is realized as a labial glide word-finally. (Krishnamurti 1998: 207)

tel-C6: A bilabial stop is realized as a labial glide preceding /w s h/. (Krishnamurti 1998: 207)

#### **Morphology**

(adequate texts unavailable)

[thp] THOMPSON Salishan, Interior Salish (Canada)

References consulted: Koch (2008), Thompson & Thompson (1992, 1996)

#### Sound inventory

C phoneme inventory: /p t k k<sup>w</sup> q q<sup>w</sup> ? p' k' k'<sup>w</sup> q' q'<sup>w</sup> ts t t ts' s  $\int x x^w \chi \chi^w h \frac{1}{2} m n m' n' 1 l' \delta j$ u w £ £<sup>w</sup> ð' j' u' w' £' £'<sup>w</sup>/ N consonant phonemes: 42 Geminates: N/A Voicing contrasts: None Places: Bilabial, Dental, Alveolar, Palato-alveolar, Velar, Uvular, Glottal Manners: Stop, Affricate, Fricative, Nasal, Central approximant, Lateral affricate, Lateral fricative, Lateral approximant N elaborations: 7 Elaborations: Creaky voice, Lateral release, Ejective, Palato-alveolar, Uvular, Pharyngeal, Labialization V phoneme inventory:  $/i I \varepsilon a \Lambda a u / u$ N vowel qualities: 8 Diphthongs or vowel sequences: None Contrastive length: None Contrastive nasalization: None Other contrasts: N/A **Notes:**  $/\mathbf{u}$   $\mathbf{u}'$  are exceedingly rare.  $/\underline{t}'$  occurs rarely and in apparent loanwords. [I] varies with [9], but this

#### Syllable structure

phoneme is generally very rare.

**Complexity Category:** Highly Complex Canonical syllable structure: C(C)(C)(C)(C)(C)(C)(C)(C)(C) (Thompson & Thompson 1992: 25-43; Thompson & Thompson 1996; Thompson et al. 1996) Size of maximum onset: 3 Size of maximum coda: 6 **Onset obligatory: Yes** Coda obligatory: No Vocalic nucleus patterns: Short vowels Syllabic consonant patterns: Nasal, Liquid Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: Predictable from word/consonantal context Morphological constituency of maximum syllable margin: Heteromorphemic (Onset, Coda) Morphological pattern of syllabic consonants: Lexical items (Liquid), Both (Nasal) **Onset restrictions:** Apparently all Cs may occur initially. Biconsonantal onsets include /kł, q<sup>w</sup>n, sx<sup>w</sup>, st<sup>2</sup>, tsk<sup>w</sup>'/. Triconsonantal onsets include /ns?, sxð, spt, sts'k/. **Coda restrictions:** Unclear if all Cs occur in codas. Biconsonantal codas quite varied, include  $/mx^w$  (t q<sup>w</sup>m ?t/. Triconsonantal codas include /x<sup>w</sup>kt x<sup>w</sup>sts psts kst tsms/. Six-consonant codas include obstruentonly sequences such as /4qsxtx<sup>w</sup>/. Notes: Canonical syllable patterns not explicitly stated, but based on examples given. Authors state that sequences of six obstruents "not uncommon" (1992: 25). Authors analyze some clusters as having underlying vowels intervening between consonants. As far as I can tell from the description, unstressed underlying vowels do not occur in actual production unless explicitly transcribed in the surface form. Coda clusters larger than six have been observed, however, example is transcribed with optional intervening schwa (nik kstkpt?(a) + 'you people already got your hands cut', 1992:25). "Study of the grammatical system shows that such words [with long obstruent sequences] are made up of strings of meaningful

subparts, morphemes, many of which have vowels when they fall under stress. But each word has just a single main stress, and vowels mostly drop out of the unstressed morphemes." (Thompson et al 1996: 612)

[thp] THOMPSON

Salishan, Interior Salish (Canada) (cont.)

**Suprasegmentals** 

Tone: No

Word stress: Yes

Stress placement: Morphologically or Lexically Conditioned

**Phonetic processes conditioned by stress:** Vowel Reduction, Consonant Allophony in Unstressed Syllables, Consonant Allophony in Stressed Syllables

**Differences in phonological properties of stressed and unstressed syllables:** Vowel Quality Contrasts **Phonetic correlates of stress:** Vowel duration (instrumental), Pitch (instrumental), Intensity (instrumental)

# Vowel reduction processes

**thp-R1:** High vowels /i u/ are nearly always realized as [ə] when preceding the main stress, except for when /u/ occurs between two velar consonants (Thompson & Thompson 1992: 32).

**thp-R2**: When  $\partial$  is adjacent to a resonant, it reduces and the resonant becomes syllabic (Thompson & Thompson 1992: 44).

**thp-R3:** In allegro speech, unstressed /i I  $\varepsilon$  a o u/ tend to be realized as [ə] (Thompson & Thompson 1992: 45).

**thp-R4**: In allegro speech, unstressed  $|\partial|$  is deleted between obstruents (Thompson & Thompson 1992: 45). **thp-R5**: Unstressed  $|\Lambda|$  is reduced to  $[\partial]$  (Thompson & Thompson 1992: 45).

**thp-R6:** In allegro speech, stressed /a, o/ and sometimes  $|\varepsilon|$  are frequently replaced by [ $\Lambda$ ] (Thompson & Thompson 1992: 46).

The processes below have quite a few phonological and some morphological complications, and the productivity is unclear. I have not included them as phonetically- or phonologically-conditioned vowel reduction in my analysis, but they should be noted:

thp-R7: Most post-tonic vowels are deleted (Thompson & Thompson 1992: 23, 33-4).

thp-R8: In successive syllables preceding main stress, /ə/ is deleted (Thompson & Thompson 1992: 31-2).

**thp-R9:** In successive syllables preceding main stress, vowels /i I  $\varepsilon$  a o u/ are deleted when adjacent to a laryngeal, pharyngeal, or homorganic semivowel and preceding the main stress (Thompson & Thompson 1992: 31-2).

# **Consonant allophony processes**

**thp-C1:** Velars are rounded following /u/ in a stressed or closed syllable. (Thompson & Thompson 1992: 36)

# **Morphology**

**Text:** "The man who went to the moon" (lines 1-65; Thompson & Thompson 1992: 200-5) **Synthetic index:** 1.7 morphemes/word (506 morphemes, 297 words) [tow] JEMEZ

References consulted: Bell (1993), Logan Sutton (p.c.), Yumitani (1998)

## Sound inventory

C phoneme inventory: /p b t d c k<sup>jh</sup> g<sup>j</sup> k<sup>h</sup> g k<sup>w</sup> ? p' t' k<sup>j</sup>' k' t f o f v s z f h fi m n r l j w/ N consonant phonemes: 30 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Labiodental, Alveolar, Palato-Alveolar, Palatal, Velar, Glottal Manners: Stop, Affricate, Fricative, Nasal, Flap/Tap, Central Approximant, Lateral Approximant N elaborations: 6 Elaborations: Voiced fricative/affricate, Ejective, Labiodental, Palato-alveolar, Palatalization, Labialization V phoneme inventory: /i e æ i a o i: e: æ: i: o: a: ĩ æ ĩ ã õ ĩ: æ: i: ă: õ:/ N vowel qualities: 6 Diphthongs or vowel sequences: None Contrastive length: All **Contrastive nasalization:** Some Other contrasts: None Notes: Yumitani lists voiceless velar stops as aspirated, but it aspiration is not contrastive. Nasalization contrast for all but /e e:/.

#### Syllable structure

Complexity Category: Simple Canonical syllable structure: (C)V(C) (Yumitani 1998: 21-22) Size of maximum onset: 1 Size of maximum coda: 1 Onset obligatory: No Coda obligatory: No Vocalic nucleus patterns: Short vowels, Long vowels Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: N/A Morphological pattern of syllabic consonants: N/A Onset restrictions: All consonants occur. Coda restrictions: //, /ʃ/ in limited environments.

Phonetic correlates of stress: Vowel duration (instrumental), Pitch (instrumental)

**Notes:** The issue of whether Jemez has true vowel-initial syllables is still up for debate; a voiced glottal fricative is often heard before the vowel (Yumitani 1998: 22-23). Though the canonical syllable structure has an optional coda, in speech there is a tendency toward a CV template. Closed syllables do not occur word-internally, and when occurring word-finally are often resyllabilitied. See discussion in Chapter 3.

# Suprasegmentals

Tone: Yes Word stress: Yes Stress placement: Morphologically or Lexically Conditioned Phonetic processes conditioned by stress: Vowel Reduction, Consonant Allophony in Unstressed Syllables Differences in phonological properties of stressed and unstressed syllables: (None)

**Phonetic correlates of stress:** Vowel duration (instrumental), Pitch (instrumental)

Notes: Pitch is not as strong an indicator as length for stress.

[tow] JEMEZ Kiowa-Tanoan, *Kiowa-Tanoan* (United States) (cont.)

# **Vowel reduction processes**

**tow-R1:** Long vowels become glottalized (V?V) word-finally before a pause (Yumitani 1998: 20; vowels not specified).

**tow-R2:** Some long vowels have short variants word-finally (Yumitani 1998: 20; vowels not specified). **tow-R3:** Non-initial (unstressed) vowels are more central and harder to identify than corresponding initial (stressed) vowels (Yumitani 1998: 31, Bell 1993: 29).

# **Consonant allophony processes**

**tow-C1:** Palatal stops are realized as palato-alveolar affricates preceding a high front vowel. (Yumitani 1998: 13)

**tow-C2:** A palato-alveolar fricative is realized as a voiced palato-alveolar affricate preceding a high front vowel. (Yumitani 1998: 13)

**tow-C3:** A voiceless alveolar fricative is realized as a glottal fricative syllable-initially in a syllable carrying low tone. (Yumitani 1998: 13)

# <u>Morphology</u>

Text: "About my childhood" (Yumitani 1998: 248-250) Synthetic index: 1.7 morphemes/word (408 morphemes, 244 words) [tzh] AGUACATENANGO TZELTAL Mayan, Mayan (Mexico)

**References consulted:** Kaufman (1971), Polian (2006), Smith (2007)

#### Sound inventory

C phoneme inventory: /p b t k ? p' t' k' ts t f ts 't f' s  $\int$  h m n l r w j/ N consonant phonemes: 21 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Dental, Alveolar, Palato-alveolar, Velar, Glottal Manners: Stop, Affricate, Fricative, Nasal, Flap/Tap, Central approximant, Lateral approximant N elaborations: 2 Elaborations: Ejective, Palato-alveolar V phoneme inventory: /i e a o u e:/ N vowel qualities: 5 Diphthongs or vowel sequences: None Contrastive length: Yes Contrastive nasalization: Some Other contrasts: N/A Notes: /f r/ occur only in loanwords in speech of 'acculturated' speakers (Kaufman 1971: 13). Kaufman

also gives /d g/. Smith calls /j/ a fricative. The few cases of apparent long vowels are often heteromorphemic; however, /e:/ contrastive in one monomorphemic word.

#### Syllable structure

Complexity Category: Complex Canonical syllable structure: (C)(C)V(C)(C) (Kaufman 1971: 9-15) Size of maximum onset: 2 Size of maximum coda: 2 Onset obligatory: No Coda obligatory: No Vocalic nucleus patterns: Short vowels Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: Tautomorphemic (Coda), Heteromorphemic (Onset)

Morphological pattern of syllabic consonants: N/A

**Onset restrictions:** Apparently no restrictions on simple onsets. Biconsonantal onsets consist of  $/s \int h/$  plus any (?) consonant.

**Coda restrictions:** Apparently no restrictions on simple codas. Biconsonantal codas limited to sequence of /h/ + voiceless stop or affricate.

Notes: Initial clusters in Spanish loans may be prefixed with  $s \int h/s$ , resulting in triconsonantal onset.

# **Suprasegmentals**

# Tone: No

Word stress: Yes

Stress placement: Fixed

Phonetic processes conditioned by stress: Vowel Reduction

Differences in phonological properties of stressed and unstressed syllables: (None)

Phonetic correlates of stress: Vowel duration (impressionistic)

Notes: Length is a correlate of stress in some dialects (Polian 2006: 23).

# [tzh] AGUACATENANGO TZELTAL Mayan, Mayan (Mexico) (cont.)

# **Vowel reduction processes**

**tzh-R1:** Vowels are realized as extra short when unstressed before a consonant following a stressed vowel (Kaufman 1971: 12)

tzh-R2: Vowels are short when unstressed before a phrasal (? 'caret') juncture (Kaufman 1971: 12). tzh-R3: In casual speech, reducible vowels (=post-tonic, if also followed by at least one more vowel and not more than two consonants before a juncture intervenes) are replaced by /a/ or /e/ (Kaufman 1971: 26-7). Notes: There are also several productive vowel reduction processes taking place in particular speech styles. In Assimilative Speech, used by unmarried children who are living at home or not yet economically dependent, reducible vowels as well as some other vowels are replaced by echo vowels. In Clipped Speech, used by men between the ages of 18 and 40 who are married or economically independent of their parents, reducible vowels are 'zeroed' wherever possible, or otherwise replaced by [ə] (Kaufman 1971: 26-7).

#### **Consonant allophony processes**

tzh-C1: Voiced stops are spirantized following a vowel. (Kaufman 1971: 11)

#### **Morphology**

**Text:** "Le voyage à la finca" (first 5 pages, Polian 2006: 235-239) **\*\*\***Central dialect**\*\*\*\* Synthetic index:** 1.5 morphemes/word (446 morphemes, 299 words) [ung] UNGARINJIN Worrorran, Worrorran (Australia)

References consulted: Coate & Oates (1970), Rumsey (1978)

#### Sound inventory

C phoneme inventory: /p t t c k m n η ŋ ŋ l l ʎ r ų w j/ N consonant phonemes: 17 Geminates: N/A Voicing contrasts: None Places: Bilabial, Alveolar, Retroflex, Palatal, Velar Manners: Stop, Nasal, Trill, Central approximant, Lateral approximant N elaborations: 1 Elaborations: Retroflex V phoneme inventory: /I e a o υ a:/ N vowel qualities: 5 Diphthongs or vowel sequences: None Contrastive length: Some Contrastive nasalization: None Other contrasts: N/A Notes: Vowel length generally not phonemic.

Syllable structure

Complexity Category: Complex Canonical syllable structure: (C)(C)(C)V(C)(C) (Rumsey 1978: 23-6) Size of maximum onset: 3 Size of maximum coda: 2 Onset obligatory: No Coda obligatory: No Vocalic nucleus patterns: Short vowels Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: Tautomorphemic (Onset, Coda) Morphological pattern of syllabic consonants: N/A

**Onset restrictions:** All consonants except for /r  $\Lambda$ / may occur in simple onsets. Biconsonantal onsets are / p<sub>4</sub>/, /t<sub>4</sub>/, /m<sub>4</sub>/, /k<sub>4</sub>/, and /pr/. Triconsonantal onset limited to /pr<sub>4</sub>/.

**Coda restrictions:** All consonants except for  $/p \ m \ \Lambda \ I / may$  occur as simple codas. Biconsonantal codas have lateral /l l/ as C<sub>1</sub> and nasal / $\eta \ n \ \eta \ m$ / as C<sub>2</sub>. These codas are always followed by an onset which is /k/ or /p/ in the following syllable.

**Notes:** Apparently /a/ is the only V syllable.

#### <u>Suprasegmentals</u>

Tone: No Word stress: Yes Stress placement: Morphologically or Lexically Conditioned Phonetic processes conditioned by stress: Vowel Reduction Differences in phonological properties of stressed and unstressed syllables: (None) Phonetic correlates of stress: see below Notes: Here it's REDUCED duration that is a correlate of stress, and for /a/ only. When

**Notes:** Here it's REDUCED duration that is a correlate of stress, and for /a/ only. When carrying primary stress in polysyllabic words, /a/ is higher and shorter than long low back vowel, by a degree which depends on which consonant follows it.

[ung] UNGARINJIN Worrorran, Worrorran (Australia) (cont.)

# **Vowel reduction processes**

**ung-R1**: Lax high vowels /I U/ are produced as tense in word-final position or before a loose juncture (Rumsey 1978: 13-16).

ung-R2: Low central vowel /a/ is realized as [ə] when unstressed (Rumsey 1978: 17-18).

# **Consonant allophony processes**

ung-C1: An alveolar lateral approximant is velarized adjacent to back vowels. (Rumsey 1978: 11)
ung-C2: A voiced bilabial stop is labialized preceding /u/. (Rumsey 1978: 9-10)
ung-C3: Velars are fronted preceding front vowels. (Rumsey 1978: 11)
ung-C4: Stops are voiced following a nasal and preceding any sound. (Rumsey 1978: 9)
ung-C5: A trill may be realized as a flap intervocalically. (Rumsey 1978: 12)
ung-C6: A trill may be realized as a flap word-finally. (Rumsey 1978: 12)

# **Morphology**

**Text:** "Ngunbangguwe 'Mt. Trafalgar" (Coate & Oates 1970: 104-110) **Synthetic index:** 2.0 morphemes/word (1142 morphemes, 573 words) [ura] URARINA Isolate (Peru)

References consulted: Olawsky (2006)

#### Sound inventory

C phoneme inventory: /b t d k k<sup>w</sup> tç f<sup>w</sup> s ∫ h h<sup>j</sup> m n ŋ l t/ N consonant phonemes: 16 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Labiodental, Alveolar, Retroflex, Alveolo-palatal, Velar, Glottal Manners: Stop, Affricate, Fricative, Nasal, Flap/tap, Lateral approximant N elaborations: 4 Elaborations: Labiodental, Retroflex, Palatalization, Labialization V phoneme inventory: /i e ʉ a u ĩ ẽ ʉ̃ ã ũ/ N vowel qualities: 5 Diphthongs or vowel sequences: Diphthongs /ae aj ej au aʉ/ Contrastive length: None Contrastive nasalization: All Other contrasts: N/A Notes: /f<sup>w</sup>/ has merged with former /h<sup>w</sup>/ for most younger speakers; most common pronunciation of the

latter is now [f<sup>w</sup>]. Distribution of /h<sup>i</sup>/ is mostly restricted to word-initial position preceding /a  $\underline{u}$   $\underline{u}$ /. Most occurrences of /p/ are predictable, but minimal pairs occur word-initially.. Author considers [ $\overline{d_3}$ ] to be predictable, but there are a few near-minimal pairs with 'complex conditioning' (Olawsky 2006: 30-49). Vowel length distinction exists at grammatical level, but minimal pairs do not exist except for loans and morphologically complex forms; also vowel length in these contexts may be variable (Olawsky 2006: 56-7). /u/ varies with [o].

## Syllable structure

**Complexity Category:** Simple Canonical syllable structure: (C)V (Olawsky 2006: 75-6) Size of maximum onset: 1 Size of maximum coda: N/A **Onset obligatory: No** Coda obligatory: N/A Vocalic nucleus patterns: Short vowels, Long vowels, Diphthongs Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: N/A Morphological pattern of syllabic consonants: N/A Onset restrictions: All consonants occur. Coda restrictions: N/A Notes: CCV syllables sometimes occur in Spanish loanwords in the speech of bilinguals, but these are usually split up by epenthesis (Olawsky 2006: 76).

#### **Suprasegmentals**

Tone: Yes Word stress: Yes Stress placement: Weight-Sensitive Phonetic processes conditioned by stress: (None) Differences in phonological properties of stressed and unstressed syllables: (None) Phonetic correlates of stress: Intensity (impressionistic) [ura] URARINA Isolate (Peru) (cont.)

**Vowel reduction processes** 

(none reported)

#### **Consonant allophony processes**

**ura-C1:** A voiceless alveolar fricative is realized as palato-alveolar following /i/ in some dialects. (Olawsky 2006: 38)

**ura-C2:** An alveolo-palatal affricate  $[\hat{t}c]$  is realized as a palato-alveolar affricate  $[\hat{d}_3]$  word-initially preceding /a/ or / $\frac{1}{4}$ /.

**ura-C3:** A sequence of  $/t^i$  may vary freely with palatalized retroflex flap  $[t^j]$  or palato-alveolar affricate  $[d_3]$ . (Olawsky 2006: 71)

**ura-C4:** A sequence of /ku/ may vary with [k<sup>w</sup>]. (Olawsky 2006: 37)

**ura-C5:** Voiceless glottal fricative and alveolar nasal may be realized as palatalized following /i/. (Olawsky 2006: 47)

# **Morphology**

Text: "Text 8," "Text 10 (Olawsky 2006: 902-905) Synthetic index: 1.6 morphemes/word (270 morphemes, 169 words) [ute] UTE

References consulted: Givón (2011), Harms (1966), Oberly (2013)

#### Sound inventory

C phoneme inventory: /p t k ? t͡ʃ β s γ m n r w j/ N consonant phonemes: 13 Geminates: N/A Voicing contrasts: None Places: Bilabial, Dental, Palato-Alveolar, Velar, Glottal Manners: Stop, Affricate, Fricative, Nasal, Flap/Tap, Central approximant N elaborations: 2 Elaborations: Voiced fricatives/affricates, Palato-alveolar V phoneme inventory: /i œ a uu u i: œ: a: uu: u: į œ a u u/ N vowel qualities: 5 Diphthongs or vowel sequences: None Contrastive length: All Contrastive nasalization: None Other contrasts: Voicing Notes: Uvulars are allophones (at least historically) of /k/ or /ɣ/ (Givón 2011: 26). The voiced/voiceless

**Notes:** Uvulars are allophones (at least historically) of /k/ or /y/ (Givón 2011: 26). The voiced/voiceless distinction in vowels is a recent development, which does seem to be distinctive in certain grammatical contexts.

#### Syllable structure

**Complexity Category:** Simple Canonical syllable structure: CV(C) (Givón 2011: 27-28) Size of maximum onset: 1 Size of maximum coda: 1 **Onset obligatory: Yes** Coda obligatory: No Vocalic nucleus patterns: Short vowels, Long vowels Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: N/A Morphological pattern of syllabic consonants: N/A Onset restrictions: All consonants occur. **Coda restrictions:** Optional coda may be /j/ or result from the recent deletion of a word-final vowel. **Notes:** Givón argues that all apparent vowel-initial words are actually glottal stop-initial (2011: 27). See discussion of syllable patterns in Chapter 3.

#### **Suprasegmentals**

Tone: No Word stress: Yes Stress placement: Fixed Phonetic processes conditioned by stress: Vowel Reduction Differences in phonological properties of stressed and unstressed syllables: (None) Phonetic correlates of stress: Vowel duration (instrumental), Pitch (instrumental) Notes: Duration is a correlate of stress for short vowels only. [ute] UTE Uto-Aztecan, *Numic* (United States) (cont.)

# **Vowel reduction processes**

**ute-R1:** Unstressed and de-stressed vowels are devoiced word-finally (Givón 2011: 20-23; environments both phonological and grammatical).

**ute-R2:** Unstressed and de-stressed vowels are sometimes devoiced word-initially (Givón 2011: 20-23; environments both phonological and grammatical).

**ute-R3:** Vowels may become devoiced in unstressed syllables beginning with a voiceless consonant /k p t s  $t\bar{f}/$ , a nasal /n m/, or a glide /w/ (Givón 2011: 21).

# **Consonant allophony processes**

ute-C1: Velar stops are labialized following back rounded vowels. (Givón 2011: 29)

**ute-C2:** Velar stops are palatalized following high vowels. (Givón 2011: 29)

**ute-C3:** A voiceless bilabial stop is realized as a labiodental fricative intervocalically. (Givón 2011: 24; process rapidly phonemicizing)

**ute-C4:** A voiceless alveolar stop is realized as a flap intervocalically. (Givón 2011: 25; process rapidly phonemicizing)

ute-C5: Velar stops are spirantized intervocalically. (Givón 2011: 26-7)

#### **Morphology**

**Text:** "Porcupine tricks Coyote" (first 5 pages, Givón 2013: 107-111) **Synthetic index:** 2.3 morphemes/word (593 morphemes, 255 words) [wba] WARAO Isolate (Venezuela)

References consulted: Arinterol (2000), Osborn (1966), Romero-Figeroa (1997)

#### Sound inventory

C phoneme inventory: /p t k k<sup>w</sup> s h m n l w j/ N consonant phonemes: 11 Geminates: N/A Voicing contrasts: None Places: Bilabial, Alveolar, Velar, Glottal Manners: Stop, Fricative, Nasal, Central approximant, Lateral flap N elaborations: 1 Elaborations: Labialization V phoneme inventory: /i e a o u/ N vowel qualities: 5 Diphthongs or vowel sequences: None Contrastive length: None Contrastive nasalization: None Other contrasts: N/A **Notes:** (1/ has [r]) and [d] variants. Osborn reports phonemic nasal contrasts for each vowel, but Romero-Figueroa states these are phonologically conditioned (1997: 108).

# Syllable structure

Complexity Category: Simple Canonical syllable structure: (C)V (Romero-Figeroa 1997: 109-112) Size of maximum onset: 1 Size of maximum coda: N/A Onset obligatory: No Coda obligatory: N/A Vocalic nucleus patterns: Short vowels Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: N/A Morphological pattern of syllabic consonants: N/A

**Suprasegmentals** 

Tone: No Word stress: Yes Stress placement: Fixed Phonetic processes conditioned by stress: (None) Differences in phonological properties of stressed and unstressed syllables: (None) Phonetic correlates of stress: Intensity (impressionistic)

## **Vowel reduction processes**

(none reported)

#### **Consonant allophony processes**

wba-C1: Voiced alveolar stop and voiceless alveolar fricative are realized as voiced palato-alveolar affricate, and voiceless palato-alveolar fricative, respectively, following /i/. (Arinterol 2000: 121)
wba-C2: Labial and palatal glides may vary freely with corresponding fricatives. (Arinterol 2000: 122)
wba-C3: Stops may become voiced preceding a vowel. (Arinterol 1997: 107)
wba-C4: Voiced alveolar stops are realized as flaps intervocalically. (Arinterol 1997: 107)

[wba] WARAO Isolate (Venezuela) (cont.)

**Morphology** 

**Text:** (fragments of texts, Romero-Figeroa 1997: 118-123) **Synthetic index:** 1.6 morphemes/word (182 morphemes, 116 words) [wmd] MAMAINDÊ Nambikuaran, Nambikuaran (Brazil)

References consulted: Eberhard (2009)

#### Sound inventory

Syllable structure Complexity Category: Complex Canonical syllable structure: (C)(C)V(C)(C) (Eberhard 2009: 124-34) Size of maximum onset: 2 Size of maximum coda: 2 Onset obligatory: No Coda obligatory: No Vocalic nucleus patterns: Short vowels, Diphthongs Syllabic consonant patterns: Nasal Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: Varies with CV sequence Morphological constituency of maximum syllable margin: Tautomorphemic (Onset, Coda) Morphological pattern of syllabic consonants: N/A Onset restrictions: Any consonant may occur as simple onset. Biconsonantal onsets are /k<sup>h</sup> t<sup>h</sup> k h/+ /w/, or /h 2/+/l n j w s/ or /2m/.

**Coda restrictions:** Simple codas are stops and nasals. Biconsonantal codas consist of stop or nasal +/2/. **Notes:** Complex onsets and codas (besides C+w onsets) always involve glottal, so this language doesn't have 'prototypically' Complex syllable structure.

# Suprasegmentals

Tone: Yes Word stress: Yes Stress placement: Morphologically or Lexically Conditioned Phonetic processes conditioned by stress: Vowel Reduction, Consonant Allophony in Unstressed Syllables, Consonant Allophony in Stressed Syllables Differences in phonological properties of stressed and unstressed syllables: (None) Phonetic correlates of stress: Vowel duration (instrumental), Intensity (instrumental)

# **Vowel reduction processes**

**wmd-R1:** Unstressed syllables may optionally lose their vowel. This can result in syllabic consonants (Eberhard 2009: 262-3; only illustrated for nasals).

**wmd-R2:** Non-front vowels /a o u/ are usually weakened in unstressed syllables (Eberhard 2009: 271; there is one morphological exception).

[wmd] MAMAINDÊ Nambikuaran, Nambikuaran (Brazil) (cont.)

# **Consonant allophony processes**

**wmd-C1:** A palatal glide is realized as a voiceless palato-alveolar affricate following a syllable-initial plosive. (Eberhard 2009: 94)

**wmd-C2:** An alveolar lateral approximant is realized as a voiceless alveolar stop following a syllableinitial oral obstruent. (Eberhard 2009: 92)

**wmd-C3:** Voiceless stops may become voiced adjacent to voiced sounds, especially word-initally preceding an unstressed vowel. (Eberhard 2009)

wmd-C4: Voiceless stops are voiced in a stressed onset. (Eberhard 2009: 55)

**wmd-C5:** Voiceless alveolar stop is realized as a voiced implosive when occurring preceding a stressed back vowel and occurring word-initially or following a glottal stop. (Eberhard 2009: 58)

**wmd-C6:** A voiceless alveolar stop is realized a a flap intervocalically preceding an unstressed vowel. (Eberhard 2009: 55)

#### **Morphology**

(adequate texts unavailable)

[wut] WUTUNG Skou (Papua New Guinea)

References consulted: Marmion (2010), Doug Marmion (p.c.)

#### Sound inventory

C phoneme inventory: /p b t d ?  $\widehat{tj} d\widehat{z} f s h m n p l w/$ N consonant phonemes: 15 Geminates: N/A Voicing contrasts: Obstruents Places: Bilabial, Labiodental, Alveolar, Palato-alveolar, Palatal, Glottal Manners: Stop, Affricate, Fricative, Nasal, Central approximant, Lateral approximant N elaborations: 3 Elaborations: Voiced fricatives/affricates, Labiodental, Palato-alveolar V phoneme inventory: /i e  $\varepsilon \theta \varepsilon o \upsilon \tilde{i} \tilde{\varepsilon} \tilde{\delta} \tilde{\upsilon} \tilde{o} \tilde{\upsilon}/$ N vowel qualities: 7 Diphthongs or vowel sequences: None Contrastive length: None Contrastive nasalization: Some Other contrasts: N/A Notes: /k/ occurs in one (possibly recent) borrowing. Contrastive nasalization for /i e  $\varepsilon \varepsilon o \upsilon$ /.

## Syllable structure

Complexity Category: Highly Complex Canonical syllable structure: (C)(C)(C)(C)V(C) (Marmion 2010: 68-76) Size of maximum onset: 4 Size of maximum coda: 1 Onset obligatory: No Coda obligatory: No Vocalic nucleus patterns: Short vowels Syllabic consonant patterns: N/A Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: N/A Morphological constituency of maximum syllable margin: Tautomorphemic (Onset) Morphological pattern of syllabic consonants: N/A Onset restrictions: All consonants occur as simple onsets. Biconsonantal onsets include /h ?/ + voiced consonant, or labial consonant + /l/. Triconsonantal onsets are /h ?/ + /b m/ + /l/, also /hpd3, hmb/. Only

consonant, or labial consonant + 1/. Inconsonantal onsets are /n 2/ + /b m/ + /l/, also /hpd3, hmb/. known example of four-consonant onset is /hmbl/.

Coda restrictions: Codas occur in rare circumstances and are always nasals /m n/.

#### Suprasegmentals

Tone: Yes Word stress: Yes Stress placement: Unpredictable/Variable Phonetic processes conditioned by stress: Consonant Allophony in Unstressed Syllables Differences in phonological properties of stressed and unstressed syllables: (None) Phonetic correlates of stress: Vowel duration (impressionistic), Intensity (impressionistic)

Vowel reduction processes

(none reported)

[wut] WUTUNG Skou (Papua New Guinea (cont.)

# **Consonant allophony processes**

**wut-C1:** A labiovelar glide may be realized as a bilabial fricative word-initially preceding a vowel. (Marmion 2010: 57-8)

**wut-C2:** A labiovelar glide may be realized as a bilabial fricative intervocalically. (Marmion 2010: 57-8) **wut-C3:** A voiced palato-alveolar affricate may be realized as a glide intervocalically. (Marmion 2010: 55)

# **Morphology**

**Text:** "Crow and white cockatoo," "Womia the mermaid" (Marmion 2010: 378-382) **Synthetic index:** 1.1 morphemes/word (340 morphemes, 313 words)

# [yak] YAKIMA SAHAPTIN Penutian, Sahaptian (United States)

**References consulted:** Hargus & Beavert (2002, 2005, 2006), Jansen (2010), Minthorn (2005), Rigsby & Rude (1996), Rude (2009), Rude & CTUIR (2014)

#### Sound inventory

C phoneme inventory: /p t k k<sup>w</sup> q q<sup>w</sup> ? p' t' k' k'<sup>w</sup> q' q'<sup>w</sup> t t ts tf ts' tf' ts f x x<sup>w</sup>  $\gamma \gamma^{w}$  h m n l w j/ N consonant phonemes: 32 Geminates: N/A Voicing contrasts: None Places: Bilabial, Dental, Palato-alveolar, Velar, Uvular, Glottal Manners: Stop, Affricate, Fricative, Nasal, Central approximant, Lateral affricate, Lateral fricative, Lateral approximant N elaborations: 5 Elaborations: Lateral release, Ejective, Palato-alveolar, Uvular, Labialization V phoneme inventory: /i i a u i: a: u:/ N vowel qualities: 4 Diphthongs or vowel sequences: None **Contrastive length:** Some **Contrastive nasalization:** None Other contrasts: N/A Notes: Vowel length contrast for /i a u/. Note that Jansen, Rigsby & Rude posit diphthongs; Hargus & Beavert (2006) argue against this on evidence from phonological processes.

# Syllable structure

Complexity Category: Highly Complex

**Canonical syllable structure:** C(C)(C)(C)(C)(C)(C)(C)(C) (Hargus & Beavert 2006, 2002; Rigsby & Rude 1996: 671)

Size of maximum onset: 4

Size of maximum coda: 4

**Onset obligatory:** Yes

Coda obligatory: No

Vocalic nucleus patterns: Short vowels, Long vowels, Diphthongs

Syllabic consonant patterns: N/A

Size of maximum word-marginal sequences with syllabic obstruents: N/A

Predictability of syllabic consonants: N/A

**Morphological constituency of maximum syllable margin:** Tautomorphemic (Onset), Both patterns (Coda)

Morphological pattern of syllabic consonants: N/A

**Onset restrictions:** All consonants occur as simple onsets. Biconsonantal onsets may be obstruent+sonorant, obstruent+obstruent, sonorant+sonorant, sonorant+obstruent and include / $\chi$ n pt qt mj tw qn lt tft/. Triconsonantal onsets are quite numerous and include sequences of three obstruents, e.g. / pf $\chi$ , tk<sup>w</sup>s/, as well as combinations with sonorants, e.g. /tmt, t $\chi$ n/. Onsets of four consonants occurring tautomorphemically include / $\int t \chi$ n, ksks/, with perhaps more when morphologically complex forms are considered (but there are few candidate prefixes).

**Coda restrictions:** /h ?/ do not occur in simple codas. Biconsonantal codas are apparently unrestricted, include /tk t'k q<sup>w</sup>'k ms wn/. Triconsonantal codas include /tks stk pt k'. Hargus & Beavert (2006) list / wtk<sup>w</sup> yq' $\chi$  jlps/ as four-consonant codas.

# [yak] YAKIMA SAHAPTIN Penutian, Sahaptian (United States) (cont.)

**Notes:** Clusters of glottalized or labialized obstruents do not occur (in reduplication contexts, their plain forms appear), but clusters of identical rearticulated plain consonants, e.g. /pp/, /qq/, do appear and are common. There seem to be place restrictions on initial obstruent sequences: except for identical rearticulated clusters, sequences of homorganic consonants generally don't occur, and dorsal+labial sequences are common but labial+dorsal sequences occur in one item (Hargus & Beavert 2002: 237). Meanwhile, there are no coherent place restrictions on YS final clusters (2002: 239). Rigsby & Rude (1996) state that initial clusters are maximally three members, but Hargus & Beavert (2006) give evidence from phonological processes that glide is a consonant and not part of previous vowel (diphthong). Minimal words in YS are CCV or CVC (Hargus & Beavert 2006). Hargus & Beavert reject syllabic obstruents for YS but Minthorn (2005) posits syllabic obstruents for related dialect Umatilla based on instrumental evidence and speaker judgments.

# **Suprasegmentals**

Tone: No Word stress: Yes Stress placement: Morphologically or Lexically Conditioned Phonetic processes conditioned by stress: Vowel Reduction Differences in phonological properties of stressed and unstressed syllables: (None) Phonetic correlates of stress: Pitch (instrumental), Intensity (instrumental) Notes: Hargus and Beavert (2005) describe language as having pitch accent.

## Vowel reduction processes

**yak-R1**: Short vowels may be realized as lax when unstressed (Jansen 2010: 40). **yak-R2**: Short vowels may be realized as lax in rapid speech (Jansen 2010: 40).

# **Consonant allophony processes**

**yak-C1:** An ejective dental stop varies with affricate variant  $[\hat{t\theta}']$  in all environments. (Rigsby & Rude 1996: 669)

**yak-C2:** Voiceless velar stops are fronted preceding high front vowels and palatal glides. (Rigsby & Rude 1996: 667)

# **Morphology**

**Text:** "Coyote and Prairie Chicken" (first 15 pages, Jansen 2010: 444-458) **Synthetic index:** 1.8 morphemes/word (575 morphemes, 324 words) [yor] YORUBA Niger-Congo, *Defoid* (Benin, Nigeria)

References consulted: Bamgbose (1966), Rowlands (1969), Seidl (2000), Siertsema (1959)

#### Sound inventory

C phoneme inventory: /b t d j k g kp  $\widehat{gb}$  f s  $\int h m l r j w/$ N consonant phonemes: 17 Geminates: N/A Voicing contrasts: Obstruents Places: Labial-velar, Bilabial, Labiodental, Alveolar, Palato-Alveolar, Velar, Glottal Manners: Stop, Fricative, Nasal, Flap/Tap, Lateral approximant, Central approximant N elaborations: 2 Elaborations: Labiodental, Palato-alveolar V phoneme inventory: /i e  $\varepsilon$  a  $\circ$  o u  $\tilde{i} \tilde{\varepsilon} \tilde{i} \tilde{u}/$ N vowel qualities: 7 Diphthongs or vowel sequences: None Contrastive length: None Contrastive nasalization: Some Other contrasts: None

Syllable structure Complexity Category: Simple Canonical syllable structure: (C)V (Bamgbose 1966: 6) Size of maximum onset: 1 Size of maximum coda: N/A Onset obligatory: No Coda obligatory: No Coda obligatory: N/A Vocalic nucleus patterns: Short vowels Syllabic consonant patterns: Nasal Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: Phonemic Morphological constituency of maximum syllable margin: N/A Morphological pattern of syllabic consonants: Grammatical items Onset restrictions: All consonants occur.

Suprasegmentals Tone: Yes Word stress: No

Vowel reduction processes (none reported)

Consonant allophony processes (none reported)

Morphology (adequate texts unavailable) [yue] CANTONESE Sino-Tibetan, Chinese (China)

References consulted: Bauer & Benedict (1997), Matthews & Yip (1994)

#### Sound inventory

N consonant phonemes: /p t k k<sup>w</sup> p<sup>h</sup> t<sup>h</sup> k<sup>h</sup> k<sup>wh</sup> ts ts<sup>h</sup> f s h m n ŋ l j w/ Geminates: N/A Voicing contrasts: None Places: Bilabial, Labiodental, Dental/Alveolar, Velar, Glottal Manners: Stop, Affricate, Fricative, Nasal, Central approximant, Lateral approximant N elaborations: 3 Elaborations: Post-aspiration, Labiodental, Labialization V phoneme inventory: /i y e ø a a ɔ u/ N vowel qualities: 8 Diphthongs or vowel sequences: Diphthongs /ai ai au au ei øi iu ui oi ou/ Contrastive length: None Contrastive nasalization: None Other contrasts: N/A Notes: /a/ longer than /a/ but there is also a quality distinction. Bauer & Benedict disagree with this vowel system and propose a 14-vowel system with length distinctions (1997: 45-48).

#### Syllable structure

Complexity Category: Moderately Complex Canonical syllable structure: (C)V(C) (Matthews & Yip 1994: 16-20, Bauer & Benedict 1997) Size of maximum onset: 1 Size of maximum coda: 1 Onset obligatory: No Coda obligatory: No Vocalic nucleus patterns: Short vowels, Long vowels, Diphthongs Syllabic consonant patterns: Nasal Size of maximum word-marginal sequences with syllabic obstruents: N/A Predictability of syllabic consonants: Phonemic Morphological constituency of maximum syllable margin: N/A Morphological pattern of syllabic consonants: Both Onset restrictions: All consonants occur. Coda restrictions: Limited to /m n ŋ p t k/ (Matthews & Yip) and semi-vowels (Bauer & Benedict).

Suprasegmentals Tone: Yes Word stress: No

Vowel reduction processes

(none reported)

# **Consonant allophony processes**

yue-C1: A voiceless alveolar fricative is realized as a palatal or palato-alveolar fricative preceding /y/ (also preceding /i:/ in Guangzhou dialect). (Bauer & Benedict 1997: 28-9) yue-C2: Alveolar affricates are realized as palato-alveolar preceding front vowels, front and central rounded vowels /i: y: œ:  $\Theta$ /. (Bauer & Benedict 1997: 29-30)

#### **Morphology**

(adequate texts unavailable)

# Appendix C: Language sample from Maddieson (2013a)

This is the sample of languages classified as having Complex syllable structure in Maddieson (2013a). These were used in the analysis in §2.2. An asterisk indicates that the language reference consulted was different than that used in Maddieson (2013a).

Language	Family	Reference
Angas	Afro-Asiatic	Burquest 1971
Arabic (Egyptian)	Afro-Asiatic	Mitchell 1962
Beja	Afro-Asiatic	Hudson 1974
Berber (Middle Atlas)	Afro-Asiatic	Penchoen 1973
Dizi	Afro-Asiatic	*Beachy 2005
Hebrew (Modern Ashkenazic)	Afro-Asiatic	Bolozky 1978; *Laufer 1999
Kotoko	Afro-Asiatic	Bouny 1977
Neo-Aramaic (Persian Azerbaijan)	Afro-Asiatic	Garbel 1965
Soqotri	Afro-Asiatic	Johnstone 1975
Tashlhiyt	Afro-Asiatic	*Ridouane 2008
Tuareg (Ahaggar)	Afro-Asiatic	Prasse 2008
Qawasqar	Alacalufan	*Viegas Barros 1991; Clairis 1977
Passamaquoddy-Maliseet	Algic	LeSourd 1993
Yurok	Algic	Robins 1958
Bashkir	Altaic	Poppe 1964
Chuvash	Altaic	Krueger 1961
Dagur	Altaic	Martin 1961; Wu 1996
Kirghiz	Altaic	Hebert & Poppe 1963
Moghol	Altaic	Weiers 2003
Tuvan	Altaic	Anderson & Harrison 1999
Uzbek (Northern)	Altaic	*Ismatulla & Clark 1992
Yakut	Altaic	Krueger 1962
Brao	Austro-Asiatic	Keller 1976
Bru (Western)	Austro-Asiatic	Thongkum 1979
Jeh	Austro-Asiatic	Gradin & Gradin 1979
Khasi	Austro-Asiatic	Rabel 1961
Khmer	Austro-Asiatic	Ehrman 1972
Khmu'	Austro-Asiatic	Svantesson 1983

**Table C1.** Language sample for analysis in §2.2.

Language	Family	Reference
Nyah Kur (Tha Pong)	Austro-Asiatic	Thongkum 1984
Sre	Austro-Asiatic	Manley 1972
Cham (Western)	Austronesian	*Ueki 2011
Indonesian	Austronesian	*Sneddon et al. 2010
Pohnpeian	Austronesian	Rehg 1984; Rehg 1981
Sa'ban	Austronesian	Clayre 1973
Taba	Austronesian	Bowden & Hajek 1999
Tetun	Austronesian	Morris 1984
Tsou	Austronesian	Wright & Ladefoged 1994
Awa Pit	Barbacoan	Curnow 1997
Basque	Basque	Saltarelli et al. 1988
Imonda	Border	Seiler 1985
Burushaski	Burushaski	Morgenstierne 1945
Camsá	Camsá	Howard 1967
Selknam	Chon	Najlis 1973
Chukchi	Chukotko-Kamchatkan	Dunn 1999
Itelmen	Chukotko-Kamchatkan	Georg & Volodin 1999
Koryak	Chukotko-Kamchatkan	Zhukova 1980
Brahui	Dravidian	Andronov 1980
Kannada	Dravidian	Steever 1998
Kota	Dravidian	Emeneau 1944
Koya	Dravidian	Tyler 1969
Tulu	Dravidian	*Bhatt 1971
Ik	Eastern Sudanic	Tucker 1971
Aleut (Eastern)	Eskimo-Aleut	Bergsland 1997
Abipón	Guaicuruan	Najlis 1966
Haida	Haida	Levine 1977
Cocopa	Hokan	Crawford 1966
Maricopa	Hokan	Gordon 1986
Albanian	Indo-European	Newmark 1957
Bengali	Indo-European	Ferguson & Chowdhury 1960
Breton	Indo-European	Ternes 1970
Bulgarian	Indo-European	Scatton 1984
English	Indo-European	Moulton 1962
French	Indo-European	*Féry 2003; Fougeron & Smith 2003

 Table C1. (cont.) Language sample for analysis in §2.2.

Language	Family	Reference
German	Indo-European	Moulton 1962; Kohler 1999
Greek (Modern)	Indo-European	Householder et al. 1964
Hindi	Indo-European	McGregor 1995
Irish (Donegal)	Indo-European	Ó Dochartaigh 1992
Kurdish (Central)	Indo-European	McCarus 1958
Latvian	Indo-European	Mathiassen 1996
Lithuanian	Indo-European	*Kenstowicz 1972
Norwegian	Indo-European	Vanvik 1972
Ormuri	Indo-European	*Kieffer 2003
Pashto	Indo-European	Penzl 1955
Persian	Indo-European	Obolensky 1963
Polish	Indo-European	*Swan 2002, *Gussman 2007
Romansch (Scharans)	Indo-European	*Liver 1982
Russian	Indo-European	*Andrews 2001
Oneida	Iroquoian	Michelson 1988; Abbott 2000
Maung	Iwaidjan	Capell & Hinch 1970
Georgian	Kartvelian	Vogt 1958
Kutenai	Kutenai	Haugen 1956
Maba	Maban	Tucker & Bryan 1966
Canela-Krahô	Macro-Ge	Popjes & Popjes 1986
Alawa	Mangarrayi-Maran	Sharpe 1972
Mangarrayi	Mangarrayi-Maran	Merlan 1989
Burarra	Mangrida	Glasgow & Glasgow 1967
Tzeltal (Aguacatenango)	Mayan	Kaufman 1971
Mixe (Totontepec)	Mixe-Zoque	*Schoenhals & Schoenhals 1965
Zoque (Copainalá)	Mixe-Zoque	Wonderly 1951
Ahtna	Na-Dene	Kari 1990
Eyak	Na-Dene	Krauss 1965
Hupa	Na-Dene	Golla 1970
Tlingit	Na-Dene	Maddieson et al. 2011
Archi	Nakh-Daghestanian	Kibrik 1994
Avar	Nakh-Daghestanian	Charachidze 1981
Ingush	Nakh-Daghestanian	Nichols 1994

 Table C1. (cont.) Language sample for analysis in §2.2.

Language	Family	Reference
Lak	Nakh-Daghestanian	Khajdakov 1966; Anderson 1997
Lezgian	Nakh-Daghestanian	Haspelmath 1993
Rutul	Nakh-Daghestanian	Alekseev 1994
Tsova-Tush	Nakh-Daghestanian	Holisky & Gagua 1989
Nambikuára (Southern)	Nambikuaran	*Kroeker 2001
Aizi	Niger-Congo	Herault 1971
Diola-Fogny	Niger-Congo	Sapir 1965
Doyayo	Niger-Congo	*Weiring & Weiring 1994
Gwari	Niger-Congo	Hyman & Magaji 1970
Kpan	Niger-Congo	Shimizu 1971
Noni	Niger-Congo	Hyman 1981
Tampulma	Niger-Congo	Bergman et al. 1969
Temne	Niger-Congo	Wilson 1961
Wolof	Niger-Congo	Ka 1994
Nivkh	Nivkh	Gruzdeva 1998
Malakmalak	Northern Daly	Birk 1976
Abkhaz	Northwest Caucasian	Hewitt 1979
Bardi	Nyulnyulan	Bowern 2012
Coos (Hanis)	Oregon Coast	*Confederated Tribes of Coos, Lower Umpqua, and Siuslaw Indians (2011)
Amuzgo	Oto-Manguean	*Buck 2000
Otomí (Mezquital)	Oto-Manguean	Priego Montfort 1989
Páez	Páezan	*Jung 2008
Djapu	Pama-Nyungan	Morphy 1983
Kala Lagaw Ya	Pama-Nyungan	Kennedy 1981
Klamath	Penutian	Barker 1964
Nez Perce	Penutian	Aoki 1970
Tsimshian (Coast)	Penutian	Mulder 1988
Bella Coola	Salishan	Nater 1984
Chehalis (Upper)	Salishan	Kinkade 1963
Lushootseed	Salishan	Bates et al. 1994
Shuswap	Salishan	Kuipers 1974
Squamish	Salishan	*Dyck 2004

 Table C1. (cont.) Language sample for analysis in §2.2. (cont.)

Language	Family	Reference
Alamblak	Sepik	Bruce 1984
Ladakhi	Sino-Tibetan	Koshal 1979
Lepcha	Sino-Tibetan	Plaisier 2007
Nyishi	Sino-Tibetan	Abraham 2005
Lakhota	Siouan	*University of Colorado Lakhota Project 1974
Murrinh-Patha	Southern Daly	Street & Mollinjin 1981
Hamtai	Trans-New Guinea	Healey 1981
Yagaria	Trans-New Guinea	Renck 1975
Hungarian	Uralic	Hall 1944
Komi-Zyrian	Uralic	Lytkin 1966
Nenets	Uralic	Sammallahti 1974
Saami (Central-South)	Uralic	*Feist 2010
Cahuilla	Uto-Aztecan	Seiler 1977
Норі	Uto-Aztecan	Whorf 1946
O'odham	Uto-Aztecan	Saxton 1982
Kwakw'ala	Wakashan	Boas et al. 1947; Grubb 1977
Makah	Wakashan	Davidson 2002
Nuuchahnulth	Wakashan	Davidson 2002; *Kim 2003
Maranungku	Western Daly	Tryon 1970
Wardaman	Yangmanic	Merlan 1994
Fulniô	Yatê	*Barbosa 1992
Ket	Yeniseian	*Georg 2007
Yukaghir (Tundra)	Yukaghir	Maslova 2003

 Table C1. (cont.) Language sample for analysis in §2.2. (cont.)

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