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LINGUISTIC AND CULTURAL FACTORS ASSOCIATED WITH PHONEMIC FLUENCY PERFORMANCE IN BILINGUAL HISPANICS

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ABSTRACT

Verbal fluency tasks are used extensively in clinical settings because of their sensitivity to a wide variety of disorders, including cognitive decline and dementia, and their usefulness in differential diagnoses. However, the effects of bilingualism on neuropsychological assessment, and verbal fluency in particular, are currently not completely understood. There is an increasing need to examine bilingualism's role in assessing verbal fluency due to the rapidly growing Hispanic population within the United States. This study investigated the performance of bilingual Hispanics in phonemic fluency compared to monolingual European-Americans using the Controlled Oral Word Association Test (COWAT). Both the standard letters of 'F', 'A', and 'S' and alternative letters were tested in an attempt to find letters that would be linguistically and culturally fair for both monolinguals and bilinguals. Various aspects of bilingualism, such as language dominance and age of acquisition of a second language, as well as acculturative factors, were examined to determine their influences on phonemic fluency. Results revealed that both language dominance and age of acquisition heavily influence phonemic fluency performance for Hispanic bilinguals. Bilingual students who were English dominant or balanced bilingual scored on par with the monolingual students. Also, bilingual students who learned their second language by the age of six performed better than those who learned their second language later. The acculturative factors of social affiliation and ethnic identification affected performance as well. Early age of acquisition bilingual participants who were better acculturated to mainstream society scored higher in phonemic fluency than those who were not as well acculturated. These results pinpoint the clinical importance of obtaining a full linguistic background of a bilingual client in order to interpret verbal fluency performance accurately so that the client may be properly diagnosed and treated.

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Bilingualism is more common around the world than is monolingualism (Harris & McGhee-Nelson, 1992). This fact is becoming more apparent as the ethnic minority population, in particular the Hispanic population, continues to grow faster than the European-American majority culture within the United States (US Census Bureau, 2006). However, clinicians do not often ask a client about bilingualism. Possible bilingual effects, positive or negative, are usually not taken into consideration in the medical and psychological community.

Verbal fluency tasks are used prominently in clinical settings because of their sensitivity to a wide variety of disorders, including cognitive decline and dementia and their usefulness in differential diagnoses (Gollan, Montoya, & Werner, 2002). For clinicians, verbal fluency tests are relatively quick and easy to administer. However, there has not been a consensus in the literature regarding the effects of bilingualism on phonemic fluency in particular. While some studies claim there is no difference between monolingual and bilingual participants, other studies do find significant differences between the two. What is needed is the thorough understanding of the numerous factors involved in bilingualism such as age of acquisition of the second language, methods of acquisition of the second language, and the preferred language of the individual. A reexamination of current phonemic fluency testing is required to ensure valid and accurate results among bilingual Hispanics.

The US Hispanic Population

The term Hispanic is used to identify “people of various ethnic, racial, national, and cultural backgrounds whose ancestors lived in Spain or Latin America” (Pontón et al., 1996). This definition includes Mexicans, Puerto Ricans, Cubans, certain Caribbeans, and Central and South Americans. However, this does not signify a homogenous people. There is great diversity among the Hispanic peoples in terms of culture, including language, customs, mores, family values, attitudes toward education and work ethic. Just as English spoken in Australia is different than English spoken in Scotland, Spanish spoken in Puerto Rico is different than Spanish spoken in Mexico or Chile -- not only in vocabulary, but in rhythm, speed and pronunciation.

Between 2000 and 2010, the Hispanic population in the United States grew by 43 percent to 50.5 million, representing 13 percent of the total US population (US Census Bureau, 2011). This same population is projected to increase to 132.8 million by 2050, representing 30 percent of the nation’s population (US Census Bureau, 2012b). The United States has the second largest Hispanic population in the world, with Mexico containing the largest population at 112 million. Currently, almost two-thirds of the Hispanic population in this country are of Mexican descent, making them the largest Hispanic group in the US (US Census Bureau, 2012b).

Thirty-seven million US residents report speaking Spanish at home, with half of those reporting speaking English “very well” (US Census Bureau, 2012b). As the Hispanic population grows, so does the number of bilingual individuals within the United States. It will become increasingly important that neuropsychological testing, including those measuring verbal fluency, accurately assess both the monolingual majority and the growing bilingual minority, so that proper diagnoses and treatments are offered.

Cultural and Educational Influences on Cognitive Abilities

Cognitive abilities that are measured through neurocognitive testing represent learned abilities that vary with the subject’s educational opportunities and cultural experiences (Ardila, 1995). Level of acculturation can influence the measurement of cognitive abilities. It is theorized that those who are more acculturated better understand the shared values, knowledge, and communication inherent in cognitive tests created by the mainstream culture (Greenfield, 1997). For example, those who are not acculturated as highly into the mainstream culture may not understand that the speed at which they complete a neuropsychological test may be an important factor, as it is in many tests (Puente & Ardila, 2000). The person who is more acculturated will not be penalized in the same way. Recent research has demonstrated that level of acculturation is associated with Verbal and Full Scale IQ in Hispanic undergraduates, suggesting that the Hispanic students who are more closely aligned with mainstream US culture perform better on standardized cognitive tests (Verney, Bennett, & Candelaria, 2006).

Within the United States, the quality and quantity of education obtained by ethnic minorities tend to be lower than that of the mainstream European-American culture (Manly, 2006). A disproportionate number of minority children are labeled learning disabled while few are placed in gifted programs (MacMillan, Gresham, & Siperstein, 1993; Naglieri & VanTassel-Baska, 2008). In research performed with African Americans, the quality of education made a difference in neuropsychological testing results. Matching African American and European-American participants with the same quantity of education, usually measured in years, often found the African Americans scoring lower than European-Americans (Manly, Jacobs, Touradji, Small, & Stern, 2002). However, more recently researchers have measured the quality of education instead of the quantity with tools such as the Wide Range Achievement Test (WRAT; Wilkinson, 1993), adjusting the scores of the African Americans by quality instead of quantity of schooling. The overall effect of race in this case was greatly reduced. In one study, after adjusting for reading level using scores from the WRAT, previously significant differences between the African American and European-American participants in the areas of word list learning and memory, figure memory, abstract reasoning and visuo-spatial skills disappeared (Manly et al., 2002). The authors suggest that years of education is an inadequate measure of educational experience among different cultures. Similar findings from a 2007 study (Rohit et al., 2007) led its authors to state that "African Americans with poor educational quality may be incorrectly classified with neurocognitive impairment based on neuropsychological tests."

Hispanics tend to be lacking in educational achievement, both in quality and in quantity, compared to their European-American counterparts. Hispanics are more likely to start their education later and end earlier. According to the US Census Bureau (US Census Bureau, 2012a), almost 38 percent of Hispanic students drop out of high school, a number more than twice that of European-American or African American students. This lack of educational attainment among the Hispanic population may appear erroneously as cognitive impairment. For example, Puente and Ardila (2000) found that non-brain-damaged Hispanic illiterates had neuropsychological testing outcomes similar to educated brain damaged subjects. Likewise, individuals with less than six years of education have been found to perform up to two standard deviations below those with 16 or more years of education (Pontón et al., 1996). Because of these educational issues, Bohnstedt, Fox, and Kohatsu (1994) suggest that clinicians consider certain neurocognitive scores for African Americans and Hispanics as an underestimate of the cognitive abilities of these two groups as compared to their European-American counterparts.

In addition to cultural and educational influences on cognitive assessment, language factors significantly affect the clinician's ability to accurately assess cognition. In the United States, since currently most people are not bilingual, the effects of bilingualism on cognition and assessment typically are not considered. When bilingualism is considered in cognitive assessment it is usually seen as a dichotomous concept: either someone is bilingual or they are not. However, bilingualism is a complex linguistic issue in which there are many variables that influence both ones cognitive abilities and assessment both positively and negatively.

Measuring Level of Bilingualism

In general, bilingual individuals fall into two categories: balanced and unbalanced. Balanced bilingual individuals can maneuver in two languages equally well, both in oral and written expression. However, it is more common to consider someone who speaks two languages equally well to be a balanced bilingual, *sans* the reading and writing skills. True balanced bilinguals are few and far between. Unbalanced bilinguals, those who are dominant in one language over the other, are more common. The level of bilingualism plays a role in cognition and verbal skills.

There is currently no standardized way to assess one's level of bilingualism. Most often in research the participants are asked to rate their abilities in their first and second language using a Likert scale. Researchers debate the reliability of this method, but self-rating is generally thought to be adequate, especially in adults. One study examining self-assessment of language skills in bilingual Hispanics (Delgado, Guerrero, Goggin, & Ellis,

1999) found college age participants to be accurate in assessing their Spanish skills in reading, writing and speaking but not as accurate in assessing the same skills in English.

Also used to determine level of bilingualism is the Boston Naming Test (BNT; Kaplan, Goodglass, & Weintraub, 1983) which consists of 60 black and white line drawings. Participants are asked to name the drawings, usually in one language and then the other. Again, by comparing the results, it is possible to get an indication as to the level of spoken bilingualism. However, the BNT was created for use with monolingual English speakers. The drawings are ordered from easiest to hardest for the monolingual population. Studies published to date have shown that bilingual Hispanics score lower on the BNT than monolinguals (Boone, Victor, Wen, Razani, & Ponton, 2007; Gollan, Fennema-Notestine, Montoya, & Jernigan, 2007; Gollan, Montoya, Fennema-Notestine, & Morris, 2005; Kohnert, Hernandez, & Bates, 1998; Roberts, Garcia, & Desrochers, 2002). For instance, an igloo may be a word known in English, but a Spanish speaker may not know the word in Spanish even if they know it in English.

One study asked bilingual students to self-rate their language ability in both languages. They also were interviewed in both languages and then were given the BNT to see which method would produce the most accurate language ratings (Gollan, Weissberger, Runnqvist, Montoya, & Cera, 2012). In this experiment, the subjective self-classifications of English dominant, Spanish dominant or balanced bilingual did not differ from the objective classifications produced by the bilingual interviews. However, the classifications created from using the BNT were significantly different from the other two methods of classification. The BNT tended to underestimate the Spanish proficiency, and in some cases, reversed the reported language dominance. It also seemed to overestimate a bilingual's ability in English as compared to the interview or the self-assessment. A new assessment needs to be created for use with the bilingual population to evaluate spoken language dominance in order to obtain an accurate objective measure;.until then, it is likely that most studies will rely on self-report.

The Effects of Bilingualism on Cognition

Early theorists believed that being bilingual hampered a child (MacSwan, 2000), but the most recent research shows ways in which bilingualism may help cognitive development. Those who learn a second language at a young age tend to be more proficient in that second language than those who learn a second language later. The age at which one needs to learn a second language in order to be completely fluent, or balanced, is widely debated and ranges from age six (Archila-Suerte, Zevin, Bunta, & Hernandez, 2012; Johnson & Newport, 1989) to onset of adolescence (Bialystok & Miller, 1999; Luk, DeSa, & Bialystok, 2011).

A bilingual individual always has two languages activated (Brysbaert, 1998), as opposed to activating the one language needed at a particular time. Therefore, a bilingual child needs to develop some sort of mechanism to stop the intrusion of one language while speaking the other. A model has been proposed based on inhibitory control (Green, 1998) in which the language not needed at a particular time is suppressed using the same executive functioning used to control attention and inhibition. This control needs to be flexible enough that someone working as a translator can shift attention from one language to another, which would require rapid monitoring and efficient switching between the two languages (Bialystok, 2007). Assuming this inhibitory model is correct, bilingual children start at a very young age to develop control over executive processing, thereby strengthening the executive functioning needed to perform this task. This strengthening of executive functioning creates an advantage in bilingual children. This strengthening has been witnessed in fMRI studies (Hernandez & Meschyan, 2006; Rodriguez-Fornells et al., 2005) where bilinguals (and not monolinguals) engage two frontal brain regions during a naming task. These regions are the dorsolateral prefrontal cortex and the anterior cingulate cortex. It is believed that in order for bilingual individuals to resolve the conflict of which language to use during a naming task, these areas of executive functioning are activated.

The advantage of a more developed executive functioning region might carry over into adulthood, making bilingual adults, on average, more efficient in certain areas of executive processing which are learned or strengthened through skills related to bilingualism. It has been hypothesized that this advantage also carries through until old age, protecting bilingual adults from the otherwise normal decline in executive functioning that traditionally is seen in older adults (Bialystok, 2007).

Bilingual and Monolingual Differences

One negative effect of bilingualism is that compared to a monolingual individual, a bilingual person is more likely to have a smaller vocabulary in each language (Gollan et al., 2002). It is typically thought that if one were to count the vocabulary of both languages for a bilingual individual, that individual would have as large a vocabulary as the monolingual, if not larger.

Also seen in bilingual speakers is a cost in processing time created by switching from one language to another (Hernandez & Kohnert, 1999). This same type of cost is similar to what is witnessed during the Stroop task: When a participant switches from naming the color of text to reading the word, there is a longer response time as the person reorients to the new task at hand. It is believed that these switching costs in older adults are caused by the increased executive processing needed in the older adults to complete the switch (Wickens, Braune, & Stokes, 1987). Like task switching costs, language switching costs have also been documented (Hernandez & Kohnert, 1999).

In a language switching task, older Spanish-English bilingual adults had longer reaction times and more errors as compared with equivalent younger, college-age bilinguals. The reaction times were the longest when the older bilingual participants were asked to continually switch between their two languages when naming pictures. These longer reaction times are attributed to task set inertia in which they suffer from increased interference from previous task commands. This task set inertia is also thought to cause the task switching costs noted above, which were attributed to the breakdown of central executive processing, a normal byproduct of aging (Hernandez & Kohnert, 1999). While this additional processing time is relatively short, it can affect neurocognitive assessment of a bilingual individual, since these assessments are usually time-based, on the theory that the faster a person can answer, or the more answers given for a particular unit of time, the more cognitively intact that person is.

With a decline in executive functioning comes a decline in the ability to ignore irrelevant stimuli or to attend selectively to environmental cues. However, research has shown less decline in executive functioning in older adults for tasks which depend on strongly ingrained habits (Hay & Jacoby, 1999). For bilinguals, especially those who learned their L2 at a young age, it is fair to say that the executive functioning tasks that the bilingual individuals have cultivated and now use out of habit are exactly the ones that usually deteriorate with age. However, it is hypothesized that bilingualism may protect older adults against this type of decline. Bialystok and Craik (2007) tested this hypothesis using younger and older bilingual participants. The results showed that both the older and younger bilinguals performed better on tasks requiring greater working memory control, not just inhibition, as compared to monolingual individuals. The authors point out that their participants used two languages on a daily basis and learned their L2 by the age of ten. Therefore, their results may not generalize across all bilinguals.

Bilingualism and Verbal Fluency

Verbal fluency is considered to be the ease with which one can produce words. In general, two types of fluency are tested: semantic and phonemic. In common tests of semantic fluency, a person is asked how many words they can name that belong to a certain category, such as fruits, vegetables, or animals. Test of phonemic fluency asks a person to generate as many words as they can that start with a certain letter of the alphabet. Verbal fluency assessment is often used to diagnose those with traumatic brain injury (Rey et al., 2001), dementia, including Alzheimer's Disease (Taussig, Henderson, & Mack, 1992), dementia from alcohol (Saxton, Munro, Butters, Schramke, & McNeil, 2000) and dementia from AIDS (Milliken, Trépanier, & Rourke, 2004) as well as frontal lobe damage (Borkowski, Benton, & Spreen, 1967).

It has been documented that bilingual individuals often score lower on semantic, or categorical, verbal fluency tests (Boone et al., 2007; Gollan et al., 2007; Gollan et al., 2005; Kohnert et al., 1998; Roberts et al., 2002). However, research on bilingual people for phonemic, or letter, fluency is mixed. While some studies report no difference between bilingual and monolingual speakers (Bialystok, Craik, & Luk, 2008;

Portocarrero, Burright, & Donovick, 2007; Rosselli et al., 2000; Rosselli et al., 2002), other studies report that the bilingual individual is at a disadvantage (Boone et al., 2007; Gollan et al., 2002) (see Table 1). Notice that among the samples listed in Table 1, there is an assortment of bilingual individuals speaking numerous languages; even the native language may vary within a single study. Also, both ethnicity and age of participants vary greatly.

Table 1

Studies of Bilingual Phonemic Fluency

Author(s)	**Sample Characteristics**		**Result**
	Sample Age and Size	**Linguistic Characteristics**	
Rosselli, Ardila et al. 2000 & 2002*	Older Adults, mean age=62, n=19	Spanish-English bilinguals, L1=Spanish	Bilinguals ≈ monolinguals
Gollan, Montoya et al. 2002	Young adult, mean age=20, n=30	Spanish-English bilinguals, L1=Spanish	Bilinguals < monolinguals
Boone, Victor et al. 2007	Various ages, n=25	Various bilinguals, using several different languages, L1=mixed	Bilinguals < monolinguals
Portocarrero, Burright et al. 2007	College Students, n=39	Various bilinguals, using several different languages, L1=mixed	Bilinguals ≈ monolinguals
Bialystok et al. 2008	College Students, n=24	Various bilinguals, using several different languages, L1=mixed	Bilinguals ≈ monolinguals

L1=First Language Learned * the same sample was used for both articles

The discrepancy found in phonemic fluency research does not seem to fall along age lines. Rosselli et al.'s (2000) participants were in their 60's and Portocarrero et al.'s (2007) participants were college students, yet they both found no difference in phonemic performance between the bilingual and monolingual participants. Gollan et al. (2002) and Boone et al. (2007) also tested different age groups and did find a difference between bilinguals and monolinguals, with monolinguals scoring significantly higher in both studies.

Rosselli et al. (2000) tested an age of acquisition effect, splitting the participants using the criteria of learning L2 before or after age 12, but did not find a significant difference in semantic or phonemic fluency. However, no further information is offered regarding percent use of both languages on a daily basis, preferred language, or education in L2. Portocarrero et al.'s (2007) sample was all foreign-born, moved to the US after the age of 5, had parents whose native language was not English, and included a wide range of first languages, including various Asian languages, Creole, Polish, Portuguese, Russian and Spanish, thus creating a very heterogeneous sample.

Boone et. al (2007) report collecting data regarding first language, age of acquisition of English, and number of years educated in the US, but these data are not published in the article. It is reported that 25 of the 161 participants spoke English as a second language, however the various first languages spoken by participants in the bilingual group are not mentioned. Boone also only mentions that those who had English as a second language scored lower on the phonemic fluency test, but reports little else about this population.

Both Portocarrero et al. (2007) and Boone et al. (2007) seem to have had a rather heterogeneous group of bilinguals, both linguistically and culturally. Confounding variables, such as participant's first language, participant's preferred language, and years of education in English may have contributed to the mixed outcomes.

Gollan et al.'s (2002) sample was more homogeneous than those found in most studies. Their sample all had Spanish as a first language, were first exposed to English at an average age of 3.4 years, claimed using English 77% of the day, and in general reported that they were had better language skills in English than Spanish. Among this more homogenous group, monolingual participants outscored the bilingual participants in both semantic and phonemic fluency. Because this sample is more homogeneous than the Boone et al. (2007) or Portocarrero et al. (2007) samples, it may appear that Gollan et al.'s (2002) results are more reliable than other studies for the Spanish-English bilingual.

While Gollan et al. (2002) report differences in both semantic and phonemic fluency, they recognize that there are greater differences in terms of scores for semantic than for phonemic categories. In other words, there is a greater bilingual effect for the semantic fluency test than the phonemic test. One-third of the bilingual participants scored at least one standard deviation below the monolinguals in phonemic fluency, while two-thirds scored at least one standard deviation below the monolingual participants in semantic fluency.

Michael and Gollan (2005) point out that one possible reason for the difference in phonemic fluency compared to semantic fluency is the use of cognates by bilingual individuals. A cognate is a word that is similar in two languages, such as the word *flower* in English and the word *flor* in Spanish. Cognates are easier for bilingual individuals to produce than non-cognates, such as *dog* in English and *perro* in Spanish (Gollan & Acenas, 2004). This is an example of cross-language facilitation. The use of cognates in phonemic fluency helps the bilingual speaker to quickly produce more words beginning with a certain letter, allowing them to score closer to, or in some studies the same, as a monolingual. The use of cognates is not found to the same degree in semantic fluency tasks, possibly explaining the greater differences found between bilingual and monolingual participants in this task.

Phonemic fluency is most often tested using the Controlled Oral Word Association Test (COWA; Spreen & Strauss, 1998). Participants are asked to generate as many words as they can, using the initial letters ‘F’, ‘A’, and ‘S’, with in one minute for each letter; hence its acronym, the FAS test. The letters ‘F’, ‘A’, and ‘S’ were chosen because of the relatively high frequency of words beginning with those letters in English. Approximately 24 percent of English words start with one of those three letters. (In comparison, less than 20 percent of Spanish words begin with ‘F’, ‘A’, and ‘S’.)

The normative sample for the COWAT were maternity patients at the University Hospital in Iowa City during the mid 1960s. No other demographic information is given for the sample, such as ethnic breakdown or bilingualism. However, since the 2000 census reported that Iowa City was comprised of 87 percent European-Americans, with only 12 percent speaking a language other than English at home, one can infer that the vast majority of maternity patients in Iowa City during the 1960s were monolingual European-Americans.

Some researchers suggest that caution be used when testing minority clients with the COWAT. One study (Johnson-Selfridge, Zalewski, & Aboudarham, 1998) found significant group differences between African-American, Hispanic, and European-American participants, with European-American participants scoring the highest and Hispanics scoring the lowest. Taussig et al. (2006) report that the letter ‘S’ is particularly problematic for Spanish speakers, including bilinguals. Words that start with the ‘S’ sound in Spanish may also begin with the letter ‘C’ or ‘Z’, creating a more difficult cognitive task for the Spanish speaker, since they must suppress the words that begin with ‘C’ or ‘Z’ during the phonemic fluency task. Also, there are far fewer words that begin with the letter ‘S’ in Spanish than there are in English (12 percent of English words start with ‘S’ while less than 6 percent of Spanish words start with S), leaving one with fewer possible words to choose from.

Since there are fewer Spanish words that begin with ‘F’, ‘A’, or ‘S’ as compared to English, it has been suggested that when testing someone in Spanish, the letters ‘P’, ‘M’, and ‘R’ should be used. This is owing to the equivalence of available words in Spanish beginning with those letters (24%) when compared to ‘F’, ‘A’, and ‘S’ in English (Gollan et al., 2007). It may be possible that there are letters that could be used for both monolingual European-Americans, who comprise the majority of the population in the United States, and bilingual Hispanics, thereby minimizing a possible language bias when testing phonemic verbal fluency.

One might assume that using ‘P’, ‘M’, and ‘R’ in English would work. However, the letters ‘F’, ‘A’, and ‘S’ account for the first letter in about 24% of English words while ‘P’, ‘M’, and ‘R’ account for the first letter in approximately 19% of English words. Clearly, results in English with ‘F’, ‘A’, and ‘S’ would not be the same as if ‘P’, ‘M’, and ‘R’ were used.

Gollan et al.’s (2002) results show that there is no significant difference between the bilingual Spanish-first Hispanics and monolingual English in the number of correct responses given in English for letters ‘M’, ‘D’, ‘F’, ‘R’, and ‘C’ (see Table 2). Even more interesting, when bilingual participants were allowed to use both languages instead of only answering in English, they had fewer responses, although this difference did not reach significance. Unfortunately, these results have not been replicated to date because other studies in the area of phonemic fluency only use the standard ‘F’, ‘A’, and ‘S’.

Table 2

Gollan et al.’s (2002) Mean (SD) for Phonemic Fluency by Letter

Initial Letter	**Bilingual**	**Monolingual**	**Significance**
F	12.93 (3.53)	13.47 (4.20)	p=0.18
A	9.80 (3.63)	13.07 (4.01)	p=0.00
S	13.87 (2.86)	16.73 (3.69)	p=0.00
R	13.00 (2.36)	13.27 (2.89)	p=0.14
C	14.53 (2.56)	14.80 (3.68)	p=0.16
M	12.13 (2.67)	12.37 (3.16)	p=0.18
D	12.67 (4.55)	13.73 (3.40)	p=0.08

Gollan et al.’s (2002) results suggest that some combination of the letters ‘C’, ‘D’, ‘F’, ‘R’, and ‘M’ could create a more linguistically fair phonemic verbal test. When one takes into account the number of words available starting with each of the letters above in both English and Spanish, a possible combination of letters that might create an even playing field for both monolingual European-Americans and bilingual Hispanics is ‘B’, ‘C’, and ‘T’. These letters account for the first letter of 21 percent of both Spanish words and English words. Matching the number of words possible using ‘B’, ‘C’, and ‘T’ gives bilinguals the chance to use cross language facilitation in the form of cognates. If a letter combination were used in which both monolingual European-Americans and bilingual Spanish-English Hispanics scored the same, it will be possible to assess the vast majority of the country with one set of valid norms. As most physicians and other health professionals assume a patient who speaks English is monolingual and tend to not inquire as to the linguistic background of their patient, norms that are valid for both monolingual European-Americans and bilingual Hispanics would decrease the incidence of erroneous diagnoses of cognitive impairment; thus in turn would lead to more accurate treatment.

Purposes and Specific Aims

The purpose of this study was to investigate phonemic fluency between bilingual Hispanics and monolingual European-Americans using standard letters ‘F’, ‘A’, and ‘S’. In addition, this research explored what other letters may be better suited for the task of measuring phonemic fluency for both populations.

Aim 1: Investigate the performance of bilingual Hispanics in phonemic fluency compared to monolingual European-Americans using the standard letters of ‘F’, ‘A’, and ‘S’.

Hypothesis 1: Bilingual Hispanics will score lower using the letters ‘F’, ‘A’ and ‘S’ when compared to monolingual European-Americans.

Aim 2: Examine five additional letters based on the literature to discover which set of three letters will lead to similar phonemic fluency performance between the two linguistic groups.

Hypothesis 2: The letters ‘B’, ‘C’, and ‘T’ will show no significant difference based on similar first letter frequency in both Spanish and English.

Aim 3: Assess bilingual-related parameters including first language learned, language dominance and preferred language on phonemic fluency performance for the bilingual Hispanics.

Hypothesis 3: English dominant, Spanish dominant and balanced bilingual participants will perform similarly using ‘C’, ‘D’, and ‘M’. Native language will not create a significant difference in the phonemic fluency scores.

Aim 4: Examine levels of acculturation and its association with phonemic fluency.

Hypothesis 4: Cultural factors, such as acculturation, will not play a role in the phonemic fluency.

Methods

Participants

Both monolingual European-American and Spanish-English bilingual Hispanic students were recruited from psychology classes in a Southwestern English speaking University. Participants were all between the ages of 18 and 35. All signed a consent that was approved by the university IRB. Participants were given course credit for their participation.

Thirty-three monolingual European-American students were recruited who were between the ages of 18 and 35 years. Three were excluded from analyses for the following reasons: one was bilingual with ASL as the second language, one was dyslexic, and one scored greater than three standard deviations below the mean for TMT-A, indicating possible deficit in processing speed.

One-hundred bilingual Hispanic students between the ages of 18 and 35 were recruited. One bilingual student was excluded from analyses because of a score greater than three standard deviations below the mean for TMT-B, indicating a possible deficit in executive functioning.

Bilingual participants only filled out a language questionnaire based on the Language History Questionnaire by Li, Sepanksi and Zhao (2006) (See Appendix A). This questionnaire asked participants to rate their ability in reading, writing, speaking and listening in both English and Spanish on a 7-point Likert scale with 1 equaling “little to no knowledge” and 7 equaling “like a native speaker.” These numbers were then averaged per language to determine the language dominance of the participant: English dominant, Spanish dominant or balanced bilingual. If the participant’s two language scores were less than 0.5 points apart, additional information regarding the participant's preferred language for watching television and/or reading a book was taken into consideration. In all cases, participants' preferred language also happened to be their dominant language, and not necessarily their first language. Table 3 presents the mean language scores derived from the Language History Questionnaire in English and Spanish for each language group.

Table 3

Mean Language Scores from Language History Questionnaire for Bilingual Participants

	Mean English Score (SD)	**Mean Spanish Score (SD)**
English Dominant	6.7 (0.53)	5.7 (0.89)
Spanish Dominant	5.7 (0.73)	6.6 (0.51)
Balanced	6.6 (0.58)	6.5 (0.51)

Materials

All participants completed a measure of depression (Center for Epidemiologic Studies Depression Scale; CES-D), a screen of alcohol misuse (Alcohol Use Disorders Identification Test; AUDIT), the Scale of Ethnic Experience as well as a biographical questionnaire. All participants also took part in a short neuropsychological assessment that included the General Ability Measure for Adults (GAMA), the Wide Range Achievement Test 3 (WRAT3) Reading test, Blue form and the Trails Making Test (TMT) parts A and B. For the phonemic fluency test, The Controlled Oral Word Association Test (COWAT) was used. All participants were asked to say as many words as they could in a minute starting with the following letters: the standard letters of 'F', 'A', and 'S', as well as 'B', 'C', 'D', 'M', 'P', 'R' and 'T'. The order of the letters given was randomized. In addition, participants were asked to participate in two semantic fluency tasks for exploratory analyses. The two categories used were “animals” and “fruits and vegetables.” Responses were audio recorded in order to verify the correct number of responses after testing.

Scale of Ethnic Experience (SEE): The SEE (Malcarne, Chavira, Hernandez & Liu, 2006) is a self-report questionnaire that measures an individual's ethnic comfort in comparison to mainstream culture across ethnicities. Four subscales were derived from a factor analysis and were consistent across the four normative ethnic groups. The SEE subscales include: Ethnic Identity, Perceived discrimination, Social Affiliation and Mainstream comfort. Ethnic Identification is defined as the degree to which one identifies with his/her own ethnicity. Perceived Discrimination is the degree to which one believes his/her ethnicity is discriminated against by mainstream culture. Mainstream Comfort is the degree to which an individual is comfortable in mainstream US society. Social Affiliation is the degree to which one prefers to associate with those of their own ethnicity. All SEE variables are measured using a 5-point Likert scale. The SEE has been found to have sound psychometrics for various ethnic groups in the US, including test-retest reliability, internal consistency, and criterion and construct validity.

General Ability Measure for Adults (GAMA): The GAMA (Naglieri & Bardos, 1997) is a nonverbal test designed to evaluate an individual's general cognitive ability. It can successfully be used with anyone who can read and understand English at a third grade level. The test yields a single general ability score with a mean of 100 and a standard deviation of 15. The GAMA is strongly correlated with other intelligence tests ($r=0.75$ for WAIS III) and was constructed for use in a diverse population. Scores are reported as estimated IQ scores according to the GAMA manual.

Wide Range Achievement Test 3 (WRAT3) Reading Test: The WRAT3 (Wilkinson, 1993) Reading Test was created to gauge English language academic achievement and to give a general indication of the English instructional level of an individual. The Reading test is constructed of English words that vary from simple (e.g. cat) to difficult (e.g. terpsichorean) based on phonetic irregularities and infrequent usage. The participant must read the words aloud to the experimenter who scores the test based on the number of words pronounced correctly. These scores are turned into standard scores based on the participant's age. Of the two forms available, only the blue form was used in this study.

Trails Making Test (TMT): The Trails Making Test consists of a "connect the dots" type of task. Part A asks participants to connect circles that are numbered from 1 to 25 by drawing a line between them in sequential order as quickly as possible. This test is known as a test of processing speed (Lezak, Howieson, & Loring, 2004). Part B consists of circles with numbers from one to 13 and letters from A to L. The participant must draw a line connecting the circles as quickly as possible in a pattern that alternates between numbers and letters (e.g., 1-A-2-B, etc.). Part B is considered a test of executive functioning (Lezak et al., 2004). The score reported for each part of the TMT is a t-score based on Halstead-Reitan norming tables that take into account the participant's age and level of education.

Data Analysis

In general, the data were examined for outliers and for a uniform distribution as well as homogeneity of variance. Correlations were run between possible confounding and dependent variables of interest. When examining phonemic fluency, significant correlations were found between bilingual students' phonemic fluency scores and level of cognitive ability as measured by the GAMA as well as drinking patterns as measured by the AUDIT. For this reason, both GAMA and AUDIT scores were used as covariates in phonemic fluency analyses. Level of current depression, as measured by the CES-D, was hypothesized to be a possible confounding variable, but it was determined that it did not affect verbal performance. Therefore was not used as a covariate. Also, a rough estimate of socio-economic status constructed from the level of parental education and income was not found to be a confound and was not used as a covariate.

To investigate Aims 1 and 2, the performance of Hispanic bilinguals in phonemic fluency compared to monolinguals using the standard letters of 'F', 'A', and 'S', as well as the alternate letters, an ANCOVA with GAMA and AUDIT scores as covariates was used to test for significant differences between the two groups.

To investigate Aim 3, to assess associations related to bilingualism on phonemic fluency performance for the Hispanic bilinguals, an ANCOVA with GAMA and AUDIT scores as covariates was used to test for significant differences between the two groups. If a significant difference was found, a post-hoc analysis using Fisher's Least Significant Difference (LSD) Test was performed to examine the following bilingual variables: language dominance, age of acquisition and native language.

For Aim 4, a regression analysis was performed using acculturative variables to explore whether acculturation had any affect on phonemic fluency performance.

Exploratory analyses included examination of semantic fluency between monolinguals and bilinguals as well as different groups of bilinguals using an ANOVA, additional examination of age of acquisition to better understand its influence on phonemic fluency performance using an ANCOVA with GAMA and AUDIT scores as covariates, and a correlational analysis to investigate the relationship of cognitive ability and phonemic fluency for monolinguals and bilinguals.

Results

Descriptive Analyses

Table 4 presents the demographic information for the monolingual (*n*=30) and bilingual participants (*n*=99). Participants had a mean age of approximately 20 years with a range of 18 to 35 and a mean education level of 12.78 years with a range of 12 to 16 years. The two linguistic groups did not differ in terms of age, years of education or sex. They also did not differ in terms of levels of depression as measured by the CES-D or amount of drinking, as measured by the AUDIT. They did, however, differ in terms of socio-economic status (SES) as measured by their parents' annual income and educational level with the monolingual students reporting significantly higher SES than the bilingual students

Table 4

Demographic Information for Monolingual and Bilingual Participants.

Characteristic	Monolingual (n=30) Mean (SD)	Bilingual (n=99) Mean (SD)	Statistic	Significance (p value)
Gender (% female)	63%	66%	χ^2=0.30	0.58
Age (in years)	19.6 (1.33)	20.00 (3.2)	F(1, 128) = 0.775	0.38
Education (in years)	12.83 (0.91)	12.72 (1.07)	F(1, 128) =0.295	0.59
Substance use (AUDIT)	5.48 (7.33)	4.24 (5.11)	F(1, 128) = 1.060	0.31
Depression (CES-D)	12.67 (9.03)	11.18 (7.99)	F(1, 128) =0.749	0.39
Parents' Education	12.40 (2.58)	7.09 (3.50)	F (1, 126) = 58.91	<0.01
Annual Income*	18.21 (2.87)	11.04 (4.43)	F(1, 121)= 65.00	<0.01

*Annual income is comprised of mother and father income and parents' education level.

Table 5 presents the neurocognitive functioning and English reading level for both groups. There are significant differences in all areas including cognitive ability as measured by the GAMA, processing speed as measured by the TMT-A, executive functioning as measured by TMT-B, and English reading ability as measured by the WRAT3 Reading test. The monolingual group scored higher on all neuropsychological functioning measures when compared to the bilingual group; however, both groups scored in the average range with the exception of cognitive ability, in which the monolinguals scored in the above average range and the bilingual scored in the average range.

Table 5

Neuropsychological Scores for Participants

Characteristic	**Monolingual (*n*=30) mean (SD)**	**Bilingual (*n*=99) mean (SD)**	**Statistic**	**Significance (p value)**
GAMA	111.67 (12.47)	102.77 (10.80)	F(1, 128)=14.52	0.01
WRAT3	106.63 (7.85)	99.37 (8.75)	F(1, 128)=16.57	0.01
TMT-A	50.77 (9.28)	44.99 (9.65)	F(1, 128)=8.40	0.01
TMT-B	56.77 (9.77)	46.99 (9.02)	F(1, 128)=26.02	0.01

Notes: GAMA = General Ability Measure for Adults; WRAT3=Wide Range Achievement Test; TMT-A=Trails Making Test A T-score; TMT-B=Trails Making Test B T-score.

Phonemic Fluency in Monolingual and Bilingual Individuals: Standardized Test Performance

Specific Aim 1 of this research investigated phonemic fluency performance of monolingual and bilingual participants on the standardized letters of ‘F’, ‘A’, and ‘S’. Table 6 presents both the individual letter performance and the summated triplet letter performance for both groups. General cognitive ability, as measured by GAMA, and substance use, as measured by AUDIT, correlated significantly with phonemic fluency for the bilinguals; thus, these two confounding variables were used as covariates in the ANCOVA used to address this aim. No significant differences in any individual letter or the triplet performance was found between the monolingual and the bilingual participants.

Table 6

Phonemic Fluency Scores For Monolingual And Bilingual Participants

Characteristic	Monolingual (*n*=30) mean (SD)	Bilingual (*n*=99) mean (SD)	Statistic F(1, 128)	Significance (p value)
F	12.07 (4.56)	10.85 (3.78)	0.74	0.39
A	10.77 (2.64)	9.17 (3.69)	1.08	0.30
S	14.20 (4.62)	12.35 (4.49)	1.125	0.29
FAS	37.10 (10.05)	32.43 (10.21)	1.40	0.24

Phonemic Fluency in Monolingual and Bilingual Individuals: Exploratory Test Performance

The purpose of Aim 2 was to examine performance with additional letters based on the literature in order to determine whether different letters seem more culturally and/or linguistically fair. Letters ‘B’, ‘C’, ‘D’, ‘M’, ‘P’, ‘R’, and ‘T’ were chosen because they showed the most promise regarding equivalent performance between monolingual and bilingual participants according to previous literature (Gollan et al., 2002). Again, there were no significant differences between the monolingual and the bilingual scores, except for the letter ‘T’, for which the monolingual participants scored significantly higher (see Table 7).

Table 7

Phonemic Fluency For Alternate Letters.

Characteristic	**Monolingual (*n*=30) mean (SD)**	**Bilingual (*n*=99) mean (SD)**	**Statistic F(1, 128)**	**Significance (p value)**
B	13.50 (3.24)	11.37 (3.78	2.58	0.11
C	12.43 (3.41)	11.27 (3.66)	0.13	0.74
T	12.93 (3.87)	10.94 (3.61)	4.22	0.04
P	12.80 (3.75)	11.30 (3.49)	1.25	0.27
M	11.37 (3.69)	10.40 (3.86)	0.08	0.78
R	11.70 (3.16)	10.40 (3.65)	1.16	0.28
D	12.17 (3.12)	10.94 (3.94)	0.05	0.82

Two more letter triplets were tested based on letter frequency in Spanish and English to facilitate the use of cognates and one triplet was constructed based on the least difference found between the two language groups using the results above. BCT was chosen because there are an equal number of words that begin with those three letters in both English and Spanish. The triplet PMR was also investigated because there are more Spanish words than English words available. The triplet CDM was investigated because each letter in this triplet had the most similar scores between the monolingual and bilingual participants. Table 8 presents the results for the alternate triplets. In all cases, no significant differences were found.

Table 8

Phonemic Fluency for Alternate Letter Triplets

Letters	Monolingual	Bilingual	F(1,128)	Significance (p value)
BCT	38.90 (8.76)	33.64 (10.01)	2.28	0.13
PMR	35.87 (8.71)	32.24 (9.56)	0.84	0.36
CDM	36.00 (8.55)	32.58 (10.22)	0.15	0.70

There are no differences in phonemic fluency between bilingual and monolingual participants, suggesting published norms could be used for this group without penalizing the bilingual participants. However, bilingualism has many linguistic attributes that are not applicable to monolingual speakers. There is reason to believe that these attributes may affect the phonemic fluency of a bilingual participant. These attributes will be explored next.

Bilingual Characteristics Associated with Verbal Fluency

Bilingualism consists of several characteristics that influence language proficiency including first language learned, language dominance, preferred language and age of acquisition of the second language. Therefore, the associations between these parameters and verbal fluency performance were investigated for the bilingual participants in this study. Table 9 presents the language characteristics for the bilingual participants. Age of acquisition of the second language (AoA) was categorized into two groups, with the early AoA group including participants who learned their second language by the age of 6, and the late AoA group including participants who learned their second language after age 6.

Table 9

Characteristics of Bilingual Participants

Characteristic	**n**	**%**
Language Dominance		
English Dominant	48	48.5
Balanced	25	25.2
Spanish Dominant	26	26.3
Descent		
Mexican/Mexican-American	94	95.0
Peruvian	1	1.0
Cuban	1	1.0
Columbian	1	1.0
Salvadorian	1	1.0
Country of Origin		
Born in US	68	68.7
Born outside US	31	31.3
First Language		
English	7	7.1
Spanish	74	74.7
Both	18	18.2
Age of Acquisition of Second language (AoA)		
Early	77	77.8
Late	22	22.2

Early AoA=second language learned by age 6 years.

First language: First language was investigated as a possible significant factor in verbal fluency by separating the bilingual participants into 3 groups based on first language: English (n=7), Spanish (n=74) or both (n=18). The participants in this study were recruited along language dominant lines, not by first language learned; thus, bilingual first language group sizes vary. Table 10 presents the demographic and neuropsychological information for the first language groups. A one-way analysis of covariance (ANCOVA) with the AUDIT and GAMA as covariates was conducted to investigate first language group differences on these variables. No significant differences among the three bilingual groups were found for English reading level, cognitive ability, age in years, or level of education. However, significant differences were found for processing speed as measured by TMT-A and cognitive flexibility as measured TMT-B. Participants who learned English first scored significantly higher than the other bilingual groups on TMT-A ($p<0.01$). Those with Spanish as a first language scored significantly lower than the other two groups on TMT-B ($p=0.02$).

Table 10

Demographic And Neuropsychological Information For Bilingual Participants Grouped By First Language.

First Language	English (*n*=7): mean (SD)	Spanish (*n*=74): mean (SD)	Both (*n*=18): Mean (SD)	Statistic F(2, 96)	Significance (p value)
Age in years:	19.71(3.68)	20.04 (3.22)	19.89 (3.32)	0.04	0.96
Years of Education:	12.86 (1.46)	12.69 (0.98)	13.00 (1.33)	0.63	0.54
GAMA:	103.57 (4.86)	103.26 (11.35)	100.44 (10.21)	0.51	0.60
WRAT3:	104.57 (4.24)	99.34 (9.08)	97.50 (8.14)	1.67	0.19
TMT-A: T-score	55.57 (7.46)	44.00 (9.44)	44.94 (9.17)	4.97	< 0.01
TMT-B: T-score	53.14 (11.61)	45.54 (8.96)	50.56 (6.17)	4.26	0.02

Table 11 presents the phonemic fluency performance for the bilingual groups according to the first language learned for the standardized letters of ‘F’, ‘A’, and ‘S’, and the exploratory letters, as well as the standardized and exploratory letter triplets. Analysis of covariance statistics was conducted to investigate group performance on each of the letters and letter triplets with GAMA and AUDIT as covariates. Significant differences among the first language groups were found for letters ‘F’, and ‘D’, and triplets BCT, PMR, and CDM.

Table 11

Phonemic Fluency Performance For Bilingual Participants Grouped By First Language.

First Language	English (n=7): mean (SD)	Spanish (n=74): mean (SD)	Both (n=18): Mean (SD)	Statistic F(2, 96)	Significance (p value)
Letter					
F	13.14 (3.44)	10.32 (3.76)	12.06(3.79)	3.02	0.05
A	10.43 (3.51)	8.88 (3.97)	9.88 (2.29)	1.13	0.33
S	13.86 (4.26)	11.89 (4.60)	13.53 (3.99)	1.51	0.23
B	12.13 (3.41)	10.89 (3.91)	12.94 (3.03)	2.71	0.07
C	12.86 (1.86)	10.84 (3.72)	12.53 (3.73)	2.45	0.09
T	12.57 (2.99)	10.42 (3.61)	12.29 (3.50)	2.67	0.08
P	13.67 (2.34)	11.01 (3.40)	11.41 (3.97)	1.74	0.18
M	12.29 (3.55)	9.95 (3.94)	11.41 (3.41)	2.31	0.11
R	11.57 (4.24)	9.99 (3.53)	11.71 (3.85)	1.94	0.15
D	12.14 (4.26)	10.39 (3.74)	12.82 (4.34)	3.37	0.04
Letter Triplet					
FAS	37.57 (9.91)	31.16 (10.53)	35.47 (8.02)	2.48	0.09
BCT	37.86 (7.40)	32.23 (10.23)	37.77 (8.91)	3.07	0.05
PMR	39.83 (6.79)	31.00 (9.48)	34.53 (9.56)	3.49	0.04
CDM	37.29 (8.99)	31.18 (10.11)	37.29 (8.99)	3.44	0.04

Language dominance. Next, bilingual participants were grouped by language dominance: English dominant (n=48), Spanish dominant (n=26), and balanced bilingual (n=25). Table 12 presents the demographic and neuropsychological test scores and related statistics for the three language dominance groups. Analysis of variance revealed a significant difference for TMT-B scores among the groups. Post-hoc analyses revealed that the English dominant group scoring significantly higher than Spanish dominant students ($t(72)=-2.56$, $p=0.01$). No significant differences were found among the language dominant groups for age, level of education, GAMA or TMT-A scores among the three bilingual groups. A marginally significant result was found for WRAT3 Reading Subtest scores with follow-up analyses revealing that the English dominant group scored significantly higher than the Spanish dominant group ($t(72)= -2.18$, $p=0.03$). In general, all bilingual groups scored in the average range for the GAMA, WRAT3 Reading, TMT-A, and TMT-B tests.

Table 12

Demographic and Neuropsychological Scores For Bilingual Participants Grouped By Language Dominance.

Characteristic	**English Dominant (*n*=48): Mean (SD)**	**Balanced (*n*=25): Mean (SD)**	**Spanish Dominant (*n*=26): Mean (SD)**	**Statistic F(2,96)**	**Significance p-value**
Age in years	19.71 (2.84)	19.76 (2.15)	20.73 (4.54)	0.93	0.40
Years of Education	12.65 (1.02)	12.84 (1.21)	12.88 (1.07)	0.51	0.61
GAMA	103.81 (10.49)	99.16 (8.91)	104.31 (12.52)	1.92	0.15
WRAT3	101.46 (8.59)	98.08 (7.84)	96.77 (9.26)	2.89	0.06
TMT-A: T-score	46.35 (9.31)	43.68 (10.69)	43.73 (9.23)	0.93	0.40
TMT-B: T-score	48.92 (8.49)	46.96 (9.03)	43.46 (9.22)	3.23	0.04

Table 13 presents the phonemic fluency performance for the language dominance groups for all letters and letter triplets. Analyses of covariance with AUDIT and GAMA as covariates resulted in significant group differences on all letters and triplets. Follow-up analyses revealed that Spanish dominant bilinguals scored significantly lower than the two other groups in all cases (t-tests resulted in $p \leq 0.01$). Similarly, follow-up analyses on the letter triplets also revealed that the Spanish dominant bilinguals scored significantly lower than the other bilingual groups for all letter triplets (FAS, BCT, PMR, CDM).

These findings suggest that Spanish dominant bilinguals are at a disadvantage for phonemic fluency performance in English.

Table 13

Phonemic Fluency Performance For Bilingual Participants Grouped by Language Dominance

Characteristic	**English Dominant (*n*=48): mean (SD)**	**Balanced (*n*=25): mean (SD)**	**Spanish Dominant (*n*=26): mean (SD)**	**Statistic F(2,96)**	**Significance p-value**
Letter					
F	11.77 (3.24)	11.21 (4.20)	8.73 (3.66)	6.28	<0.01
A	9.63 (3.32)	10.04 (3.99)	7.50 (3.74)	4.74	0.01
S	13.10 (3.97)	13.33 (5.00)	9.93 (4.31)	5.93	<0.01
B	12.21 (3.37)	12.17 (4.32)	9.08 (3.12)	8.40	<0.01
C	11.79 (3.35)	12.42 (3.87)	9.27 (3.40)	6.84	<0.01
T	11.54 (3.35)	12.25 (3.91)	8.46 (2.63)	9.52	<0.01
P	12.21 (3.31)	11.54 (3.27)	9.12 (3.17)	8.15	<0.01
M	11.48 (3.11)	11.08 (4.01)	7.66 (3.80)	12.24	<0.01
R	11.15 (3.35)	11.25 (3.18)	8.23 (3.90)	7.03	<0.01
D	11.88 (3.59)	11.88 (3.79)	8.35 (3.74)	9.86	<0.01
Letter Triplet					
FAS	34.58 (9.01)	34.58 (11.36)	26.23 (9.09)	7.76	<0.01
BCT	35.68 (8.80)	36.92 (10.98)	26.81 (8.23)	10.60	<0.01
PMR	34.85 (7.99)	33.96 (9.22)	25.28 (9.67)	11.83	<0.01
CDM	35.15 (8.55)	35.38 (10.43)	25.27 (9.58)	12.86	<0.01

Age of acquisition of the second language (AoA). Finally, bilingual participants were categorized into groups based on the age at which they acquired their second language, regardless of whether the second language was English or Spanish. The early group consisted of participants who learned their second language by age 6 (AoA average age 3.2 years, n=77). Of these, eleven were Spanish dominant, 21 were balanced and 45 were English dominant bilinguals. The late group consisted of participants who learned their second language after age 6 (AoA average age 10.0 years, n=22). Of these, fifteen were Spanish dominant, four were balanced and three were English dominant bilinguals. Table 14 presents the demographic and neuropsychological information for the bilinguals divided into early and late AoA groups. Analyses of variance resulted in a group difference for age, with the late AoA group being significantly older than the early group. No significant group differences were found for education. The early AoA group scored significantly higher than the late group on the WRAT3 Reading subtest suggesting greater English reading ability. However, both groups scored at a high school reading level for English. No significant differences were found between the AoA groups for GAMA, TMT-A, or TMT-B scores. As before, all groups scored in the average range in each neuropsychological domain.

Table 14

Demographic and Neuropsychological Scores for Bilingual Participants Grouped by Age of Acquisition (AoA).

Characteristic	**Early AoA* (*n*=77): mean (SD)**	**Late AoA (*n*=22): mean (SD)**	**Statistic F(1,97)**	**Significance p-value**
Age in years	19.65 (2.53)	21.18 (4.87)	3.96	0.05
Education in years	12.71 (1.07)	12.91 (1.11)	0.56	0.46
GAMA	103.03 (10.64)	101.86 (11.56)	0.20	0.66
WRAT3	100.77 (8.81)	94.50 (6.71)	9.53	<0.01
TMT-A: T-score	45.45 (9.68)	43.36 (9.58)	0.80	0.37
TMT-B: T-score	47.44 (8.00)	45.41 (12.03)	0.87	0.35

* Early AoA = those who learned a second language by the age of 6 years.

Table 15 presents the phonemic fluency performance for the early and late AoA groups. Analyses of covariance with GAMA and AUDIT as covariates revealed that the early AoA bilinguals scored significantly higher for all letters and triplets compared to the late AoA bilinguals, with the exception of the letter ‘A’ in which the early AoA group scored higher, with the significance equal to 0.06.

Table 15

Phonemic Fluency Performance For Bilingual Participants Grouped By Age Of Acquisition (AoA).

Characteristic	Early AoA (n=77): mean (SD)	Late AoA (n=22): mean (SD)	Statistic F(2,96)	Significance p-value
Letters				
F	11.30 (3.47)	9.18 (4.44)	5.36	0.02
A	9.59 (3.39)	7.68 (4.43)	3.52	0.06
S	13.00 (4.10)	9.95 (5.09)	6.28	0.01
B	11.88 (3.32)	9.64 (4.80)	4.97	0.03
C	11.72 (3.39)	9.73 (4.26)	3.89	0.05
T	11.36 (3.33)	9.32 (4.18)	5.01	0.03
P	11.80 (3.39)	9.36 (3.17)	7.74	0.01
M	11.07 (3.50)	7.95 (4.17)	9.96	<0.01
R	10.93 (3.28)	8.55 (4.38)	6.26	0.01
D	11.76 (3.64)	8.09 (3.79)	14.73	<0.01
Letter Triplets				
FAS	33.93 (8.94)	26.95 (12.65)	6.73	0.01
BCT	35.05 (8.76)	28.68 (12.60)	5.83	0.02
PMR	33.97 (8.52)	26.00 (10.59)	11.01	<0.01
CDM	34.56 (9.02)	25.77 (11.35)	11.94	<0.01

In summary, bilingual characteristics appear to have a significant impact on phonemic fluency performance. Categorizing bilingual participants by language dominance and age of acquisition of second language (AoA) resulted in strong and consistent differences in phonemic fluency performance: Spanish dominant bilinguals scored significantly lower than English dominant and balanced bilinguals on all letters and triplets and late AoA bilinguals scored significantly lower than early AoA bilinguals on virtually all letter and triplets. Categorizing the bilingual participants by first language learned did not result in these consistent significant differences. Therefore, this method of differentiating bilinguals does not capture the variance in phonemic fluency performance as well as the language dominance and AoA strategies was able to.

Acculturation And Its Association With Phonemic Fluency

Phonemic fluency performance for the bilingual students was examined in the context of several cultural factors including generational status, four acculturation factors, and country of education.

Generational status. Within the bilingual participants, 35 were born in another country (called first generation), 51 were born in the US but their parents were not (2^{nd} generation), three were born in the US along with their parents (3^{rd} generation), five reported being 4^{th} generation and four reported being 5^{th} generation. Participants categorized in the 3^{rd}, 4^{th}, or 5^{th} generation were combined into a single group because of the small sample sizes and acculturation variations in these generations in the U.S. are not likely to vary significantly compared to the first and second generation groups. The associations between the generational status (1^{st} generation, 2^{nd} generation, and greater than 2^{nd} generation) and phonemic fluency using letters ‘F’, ‘A’, and ‘S’ along with the FAS triplet were examined with Pearson correlations. ‘A’ and ‘S’ and the FAS triplet were significantly correlated with generational status indicating that those who came from families that were in the US longer scored significantly higher (r= 0.20-0.22) than those whose families had arrived more recently.

Acculturation. Acculturation was assessed with the four subscales from the Scale of Ethnic Experience (SEE): ethnic identity, perceived discrimination, mainstream comfort, and social affiliation. Table 16 presents the mean and standard deviation scores for the early AoA and late AoA groups. An ANOVA demonstrated no differences in acculturation between the early and late AoA groups.

Table 16

Acculturation Scores for Bilingual Participants*

Acculturation Variable	Ethnic Identity: Mean (SD)	Social Affiliation: Mean (SD)	Perceived Discrimination: Mean (SD)	Mainstream Comfort: Mean (SD)
Early AoA	3.82 (0.49)	2.54 (0.67)	3.31 (0.66)	3.59 (0.68)
Late AoA	3.88 (0.61)	2.48 (0.92)	3.10 (0.76)	3.35 (0.66)

* All acculturation scores are on a scale of 1 to 5.

Again, associations between the acculturation variables and letters ‘F’, ‘A’, and ‘S’ along with the triplet FAS were examined with Pearson correlations. The correlation between the letter ‘F’ and social affiliation was marginally significant (p=0.09, r=-0.17) and the correlation between the letter ‘S’ and ethnic identity was marginally significant p=0.09, r=-0.17).

A hierarchical regression analysis was conducted with the bilingual participants to evaluate the prediction that acculturation would not play a role in phonemic fluency. Using FAS as the dependent variable and the acculturation variables as the independent variables (ethnic identity, mainstream comfort, social affiliation, perceived discrimination), it was determined that acculturation variables accounted for 10 percent of the variance in the bilingual students' phonemic fluency scores. This model was marginally significant at p=0.07 with generational category being a significant factor and perceived discrimination and social affiliation reaching marginal significance (see Table 17).

Since age of acquisition of the second language has a significant influence on the phonemic fluency of the bilingual participants, hierarchical regression analyses were conducted using only the early AoA bilingual students and only the late AoA bilingual participants. It was determined that acculturation variables accounted for 17% of the variance in the early AoA students' phonemic fluency scores. This model was significant at the p=0.02 level with ethnic identity and social affiliation being significant factors. This indicates that the early AoA students who were better acculturated to mainstream society performed better than those who were not as well acculturated. Acculturation variables accounted for 18% of the variance in the late AoA students' phonemic fluency scores but this model did not reach significance.

Table 17a

Regression Model Summaries

	R^2	Adj R^2	Statistic	Significance
All Bilingual	0.10	0.05	F[5, 94] =2.10	0.07
Early AoA	0.17	0.11	F[5, 72]=2.86	0.02
Late AoA	0.18	-0.10	F[5,17]=0.65	0.67

Table 17b

Regression Model Coefficients

Model	**Standardized Coefficients**		
	Beta	**T**	**Significance**
All Bilinguals			
Ethnic ID	-0.17	-1.59	0.12
Social Affiliation	-0.19	-1.76	0.08
Perceived Discrimination	0.19	1.67	0.10
Mainstream Comfort	0.02	0.22	0.83
Generational Category	0.20	1.96	0.05
Early AoA			
Ethnic ID	-0.23	-2.15	0.04
Social Affiliation	-0.29	-2.69	0.01
Perceived Discrimination	-0.01	-0.11	0.92
Mainstream Comfort	-0.02	-0.20	0.85
Generational Category	0.09	0.75	0.45
Late AoA			
Ethnic ID	0.01	0.02	0.99
Social Affiliation	0.05	0.14	0.89
Perceived Discrimination	0.45	1.30	0.22
Mainstream Comfort	0.27	0.88	0.39
Generational Category	-0.14	-0.55	0.59

Among the early AoA bilingual participants, acculturation was significantly associated with better phonemic fluency performance. Since the majority of the bilingual students had an early AoA, the bilingual group as a whole was marginally significant but as can be seen from the model summaries, the late AoA bilinguals do not enjoy the boost in phonemic fluency performance owing to acculturative factors.

Exploratory Analyses

Semantic Fluency. The semantic categories of “animals” and “fruits and vegetables” were tested with monolingual and bilingual participants. An ANOVA was used to compare monolingual and bilingual participants. Monolingual participants scored significantly higher than bilingual participants for both categories (see Table 18).

Table 18

Semantic Fluency Scores For Monolingual And Bilingual Participants.

Language Characteristic	Monolingual (*n*=30) Mean (SD)	Bilingual (*n*=74): Mean (SD)	Statistic F(1, 128)	Significance (p value)
Animals	21.23 (5.65)	17.67 (4.38)	13.15	<0.01
Fruits and Vegetables	19.57 (4.85)	16.75 (4.15)	9.82	<0.01

Table 19 presents the results of semantic fluency when separating the bilingual participants by first language. Those that learned English first or both languages simultaneously scored higher in the animals category than those that had Spanish as a first language. For the category of fruits and vegetables, those that had English as a first language scored significantly higher than either of the other groups. Those that learned both languages simultaneously scored significantly higher than those who learned Spanish first.

Table 19

Semantic Fluency Scores for Bilinguals Grouped by First Language

First Language	**English (n=7): Mean (SD)**	**Spanish (n=74): Mean (SD)**	**Both (n=18): Mean (SD)**	**Statistic F(2, 96)**	**Significance (p value)**
Animals	21.43 (5.44)	16.96 (4.07)	18.69 (3.79)	5.11	0.01
Fruits and Vegetables	21.71 (4.75)	15.93 (3.47)	18.00 (5.01)	8.60	<0.01

Table 20 presents the semantic fluency results among bilinguals when they are grouped by language dominance. English dominant and balanced bilinguals scored similarly, with both scoring significantly higher than the Spanish dominant for both categories.

Table 20

Semantic Fluency Scores for Bilinguals Grouped by Language Dominance.

Characteristic	**English Dominant (n=48): mean (SD)**	**Balanced (n=25): mean (SD)**	**Spanish Dominant (n=26): mean (SD)**	**Statistic F(2,96)**	**Significance p-value**
Animals	18.60 (4.08)	18.92 (3.24)	14.46 (4.00)	12.63	<0.01
Fruits and Vegetables	17.88 (4.26)	16.71 (4.13)	14.54 (3.05)	6.20	<0.01

Table 21 presents semantic fluency results when bilinguals are separated by age of acquisition of their second language. Just like when examining phonemic fluency, those with an early AoA scored significantly higher in both categories than the late AoA group.

Table 21

Semantic Fluency Scores for Bilinguals Grouped by Age of Acquisition

Characteristic	Early AoA (n=77): mean (SD)	Late AoA(n=22): mean (SD	Statistic F(1,97)	Significance p-value
Animals	18.31 (3.89)	15.05 (4.64)	8.64	<0.01
Fruits and Vegetables	17.22 (3.88)	14.91 (4.62)	4.96	0.03

In general, significant differences were evident between monolingual and bilingual participants in semantic fluency, where differences were not so obvious in phonemic fluency. When examining bilingual participants separately, taking into account characteristics important to bilingualism, similar patterns surface in semantic and phonemic fluency.

Additional Exploration of Age of Acquisition. Figure 1 presents the relationship of age of acquisition of a second language among the bilingual participants and phonemic fluency.

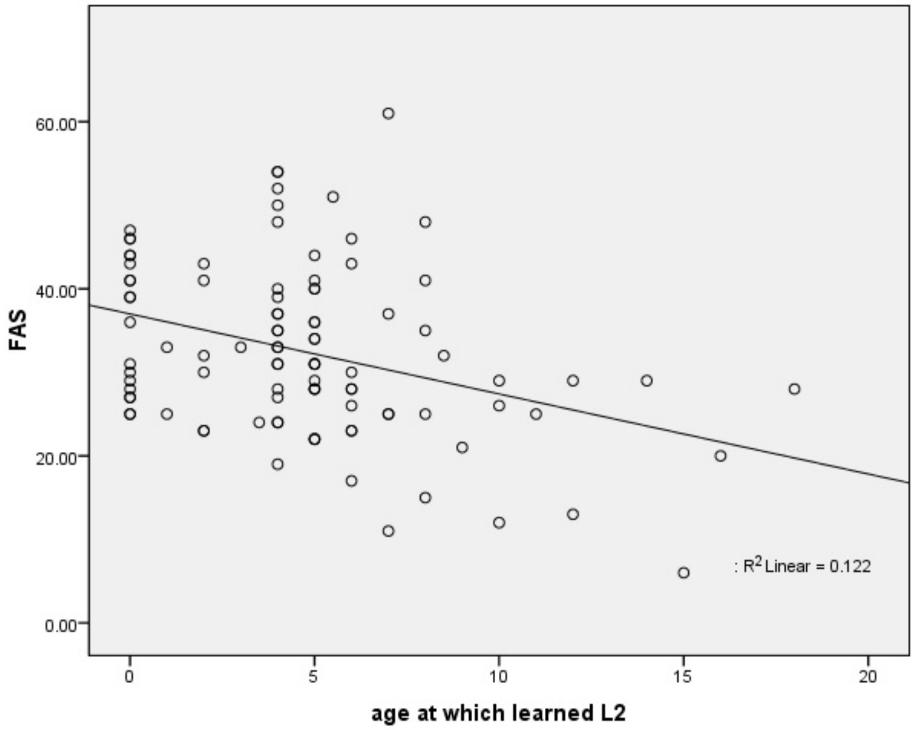

Figure 1: Scatterplot Between Phonemic Fluency Scores and Age of Acquisition for Bilingual Participants

The scatterplot illustrates clearly that an earlier age of acquisition is related to a higher phonemic fluency score.

In an effort to further understand age of acquisition and its role in phonemic fluency, early AoA bilingual participants were compared to the monolingual participants. Table 22 presents the neuropsychological scores and phonemic fluency performances for the two groups. Monolingual students scored significantly higher on every neuropsychological measurement, although the early AoA bilingual participants did score in the average range for all tests. In terms of phonemic fluency, the early AoA bilingual students scored similarly to the monolingual students for all letter triplets.

Table 22

Neuropsychological And Phonemic Fluency Scores For Monolingual And Early AoA Bilingual Participants.

Characteristic	Monolingual (*n*=30): Mean (SD)	Early AoA (*n*=77): Mean (SD)	Statistic F(1,106)	Significance (p value)
Neuropsychological Test				
GAMA	111.67 (12.47)	103.03 (10.64)	12.90	<0.01
WRAT3	106.63 (7.85)	100.77 (8.81)	10.16	<0.01
TMT-A T-score:	50.77 (9.28)	45.45(9.68)	6.65	0.01
TMT-B T-score:	56.77 (9.77)	47.44 (8.00)	25.83	<0.01
Letter Triplets				
FAS	37.34 (10.14)	33.93 (8.94)	0.68	0.41
BCT	38.76 (8.88)	35.05 (8.76)	1.36	0.25
PMR	36.00 (8.83)	33.97 (8.52)	0.13	0.72
CDM	36.00 (8.55)	34.55 (9.02)	0.04	0.84

To further understand the role of age of acquisition and language dominance, the Spanish dominant bilingual participants were split into two groups along AoA lines. Eleven Spanish dominant participants had an early age of acquisition while 15 had a late age of acquisition. Table 23 presents both neuropsychological and phonemic fluency scores for the two groups. The two groups only differed in terms of the WRAT3 reading test, with early AoA Spanish dominant bilinguals scoring significantly lower. The GAMA and TMT-B scores are marginally significant with the early AoA Spanish dominant bilinguals scoring higher. There were significant differences between all letter triplets, with the greatest difference found for the triplet FAS in which the late AoA

Spanish dominant participants scored approximately two standard deviations below the mean. Even though the early AoA participants scored significantly higher on the English reading test, both scored as reading English at a high school level.

Table 23

Neuropsychological And Phonemic Fluency Scores For Spanish Dominant Bilingual Participants.

Characteristic	**Early AoA (*n*=11): mean (SD)**	**Late AoA (*n*=15): mean (SD)**	**Statistic F (1,25)**	**Significance (p value)**
Neuropsychological Test				
GAMA	109.73 (11.38)	100.33 (12.14)	4.00	0.06
WRAT3	103.91 (9.31)	91.53 (4.66)	19.93	<0.01
TMT-A T-score:	47.00 (10.98)	41.33 (7.17)	2.54	0.12
TMT-B T-score:	47.27 (8.88)	40.67 (8.71)	3.59	0.07
Letter Triplets				
FAS	32.27 (5.66)	21.80 (8.65)	12.21	<0.01
BCT	31.45 (6.82)	23.40 (7.63)	7.72	0.01
PMR	31.80 (9.53)	20.93 (7.16)	10.62	<0.01
CDM	31.82 (8.76)	20.47 (7.12)	13.28	<0.01

Since there is a clear difference in performance between the early and late AoA Spanish dominant bilingual students, a comparison was then made between the early AoA Spanish dominant bilinguals and the monolinguals to investigate whether the norms used for monolinguals could possibly be valid for the early AoA Spanish dominant bilinguals. Table 24 presents neuropsychological and phonemic fluency scores for these two groups. The monolingual group differed significantly only in terms of the TMT-B test, with the monolingual students scoring higher. Only the triplet BCT was significantly different between the two groups with monolinguals, again, scoring higher.

Table 24

Neuropsychological And Phonemic Fluency Scores For Monolingual And Early AoA Spanish Dominant Bilingual Participants.

Characteristic	Monolingual (*n*=30): mean (SD)	Spanish Dominant, Early AoA (*n*=11): mean (SD)	Statistic F(1,30)	Significance (p value)
Neuropsychological Test				
GAMA	111.67 (12.47)	109.73 (11.38)	0.20	0.65
WRAT3	106.63 (7.85)	103.91 (9.31)	0.88	0.36
TMT-A T-score:	50.77 (9.28)	47.00 (10.98)	1.20	0.28
TMT-B T-score:	56.77 (9.77)	47.27 (8.88)	7.95	<0.01
Letter Triplets				
FAS	37.10 (10.05)	32.27 (5.66)	2.50	0.12
BCT	38.90 (8.76)	31.45 (6.82)	6.12	0.02
PMR	35.87 (8.71)	31.80 (9.53)	2.11	0.16
CDM	36.00 (8.55)	31.82 (8.76)	2.10	0.16

It would appear from these results that the bilingual characteristic of age of acquisition of a second language is a stronger determinant of phonemic fluency than is language dominance, since the language dominant group that seemed to be at a disadvantage had that disadvantage disappear when only the participants with an early AoA were examined.

Cognitive Ability and Phonemic Fluency. A correlational analysis was performed to explore the relationship between GAMA scores measuring general cognitive ability and phonemic fluency. This analysis was performed using the letters 'F', 'A', and 'S' for both monolingual and bilingual participants. Figure 2 shows a strong, significant correlation for the monolingual participants (r=0.53, p<0.01) but no significant correlation for the bilingual participants, either as a whole or when divided by early or late AoA.

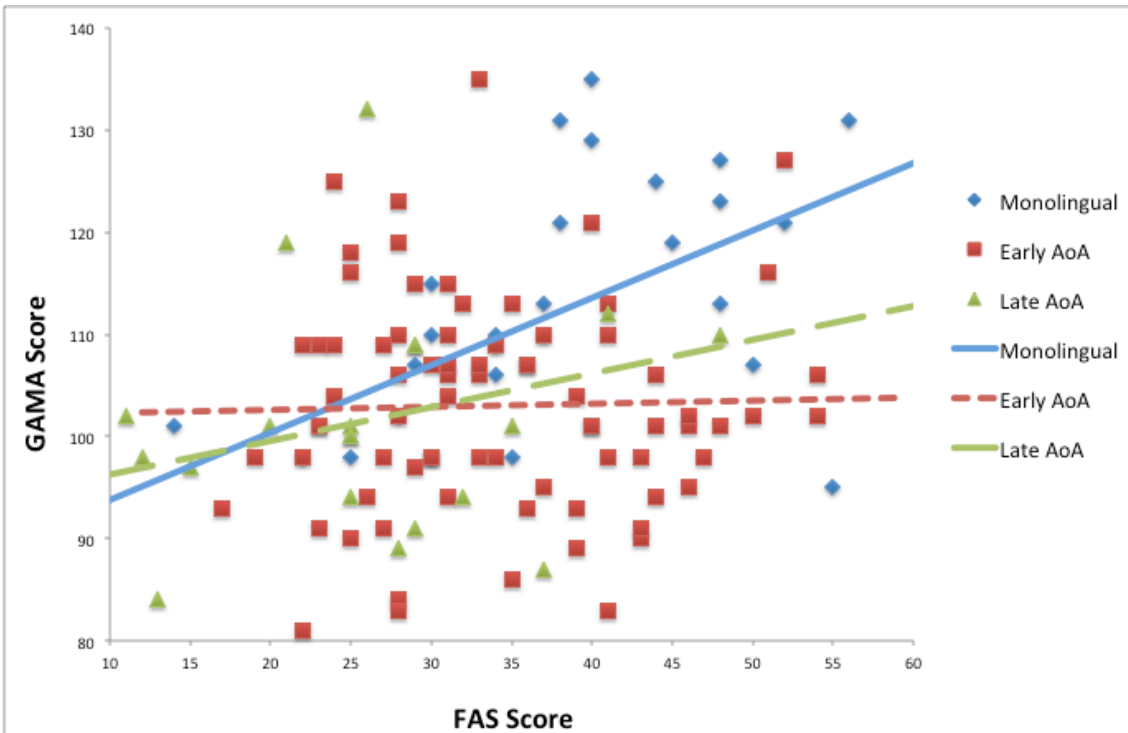

Figure 2: GAMA and Phonemic Fluency Scores For Monolingual and Bilingual Participants

As seen in Table 22, the GAMA scores varied significantly for the early AoA bilingual students and the monolingual students, yet there was not a significant difference in the letter triplet FAS. To further assess the relationship between cognitive ability and phonemic fluency performance, a subset of the monolingual and early AoA bilingual participants were matched on GAMA, age, and education (*n*=22 per group). For the matched groups, GAMA scores ranged from 95 to 125. Age in years ranged from 18 to 23 and education ranged from 12 to 13 years. When matching, GAMA scores varied no more than two points, education varied no more than one year and age varied no more than two years. As illustrated in Figure 3, the subgroup of monolingual participants demonstrated a strong significant correlation (r=0.56, p=0.01), but again there was no significant correlation between cognitive ability and phonemic fluency for the bilingual participants (r=-0.28, p=0.22).

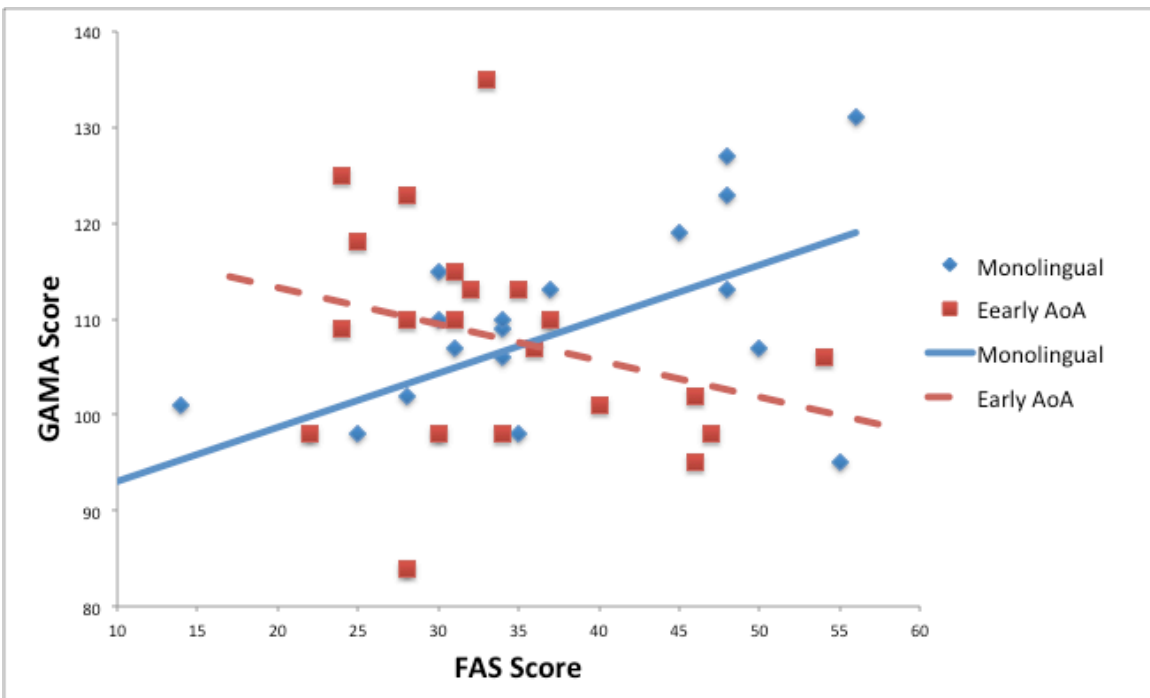

Figure 3: GAMA and Phonemic Fluency Scores For Matched Sub-Groups

Even with the linguistic groups matched for cognitive ability, age, and education, there is no correlation between cognitive ability and phonemic fluency score for the early AoA bilingual students, while the correlation for the monolingual students becomes stronger. It is possible that the early AoA bilingual brain is organized differently and/or they are using different resources for the task.

Discussion

This study investigated Spanish-English Hispanic bilinguals' performance on phonemic fluency tasks compared to monolingual European-American scores. Overall, bilingual and monolingual students scored similarly in phonemic fluency, both when using the standard letters of 'F', 'A', and 'S' and when using alternate letters. However, further analysis indicated that bilingual characteristics, in particular the age of acquisition of the second language (AoA) and language dominance, affect a bilingual's performance in phonemic fluency. Those with an earlier AoA perform on par with monolinguals and perform significantly better than bilingual participants who learned a second language later. Similarly, those who were Spanish dominant performed significantly lower than English dominant and balanced bilinguals as well as monolinguals. Results also demonstrated that acculturation factors may also influence phonemic fluency scores. The early AoA bilinguals who were better acculturated to the mainstream culture scored higher in phonemic fluency. These results suggest that bilingual characteristics and language history need to be considered when interpreting the phonemic fluency performance of any bilingual individual.

Age of Acquisition

Age of acquisition of a second language demonstrated the strongest influence on verbal fluency in this study. AoA is known to affect the level of bilingualism attained by an individual (Archila-Suerte et al., 2012; Bialystok, 2009; Bialystok & Miller, 1999; Hirsh, Morrison, Gaset, & Carnicer, 2003). There is much debate regarding at what age learning a new language becomes more difficult if not impossible. Basing their work on Lenneberg's principles of critical period hypothesis of a first language (1967), Johnson and Newport (1989) found that those who are exposed to their second language before the age of seven reach “native performance” in the second language (1989). Based on these data, our participants were grouped by whether they learned their second language by the age of six years (early AoA) or after age six (late AoA).

Those in the early AoA bilingual group scored similarly to monolinguals for all letter triplets, even though the bilingual participants scored significantly lower on all neuropsychological tests (see Table 22). When comparing early and late AoA bilinguals to each other, early AoA bilingual participants scored significantly higher for all letters except ‘A’, which approached significance (see Table 14). Consequently, the scores for all letter triplets were different, with the early AoA group scoring significantly higher. In terms of number of responses, the late AoA group tended to score approximately one standard deviation lower than the early group. One might assume that the neuropsychological test scores between the two groups would be significantly different as well. However, neuropsychological test scores were similar between the early and late AoA bilingual groups in all areas except in ability to read English, as measured by the WRAT3 Reading test, where the early AoA group scored significantly higher. Bilinguals with an early AoA score better during phonemic fluency tasks than those with a late AoA regardless of other neuropsychological factors, allowing them to perform on par with monolingual individuals.

Language Dominance

When the bilingual group was split along the three language dominant lines (English dominant, Spanish dominant and balanced bilingual), apparent advantages and disadvantages in phonemic fluency were observed. Scores for English dominant and balanced bilingual participants were not significantly different than monolingual participants. The Spanish dominant participants scored significantly lower than the monolingual participants for all letters. When comparing the three bilingual groups to each other, we see the same pattern of the English dominant bilinguals and balanced bilinguals scoring similarly, but Spanish dominant bilingual students scoring significantly lower. In terms of neuropsychological test scores among the three bilingual groups, there are no significant differences except for TMT-B (see Table 12 and discussion below). When examining results for the letter triplets, English dominant and balanced bilinguals scored similarly while the Spanish dominant scored approximately one standard deviation lower than the other two groups. Possible reasons for the lower scores among the Spanish dominant bilinguals include a smaller English vocabulary (Gollan et al., 2002), giving them fewer words to choose from than the other bilinguals; weaker connections to the English words owing to lower frequency of use (Gollan & Acenas, 2004); and cross language interference which can result in delays when accessing words (Sandoval, Gollan, Ferreira, & Salmon, 2010).

Research has shown that the semantic representation of a word is available before the phonological representation (Abutalebi & Green, 2007; Guo & Peng, 2007). For an unbalanced bilingual, the cross language interference between the two possible phonological options creates a longer delay before answering because the bilingual must suppress one language while searching for the correct word in the requested language. This behavior has been observed in event-related potential (ERP) studies (Guo & Peng, 2007; Guo, Peng, Lu, & Liu, 2005) where researchers have been able to measure the time it took for an unbalanced bilingual to retrieve phonological information after semantic information became available (170ms). This phenomenon would be more pronounced for the Spanish dominant bilingual in this study since they are required to answer in the language they use least, leading to weaker semantic to phonologic connections, since connection strength depends on the degree and recency of use of a word (Burke, MacKay, Worthley, & Wade, 1991). This same disadvantage may not be as apparent in the English dominant bilingual students since they are answering in their dominant language. Thus, the words in English should have stronger semantic to phonologic connections.

Spanish dominant participants in this study made up 71% of the late AoA group and only 14% of the early AoA group. A later AoA is believed to negatively affect vocabulary size and cognitive flexibility compared to an earlier AoA (Bialystok, 2009; Luo, Luk, & Bialystok, 2010); thus, it appears likely that the late AoA of the Spanish dominant bilingual group is responsible for their lower scores. To test this hypothesis, early AoA Spanish dominant participants were compared to late AoA Spanish dominant students. Eleven Spanish dominant bilinguals had an early AoA and 15 had a late AoA. The early AoA group scored significantly higher on the test of English reading ability, but even the late AoA group scored in the average range for their age. Thus, they would most likely be considered fluent in an educational setting. General cognitive ability and cognitive flexibility approached significance (see Table 23) with the early AoA group performing better. There was no difference in processing speed, as measured by TMT-A. When examining the results for the letter triplets, the late AoA Spanish dominant bilinguals scored at least one standard deviation below the early AoA Spanish dominant bilinguals, and more than one and a half standard deviations below the early AoA group for the FAS triplet, the one most commonly used in neuropsychological testing. Even among the Spanish dominant bilinguals who are at a disadvantage regarding phonemic fluency (i.e. limited English vocabulary and slower response time owing to cross language interference), an early AoA created a substantial advantage.

Comparing the subgroup of early AoA Spanish dominant bilingual students with monolingual students revealed no difference in general cognitive ability, English reading ability or processing speed. When the monolingual participants were compared to the complete group of Spanish dominant bilinguals there were considerable differences, with the Spanish dominant bilinguals scoring lower in all neurocognitive domains. In terms of phonemic fluency, monolingual participants and the early AoA Spanish dominant bilinguals scored similarly for all letter triplets except for BCT ($p=0.02$), where the monolingual participants scored higher. The early AoA compensated for what appeared to be several disadvantages among the Spanish dominant bilinguals. While there is more than one explanation as to why the Spanish dominant bilinguals scored lower than other groups, it seems that it can be at least partially explained by the fact that a majority of them learned their second language after the age of six.

First Language

Many studies make the assumption that the first language of bilingual individuals is the dominant language, and consequently they will perform better in this language than their second language. However, this study had only seven bilingual students with English as a first language but had 48 students who reported English as their dominant language. In terms of phonemic fluency, there were no consistent patterns discerned. In general, the bilingual students who had Spanish as their first language scored lower than those who had English first or those who learned both languages from birth. In eight out of ten cases this difference did not reach significance. In terms of neuropsychological scores, those who had English or Spanish as their first language scored the same in terms of cognitive ability as measured by the GAMA. Those who learned both languages from birth scored lower than the others, but not significantly so. As well, those who learned both languages from birth scored the lowest in terms of English reading ability, but this difference also did not reach significance. Those with English as a first language scored significantly higher in terms of processing speed, as measured by TMT-A, while the other two groups scored similarly. Those with Spanish as a first language scored significantly lower than the other groups in terms of cognitive flexibility as measured by TMT-B. Thus, as with the phonemic fluency scores, there is no perceptible pattern when examining first language. Caution must be used when interpreting these results, however, since the sample sizes are unequal (English first: n=7; Spanish first: n=74; English and Spanish: n=18). Recruitment for the study was based on language dominance, not first language. Therefore the unequal sample sizes do not make it possible to make a definitive conclusion.

Cognitive Ability and Phonemic Fluency

When compared to the monolinguals, the bilinguals within the early AoA group scored significantly lower on all neuropsychological tests including general cognitive ability, processing speed and cognitive flexibility (see Table 22) but scored similarly for all letter triplets in the phonemic fluency test. In this study, a significant correlation between cognitive ability and phonemic fluency was found among the monolingual students, but no significant correlation was found between these two neuropsychological areas for the bilingual students, even when bilinguals were matched for age, education and cognitive ability with the monolingual sample (see Figure 3). This is noteworthy given the wealth of literature linking phonemic fluency with cognitive ability. For example, Steinberg et al. (2005) found a strong correlation between phonemic fluency and cognitive ability among Caucasian older adults (r=0.368 to 0.495). This correlation was stronger than the correlation found between phonemic fluency and education. Arffa (2007) also found a strong correlation among school-aged children between phonemic fluency and cognitive ability. His sample was reported to be 88% Caucasian.

The lack of a phonemic fluency-cognitive ability correlation with the Hispanic bilingual students raises issues of construct validity. As mentioned above, the relationship between phonemic fluency and cognitive ability among monolingual Caucasians has been previously established through many studies. However, if both the phonemic fluency and the cognitive ability tests exhibit sound construct validity, the positive correlation between them should hold regardless of ethnicity or linguistic traits. Thus, the lack of association found between the two tests for the bilingual students suggest a lowered construct validity for either one or both of the tests. One possible explanation would be that the cognitive ability test (i. e., GAMA) has lower validity for the bilingual students. However, the GAMA was chosen for this study because it is a nonverbal test that was normed on a wide range of ethnic groups and bilinguals. Also, researchers have found the GAMA to be independent of education or linguistic ability (Davis, Bardos, & Woodward, 2006). If the GAMA is measuring cognitive ability similarly for both linguistic groups, then another explanation for the lack of correlation among the bilingual group may be the lowered validity for the phonemic fluency test. The results from this study show that different aspects of bilingualism affect phonemic fluency performance -- both among bilinguals and when compared to monolinguals.

The Bilingual Brain

One possible reason for the lack of association between cognitive ability and phonemic fluency for the early AoA bilinguals might be the difference in brain structure between them and the other participants. It is well known that environment, and the experiences it offers, affects both the growth and structure of the brain. Researchers have suggested that a bilingual environment qualifies as such a catalyst (Kim, Relkin, Lee, & Hirsch, 1997; Kovelman, Baker, & Petitto, 2008; Mechelli et al., 2004). Studies using fMRI technology have illustrated that early AoA bilinguals have greater grey-matter density in the left inferior parietal cortex, the same area that is activated during verbal-fluency tasks. These same studies have also shown a relationship between the density of this same grey matter and the level of proficiency in a second language (Mechelli et al., 2004). These results suggest that the denser this grey matter, the more proficient one can become in a second language. However, there may be a critical period after which the grey matter will not increase in density. This does not mean a second language cannot be acquired, but that the level of proficiency might be compromised.

fMRI studies have revealed that early AoA bilinguals' languages overlap within Broca's area (Kim et al., 1997; Kovelman et al., 2008). Late AoA bilinguals appear to have two distinct areas within the same region (Kim et al., 1997). Interestingly, both early and late AoA bilinguals appear to have overlapping language regions within Wernicke's area (Kim et al., 1997). Even though there are overlapping regions in brain areas for bilinguals, it should be noted that bilinguals appear to have differentiated neural pathways for the two languages. This has been observed in aphasia patients as well as in fMRI studies (Kim et al., 1997). Further, in Kovelman et al.'s study (2008), early AoA Spanish-English bilinguals demonstrated greater recruitment of left inferior frontal cortex than monolinguals. The left inferior frontal cortex is an area known for all aspects of language processing. Kovelman hypothesizes that this area may be modified by the early experience of two languages.

The evidence presented through fMRI studies illustrates that the early AoA bilingual brain is both structured and functions differently than the monolingual brain. The information gained from this study regarding the lack of correlation between cognitive ability and phonemic fluency exposes the need to continue both behavioral and neuroimaging research to better understand how the bilingual brain is structured and how it functions.

Semantic Fluency

As part of the exploratory analyses, semantic fluency was tested using the categories of "Animals" and "Fruits and Vegetables." Consistent with the current literature, the monolingual group scored significantly higher than the bilingual participants as a whole for both semantic categories (see Table 18). Among bilinguals only, the same types of patterns emerged as was seen regarding phonemic fluency. Early AoA bilingual participants scored significantly higher than the late AoA group. English dominant and balanced bilinguals scored similarly while Spanish dominant bilingual students scored significantly lower. However, there is an important difference between the phonemic fluency and semantic fluency performances for the bilinguals. While certain characteristics of bilingualism allowed for some of the bilingual groups to score on par with the monolingual group during the phonemic fluency task (i.e., being an English dominant or a balanced bilingual or having an early AoA), none of these characteristics seemed to allow for the bilinguals to perform similarly to the monolingual group during semantic fluency assessment. There is one caveat to be considered on this matter. When bilinguals were separated by first language, those with English as a first language scored similarly to the monolinguals. However, the English as a first language sample is very small (n=7) and it is most likely that with a larger sample size, the average number of responses in both semantic categories would decrease, exposing a significant difference between this bilingual subgroup and monolinguals, with the monolinguals scoring higher.

Research indicates that semantic and phonemic fluency tasks require different resources (Luo et al., 2010). The brain organically arranges information and language into semantic categories. For instance, in a series of fMRI studies, when subjects were asked to name nouns, different specific areas in the inferotemporal lobe were activated depending on the category to which the noun belonged (Kolb & Whishaw, 2009). Since word generation is based on semantic associations, semantic fluency is considered an over-learned task (Luo et al., 2010). This over-learned task illustrates some of the detriments of bilingualism. Both the effects of vocabulary size and cross language interference are demonstrated during the semantic fluency task where automaticity is strongly relied upon for answers. The monolingual participants have no cross language interference to be concerned with and can therefore produce answers more quickly. Phonemic fluency, on the other hand, requires additional executive functioning on the part of both the monolingual or bilingual participant. This has been observed in phonemic fluency neuroimaging studies where frontal areas, such as the inferior frontal gyrus, is activated. This area is also activated in language-free cognitive tasks (Yeung, Nystrom, Aronson, & Cohen, 2006). Yet other studies have shown this area is involved in selective response suppression in go/no-go tasks and therefore plays an important role in inhibition (Forstmann, Wildenberg, & Ridderinkhof, 2008). This is similar to what is seen in bilinguals who must constantly suppress one language over the other. In this case, however, the bilingual participants have the advantage, especially the bilingual participants with an early AoA. As mentioned in the introduction, bilingual children have to learn at a young age how to manage two languages. This requires inhibiting one language, shifting mental sets, selective attention, and updating information in working memory (Bialystok, 2009), all which are processes of executive control. Since the early bilingual must develop these executive skills at a young age, it is believed that they possess better executive functioning skills throughout their lifetime, both in terms of linguistic and performance tasks (Bialystok, 2009). This well developed executive functioning allows for the possibility for bilinguals to make up for the time lost from cross language interference when performing phonemic fluency tasks. Assuming the vocabulary is available, as it is for English dominant and balanced bilinguals, these superior executive functioning skills allow bilingual participants to perform on par with to the monolingual participants in phonemic fluency. It seems that even with a smaller vocabulary, the stronger executive control created by learning a second language at a young age can overcome the lack of vocabulary, as seen in this study when comparing early AoA Spanish dominant bilinguals to monolinguals (see Table 22).

Cognates

This study was originally designed with the hypothesis that cognates, words that sound similar in two languages such as flower and *flor*, would help the bilingual participant perform better in the phonemic fluency task, as suggested by Michael and Gollan (2005), and that different letter combinations would be more linguistically fair for the bilingual. However, the results did not confirm this hypothesis. Additionally, other researchers who were performing a picture naming task with cognates and non-cognates (Ivanova & Costa, 2008), observed latencies for both groups of words. The latencies for the cognates were slightly less, but were apparent nonetheless. The cross language facilitation that was expected was not found in this case. The authors state that the apparent disadvantages for bilinguals cannot be overcome by phonological similarities.

Acculturation

There is scant research regarding the effects of acculturation on neuropsychological testing. With ethnic minorities accounting for the majority of population growth within the US, acculturative status will continue to grow in importance. In this research, four acculturation variables were studied: Ethnic Identity, Social Affiliation, Perceived Discrimination and Mainstream Comfort. In this particular sample, the Hispanic bilingual students appeared to be relatively acculturated to mainstream U.S. society. Students felt that their ethnic identity was of moderate importance to them. They seemed to have a mixture of Hispanic and non-Hispanic affiliates, felt some discrimination against them by society at large (such as in the media or by the government) and felt moderately comfortable in mainstream society. The level of acculturation was the same for both early and late AoA groups of bilinguals. This sample attends a university in a minority-majority state where the Hispanic culture is accepted as part of the mainstream culture. These acculturation variables will vary, even within other minority-majority states. The level of acculturation of a single bilingual or group of Hispanics cannot be assumed based on these results. A correlational analysis revealed that bilingual students scored better on the letter 'F' if they did not feel a need to affiliate with other Hispanics and scored better on the letter 'S' if they did not identify as Hispanic. A more surprising outcome is the amount of variance accounted for in the FAS scores (17%) by the same acculturative factors of ethnic identity and social affiliation for the early AoA bilingual students. The late AoA bilinguals had a similar amount of variance accounted for by the same acculturation variables (18%) in the FAS scores but the model was not significant, likely owing to the small sample size (see Table 17a). We have already seen that the early AoA bilingual students have a considerable advantage over the late AoA bilingual students in terms of phonemic fluency. It was observed that they were able to boost their performance even more based on whether they are better acculturated to mainstream culture. As discussed earlier, the development and function of the early AoA brain is influenced by its environment. Acculturation can be considered part of that environment. Those bilinguals that either live in a highly acculturated family or attend a school which is highly acculturated will have the opportunities to acquire the vocabulary common to the mainstream culture and, in this case, be exposed to more English words, since that is the language of the mainstream culture. Early AoA Hispanic bilinguals that are not as acculturated would be lacking these same benefits, resulting in lower phonemic fluency scores.

Limitations

This study was constructed with the hypothesis that language dominance would be the major influence on phonemic fluency for bilingual participants. Therefore, bilingual participants were recruited along language dominance lines. While sample sizes for language dominance were adequate, other cell sizes were small when the bilingual students were grouped along different linguistic criteria, such as first language. Surprisingly, only seven of the 99 bilingual students recruited learned English first. It is difficult to make any conclusions regarding bilinguals whose native language is English based on such a small sample.

Additionally, the undergraduate student sample used in this study may differ from a Hispanic community sample. All participants had at least 12 years of education and ranged in age from 18 to 35. Therefore, caution should be used when extending the results of this study to those less educated or outside the age range investigated, especially a geriatric population whose cognitive functioning may be in decline.

While there was a measurement of English language proficiency (WRAT3 Reading), there was no measurement of Spanish language proficiency or of vocabulary size in either language. Recent research shows that vocabulary size of bilingual participants is of importance. Bialystok et al. (2008) reported that bilinguals with a large vocabulary can outperform monolinguals in phonemic fluency tasks. The importance of proficiency in both languages and the size of vocabulary had not been published when this study was designed.

Conclusions and Clinical Implications

Bilingual participants examined as one group did not differ significantly compared to monolingual participants when using the standard letters ‘F’, ‘A’, and ‘S’, or the alternate letters (See tables 6 and 7). This contrasts with the Gollan study (2002) used to select alternate letters to test. In that study, ‘A’ and ‘S’ were significantly different and ‘D’ was marginally significant (see table 2). While AoA was reported for the entire group (3.4 years), this aspect was not examined on its own or taken into consideration when reviewing results.

When reviewing the results from only this study, one might assume that the current norms for phonemic fluency that are based on a monolingual sample are valid for all Hispanic bilinguals. However, the majority of bilingual participants in this study was either English dominant or balanced (74%) and were early bilinguals (78%). These two factors make the entire population to appear to be performing similarly to the monolingual sample. However, it has been found in this study that any bilingual individual who was either Spanish dominant or had a late AoA would be in danger of being misdiagnosed using the current norms.

In the past, assumptions have been made based on a person’s first language, including level of acculturation and ones dominant language. However, within this bilingual sample, seven participants learned English first and 74 learned Spanish first. Of that sample, 48 participants were English dominant and only 26 were Spanish dominant. For this reason, asking ones native language is not sufficient when measuring linguistic skills or acculturation. In minority-majority states, such as New Mexico, California and Texas, it is not uncommon for a child to only learn the parents’ language and be exposed to English when the child starts school around five years of age. Once the child begins instruction in English, this may become her dominant language. Also demonstrated in this study is that a bilingual may be Spanish dominant but still be considered fluent in English. However, we have seen that Spanish dominant bilinguals are at a disadvantage in language tasks because of a smaller vocabulary in English and delays owing to cross language interference. In such cases, the person may be erroneously diagnosed as having an impairment.

While this study examined Hispanic bilinguals in particular, it is reasonable that the results would pertain to bilinguals in general. The bilingual environment influences brain development. Current neuroimaging research with bilinguals who speak English and Mandarin shows that these bilinguals with vastly contrasting languages use the same neural pathways as the Spanish-English bilinguals (Guo, Liu, Misra, & Kroll, 2011; Liu, Hu, Guo, & Peng, 2010; Wang, Xue, Chen, Xue, & Dong, 2007). Whether the two languages of a bilingual are of the same linguistic family, such as two Romance languages, or from two disparate language groups, such as Indo-European and Sino-Tibetan, the bilingual brain appears to develop in a similar way. Therefore, the results found here should be applied to any bilingual individual during neuropsychological testing.

We have seen here that bilingualism is a complex linguistic ability, with many factors that are often overlooked in a clinical setting. These factors need to be taken into consideration, especially since the US is becoming increasingly bilingual. In order for a neuropsychological assessment to be fair and accurate for a bilingual individual, linguistic history and level of acculturation need to be obtained and taken into consideration in diagnosis and treatment.

Appendix A

Language History Questionnaire

Current age ______

First Language Learned (L1) English Spanish both Other _______

Second Language Learned (L2) English Spanish both Other _______

Age exposed to (L2) _______

Where did you learn L2? Home School TV Other ________

In what country did you attend school? (K-12) _______________
If you changed countries while attending school, please list which grades were completed in which country and the language of instruction.

Country of birth ________

If born outside of the US, at what age did you move to US? ________

Please rate your level of both languages below using the scale:
1=little to no knowledge and 7=like a native speaker

Reading in L1 ______ in L2 ________

Writing in L1 _______ in L2 ________

Speaking in L1 ______ in L2 ________

Listening in L1 ______ in L2 ________

Language spoken by your mother ____________________

Language spoken by your father ____________________

Language preference at home ______________ at school _____________

Language preference with friends ______________ with relatives_____________

to watch TV ______________ To read ________________

% of your overall day you use L1 _______

% of your day you use L1 at work_______ at school ______ at home _________

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