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Teaching semantic-syntactic categories to a child who uses AAC

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by

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Teaching Semantic-Syntactic Categories to a Child Who Uses AAC

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Abstract

Purpose: The purpose of this investigation was to evaluate the effects of an intervention program designed to elicit productions of two-term semantic-syntactic relations using correct word order from a preschooler who used augmentative and alternative communication (AAC).

Method: This study employed a single case, multiple probe across targets design with one preschooler (5;1) who used AAC. Initially, the participant was provided instruction sequentially in the use of two, two-term semantic-syntactic relations (possessor-entity and action-object); however, as the study progressed it was necessary to add a third, two-term semantic-syntactic relation (attribute-entity). The intervention employed two key components: aided AAC modeling and contrastive targets.

Results: The participant demonstrated minimal gains with the first target (possessor-entity) and exhibited numerous negative behaviors. However, the participant demonstrated significant gains with both the second and third targets (action-object and attribute-entity, respectively).

Conclusions: The intervention presented in this study may be used to teach children to produce two-term semantic-syntactic relations. Given the minimal success demonstrated with the first target, however, some changes may be required when targeting certain structures. Theoretical and clinical implications as well as future research directions are discussed.

KEY WORDS: augmentative and alternative communication (AAC), intervention, aided AAC modeling, contrastive targets, semantic-syntactic relations, multi-word combinations

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Children who use augmentative and alternative communication (AAC) to communicate typically present with severe, congenital motor speech impairments and are unable to communicate effectively using spoken language. On average, 24% of preschool children on a school-based speech-language pathologist's caseload require the use of some type of AAC (Binger & Light, 2006). The aided AAC devices (e.g., communication boards and speech-generating devices, or SGDs) that these children use to communicate expressively are assistive devices external to the individual using them. Each device contains a set of vocabulary depicted with picture symbols or orthography for the child to use to communicate. One category of aided AAC devices that are frequently used with children with severe motor-speech impairments are speech generating devices (SGDs), which are devices that produce voice output when symbols are selected.

Although SGDs increase the ability of the population of children with motor-speech disorders to communicate effectively, the generative language of this population continues to be limited. Additionally, they frequently use single symbol utterances to communicate (Binger & Light, 2008; Chen & Whittington, 2006; Goossens', 1989; Hooper, Connell, & Flett, 1987; Smith & Grove, 1999; Sutton & Gallagher, 1995) and often have difficulty expressing multi-symbol utterances (Smith & Grove, 2003). Multi-symbol utterances are created when multiple graphic symbols on a device are combined to create a message containing two or more words (e.g., *MONKEY DROP LION* to create a message meaning *Monkey drops Lion*). Expressive grammar skills are particularly difficult for this population to master, including the use of correct word order when communicating via graphic symbols (Binger & Light, 2008; Blockberger & Sutton, 2003; Sutton, Soto, & Blockberger, 2002; Sutton, Trudeau, Morford, Rios, & Poirier, 2010). Finally, some children using AAC have been shown to demonstrate large receptive-expressive language gaps (Binger, Kent-Walsh, & Taylor, 2010; Kent-Walsh, Binger, & Hasham, 2010), meaning that they understand a great deal more spoken language and grammar than they can actually express. It appears that they are able to acquire grammatical rules receptively, but are unable to effectively implement those same grammatical rules easily via any modality.

One of the reasons that many individuals who use aided AAC find it difficult, if not impossible, to maintain social relationships, obtain a quality education, and sustain steady employment, is their limited ability to communicate effectively with other individuals using grammatical, rule-based language (Lund & Light, 2007; McNaughton & Bryen, 2002). Although some interventions currently are used in an attempt to improve language outcomes in children who use aided AAC, in general, the expectations for this population still remain too low. Two recent studies demonstrated that children with a variety of expressive and receptive profiles could be taught to use multi-symbol messages using aided AAC following approximately one hour of intervention (.5 to 1.8 hours; Binger, Kent-Walsh, Berens, Del Campo, & Rivera, 2008; Binger et al., 2010). By providing appropriate interventions, clinicians may be able to lessen the size of the receptive-expressive language gaps that exist among the population of individuals who use aided AAC.

Some of the possible reasons for the generative language delays observed in this population include slow selection rate (i.e., it is time-consuming to create longer messages), a lack of grammatical morphemes provided on devices, and non-facilitative communication strategies used by communication partners (e.g., Blockberger & Sutton, 2003; Soto, 1999). With regard to partner communication strategies, two common communication patterns appear to affect the quality and quantity of communication elicited from children: the lack of communication opportunities provided and the frequency of yes/no questions asked by communication partners (Light, Binger, & Kelford Smith, 1994). Although all of these factors contribute to the communication profiles of individuals who use aided AAC, they do not fully explain the receptive and expressive language disparity. The modality specific hypothesis and the transposition hypothesis help to further explain why such similar communication patterns exist across this diverse population.

Modality Specific Hypothesis

The modality specific hypothesis states that restrictions inherent in communication using visual-graphic symbols may contribute to language acquisition difficulties for individuals who use aided AAC (Smith, 1996; Soto, 1999; Sutton & Morford, 1998). Some of these restrictions include the following: grammatical morphemes may be excluded from SGDs; graphic symbols may be opaque (i.e., not represent the referent clearly); the graphic symbols present on the display may be too limiting; and message production time may be slowed due to limitations of the device itself (e.g., delayed voice output). In addition, visual-graphic communication modalities may have inherent restrictions that are unique unto themselves, as opposed to spoken (auditory-oral) and signed (visual-gestural) modalities. That is, aided AAC communication (visual-graphic) may have its own set of linguistic and organizational rules that are unique to this modality. The effect a specific modality can have on the grammatical construction of a language can best be highlighted by the effect of the visual-gestural modality on American Sign Language (ASL). For example, the visual nature of sign language makes object-agent-action constructions more salient than agent-action-object grammatical forms, which are common in spoken languages; for this reason, in ASL the former grammatical structure is more frequently used than the latter (Braze, 2004). According to the modality specific hypothesis, a similar effect may also account for the word order differences noted between aided AAC communication and spoken communication. In communication via SGDs, semantic-syntactic relations typically are represented using separate graphic icons which may or may not adhere to spoken language syntax. For example, when preschoolers use graphic symbols, they may be more inclined to use object-action constructions rather than action-object constructions (Sutton et al., 2002). In order for individuals who use aided AAC to attain expressive communicative competence, they must be able make a connection between the spoken language and the graphic symbols associated with the spoken words. This may be extremely difficult due to the limitations of the SGD.

Translation Hypothesis

Along with the modality specific hypothesis, the translation hypothesis helps to explain some of the communication difficulties noted in individuals using aided AAC.

The translation hypothesis states that when conveying a message on an SGD, individuals translate the message from an internal representation of the spoken language into a graphic symbol representation of the message; that is, the individual will 'translate' a message from the spoken language into visual-graphic symbols (Sutton et al., 2010). In other words, an individual must first form an internal representation of a message in the spoken language (e.g., English) when communicating via an SGD. Next, the individual will translate the message from the spoken language representation into an external representation of the message using only the graphic symbols available on the SGD. This means the message will be restricted by the limitations of the specific SGD provided to the child. For example, the child likely will be limited in his message creation by the number and variety of graphic symbols available (Smith, 1996; Smith & Grove, 2003). The translation hypothesis can be contrasted with the modality specific hypothesis, which states that graphic symbols have their own inherent linguistic status, containing their own set of linguistic rules differing from spoken or signed languages.

Studies Relating to the Modality Specific and the Translation Hypotheses

Recently, several studies relating to both the modality specific hypothesis and the translation hypothesis have been conducted. Two studies were completed with individuals without disabilities in order to isolate the structural effects of the SGDs on communication. The first study assessed the use of SGDs by 30 children (7-8; 11 years old), 30 teenagers (12-13;11 years old), and 30 adults (18 years old and over). The participants were asked to describe photographs highlighting various syntactic relations using graphic symbols on an SGD. The results of the study demonstrated that simpler sentences were more often produced with correct word order on the SGD by all participants (i.e., *The girl pushed the clown* became *GIRL PUSH CLOWN* when using aided AAC). As sentence complexity increased (i.e., *The girl wearing the hat pushed the clown*), the word order of the aided AAC productions became less consistent and the clarity of the graphic symbol utterances produced decreased; in other words, translation became more difficult. Interestingly, the youngest age group differed greatly in their abilities to produce clear graphic symbol messages, compared with the other two groups. The 7-8 year old children tended to produce aided AAC messages that did not conform to spoken syntax, and this group also demonstrated high rates of syntactical variability in their productions. The authors came to the conclusion that "although children 7-8 years of age can comprehend and produce complex sentences in their oral language (tapping into their linguistic skills), the added difficulty of having to transpose [i.e., translate] complex utterances into a graphic sequence (tapping into their metalinguistic skills) made the task more difficult for them" (Trudeau, Sutton, Dagenais, Broeck, & Morford, 2007).

Another study following this same line of research was completed by Sutton et al. (2010). The study assessed the use of SGDs by 30 preschool children between the ages of three and four. The children were asked to describe pictures by translating and expressing three-symbol agent-action-object messages using an SGD. The results indicated that only one child consistently and accurately translated all three elements of these messages using word order that matched the grammatical structure of the spoken messages. Although the other 29 children consistently chose the correct symbols (i.e., did not select irrelevant symbols), the word order of their messages varied greatly when producing three symbol utterances. Some children produced two-symbol messages instead of three (e.g., *GIRL CLOWN* instead of *GIRL PUSH CLOWN*); for children who used this technique, 22 children consistently and correctly used the appropriate word order. The authors concluded that, in general, three and four year old children do not yet have adequate metalinguistic abilities to translate simple, spoken messages accurately into the graphic symbol modality, even though they are capable of creating the same language structures in the spoken (auditory-oral) modality. It is important to note, however, that several children in this study did consistently produce two-symbol messages using correct word order, and findings from intervention studies involving preschoolers who use aided AAC indicate that these children are capable of readily producing multi-symbol messages when provided with appropriate intervention (Binger et al., 2008; 2010).

Trudeau et al. (2007) and Sutton et al. (2010) indicate, then, that both the modality specific and translation hypotheses are at least partially supported by the findings. With regard to the modality specific hypothesis, the studies demonstrate that the graphic symbol utterances produced by participants frequently did not match spoken language grammar; that is, for many messages, the graphic symbols did not appear to correspond one-to-one with spoken words in the more complex productions of the adults in the first study, and in the simpler productions of the three and four year olds in the second study. If the modality specific hypothesis is valid, the participants' aided AAC productions would be predicted to exhibit their own unique and consistent grammar as the limitations inherent in the device would encourage the development of a particular set of grammatical structures. Given the high amount of variation within and across the productions of the participants (particularly in the second study), the results do not provide strong support for this hypothesis; that is; there was no consistent "aided AAC grammar" that emerged from the data of either study, or in earlier studies from the same line of research (Sutton, Morford, & Gallagher, 2004; Sutton, Gallagher, Morford, & Shahnaz, 2000). With regard to the translation hypothesis, the studies appear to support the idea that individuals using aided AAC to communicate may start with an internal representation of a spoken language utterance and attempt to translate that utterance into a graphic symbol utterance. This is supported by the fact that the older participants typically produced aided AAC utterances that followed spoken word order, and their utterances did not have a unique "aided AAC grammar". However, the translation task is not straightforward; that is, both younger and older participants chose relevant vocabulary, but only the older children and adults' development adhered to spoken language word order with simple (three-symbol) messages, and even the older children and adults sometimes failed to consistently adhere to spoken word order with more complex messages.

Word Order Production Patterns

The previous research findings provide minimal support for the modality specific hypothesis by demonstrating that although there may be variation in word order between spoken language and aided AAC utterances produced by individuals without disabilities, these utterances lack a consistent organization of the aided AAC symbol order. These studies also demonstrate that there may be both intra-individual and inter-individual word order variation between spoken and graphic symbol sequences.

Although it is useful to look at the graphic symbol sequence constructions of individuals without disabilities, it is also important to analyze the graphic symbol sequences constructed by individuals with disabilities who use aided AAC. In Binger & Light (2007), even when provided with aided AAC models (i.e., spoken and aided AAC models, such as *The dog bites the cat DOG BITE CAT*]) from a communication partner, four of five children with a variety of disabilities failed to adhere to the spoken word order in at least some of their messages. Trudeau and colleagues recently examined the word order patterns in graphic symbol sequences of individuals, ages 8-49, who use aided AAC in their daily life. Seventeen of the 22 participants constructed utterances with stable response patterns; that is, each individual consistently used a particular word order pattern (Trudeau, Sutton, Morford, Cote-Giroux, Pauze, & Vallee, 2010). Of the individuals with stable response patterns, 88% followed spoken word order when constructing simple agent-action-object sequences, and 94% followed spoken word order when constructing object relative clauses (e.g., *The clown pushes the girl who wears the scarf*). When constructing subject relative clauses (e.g., *The clown who pushes the girl wears the scarf*) the individuals with stable response patterns used two different techniques. The first was to follow spoken word order (e.g., *CLOWN PUSH GIRL WEAR HAT)* and the second was to change the spoken word order in order to reduce the ambiguity of the utterance (e.g., *CLOWN WEAR HAT PUSH GIRL*]). The authors concluded that "spoken language is a strong mediator in graphic-symbol communication" (Trudeau et al.; p. 309).

The findings of the four aforementioned studies appear to demonstrate that no inherent "aided AAC syntax" exists and that the modality specific hypothesis does not fully explain why language production is more difficult for individuals who use aided AAC. If this is the case, then we may turn to the translation hypothesis for a more complete picture of the word order difficulties that are present for individuals with and without disabilities.

It is highly relevant to address word order issues that are present in aided AAC communication. Using incorrect word order can decrease the likelihood that a communication attempt will be interpreted accurately, thereby causing a communication breakdown. If children who use aided AAC are to master the syntax of the language spoken within their communities – a primary goal for many individuals who use aided AAC – it is essential that that they learn to translate spoken language into graphic symbol-based messages.

The first step toward generative, grammatical, rule-based language is the transition from single symbol utterances to two-term semantic-syntactic relations (e.g., possessor-entity; action-object; Paul, 1997). Although children using AAC use a preponderance of single symbol messages (Binger & Light, 2007), numerous studies have demonstrated that children who use aided AAC to communicate can be taught to use multi-symbol utterances (albeit messages that do not always adhere to spoken word order) in a very short period of time (Binger & Light, 2007; Binger et al., 2008; 2010).

To date, only one known study has focused on teaching the use of correct word order when producing semantic-syntactic relations.

Nigam, Schlosser and Lloyd (2006) instructed three children with cognitive disabilities and unintelligible speech to use one two-term semantic-syntactic relation -- action-object -- using graphic symbol-based AAC displays (not SGDs). The intervention strategy was effective for increasing the number of action-object combinations produced by two of the three children. The first child produced 67% of untrained action-object combinations during generalization, and the second child produced 58%. The authors tracked all of the two-term combinations and then coded them either as correct productions (action-object) or incorrect productions (object-action) for each of these two children and found that initially neither child produced object-action combinations. As the intervention progressed, both children began to produce an increased number of object-action combinations; however, by the end of the study each child only produced one or two targets with incorrect word order. The authors concluded that "some of the reversed combinations were transferred into correct combinations as instruction progressed over time" (Nigam et al., 2006; p. 170). In other words, the children were taught to translate spoken language into graphic symbol sequences.

Rationale for the Current Study

In summary, children who use aided AAC to communicate often present with large receptive-expressive language gaps and have difficulty producing grammatically correct, multi-symbol utterances. These language delays make it difficult for these children to learn to use the generative language that is so important for attaining future educational and vocational goals. Learning to produce two-term semantic-syntactic relations is the first step towards acquiring the ability to use generative language. Although multiple studies have shown that interventions designed to teach children to produce multi-symbol utterances have been effective (Binger et al., 2008; 2010), only one known study has been designed to teach specific semantic-syntactic relations (Nigam et al., 2006). To address difficulties children have with learning to systematically combine symbols that adhere to spoken language word order, a pilot investigation, using current best practices for intervention, was implemented with a preschool child who used aided AAC; specifically, two semantic-syntactic relations (possessor-entity and action-object) were targeted.

The findings of this investigation will provide important implications for both the modality specific and translation hypotheses. If children who use aided AAC are able to learn to produce sequentially ordered two-term semantic-syntactic relations, the argument for the unique "aided AAC grammar" outlined by the modality specific hypothesis is negated and the translation hypothesis is strengthened; that is, such findings would provide initial indications that the children may be able to learn to translate an internal representation of spoken language into graphic symbol utterances that adhere to the spoken language syntax. In other words, positive findings would indicate that children may be able to be explicitly taught to overcome the limitations inherent in using graphic symbols to communicate (i.e., the modality specific hypothesis) and use a translation approach when creating graphic symbol-based messages.

Research Question

This study will assess the effect of an intervention designed to highlight spoken word order on the production of two-term semantic-syntactic relations for a preschooler who uses aided AAC. The specific research question addressed by this study is as follows: What is the effect of an intervention designed to highlight spoken language word order on the productive use of two-term semantic-syntactic relations by a preschooler who uses aided AAC?

Relevance. Children who use aided AAC frequently use single symbol utterances to communicate and demonstrate difficulties creating multi-symbol utterances that follow spoken language syntax. Since developing the use of two-term semantic-syntactic relations is one of the first steps towards developing the ability to use generative language, it is important for this population to learn to use sequentially ordered, two-term semantic-syntactic relations.

Method

Design

This study employed a single case, multiple probe across targets design with one preschooler who used aided AAC. Single subject designs are appropriate for use with populations who use AAC because they allow for the heterogeneous nature of the group and the analysis of skill acquisition of individual participants, an important factor when developing new interventions such as the intervention in the current investigation (Kratochwill, Hitchcock, Horner, Levin, Odom, Rindskopf, & Shadish, 2010). Initially, the participant was provided instruction sequentially in the use of two, two-term semantic-syntactic relations (possessor-entity and action-object); however, as the study progressed it was necessary to add a third, two-term semantic-syntactic relation (attribute-entity; see Results for details). One two-term semantic-syntactic relation was mastered or terminated before intervention on the next semantic-syntactic relation began.

Dependent Measure

The dependent measures included the number of targeted two-term semantic-syntactic relations produced using correct word order during the 20 minute play-based portion of intervention. Only aided AAC productions that were non-imitative and that did not immediately follow a direct verbal prompt (e.g., *Tell me*) were counted as correct productions.

Components of the Intervention

The key components of the intervention were aided AAC modeling and contrastive targets. Aided AAC models consisted of a complete spoken model of the target, paired with a model on the SGD (Binger & Light, 2007; e.g., *That's Monkey drops Lion DROP LION;* and *that's Lion drops Monkey DROP MONKEY*). In order to highlight the importance of word order, 10 pairs of contrastive targets (e.g., *Owl's horse* and *Horse's owl; Monkey drops Lion* and *Lion drops Monkey*, etc.) were modeled at the beginning of each session. Contrastive targets were selected as a key component of this intervention as they have been effectively implemented in order to teach children to use both morphological and syntactical structures correctly (Courtright & Courtright, 1976; Courtright & Courtright, 1979). Other intervention techniques known to facilitate language productions, including sabotage (i.e., the instructor intentionally produced an incorrect production on the SGD in order to elicit a correction from the child), expectant delay, and withholding desired objects were included in all phases of the study.

Participant

After receiving Institutional Review Board (IRB) approval, the participant was recruited through contacts with the UNM Speech and Hearing Clinic and the Assistive Technology Team at the Albuquerque Public School District (APS). Criteria for participation included the following: (a) be three to five years old; (b) be a monolingual English speaker; (c) require AAC to communicate; (d) have a severe, congenital motor speech impairment; (e) have an expressive vocabulary (verbal and gestural) of at least 25 words/symbols on the Communicative Development Inventories (Fenson, Dale, Reznick, Thal, Bates, Hartung, Pethick, & Reilly, 1993); (f) obtain a raw score of greater than 10 (approximately the16th percentile for a 5 year old, which indicates understanding of basic sentence structures) on the Elaborated Phrases and Sentences subtest of the Test of

Auditory Comprehension of Language (TACL-3) (Carrow-Woolfolk, 1999); (g) comprehend target semantic-syntactic relations with at least 80% accuracy using tasks developed by Miller and Paul (1995); (h) have received no intervention for semantic-syntactic relations production prior to the start of the study; (i) have vision and hearing functional for viewing graphic symbols and participating in session activities; (j) and not be diagnosed with an autism spectrum disorder. Other tests that were administered solely for descriptive purposes were the Peabody Picture Vocabulary Test (PPVT-4; Dunn & Dunn, 2007) to assess receptive language and the Columbia Mental Maturity Scale (Burgemeister, Blum, & Lorge, 1972) to assess nonverbal intelligence.

The chosen participant, who from now on will be referred to by the pseudonym Jorge, was recruited through contacts with the APS Assistive Technology Team. Jorge was 5;1 at the start of the study, was a Latino monolingual English speaker and had a congenital motor speech impairment for which he required aided AAC to communicate. Just prior to the start of the study, Jorge acquired a Prentke-Romich SGD for use in his home. He had minimal experience using any device and had not received prior intervention for semantic-syntactic relations. At the onset of the study, Jorge had an expressive vocabulary of 94 spoken words and gestures, according to parent report on the Communicative Development Inventory (Fenson, et al., 1993), and demonstrated comprehension of each of the target semantic-syntactic relations with at least 80% accuracy for the Miller and Paul (1995) tasks (possessor-entity = 100%; action-object = 88%). Additional participant information is located in Table 1.

Table 1

Participant Test Results Including Age Equivalency Scores, Raw Scores, Standard Scores, and Percentiles

Standardized tests	Scores			
	AE/MI	RS	SS/ADS	Percentile
TACL-3				
Vocab	< 3 AE	9	3 SS	1st
GM	< 3 AE	2	5 SS	5th
EPS	4;6 AE	14	8 SS	25th
Total	4;2 AE	--	70 SS	2nd
PPVT-4	3;1 AE	43	72 SS	3rd
Columbia	Below 3U MI	5	54 ADS	<1st

Note. Dashes indicate that score was not available for the test in question. TACL-3=Test for Auditory Comprehension of Language—3rd edition; AE=age equivalent; MI=maturity index; RS=raw score; SS=standard score; ADS=age deviation score; Vocab=Vocabulary; GM=Grammatical Morphemes; EPS=Elaborated Phrases and Sentences; PPVT-4=Peabody Picture Vocabulary Test—4th edition.

Setting and Experimenter

All baseline and intervention sessions were held at the University of New Mexico Speech and Language Clinic in a private therapy room. The primary investigator administered all tests and provided instruction during all sessions. Jorge was seated next to the clinician at a table or on the floor so that both the clinician and child had immediate access to the SGD.

Materials

Photographs were used during the concentrated modeling portion of all sessions (i.e., modeling non-contrastive targets during baseline and contrastive targets during intervention). As the two, initial semantic-syntactic relations under investigation were easily depicted via photographs, photographs were taken of the puppets and used during the sessions. For example, for possessor-entity, large puppets were photographed holding smaller finger puppets in order to demonstrate ownership. With regard to action-object, puppets were photographed acting out five different actions (drop, bite, chase, touch, and ride). The photographs were printed out and laminated. When in use during sessions, the laminated photographs were placed two to a page in a photo album.

Jorge was provided with an SGD, the Dynavox 4, for use during each session. The symbols he used to create messages (i.e., line drawings of each possessor, entity, action, and object) were programmed onto the SGD. For all graphic symbols (e.g., *LION, RIDE, JUMP*, etc.), Picture Communication Symbols (PCS) line drawings were used (Johnson, 1994). PCS were chosen because they are commonly used in the AAC community and can be used to depict abstract concepts such as verbs. The device was programmed with a separate communication page for each semantic-syntactic pair and contained vocabulary relevant to each target (i.e., one page for possessor-entity structures and one for action-object; see Appendix A). To highlight the importance of attending to the word order for each grammatical structure, all photographs presented were designed to have contrastive targets (e.g., nouns served as both possessors and entities, such as *Horse's owl HORSE OWL* and *Owl's horse OWL HORSE*). For each communication page, symbols were grouped by parts of speech rather than by more traditional organization by semantic-syntactic category (e.g., Fitzgerald key), as some symbols served multiple functions. See Table 2 for a list of vocabulary used in the study. During the play-based portion of the sessions, a variety of toys (e.g., puppets, basketball hoops, etc.) were used.

Procedures

The study was divided into four segments: pre-assessment and symbol training, baseline sessions, intervention sessions, and maintenance. The primary investigator administered all testing and intervention procedures during all segments of the study. Sessions were held approximately two times per week, with each session lasting approximately 30-45 minutes. The entire study, from the first baseline session to the final maintenance session, lasted a total of 24 weeks.

Table 2

Vocabulary Used for Each Semantic-Syntactic Relation

Dependent Measure 1: possessor-entity	Dependent Measure 2: action-object	
	Agent/object	Action
Bear	Alligator	Bite
Horse	Cow	Chase
Monkey	Dog	Drop
Owl	Frog	Ride
Penguin	Lion	Touch
Squirrel	Monkey	

Pre-assessment and Symbol Training

Prior to baseline and the start of intervention, Jorge received instruction in order to learn the meanings of the PCS symbols present on the SGD display. First, he was asked to identify each symbol on each communication page used throughout the investigation. For any symbols that he did not identify, a paired instructional paradigm (Schlosser & Lloyd, 1997) was used to teach the symbols. For this procedure, the instructor showed the symbol and the referent to Jorge while providing an explanation about how the symbol and referent were related and a short comment about the referent. For example, to teach the symbol for *RIDE*, the instructor said, *This is RIDE* while demonstrating one animal riding another animal while simultaneously selecting the symbol for *RIDE* on the SGD. Jorge was required to label all symbols in all phases of the study with at least 90% accuracy before baseline sessions began. In addition, all standardized testing was completed during this phase of the study.

Baseline

Three baseline sessions per target were completed prior to the start of the coinciding intervention phase of each target. For example, all three possessor-entity baseline sessions were completed prior to the start of the first possessor-entity intervention session. Each baseline session consisted of a 'control intervention' with two components: (1) a concentrated modeling segment and (2) play routine. The control intervention lasted approximately the same amount of time as the intervention sessions and followed a similar format to the intervention sessions (see below). Jorge was allowed access to the SGD throughout each of the baseline sessions. The same materials were used for both the baseline and intervention phases. Baseline was considered stable when his accuracy was no greater than 30% with less than 20% variation across a minimum of three sessions.

Baseline: concentrated models. As one of the key components of the intervention strategy was modeling contrastive targets (see below), no contrastive targets were presented during baseline. Instead, 10 pairs of *non*-contrastive semantic-syntactic relations were used during each session (e.g., *Monkey's squirrel* vs. *Owl's horse*; *Monkey drops Lion* vs. *Cow rides Alligator*, etc.). During the sessions, non-contrastive photographs were placed two to a page in sleeves of a binder. The instructor provided a spoken model of the first target and did not access the SGD. For example, the instructor said, *This is Lion bites Frog* while pointing to the first photograph, followed by *This is Dog rides Monkey* while pointing to the second photograph. To allow an opportunity for Jorge to fully comprehend the underlying grammatical rule being modeled, he was not given the opportunity to respond in between models (Courtright & Courtright, 1976; 1979). This technique is referred to as concentrated modeling and has been shown to be more effective than mimicry (i.e., immediate imitation) in teaching children to use and generalize specific grammatical rules.

Baseline: play routines. The same materials (e.g., puppets, etc.) were used for both baseline and intervention sessions. The instructor participated in semi-structured play with the puppets, creating a variety of opportunities for Jorge to use the target structure and responding to Jorge's communicative attempts. The instructor attempted to elicit the target structure by using a variety of prompts (see Table 3) and contingent responses (see Appendix B). The instructor did not provide any aided AAC models, produce any contrastive target exemplars, or explicitly direct Jorge's attention to the SGD during baseline sessions.

During baseline sessions the instructor elicited communication from Jorge by initiating an activity and then providing an opportunity for him to communicate (expectant delays, sabotage). For example, for action-object, the instructor initiated an activity by making the monkey puppet drop the lion puppet, and then by allowing Jorge the opportunity to comment on the action or request more of this activity. The instructor used various prompts to elicit participant turns, including expectant delay, sabotage, and brief verbal prompts such as WH questions (e.g., to elicit possessor-entity: *Who should* *we play with next?*; For action-object: *What would you like to do next?*). Depending on Jorge's response, the instructor provided a corresponding contingent response (see Appendix B).

Table 3

Prompts Used During All Phases of the Study

Prompts		Study phase	
Type of instructor prompt	Example of instructor prompt	Baseline	Intervention/ maintenance
Spoken model	*Monkey is going to drop Lion.*	X	
Expectant delay	Pause for approximately 5 seconds while gazing expectantly at the child.	X	X
WH question	*What should Monkey do?*	X	X
Direct verbal prompt	*Tell me.*	X	X
Silent gesture to the SGD	Point to the device or move the device towards the child without providing verbal prompts.		X
Aided AAC model	*Monkey is going to drop Lion DROP LION.*		X

Intervention

The intervention portion of each session was comprised of two components: (1) concentrated aided AAC models of contrastive targets, and (2) play routine. Each component is discussed in detail below.

Intervention: concentrated models with contrastive targets. Ten pairs of reversible semantic-syntactic relations (e.g., *Horse's owl, Owl's horse; Monkey drops Lion, Lion drops Monkey*, etc.) were used during the concentrated modeling portion of each session. To provide each concentrated model, the instructor presented a pair of photographs on a page of a photo album and pointed to each of the two photographs successively while providing an aided AAC model of each photograph. For example, during an action-object session, the instructor presented a page in a photo album and said, *Monkey drops Lion* (while modeling *DROP LION* on the SGD), and *Lion drops Monkey* (while modeling *DROP MONKEY*). As in baseline, Jorge was not provided with an opportunity to respond in between models.

Intervention: play routines. During intervention sessions, the instructor participated in semi-structured play with the puppets similar to those in baseline, creating a variety of opportunities for the target structure to be used and responding to Jorge's communicative attempts. The instructor used the same prompts that were used during the baseline phase to elicit the desired target structures (i.e., expectant delay, WH questions, and direct verbal prompts), plus two additional prompts: providing aided AAC models and gesturing toward the SGD (see Table 3). These additional prompts directly addressed the goal of teaching Jorge to map language onto the SGD by highlighting the importance and necessity of using the SGD to communicate. Moreover, aided AAC modeling provided an opportunity for the instructor to specifically demonstrate the language mapping process. The clinician also provided contingent responses to Jorge's productions on the SGD (see Appendix B).

Jorge was considered to have mastered a two-term semantic-syntactic relation when he demonstrated a considerable increase from baseline levels in the number of targeted two-term semantic-syntactic relations produced using correct word order during the 20 minute play-based segment of intervention for three consecutive sessions. Only non-imitative aided AAC productions counted towards the dependent variable – that is, accurate productions that did not immediately follow a direct verbal prompt combined with an aided AAC model (e.g., Jorge's production in this example would not have counted: Instructor: *Tell me Owl's monkey OWL MONKEY;* Jorge: *OWL MONKEY*).

Maintenance

After intervention was terminated or completed for each target, three maintenance sessions were planned for approximately 2, 4, and 8 weeks after the final intervention session for the completed target. Maintenance sessions followed the same format and procedures as the intervention sessions for each of the targets. Data were taken on Jorge's ability to continue to use the target grammatical structures without intervention.

Coding

All sessions were video recorded. Because results needed be calculated concurrently in order to determine when to shift study phases, coding of data was not blinded. The play-based portion of each session was transcribed in full by the primary investigator and two trained speech-language pathology students. Both instructor and participant behaviors including speech/vocalizations, actions, and SGD productions were transcribed. In addition, actions that clarified events (such as puppet-related actions) were transcribed.

Operational definitions were developed to code the dependent and independent measures. For the dependent measure (i.e., number of non-imitated semantic-syntactic relations with correct word order), data was coded according to the definitions provided in the Dependent Measures section, above. The independent measures that were manipulated during the study were the components of the intervention (e.g., contrastive pairs, aided AAC modeling, gesturing towards the SGD, etc.).

Treatment Fidelity

In order to demonstrate treatment fidelity, a number of instructor behaviors were coded and assessed (See Table 4). To ensure accurate implementation of the intervention, procedural reliability data was gathered for a minimum of 20% of the baseline, intervention, and maintenance sessions. After data analysis was completed, procedural reliability for instructor behaviors was found to be 100% for each phase of the study.

Table 4

Instructor Behaviors Used to Determine Treatment Fidelity

	Session components		
Study phase	Concentrated models	Play routines	
Baseline	Provide models of 10 non-contrastive pairs	Provide at least 15 spoken models	Respond contingently to the child's productions on the device in at least 70% of relevant opportunities (speech only).
Intervention/ maintenance	Provide models of 10 contrastive pairs	Provide at least 15 aided AAC models	Respond contingently to the child's productions on the device in at least 70% of relevant opportunities (speech and aided AAC models.)

Transcript and Data Reliability

The video recordings of all sessions were analyzed and coded. The primary investigator and one trained speech-language pathology student both served as primary transcribers. Each person transcribed her assigned sessions and determined the number of correct productions of the dependent measure produced by the child for each session. In order to obtain transcript reliability, a third trained speech-language pathology student served as secondary transcriber for at least 20% of the sessions for each phase and each target of the investigation. Each transcript was created independently with neither transcriber referencing the other's transcript.

Inter-rater agreement for transcript reliability was calculated for both the instructor and participant behaviors. For the instructor, point by point agreement for each spoken and graphic symbol was recorded. For the child, point by point agreement for each graphic symbol was calculated. Percent agreement was calculated by dividing the total number of agreements by the total number of agreements, disagreements, and omissions (e.g., a word was present on the primary transcript but was not on the secondary transcript) for each session. Inter-rater agreement for the transcripts was as follows: for possessor-entity sessions instructor behaviors = 94.3% and child behaviors =96.3%; for action-object sessions instructor behaviors = 96.4% and child behaviors = 92.6%; for attribute-entity sessions instructor behaviors = 97.2% and child behaviors = 96.6%.

Data reliability for the dependent variable was calculated for at least 20% of the sessions for each phase and each target of the investigation. Trained students examined the transcripts and viewed the videos to determine the number of correct productions per 20 minute segment of the play-based portion of each session. Data reliability was 100% for possessor-entity sessions, 90% for action-object sessions, and 86% for attribute-entity sessions.

Data Analysis

Visual analysis techniques were employed in order to analyze the raw data from this study. According to Kratochwill et al. (2010), "Single case researchers traditionally have relied on visual analysis of the data to determine: a) whether evidence of a relation between an independent variable and an outcome variable exists; and b) the strength or magnitude of that relation" (p. 17). In a recent review of single-case design methodologies for the Institute of Educational Sciences (IES), researchers concluded that, currently, there is little consensus regarding appropriate statistical analyses and quantitative effect size measures for single case designs (Kratochwill et al., 2010). Therefore, no statistical analyses were completed for this study. Instead, visual analysis standards recently described by Kratochwill et al. were used to provide a systematic analysis of the data. The IES standards provide researchers with a number of potential parameters to use to assess effect sizes. These parameters include level, trend, and variability of data within each phase of the study as well as the immediacy of effect and percentage of overlapping data between different phases of each target. Additionally, the consistency of data patterns across similar phases of different targets in the study also can be analyzed.

For the current study, certain parameters are more relevant than others, namely, level, trend, and consistency of the data points across targets. An increase in level from the baseline to the intervention phase is relevant, as an increase in the average number of target two-term semantic syntactic relations would demonstrate that the child is beginning to learn to translate spoken language into the visual-graphic modality. "Trend, which is the tendency for performance to decrease or increase systematically or consistently over time" (Kazdin, 1982, p.106) is relevant as well, as an increase in trend will signal that the child is progressively improving his ability to translate spoken language onto the SGD. Finally, consistency of the data across targets is one of the most relevant parameters, as a high level of consistency signals an increased likelihood of the presence of a causal relationship between the independent and dependent measures. This parameter involves comparing data from each target during similar phases of the study (e.g., data from all targets during the baseline phase) in order to determine if a consistent pattern is present across targets.

This study will not focus on the percent of non-overlapping data or immediacy of effect. These measures are appropriate when immediate gains are expected, which is not necessarily expected in the current study; multiple sessions may be required for the participant to learn to translate spoken language onto the SGD, and a slightly delayed treatment effect will not negatively impact the implications of the theoretical perspectives of this investigation. The child's data in this study is not expected to be highly variable since findings from other studies similar to this one (e.g., Binger & Light, 2007; Binger, Maguire-Marshal, & Kent-Walsh, 2011; Nigam et al., 2006) demonstrated that the children's data remained relatively stable. For this reason, variability will not be a focus of the current data analysis.

Results

Acquisition of Possessor-Entity

Baseline and intervention. As seen in Figure 1, the child maintained a stable baseline at zero across three sessions for possessor-entity. During this phase, Jorge created a number of single and multi-symbol messages using the SGD, which sometimes served a listing function (e.g., listing the animals available for play). Additionally, he produced numerous two-symbol messages consisting of two nouns, but the context did not support his use of possessor-entity structures (e.g., Jorge selected *PENGUIN HORSE* to indicate a desire to obtain Penguin and Horse, not Penguin's horse).

Although intervention for this target was terminated, Jorge did demonstrate some improvement with the possessor-entity target during intervention; the dependent measure remained above baseline levels for 5 out of 7 sessions. The level of the data shifted from 0.0 during baseline to 1.3 during intervention. The slope of the data during baseline was flat (at zero) and was slightly negative during intervention, signaling a slight increase between baseline and intervention followed by a steady decrease in the number of correct target two-term semantic-syntactic relations produced during each successive session. Consistency of data phases will be discussed in the action-object and attribute-entity sections below. These analyses indicate that the intervention had a mild effect on the dependent measure for the possessor-entity target.

Supplementary analyses were completed relating to the total number of correct productions and unique productions of the targets (see Table 5) and vocabulary produced during the intervention phase (see Appendix C). For possessor-entity, Jorge used a relatively small range of two-term possessor-entity combinations, and he appeared to favor some vocabulary items more than others (e.g., Squirrel as an entity). The fact that Jorge did not use all of two-term combinations or vocabulary items may be due to the fact that he appeared to prefer certain materials during the session over others (e.g., Squirrel was most frequently preferred).

Figure 1

Number of Correct Target Two-Term Semantic-Syntactic Relations Produced

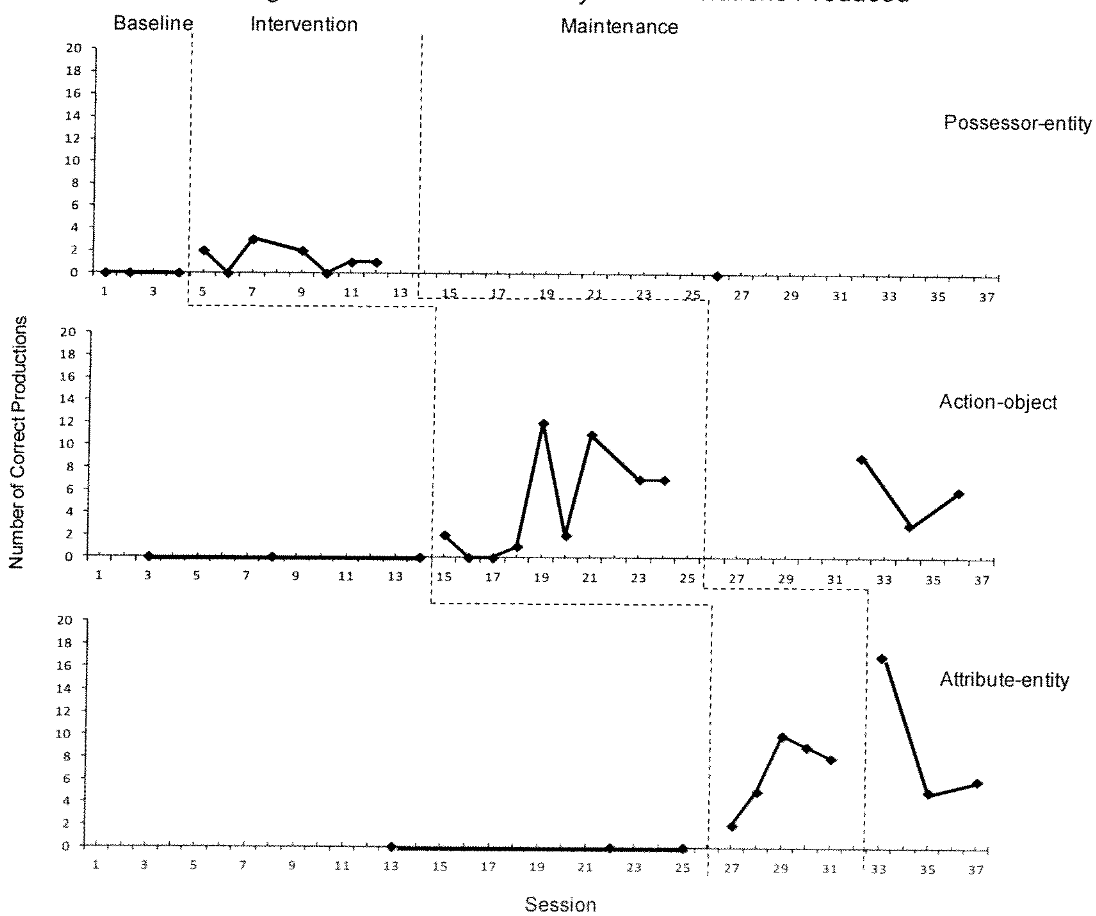


Table 5

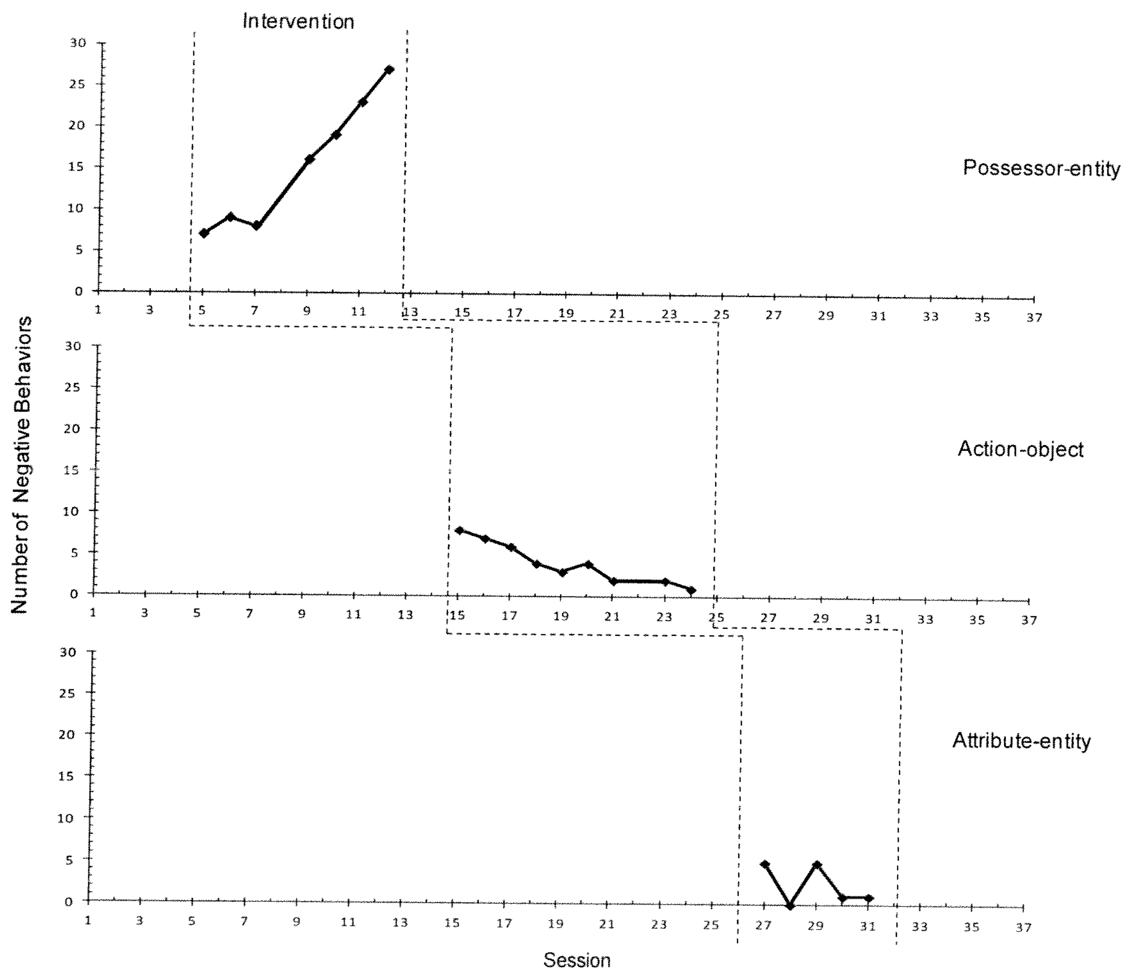
Number of Correct and Unique Semantic-Syntactic Relations for Each Dependent Measure During the Intervention Phase

Two-term semantic-syntactic relation	Total number of intervention sessions	Total number of correct utterances produced	Total number of unique two-term semantic-syntactic relations used (out of 30 possible for each target)
Possessor-entity	7	9	7/30 = 23%
Action-object	9	42	17/30 = 57%
Attribute-entity	5	34	10/30 = 29%

Negative Behaviors. As the sessions progressed for possessor-entity, Jorge demonstrated an increasing number of negative behaviors, which included the following: the child demonstrating a verbal negation, including saying or yelling *No, Uh uh, Night night, Aw, Go away, All done, me, or mine* in a strained or frustrated manner. Other spoken negative behaviors included shushing the instructor, groaning, growling, sighing, moaning, and whining. Negative physical behaviors included aggressively grabbing the animals, hitting the device, blowing on the instructor, covering his face, putting his head on the ground or between his legs, turning away from the device or instructor, rolling or rubbing his eyes, trying to block the instructor from using the device, frowning, shaking his head in negation, sticking his tongue out, and pushing/ pulling/kicking the instructor. Negative behaviors typically followed an instructor prompt (e.g., *Tell me*) or contingent response (e.g., *Tell me both parts* or a correction with an aided AAC model). An inverse relationship between the number of correct possessor-entity productions and the number of negative behaviors was noted; that is, as the number of correct productions reduced to near baseline levels, Jorge's negative behaviors steadily increased (see Figure 2). Therefore, the intervention for the possessor-entity target was discontinued.

Figure 2

Negative Behaviors Demonstrated During Intervention



Maintenance. As the child did not reach mastery for possessor-entity, only one, eight-week maintenance session was completed for this target. Jorge did not produce any correct targets during this session. His negative behaviors during this session decreased significantly from the final possessor-entity intervention session (i.e., from 27 to 6). The maintenance phase for possessor-entity could not be analyzed for consistency, as only one maintenance session was completed due to the minimal gains noted for the target.

Acquisition of Action-Object

Baseline and intervention. As seen in Figure 1, the child maintained stable baselines at zero across three sessions for action-object. During baseline for action-object, Jorge created a number of single and multi-symbol messages using the SGD. As with possessor-entity, his productions sometimes appeared to serve a listing function (e.g., listing the animals available for play). Although Jorge produced numerous single and multi-symbol messages during this time (often listing the animals available for play), he did not produce any action-object combinations using correct word order.

Jorge demonstrated proficiency for action-object after a slight delay. He produced very few correct productions during the first four action-object sessions, then after the fifth session he began to demonstrate relatively steady gains (see Figure 1). The level of the graph shifted from 0.0 during baseline to 4.7 during intervention. The slope of the data during baseline was flat (at zero) and was positive during intervention, signaling an increase in the number of correct target two-term semantic-syntactic relations produced as sessions progressed. With regard to consistency across phases, the baseline phases for possessor-entity and action-object showed a consistent pattern, with both maintaining a flat slope at zero for the entire phase. However, a differential effect was noted during intervention; that is, possessor-entity showed a decreasing slope and action-object showed an increasing slope and a higher level than possessor-entity. Taken as a whole, these analyses indicate that the intervention had a greater effect for the action-object target, but less significant for possessor-entity.

As with possessor-entity, supplementary analyses for action object were completed (see Table 5 and Appendix C, respectively). Jorge appeared to favor some vocabulary items over others for this target (e.g., touch, drop, Cow, etc.); however, he produced action-object structures using a relatively varied set of vocabulary and action-object combinations.

Negative behaviors. To ensure that Jorge's challenging behaviors resulted from issues with the possessor-entity target and not from the overall study procedures, Jorge's challenging behaviors were tracked for action-object sessions. The presence of challenging behaviors was negligible for this target; these behaviors were low throughout the intervention phase with a decreasing slope (see Figure 2).

Maintenance. Due to a miscommunication error, the maintenance sessions that were planned for 2, 4, and 8 weeks post-intervention were actually completed 5, 7, and 9 weeks after the final action-object intervention session. During this phase, Jorge's data were somewhat variable, and the slope of the data was slightly negative. Compared with baseline levels, he continued to demonstrate considerable increases in his ability to use correct, non-imitated, two-term semantic-syntactic relations during the first and third maintenance sessions (i.e., 9 and 6 correct productions, respectively). However, he produced only three action-object combinations correctly during the second maintenance session. The level of the graph shifted from 4.7 during intervention to 6.0 during maintenance.

Target 3: Attribute-Entity

Because Jorge did not demonstrate clear and consistent gains with the first target (possessor-entity), it was no longer possible to demonstrate experimental control for the first two targets. In order to re-establish such control, a third target – attribute-entity – was added.

The same baseline and intervention procedures were used for attribute-entity as for the first two targets, unless otherwise noted below. Additional materials included the development of a communication page using PCS symbols, similar to the procedure for the previous two targets (see Appendix A). Targeted vocabulary for the attribute-entity target is located in Table 6.

Table 6

Vocabulary for Attribute-Entity

Dependent measure 3: attribute-entity	
Attribute	Entity
Big	Cow
Little	Horse
Hard	Monkey
Soft	Penguin
Dry	Pig
Wet	

Baseline and Intervention. Baseline and intervention procedures mirrored those for the other two targets except for one change made to the concentrated modeling portion of the attribute-entity sessions. For possessor-entity and action-object, photographs were used to depict semantic-syntactic relations (e.g., photographs of Lion dropping Dog and Dog dropping Lion). However, for attribute-entity, the actual animals were used as props, as the attributes of each animal were not easily depicted in photographs (e.g., hard vs. soft Cow).

Acquisition of Attribute-Entity

Baseline and intervention. As seen in Figure 1, Jorge maintained a stable baseline at zero for attribute-entity. Patterns of vocabulary use for attribute-entity paralleled that of possessor-entity and action-object; that is, Jorge demonstrated his ability to create single and multi-symbol messages, but he did not correctly produce any targeted attribute-entity combinations using correct word order.

Jorge demonstrated rapid increases for this target, as evidenced by two correct productions of the target in the first intervention session. Sustained gains of the target were achieved within 5 sessions (see Figure 1). Visual inspection revealed considerable changes in both the level and slope of the data. Baseline levels shifted from 0.0 during baseline to 6.8 during intervention. The slope of the data during baseline was flat (at zero) and immediately became positive during intervention. This positive slope continued throughout the intervention phase, signaling a steady and rapid increase in the number of correct target two-term semantic-syntactic relations used by the child. Consistency of the data was noted across the action-object and attribute-entity targets; specifically, baseline and trend levels were both at zero, and level and slope increases were apparent for both targets. Overall, these analyses indicate that the intervention had an effect for the attribute-entity target and demonstrate that there may be a causal relationship between the independent and the dependent measures.

Jorge used a total of 10 different attribute-entity combinations during intervention (see Table 5). As with the other two targets, he appeared to favor some vocabulary items more than others (see Appendix C), which again was likely due to a preference for certain materials (e.g., penguin) and attributes (e.g., wet). Jorge's use of the targeted structure demonstrated his ability to generalize the target over a somewhat varied set of vocabulary and attribute-entity combinations.

Negative behaviors. Jorge exhibited relatively few negative behaviors during most of the attribute-entity baseline and intervention sessions (see Figure 2).

Maintenance. Three maintenance sessions were completed for the attribute-entity target at 2, 4, and 8 weeks after the final attribute-entity intervention session. Jorge continued to show significant improvement in his ability to use correct attribute-entity combinations during all three of these sessions. The level of the graph increased from 6.8 during the intervention phase to 9.3 during the maintenance phase, indicating that after intervention had terminated Jorge continued to demonstrate ongoing improvement in his ability to produce the target semantic-syntactic relation. The data from maintenance phases of action-object and attribute-entity were relatively consistent: both showed an increase in level and had somewhat variable data points with the first data point for being highest, the second dropping, and the third increasing again. Overall, the data indicate that Jorge maintained use of attribute-entity target over time.

Discussion

Target 1: Possessor-Entity

Jorge made minimal gains with the possessor-entity target and exhibited a far greater number of negative behaviors in comparison to both action-object and attribute-entity. Jorge's successful acquisition of the action-object and attribute-entity targets, as discussed below, indicates that his lack of progress for the possessor-entity target may have been due to factors other than an inability to learn to translate spoken language onto his SGD. Other possible contributing factors are discussed below.

Several factors may have contributed to Jorge's lack of success with the possessor-entity target. First, it is not typical for possessor-entity to be used within the context of animals 'owning' other animals. A more common context would be an animate object owning an inanimate object (e.g., the dog's leash, mom's cup, etc.). For this reason, the concept of animals owning other animate creatures may have been too far removed from Jorge's real life experience.

Second, the target may not have been particularly salient for Jorge. That is, there may not have been a reason for him to use both parts of the semantic-syntactic relation within the sessions. For example, the fact that the finger puppet squirrel belonged to the hand puppet horse (e.g., *Horse's squirrel*) may have not been a salient enough relationship to make the effort to state both parts, since the two puppets actually were two separate entities and did not have a permanent corresponding relationship. Jorge's reaction can be explained by the Gricean principles, which outline basic rules of human interaction (Grice, 1975). As a rule, speakers generally do not make their statements more informative than necessary (maxim of quantity) and only provide information that they deem relevant (maxim of relevance). In Jorge's case, he did not need to tell the instructor *HORSE SQUIRREL* in order to get his point across that he wanted the squirrel, even though both Horse's squirrel and Squirrel's horse were present. The same appeared to be true for Jorge's motivation to make a comment about the animals.

Targets 2 and 3: Action-Object and Attribute-Entity

Jorge successfully used both the action-object and attribute-entity targets. The data for both targets followed similar patterns with each slope appearing to steadily increase over time. This may demonstrate the efficacy of the intervention to teach Jorge to map spoken language onto the SGD. Similarly, Jorge had an insignificant number of negative behaviors during these sessions in comparison with the number of negative behaviors he had during the possessor-entity sessions.

Jorge's pattern of success (i.e., acquiring the second target [attribute-entity] more quickly than the first [action-object]) lends some support for the translation hypothesis and may demonstrate that Jorge has started to develop the ability to map spoken language onto an SGD. It also may show that some of his difficulties producing aided AAC utterances as evidenced in baseline did not result from language delays but instead from an inability to translate spoken language onto the SGD (discussed further in Theoretical Implications, below). Although this pattern did not occur as predicted for the possessor-entity versus action-object targets, it did occur for the action-object versus attribute-entity targets. That is, after successfully acquiring the second target (action-object), Jorge acquired the third target (attribute-entity) more quickly. Also, even though intervention with possessor-entity was less successful than the other two targets, the possessor-entity intervention may have made it more likely that Jorge would be successful with action-object and attribute-entity (i.e., priming effect).

In terms of the maintenance phase, the data for action-object paralleled that of attribute-entity; with both targets, Jorge demonstrated increases in the level of the data compared with both baseline and intervention phases, indicating that Jorge maintained the targets over time, although his performance was not at a consistently high level for either target during maintenance. It is not possible to determine for certain why Jorge's performance dropped during one of the maintenance checks for each of these targets. One possibility is that he was simply having an off day. Regardless, the fact that the number of correct productions increased again during the last session for both action-object and attribute-entity indicates that he ultimately was able to maintain use of these linguistic rules over time.

Theoretical Implications

Learning to communicate via an SGD is not an easy task. As discussed earlier, one of the possible reasons for the increased difficulty of this task may be related to the restrictions inherent to a device (i.e., the modality specific hypothesis). This study provides some initial evidence that these factors can be overcome when appropriate interventions are implemented. Over the course of the study, Jorge learned to produce two of the three target semantic-syntactic relations correctly even though the following device restrictions may have been present: lack of grammatical morphemes for the possessor-entity communication page, the selection of vocabulary present (only 6-11 items per communication board), and the rate at which the device voiced a button that was selected. The presence of the device itself also potentially increased the cognitive load for Jorge as he needed to pay attention to the clinician, the puppets, and the device all at the same time during each session. Again, even though these limitations were present, Jorge was able to successfully learn to produce two different two-term semantic-syntactic relations and overcome some of the limitations inherent to the modality specific hypothesis.

Part of the modality specific hypothesis indicates that a separate grammar inherent in the visual-graphic modality may exist and be the reason that children demonstrate difficulties using SGDs. As previously discussed, findings from two recent studies, Trudeau et al. (2007) and Sutton et al. (2010), do not provide strong support for this hypothesis. Both studies demonstrated that individuals without disabilities from a variety of age groups had difficulty following spoken word order when producing aided AAC messages. A high amount of word order variation within and across the productions of the participants was noted in both studies, which did not lend support for the existence of a unique "aided AAC grammar". If the modality specific hypothesis were true, a consistent "aided AAC grammar" should have been noted. Similarly, throughout the current investigation, Jorge produced aided AAC utterances with a great deal of word order variation (e.g., action-object, object-action, etc.). Progressively, he steadily improved his ability to correctly produce two, two-term semantic-syntactic relations (action-object and attribute-entity) using spoken word order. This study appears to be in accordance with both Trudeau et al. and Sutton et al., as it provides some preliminary evidence against the modality specific hypothesis and a unique "aided AAC grammar".

In contrast, the translation hypothesis proposes that in order to produce spoken word order on an SGD, an individual must be taught to translate an internal representation of spoken language into a graphic symbol representation of the message. The findings from the current study provide some initial support for this hypothesis as well as the idea that "spoken language is a strong mediator in graphic-symbol communication" (Trudeau et al., 2010, p. 309), and that children can be taught to produce specific grammatical rule-based language onto an SGD (Nigam et al., 2006). That is, Jorge's accurate production of action-object and attribute-entity support the hypothesis that he was able to learn to translate internal representations of a spoken English utterance into a graphic symbol utterance. Also, the fact that Jorge completed the final target more rapidly than the second target demonstrates that some carryover between targets may have occurred and that his communication difficulties may be caused in part by initial challenges of converting the spoken language modality into the graphic symbol modality– challenges which he was able overcome with the support of the current intervention. If Jorge had taken just as long or longer to acquire the final target, this might have indicated that he was truly in the process of learning to express this linguistic rule via any modality (including speech). However, he rapidly began producing accurate attribute-entity structures, which seems to indicate that his difficulties stemmed from his inexperience translating spoken messages onto the SGD, not from his lack of knowledge of the specific linguistic structure itself. This result would only be expected if Jorge had truly learned to translate spoken language onto the SGD.

Even with some cognitive and linguistic delays, Jorge was able to learn to produce spoken messages with correct word order on an SGD. His ability to learn this task provides initial evidence against the idea that children eight and under (with or without typical cognition) may not have the metalinguistic capabilities needed to translate spoken messages into the visual graphic modality (Trudeau et al., 2007; Sutton et al., 2010). It appears that fully developed metalinguistic skills are not necessary in order for a child to learn to translate spoken language onto an SGD, since Jorge, a five year old with developmental delays, learned to produce two grammatical forms on an SGD at age five – that is, before his metalinguistic skills were fully developed. That is, he may have implicitly learned the grammatical structures without first having the explicit metalinguistic knowledge of said structures (Ravid & Tolchinsky, 2002). Jorge's ability to learn to produce two semantic syntactic relations appropriately appears to lend some support for the idea that explicit metalinguistic knowledge may not be a necessary prerequisite when learning to translate spoken language onto an SGD.

The fact that Jorge was able to learn to produce two, two-term semantic-syntactic relations using correct word order appears to support the idea that young children can be taught to use a translation approach when communicating via an SGD. Furthermore, these findings demonstrate that the limitations inherent to the SGD may be overcome when appropriate intervention strategies are implemented. These findings provide initial pilot evidence that children may be taught to adopt a translation approach for creating multi-symbol messages.

Clinical Implications of Results

The results of this study also have important implications for clinical intervention. The fact that Jorge was able to successfully learn to produce two different rule-based grammatical forms on an SGD demonstrates that it may be possible for clinicians to teach preschool children with or without cognitive delays to not only use an SGD to communicate, but also to map specific rule-based spoken language onto an SGD. This study provides initial evidence that certain intervention strategies, including aided AAC modeling and contrastive targets, can be used to teach a child to translate spoken language onto an SGD.

The lack of significant gains observed with the possessor-entity target in this study provides clinicians with several excellent reminders about the provision of effective treatment. Although the precise reasons for the participant's relative difficulties with acquiring the possessor-entity target cannot be conclusively determined, two possible factors may be lack of salience of targets and lack of motivation. One possible way to address these factors is by creating and implementing a required context for targets. For example, one way to create a required context for possessor-entity would be to select possessors and entities that were inextricably linked to each other so that the use of the two semantic categories together would be required when making a request or comment (e.g., my hair, Monkey's hair; your arm, his arm, etc.). This would create a situation where using both terms would be the only method to clearly get one's point across.

Another possible reason that Jorge may have been somewhat less successful with possessor-entity could have been lack of motivation. If he did not really care which animal he had or did not particularly like the activities chosen for the sessions, he may have been less likely to produce the targets. This pattern was observed elsewhere in the study; for example, Jorge did not particularly like the animals biting each other, so he rarely produced targets with the word *bite* in them. In summary, clinicians need to consider specific client motivations when planning intervention. If the activities are not motivating to a specific child, then he will be much less likely to use the target vocabulary or grammatical structure appropriately.

Limitations

Several factors limit the findings of this study. First, as with all single-case designs, one weakness is a lack of external validity; the study must be replicated with more participants to strengthen the findings and to provide more support for the use of the intervention strategy. Second, according to Kratochwill et al. (2010) the current investigation, taken as a whole, does not meet current single-case design standards. Current recommendations for single case designs require at least three demonstrations of the experimental effect. That is, "In most [instances] experimental control is demonstrated when the design documents *three* demonstrations of the experimental effect at *three* different points in time with a single case (within-case replication)…" (Kratochwill et al.). In the current study, however, only two demonstrations were achieved. Although the standards were not met for this requirement, a degree of experimental control was still demonstrated by replicating success of the second target (action-object) with the third target (attribute-entity). Additionally, the current study "met standards with reservations" instead of meeting full standards (Kratochwill et al.)

with regard to the number of baseline sessions completed for each target. That is, due to time constraints, only three baseline sessions for each target were completed, rather than the five recommended by Kratochwill and colleagues. However, it should be noted that collecting baseline data for more than three baseline sessions can be problematic with this type of research; that is, the child may become frustrated and uncooperative due to the lack of supports provided during baseline sessions, even to the point of being unwilling to participate in the project. In this study, the effect delayed success had on Jorge during the possessor-entity intervention phase can easily be seen by comparing his number of correct productions of the target (see Figure 1) with the number of negative behaviors that were present in each session (see Figure 2). As the sessions progressed and Jorge continued to remain unsuccessful his negative behaviors began to progressively increase. In time, this pattern most likely would have continued and his parents might have decided to remove him from the study. The continued failure pattern could potentially affect the child's performance during other phases and with other targets causing potentially functional intervention programs to fail. Fourth, due to time constraints, no generalization measures for other related and un-related semantic-syntactic relations were obtained; such data might yield more concrete evidence that a child has truly learned the translation method when creating graphic symbol messages. Also, if the child consistently produced an unrelated semantic-syntactic relation, this would demonstrate that the child has truly learned how to translate grammatical rules from their spoken forms onto an SGD.

Directions for Future Research

The development of interventions to teach children to map specific linguistic rules onto an SGD is still in the early stages, and the findings from this study demonstrate that certain changes need to be made to the study in order for it to meet standards and to provide more valid evidence for or against both the modality specific and the translation hypotheses. For external validity purposes, this study should be replicated with additional participants. Some important changes to the design that would fulfill the requirements needed to meet the new standards by Kratochwill et al. (2010) would be to include three target semantic-syntactic relations from the beginning of the study, 5 baseline sessions, and the addition of generalization targets (both related and unrelated to the three targets). Additionally, including generalization targets would provide an excellent opportunity to observe whether the ability to translate spoken language on a device can be transferred to targets that previously have not been taught. If a child generalized to novel targets, this would clearly demonstrate a wide spread adoption of the ability to map spoken syntax onto an SGD.

Another beneficial addition would be the inclusion of booster sessions for a target if the child's performance decreases during maintenance, which could signal that the child did not fully acquire the translation method. This recommendation is highlighted since the number of correct semantic-syntactic relations produced by Jorge during the maintenance phase decreased slightly from the intervention phase. If the child were able to maintain significant increases in his performance after the booster sessions and second maintenance phase, then it would be more certain that he had truly acquired the ability to translate spoken messages onto an SGD.

Finally, it would be informative to track word order reversals of the target semantic-syntactic relations – that is, comparing the number of correct productions with the number of productions containing the correct vocabulary but the wrong word order. This type of analysis would be useful in tracking a participant's progress with acquiring the ability to translate spoken messages into graphic symbol utterances. It is recommended that future studies include this type of data analysis.

Future clinical studies may want to address the difficulties that manifest for the possessor-entity target. For example, future researchers may want to examine methods for adapting the possessor-entity vocabulary and context so that the target would be more salient to the participants. More salient vocabulary items might include the use of first and second person pronouns as possessors, body parts as entities, or the combination of animate possessors with inanimate objects that are commonly owned (e.g., the man's shirt, the girl's house). Another possible direction for research is to compare the translation abilities of children with typical cognition versus children with developmental delays. This is particularly important due to the heterogeneous nature of the group of individuals who use AAC. It is possible that one intervention strategy may be more appropriate for a child with developmental delay while another may be for a child with typical cognition.

Finally, since this study only examined the intervention as a whole, it is impossible to say which parts of the intervention are most important or if all parts are equally important. Therefore, another possible direction for future research would be to attempt to determine which components of the intervention have the greatest effect on a child's ability to learn to translate spoken language onto an SGD.

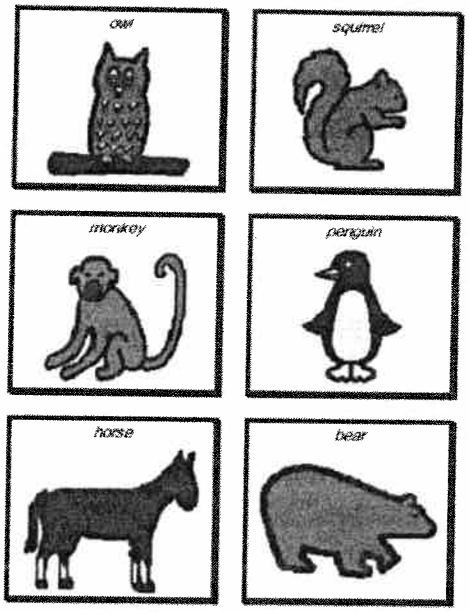
As previously mentioned, learning to map specific grammatical rules onto an SDG is not a straightforward task. Because of this, it is extremely important to find successful interventions that will support children who use AAC in their use of grammatical, rule-base language so that they can more actively participate in the social, educational, and vocational opportunities that are available to them. The current study is an important addition to a line of research aiming to address this challenge.

List of Appendices

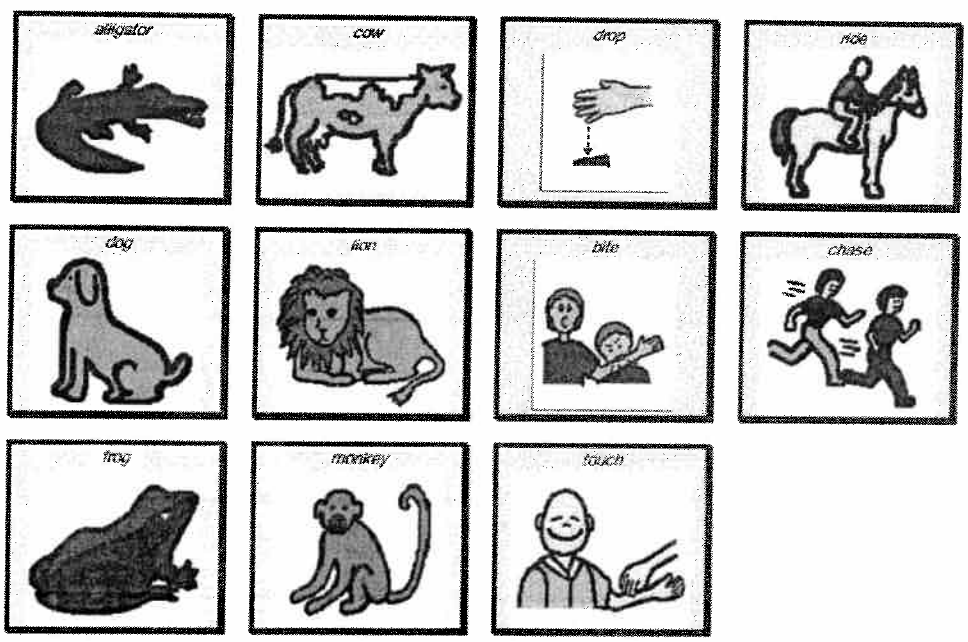
Appendix A

Communication Boards Used During All Phases of the Study

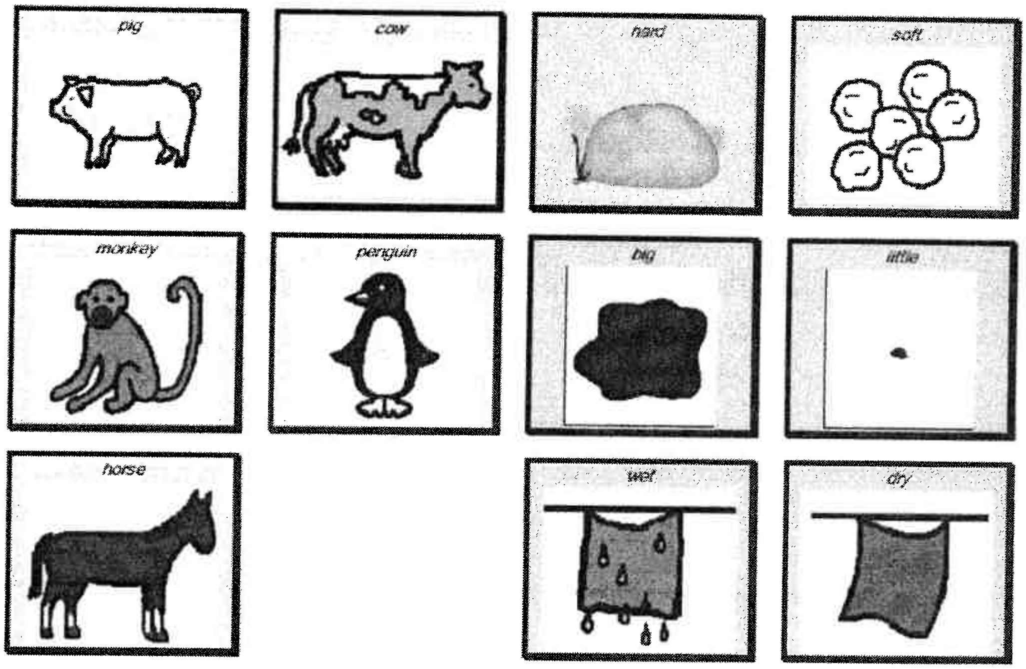
Possessor-entity



Action-object



Attribute-entity



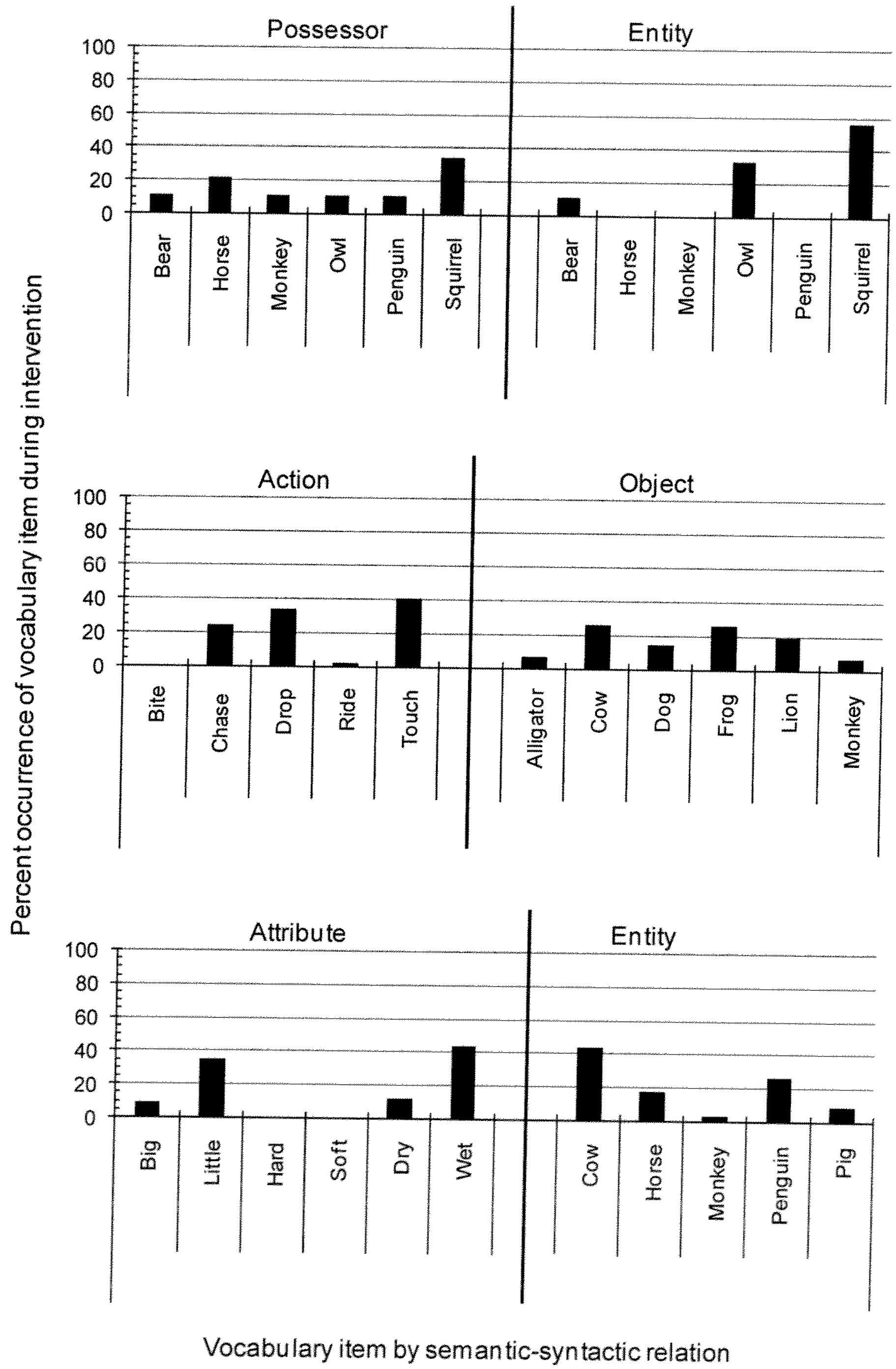
Appendix B

Contingent Responses Used During Sessions; Example Target Below is Monkey drops Lion DROP LION

		Baseline		Intervention	
Type of child production	Example of child production	Type of instructor response	Example of instructor response	Type of instructor response	Example of instructor response
On topic					
1 symbol	*LION*	Spoken expansion	*Oh, you mean you want Monkey to drop Lion.*	Request for expansion	*Tell me both parts.*
2 symbol	*DROP LION*	Imitation	*That's right! Monkey drops Lion.*	Imitation	*That's right! Monkey drops Lion DROP LION.*
Incorrect					
1 symbol	*DOG*	Spoken correction	*We're not playing with Dog. Monkey drops Lion.*	Spoken correction with an aided AAC model	*We're not playing with Dog. Monkey drops Lion DROP LION.*
2 symbol	*LION DROP*	Spoken correction	*Lion is not dropping Monkey. Monkey drops Lion.*	Spoken correction with an aided AAC model	*Lion is not dropping Monkey DROP MONKEY. Monkey drops Lion DROP LION.*
Unclear					
1 symbol	*DOG*	Request clarification	*Do you want Dog?*	Request clarification with or without an aided AAC model	*Do you want Dog? DOG.*

Appendix C

Frequency of Occurrence of Vocabulary Used During Intervention Phase of Each Two-Term Semantic-Syntactic Relation



References

Binger, C., Kent-Walsh, J., Berens, J., Del Campo, S., & Rivera, D. (2008). Teaching Latino parents to support the multisymbol message productions of their children who require AAC. *Augmentative and Alternative Communication, 24*, 323-338.

Binger, C., Kent-Walsh, J., & Taylor, S. (2010). Teaching educational assistants to facilitate the multisymbol message productions of young students who require augmentative and alternative communication. *American Journal of Speech-Language Pathology, 19 (2),* 108-120.

Binger, C., Maguire-Marshall, M., Kent-Walsh, J. (2011). Using aided AAC models, recasts, and contrastive targets to teach grammatical morphemes to children who use AAC. *Journal of Speech, Language, and Hearing Research, 54,* 160-176.

Binger, C., & Light, J. (2006). Demographics of preschoolers who require AAC. *Language, Speech & Hearing Services in Schools, 37 (3),* 200-208.

Binger, C. & Light, J. (2007). The effect of aided AAC modeling on the expression of multi-symbol messages by preschoolers who use AAC. *Augmentative and Alternative Communication, 23 (1),* 30-43.

Binger, C. & Light, J. (2008). The morphology and syntax of individuals who use AAC: Research review and implications for effective practice. *Augmentative and Alternative Communication, 24 (2),* 123-138.

Blockberger, S., & Sutton, A. (2003). Towards linguistic competence: The language experiences and knowledge of children with extremely limited speech. In J. Light, D. Beukelman, & J. Reichle (Eds), *Communicative competence for individuals who use augmentative and alternative communication.* Baltimore, MD: Paul H. Brookes.

Braze, D. (2004). Aspectual inflection, verb raising, and object fronting in American Sign Language. *Lingua, 114 (1),* 29-58.

Burgemeister, B., Blum, L., & Lorge, I. (1972). *Columbia Mental Maturity Scale*. The San Antonio, TX: The Psychological Corporation.

Chen, L. & Whittington, D. (2006). Organizing language intervention relative to the client's personal experience: A clinical study. *Clinical Linguistics and Phonetics, 6,* 167-178.

Carrow-Woolfolk, E. (1999). *Test for auditory comprehension of language* (3rd ed.) Austin, TX: Pro-Ed.

Courtright, J. & Courtright, I. (1976). Imitative modeling as a theoretical base for instructing language-disordered children. *Journal of Speech and Hearing Research, 19 (4)*, 655-663.

Courtright, J. & Courtright, I. (1979). Imitative modeling as a language intervention strategy: The effects of two mediating variables. *Journal of Speech and Hearing Research, 22 (2),* 389-402.

Dunn, L. and Dunn, D. (2007). *Peabody Picture Vocabulary Test-4*. Minneapolis, MN: Pearson, Inc.

Fenson, L., Dale, P., Reznik, J., Thal, D., Bates, E., Hartung, J., Pethick, S., & Reilly, J. (1993). *MacArthur communicative development inventories*. San Diego: Singular Publishing Group.

Goosens', C. (1989). Aided communication intervention before assessment: A case study of a child with cerebral palsy. *Augmentative and Alternative Communication, 5,* 14-26.

Grice, P. (1975). "Logic and conversation". In *Syntax and Semantics, 3: Speech Acts*, ed. P. Cole & J. Morgan. New York: Academic Press. Reprinted in *Studies in the Way of Words*, ed. H. P. Grice, pp. 22–40. Cambridge, MA: Harvard University Press (1989).

Hooper, J., Connell, T. M., & Flett, P. J. (1987). Blissymbols and manual signs: A multimodal approach to intervention in a case of multiple disability. *Augmentative and Alternative Communication, 3,* 68-76.

Johnson, R. (1994). *The Picture Communication Symbols Combination*. Solana Beach, CA: Mayer-Johnson Co.

Kazdin, A. (1982). *Single-case research designs: Methods for clinical and applied settings*. Oxford University Press: New York.

Kent-Walsh, J., Binger, C., & Hasham, Z. (2010). Effects of parent instruction on the symbolic communication of children using augmentative and alternative communication during storybook reading. *American Journal of Speech-Language Pathology, 19 (2),* 97-107.

Kratochwill, T. R., Hitchcock, J., Horner, R. H., Levin, J. R., Odom, S. L., Rindskopf, D. M., Shadish, W. R. (2010). Single-case designs technical documentation. Retrieved from *What Works Clearinghouse* website: http://ies.ed.gov/ncee/wwc/pdf/wwc_scd.pdf.

Light, J., Binger, C., & Kelford Smith, A. (1994). Story reading interactions between preschoolers who use AAC and their mothers. *Augmentative and Alternative Communication, 10,* 255-268.

Lund, S. & Light, J. (2007). Long-term outcomes for individuals who use augmentative and alternative communication: Part III-contributing factors. *Augmentative and Alternative Communication, 23 (4),* 323-335.

McNaughton, D. & Bryen, D. (2002). Enhancing participation in employment through AAC technologies. *Assistive Technology: The Official Journal of RESNA, 14 (1),* 58-70.

Miller, J. F. & Paul, R. (1995). *The clinical assessment of language comprehension.* Baltimore, MD: Paul H. Brookes.

Nigam, R., Schlosser, R., & Lloyd, L. (2006). Concomitant use of the matrix strategy and the mand-model procedure in teaching graphic symbol combinations. *Augmentative and Alternative Communication, 22 (3),* 160-177.

Paul, R. (1997). Facilitating transitions in language development for children using AAC. *Augmentative and Alternative Communication, 13,* 141-148.

Ravid, D. & Tolchinsky, L. (2002). Developing linguistic literacy: a comprehensive model. *Journal of Child Language, 29,* 417-447.

Schlosser, R. & Lloyd, L. (1997). Effects of paired-associate learning versus symbol explanations on blissymbol comprehension and production. *Augmentative and Alternative Communication, 13,* 226-238.

Smith, M. (1996). The medium or the message: A study of speaking children using communication boards. In S. von Tetzchner & M. H. Jensen (Eds), *Augmentative and alternative communication: European perspectives* (pp. 119-136). San Diego, CA: Singular Publishing Group.

Smith, M. & Grove, N. (1999). The bimodal situation of children learning language using manual and graphic signs. In F.T. Loncke, J. Clibbens, H. H. Arvidson, 7 L. L. Lloyd (Eds), *Augmentative and alternative communication: New directions in research and practice* (pp. 8-30). London: Whurr Publishers.

Smith, M. & Grove, N. (2003). Asymmetry in input and output for individuals who use augmentative and alternative communication. In J. Light, D. Beukelman, & J. Reichle (Eds), *Communicative competence of individuals who use augmentative and alternative communication.* Baltimore, MD: Paul H. Brookes.

Soto, G. (1999). Understanding the impact of graphic sign use on the message structure. In F. T. Loncke, J. Clibbens, H. H. Arvidson, & L. L. Lloyd (Eds), *Augmentative and alternative communication: New directions in research and practice* (pp. 40-48). London: Whurr Publishers.

Sutton, A. & Gallagher, T. (1995). Comprehension assessment of a child using an AAC system: A comparison of two techniques. *American Journal of Speech-Language Pathology, 4 (3),* 60-68.

Sutton, A., Gallagher, T., Morford, J., & Shahnaz, N. (2000). Relative clause sentence production using augmentative and alternative communication systems. *Applied Psycholinguistics, 21,* 473-486.

Sutton, A., & Morford, J. (1998). Constituent order in picture pointing sequences produced by speaking children using AAC. *Applied Psycholinguistics, 19,* 525-536.

Sutton, A., Morford, J., & Gallagher, T. (2004). Production and comprehension of graphic symbol utterances expressing complex propositions by adults who use augmentative and alternative communication systems. *Applied Psycholinguistics, 25,* 349-371.

Sutton, A., Soto, G., & Blockberger, S. (2002). Grammatical issues in graphic symbol communication. *Augmentative and Alternative Communication, 18,* 192-204.

Sutton, A., Trudeau, N., Morford, J., Rios, M., & Poirier, M. (2010). Preschool-aged children have difficulty constructing and interpreting simple utterances composed of graphic symbols. *Journal of Child Language, 37,* 1-26.

Trudeau, N., Sutton, A., Dagenais, E., Broeck, S., & Morford, J. (2007). Construction of graphic symbol utterances by children, teenagers, and adults: The effect of structure and task demands. *Journal of Speech, Language, and Hearing Research, 50,* 1314-1329.

Trudeau N., Sutton A., Morford J., Cote-Giroux P., Pauze A., & Vallee V. (2010). Strategies in construction and interpretation of graphic-symbol sequences by individuals who use AAC systems. *Augmentative and Alternative Communication, 26 (4),* 299-312.