THE EFFECTS OF AIDED AAC MODELING ON THE EXPRESSION OF
MULTI-SYMBOL MESSAGES BY CHILDREN WHO USE AUGMENTATIVE
AND ALTERNATIVE COMMUNICATION

A Thesis in
Communication Sciences and Disorders

by

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ABSTRACT

Preschoolers who have severe communication disorders and who require the use of augmentative and alternative communication (AAC) systems (e.g., communication boards, computerized voice-output systems) are at risk for all aspects of development, including language development (e.g., Lund, 2001). One area of language development that is particularly challenging for preschoolers who use AAC is transitioning from the use of single- to multi-symbol messages (Smith & Grove, 2003). This critical stage of language development marks the beginning of the use of generative language (Paul, 1997). To address this critical problem, the current investigation evaluated the impact of using a modeling technique – specifically, aided AAC modeling – to support the production of early multi-symbol messages with preschoolers who use AAC within a child-centered approach to intervention. The study used a single subject multiple probe design across participants (McReynolds & Kearns, 1983). Five preschoolers (ages 3-5) who required AAC participated in the investigation. Three preschoolers who used voice output communication systems were in the first cohort of participants, with two additional preschoolers who used light tech communication boards comprising the second cohort. To provide aided AAC models, the investigator pointed to two symbols on the child’s aided AAC system and then provided a grammatically complete spoken model while engaging in play activities with the participants. Results indicated that four of the five preschoolers learned to consistently produce multi-symbol messages and used a range of vocabulary and semantic-syntactic categories to produce these messages.
The fifth participant did not learn to consistently produce multi-symbol messages and
demonstrated relatively low rates of symbolic message productions. The four
preschoolers who met criterion all evidenced long-term use of symbol combinations and
also demonstrated generalized use of symbol combinations to novel play routines.
Results, clinical implications, and future research directions are discussed.
# TABLE OF CONTENTS

LIST OF FIGURES ........................................................................................................... ix

LIST OF TABLES ............................................................................................................... x

ACKNOWLEDGEMENTS ................................................................................................. xi

CHAPTER 1  Introduction and Review of the Literature ................................................. 1
Early Multi-Symbol Messages ....................................................................................... 2
Input-Output Asymmetry .............................................................................................. 6
Modeling and Child Language Disorders .................................................................... 9
   Types of Spoken Models ........................................................................................... 9
   Focus of Spoken Models .......................................................................................... 11
Adapting Models for Children who use AAC ............................................................... 12
Providing Models using Aided AAC .......................................................................... 13
   Definitions ................................................................................................................ 13
   Modes Used within AAC Models ............................................................................ 15
   Timing of Aided AAC Models within Intervention Setting ................................... 16
Components of Aided AAC Models ............................................................................ 16
   Timing of Components within Aided AAC Models ............................................... 17
Purpose of Providing Models Using Aided AAC .......................................................... 19
Context for the Intervention ....................................................................................... 20
Modeling using Aided AAC: Research to Date ............................................................. 21
   Aided Language Stimulation .................................................................................. 22
   System for Augmenting Language ......................................................................... 24
Modeling using Aided AAC within Other Intervention Programs ............................... 26
Limitations of Past Research ..................................................................................... 31
Research Questions .................................................................................................... 34

CHAPTER 2  Method ...................................................................................................... 35
Research Design ........................................................................................................... 35
Participants .................................................................................................................. 36
   Criteria for Participation ......................................................................................... 36
Assessment of Participant Skills ................................................................................ 37
   Speech Impairment .................................................................................................. 37
   Expressive Language ............................................................................................... 38
   Receptive Language ............................................................................................... 40
Comprehension of Graphic Symbols .......................................................................... 41
Pool of Potential Participants ..................................................................................... 42
Participant Demographics ......................................................................................... 42
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participant Profiles</td>
<td>43</td>
</tr>
<tr>
<td>Valerie</td>
<td>44</td>
</tr>
<tr>
<td>Timmy</td>
<td>49</td>
</tr>
<tr>
<td>Robyn</td>
<td>53</td>
</tr>
<tr>
<td>Nathan</td>
<td>56</td>
</tr>
<tr>
<td>Richard</td>
<td>59</td>
</tr>
<tr>
<td>Materials</td>
<td>61</td>
</tr>
<tr>
<td>Play Scenarios</td>
<td>61</td>
</tr>
<tr>
<td>AAC Systems</td>
<td>62</td>
</tr>
<tr>
<td>Vocabulary</td>
<td>62</td>
</tr>
<tr>
<td>Graphic Representations</td>
<td>63</td>
</tr>
<tr>
<td>Layout</td>
<td>65</td>
</tr>
<tr>
<td>Voice Output versus Non-electronic Communication Boards</td>
<td>67</td>
</tr>
<tr>
<td>Procedures</td>
<td>68</td>
</tr>
<tr>
<td>Baseline Phase</td>
<td>69</td>
</tr>
<tr>
<td>Instructional Phase</td>
<td>73</td>
</tr>
<tr>
<td>Generalization Phases</td>
<td>76</td>
</tr>
<tr>
<td>Generalization Without Models (GEN W/O)</td>
<td>76</td>
</tr>
<tr>
<td>Generalization With Models (GEN W/)</td>
<td>77</td>
</tr>
<tr>
<td>Maintenance Phase</td>
<td>77</td>
</tr>
<tr>
<td>Procedural Reliability</td>
<td>78</td>
</tr>
<tr>
<td>Measures</td>
<td>78</td>
</tr>
<tr>
<td>Dependent Measures</td>
<td>78</td>
</tr>
<tr>
<td>Data Collection</td>
<td>79</td>
</tr>
<tr>
<td>Coding</td>
<td>80</td>
</tr>
<tr>
<td>Definition of a Symbol</td>
<td>81</td>
</tr>
<tr>
<td>Definition of a Multi-Symbol Message</td>
<td>81</td>
</tr>
<tr>
<td>Definition of Different Multi-Symbol Messages</td>
<td>86</td>
</tr>
<tr>
<td>Definitions of Semantic-Syntactic Categories</td>
<td>87</td>
</tr>
<tr>
<td>Definitions for Various Modes of Communication</td>
<td>89</td>
</tr>
<tr>
<td>Data Reliability</td>
<td>91</td>
</tr>
<tr>
<td>Data Analyses</td>
<td>93</td>
</tr>
<tr>
<td>Social Validation</td>
<td>93</td>
</tr>
<tr>
<td>CHAPTER 3  Results</td>
<td>96</td>
</tr>
<tr>
<td>Voice Output Cohort</td>
<td>96</td>
</tr>
<tr>
<td>Production of Multi-Symbol Messages</td>
<td>96</td>
</tr>
<tr>
<td>Acquisition of Multi-Symbol Messages</td>
<td>96</td>
</tr>
<tr>
<td>Generalization</td>
<td>103</td>
</tr>
<tr>
<td>Generalization to New Play Routines Without Aided AAC Modeling (GEN W/)</td>
<td>103</td>
</tr>
<tr>
<td>Maintenance</td>
<td>104</td>
</tr>
<tr>
<td>Different Multi-Symbol Messages</td>
<td>104</td>
</tr>
<tr>
<td>Semantic-Syntactic Categories</td>
<td>107</td>
</tr>
<tr>
<td>Section</td>
<td>Page</td>
</tr>
<tr>
<td>------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Modes of Communication</td>
<td>115</td>
</tr>
<tr>
<td>Communication Board Cohort</td>
<td>116</td>
</tr>
<tr>
<td>Production of Multi-Symbol Messages</td>
<td>116</td>
</tr>
<tr>
<td>Acquisition of Multi-Symbol Messages</td>
<td>116</td>
</tr>
<tr>
<td>Generalization</td>
<td>118</td>
</tr>
<tr>
<td>Maintenance</td>
<td>119</td>
</tr>
<tr>
<td>Different Multi-Symbol Messages</td>
<td>119</td>
</tr>
<tr>
<td>Semantic-Syntactic Categories</td>
<td>120</td>
</tr>
<tr>
<td>Modes of Communication</td>
<td>125</td>
</tr>
<tr>
<td>Social Validation</td>
<td>125</td>
</tr>
<tr>
<td>CHAPTER 4 Discussion</td>
<td>128</td>
</tr>
<tr>
<td>Effectiveness of the Intervention</td>
<td>128</td>
</tr>
<tr>
<td>Content of the Intervention</td>
<td>129</td>
</tr>
<tr>
<td>Context of the Intervention</td>
<td>135</td>
</tr>
<tr>
<td>Type of AAC System</td>
<td>138</td>
</tr>
<tr>
<td>Word Order Difficulties: Timmy</td>
<td>139</td>
</tr>
<tr>
<td>Efficiency of the Intervention</td>
<td>145</td>
</tr>
<tr>
<td>Promoting Generative Language</td>
<td>146</td>
</tr>
<tr>
<td>A Special Case: Robyn</td>
<td>149</td>
</tr>
<tr>
<td>Intrinsic Variables</td>
<td>151</td>
</tr>
<tr>
<td>Cognition and Communication</td>
<td>151</td>
</tr>
<tr>
<td>Motor</td>
<td>154</td>
</tr>
<tr>
<td>Sensory/Perceptual</td>
<td>154</td>
</tr>
<tr>
<td>Psychosocial</td>
<td>155</td>
</tr>
<tr>
<td>Extrinsic Variables</td>
<td>158</td>
</tr>
<tr>
<td>Communication Partner</td>
<td>158</td>
</tr>
<tr>
<td>Intervention</td>
<td>159</td>
</tr>
<tr>
<td>AAC System</td>
<td>162</td>
</tr>
<tr>
<td>Generalization of Multi-Symbol Messages</td>
<td>164</td>
</tr>
<tr>
<td>Generalization to New Play Scenarios: Without Models (GEN W/O)</td>
<td>165</td>
</tr>
<tr>
<td>Generalization to New Play Scenarios: With Models (GEN W/)</td>
<td>167</td>
</tr>
<tr>
<td>Maintenance of Multi-Symbol Messages</td>
<td>168</td>
</tr>
<tr>
<td>Implications of the Findings</td>
<td>169</td>
</tr>
<tr>
<td>Clinical Implications</td>
<td>169</td>
</tr>
<tr>
<td>Potential Modifications to Aided AAC Modeling</td>
<td>171</td>
</tr>
<tr>
<td>Summary of Contributions</td>
<td>174</td>
</tr>
<tr>
<td>Limitations of the Investigation</td>
<td>175</td>
</tr>
<tr>
<td>Directions for Future Research</td>
<td>178</td>
</tr>
<tr>
<td>Conclusions</td>
<td>182</td>
</tr>
<tr>
<td>REFERENCES</td>
<td>183</td>
</tr>
<tr>
<td>APPENDICES</td>
<td>Page</td>
</tr>
<tr>
<td>---------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Appendix A – Comprehension of Spoken Two- and Three-Word Relations</td>
<td>194</td>
</tr>
<tr>
<td>Appendix B – Comprehension of Target Graphic Symbols</td>
<td>196</td>
</tr>
<tr>
<td>Appendix C – Participants’ Aided AAC Display Samples</td>
<td>197</td>
</tr>
<tr>
<td>Appendix D – Vocabulary Items for Play Scenarios</td>
<td>203</td>
</tr>
<tr>
<td>Appendix E – Procedural Standard</td>
<td>205</td>
</tr>
<tr>
<td>Appendix F – Sample Transcript of Intervention Session</td>
<td>209</td>
</tr>
<tr>
<td>Appendix G – Procedural Reliability Form</td>
<td>210</td>
</tr>
<tr>
<td>Appendix H – Multi-Symbol Messages Data Collection Form</td>
<td>212</td>
</tr>
<tr>
<td>Appendix I – Video Feedback Form</td>
<td>213</td>
</tr>
</tbody>
</table>
LIST OF FIGURES

Figure 1. Number of Multi-Symbol Messages within 15 Minute Play Sessions: Voice Output Cohort................................................................. 96

Figure 2. Robyn’s Rate of Symbolic Message Production within Each 15 Minute Session........................................................................................ 100

Figure 3. Number of Different Multi-Symbol Messages within 15 Minute Play Voice Output Cohort............................................................................... 104

Figure 4. Number of Different Semantic-Syntactic Categories Expressed per Session Out of 18 Possible Categories within Multi-Symbol Messages: Voice Output Cohort .......................................................................................108

Figure 5. Number of Multi-Symbol Messages within 15 Minute Play Sessions: Communication Board Cohort.......................................................... 116

Figure 6. Number of Different Multi-Symbol Messages within 15 Minute Play Sessions: Communication Board Cohort .......................................................... 119

Figure 7. Number of Different Semantic- Syntactic Categories Expressed per Session Out of 18 Possible Categories within Multi-Symbol Messages: Communication Board Cohort .......................................................... 121
LIST OF TABLES

Table 1.  Participant Demographics ........................................................................45
Table 2.  Summary of Procedures ..........................................................................69
Table 3. Operational definitions for semantic-syntactic categories .........................87
Table 4. Ratio of Different Multi-Symbol Messages to Total Multi-Symbol Messages across All Sessions: Voice Output Cohort .................106
Table 5. Presence of Brown’s Minimal Two-Term Semantic Relations: Voice Output Cohort .........................................................................................................................109
Table 6. Percent Correct and Number of Correct Messages in Word Order for Selected Semantic Relation Combinations: Voice Output Cohort ..........110
Table 7. Accuracy Levels and Number of Correct Word Order for Agent, Action, and Object Relations with No Additional Relations Present: Timmy ........................................................................................................111
Table 8. Accuracy of Timmy’s Performance during Syntax Intervention ...............113
Table 9. Percentages of Occurrence of Communication Modes for Symbols Produced within Multi-Symbol Messages: Voice Output Cohort ........114
Table 10. Ratio of Different Multi-Symbol Messages to Total Multi-Symbol Messages across All Sessions: Communication Board Cohort ............120
Table 11. Presence of Brown’s Minimal Two-Term Semantic Relations: Communication Board Cohort ...........................................................................................................122
Table 12. Percent Correct and Number of Correct Messages in Word Order for Selected Semantic Relation Combinations: Communication Board Cohort ........................................................................................................123
Table 13. Percentages of Occurrence of Communication Modes for Symbols Produced within Multi-Symbol Messages: Communication Board Cohort ........................................................................................................124
Table 14. Feedback on Strengths and Suggestions for Improvement from Caregivers, Classroom Teacher, and Speech-Language Pathologists ....126
Table 15. Mean seconds to Complete Two-Symbol Messages: Robyn .....................156
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Ralph Waldo Emerson

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CHAPTER 1

Introduction and Review of the Literature

In the United States, over 11% of preschool children who receive special education services have communication disorders that are so severe that they require the use of techniques other than speech for communication (Binger & Light, 2003). Such children require the use of augmentative and alternative communication (AAC), which includes the use of speech approximations, vocalizations, gestures, gaze, signs, picture boards/books, and/or voice output communication devices for communication. Children who use AAC may have disabilities such as cerebral palsy, mental retardation, and autism. Children who require AAC are at risk in all aspects of development, including language development (Lund, 2001). It has been hypothesized that difficulties with language development may stem from a variety of factors for any given child and may include both intrinsic factors, such as cognitive disorders and motor speech disorders, and extrinsic factors, such as lack of opportunities to communicate (Light, 1997; Light, Collier, & Parnes, 1985a; Romski, Sevcik, & Adamson, 1997).

Finding ways to support the language acquisition of children who use AAC is a primary goal of intervention (e.g., Light, 1997). One area of particular vulnerability is the development of multi-symbol messages. Frequently, children who use AAC rely on telegraphic messages to communicate and have difficulty transitioning from single-symbol to multi-symbol messages (e.g., Light, Binger, & Kelford Smith, 1994;
Smith & Grove, 2003; von Tetzchner & Martinsen, 1996). This transition is a critical period of language development; it marks the beginning of the transition from semantics to syntax and the onset of generative language (Paul, 1997). To date, minimal research has been conducted to evaluate the impact of intervention techniques to increase productions of symbol combinations with children who require AAC. The current investigation was designed to address this need within the AAC field by evaluating the impact of a modeling procedure to facilitate the early multi-symbol productions of preschoolers who require AAC.

**Early Multi-Symbol Messages**

The transition to multi-symbol productions marks an important stage of language development. Paul (1997) described this critical transition point as a transition from semantics to syntax. The addition of syntax, she noted, does not simply increase the length of utterances, but also adds a “hierarchical principle” (p. 142), with the need to preserve the word order of utterances. Further, children can begin to provide more complex information once they begin to combine symbols. This stage of development, then, constitutes the first step toward more complex syntactical relationships. Similarly, this stage of development marks the onset of truly creative and generative language. During this stage, children begin to create unique combinations of symbols to express themselves. Supporting this stage of language development, then, is a critical first step in promoting the development of syntax and generative language.
Unfortunately, however, children who use AAC often experience difficulties transitioning from single- to multi-symbol productions (e.g., Light et al., 1994; Smith & Grove, 2003). Research has indicated that when young children rely on aided AAC systems, many predominantly use single-word messages. This has been noted in case studies of preschoolers who use AAC (Basil, 1992; Goossens', 1989; Smith & Grove, 1999; Sutton & Gallagher, 1995; von Tetzchner & Martinsen, 1996), in large-scale studies of children who use AAC (e.g., Udwin & Yule, 1990), and even with young typically developing children who use aided AAC for research purposes (Smith, 1996; Sutton & Morford, 1998). For example, von Tetzchner and Martinsen (1996) examined the communication patterns of four children aged 5-8 with primary motor speech disorders and found that all of these children relied on gestures, gaze, vocalizations, facial expressions, and single graphic symbols for communication. Only one instance of a symbol combination using aided AAC was reported (CHEESE + SANDWICH\(^1\)), despite the fact that the children (a) each had access to an array of picture symbols for communicative purposes (mean number of aided symbols = 431; range = 145-845), and (b) had language comprehension age equivalent scores of three years or greater. With language comprehension scores such as these, it might be reasonable to predict that these children should have been producing many multi-symbol messages, but none had yet begun to do so. Other researchers have also reported very low levels of multi-symbol

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\(^1\) The notational conventions used throughout this document to indicate various modes of communication (speech, manual signs, graphic symbols, voice output systems, etc.) follow the guidelines originally proposed by von Tetzchner and Hygum Jensen (1996) and utilized by the peer-reviewed *Augmentative and Alternative Communication* journal published by Taylor & Francis.
message production for children who use AAC (Goossens', 1989; Light et al., 1994; Smith & Grove, 1999; Sutton & Gallagher, 1995; Udwin & Yule, 1990).

Researchers have offered several potential explanations for the predominant use of single-symbol messages when children use aided AAC, including (a) communicative efficiency; (b) factors inherent within graphic symbol representations; (c) lack of opportunities to communicate; (d) impact of aided AAC systems; and (e) input-output asymmetry. First, using brief messages may be a way of achieving communicative efficiency (Smith & Grove, 2003; Smith, 1996; Sutton, Soto, & Blockberger, 2002). The speed of communication tends to be far slower for individuals using AAC than for speaking individuals (Beukelman & Mirenda, 1998), and one way of speeding up communication is to use shorter messages. Another way to speed up communicative efficiency is to co-construct messages; that is, the communication partner labels the graphic symbols that the child selects and uses contextual knowledge about the child to expand the child’s message and infer the child’s meaning (Harris, 1982; Soto, 1999). Co-construction of messages occurs frequently when individuals use aided AAC and appears to impact message length (e.g., Bedrosian, 1997; Smith, 1996; Soto, 1999; von Tetzchner & Martinsen, 1996). For example, in an interaction between a child who used AAC and his father, every time the child produced a single symbol message, the father immediately requested clarification from the child or expanded on the child’s utterance (von Tetzchner & Martinsen, 1996). In such instances, the communication partner may, in effect, preempt opportunities for the child to create longer messages.

Second, there is no way of knowing precisely what a graphic symbol represents to an individual; a particular symbol may, in fact, represent multiple concepts
simultaneously for a child, thus negating the need to point to additional symbols (Smith, 1996). For example, the Picture Communication Symbol (PCS; Johnson, 1994) for the concept “eat” contains a line drawing of a person raising a spoon to her mouth and could represent not only “eat” but also, potentially, “I am eating,” or even, “I want to eat some chocolate pudding.”

Third, research has consistently shown that children who require AAC are provided with few opportunities to communicate; partners tend to control conversations when interacting with children who use AAC (Light et al., 1985a). Further, partner tend to ask questions that do not necessitate the production of multi-symbol responses, such as yes/no questions (Kent-Walsh, 2003; Light et al., 1994; Light et al., 1985a). Thus, both the lack of opportunities to communicate and the types of opportunities that are sometimes provided may contribute to the low rates of multi-symbol messages observed in children who rely on AAC.

Fourth, it has been argued that aided AAC systems may, in and of themselves, impact expressive communication in unique ways. Several researchers have studied the performances of typically developing children using aided AAC systems to test this hypothesis. In one study, over 80% of the PCS messages produced by typically developing preschoolers (aged 3;5-4;7) consisted of a single symbol during a picture description task, despite the fact that these children had intact speech and language skills and had received 10 hours of instruction in the use of PCS (Smith, 1996). Other findings indicate that typically-developing kindergarteners also tend to use single-symbol messages when using aided AAC for research purposes (Sutton & Morford, 1998). Message length does increase as children grow older when typically developing children
use aided AAC; the second, fourth, and sixth graders in Sutton and Morford’s study tended to produce longer messages with the graphic symbols than the kindergarteners. Although these findings suggest that preschoolers typically communicate telegraphically when using AAC, initial findings do indicate that at least some preschoolers can learn to combine symbols (Goossens', 1989; Smith, 1996) and that message length does increase – at least for typically developing children – with increasing age (Sutton & Morford, 1998).

Finally, it has also been argued that children’s limited AAC productions are due to an inherent input-output asymmetry (Smith & Grove, 1999; Smith & Grove, 2003; Soto, 1999); that is, the linguistic input that children who use AAC receive (i.e., spoken language) differs markedly from the linguistic output they are expected to use (i.e., aided AAC, signs, etc.). The intervention approach evaluated in the current investigation was designed to address the asymmetry between linguistic input and output for preschoolers who use AAC. A more in-depth discussion of input-output asymmetry follows.

**Input-Output Asymmetry**

Different theories of typical language development stress the importance of linguistic input for early child language development, although the features of such input that are assumed to be critical for learning differ (e.g., Bates & MacWhinney, 1989; Hoff & Naigles, 2002; Hollich, Hirsh-Pasek, & Golinkoff, 2000; Smiley & Huttonlocher, 1995). For example, within some theories, the social context in which the linguistic input is embedded is of central importance (e.g., Snow, 1999). Other theories purport that
children use linguistic input to induce the grammatical rules through the use of innate, domain-general mechanisms and stress the importance of the frequency and reliability of certain grammatical constructs (e.g., Bates & MacWhinney, 1989). Other researchers have attempted to integrate various theoretical approaches by demonstrating the critical roles of a variety of factors, including attentional, social, and linguistic input (Hollich et al., 2000). Regardless of the theoretical approach, one key factor that researchers from across a variety of perspectives agree upon is the overall importance of linguistic input for learning language.

However, there is an inherent asymmetry between the linguistic input and output for children who require AAC. Using AAC productively does not seem to be an intuitive process for most children who use AAC. Children who use AAC do not become linguistically competent simply by having access to AAC. It has been argued that a core reason for the difficulties that children using AAC experience is the lack of input they receive using the communication modes that they are expected to use (Smith & Grove, 1999; Smith & Grove, 2003). Children using AAC typically receive input via spoken language, as other children do, but they must use a variety of communication modes for output, such as picture symbols and/or signs (Smith & Grove, 2003).

Children using AAC typically do not observe models of multi-symbol messages in their natural environments using their own output modes; it is unusual to see others communicate using AAC. von Tetzchner and Martinsen (1996), for example, examined the interactions between four children who used aided AAC and their parents, with results indicating that the parents rarely pointed to their children’s graphic symbols. When they did so, parents tended to point to the aided symbols as one would point to
pictures in a picture book; that is, they used the communication board as a topic of conversation instead of as a means of expressive communication. Sevcik and colleagues (Sevcik, Romski, Watkins, & Deffebach, 1995) trained communication partners (i.e., parents and teachers) to model the use of aided AAC by pointing to key symbols on the voice output devices of school-aged children who used aided AAC. However, following a training program that consisted of three 1-hour instructional sessions during which partners were shown how to provide such models (in addition to being taught other skills relating to managing the use of voice output systems), partners provided models using aided AAC within only 3-14% of their utterances. Although adults certainly can be taught to consistently provide input using AAC (e.g., Kent-Walsh, 2003), findings to date indicate in most circumstances, the vast majority of the linguistic input provided to children using AAC consists of spoken language.

Given the central importance of linguistic input in developing language skills, it may be that this asymmetry between language input and output contributes to the difficulty that young children have with creating multi-symbol messages. Smith and Grove (2003) suggested that one way to restore symmetry may be to “match as closely as possible the structural characteristics of communication systems provided for both input and output” (p. 182). One specific technique that frequently has been recommended in the literature is providing linguistic input not only via speech but also using the AAC systems that the children are expected to use to communicate. For preschoolers who use AAC, this may mean providing input using signs, graphic symbols, or a combination of both. If the input-output asymmetry typically experienced by children using AAC is to blame for their limited linguistic output – and more specifically, for the relative lack of
multi-symbol productions – correcting the asymmetry by providing input via AAC should have a positive impact on their productive language skills.

The assumption that providing such input will assist children who use AAC with improving their communication skills has been prevalent in the literature for some time. Providing models for children via AAC, which is one way of increasing the symmetry between linguistic input and output, has been recommended in the literature and has been used frequently as a part of intervention programs (e.g., Basil, 1992; Basil & Sorocamats, 1996; Bruno & Dribbon, 1998; Kent-Walsh, 2003). The roots of modeling are found in the child language disorders literature, where spoken models are often used by adults to support the development of new language forms by children with language disorders.

**Modeling and Child Language Disorders**

**Types of Spoken Models**

For decades, various modeling procedures have been used to support the early language development of children with language disorders. Various types of spoken recasts — that is, models that provide new linguistic information to the child that contain a partial repetition of the child’s utterance (Camarata, 1995) – have frequently been used for facilitating early language development. Most current intervention approaches utilize a combination of various types of spoken recasts to support language acquisition of
preschoolers with language disorders. For example, Fey and colleagues (Fey, Cleave, & Long, 1997; Fey, Cleave, Long, & Hughes, 1993) utilized the following techniques to facilitate early grammatical structures of preschoolers with language disorders: (a) simple expansions, in which the child’s errors are corrected (e.g., the adult says “He is walking” after the child says “He walking”); (b) changes in the form of the child’s utterances (e.g., the adult says “Is he walking?” to highlight the auxiliary verb after the child says, “He walking”); (c) build-ups, in which multiple utterances are combined into a single utterance (e.g., the adult says “He is walking to the gas station” after the child says, “He walking. Go gas station.”); and (d) breakdowns, in which the child’s utterance is broken down into its constituent parts (e.g., the adult says “He is walking. He is going to the gas station” after the child says, “He walk to go gas station.”). Direct models (i.e., stating the exact target, usually followed by an elicitation question) and indirect models (i.e., providing an embedded or delayed model of the target) are other commonly used models with young language learners (e.g., Olswang, Bain, & Johnson, 1992).

The relative impact of these types of spoken models has been frequently discussed in the child language disorders literature. In a review of the literature, Law (1997) concluded that modeling techniques such as recasts for children with language disorders were useful techniques that often have been shown to be superior to imitation in teaching most language targets; the one exception noted was with teaching gerunds, where evidence suggested the superiority of imitation (Camarata & Nelson, 1992).
Focus of Spoken Models

In addition to considering the types of spoken models that are provided, the focus of spoken models must also be considered. Intervention approaches are frequently classified on a continuum ranging from child-directed to adult-directed (for a review, see Fey, 1986). Within child-directed approaches to intervention, models may be provided in response to the child’s communicative behaviors, after the child says or looks at something (e.g., Fey et al., 1997; Fey et al., 1993), or models also may be provided that reflect the child’s actions during play (Kaiser & Hester, 1994; Leonard et al., 1982). Within more adult-directed approaches, the adult may initiate a model without respect to the child’s focus of attention (e.g., Rogers-Warren & Warren, 1980). Investigators who focus on the importance of the social context of language have stressed the importance of following the child’s lead when providing models (Tomasello & Farrar, 1986; Tomasello & Kruger, 1992). In contrast, proponents of the classic milieu interventions have traditionally utilized a more adult-directed approach to intervention, particularly when mand-models are used (e.g., Rogers-Warren & Warren, 1980). With mand-models, the adult provides the child with direct prompts to communicate (e.g., “Tell me what you want”). While prompts sometimes are provided after the child initiates communication, the adult may also provide spoken models and prompts without following the child’s lead. For example, the adult may offer the child choices (e.g., “I have red paper and green paper. Tell me what you want”), and the adult may also attempt to evoke descriptions of what that child is doing during play (e.g., “Tell me what you are doing”; Rogers-Warren & Warren, 1980). Thus, when mand-models are used, the models are often adult-directed.
in nature. Recently, however, some investigators have revised the milieu approach and now stress the importance of responding to the child’s focus of attention and making use of child-directed models such as expansions (e.g., Hemmeter & Kaiser, 1994; Kaiser & Hester, 1994). Thus, many investigators from various theoretical backgrounds seem to now agree on the importance of using relatively child-centered approaches, at least some of the time, when providing models.

**Adapting Models for Children who use AAC**

Various types of models can be adapted to teach early multi-symbol messages to preschoolers who use aided AAC. The following is an example of a simple expansion using a communication board:

Child: *MILK* (i.e., child points to the symbol for milk)

Adult: *{MORE more}{MILK milk}* (i.e., the adult says *More milk* while pointing the symbols *MORE* and *MILK*)

*Or*

Adult: *{MORE more}{MILK milk} The dog wants more milk.* (i.e., the adult says *More milk* while pointing the symbols of *MORE* and *MILK*, and then provides a grammatically complete spoken utterance)

Essentially, all that is required to turn a spoken model into a model that includes the use of aided AAC is to point to and label key graphic symbols on the child’s AAC
device. Further discussion of aided AAC modeling as it was used for the current investigation, including an operational definition of aided AAC modeling, follows.

Providing Models using Aided AAC

Definitions

Two of the terms that have predominantly been used in the literature for models that involve the use of AAC are “augmented input” (e.g., Romski & Sevcik, 1993; Sevcik et al., 1995) and “aided language stimulation” (e.g., Goossens', 1989; Goossens', Crain, & Elder, 1995). Romski and Sevcik (1988) defined augmented input as “incoming communication/language from the learner’s partner that included speech which is augmented by other AAC system components” (p. 89). According to this definition, augmented input may take the form of aided AAC (e.g., graphic symbols) and/or unaided AAC (e.g., manual signs). With aided language stimulation, “the facilitator (clinician, parent) points out picture symbols on the child’s communication display in conjunction with all ongoing language stimulation” (Goossens', 1989, p. 16). As the name implies, this term only refers to models that are provided using aided AAC. Further, it implies the use of other types of language stimulation procedures, which Goossens' and colleagues have described at length (Elder & Goossens', 1994; Goossens', 1989; Goossens' et al., 1995) and which are reviewed later in this chapter. The current investigation focused on the use of aided AAC (not the use of manual signs) but did not include all of the
components included in the Aided Language Stimulation Program developed by
Goossens' and colleagues. Therefore, a different term was used to describe the models
provided in the current investigation: aided AAC modeling. This term is used to refer to
models in which the communication partner does the following: (a) points to aided AAC
symbols located on the child’s aided AAC system; and (b) labels the symbols orally, if
light tech aided AAC is used, or allows the speech synthesizer to provide the label when
a voice output system is used. Aided AAC models are provided within ongoing activities
as a part of normal conversational turns, and are not used for the sole purpose of eliciting
specific responses (i.e., pointing to the graphic symbol \textit{PIG} while saying \textit{Tell me pig}
would not constitute an aided AAC model, according to the above definition). In addition
to the aided AAC model, a separate spoken model may be provided after the aided AAC
model that reflects the target structures after pointing to the graphic symbols (e.g., The
instructor provides the aided AAC model \{\textit{Drink DRINK}\} \{\textit{tea TEA}\}, followed by the
spoken model \textit{Doll drinks his tea}).

There are a number of factors to consider in defining aided AAC models,
including the (a) modes used within the aided AAC models, (b) components of aided
AAC models; (c) timing of aided AAC models within the intervention setting, (d) timing
of the components within the aided AAC models, and (e) purpose of the aided AAC
models. Each of these issues is discussed below.
**Modes Used within AAC Models**

Young children who use AAC may use various modes of symbolic communication, including speech approximations, manual signs, and graphic symbols. Including natural speech within models for children who use AAC serves two major purposes: (a) aids with comprehension, as the majority of linguistic input that children who use AAC receive is via natural speech (Sevcik et al., 1995); and (b) provides input via a communication mode that the child will potentially use at least some of the time for communication. Therefore, the models presented within the current investigation (including the baseline phase) always included the use of natural speech.

With respect to augmented modes of symbolic communication (i.e., manual signs and graphic symbols), the choice to provide AAC models only via graphic symbols for the current investigation was made for several reasons. First, using unaided models alone (i.e., manual signs) was ruled out because many children who require AAC have severe motor impairments that prevent them from producing many (or any) signs. The choice to focus on only aided AAC models as opposed to multimodal AAC models was more difficult. Communication for children who use AAC is a multimodal process (Light, Collier, & Parnes, 1985b), and providing multimodal models – that is, providing models using both graphic symbols and manual signs – would provide children with models of how to use these various communication modes. However, it was unknown at the onset of the investigation how many of the potential participants would be able to use signs. Further, participants would have been required to learn two different symbol sets (i.e., manual signs and graphic symbols) before beginning the investigation. Finally, utilizing
only aided AAC models promotes a higher degree of experimental control than using both aided and unaided AAC. Therefore, only aided AAC models were used in the investigation. Thus, the review of the pertinent AAC literature (below) focused on the research utilizing aided AAC models. Future research should explore the effects of multimodal AAC models on the expressive language development of children who require AAC.

**Timing of Aided AAC Models within Intervention Setting**

Aided AAC models may be provided at various points within the communication process. As discussed above with respect to the child language disorders literature, models may be provided within a child-directed approach to intervention, where models are provided in response to the child’s communicative behaviors, or alternatively, the adult may initiate modeling of a target structure, regardless of the child’s focus of attention (Fey, 1986). As current research indicates that providing models of target structures following the child’s lead can be highly beneficial in facilitating production of various types of early symbol combinations (e.g., Fey et al., 1997; Fey et al., 1993; Hemmeter & Kaiser, 1994; Kaiser & Hester, 1994), the aided AAC models provided within the current investigation were based on the child’s focus of attention and were provided following the child’s communicative attempts and actions during play.
Components of Aided AAC Models

There are two basic components to consider with aided AAC models: (1) selecting the graphic symbol on the child’s AAC device, and (2) providing a spoken label for the chosen graphic symbol. For the example \{Pig PIG\}{hit HIT}, the adult selects the symbols PIG and HIT on the child’s voice output system and also provides the spoken labels pig and hit while selecting those two symbols. A brief, grammatically complete spoken model (that is not actually part of the aided AAC model) may also be provided (e.g., \{Pig PIG\}{hit HIT} The pig hit the bus). The number of symbols that the communication partner selects while providing aided AAC models can vary. One approach is to consistently select a certain number of aided symbols during each aided AAC model, for example, \{Pig PIG\}. Another approach is to select key words on the child’s AAC system, which is an approach that has been used in various intervention programs (e.g., Kent-Walsh, 2003; Romski & Sevcik, 1996). In this case, the number of symbols that are selected may vary. For example, the partner may say \{Pig PIG\} The pig hit the bus; \{Pig PIG\} {bus BUS} The pig hit the bus; or \{Pig PIG\}{Hit HIT}{BUS bus} The pig hit the bus. One final approach is for the adult to select symbols on the child’s system that match up with every word that the adult speaks; obviously, this approach can only be taken if the child has all of the accompanying symbols on his or her AAC system.

The provision of the spoken label for the system typically takes one of two forms: when non-electronic communication symbols are used, as in the examples above, the communication partner provides the labels, typically while selecting the symbols (e.g., \{Pig PIG\}{Hit HIT}). However, when voice output systems are used, the label is
provided by the speech synthesizer on the child’s AAC system (e.g., “pig hit”).

Typically, there is a slight delay between the selection of the graphic symbol and the activation of the speech synthesizer.

It is important to note that the two key components of aided AAC models are pointing to the symbols and labeling the symbols; the grammatically complete spoken utterance *The pig hit the bus* in the examples above is not part of the aided AAC model, but is instead a separate spoken model.

**Timing of Components within Aided AAC Models**

As discussed above, there are two components to aided AAC models (i.e., selecting the graphic symbols on the child’s AAC device and providing spoken labels for those symbols). In addition, a brief spoken model may also be provided. The timing of when these three components may be provided may vary. Selecting the symbol and providing a spoken label for the symbol typically occur simultaneously (or, when voice output systems are used, there may be a brief delay). The grammatically complete spoken utterance can occur before, during, or after selection and labeling of the graphic symbols. For example, when using a voice output system, the spoken utterance *The pig hit the bus* could occur before selecting “pig hit” (i.e., *The pig hit the bus “pig hit”*), while selecting “pig hit” (i.e., *The {pig “pig”}{ hit “hit”} the bus*), or after selecting “pig hit” (i.e., “Pig hit” *The pig hit the bus*). Similarly, when using a non-electronic communication symbols, the spoken utterance could occur before selection *PIG HIT* (i.e., *The pig hit the bus {pig PIG}{hit HIT}*), while selecting *PIG HIT* (i.e., *The{ pig PIG}{hit HIT} the bus*), or after
selecting PIG HIT (i.e., \{Pig PIG\}{hit HIT} The pig hit the bus). When using a voice output system and the grammatically complete utterance is provided during selection of the symbols, separate labels for the symbols may or may not be provided. That is, the person providing the model may say, The \{pig “pig”\}{hit “hit”} the bus, or, alternatively, The “pig hit” the bus. In the latter example, the speech synthesizer provides the only labels for the symbols. Obviously, this is not an option when non-electronic systems are used. Most of the intervention studies published to date have not discussed the timing of these components, and it is unclear in most published studies if and when the spoken models have been provided relative to selection of the graphic symbols.

**Purpose of Providing Models Using Aided AAC**

Providing aided AAC models may serve several purposes. First, selecting and labeling the graphic symbols and providing grammatically complete spoken models may assist the child with comprehension (Romski & Sevcik, 1993; Wood, Lasker, Siegel-Causey, Beukelman, & Ball, 1998). Second, selection of the graphic symbols may provide the child with a model of what she must do to create a multi-symbol message (e.g., Goossens', 1989; Romski & Sevcik, 1996). Finally, providing a grammatically complete spoken model (which is not actually part of the aided AAC model) may clarify the underlying meaning of the symbols that the communication partner selects. For example, if the partner selects \{pig “pig”\}{truck “truck”}, the partner’s intended meaning might be Pig hit the truck, It’s the pig’s truck, or The pig is in the truck.
Providing a grammatically complete spoken model in addition to the aided AAC model clarifies the meaning for the child.

**Context for the Intervention**

Aided AAC models are always provided within a given context, which may fall anywhere within a broad continuum ranging from highly child-centered to highly adult-centered contexts. Most current interventions for supporting early child language development are embedded within relatively child-directed contexts (e.g., Fey et al., 1997; Fey et al., 1993; Fey, Long, & Finestack, 2003; Kaiser, Hemmeter, & Hester, 1997; Kaiser & Hester, 1994; Kent-Walsh, 2003). According to Fey (1986), child-directed approaches to intervention typically involve the use of facilitative play contexts during which the adult follows the child’s lead, provides various types of recasts of the child’s utterances, and simplifies the linguistic complexity of the adult’s input to the child (Fey, 1986). Play contexts are used to create highly accepting and responsive environments, and following the child’s lead within these play contexts maximizes the chance that the child is motivated to communicate about the topic at hand. Another advantage of following the child’s lead is that this helps to ensure the child’s joint attention between the play materials and the communication partner. Significant additional joint attention demands are placed on children who use aided AAC, as they must shift attention between the communication partner, the play materials, and the aided AAC device (Cress, 2002). Providing models that follow the child’s lead should help minimize this attentional burden.
Various types of recasts are used to provide the child with models of linguistic structures that are based on the child’s own utterances, and simplified speech is provided to help support the child’s communication needs. Recasts also build on the child’s own utterances, thereby making the child’s errors more salient to the child while simultaneously providing a model for how to correct the error (Bernstein & Tiegerman-Farber, 2002).

Providing models such as expansions has been proven successful for teaching a variety of linguistic structures to many children with language disorders who use speech as a primary means of communication (e.g., Fey et al., 1997; Fey et al., 1993; Leonard et al., 1982), and the use of these techniques has been well-grounded within child-centered approaches to language intervention. Adapting these modeling techniques within child-centered approaches to intervention for children who use AAC may prove to be beneficial as well. A review of the research to date in which partners used the child’s aided AAC system as part of intervention follows.

**Modeling using Aided AAC: Research to Date**

Intervention programs have often recommended that partners use aided AAC when communicating with children who require AAC. This recommendation has been included as part of intervention programs with a variety of participants, including those with motor speech disorders, mental retardation, and autism (e.g., Cafiero, 2001; Goossens', 1989; Romski & Sevcik, 1996). Two of the primary intervention programs cited in the literature that have had partners use the child’s aided AAC system are the
Aided Language Stimulation Program (Elder & Goossens', 1994; Goossens', 1989; Goossens' et al., 1995) and the System for Augmenting Language (Romski & Sevcik, 1996; Sevcik et al., 1995; Wilkinson, Romski, & Sevcik, 1994). Other intervention programs designed to improve the communication skills of children using AAC have also recommended that partners use the child’s aided AAC system (e.g., Basil, 1992; Bruno & Dribbon, 1998; Kent-Walsh, 2003). Details of these intervention programs, including empirical support for the programs, follow.

Aided Language Stimulation

In a case study of a young child with severe cerebral palsy, Goossens' (1989) published one of the first peer-reviewed articles recommending that partners use the child’s AAC system to promote early language comprehension and expression. The program described in this study is known as “aided language stimulation” (Elder & Goossens', 1994; Goossens', 1989; Goossens' et al., 1995). This program contains many features and immerses the child in an environment filled with graphic symbols, with the adult supplementing spoken language by pointing to graphic symbols on the child’s AAC system so that the child “can begin to establish a mental template of how symbols can be combined and recombined generatively to mediate communication during the activity” (Goossens' et al., 1995, p. 101). For example, the adult might say, “The doll wants to wear her red dress” while pointing to the picture symbols for DOLL, RED, and DRESS. In addition to the adult providing such models within conversational speech, other techniques are used to elicit productions from the child. The adult provides nonverbal
signals, including the use of facial expressions, gestures, and body postures, to highlight symbols on the communication display. For example, the adult might indicate a doll’s brand new dress by pointing at it in an exaggerated manner and looking at it with wide eyes. This program also includes the use of a least-to-most cueing hierarchy to encourage the child’s productions. This hierarchy consists of a variety of cues, including the following (from lowest cueing level to highest): contextual cues (i.e., setting up materials to prompt communication, such as presenting the child with a box that cannot be opened without help), indirect verbal cues (e.g., asking the child a question such as “I wonder what we should do next?”), search light cues (i.e., scanning the picture symbols by using a small flashlight, to bring attention to the symbols), direct verbal cues (i.e., calling attention directly to what the child should say, such as “We need to do something with that box”), momentary light cues (i.e., shining the flashlight briefly on the target symbol), and constant or flashing light cues (i.e., shining the flashlight on the symbol until it is selected).

There has been little empirical evidence to support the use of aided language stimulation. To date, only two case studies have been published within peer-reviewed journals to evaluate the effectiveness of this program (Cafiero, 2001; Goossens', 1989). In one study, a child with cerebral palsy (aged 6;3) progressed from having no way to express herself symbolically at the onset of the investigation to producing up to 3-symbol messages after seven months of intervention (Goossens', 1989). Cafiero (2001) utilized this program with a thirteen year old boy with autism whose only means of symbolic communication at the onset of the investigation was the use of five signs. He frequently demonstrated challenging behaviors, particularly tantrum behaviors and leaving his seat.
Academic programming was nonexistent when the investigation began. Following 12 months of intervention, he was functionally using 67 symbols and demonstrating the use of a few multi-symbol combinations. In addition, the participant demonstrated decreased use of challenging behaviors. The participant’s ability to understand and use multiple symbols functionally also affected the staff’s perception of his academic abilities, and academic plans for building his reading and math skills were implemented as a result. Despite these positive outcomes, however, neither study utilized controlled experimental designs; therefore, no firm conclusions regarding the efficacy of the intervention can be made. To date, then, no empirically-based, peer-reviewed articles have been published to evaluate the impact of this program. Further, the Aided Language Stimulation Program is a package intervention (as are all of the other programs discussed below), and it is not possible to evaluate the specific impact of partners modeling the use of aided AAC based on the results of the case studies discussed above. These case studies do indicate, nonetheless, that partners accessing the child’s aided AAC system may be promising for promoting beginning language expression, including the expression of early word combinations.

**System for Augmenting Language**

Another AAC intervention program during which communication partners accessed the children’s AAC devices is the System for Augmenting Language (SAL). This program was evaluated over the course of an extensive two-year longitudinal investigation (Romski & Sevcik, 1996; Sevcik et al., 1995; Wilkinson et al., 1994). SAL
contains the following five core components: (1) provision of a speech output communication device; (2) provision of graphic symbols representing specific lexical items; (3) instruction through natural communication exchanges; (4) use of aided AAC input (called “augmented input” by the authors); and (5) monitoring ongoing use (Romski & Sevcik, 1996). The participants were 13 school-aged children and adolescents between the ages of six and twenty, all of whom had mental retardation. The participants’ teachers and parents were trained to use SAL and conducted intervention within the participants’ natural environments (i.e., during daily school and home activities). For the first year of the investigation, intervention took place in the home for half of the participants, while the other half received intervention while at school; during the second year, all participants received intervention in both locations (Romski & Sevcik, 1996).

The way that partners accessed the students’ aided AAC devices within the SAL program was very similar to methods described in the Aided Language Stimulation Program. With the SAL program, the researchers instructed the adults to touch key words on the voice output systems while also providing spoken models. The overall results of the investigation were positive. Throughout the course of the 2-year study, all of the participants learned the meanings of a variety of both referential and social-regulative symbols and were able to use these symbols on their voice output devices to communicate a variety of communicative functions within functional communication settings (Romski & Sevcik, 1996). By the end of the investigation, 7 of the 13 participants had produced more than 5 multi-symbol combinations during the course of the investigation (Wilkinson et al., 1994). With respect to the communication partners, the results indicated that when partners accessed the students’ AAC systems, over 50% of
the partners’ productions consisted of recasts or repetitions of the participants’ messages (Sevcik et al., 1995). However, only 3-14% of input was modeled for the children using aided AAC (Wilkinson et al., 1994).

The SAL program shares many similarities with the aided language stimulation program (cf. Cafiero, 2001; Goossens', 1989; Sevcik et al., 1995). Both of these programs recommend using the child’s aided AAC system to provide models that reflect the child’s communicative attempts (e.g., using recasts) and to use the child’s system within the child’s natural environments (e.g., various classroom activities). Further, both programs stress the importance of using the child’s aided AAC system within conversational speech; communication partners are encouraged to use the child’s system not just to elicit particular messages within a given moment, but to demonstrate consistently the use of aided AAC whenever possible. One difference between the programs is that Goossens' and colleagues (Goossens' et al., 1995) now recommend the use of a least-to-most cueing hierarchy to elicit responses (although the use of this hierarchy was not mentioned in Goossens' 1989 case study), but the SAL program does not delineate the use of any specific prompts. Otherwise, these programs take quite similar approaches to providing models using aided AAC.

Modeling using Aided AAC within Other Intervention Programs

All of the remaining intervention programs that recommended that partners use the child’s AAC system were parent and/or teacher training programs (e.g., Basil, 1992; Bruno & Dribbon, 1998; Kent-Walsh, 2003), and all programs encouraged use of the
aided AAC systems within the children’s natural environments (e.g., during school activities such as storybook reading or daily life activities such as getting dressed). However, the majority of these studies failed to provide details regarding (a) instructional techniques to teach the communication partners to use the child’s aided AAC system; (b) the timing of the models that were provided, and (c) the communication partners’ actual use of the child’s AAC system.

Basil (1992) implemented a parent training program designed to improve the participation patterns of four children who used AAC. As part of the program, parents were told to “make their own responses and expansions explicit on the children’s board from time to time” (p. 190). Parents were also told to speak slowly, provide time for the child to answer, provide prompts as needed, and ask open-ended questions. Although the proportion of turns in which the children used their communication devices increased (i.e., from 6% before intervention to 44% following intervention), no measures of the parents’ use of aided AAC models were reported, and the models were provided as one component of a larger intervention program.

Bruno and Dribbon (1998) also instructed parents to use their children’s aided AAC systems as part of a parent training program within the context of a camp setting for children who used AAC and their families. As one part of the program, parents were encouraged to communicate with their children using their communication devices to provide the children with models for communication. Other recommended techniques included ensuring access to AAC, providing time for the child to communicate, directing the child to use the device when necessary, and asking open-ended questions. Parents completed questionnaires once the camp was over, with the results indicating that the
parents perceived positive changes in their own skills with interacting with their children as well as positive changes in their children’s AAC device performance. Again, however, no direct measures of the parents’ implementation of the models – or of the other techniques – were reported. Further, no direct measures of children’s performance were reported, although the parents did perceive positive changes in their children’s use of aided AAC for several pragmatic functions, including participating in social exchanges and providing responses.

Basil and Soro-Camats (1996) reported a case study of a young girl with severe cerebral palsy and cognitive impairments (aged 3;9). These researchers taught communication partners to use the child’s aided AAC system as one component of the intervention program. The investigators provided the child with PCS on an eye gaze frame and taught her parents and classroom teacher how to use the child’s aided AAC system to help support her language development. No data regarding the communication partners’ acquisition of this skill was reported. At the onset of the investigation, the child communicated primarily through crying. By the end of the study, when the child was aged 7;3, she had a productive vocabulary of 151 graphic symbols. The investigators did not report any incidents of multi-symbol messages during the investigation. There were no experimental controls in this investigation, so it is uncertain what impact the partners using the child’s aided AAC system – or even the intervention package as a whole – might have had on the results.

McConachie and Pennington (1997) implemented a teacher training program designed to promote the communication skills of children using AAC. Teachers were encouraged to “use the same [communication] modes as the child” (p. 284). Post-testing
indicated that the teachers demonstrated an overall increase in using the same modes as the children, but no specific information regarding the content or timing of the models was reported. Further, no measures of the children’s performance were taken.

The three remaining studies, unlike the others discussed above, contained experimental controls as part of their investigations. Two studies conducted by Johnston and colleagues (Johnston, McDonnell, Nelson, & Magnavito, 2003; Johnston, Nelson, Evans, & Palazolo, 2003) used single-subject experimental designs across participants to successfully teach various communication skills to preschoolers. In the first study, three preschool children with autism learned to use a graphic symbol to request entrance into play activities by using a symbol representing CAN I PLAY? (Johnston, Nelson et al., 2003). Three different preschoolers (aged 3;3 – 4;6) participated in the second study (Johnston, McDonnell et al., 2003). One child had developmental delays and learned to request entrance into play groups in the same manner as the children with autism in the first study. A second child who had severe cerebral palsy and developmental delays learned to request attention from others by using a single switch to activate the message, “I want to tell you something.” The third child had severe multiple disabilities and learned to request continuation of an activity she enjoyed (i.e., “More singing, please”).

The intervention program was the same for both of these studies and included the following components: (a) create communicative opportunities for the child to communicate and wait for the child to show interest in the activity; (b) encourage peers and teachers to model use of the graphic symbols; (c) utilize a least-to-most prompting hierarchy to elicit a response from the child (i.e., indirect verbal/gestural prompt, direct verbal/gestural prompt, partial physical prompt, and full physical prompt); and (d)
provide natural consequences (e.g., allow child to join play activity). Procedural reliability data indicated that the communication partners consistently provided aided AAC models throughout the intervention during both investigations. Further, all participants in both studies successfully learned to use their symbols spontaneously.

Finally, Kent-Walsh (2003) instructed educational assistants (EAs) to use their students’ aided AAC systems as one component of program to facilitate the turn-taking skills of children who used AAC during storybook reading. This investigator utilized a single-subject design across participants; both the EAs and the students served as participants in this investigation. All five students demonstrated gains with their turn-taking skills after the EAs completed the training. The EA training program contained multiple components, including an introductory session, practice sessions, and an instructional follow-up session. The introductory session included the following instructional steps: (1) strategy description, (2) educational assistant commitment, (3) strategy demonstration, (4) verbal practice of strategy steps, and (5) controlled practice with feedback. The targeted strategy involved providing students with opportunities to communicate by eliciting communicative turns from the students and by providing appropriate responses to all of the communicative turns taken by the students. For the elicitation component of the strategy, the EAs were taught to implement the following steps with their students in sequential order: (a) read + model (i.e., orally read the book and select at least one symbol on the child’s aided AAC system on each page); (b) use an expectant delay; (c) ask an open-ended question + model (i.e., ask a wh- question while selecting at least one symbol on the child’s aided AAC system); (d) use an expectant delay again; and (e) answer + model (i.e., orally answer the question while selecting at
least one symbol on the child’s aided AAC system). For the practice sessions, the EAs developed their skills with implementing the target strategy within a controlled environment and then within the natural environment. During the instructional follow-up session, the EAs were provided an opportunity to demonstrate changes in their communicative behaviors and generated plans for maintenance and generalization of the students’ turn-taking skills. One of the core components of the instructional program was to teach EAs how to use the child’s aided AAC system when reading storybooks with the child. The EAs were instructed to use the student’s system while reading the book, while asking open-ended questions, and while answering questions. The EAs selected key words on the child’s aided AAC device while reading the text of the story. All of the EAs readily learned to implement the steps of the program – including the provision of aided AAC models – and all of the children who used AAC demonstrated gains in their turn-taking skills.

Overall, then, communication partners have used children’s aided AAC systems within various intervention programs to teach a range of skills to children with various types of disabilities who use aided AAC, with largely positive results. Caution must be taken, however, in interpreting the results; the limitations of these research studies are discussed below.

Limitations of Past Research

Although the research to date investigating the impact of communication partners using children’s aided AAC systems has been promising, there are serious limitations to
the findings. First, very few studies in which partners have used children’s aided AAC systems have used controlled, experimental research designs. Controlled, experimental research designs are needed to clearly establish the impact of the techniques that have been included within intervention programs. Only three such studies were located, with all reporting positive results, as discussed above (Johnston, McDonnell et al., 2003; Johnston, Nelson et al., 2003; Kent-Walsh, 2003). There is a dire need for more controlled research of this kind.

Second, no research has been published to date that isolates the impact of providing models by using the child’s aided AAC system. The assumption within all of the intervention programs discussed above has been that using the child’s aided AAC system should be included as a component within programs that contain other facilitative techniques, but to date, no one has attempted to isolate this type of modeling to examine its efficacy. Such systematic research is critical to accurately determine the key components of intervention strategies and programs.

Finally, there are no studies that specifically investigate the impact of communication partners using children’s aided AAC systems on the development of generative language, and more specifically on the development of early multi-symbol messages. Regardless of the techniques recommended, the general trend within the AAC literature has been to focus on improving pragmatic and semantic skills such as improving turn-taking (e.g., Kent-Walsh, 2003), increasing expressive vocabulary (Cafiero, 2001; Goossens', 1989; Sevcik et al., 1995), and improving general interaction skills (Bruno & Dribbon, 1998). It is critical, as a field, to begin extending beyond these
early communicative behaviors and ensure that children are achieving their maximal level of language development.

One critical step within the early stages of language development is the shift from single- to multi-symbol productions (Paul, 1997). As discussed above, this transition is a challenging one for children who rely on aided AAC for communication. The research findings to date indicate that communication partners providing models by using the child’s aided AAC system is a promising technique for teaching children to produce multi-symbol messages. As discussed above, several studies reported productions of multi-symbol messages after participating in intervention programs in which communication partners used the child’s system (Cafiero, 2001; Goossens', 1989; Sevcik et al., 1995). However, all of the research to date in which partners provided models using by aided AAC has included this component within larger intervention programs, and the relative impact and importance of the use of these types of models are unknown.

Therefore, it is critical to evaluate the specific impact of using aided AAC models on the production of multi-symbol messages with children who require AAC. If providing aided AAC models to these children is found to support the transition from single- to multi-symbol messages, the use of aided AAC models will help children who use AAC to gain a critical productive language skill and will provide much-needed data to support a common component of frequently recommended intervention programs.
Research Questions

The current investigation sought to investigate the impact of using aided AAC models within a child-centered approach to intervention on the production of multi-symbol messages by preschoolers who use AAC. Specifically, the following research questions were examined: (1) What is the effect of using aided AAC models on the use of multi-symbol messages by preschoolers who use AAC? (2) What is the effect of this intervention on the participants’ generalization of multi-symbol messages to new play scenarios when aided AAC models are no longer provided? (3) What is the effect of the intervention on the participants’ generalization of multi-symbol messages to new play scenarios with the continued support of aided AAC models? (4) What is the effect of the intervention on the participants’ maintenance of multi-symbol messages after intervention has ceased?
CHAPTER 2

Method

Research Design

This investigation utilized a single subject, multiple probe research design (McReynolds & Kearns 1983) across one set of three participants, all of whom used voice output systems to communicate. The same design was utilized with an additional set of two participants, both of whom used non-electronic communication boards for communication. The independent variable for the investigation was the use of aided AAC models during play scenarios. The main dependent variable was the frequency of multi-symbol combinations produced by participants during fifteen minute play sessions. The study involved five phases: baseline, instruction, generalization without aided AAC models (GEN W/O), generalization with aided AAC models (GEN W/), and maintenance.

A single subject design is ideally suited for this study, as this design allows for the establishment of experimental control and also allows for the evaluation of the efficacy of interventions that include participants from low incidence and heterogeneous populations, as each participant serves as his or her own control (Light, 1999; McReynolds & Kearns, 1983). Using a multiple probe design was more appropriate than any design involving a withdrawal stage, as participants learned behaviors that were not expected to return to
baseline levels (McReynolds & Kearns, 1983). Further, this design provided repeated measures, which allowed for analysis of individual performances and for detailed recording of behavioral changes throughout intervention (McReynolds & Kearns, 1983). A multiple probe design was chosen instead of a multiple baseline design as fewer baseline probes are required with a multiple probe design; with a multiple probe design, intermittent baseline observations are used to approximate the level of accuracy obtained through continuous testing (McReynolds & Kearns, 1983). This was a practical alternative to a multiple baseline design that helped to minimize boredom and fatigue that may have occurred if extended measures of the dependent variable at baseline had occurred.

**Participants**

**Criteria for Participation**

Five children who required AAC were recruited from preschools in central Pennsylvania by requesting nominations from early intervention teachers, speech-language pathologists, and family members via phone and email.

The selection criteria included the following: (a) was between 3-5 years of age; (b) presented with a severe, congenital speech impairment that necessitated the use of AAC to meet functional communication needs; (c) had experience using aided AAC; (d) had an expressive vocabulary of at least 25 words/symbols; (e) communicated using
telegraphic messages (i.e., at least 90% of messages involved no more than one symbol); (f) comprehended and early two-word relations with at least 80% accuracy; (g) comprehended at least 90% of graphic symbols; (h) successfully selected picture symbols within a field of 15 symbols using direct selection; (i) had vision or corrected vision that was functional for seeing the aided AAC symbols; and (j) had hearing or corrected hearing that was functional for listening to speech in a quiet environment.

The policies and procedures instituted by Penn State’s Office for Research Protections were followed in order to ensure proper protection of all participants. A parent or guardian for each participant provided informed consent before the investigation began.

**Assessment of Participant Skills**

Parents and school records were used to determine the age, nature of the speech disorder (i.e., type of disability; congenital vs. acquired), vision status, hearing status, and experience using aided AAC. The following assessment procedures were used to determine whether or not potential participants met the remaining participation criteria.

**Speech Impairment**

To ensure that each child fit the criterion for having a severe speech impairment that necessitated the use of AAC, stimuli from the Index of Augmented Speech Comprehensibility in Children (I-ASCC) (Dowden, 1997) were administered to measure
each participant’s speech comprehensibility. To be eligible for this investigation, each child’s speech had to be less than 75% intelligible to unfamiliar partners at the single word level in the “no context” and “semantic context” conditions on the I-ASCC. As indicated in the I-ASCC procedures (Dowden, 1997), the test words were elicited (and simultaneously recorded) using the following cueing hierarchy: (1) picture only, (2) picture plus contextual cue (e.g., “toys boys play with”); (3) picture plus embedded model. Recordings were played for unfamiliar listeners. In the “no context” condition, listeners were asked to listen to audio-taped recordings of the child, listening to each sample twice, and write down the word or phrase that they heard. In the “semantic context” condition, listeners read a phrase that described each situation (e.g., “something children use during craft time” as the context for the item “scissors”), listened to each sample twice, and then wrote down the word.

**Expressive Language**

To ensure that participants met the expressive vocabulary criterion – that is, that they were expressing at least 25 words – caregivers completed the MacArthur Communicative Development Inventories, or CDI (Fenson et al., 1993), a vocabulary checklist for parents to indicate the vocabulary their children use. Caregivers were instructed to identify all the words their child used consistently, regardless of communication mode (i.e., speech, sign, graphic symbol). Although a typically developing child is not expected to combine words until her expressive vocabulary reaches approximately 30-50 words (Rescorla, 1989), the criterion for children using
AAC was set at a lower level of 25 words for several reasons. Many children who require AAC have access to relatively few vocabulary words for expressive use. Typically, very few of their spoken words are intelligible, and they only have access to the graphic symbols that are provided for them by others (e.g., Basil & Soro-Camats, 1996; Sevcik et al., 1995). Many factors affect the limited aided AAC vocabulary to which children often have access. First, it is difficult to pictorially represent some of the early abstract concepts that young speaking children use, such as “up” and “big” (Drager, Light, Speltz, Fallon, & Jeffries, 2003). Other factors include the labor-intensive nature of creating aided AAC “pages” (Beukelman & Mirenda, 1998) and the lack of AAC training of many primary service providers (Koul & Lloyd, 1994; Ratcliff & Beukelman, 1995). Finally, even if children do have access to a wide range of vocabulary, they seldom see others using these symbols as an expressive means of communication (Sevcik et al., 1995), which may have a negative impact on their expressive communication (Smith & Grove, 2003). These children, then, may demonstrate limited expressive vocabularies due, at least in part, to these extraneous factors and not to inherent developmental limitations. Therefore, a lower level was set for the expressive vocabulary requirement.

In addition to the CDI, videotaped recordings of 15 minute language samples were taken of each preschooler interacting with the investigator in a free play setting (Miller, 1981). Language samples were transcribed and analyzed to ensure that at least 90% of each child’s messages involved no more than one symbol.
Receptive Language

The participants’ comprehension was assessed using criterion-referenced assessment tasks adapted from Miller and Paul (1995) to target the comprehension of two- and three-word relations. Additionally, all participants completed the Test of Auditory Comprehension of Language – 3 (TACL-3). These comprehension measures were chosen because spoken responses were not required for completion. Also, adequate reliability and validity data have been reported for the TACL-3.

The assessment procedures for comprehension of two- and three-word messages were adapted from Miller and Paul (1995) and are included in Appendix A. Essentially, the children were provided with objects including stuffed animals, miniature people, and other toys such as cups, plates, and spoons and were then asked various questions. For each action + object trial, the child was provided with two toy animals or figurines (e.g., a giraffe and a dog) and two objects (e.g., a washcloth and a cookie) and was then instructed to carry out an action (e.g., Wash the dog). Similarly, for the agent + action + object trials, the child was provided with the same number of items as for the action + object task and was then asked to perform actions (e.g., Show me, ‘The dog is eating a cookie’). For each possessor + possession trial, two possessors were placed in front of the child (e.g., a giraffe and a dog) and four possessions (e.g., a teacup and a spoon in front of the giraffe, and another teacup and spoon in front of the dog). The child was then asked to point to an object belonging to a possessor (e.g., Where’s Giraffe’s spoon?). All vocabulary items used on this assessment protocol were items that were used in the play scenarios throughout the study. The assessment involved 10 trials for action + object
relations, 10 trials for possessor + possession relations, and 10 trials for agent + action + object relations. Participants needed to achieve 80% accuracy or higher on the first two tasks in order to qualify for participation in the study.

The TACL-3 (Carrow-Woolfolk, 1999) was administered according to instructions in the manual. None of the participants required any adaptations to the materials to complete the test.

**Comprehension of Graphic Symbols**

Procedures for ensuring that participants comprehended the target graphic symbols are listed in Appendix B. Participants were presented with the communication boards that were used throughout the course of the investigation. Examples of the boards that were used for each play scenario are located in Appendix C (details regarding development of the communication boards are located in the “AAC Systems” section below). The researcher held up the object (e.g., “baby”) or acted out the target action (e.g., “wash”) and said, “Show me [target].” The child was required to point to the symbol representing the object or action from the array of 15 graphic symbols. Items that the child missed were taught to the child via a paired instructional paradigm (e.g., Hunt-Berg, 1996; Schlosser & Lloyd, 1997), where the child observed the investigator providing a spoken label while showing the object or action along with the matching symbol. Each item was labeled 3-4 times; once all missed items were taught, the missed items were placed into a pool of at least ten symbols and the child was then retested. Participants had to achieve at least 90% accuracy across all symbols to continue to the
baseline phase. Achieving this accuracy level not only ensured that the preschooler comprehended the majority of the symbols but also met the criterion for being able to make selections from a field of 15 graphic symbols.

**Pool of Potential Participants**

A total of seven potential participants were nominated by early intervention teachers, speech-language pathologists, and family members. However, two of these participants did not meet the selection criteria. One child with severe cerebral palsy had a significant visual impairment that required symbols to be quite large, and subsequently, he was unable to make direct selections from a field of greater than 4 symbols. Furthermore, he did not consistently identify the target symbols. For the second child, more than 10% of his messages were multi-symbol messages during the language sample. The remaining 5 children met all of the above selection criteria and were deemed appropriate for the investigation.

**Participant Demographics**

A total of 5 children participated in the investigation, 3 males and 2 females. All participants were Caucasian and from either lower-middle or middle class socioeconomic backgrounds. All participants lived in central Pennsylvania and ranged in age from 3;4-4;6. Four of the five participants were enrolled in early intervention preschool programs; the fifth child (Timmy) received speech-language services in his home. The researcher
completed the investigation with three of the children at school; the remaining two were seen at home. In accordance with the selection criteria, all children had severe speech impairments. Participants had the following diagnoses: Two children with a diagnosis consistent with developmental apraxia of speech, one child with Prader-Willi Syndrome, one with DiGeorge Syndrome, and one with Down Syndrome. All five children demonstrated significant speech impairments: the comprehensibility of their spoken single words was well below 75% for unfamiliar partners (0% comprehensibility for all children for the no context condition; 0-7% comprehensibility for the semantic context condition). All five participants achieved at least 90% accuracy on comprehension of the target graphic symbols and at least 80% accuracy on comprehension of spoken two- and three-word relations. On the TACL-3, overall standard scores ranged from 74 to 102, percentile ranks from the 4th to the 55th percentile, and age equivalents from 3;4-3;11. On the MacArthur Communicative Developmental Inventory, the number of words that parents indicated that their children expressed ranged from 27-248. See Table 1 for a summary of participant demographics. To protect the confidentiality of the participants, pseudonyms have been used.

**Participant Profiles**

Three of the preschoolers (Valerie, Timmy, and Robyn) used voice output communication systems as their aided AAC systems for the investigation; they formed the first cohort in the study. The second cohort (Nathan and Richard) used non-electronic light tech communication boards. Specific profiles of each child follows.
Valerie

Valerie was age 4 years, 3 months at the onset of the investigation. She had been diagnosed with Prader-Willi Syndrome at 3 months of age. This syndrome is typically characterized by hypotonia, small hands and feet, obesity, and delayed developmental milestones, with many children demonstrating speech and language delays (Jung, 1989). At the time of the investigation, Valerie presented with all of these symptoms with the exception of obesity; her parents reported that she was not yet showing signs of overeating. Valerie was taking a growth hormone (Genotropin) to help support her physical development. In addition to the above characteristics, Valerie also had scoliosis and wore a back brace to support the proper growth and alignment of her spine. Three surgeries had been completed on her hips to remediate dislocations. She began walking independently at age 2 and needed to learn to walk again following her first two surgeries. Both her vision and hearing had been recently screened and found to be within normal limits. Developmental milestones were reported to be delayed. She was ambulatory and could go up and down stairs unassisted. By the end of the investigation, she had achieved success with toilet training during the day but not at night.

Valerie attended an early intervention preschool four days each week for 3.5 hours per day. All of the children in her classroom were receiving special education services. She had a one-on-one personal care aide in the classroom to help with all academic and personal needs. She received occupational therapy (0.5 hours per week) and physical therapy (1.25 hours per week) in addition to speech-language therapy. Her physical therapy goals focused on development of balance, coordination, and strength.
<table>
<thead>
<tr>
<th>Participant</th>
<th>Age</th>
<th>Gender</th>
<th>Primary Disability</th>
<th>CDI+</th>
<th>Speech Comprehensibility</th>
<th>TACL-3 Total Test Scores</th>
<th>Miller &amp; Paul++ Tasks</th>
<th>Communication Modes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No Context</td>
<td>Semantic Context</td>
<td>Standard Score</td>
<td>%ile Rank</td>
<td>Age Eq.</td>
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<tr>
<td>Valerie</td>
<td>4;3</td>
<td>Female</td>
<td>Prader-Willi Syndrome</td>
<td>248</td>
<td>0%</td>
<td>3%</td>
<td>81</td>
<td>10th</td>
</tr>
<tr>
<td>Timmy</td>
<td>3;5</td>
<td>Male</td>
<td>DiGeorge Syndrome</td>
<td>160</td>
<td>0%</td>
<td>0%</td>
<td>102</td>
<td>55th</td>
</tr>
<tr>
<td>Robyn</td>
<td>4;6</td>
<td>Female</td>
<td>Down Syndrome</td>
<td>188</td>
<td>0%</td>
<td>0%</td>
<td>74</td>
<td>23rd</td>
</tr>
<tr>
<td>Nathan</td>
<td>4;4</td>
<td>Male</td>
<td>Devp’l Apraxia of Speech</td>
<td>27</td>
<td>0%</td>
<td>7%</td>
<td>89</td>
<td>23rd</td>
</tr>
<tr>
<td>Name</td>
<td>Age</td>
<td>Gender</td>
<td>Score</td>
<td>Error</td>
<td>Language</td>
<td>Speech</td>
<td>Manual Signs</td>
<td>Gestures</td>
</tr>
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<td>--------</td>
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</tr>
<tr>
<td>Richard</td>
<td>4;2</td>
<td>Male</td>
<td>117</td>
<td>0%</td>
<td>90%</td>
<td>19th</td>
<td>3;8</td>
<td>90%</td>
</tr>
</tbody>
</table>

Natural speech; a few manual signs; gestures, light tech communication boards

+CDI = MacArthur Communication Development Inventory: Words and Sentences (Fenson et al., 1993); **Miller & Paul = adapted tasks from Miller & Paul (1995)**
She was right-handed and could easily isolate a pointer finger to access her AAC system. She was able to hold writing instruments for drawing and could feed herself. Her occupational therapy goals primarily were designed to improve her endurance and muscle tone. No recent reports of standardized cognitive testing were available.

Valerie’s speech-language pathologist and classroom teacher reported that Valerie could identify and label colors and could sort items according to size (big vs. small). She enjoyed engaging in symbolic play using a variety of toys and was particularly fond of playing with dolls.

Valerie had a limited sound repertoire that mainly consisted of vowels, nasals, and a few stop sounds. She could produce the following consonants in isolation, according to her speech-language pathologist (SLP): /p/, /b/, /t/, /d/, /m/, /s/, and “sh.” Combining sounds was very difficult for Valerie; most sound combinations were consonant + vowel (CV) combinations, and many of her sound productions were inconsistent. She had a small repertoire of intelligible words, including no, hi, bye, mine, baby, mama, and dada. Her speech-language pathologist also reported that Valerie had poor oral-motor skills, including poor motor programming and muscle weakness.

Valerie’s scores on the TACL-3 revealed that her language comprehension skills were delayed, with an overall percentile rank of 10 and a standard score of 81. On the vocabulary, morphemes, and syntax subtests of the TACL-3, she received standard scores of 7, 6, and 8, respectively (maximum possible score = 20, average score = 10); her percentile ranks were 16, 9, and 25, respectively.

On the Miller and Paul comprehension tasks (1995), she
achieved 100% accuracy on both the action + object and possessor + possession tasks (10/10 on each task), and 90% accuracy on the comprehension of agent + action + object task. Valerie’s speech-language pathologist reported that Valerie could readily follow one- and two-step directions and understand simple wh- and yes/no questions in the classroom.

Expressively, Valerie used gestures, speech approximations, approximately 150 signs, and approximately 300 symbols on her Mercury\textsuperscript{2} to communicate. On the CDI checklist, Valerie’s mother indicated that Valerie was able to express a total of 248 words via speech, manual signs, and/or her voice output system. During her language sample, Valerie and her communication partner took an equal number of symbolic turns (turn-taking ratio = 1:1), indicating that the participation patterns were symmetrical (cf. Light et al., 1994). She communicated at a rate of 4 turns per minute.

Valerie had received her Mercury approximately 1 year prior to the beginning of the investigation. She used Speaking Dynamically Pro\textsuperscript{3} software and primarily used PCS within the software program to communicate. Speaking Dynamically Pro is a software program that allows any MacIntosh® or Windows®-based computer to function as an AAC device, using dynamic display screens. PCS is a commercially available set of line drawings that are commonly used in the AAC field and is available for use within Speaking Dynamically Pro software. The “pages” within Valerie’s Mercury contained

\footnotesize

\textsuperscript{2} Mercury is a Windows® XP-based AAC device and is a product of Assistive Technology, Inc., 333 Elm St., Dedham, MA 02026, \url{www.assistivetech.com}

\textsuperscript{3} Speaking Dynamically Pro is a product of Mayer Johnson, Inc., P.O. Box 1579, Solana Beach, CA 92075-7579, \url{www.mayerjohnson.com}
up to 35 symbols per page; she had approximately 300 graphic symbols on her device. Her expressive communication typically consisted of either a gesture (such as pointing or nodding) or use of a single symbol (speech approximation, sign, or aided AAC symbol). Her SLP and classroom teacher reported that she relied more on signs, gestures, and speech approximations than on her voice output system throughout much of the school day. Valerie was an active communicator; she was very motivated to communicate and typically persisted, using any means of communication at her disposal (vocalizations, gestures, signs, aided AAC), until her intent was accurately deciphered. All of Valerie’s sessions for this investigation took place in either her home (with her father present) or at her grandparents’ home (with her grandmother present).

**Timmy**

Timmy was 3 years, 5 months old at the beginning of the investigation. He was diagnosed with DiGeorge Syndrome soon after birth. DiGeorge Syndrome, also known as Chromosome 22q11.2 Syndrome, is a primary immune deficiency disorder characterized by certain facial features (such as low-set ears, underdeveloped chin), parathyroid gland abnormality, heart defects, and thymus gland abnormalities (*IDF Patient and Family Handbook*, 2001). Other clinical features may include cleft palate, poor function of the palate, delayed acquisition of speech, and difficulties with feeding and swallowing. (*IDF Patient and Family Handbook*, 2001). The presence and extent of symptoms vary widely across children. Timmy’s primary difficulties were with his heart and with his speech development; his immune system had not been significantly
compromised by the syndrome. Timmy had two heart surgeries and a heart
catheterization prior to the study and was expected to require another heart surgery when
he turned five. He had a history of feeding problems, with liquids being regurgitated
through his nose, although all of his feeding problems had resolved during his second
year of life. He also had a history of frequent otitis media and had his second pair of
myringotomy tubes inserted several months before the onset of the investigation. He
experienced several ear infections during the present investigation; several sessions were
rescheduled as a result. Timmy’s otolaryngologist and audiologist carefully monitored
his hearing. His hearing was tested following one bout of otitis media during the
investigation and was found to be within normal limits. His vision had been screened
and no difficulties were reported.

Timmy was receiving special education services during the investigation but was
not attending preschool, due to difficulties with finding a personal care aide as well as
his family’s preference for him to stay at home. He received SLP services at home for
one hour per week. He was not receiving any occupational or physical therapy services.
The Infant/Toddler Sensory Profile was administered by an occupational therapist a year
before the onset of the investigation, with findings indicating that his fine motor skills
were well within normal limits (percentile rank = 79; standard score = 112) but that he
was demonstrating some difficulties with his gross motor skills (percentile rank = 13;
standard score = 83), including frequent falls and general clumsiness. He demonstrated
good self-help skills (feeding, dressing), and toilet training had been completed by the
end of the investigation. Timmy received a percentile rank of 86 on the cognitive subtest
of the Battelle Developmental Inventory (Newborg, Stock, Wnek, Guidubaldi, & Svinicki, 1984), which was administered when Timmy was age 2;3.

Timmy’s educational records indicated that he was able to follow two-step directions, understand wh- and simple yes/no questions, and identify detailed parts of objects (e.g., parts of vehicles, animals). Timmy actively communicated about events other than those in his immediate surroundings and frequently communicated about events that had taken place in the recent past (for example, initiating telling the investigator about his grandfather hitting a bear with his tractor trailer truck).

Timmy’s speech was characterized by severe velopharyngeal insufficiency (VPI). His vocalizations and speech sounds were all very hypernasal. He was unable to blow air through his mouth without plugging his nose, and he was unable to produce any non-nasal sounds. His speech sound repertoire consisted of a few nasal vowels and the consonants /m/, /n/, and /h/, with air escaping through his nose for the production of /h/. During the investigation, his family was attempting to schedule an appointment with a DiGeorge Syndrome clinic, with one of the goals of the visit being further investigation of the functioning and possible remediation of his VPI. Timmy maximized use of the phonemes in his repertoire and of intonation in his speech approximations. For example, he produced a range of environmental sounds, such as the sound of a train’s whistle, to represent various concepts. Words such as “uh huh” (for “yes”) and sounds such as “n-n” (for “no”) were noted to emerge during the investigation.

Timmy exhibited receptive language skills that were within the average range for a child his age. On the TACL-3, he received an overall percentile rank of 55 and an age equivalent score of 3;5. On the vocabulary, morphemes, and syntax subtests of the
TACL-3, he received standard scores of 11, 10, and 10, respectively (percentile ranks = 63, 50, 50). On the Miller and Paul (1995) comprehension tasks, Timmy achieved 100% accuracy (10/10) on both the action + object and possessor + possession tasks and 90% (9/10) accuracy on the agent + action + object task.

Expressively, Timmy used a combination of speech approximations, vocalizations, gestures, signs, and a voice output system to communicate. Timmy had an expressive sign vocabulary of approximately 150 signs at the onset of the investigation. At baseline, prior to intervention, Timmy demonstrated a symbolic turn-taking rate of two turns per minute and took 29% of the symbolic turns during the sample (3:7 turn-taking ratio).

He had recently obtained a voice output system (a Mercury) through the early intervention team and was just beginning to use it when the investigation began. He used Speaking Dynamically Pro software on his voice output system. By the end of the investigation, his voice output system contained approximately 200 symbols; the graphic symbols on this system were a mixture of digital photographs and PCS, in addition to scanned images from storybooks. Some of the “pages” on his system were organized by activity (e.g., the “going places” page) and others were organized taxonomically (e.g., the “people” page). Timmy was very motivated to communicate and usually persisted with communication until his partner could determine what he was trying to say. All sessions for this investigation took place in Timmy’s grandmother’s home, where he spent most of his days while his mother worked. His grandmother was present during all of the sessions.
Robyn was 4 years 6 months at the beginning of the investigation and was diagnosed with Down Syndrome. Her developmental milestones were delayed and she was still in the process of being toilet trained during the investigation. Besides being allergic to certain foods such as wheat, there were no medical concerns. Robyn’s mother reported that both her vision and hearing had been tested within the past year and were found to be within normal limits.

Robyn attended an early intervention preschool 5 days a week for 2½ hours each day. Another participant, Richard, was in the same classroom. There were several typically developing children in the classroom, but the majority of the children received special education services. Robyn received speech/language and occupational therapy services each week (30 minutes per week for each service). Her occupational therapy goals included holding scissors and cutting appropriately, tracing shapes, stringing beads, pulling zippers, manipulating buttons, and increasing overall muscle strength. Reports indicated that Robyn had not yet established hand dominance, and she alternated between using her left and right index fingers when accessing her aided AAC system.

The Battelle Developmental Inventory (Newborg et al., 1984) was administered when Robyn was 54 months old. She achieved an overall age equivalent score of 28 months and a cognitive subtest score of 28 months. Robyn’s school records indicated that she was able to do the following: (a) follow one-step directions, (b) follow two-step directions (emerging), (c) respond consistently to simple yes/no questions, (d) match
colors, and (e) name several colors (red, blue, yellow, green). She could identify body parts and engage in symbolic play with dolls and other toys. Rote counting was still a challenge for her. Behaviorally, Robyn was generally compliant until she became bored or uninterested in an activity. Her classroom teacher, classroom aides, and SLP reported that when this occurred, Robyn would simply refuse to participate and would hide her face, lie on the floor, turn her back on the activity and communication partner, or get out of her seat and walk away. These behaviors were also observed by the investigator throughout the course of the investigation.

Robyn’s speech was highly unintelligible. An unfamiliar listener could not understand any of the words she produced on the I-ASCC index (Dowden, 1997), even when the contextual cues were provided. Robyn was fairly vocal at home but seldom vocalized at school. Her speech sound repertoire was very limited; she produced some vowel sounds in addition to /b/, /n/, /m/, /k/, and an unconventional glottal sound. When attempting single words, she seldom linked two syllables together, with most productions consisting of CV syllables. However, during certain tasks (such as pretending to read a book), she would string together a series of vowel sounds.

Robyn’s receptive language skills were delayed relative to her chronological age. On the TACL-3, she received an overall percentile score of 4. Her standard scores on the Vocabulary, Grammatical Morphemes, and Elaborated Phrases and Sentences subtests were 5, 7, and 6 (percentile ranks = 5, 16, and 9), respectively. The Battelle Developmental Inventory (Newborg et al., 1984) was administered when Robyn was 54 months old, and her age equivalent score on the communication subtest was 22 months (C.A. = 54 months). On the Miller and Paul (1995) comprehension tasks, Robyn
achieved 90% accuracy on the action + object task and 80% accuracy on both the
possessor + possession task and the agent + action + object task.

Expressively, Robyn relied heavily on gestures to communicate at school,
including head nod/shake, shoulder shrug, and pointing. At the time of the study, she
was learning some manual signs, which she was beginning to use spontaneously at
school (e.g., “help,” “want”). Robyn’s mother had recently purchased several videotapes
to teach Robyn some signs, and Robyn’s mother reported that Robyn enjoyed watching
the tapes and had spontaneously used several new signs (e.g., pointing to cow while
riding in the car and signing “cow”). On the MacArthur CDI (Fenson et al., 1993),
Robyn’s mother reported that Robyn was able to express a total of 188 words through
speech, signs, and/or picture symbols. At school, Robyn had access to a variety of
picture symbols (PCS, photographs) located throughout the classroom. Activity-specific
communication boards were made available for certain classroom activities (e.g.,
playing with sponges and water, playing with shaving cream). During her language
sample, Robyn demonstrated a symbolic turn-taking rate of 3.5 turns per minute and
took 40% of the turns in the sample, with her partner taking 60% of the turns, a 2:3 turn-
taking ratio.

Robyn also had a voice output system that utilized digitized speech, which was
an EasyTalk. Her exposure to the Easy Talk in the classroom was quite limited,
however. Four of the eight levels of the system contained symbols specific to this

4 EasyTalk is manufactured by Sym Systems and is available through the Saltillo Corporation, 2143
TR112, Millersburg, OH, 44654, www.saltillo.com
investigation and were only available to her during data collection. The remaining four levels were programmed with activity-based vocabulary for school (e.g., free play, Play-Doh). Each of these four levels contained a total of 20 symbols (5 symbols per column, 4 symbols per row). Vocabulary was represented using a combination of photographs and PCS and included agents, actions, objects, and attributes. There were many activities during the day for which the EasyTalk was not useful to her (e.g., circle time, outdoor play, various rotating play activities), as there was no additional space to program appropriate vocabulary on the device.

The majority of sessions for the research study took place at Robyn’s school, within the SLP’s office. Several sessions also took place in her home, between the end of the regular school year and the beginning of summer school. Robyn’s mother observed the sessions taking place at home. No one else was present for the sessions at school.

_Nathan_

Nathan, a male aged four years four months, was diagnosed with severe developmental apraxia of speech by his speech-language pathologist. He had no known medical problems. Nathan’s vision and hearing were both screened within one year of the investigation and found to be within normal limits.

Nathan attended an early intervention preschool program, 5 days a week for 2½ hours each day. The majority of the children in the classroom were receiving special education, with a few typically developing peers. Nathan was receiving speech and
language services once a week for 30 minute sessions. He also received occupational and physical therapy for motor delays. His gross motor goals targeted improvement of balance, trunk strength, stability, with fine motor goals designed to improve skills such as cutting. He demonstrated overall difficulties with initiating movement. He readily engaged in symbolic play across a variety of play materials (e.g., pretending to have stuffed animals eat plastic food, etc.). He was described by his classroom teacher as a child who was happy and enjoyed exploring his environment. The Battelle Developmental Inventory was administered when Nathan was 50 months old; he received an overall age equivalent score of 27 months and cognitive subtest score of 33 months.

Nathan’s speech was characterized by a limited speech sound repertoire and inconsistent speech sound productions. His speech was highly unintelligible to both familiar and unfamiliar partners. On the I-ASCC index (Dowden, 1997), an unfamiliar listener understood none of the words Nathan produced in the “no context” condition and only 7% of messages in the “semantic context” condition. He had very few intelligible words (e.g., “hi,” “car,” “bye-bye”). Nathan was able to imitate the consonants /m/, /b/, /p/, /t/, and /d/ in isolation and in single syllables; his connected speech consisted mainly of vowels, which he was able to string together.

Nathan’s standard scores were 8 on all three subtests of the TACL-3, yielding percentile ranks of 25 for each subtest. His age equivalent scores ranged between 3;6-3;9. On the Miller and Paul (1995) comprehension tasks, Nathan achieved 90% accuracy on both the agent + action and possessor + possession tasks, and 80% accuracy on the
agent + action + object task. His school records indicated that Nathan was able to follow one-step directions in the classroom and understand basic wh- and yes/no questions.

Nathan communicated using a combination of gestures, vocalizations, speech approximations, and PCS at school. On the MacArthur CDI (Fenson et al., 1993), his parents reported that Nathan was able to express only 27 words. Nathan demonstrated a symbolic turn-taking rate of two symbols per minute during his language sample and took 34% of the symbolic turns, with his partner fulfilling 66% of the turns, a 1:2 ratio.

Sign language was not a major focus of Nathan’s educational programming, and he used few signs during the investigation. Nathan had a communication book containing approximately 15 PCS symbols that he brought to school with him and took home each night. He seldom used this AAC system in either location. All of the symbols in this book were nouns, including various food items and preferred play activities (e.g., car, blocks, beads, puzzle, and bubbles). Nathan was much more likely to use the variety of picture symbols and photographs in various locations in his classroom and activity-specific communication boards. He received an age equivalent score of 21 on the communication subtest of the Battelle Developmental Inventory (C.A. = 50 months). Nathan’s teacher reported that when Nathan was displeased with others (e.g., when an adult took the toy he was playing with), he turned his head and body away from communication partners; however, in other situations (according to his classroom teacher and school records), Nathan readily made eye contact with partners, answered yes/no questions, and initiated communication. All sessions for this investigation took place in a quiet room at Nathan’s school, with only Nathan and the investigator present.
Richard

Richard, a male aged 4 years 2 months at the onset of the investigation, was diagnosed with developmental apraxia of speech by his speech-language pathologist. His birth history was unremarkable and he had no medical concerns. Richard’s vision and hearing were screened and found to be within normal limits.

Richard attended an early intervention classroom that consisted mainly of children who were receiving special education services; several of the children were typically developing. Richard received speech/language therapy services one time per week for 30 minutes; he did not receive occupational or physical therapy. He was ambulatory and was able to engage in a full range of activities typical of a child his age. According to his school records, Richard was able to follow one- and two-step directions in the classroom, respond to simple wh- questions and yes/no questions, and put simple puzzles together. When Richard was aged 50 months, the Battelle Developmental Inventory was administered. He received an overall age equivalent score of 27 months and a cognitive subtest score of 33 months. Richard was a very compliant, happy child who enthusiastically engaged in symbolic play, laughing readily whenever something unexpected or unusual happened during the course of play.

On the TACL-3, Richard received an overall standard score of 87 and was in the 19th percentile. His standard scores on the Vocabulary, Grammatical Morphemes, and Elaborated Phrases and Sentences subtests were 8, 9, and 7, respectively (25th, 37th, and 16th percentiles). These scores indicated a mild delay with some of his receptive language skills. He achieved 90% accuracy on each of the Miller & Paul (1995)
receptive language tasks (agent + action, possessor + possession, agent + action + object).

Richard communicated mainly through the use of gestures (pointing and reaching), vocalizations, and speech approximations in addition to using the picture symbols available in his classroom. During his language sample, he demonstrated a very low symbolic turn-taking rate (<1 turn per minute); he produced only eight symbolic turns during the 15 minute sample. Only 11% of the total symbolic turns in the sample were his, with 89% fulfilled by his partner (ratio = 1:9). Richard’s educational program was not focused on teaching him signs, and he used few signs throughout the course of the investigation. At school, Richard produced very few intelligible words besides “no,” although he vocalized frequently, often using multi-syllable structures. He repetitively used one particular sound combination (“muh-nee”) regardless of what he was trying to tell his partner. Richard seldom used head nods or shakes to indicate “yes” and “no.” On the MacArthur CDI (Fenson et al., 1993), Richard’s parents indicated that he was able to express 118 words. In spontaneous speech, he was able to produce several vowels and the consonants /m/, /n/, and /b/. Richard used various picture symbols (PCS) and photographs that were located throughout his classroom (such as symbols to represent various types of weather during circle time) as well as activity-specific communication boards (such as playing with Play-Doh). All sessions with Richard took place in a quiet room at his school, with only Richard and the investigator present.
Materials

A variety of play scenarios were used as the contexts for teaching multi-symbol messages to the participants. Specific information pertaining to the play scenarios as well as AAC systems follows.

Play Scenarios

Play scenarios were used as contexts for intervention for this investigation. The play scenarios were selected based on their age- and developmental-appropriateness for the participants. These types of scenarios have been used successfully in past research (e.g., Camarata, Nelson, & Camarata, 1994; Cleave & Fey, 1997; Drager et al., 2003; Tyler, Lewis, Haskill, & Tolbert, 2002; Warren & Bambara, 1989). A total of seven imaginative scenarios were chosen for this investigation and included the following: washing a baby, having a tea party, playing with vehicles, playing with a farm, eating fast food, going to a birthday party, and cleaning the kitchen. One consistent set of toys was used across participants for each scenario. Toys were selected to specifically foster agent + action, action + object, and agent + object combinations. For example, for the tea party scenario, the toys included a doll, a stuffed dog, a stuffed giraffe, a teapot, and a carton of milk, in addition to several plastic cookies, cups, and plates. For this scenario, the doll, dog and giraffe (in addition to the child and researcher) all bit the cookies and also drank and spilled the milk and tea.

At the onset of the investigation, each child selected four play scenarios (from the original pool of seven) to be used for the study. Allowing participants to indicate
their preferences for certain play activities helped to ensure maximum interest in the scenarios throughout the investigation (Reichle, York, & Sigafoos, 1991). All of the play materials were placed in front of the children, with each set of toys placed in a different container, and the children chose the containers holding the toys with which they wished to play. Two of the play scenarios that the children selected were then randomly assigned to the intervention phase (Play Scenario Set A) and two to the generalization phases (Play Scenario Set B). In one case, a parent ruled out the use of one play scenario; Valerie’s father preferred that Valerie did not play with the fast food toys, as the family wanted to minimize her exposure to fast food.

AAC Systems

Activity-based communication boards were created for each play scenario selected by the participants. Specific information pertaining to the vocabulary, graphic representations, and layouts of the AAC systems follows.

Vocabulary

A total of 15 symbols were included for each play scenario. Nine unique vocabulary items related to each specific context were selected for each scenario: (a) three agents (e.g., doll, giraffe, dog); (b) three actions (e.g., bite, drink, spill); and (c) three objects (e.g., tea, milk, cookie). Additionally, several other symbols were available for all of the scenarios, as pilot data indicated that these items greatly enhanced
interactions during play. These items included the following: [child’s name],
[researcher’s name], “want,” “more,” “allgone,” and “no.” Appendix D contains a list of
all vocabulary items used in the scenarios. All vocabulary words (with the exception of
people’s names) were selected from the CDI (Fenson et al., 1993). The words contained
on this checklist were selected from data on the early lexical development of typically
developing children ages 9-36 months.

Children at the early two-symbol stage of development typically express a range
of semantic categories (Brown, 1973; Lahey, 1988; Retherford, Schwartz, & Chapman,
1981). The vocabulary provided allowed for modeling of a variety of semantic
categories, including agent, action, object, negation, recurrence, state, entity, and others.
Although existence (e.g., “this cow”) and the early “protoverbs” such as in, on, and
there develop very early in typically developing children (Barrett, 1966, as cited in
Owens, 2001), these concepts are abstract and are difficult to represent graphically, and
therefore were not included. For this initial investigation, only semantic-syntactic
categories that could be graphically represented with relative ease were chosen.

**Graphic Representations**

All of the agents and objects were represented using photographs of the actual
items that were used in the study (e.g., photographs of the actual girl, bunny, pig, bus,
truck, and car that were used in the “playing with vehicles” scenario), as photographs
are highly iconic (Mizuko, 1987). As all of the actions were used with multiple agents
and objects (e.g., “chase” could be used when the girl chased the bus, the truck chased
the car, etc.), representations that applied to a variety of situations were used for the actions. Specifically, the line drawings contained in the Picture Communication Symbols (PCS) system (Johnson, 1994) were used whenever possible. This symbol set has been shown to be more iconic than other line drawing symbol sets such as PicSyms (Mizuko, 1987). Further, all of the participants had been previously exposed to PCS. All of the symbols used in the classrooms of Robyn, Nathan, and Richard were PCS, and the communication boards used by all of the children prior to the onset of the study contained PCS.

For five vocabulary items, modifications were made to the PCS to more accurately reflect the nature of the actions involved for five vocabulary items, including “blow,” “drop,” “lick,” “dry,” and “splash.” For example, the PCS for “splash” is a picture of a whale’s tail splashing water, but in the “washing baby” play scenario, a baby and other animals were splashing – not a whale. Therefore, the whale’s tail was removed from the symbol so that the picture simply included water waves and droplets. In three cases, line drawings were created by the investigator to better reflect the actions, including “ride,” “brush,” and “chase.” For example, for the “playing with a farm” scenario, all of the agents were people and all of the objects were animals, so symbols for “ride” and “brush” were created that contained people (two-legged stick figures) who were riding and brushing animals (four-legged stick figures).

Representations for the child and researcher consisted of photographs of their faces. For “want,” “more,” and “allgone,” photographs of each child producing each sign were used as graphic representations of those concepts. All participants had previously been exposed to these signs through the teaching staff and/or their families.
Finally, a photograph of each child shaking his or her head “no” was used to represent “no.” The backgrounds of each photograph were erased to make each symbol more salient. Appendix C contains examples of the communication boards that were used for each play context.

As discussed previously, participants had to achieve at least 90% accuracy with identifying the target symbols before progressing to the baseline phase of the investigation (see Appendix B for specific instructions). Valerie and Timmy achieved over 90% accuracy on the symbols on their first trial and did not, therefore, need to be taught the symbols. Robyn achieved 71% accuracy and needed to be taught 12 symbols; she achieved 90% accuracy on the third trial. Nathan and Richard both achieved 76% accuracy on the first trial, with both achieving 93% accuracy on the third trial.

**Layout**

Separate communication boards were developed for each different activity for each individual child. For the preschoolers who had voice output systems with dynamic displays (Valerie and Timmy), the “pages” or boards were programmed into their systems. To maintain control over the amount of exposure to the displays, these pages were not linked to any of their other existing pages on their devices, and the children could not access them on their own. Nathan and Richard both used light tech non-electronic devices, and their new displays were created on paper. Robyn used a voice output system that utilized a static display – that is, each “page” on the electronic system
needed to be changed manually. Her new displays were also created on paper. Each child only had access to the displays during research sessions.

The displays allowed the investigator to provide aided AAC models with ease. The investigator presented the correct display at the beginning of each play session. Each page was organized in a grid layout of four columns and four rows using a Fitzgerald key (McDonald & Schultz, 1973); this system organizes symbols from left to right, following typical word order patterns, such as wh- questions, people, verbs, adjectives, prepositions, object nouns, etc. (Bruno, 1989). The arrays used for the present study were organized with agents, actions, and objects in columns from left to right, respectively. As none of the participants had visual or motor challenges that restricted the size and spacing of the symbols, similar arrays were used for all the participants, except for Robyn. Her electronic AAC device (an EasyTalk), required that each symbol fit within a 1.25 x .75 inch space. For the remaining participants, each symbol was approximately 1.75 x 1.75 inches, with approximately .5 inches between the symbols. Symbols for the children using light tech systems were placed on 8.5 x 11 inch paper and placed in protective sleeves. Background colors were used for each symbol type (Goossens' et al., 1995). The background colors were yellow for agents, green for actions, blue for objects, and pink for the remaining symbols (“more,” “alldone,” and “no”). Appendix C contains examples of five boards used for Valerie, Timmy, Nathan, and Richard (whose layouts were all identical) and two boards containing the layouts used for Robyn’s EasyTalk.
Voice Output versus Non-electronic Communication Boards

Three of the participants – Valerie, Timmy, and Robyn – used voice output devices to communicate, and Nathan and Richard used non-electronic light tech communication boards. There were similarities as well as differences between using a high tech and a light tech AAC system for aided AAC modeling. For both types of systems, the visual models were provided by the instructor by touching the target symbols (e.g., touching the symbols for “drink” and “tea”). One difference was that when models were provided via a voice output system, the system itself provided voice output to label each symbol, but with the picture-based communication boards, the symbols were labeled by the investigator. It is possible that spoken labels provided with one type of system may have been more or less effective than the other. (After selecting the two symbols, the investigator provided a spoken model – just like the spoken models provided during baseline – regardless of the type of system that was used.)

It is possible that the nature of the language learning process may differ, depending on the type of device. A child must have a partner actually look at a light tech system in order to communicate a message, but this is not true for high tech systems (Romski & Sevcik, 1996). Also, it has been argued that the consistent speech output provided on high tech AAC devices may facilitate learning and use of symbols (Brady, 2000; Paul, 1997). Alternatively, the speech intelligibility of voice output systems – even with recent improvements with speech synthesizers – is not as high as natural speech at the single word level (Mirenda & Beukelman, 1987, 1990). These differences may impact the acquisition of multi-symbol messages for children, depending on the
type of AAC device that they use. To control for these differences, three participants were selected who used high tech voice output systems (i.e., Valerie, Timmy, and Robyn) and were placed in the first cohort; for the second cohort, the two selected participants used light tech communication boards (i.e., Nathan, Richard).

It should also be noted, however, that there were differences even within the high tech cohort. Valerie and Timmy both used Mercury devices with synthesized speech (i.e., Microsoft Speech with Sapi 4®, for both Valerie and Timmy), but Robyn’s system (an EasyTalk) used digitized speech. The investigator’s voice was programmed onto the latter system for the voice output for each symbol. One further difference between the voice output systems was that the symbols on the EasyTalk were smaller than for the other children in order to fit the templates for the device.

**Procedures**

There were four to five phases in the investigation for each child: baseline, intervention, generalization to new play contexts without aided AAC models (GEN W/O), generalization to new play contexts with aided AAC models (GEN W/), and maintenance. Not all preschoolers completed the GEN W/ phase; for further details, see “Generalization with Models (GEN W/),” below. All of the play sessions took place in a quiet space in each participant’s home or school, whichever was preferred by their caregivers. All phases of the study were conducted by the primary researcher. Each session within each phase of the investigation lasted 15 minutes. Sessions took place between 1-4 times per week, depending on scheduling needs. At least one day passed
between any sessions within a given phase (e.g., two intervention sessions did not take place on the same day). Robyn, Richard, and Nathan all attended the same school, and Robyn and Richard attended the same classroom. The individual sessions for all three of these children took place within a quiet room separate from their classrooms. As no phase of the investigation took place within the classroom itself, experimental control was maintained for these three children. The specific procedures for each phase of the investigation follow.

**Baseline Phase**

Baseline measures were taken prior to the onset of the instructional phase in order to establish the participants’ current levels of functioning on the dependent measure. The only difference between the baseline and instructional phases was the introduction of the independent variable during intervention (Richards, Taylor, Ramasamy, & Richards, 1999), that is, the use of two-symbol aided AAC models. (See Table 2 for a summary of the procedures during each phase of the investigation.)

Current best practices for supporting communication with young children who use AAC were used during baseline, including providing the children with time to communicate, using expectant delays (i.e., pausing and looking expectantly at the child), and ensuring availability of appropriate vocabulary (e.g., Kent-Walsh, 2003; Light & Binger, 1998; Light, Binger, Agate, & Ramsey, 1999). The aided AAC systems were placed in front of the researcher facing the child at the beginning of every play session.
Table 2

*Summary of Procedures*

<table>
<thead>
<tr>
<th>Phase of Investigation</th>
<th>Baseline</th>
<th>Intervention</th>
<th>Generalization without Aided AAC Models</th>
<th>Generalization with Aided AAC Models</th>
<th>Maintenance</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Instructor sets up AAC device</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
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<tr>
<td>2. Instructor provides two models</td>
<td>Spoken model only</td>
<td>Aided AAC model + spoken model</td>
<td>Spoken model only</td>
<td>Aided AAC model + spoken model</td>
<td>Aided AAC model + spoken model</td>
</tr>
<tr>
<td>3. Instructor pauses</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>4. Instructor provides model</td>
<td>Spoken model only</td>
<td>Aided AAC model + spoken model</td>
<td>Spoken model only</td>
<td>Aided AAC model + spoken model</td>
<td>Aided AAC model + spoken model</td>
</tr>
<tr>
<td>5. Instructor provides expectant delay, if child says/does nothing</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>6. After child takes symbolic turn or completes action, instructor pauses</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>7. Instructor provides model</td>
<td>Spoken model only</td>
<td>Aided AAC model + spoken model</td>
<td>Spoken model only</td>
<td>Aided AAC model + spoken model</td>
<td>Aided AAC model + spoken model</td>
</tr>
<tr>
<td>8. Instructor pauses</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>9. Instructor provides expectant delay, if child says/does nothing</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>10. Instructor provides another model if child still does/says nothing</td>
<td>+</td>
<td>+</td>
<td>+</td>
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</tr>
</tbody>
</table>
The researcher provided spoken models (e.g., “Pig hit the truck!”, “More cookies!”) after the child’s communicative turn and/or after the child completed an action during play (Cafiero, 2001; Sevcik et al., 1995); the investigator waited a minimum of one second after these events before providing a spoken model to ensure the child’s turn was complete (Garvey & Beringer, 1981). Typical turn-transfer times within child-adult dyads are typically less than one second in length (Garvey & Beringer, 1981), and data on the turn-transfer times of the five participants during their language samples confirmed that this was true for each participant; the mean turn transfer times for each participant, taken over 10 turns, ranged from 0.2 to 0.5 seconds. The spoken models reflected the child’s communicative behaviors, including what the child looked at, pointed to, played with, and/or said (Siegel & Cress, 2002). Additionally, spoken models were provided after a child completed an action during play (Leonard et al., 1982). If a participant said or did nothing following the researcher’s presentation of a spoken model, the investigator provided an expectant delay (typical turn transfer time + 5 seconds) before providing another spoken model.

Each spoken model consisted of a brief utterance that was usually grammatically complete and that contained at least two of the vocabulary words included on the AAC system for that particular play scenario. For example, in the playing with vehicles scenario, if the child pointed to the car that the girl was driving to indicate that the child wanted the car to hit the bus, the researcher said, *The girl’s gonna hit the bus!* The investigator provided a minimum of 30 spoken models within each session.

Baseline data were taken for the two play scenarios that were selected for the intervention phase (Play Scenarios A) as well as the two scenarios selected for the
generalization phases (Play Scenarios B) for each participant. During each 15 minute baseline session, then, the child played with two sets of toys (i.e., either Play Scenarios A or B). Each of the two play scenarios were used for a minimum of 2 minutes and a maximum of 13 minutes during each session. Play scenarios were changed under two conditions: (a) when the child was not enjoying the play scenario, or (b) to ensure that both scenarios were used within the session.

Baseline probes were taken for a minimum of three sessions for each participant, for both Play Scenarios A and B, and continued until there was little variability in the data with no evident trend of increasing performance (McReynolds & Kearns, 1983). Minimum variability was operationally defined as a maximum variability of 3 multi-symbol messages between the highest and lowest data point. The development of multi-symbol messages is a process that takes place over a period of time with young children, and they exhibit some variability with their productions (Miller & Chapman, 1981). Therefore, it was important to allow for some flexibility with their productions during the baseline phase. Further, participants could not produce more than five multi-symbol messages per 15 minute session during baseline to remain in the investigation; as the purpose of the investigation was to help preschoolers begin to express multi-symbol messages, higher rates of production would indicate that a child was already acquiring this skill. All baseline sessions were videotaped; specifics regarding videotaping procedures are in the “Data Collection” section below. Please see Appendix E for specific baseline instructions.
Instructional Phase

Within each cohort, following the establishment of a stable baseline, the instructional phase of the investigation began with the first participant; the remaining participants remained in baseline (McReynolds & Kearns, 1983; Richards et al., 1999). The second participant entered the instructional phase as soon as a treatment effect was demonstrated for the first participant. Similarly, for the first cohort, the third participant remained in baseline until the second participant demonstrated a treatment effect. The treatment effect was defined as the highest baseline point plus five multi-symbol messages; for example, if a participant’s highest baseline point was three multi-symbol messages, a treatment effect would be demonstrated once she produced at least eight multi-symbol messages. An increase of five symbol combinations from the highest baseline level was chosen for the following reason: the highest number of symbol combinations permitted during baseline was five, so the minimum number of symbol combinations to yield a treatment effect was at least twice as many combinations as those produced in baseline.

During the instructional phase, the same guidelines were followed for providing pauses to allow participants opportunities to communicate and for providing spoken models (see “Baseline Phase” for specific procedures). However, during instruction, the researcher also provided aided AAC models (i.e., the independent variable for this study). At the beginning of each new play scenario, the researcher provided two aided AAC models to provide the child with immediate examples of how to produce multi-symbol messages. After the initial models, aided AAC models were provided each time
the child communicated, or when an action was completed. Specifically, the researcher (a) touched two-symbol combinations of key words on the child’s AAC system, and (b) labeled each of the two symbols; for the voice output systems, the speech synthesizer provided the label. The investigator then provided a spoken model that reflected the child’s communicative intent or the events taking place during play; these spoken models were the same as those provided at baseline. For example, in the playing with vehicles scenario, if a child with a light tech communication board pointed to the car that the girl was driving to indicate that he wanted the girl to hit the bus, the researcher would provide an aided AAC model by selecting the symbols GIRL and HIT while saying girl and hit. For a voice output system, the researcher would select the symbols for “Girl” and “hit” to activate the synthesized or digitized speech for these two symbols. In both cases, the investigator would then provide a spoken model (The girl’s gonna hit the bus!) like the spoken models provided during baseline. The only difference between baseline and intervention, then, was the provision of the two-symbol aided AAC models.

A minimum of 30 aided AAC models were provided within each session. See Appendix F for a sample intervention transcript. The investigator produced the following types of two-symbol semantic-syntactic relations using aided AAC models, according to the definitions provided in Retherford and colleagues (Retherford et al., 1981): agent + action, action + object, agent + object, experiencer + state, state + entity, experiencer + entity, possessor + entity, recurrent + X, and negative⁵ + X.

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⁵ Retherford and colleagues (1981) did not include negation in their coding scheme.
Each aided AAC model consisted of two symbols, as the goal for each child was to increase productions using aided AAC. Providing models in this manner helped ensure that instruction remained within the child’s “zone of proximal development” (Vygotsky, 1978) – that is, the level of potential development when supported by adult guidance. The two-symbol aided AAC model was not provided during baseline. Spoken grammatically complete models were provided during both the baseline and intervention phases. The aided AAC models provided during the intervention phase contained two elements that were not present during baseline: selection of the aided AAC symbols, and spoken labels for the aided AAC symbols.

Each intervention session lasted 15 minutes. The intervention phase continued for each participant until the child produced a minimum of 12 two-symbol messages during a 15-minute play session over three consecutive sessions. This criterion was established based on several factors. First, it was important to set the criterion high enough to indicate a clear increase from baseline levels. At the same time, moving from one- to multi-symbol messages is a process – that is, children gradually increase the number of multi-symbol messages that they produce (e.g., Bloom, 1973; Miller & Chapman, 1981), so it was important not to set the level too high. Also, allowances needed to be made in case any participants had motor impairments that slowed their ability to access their aided AAC systems. Based on these factors, the criterion was set at a moderate level of 12 multi-symbol messages within each 15 minute session. Please see Appendix E for the specifics regarding the content of the intervention phase.
Generalization Phases

Generalization probes were taken to determine whether the participants were able to generalize use of two-symbol messages to novel play scenarios under two conditions: (a) without the investigator continuing to provide the support of aided AAC models (GEN W/O), and (b) with the investigator providing aided AAC models (GEN W/). The remaining two play scenarios (out of the original four scenarios that were selected by the participants) were utilized for these phases (i.e., Play Scenarios “B”). The only time the preschoolers had used these play routines prior to this stage of the investigation was during the baseline phase.

Generalization Without Models (GEN W/O)

Two probes were taken for the GEN W/O phase for each participant. The procedures for GEN W/O were identical to the baseline phase; that is, only spoken models were provided. This phase provided information about whether or not the preschoolers continued to produce multi-symbol messages after they met criterion, once aided AAC models were no longer provided. If a participant did not produce at least 12 multi-symbol messages by the second GEN W/O session, he or she moved on to the GEN W/ condition. If a participant did produce at least 12 symbol combinations within at least one of the GEN W/O phases, the participant was not required to complete the GEN W/ phase.
Generalization With Models (GEN W/)

Two probes were taken for participants who completed the GEN W/ phase of the investigation. This phase of the investigation provided information regarding the participants’ ability to generalize productions of symbol combinations to new play scenarios with the ongoing support of aided AAC models. For this phase, the procedures for the intervention phase were followed. That is, the researcher played with the child, using the new play contexts, while providing aided AAC models. As with the other phases of the investigation, each generalization session lasted 15 minutes. All generalization probes were taken within a month after completion of the intervention.

Maintenance Phase

Maintenance probes were conducted two weeks, one month, and two months following completion of the generalization phase to determine if the participants continued to use two-symbol messages without ongoing instruction. The procedures for the maintenance phase were identical to those used during the intervention phase; that is, the same play scenarios were used, and the investigator provided aided AAC models. Measurements were taken on the main dependent variable, that is, the participants’ use of two-symbol messages. If any participant had used fewer than 12 multi-symbol messages for maintenance, additional “booster” sessions would have been implemented until the participant’s performance returned to criterion again; however, none of the participants who completed this phase of the investigation fell below the criterion.
**Procedural Reliability**

A procedural standard for each phase of the investigation was developed and is located in Appendix E. The researcher and a reliability coder were trained on all instructional procedures within the standard. Training continued until the researcher and coder reached 90% compliance with the standard, as measured by checks of each of the steps included for each phase of the investigation. To ensure procedural reliability, approximately 20% of the videotaped sessions for each participant were randomly selected and evaluated by the second coder. Procedural reliability forms are located in Appendix G. Procedural reliability was evaluated as follows: number of steps correctly implemented divided by the number of steps correct, incorrect, and omitted. If procedural reliability had fallen below 90% at any point, the researcher would have participated in additional instructional procedure training to restore procedural integrity. However, these training sessions were not necessary. The mean procedural reliability across intervention sessions was 93% (range = 91-100%), suggesting that the procedures were followed consistently.

**Measures**

**Dependent Measures**

The dependent variable for the proposed investigation was the frequency of multi-symbol messages produced by the participants during each 15-minute play period.
Collateral data were also collected on the number of different multi-symbol combinations (e.g., *FEED HORSE* vs. *FEED COW*) and the number of different semantic-syntactic categories within each multi-symbol message (e.g., agent vs. action vs. recurrence) expressed during each session as indicators of the diversity of the preschoolers’ productions. Operational definitions for these measures are located in the “Coding” section, below.

**Data Collection**

In order to complete data collection, each session was videotaped. The camcorder was mounted on a tripod and remained stationary throughout videotaping. It was placed in position at least two minutes before the start of every session, with the child in the room, to control for reactivity (Richards et al., 1999). The camcorder was positioned to provide a clear view of the participant, the AAC device, and the researcher. One of two seating arrangements was typically made, depending on the seating alternatives in the room, the positioning that maximized the child’s attention, and the child’s preference: (a) the child sat at a ninety degree angle from the researcher, with the AAC device in front of the researcher facing the child; (b) the child and researcher sat opposite each other, with the AAC device facing the child but at a slight angle for better viewing on the video recording.
Coding

Coding of the preschoolers’ behaviors was completed in two steps. For the first step, the investigator transcribed the video recordings of all sessions via repeated viewings of the videotapes. Both the participants and investigators’ behaviors were transcribed for each 15 minute session, using the operational definitions below. The following participant behaviors were recorded on each transcript: symbols expressed (spoken words, aided AAC, manual signs, or yes/no head nods/shakes), vocalizations (e.g., unintelligible speech sounds, laughing), and actions (e.g., pointing, reaching, giving). The following investigator behaviors were recorded: spoken words, aided AAC, expectant delays, and actions. In addition, the time between each symbol expressed by a participant (in tenths of a second) and the time between the end of a turn and the beginning of the investigator’s turn (in tenths of a second) was recorded. For the second step of the coding, the investigator reviewed the video recordings again, with reference to the completed transcripts, to record all multi-symbol messages, semantic-syntactic categories, and modes of communication that the participant produced. These data were recorded on a separate data collection sheet, which is located in Appendix H.

The operational definitions for symbols, multi-symbol messages, different multi-symbol messages, semantic-syntactic categories, and modes of communication follow, in addition to details regarding how multi-symbol messages were timed. The procedures and results of the data reliability measures follow the operational definitions below.
Definition of a Symbol

As symbols formed the basis of multi-symbol messages, it was essential to clearly define what constituted a symbol. When a participant produced any of the following behaviors, the child was given credit for producing a symbol: (a) pointing to a graphic symbol on the aided AAC device; (b) speaking a word that was consistently produced using the same phonemes that only referred to one concept (e.g., if a child said /ba/ for bus and baby, it did not count as a symbol) and that was recognized by a family member or a member of the teaching staff; (c) producing a manual sign that was consistently produced by using the same hand shapes and movement and was recognized by a family member or a member of the teaching staff; or (d) producing the conventional gestures for ‘yes’ (i.e., head nod) or ‘no’ (i.e., head shake).

Definition of a Multi-Symbol Message

Messages were counted as multi-symbol messages whenever a participant produced two or more symbols with no more than a one second pause between each symbol. In order to establish boundaries for multi-syllable utterances, message boundaries needed to be defined. Establishing message boundaries is challenging with individuals who use aided AAC (Bedrosian, 1997; Smith, 1996; Soto, 1999). With spoken language, utterance boundaries may be defined by pauses, rising or falling intonation, or changes in speakers (e.g., Garvey & Beringer, 1981; Miller, 1981). While issues pertaining to turn boundaries often have been discussed in the AAC literature (e.g., Buzolich, 1984; Clarke & Kirton, 2003; Light et al., 1985a), issues pertaining to
message (or utterance) boundaries have been discussed less frequently. Smith (1996) provided one thoughtful exception (although it should be noted that this researcher used the terms utterance [i.e., message] and turn boundaries interchangeably). She analyzed the data of typically developing preschoolers (aged 3;5-4;7) who used graphic symbols for research purposes by defining message boundaries using two separate sets of operational definitions. She first analyzed the data according to speaker-listener changes; a message was counted as complete even when the partner simply labeled the child’s aided AAC selection. Using this analysis, nearly all of the aided messages that the children produced (83%) consisted of single graphic symbols. Smith then analyzed the data according to the following criteria: (a) terminal falling pitch, when spoken language was used; (b) gaze, when pitch was not sufficient or no speech was produced; and (c) body movement (i.e., removing the communication board from the immediate area). Using these revised criteria, only 49% of the children’s messages were single symbols. Analyses of the length of messages when children use aided AAC, then, can be impacted greatly depending on how message boundaries are defined.

For the purposes of this initial investigation, no distinction was made between message and turn boundaries. Although Smith (1996) also defined message and turn boundaries in the same manner, Smith’s criteria were not used for the current investigation. As discussed above, Smith first defined message boundaries by changes in the speaker; however, this definition presented several problems. If the partner taking the floor indicates the end of a message for the child, the partner may prevent the child from fully completing his message. Further, it was essential that the partner providing labels for the child’s symbol selections did not indicate the end of a message. This was
important for two reasons. For the children who used voice output systems in this investigation, the speech synthesizer labeled each symbol as the children made their selections. To maintain consistency across cohorts, the investigator needed to provide spoken labels for the children using light tech communication boards. Also, pilot data indicated that children sometimes waited for the investigator to label their selections (seemingly to confirm that the investigator had noted their selection) before selecting a second symbol; similar patterns were noted in Smith (1996). Defining message boundaries according to Smith’s (1996) second set of criteria also would have been problematic – that is, by relying on pitch, gaze, and body movement. Pitch markers, obviously, can only be used when the child relies on vocalizations to communicate, and the children in the current investigation had very little comprehensible speech. With respect to gaze, Smith noted that this was a problematic marker, as the children in her investigation frequently looked up from their communication boards for clarification of their selections, even though they may not have truly completed their message. Smith only relied on body movements to indicate that a message was complete on the relatively rare occasions when the child actually moved the AAC system away, which clearly could not be used as the only marker of message completion (nor is this a desirable behavior to encourage). Therefore, definitions of turn boundaries for children who use AAC were also examined.

In a study involving 12 children (aged 7-16) with physical disabilities who used AAC, Clarke and Kirton (2003) used two second pauses supported by the presence of the following behaviors to mark the end of a turn: pitch movement, nonverbal signals such as eye contact, the listener taking a turn, and the child coming to rest. For the
reasons discussed above, pitch movement, eye contact, and changes in speakers would have been problematic for the current investigation – at least, if these markers were used in isolation. Also, pilot data revealed that pausing for two seconds or more was often problematic, as the children frequently shifted their focus of attention back to the toys – and often, to engaging in new actions with the toys – immediately after taking a turn. This was particularly problematic because the aided AAC models were to reflect the child’s prior message or actions. Once the child’s attention had switched to a new action, the investigator’s aided AAC model would have been irrelevant to the child and would have required further shifts in the child’s attention, when joint attentional demands were already high (Cress, 2002). In their study involving young children who used AAC (aged 4;5-6;11), Light and colleagues (Light et al., 1985a) defined turn boundaries as a pause of at least one second. These authors successfully used this criterion to analyze interactions between caregivers and the participants. The turn-transfer data taken during language samples of the participants in the current investigation suggested that a one second pause would be sufficient for marking the end of a turn; their mean turn transfer times ranged from 0.2-0.5 seconds. Thus, a pause of one second or more was used to mark the end of the child’s message as well as the end of the child’s turn. Whenever the child produced two or more symbols within one second of each other, then, these messages were counted as multi-symbol messages.

To promote data reliability, operational definitions for marking the end of each type of symbol (spoken word, aided AAC symbol, etc.) and the end of each message were defined. The end of each symbol was defined as follows: (a) spoken word – the child ceased vocalization; (b) aided AAC device – the child lifted his/her finger off and
away from the AAC device; (c) manual sign – the child ceased final movement of the
sign; and (d) yes/no head nod/shake – the child ceased final movement of the symbolic
gesture (i.e., end of head nod/shake), with the head coming to rest.

A one-second pause or longer marked the end of a message. The timer for
determining if a second had passed or not began after each of the following conditions:
(a) the end of a spoken word, sign, or gesture; and (b) the end of an aided AAC
selection, if the child subsequently pulled his hand away from the device. (If the child’s
hand hovered over the device, this indicated that the child had not completed the
message.)

The timer ended at the onset of the child’s next symbol production, which was
defined as follows: (a) spoken word – the child began vocalization; (b) aided AAC
device – the child began directing a finger toward the AAC device; (c) manual sign – the
child began initial movement of the sign; and (d) yes/no head nod/shake – the child
began initial movement of the symbolic gesture (i.e., beginning of head nod/shake).

The frequency of multi-symbol messages produced by the participants during
each 15-minute play period was calculated. All multi-symbol messages during the 15-
minute play periods were counted toward the dependent measure, regardless of the mode
of communication (e.g., 2 graphic symbols, 1 graphic symbol + 1 sign, 1 graphic symbol
+ 1 symbolic gesture, etc.).
Definition of Different Multi-Symbol Messages

To examine the diversity of the preschoolers’ messages, two different measures were taken. First, the number of different multi-symbol combinations within each session was calculated. As a second, broader measure of diversity, the ratio of the total number of different symbol combinations (across all sessions) to the total number of symbol combinations (across all sessions) was calculated, which functioned as a modified version of a type token ratio (Miller, 1981). The following rules were used to define different multi-symbol messages: (a) symbols were analyzed only for content and not for mode; for example, ‘no’ (head shake) + BUS (light tech graphic symbol) versus NO BUS (two light tech graphic symbols) was only counted once; (b) symbols produced in immediate succession were counted only once (e.g., CHASE BUS versus CHASE CHASE BUS was counted only once); and (c) if symbol combinations differed only in their word order (e.g., CHASE BUS versus BUS CHASE), they were counted as two different combinations, as these combinations have two different meanings. There was one exception to this last rule: if symbol combinations including the concepts “yes” or “no” differed only in their word order (e.g., NO BUS versus BUS NO), they were only counted once. This exception was made because head nods and head shakes sometimes overlapped with other symbols and could not be clearly placed within a certain order within a message. Further, changes in word order with affirmations and negations do not typically mark a difference in underlying meaning (Brown, 1973).
Definitions of Semantic-Syntactic Categories

Several measurements were taken to determine the semantic-syntactic diversity of the participants’ productions, including the number of different semantic-syntactic categories produced within multi-symbol messages during each session, the presence of various early two-term semantic relations, and adherence to word order rules. In order to calculate the number of different semantic-syntactic categories expressed within each multi-symbol message during each session, the operational definitions developed by Retherford and colleagues (Retherford et al., 1981) were utilized. This is a commonly used composite coding scheme derived from the work of several other researchers (Bloom, 1973; Brown, 1973; Greenfield, Smith, & Lauger, 1976; Schlesinger, 1971, 1974) and includes 15 semantic roles in addition to 5 grammatically defined categories (see Table 3 for operational definitions). Two additional semantic relations also were coded: affirmations (i.e., concurrence expressed via any mode of communication, including head nod) and social conventions, including various forms of “hello” (e.g., hello, hi) and “good-bye” (e.g., bye, bye-bye). Typically, each symbol within each multi-symbol message was assigned to one semantic-syntactic category. (It was also possible for more than one symbol to be assigned to a single category; for example, if a child had said tiger in house to describe the location of the tiger, tiger would have been coded as “entity,” and in house would have been coded as “locative.”) Once all semantic-syntactic categories within each multi-symbol message were coded for a given session, a tally of the number of different semantic-syntactic categories the child expressed during
Table 3

*Operational definitions for semantic-syntactic categories (Retherford et al., 1981)*

<table>
<thead>
<tr>
<th>Semantic Categories</th>
<th>Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Action</td>
<td>A perceivable movement or activity engage in by an agent (animate or inanimate)</td>
</tr>
<tr>
<td>Locative</td>
<td>The place where an object or action was located or towards which it moved</td>
</tr>
<tr>
<td>Agent</td>
<td>The performer (animate or inanimate) of an action. Body parts and vehicles, when used in conjunction with action verbs, were coded AGENT.</td>
</tr>
<tr>
<td>Object</td>
<td>A person or thing (marked by the use of a noun or pronoun) that received the force of an action</td>
</tr>
<tr>
<td>Demonstrative</td>
<td>The use of demonstrative pronouns or adjectives, <em>this, that, these, those</em> and the words <em>there, right there, here, see</em>, when stated for the purpose of pointing out a particular referent</td>
</tr>
<tr>
<td>Recurrence</td>
<td>A request for or comment on an additional instance or amount; the resumption of an event; or the reappearance of a person or object</td>
</tr>
<tr>
<td>Possessor</td>
<td>A person or thing (marked by the use of a proper noun or pronoun) that an object was associated with or to which it belonged, at least temporarily</td>
</tr>
<tr>
<td>Quantifier</td>
<td>A modifier which indicated amount or number of a person or object. Pre-articles and indefinite pronouns such as <em>a piece of, lots of, any, every, and each</em> were included.</td>
</tr>
<tr>
<td>Experiencer</td>
<td>Someone or something that underwent a given experience or mental state. Body parts, when used in conjunction with state verbs, were coded EXPERIENCER</td>
</tr>
<tr>
<td>Recipient</td>
<td>One who received or was named as the recipient of an OBJECT (person or thing) from another</td>
</tr>
<tr>
<td>Beneficiary</td>
<td>One who benefited from or was named as the beneficiary of a specified action</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Syntactic Categories</th>
<th>Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entity (One-term)</td>
<td>Any labeling of the present person or object regardless of the occurrence or nature of action being performed on or by it</td>
</tr>
</tbody>
</table>
**Entity (Multi-term)**

The use of an appropriate label for a person or object in the absence of any action on it (with the exception of showing, pointing, touching, or grasping); or someone or something which caused or was the stimulus to the internal state specified by a state verb, or any object of person which was modified by a possessive form (ENTITY was used to code a possession if it met either of the preceding criteria)

**Negation**

The expression of any of the following meanings with regard to someone or something, or an action or state: non-existence, rejection, cessation, denial, disappearance

**Attribute**

An adjectival description of the size, shape, or quality of an object or person; also, noun adjuncts which modified nouns for a similar purpose (e.g., gingerbread man). Excluded were the semantically coded categories RECURRENCE and QUANTIFIER.

**Adverbial**

Included in this category were the two subcategories of action/attribute and state/attribute

**Action/Attribute**

A modifier or an action indicating time, manner, duration, distance, or frequency (Direction or place of action was separately coded as LOCATIVE, repetition as RECURRENCE)

**State/Attribute**

A modifier indicating time, manner, quality, or intensity of a state

that session was calculated. For example, if a participant produced at least one agent, action, object, locative, and negation within the multi-symbol messages during one 15minute session, the child was given credit for producing 5 different semantic-syntactic categories for that session.

The presence of various early two-term semantic relations was also calculated (Bloom, 1973; Brown, 1973; Schlesinger, 1971). If a child produced a given two-term relation at any point during the investigation (e.g., agent + action, possessor + possession), the child was given credit for producing that relation. Participants were given credit for producing these relations regardless of the order in which they were produced, in concurrence with Brown’s coding techniques (1973). Further, participants
were given credit for these multi-term relations whether or not they produced these relations in isolation or in combination with other semantic or syntactic categories (Braine, 1976). For example, if a participant produced a “negation + agent + action” combination, she was given credit for producing both “negation + X” and “agent + action.”

Finally, an analysis of adherence to word order rules was calculated for several common semantic relations, including agent + action, action + object, agent + object, agent + action + object, entity + locative, and possessor + possession. Each multi-symbol message containing these semantic-syntactic categories was coded for its adherence to proper word order rules. For example, if a child produced \textit{WASH ARM} to indicate that she wanted the investigator to wash the baby’s arm, the message was coded as an action + object production, and the child was given credit for producing one action + object message using the correct word order. However, if the child produced \textit{ARM WASH} within the same context, the message was coded as having an incorrect word order for an action + object production.

\textit{Definitions for Various Modes of Communication}

Data pertaining to the various modes of communication that the preschoolers produced during the investigation were also collected. Specifically, data were collected on the modes that the children used to produce their multi-symbol messages, including aided AAC, manual signs, speech, and yes/no head nods/shakes. Children were given
credit for selecting symbols according to the definitions in the “Definition of Symbol” section above.

Data Reliability

Reliability was calculated for the transcripts and also for the data. Approximately ten percent of the sessions for each participant were randomly selected and transcribed. A trained coder independently generated transcripts while repeatedly viewing the videotapes. The coder followed the operational definitions above. For child behaviors, agreement for the following behaviors was calculated: spoken words, aided AAC symbols, manual signs, head nods, head shakes, vocalizations, and actions (e.g., pointing, reaching). For investigator behaviors, agreement was calculated on the following behaviors: spoken utterances, aided AAC messages, expectant delays, and actions. Agreement was calculated by dividing the number of agreements by the total number of agreements, disagreements, and omissions. The mean reliability score for each participant was as follows: Valerie = 83% (range = 79%-88%); Timmy = 91% (range = 87%-94%); Robyn = 88% (range = 80%-92%); Nathan = 82% (range = 80%-90%); and Richard = 85% (range = 80%-91%). For investigator behaviors across all participants, the mean reliability was 99% (range = 97%-100% across participants). These results suggest adequate reliability for the transcripts. The samples selected for reliability measurements were re-examined by the coders, and the discrepancies were discussed until a consensus was reached. The transcripts were then corrected to reflect these decisions.
In order to determine the reliability of the timing data, Pearson correlation coefficients were calculated between the investigator and the coder for two sets of time measurements: (a) the time between the symbols that the participants produced (to one-tenth of a second), and (b) the pauses that the investigator provided after a child’s turn before providing an aided AAC model (to one-tenth of a second). There were very strong significant correlations between the coders for both the time between symbols that the participants produced ($r = .97, p < .01$) and the pauses that the investigator provided ($r = .92, p < .01$), suggesting that the data were reliable.

Point-by-point inter-rater agreement was calculated for the following participant behaviors for the 15 minute sessions: frequency of multi-symbol messages, different multi-symbol messages expressed within sessions, semantic-syntactic categories expressed within multi-symbol messages, and modes of communication used for expressing multi-symbol messages. A trained coder analyzed approximately 10% of the sessions for each participant. Both the investigator and the coder collected data on the behaviors listed above by reviewing the videotapes while examining the transcripts that were created by the investigator. The investigator and coder began each coding session with a copy of the blank data collection form that is located in Appendix H. To ensure that the two coders were observing the same symbol combinations, both the investigator and the coder wrote down the counter number for the onset of each symbol combination on the data collection forms. Once the investigator and coder separately collected the pertinent data, inter-rater agreement was calculated on each measurement listed above by dividing the number of agreements by the total number of agreements, disagreements, and omissions. The mean reliability score was 95% (range = 79% to
100% across participants) for the frequency of multi-symbol messages, 95% (range = 75% to 100% across participants) for different multi-symbol messages expressed within 15 minute sessions, 86% (range = 79% to 100% across participants) for the semantic-syntactic categories expressed within multi-symbol messages, and 95% (range = 79%-100%) for the modes of communication used for expressing multi-symbol messages. These results suggest accurate recording of the data.

**Data Analyses**

The data were graphed and visually inspected for changes in the trend, slope, and level of the data (Kazdin, 1982; McReynolds & Kearns, 1983). The trend analyses compared the direction of the dependent variable before versus after the implementation of the intervention, with the analyses of slope indicating the strength of the trend (McReynolds & Kearns, 1983). Inspection of the level compared the overall relative increase (or decrease) of the data points before and after intervention began (McReynolds & Kearns, 1983). The percentage of non-overlapping data points across phases was also calculated (Kazdin, 1982), that is, the percentage of points during the intervention phase that exceeded the highest data point during the baseline phase.

**Social Validation**

The social validity of the results was assessed to ensure the real-life functionality of the intervention (Schlosser, 1999). For children who received intervention at their
school, the child’s lead classroom teacher and speech-language pathologist completed the social validation measures; for those who received services in their home, the child’s caregiver and speech-language pathologist completed these measures. For the first measure, the adults viewed five minute segments from two videotapes of their child or student, including one tape from baseline and one tape after instruction was complete. All video clips included segments during periods when the child was actively engaged with the investigator and the play scenarios (i.e., not attending to extraneous events such as someone coming into the room). All video clips showed the child playing with only one play scenario. Within these parameters, the video segments were randomly selected.

Although the viewers knew of the goals of the study, as they had been briefed on the child’s progress throughout the investigation, they were blind to the status of the videotapes – that is, which of the tapes were pre- versus post-instruction. After viewing the videotapes (one baseline and one post-instruction), they answered two forced-choice questions: (1) In which tape do you think your child/student used better language skills?, and (2) In which tape do you think your child/student communicated more effectively? They were also asked to explain why they chose the tape they selected. The percentage of observers who selected the post-instruction tape for each question was calculated. Questionnaires are located in Appendix I.

After instruction was complete, the investigator completed informal interviews with the child’s caregiver (for children seen in the home), classroom teacher (for children seen at school) and speech-language pathologist (for all children) to determine their perceptions of the strengths of the intervention. Specifically, the adults were asked what they liked best about the intervention, what suggestions they had for improving the
intervention, and whether or not they would choose to allow their child or student to participate in the study again.
CHAPTER 3

Results

Data are presented for the voice output cohort first (Valerie, Timmy, and Robyn), followed by the communication board cohort (Nathan and Richard). The following data pertaining to the participants are presented below: (a) acquisition, generalization, and maintenance of multi-symbol messages, (b) productions of different multi-symbol messages; (c) use of various semantic-syntactic constructions; (d) modes of communication; and (e) social validation measures.

Voice Output Cohort

Production of Multi-Symbol Messages

Acquisition of Multi-Symbol Messages

The number of multi-symbol messages that Valerie, Timmy, and Robyn produced is located in Figure 1. Both Valerie and Timmy successfully met criterion (i.e., at least 12 symbol combinations within three consecutive 15 minutes sessions). At baseline, Valerie produced between three and five multi-symbol messages in each session and Timmy produced one to four multi-symbol messages per session. As
Figure 1. Number of Multi-Symbol Messages within 15 Minute Play Sessions: Voice Output Cohort

Valerie
- Baseline
- Intervention
- Generalization w/o Models
- Maintenance

Rate of Multi-Symbol Message Productions within 15 Minute Sessions

Set A Play Scenarios
Set B Play Scenarios
2nd Intervention (Robyn only)
3rd Intervention (Robyn only)

Timmy

Robyn

Intervention 2
Intervention 3

Session
evidenced in Figure 1, both Valerie and Timmy readily began expressing two-symbol messages after the onset of instruction. Valerie met the criterion after only three intervention sessions, with Timmy requiring a total of five intervention sessions to meet criterion. Both Valerie and Timmy demonstrated 100% non-overlapping data with baseline; further, they both demonstrated impressive totals immediately after intervention began (i.e., 13 and 18 multi-symbol combinations, respectively). It should also be noted that Valerie’s data showed an ascending trend in the baseline just before she began the intervention phase; ideally, baseline levels should show no trend or a trend in the direction opposite of the trend that is predicted to occur once the intervention phase begins (Kazdin, 1982). However, the fact that Valerie demonstrated a marked increase in her multi-symbol productions during the first intervention session – yielding a marked increase in the slope of her data – indicates that the changes in her performance can probably be attributed to the introduction of aided AAC models and not to other extraneous factors (Kazdin, 1982).

Unlike Valerie and Timmy, Robyn did not meet criterion. At baseline, Robyn produced zero to two symbol combinations per session; after completion of 21 intervention sessions, she did not meet criterion. Robyn’s productions of multi-symbol messages during intervention exceeded baseline levels for the majority of the sessions; the percentage of non-overlapping data was 81%. One of the overlapping data points was the very first intervention session; the remaining three took place within the last four intervention sessions. Robyn’s performance suggested some changes in the means across phases (Kazdin, 1982). She produced an average of 0.7 symbol combinations during the baseline phase and an average of 4.0 during the first intervention phase,
suggesting some increase in production of multi-symbol messages. However, no sustained learning curve is evident in her performance.

Because Robyn did not meet criterion, changes were made to the intervention once her performance returned to baseline levels for two consecutive sessions (Sessions 27 and 28 in Figure 1). Based on observations, it was hypothesized that Robyn’s performance might have been affected by boredom with the play routines, boredom with the types of play routines, and frustrations with using the EasyTalk. Therefore, a second intervention phase was introduced (see Figure 1). The following changes were made during the second intervention phase: (a) providing Robyn with a selection of eight new play routines; (b) including a variety of craft activities and one figurine assembly activity (Mrs. PotatoHead) instead of dramatic play routines; and (c) switching from the use of her high tech voice output device, the “EasyTalk,” to light tech communication boards like those used by Nathan and Richard. New play routines were used as Robyn appeared bored with using the same play items during each session; for example, she often said no, put her head on the table, or lay down on the floor when the toys were brought out. Craft activities were chosen instead of dramatic play routines for several reasons. First, informal observations in the classroom indicated that Robyn sometimes used symbol combinations in the classroom while playing with craft activities. Also, unlike dramatic play, many craft activities require help from an adult (e.g., opening the Play-Doh container, drawing a particular animal) and it was thought that presenting such activities might motivate Robyn to communicate more with the investigator while engaging in play. Craft activities included tracing shapes from cut-out sponges, using stickers to make faces on balloons, putting paper dolls together, putting paper flowers
together, drawing animals on a “Doodleboard,” making figures with Play-Doh, and creating animals out of foam cut-outs. Playing with Mrs. PotatoHead was also offered as an option. Light tech communication boards were used instead of the EasyTalk for two reasons. First, light tech boards were more readily available in the classroom and Robyn had had more exposure to them prior to the onset of the investigation. Second, the communication boards allowed the use of larger symbols. The space available for the symbols on the EasyTalk was very small – and therefore the symbols were very small (i.e., 1.25 x .75 inch space). Using larger symbols may have been a more attractive option for Robyn.

If the source of Robyn’s difficulties had been due to the variables changed during this phase, it was anticipated that her performance would have improved. However, Robyn did not show consistent improvements in her production of symbol combinations. The number of multi-symbol messages she produced during this phase of the investigation was 4, 10, 3, and 3. Although the second data point in this phase represented the most multi-symbol messages she had produced in any session, her performance in the following two sessions was just above baseline levels. Her mean level of productions during this phase was 5.0 multi-symbol messages.

A final, third intervention phase was introduced in which multimodal models, instead of only aided AAC models, were provided; that is, models were provided via both picture communication boards and manual signs. Robyn had been exposed to manual signs both in her classroom and at home, and observations indicated that at times, she produced signs both imitatively and spontaneously. However, her performance did not increase significantly during this phase, compared with her
performance in the other intervention phases. She produced between three and six multi-symbol messages during each of these four sessions, with a mean of 4.5 symbol combinations. Intervention was terminated after the fourth data collection point in this phase as she had not demonstrated improvements in her performance with the dependent variable. Further, the last intervention session took place on the last day of summer school, so intervention sessions could no longer take place at Robyn’s school.

An analysis to determine the total number of symbolic messages that Robyn produced during each phase was also completed (see Figure 2). All messages consisting of at least one symbol, adhering to the definition of a symbol provided in Chapter 2, were included in this analysis, with two exceptions: affirmations (Okay, head nod, etc.) and negations (No, head shake, etc.) were excluded. An initial analysis revealed that

Figure 2. Robyn’s Rate of Symbolic Message Production within Each 15 Minute Session*

*Excludes turns that consisted only of affirmations and/or negations; dashed lines indicate average rate of performance within each phase. Dashed lines indicate the mean for the phase.
79% of Robyn’s symbolic turns consisted of affirmations and/or negations, which falsely inflated the number of symbolic messages that she produced. The analysis of Robyn’s symbolic messages revealed variability with her performance, and was, on the whole, quite low. Excluding messages that consisted only of affirmations and/or negations, Robyn produced an average of 8 symbolic messages during baseline (range = 3-19), 8 messages during Intervention Phase #1 (range = 1-15), 7 messages during Intervention Phase #2 (range = 4-12), and 19 messages during Intervention Phase #3 (range = 13-27). Although Robyn’s mean rate of symbolic productions increased during the third intervention phase (i.e., mean = 19 messages), the instability of her data during the baseline phase makes it difficult to draw any conclusions regarding improvements in her performance. Other factors also warrant caution with interpreting the results. First, the percent of non-overlapping data between Intervention Phase #3 and baseline was only 25%. Second, a decreasing trend was apparent at the end of Intervention Phase #3. Finally, no baseline data were taken for the interventions utilized in Intervention Phases #2 and #3, so there was no experimental control for these phases. The changes in means, then, suggest that using multimodal AAC models may have had some impact on Robyn’s rate of symbolic productions, but caution must be taken in interpreting the results.

Overall, Robyn’s data indicated that she (a) did not meet criterion; (b) demonstrated a modest shift in the means (mean gain = 3.3 symbol combinations) across the baseline phase and Intervention Phase #1, although performance returned to baseline levels during the last few sessions; (c) did not demonstrate a learning curve with the dependent variable throughout the course of intervention (i.e., there was no increase in
slop over time); (d) did not demonstrate notable increases with the dependent variable between the first intervention phase and the subsequent two intervention phases; and (e) demonstrated variability across sessions.

In summary, two of the three participants in the voice output cohort (Valerie and Timmy) acquired learned to express multi-symbol utterances following the aided AAC modeling intervention, while a third participant (Robyn) did not.

**Generalization**

Generalization to New Play Routines Without Aided AAC Modeling (GEN W/)

During this phase of the investigation, the preschoolers played with toys from two play scenarios (“Set B”) that were different from the two scenarios used during the intervention phase (“Set A”). No aided AAC models were provided during this phase; conditions were identical to baseline conditions. At baseline, Valerie produced between 4 and 5 symbol combinations with the Set B toys during each 15 minute session; during the generalization phase following intervention, she produced 16 and 18 symbol combinations, respectively. Timmy produced between 1 and 2 symbol combinations with these play routines at baseline. During the generalization phase, he produced 17 and 23 combinations, respectively. These date indicate that both Valerie and Timmy (a) generalized production of multi-symbol messages to new play routines, and (b) did not require aided AAC models to produce multi-symbol messages with these play scenarios.
Both Valerie and Timmy met criterion during the GEN W/ phase and therefore did not participate in the GEN W/O phase. Robyn did not complete the generalization phase of the investigation, as she did not successfully complete the intervention phase.

**Maintenance**

Maintenance data were collected 2, 4, and 8 weeks following completion of the generalization phase. Both Valerie and Timmy maintained acceptable levels of multi-symbol productions during the maintenance phase. Valerie’s performance dropped from 18 to 12 symbol combinations from the second to the third maintenance session; however, her performance was still at criterion level. Timmy’s performance continued at high levels; in the three maintenance sessions, he produced 24, 24, and 27 multi-symbol messages, respectively. No maintenance data were taken for Robyn, as she failed to meet criterion during the intervention phase.

**Different Multi-Symbol Messages**

Collateral data were collected on the number of different multi-symbol messages that the participants produced during each session as a measure of the diversity of their messages. The number of different multi-symbol combinations that Valerie, Timmy, and Robyn produced during each session is located in Figure 3. Valerie and Timmy demonstrated clear increases in their productions of different two-symbol combinations during the post-baseline phases of the investigation. At baseline, Valerie produced a
Figure 3. Number of Different Multi-Symbol Messages within 15 Minute Play Sessions: Voice Output Cohort
maximum of 5 different combinations, and in the intervention sessions, she produced between 7 and 14 different combinations (100% non-overlapping data with baseline). With the exception of the last data point during the intervention phase, the data across all phases for this measure tended to mirror Valerie’s overall productions of symbol combinations, albeit at somewhat lower rates. Data were also collected on the ratio of the number of different symbol combinations across all sessions compared with the total number of symbol combinations across all sessions (see Table 4). The higher the ratio, the greater the diversity; a ratio of 1.0 would indicate that a child never produced the same multi-symbol message twice throughout the course of the investigation; conversely, a ratio of 0.1 would indicate that a child frequently produced the same symbol combinations (i.e., only 1 in 10 symbol combinations had not been produced previously). Valerie demonstrated a relatively high degree of diversity with this measure, with a ratio of 0.67.

Timmy produced between 1 and 4 different multi-symbol messages during baseline sessions and between 9 and 27 during the intervention phase; there were no overlapping data points with baseline. His data on this measure tended to follow the same trend lines as his data for his productions of all multi-symbol messages in Figure 1, indicating that in sessions when he was producing more overall symbol combinations, he was also producing many different combinations. Timmy repeated symbol combinations infrequently; his ratio of different multi-symbol combinations compared with his total symbol combinations was 0.78 (see Table 4). Timmy, like Valerie, demonstrated the ability to generate many different symbol combinations.
Table 4

*Ratio of Different Multi-Symbol Messages to Total Multi-Symbol Messages across All Sessions: Voice Output Cohort*

<table>
<thead>
<tr>
<th>Name</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valerie</td>
<td>0.67</td>
</tr>
<tr>
<td>Timmy</td>
<td>0.78</td>
</tr>
<tr>
<td>Robyn</td>
<td>0.73</td>
</tr>
</tbody>
</table>

Robyn produced between zero and two different combinations during the baseline phase, and between one and eight during Intervention Phase #1. Her data indicate variability in her rates of different symbol combination productions throughout the intervention phases. The majority of her data in the first intervention phase (81%) were non-overlapping with the baseline phase, indicating an overall improvement in the diversity of her messages; however, it should be noted that three of the four overlapping data points occurred at the end of the first intervention phase. The ratio of different symbol combinations to total symbol combinations was 0.73, indicating that there was diversity across sessions with her productions of multi-symbol messages.

**Semantic-Syntactic Categories**

Collateral data were collected on the semantic-syntactic categories that the participants produced during the investigation as additional measures of the diversity of their messages. Results are presented below, for the voice output cohort, pertaining to
(a) the number of different semantic-syntactic categories that the participants produced within multi-symbol messages within each session, (b) the presence of various early two-term semantic relations, and (c) adherence to word order rules.

The number of different semantic-syntactic categories that Valerie, Timmy, and Robyn produced during each session is located in Figure 4. At baseline, Valerie produced between 5 and 7 different semantic-syntactic categories (e.g., agent, action, recurrence); during the intervention phase, she produced between 4 and 12. She demonstrated 50% non-overlapping data with the baseline phase. She produced a range of different semantic-syntactic categories (listed in Table 5) within her multi-symbol messages during the investigation; it should be noted that Valerie (as well as the other four participants) may have produced other semantic-syntactic categories within single symbol messages; these were not coded for the analyses in the current investigation.

Valerie used correct word order for most of her productions (see Table 6), with the exception of agent + action + object constructions; this structure was never modeled for her via aided AAC, as all aided AAC models consisted of only two aided symbols. She produced very few agent + object and entity + locative constructions, and no firm conclusions regarding Valerie’s word order with these structures can be made.

Timmy produced between 1 and 4 different semantic-syntactic categories in his baseline sessions, and between 6 and 10 during the intervention phase; there were no overlapping points with the baseline phase. Timmy produced all of the semantic-syntactic combinations listed in Table 5, with the exception of demonstrative + entity; he did not have access to any aided AAC symbols that would have allowed him to produce this structure. Timmy’s word order data (see Table 6) revealed that he had
Figure 4. Number of Different Semantic-Syntactic Categories Expressed per Session out of 18 Possible Categories within Multi-Symbol Messages: Voice Output Cohort

Valerie
- Baseline
- Intervention
- Generalization w/o Models
- Maintenance

Timmy
- Set A Play Scenarios
- Set B Play Scenarios
- 2nd Intervention (Robyn only)
- 3rd Intervention (Robyn only)

Robyn

Session
Table 5

*Presence of Brown's Minimal Two-Term Semantic Relations: Voice Output Cohort*

<table>
<thead>
<tr>
<th>Construction</th>
<th>Valerie</th>
<th>Timmy</th>
<th>Robyn</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agent + action&lt;sup&gt;a&lt;/sup&gt;</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Action + object&lt;sup&gt;a&lt;/sup&gt;</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Agent + object&lt;sup&gt;a&lt;/sup&gt;</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Action + locative</td>
<td>-</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Entity + locative</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Possessor + possession</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Attributive + entity&lt;sup&gt;b&lt;/sup&gt;</td>
<td>+</td>
<td>+</td>
<td>-&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>Recurrent + X</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Demonstrative + entity&lt;sup&gt;b&lt;/sup&gt;</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Negative + X</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

<sup>a</sup>Experiencer + State + Entity combinations (e.g., “I want truck”), as defined by Retherford and colleagues (Retherford et al., 1981), are included in this data.

<sup>b</sup>Participants did not have access to any attributive or demonstrative words on their aided AAC boards/devices.

<sup>c</sup>Robyn did express attributes within other constructions, including Negation + Attribute (“No hot”) and Affirmation + Attributive (“Yes hot”).

difficulties in this area. Specifically, the accuracy of his productions of action + object, agent + object, and agent + action + object structures occurred at approximately chance levels. The fact that Timmy also frequently produced additional relations within his multi-symbol productions, such as negation, recurrence, locative, and recipient, should also be noted. In approximately 57% of his incorrect productions for various agent + action + object combinations, Timmy was also attempting to include at least one additional semantic relation (e.g., agent + action + object + recipient). Therefore, an
Table 6

*Percent Correct and Number of Correct Messages in Word Order for Selected Semantic Relation Combinations: Voice Output Cohort*

<table>
<thead>
<tr>
<th>Construction</th>
<th>Valerie</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% Correct</td>
<td># Correct/Total</td>
<td>% Correct</td>
<td># Correct/Total</td>
<td>% Correct</td>
<td># Correct/Total</td>
<td></td>
</tr>
<tr>
<td>Agent + action</td>
<td>86%</td>
<td>6/7</td>
<td>70%</td>
<td>7/10</td>
<td>88%</td>
<td>7/8</td>
<td></td>
</tr>
<tr>
<td>Action + object</td>
<td>75%</td>
<td>9/12</td>
<td>48%</td>
<td>30/63</td>
<td>75%</td>
<td>9/12</td>
<td></td>
</tr>
<tr>
<td>Agent + object</td>
<td>75%</td>
<td>3/4</td>
<td>56%</td>
<td>11/19</td>
<td>100%</td>
<td>4/4</td>
<td></td>
</tr>
<tr>
<td>Agent + action + object</td>
<td>50%</td>
<td>1/2</td>
<td>16%</td>
<td>6/37</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Entity + locative</td>
<td>67%</td>
<td>2/3</td>
<td>100%</td>
<td>6/6</td>
<td>-</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>Possessor + possession</td>
<td>84%</td>
<td>26/31</td>
<td>100%</td>
<td>3/3</td>
<td>40%</td>
<td>2/5</td>
<td></td>
</tr>
</tbody>
</table>

*Various iterations of Experiencer + State + Entity (e.g., “I want truck”), as defined by Retherford and colleagues (Retherford et al., 1981), are included in this data.*

Additional analysis was completed to calculate his accuracy levels for various agent + action + object combinations when he produced no additional semantic relations (see Table 7). Timmy’s accuracy levels were somewhat higher when he produced only two symbols within a message (i.e., 61% and 71% for action + object and agent + object relations, respectively), but he demonstrated difficulties with action + object and agent + object messages. It is difficult to draw any conclusions for agent + action constructions, as he produced so few of these structures. When Timmy produced three-symbol messages containing an agent, action, and object, he was never successful in putting these relations in the correct order.
Table 7

Accuracy Levels and Number of Correct Word Order for Agent, Action, and Object Relations with No Additional Relations Present: Timmy

<table>
<thead>
<tr>
<th>Construction</th>
<th>% Correct</th>
<th># Correct/Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agent + action</td>
<td>100%</td>
<td>2/2</td>
</tr>
<tr>
<td>Action + object</td>
<td>61%</td>
<td>17/28</td>
</tr>
<tr>
<td>Agent + object</td>
<td>71%</td>
<td>5/7</td>
</tr>
<tr>
<td>Agent + action + object</td>
<td>0%</td>
<td>0/11</td>
</tr>
</tbody>
</table>

Additional intervention sessions were held with Timmy to remediate his word order difficulties. The two play routines that Timmy used during the generalization phase (specifically, tea party and kitchen) were utilized for this intervention. In addition to providing two-symbol aided AAC models, the intervention program also included the following elements: (a) correcting Timmy’s longer productions (i.e., more than two symbols) by providing aided AAC models that matched the length of his own productions (e.g., agent + action + object); (b) adding a “message bar” at the top of each “page” on his AAC device, so that whole messages could be played back and heard in their entirety; (c) providing Timmy with general feedback regarding the accuracy of his productions (e.g., “I’m sorry, I didn’t understand that); (d) providing Timmy with specific feedback regarding the accuracy of his productions (e.g., “No, I think you mean ______”), and (e) prompting Timmy to imitate aided AAC models (e.g., “Now you try). Each intervention session lasted approximately 20 minutes. It was important to provide aided AAC models that were longer than two symbols in order to correct Timmy’s
longer productions. During the intervention and maintenance phases of the investigation, all of the aided AAC models were two symbols in length, and he did not receive any feedback to correct errors with his longer productions. A “message bar” was added to the top of each page so that Timmy could see the messages as he was constructing them – each symbol appeared at the top of the page as he selected it – and he then played back the message once it was complete. Thus, Timmy received auditory feedback for his entire messages once he completed a message. The investigator provided him with feedback regarding the accuracy of his productions so that Timmy would know that he needed to change the word order of his productions; such feedback was not provided at any time during the rest of the investigation. Finally, Timmy was encouraged to imitate the investigator’s correct productions to increase the saliency of the models (Fey, 1986).

The results of this instructional program, which include all of Timmy’s spontaneous, correct productions of various iterations of agent + action + object combinations, are listed in Table 8. Timmy successfully learned to produce various agent + action + object combinations with over 90% accuracy after approximately 1.75 hours of intervention. Thus, he was able to correct his word order difficulties with minimal additional instructional time.

Robyn produced between 0 and 3 different semantic-syntactic categories during the baseline phase, 2 to 10 during Intervention Phase #1, and 4 to 6 in both Intervention Phases #2 and #3. Robyn exhibited a fairly steady decrease in performance on this measure after the twelfth data point in Intervention Phase #1. There were 62% non-overlapping data points with baseline for this phase. Her performance improved again
Table 8

*Accuracy of Timmy’s Performance during Syntax Intervention*

<table>
<thead>
<tr>
<th>Accuracy</th>
<th>% Correct</th>
<th>(#Correct/Total)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Session 1</td>
<td>30%</td>
<td>(3/10)</td>
</tr>
<tr>
<td>Session 2</td>
<td>44%</td>
<td>(12/27)</td>
</tr>
<tr>
<td>Session 3</td>
<td>27%</td>
<td>(4/15)</td>
</tr>
<tr>
<td>Session 4</td>
<td>52%</td>
<td>(14/27)</td>
</tr>
<tr>
<td>Session 5</td>
<td>93%</td>
<td>(13/14)</td>
</tr>
<tr>
<td>Session 6</td>
<td>90%</td>
<td>(18/20)</td>
</tr>
</tbody>
</table>

Includes all spontaneous productions of agent + action, action + object, agent + object, and agent + action + object.

during Intervention Phases #2 and #3; there were no data points that overlapped with baseline during these last two phases. The results listed in Table 5 indicate that Robyn produced a range of different semantic-syntactic category categories, although she did not produce any combinations containing locatives. With respect to word order, her data indicate that she demonstrated fairly high accuracy levels with agent + action, action + object, and agent + object combinations. However, she achieved only 40% accuracy with her productions of possessor + possession constructions, indicating that this symbol combination may be challenging for her.
Modes of Communication

The participants used various communication modes to convey multi-symbol messages. Table 9, below, lists the percentages of occurrence with which Valerie, Timmy, and Robyn used aided AAC, manual signs, intelligible speech, and yes/no head nods/shakes to produce symbols within multi-symbol combinations throughout the investigation. All three participants utilized all of these symbolic communication modes.

Table 9

Percentages of Occurrence of Communication Modes for Symbols Produced within Multi-Symbol Messages: Voice Output Cohort

<table>
<thead>
<tr>
<th></th>
<th>Aided AAC</th>
<th>Manual Signs</th>
<th>Speech</th>
<th>Yes/no Head Nods/Shakes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Valerie</td>
<td>37%</td>
<td>12%</td>
<td>35%</td>
<td>16%</td>
</tr>
<tr>
<td>Timmy</td>
<td>84%</td>
<td>7%</td>
<td>1%</td>
<td>8%</td>
</tr>
<tr>
<td>Robyn</td>
<td>64%</td>
<td>13%</td>
<td>13%</td>
<td>10%</td>
</tr>
</tbody>
</table>

Valerie used aided AAC 37% of the time and relied heavily on other modes of communication as well, especially her speech. In contrast, 84% of the symbols Timmy produced within multi-symbol messages were produced using aided AAC, and he produced virtually no intelligible speech. Approximately two-thirds of the symbols Robyn produced within symbol combinations consisted of aided AAC, with the remaining symbol productions balanced fairly equally across manual signs, speech, and yes/no head nods/shakes.
Communication Board Cohort

Production of Multi-Symbol Messages

Acquisition of Multi-Symbol Messages

Both Nathan and Richard successfully learned to produce multi-symbol messages using non-electronic communication boards. Figure 5 contains graphs of their progress. At baseline, Nathan produced between zero and two multi-symbol messages during each 15 minute session, and he immediately began to show an increase in his rate of symbol combinations once intervention began. Nathan demonstrated 100% non-overlapping data with baseline. He made steady progress fairly quickly, achieving a high point of 21 symbol combinations in Intervention Session #7. Nathan then demonstrated a decrease in performance before returning to and stabilizing above the criterion level (Sessions #16-18 in Figure 5).

Richard produced a maximum of only one multi-symbol combination during baseline. The percent of non-overlapping data with baseline was 70%; the three overlapping data points occurred during the first three intervention sessions. Within several sessions after the onset of intervention, he began to demonstrate improvements in his rates of production of multi-symbol messages. His production rates steadily increased throughout the intervention phase. Richard completed the intervention phase in 10 sessions.
Figure 5. Number of Multi-Symbol Messages within 15 Minute Play Sessions: Communication Board Cohort

Nathan

Richard
Generalization

Generalization to New Play Routines Without Aided AAC Modeling (GEN W/O)

Nathan and Richard played with new toys during this phase (“Set B” play scenarios) and did not receive any aided AAC models. Nathan produced 10 and 9 symbol combinations, respectively, during this phase. His performance was well above baseline levels but was not at criterion. Richard produced 21 and 24 symbol combinations, respectively, during this phase of the investigation, indicating that he generalized production of multi-symbol messages to new play routines and did not require aided AAC models to achieve production levels above criterion.

Generalization to New Play Routines With Aided AAC Modeling (GEN W/)

Nathan was the only participant who was required to complete this phase of the investigation, as he did not meet criterion during the first generalization phase. Nathan produced 12 and 21 multi-symbols, respectively, during this phase of the study, indicating that he produced symbol combinations within new play routines with higher rates of production when aided AAC models were provided than when they were not (i.e., higher rates for the GEN W/ phase than the GEN W/O phase).

Richard also completed this phase of the investigation, as the messages he produced during the first generalization phase contained relatively few different semantic relations, and it was hoped that the provision of aided AAC models would help
Richard to increase the diversity of his multi-symbol messages (discussed below). He produced 24 and 28 two-symbol messages, respectively, during this phase; his last data point exceeded those observed in the GEN W/O phase.

**Maintenance**

Nathan and Richard produced a minimum of 16 and 20 symbol combinations, respectively, during each maintenance session. Thus, both Nathan and Richard maintained high levels of multi-symbol productions for a period of two months after the generalization phase.

**Different Multi-Symbol Messages**

The number of different multi-symbol combinations that Nathan and Richard produced within each session is located in Figure 6. Both participants demonstrated increases in their productions of different two-symbol combinations after the onset of the intervention phase. At baseline, Nathan produced 0 to 2 different combinations in each session; during the intervention phase, he produced a low of 2 different combinations (during his first intervention session) and a high of 18. The only data point that overlapped with baseline was during the first intervention session (93% non-overlapping data). He demonstrated fairly steady gains initially, with performance dropping during the eighth intervention session and then increasing again for the last three intervention
Figure 6. Number of Different Multi-Symbol Messages within 15 Minute Play Sessions: Communication Board Cohort

Nathan's performance on this measure dropped during the GEN W/O phase and then increased once aided AAC models were provided in the GEN W/ phase. He continued to produce high rates of different multi-symbol messages during the maintenance phase. Slightly more than half of the multi-symbol combinations he produced were different...
from his other symbol combinations (See Table 10). Richard produced an increasing number of different symbol combinations throughout the intervention phase. He maintained relatively high rates of different multi-symbol productions during the generalization and maintenance phases, although his performance dropped during the last generalization data point and during the second maintenance check. During his last maintenance check, he produced one of his highest rates of different symbol combination productions. Of all the participants, Richard had the lowest ratio of different to total symbol combinations at 0.48. However, this number still indicates a high degree of diversity.

Table 10

<table>
<thead>
<tr>
<th>Ratio of Different Multi-Symbol Messages to Total Multi-Symbol Messages across All Sessions: Communication Board Cohort</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ratio of Different Multi-Symbol Messages to Total Multi-Symbol Messages</td>
</tr>
<tr>
<td>Nathan</td>
</tr>
<tr>
<td>Richard</td>
</tr>
<tr>
<td>0.56</td>
</tr>
<tr>
<td>0.48</td>
</tr>
</tbody>
</table>

**Semantic-Syntactic Categories**

The number of different semantic-syntactic categories within multi-symbol messages that Nathan and Richard produced within each session is located in Figure 7. At baseline, Nathan produced between zero and three different semantic-syntactic categories within each session. During the intervention phase, he produced between three and nine of these structures. His graphs indicate that he demonstrated some
Figure 7. Number of Different Semantic-Syntactic Categories Expressed per Session out of 18 Possible Categories within Multi-Symbol Messages: Communication Board Cohort

Nathan

Richard
variability with the number of semantic-syntactic categories that he produced, although
his performance was above baseline levels for most sessions; he exhibited 87% non-
overlapping data points with baseline. Nathan demonstrated a high degree of diversity
with two-term semantic relations. The only semantic relations combination listed in
Table 11 that Nathan failed to exhibit during the investigation was attributive + entity,
and Nathan did not have access to any aided AAC symbols that would have permitted
him to express this structure. As evidenced in Table 12, Nathan achieved high accuracy
levels with the word order of his symbol combinations.

Table 11

<table>
<thead>
<tr>
<th>Construction</th>
<th>Nathan</th>
<th>Richard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agent + action</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Action + object</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Agent + object</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Action + locative</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Entity + locative</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Possessor + possession</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Attributive + entity\textsuperscript{a}</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Recurrent + X</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>Demonstrative + entity\textsuperscript{a}</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Negative + X</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

\textsuperscript{a} Participants did not have access to any attributive or demonstrative words on their aided AAC boards/devices
Richard produced between zero and three different semantic-syntactic categories during baseline, and between zero and eight during the intervention phase. In the intervention phase, his data yielded only 40% non-overlapping data points with baseline; however, all six of the overlapping points occurred within the first six intervention sessions. Richard produced fewer types of two-term semantic relations than any other participant. Nonetheless, his data indicated that he did produce a range of these symbol combinations (see Table 11). Finally, Richard’s word order data indicate that he did not demonstrate any notable word order difficulties during the investigation.

Table 12

Percent Correct and Number of Correct Messages in Word Order for Selected Semantic Relation Combinations: Communication Board Cohort

<table>
<thead>
<tr>
<th>Construction</th>
<th>Nathan</th>
<th>Richard</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Correct</td>
<td># Correct/ Total</td>
<td>% Correct</td>
</tr>
<tr>
<td>Agent + action(^a)</td>
<td>83%</td>
<td>100%</td>
</tr>
<tr>
<td>Action + object(^a)</td>
<td>86%</td>
<td>97%</td>
</tr>
<tr>
<td>Agent + object(^a)</td>
<td>100%</td>
<td>100%</td>
</tr>
<tr>
<td>Agent + action + object(^a)</td>
<td>100%</td>
<td>94%</td>
</tr>
<tr>
<td>Entity + locative</td>
<td>100%</td>
<td>-</td>
</tr>
<tr>
<td>Possessor + possession</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

\(^a\)Various iterations of Experiencer + State + Entity (e.g., “I want truck”), as defined by Retherford and colleagues (Retherford et al., 1981), are included in this data.
Modes of Communication

Nathan utilized various modes of communication to produce multi-symbol messages, as depicted in Table 13. He relied heavily on aided AAC; nearly three-fourths of the symbols he used within symbol combinations were aided AAC symbols. He also used speech and yes/no head nods/shakes to communicate and occasionally produced manual signs. Richard, however, almost exclusively used aided AAC to produce symbol combinations. He did not use any manual signs or yes/no head nods/shakes. This latter finding is surprising, given that Richard had no physical impairments that prevented him from producing head nods and head shakes. Richard did occasionally produce intelligible speech, which primarily consisted of the word no.

Table 13

Percentages of Occurrence of Communication Modes for Symbols Produced within Multi-Symbol Messages: Communication Board Cohort

<table>
<thead>
<tr>
<th></th>
<th>Aided AAC</th>
<th>Manual Signs</th>
<th>Speech</th>
<th>Yes/No Head Nods/Shakes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nathan</td>
<td>73%</td>
<td>3%</td>
<td>14%</td>
<td>10%</td>
</tr>
<tr>
<td>Richard</td>
<td>97%</td>
<td>0%</td>
<td>3%</td>
<td>0%</td>
</tr>
</tbody>
</table>

Social Validation

Caregivers, classroom teachers, and speech-language pathologists viewed 5 minute videotaped segments of the participants – one from a baseline session and one from a post-intervention session – to determine if the viewers noticed differences in the participants’ language and communication skills (see Appendix I to view the
questionnaire). The videos were presented in random order, and the viewers were blind to the status of the clips (i.e., pre- versus post-instruction). Each segment depicted the child actively engaged in play during one play scenario. For each child who received intervention at his or her home (i.e., Valerie and Timmy), the child’s caregiver and speech-language pathologist viewed the tapes and filled out the questionnaire. For participants who were seen at school (i.e., Nathan and Richard), the children’s classroom teachers and speech-language pathologists viewed the videotapes. All parents, teachers, and speech-language pathologists chose the videos from the post-intervention sessions as the ones in which the participants demonstrated better speech and language skills. (As Robyn did not successfully complete the program, this portion of the social validation data was not collected for her.)

After viewing the videos, parents, classroom teachers, and speech-language pathologists also participated in brief, informal interviews (see Table 14). They were asked what they liked best about the intervention, what they would change, and whether or not they would have their child/student participate in the study again. These adults indicated that they appreciated the following benefits of the program: eliminating the child’s frustration with communication, seeing the child’s language skills increase, enjoying seeing the child communicating effectively and being understood, and seeing improvements with the child’s speech. One of the speech-language pathologists, who provided service for Robyn, Nathan, and Richard, also stated that the intervention made her realize that the children had better receptive language skills than she had previously believed and that the staff realized that these children could do much more than had previously been thought. One suggestion made for changing the intervention, which was
made by a speech-language pathologist, was to provide more intervention in the classroom. One speech-language pathologist and one caregiver expressed a wish for intervention to expand and continue, and all adults indicated that they would definitely have the children participate in the program again.

Table 14

*Feedback on Strengths and Suggestions for Improvement from Caregivers, Classroom Teacher, and Speech-Language Pathologists*

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Suggestions for improvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eliminating the child’s communication frustrations</td>
<td>Provide more intervention in classroom</td>
</tr>
<tr>
<td>Seeing improvements in the child’s language skills</td>
<td>Continue and expand scope of intervention</td>
</tr>
<tr>
<td>Seeing improvements in effectiveness of the child’s communication</td>
<td></td>
</tr>
<tr>
<td>Seeing others understand child better</td>
<td></td>
</tr>
<tr>
<td>Seeing improvements with the child’s speech</td>
<td></td>
</tr>
<tr>
<td>Learning that the child had better receptive language skills than had been believed previously</td>
<td></td>
</tr>
</tbody>
</table>
CHAPTER 4

Discussion

Results of this investigation provide evidence that aided AAC modeling was effective for increasing the multi-symbol messages produced by four of the five preschoolers who participated in the study. Four participants met the established criterion. The fifth participant, Robyn, did not meet criterion; she did, however, demonstrate an overall increase over baseline levels. This chapter discusses these results in addition to the implications of the findings, limitations of the current investigation, and directions for future research.

Effectiveness of the Intervention

Factors influencing the effectiveness of the intervention, including factors relating to both the content and context of the intervention, are discussed below. Conditions under which the intervention was effective – particularly, the types of AAC systems utilized – are also discussed. The final discussion within this section pertains to the word order difficulties that Timmy demonstrated. The lack of effectiveness of the intervention with Robyn is discussed in a separate section later in this chapter.
Content of the Intervention

A number of hypotheses relating to the content of the intervention may help explain the positive results of the investigation for four of the five participants. From the outset, this investigation was based on the premise that the linguistic input that children receive is critical for the early stages of language development (e.g., Hollich et al., 2000; Tomasello, 2000) and that children who use AAC for expressive communication experience an inherent asymmetry between the linguistic input they receive and the output they produce (Smith & Grove, 1999; Smith & Grove, 2003). As discussed in Chapter 1, the input-output asymmetry hypothesis has been cited as a major reason for the limited use of multi-symbol messages that are observed in children who use AAC, as well as difficulties with both word order and bound morphemes (see Smith & Grove, 2003, for a summary). In typical daily interactions, these children primarily receive linguistic input from the spoken models of language surrounding them (Sevcik et al., 1995). The communication partners of children who use AAC seldom use the child’s AAC system when communicating with the child (von Tetzchner & Martinsen, 1996; Wilkinson et al., 1994). However, the children are expected to use other modes of communication, such as picture symbols and signs, for expressive language (Smith & Grove, 1999; Smith & Grove, 2003). According to the input-output asymmetry hypothesis, this is problematic for young language learners because they do not receive models using the modes of communication they are expected to use (Smith & Grove, 1999; Smith & Grove, 2003).
The results of the current investigation indicate that increasing the symmetry between input and output may have assisted at least some of the participants in learning to express multi-symbol messages. By providing aided AAC models, a child receives input using one of the main communication modes that the child is expected to use. If the asymmetry between linguistic input and linguistic output is to blame for the child’s low rates of multi-symbol productions, then providing aided AAC models for children who are expected to use aided AAC to create multi-symbol messages should assist them in learning to create symbol combinations. For four of the five participants, using this modified input – that is, providing input not only via speech but also via aided AAC – seems to have assisted them in learning to produce symbol combinations.

It is important to note that all of the aided AAC models that were provided during intervention were two symbols in length. When the preschoolers began the study, their symbolic communication primarily consisted of single symbols. Providing models that were two symbols in length exposed them to models that were slightly above their current levels of functioning. Therefore, not only providing the children with aided AAC models, but also providing them with models that were within their “zone of proximal development” (Vygotsky, 1978) may have been critical.

A related factor to consider is the fact that the provision of aided AAC models (i.e., pointing to and labeling two symbols) followed by spoken models (i.e., brief spoken grammatically complete utterances) provided participants, in effect, with build-ups and breakdowns of early grammatical structures. Build-ups and breakdowns have been used successfully as part of intervention programs to teach grammar skills to children with language disorders (e.g., Fey et al., 1993). It has been argued that
providing varied forms of the same intended message can help show the child how the phrase breaks down into parts and also how the same intended message can be provided in a variety of ways (Paul, 1997).

It is important to note that providing models using aided AAC changes the nature of the input to the child in several other ways. When a person communicates using aided AAC, the communication process is slowed down, and greater emphasis is placed on the concepts that are communicated via the aided AAC system (Beukelman & Yorkston, 1977; Hustad & Beukelman, 2000). This slower input rate provides the listener with greater processing time (Beukelman & Yorkston, 1977), and the additional stress that is placed on the input that is provided via aided AAC may also assist the listener. Thus, the slower rate of input and the increased stress on two-symbol messages when the investigator provided aided AAC models may have impacted the participants’ acquisition of multi-symbol messages. For example, when the aided AAC model and spoken model \{Tiger TIGER\} \{blow BLOW\} Tiger blows the balloon, was provided, the aided AAC model (i.e., \{Tiger TIGER\} \{blow BLOW\}) was provided at a slower rate than the spoken model, and there was an increased stress placed on the labeling of the two target symbols. This slower rate was present with all aided AAC models that were provided in the investigation. The nature of the increased emphasis was different for different participants, however, depending on whether non-electronic communication boards or voice output systems were used. With the communication boards, stressed intonation patterns were used to place emphasis on the target symbols (e.g., \{Tiger TIGER\} \{blow BLOW\}). With voice output systems, the speech synthesizer provided the labels for the symbols (e.g., “tiger blow”) for two preschoolers (Valerie and Timmy),
and digitized speech output provided the labels for a third (Robyn). Speech produced via a speech synthesizer or even digitized speech is qualitatively different from natural speech, and it is not known what impact these different types of input may have had on the participants. Regardless of the differences between synthesized speech, digitized speech, and natural speech, the slower rate of input and the greater emphasis placed on the two-symbol targets when modeling was provided via aided AAC may have impacted the participants’ learning.

It is fascinating to note that providing aided AAC models seemed to facilitate production of multi-symbol messages across different modes of communication for several children. Richard was the only child who relied almost exclusively on aided AAC to produce multi-symbol message; he used aided AAC for 97% of the symbols he produced in his symbol combinations. The other children used other modes of communication to various extents, including the use of manual signs, speech, and yes/no head nods/shakes.

There are various possible explanations for this phenomenon. First, models were provided not only via aided AAC but also via speech. More than 10% of the symbols that Valerie, Robyn, and Nathan used during multi-symbol productions were intelligible spoken words. As discussed previously, spoken labels that were two symbols in length were provided consistently during the intervention phase as part of the aided AAC models, and providing the preschoolers with spoken labels that were slightly above their current levels of functioning may have assisted in facilitating their productions of symbol combinations.
All of the children except for Richard also used manual signs and yes/no head nods/shakes within some of their multi-symbol productions. With respect to manual signs, Valerie and Timmy relied heavily on signs for communication prior to the onset of the investigation. In particular, Timmy had virtually no intelligible speech and had an expressive sign vocabulary of approximately 160 words when the investigation began. Given that he had exposure to only 15 aided AAC symbols during any given play scenario but was capable of producing many more signs, his relatively low rates of sign production (i.e., 7% of the symbols he produced within multi-symbol messages) may be an indication that Timmy was primarily using the modes that his communication partner was using. The children may also have used signs as a “back-up.” That is, they only had access to 15 aided symbols and may have needed to express other concepts. Of the 53 signs that Timmy produced during the investigation, for example, only 3 of these signs were concepts that were represented on his aided AAC system. The same held true for Valerie; in all but 2 out of 54 cases, she used signs within multi-symbol messages for concepts for which she did not have access with her aided AAC system.

For Robyn, the majority of the signs she produced within multi-symbol messages fit into one of two categories. First, she produced the sign HOT for the majority of her signed productions within multi-symbol messages (23/34, or 68%). The two play scenarios Robyn used during the intervention phase were fast food and tea party, and when engaged with play she often told the investigator whether the food and drink were hot or not. She had no other way of expressing this than using a sign, as she did not have access to an aided symbol for HOT. Further, in every case, she produced this sign in conjunction with either an affirmation (spoken word representing yes and/or head nod)
or negation (spoken word representing *no* and/or head shake). As discussed previously, spoken models were provided during intervention (including the use of *yes* and *no*), and also, the procedures did not prevent the investigator from using yes/no head nods and head shakes during the investigation. Therefore, Robyn was receiving input using the modes she used to create these two-symbol messages, with the exception of the sign HOT. For seven of the nine remaining manual signs that Robyn produced during the first intervention phase, Robyn produced the manual signs immediately after she accessed these symbols on her voice output system. For example, as one part of a multi-symbol message, she selected the symbol “more” on her voice output systems and then manually signed MORE, followed by another, different symbol. Although it is not possible say for sure, she appeared to be confirming the voice output on her aided AAC system in these cases.

Finally, it should be noted that all the participants except for Richard used head nods and head shakes within some of their multi-symbol productions. The investigator did use these gestures as a normal part of conversation during the investigation. Therefore, the participants did receive input using these gestures during the investigation, and the participants may have learned to use these symbols within multi-symbol messages as a result.

Overall, then, the results pertaining to the modes of communication that the preschoolers used argue in favor of the input-output hypothesis. The participants tended to use the modes of communication that the investigator used (i.e., aided AAC, speech, and yes/no head nods/shakes), except when the children did not have access to these modes for the concepts that they wished to express. That is, in instances when they
could not produce the spoken words and did not have graphic symbols available for concepts they wished to express, they sometimes produced manual signs to express those concepts.

It is also possible that the impact of the build-ups and breakdowns that were provided during intervention had an impact on the modes that the children used. Build-ups and breakdowns are purported to facilitate the child’s learning of underlying grammatical structures (Fey et al., 1993; Paul, 1997). If the participants learned these underlying structures, they potentially could express these structures using any communication mode. Manual signs were not provided during the investigation, yet, as discussed above, several of the children used manual signs during the investigation, albeit with lower frequencies than other communication modes.

**Context of the Intervention**

The context of the investigation may also have had an impact on the findings. The context of the intervention for the current investigation may be divided into three parts: (a) the use of communication techniques that were designed to facilitate language development; (b) the use of play routines; and (c) the use of a child-centered approach to intervention. Each factor is discussed below.

First, it is critical to note that the use of aided AAC modeling in this study took place within a specific framework, one that included the use of a variety of communication supports that previously have been validated in the literature and have been used in conjunction with aided AAC modeling in previous studies. The specific
techniques that were used throughout the investigation (i.e., during baseline as well as the remaining phases) included the following: access to aided AAC symbols, provision of adequate time to communicate (Basil, 1992; Bruno & Dribbon, 1998), provision of spoken models (e.g., Fey, 1986; Olswang et al., 1992), and provision of expectant delays when the children said or did nothing following spoken models (Kent-Walsh, 2003; Light, Binger, Agate, & Ramsey, 1999). During baseline, all of these techniques were used; the only addition during the intervention phase was the use of aided AAC models. This investigation, then, demonstrated the effects of aided AAC modeling when used within the context of these techniques, and it is not clear what impact providing aided AAC modeling would have within other contexts (e.g., using more directive intervention techniques to teach very specific linguistic structures). The results of this investigation should not be interpreted to mean that providing access to AAC, time to communicate, spoken models, and expectant delays are not necessary. It does appear, however, that the use of these other techniques was not sufficient for promoting the production of early multi-symbol messages with these children, since they produced very few multi-symbol messages during baseline.

Second, age-appropriate dramatic play scenarios were used as contexts for intervention. Such play routines have been widely used as successful contexts in intervention studies with preschoolers with language disorders for teaching various grammatical structures (e.g., Camarata et al., 1994; Cleave & Fey, 1997; Tyler et al., 2002; Warren & Bambara, 1989). Within the current investigation, these dramatic play scenarios were loosely organized. Although some interventions have utilized scripts or “joint action routines” with a set order and agenda for teaching specific linguistic
structures (e.g., Bain, Olswang, & Johnson, 1992; Culatta, 1994), the play activities in this investigation were largely driven by the child’s interactions with and interest in the toys. Using this type of facilitative play is designed to “create a highly accepting and responsive environment in which the child is motivated to communicate spontaneously with her social partner” (Fey, 1986, pp. 194-195). The effects of using aided AAC modeling within other contexts, such as joint action routines or daily life activities such as getting dressed or completing a cooking activity is unknown.

The types of play routines used relate closely to the last consideration of the context for intervention: that the intervention was largely child-centered in nature. With adult-directed approaches, the goals for intervention are typically direct and specific (Fey, 1986). However, the goal for the current investigation was very broadly defined: that is, to facilitate the general development of early symbol combinations. The investigator was not constrained with the specific types of two-symbol messages that could be modeled, and ample opportunities arose to provide models of a variety of structures (e.g., agent + action, action + object, negation + X, etc.). This child-centered approach, which included modeling of various semantic-syntactic structures, appeared to facilitate the development of a broad array of early symbol combinations; all participants expressed a variety of semantic relations within their symbol combinations.

Therefore, the results of the investigation indicate that aided AAC modeling is an effective means for teaching multi-symbol messages to some children, when the aided AAC models are provided: (a) in conjunction with other communication supports, including time to communicate, expectant delays, and spoken models; (b) within loosely organized play scenarios; and (c) within a child-centered approach to intervention.
Future research is required to investigate the effects of aided AAC models in other intervention contexts.

**Type of AAC System**

It is interesting to note that similar effects were observed with the first two participants in the voice output cohort (Valerie and Timmy) and with the two preschoolers in the communication board cohort (Nathan and Richard). The type of aided AAC systems utilized by the participants did not seem to play a major role in the outcomes of the investigation. The first cohort of participants utilized voice output systems as their aided AAC systems for the current investigation, and the second cohort utilized light tech communication boards. Two children in the first cohort, Valerie and Timmy, both met criterion for using multi-symbol messages, as did both Nathan and Richard in the second cohort. Valerie and Timmy met criterion more quickly than both Nathan and Richard, but many variables besides the type of system may have accounted for this. The design of the study precludes any conclusions from the data regarding the relative superiority of one type of system over another.

Robyn presented somewhat of a special case, with respect to the type of aided AAC device. She began the investigation utilizing a voice output system but switched to light tech communication boards like the ones used by Nathan and Richard in the second and third intervention phases, as she was experiencing only limited success when using the voice output system. In addition, during the third intervention phase, multimodal AAC models (i.e., manual signs and picture communication board) were utilized.
However, her performance with producing symbol combinations did not improve notably once these changes were made, and she did not meet criterion during any intervention session. It seemed that the mode used for modeling was not a controlling factor in her performance. Overall, then, the type of aided AAC system that was used did not appear to impact the results of the investigation.

Although the intervention was effective in teaching four of the five participants to produce multi-symbol messages, particular issues that arose with two of the participants warrant further discussion: the difficulties Timmy exhibited with word order and the lack of effectiveness of the intervention with Robyn. Further discussion of Timmy follows; the findings pertaining to Robyn are discussed later in this chapter.

**Word Order Difficulties: Timmy**

Timmy demonstrated difficulties with word order throughout the investigation, despite that fact that he successfully met criterion (i.e., at least 12 multi-symbol messages over three consecutive sessions) within just five sessions and maintained high levels of multi-symbol message productions during both the generalization and maintenance phases. In particular, he had difficulties producing various iterations of agent + action + object structures in the proper order. Out of all five participants, Timmy was the only one to have exhibited significant word order difficulties, a surprising finding given that he was the only participant whose language comprehension skills were within normal limits. Although it is possible that Timmy experienced an intrinsic linguistic deficit that was expressive in nature (akin to children with expressive Specific
Language Impairments), the fact that he was able to correct these word order difficulties after less than two hours of intervention indicates that he was able to remediate his word order difficulties relatively quickly.

Numerous case studies have been reported in the literature of word order difficulties with children who use aided AAC (e.g., Smith & Grove, 2003; Smith, 1996; van Balkom & Welle Donker-Gimbrère, 1996). Smith and Grove (2003) offered various hypotheses (in addition to a linguistic deficit hypothesis) for why these difficulties may occur. One plausible explanation for word order problems these authors offer is that “the development of structure is constrained within the AAC modality because its function remains primarily communicative, not linguistic” (p. 175). In other words, aided AAC systems that utilize graphic symbols may not be inherently linguistic in nature (Soto, 1999). Smith and Grove speculate that as a result, children may rely heavily on a pragmatic style of communication, which is an earlier stage of development that is characterized in part by low noun-verb ratios (i.e., relying heavily on the use of nouns and infrequent use of verbs), no use of grammatical morphology, and the presence of topic-comment structures.

Timmy did demonstrate a low noun-verb ratio; his ratio of nouns to verbs was 7:2, for the nouns and verbs that he produced within multi-symbol messages. It should be noted, however, that more nouns than verbs were available to him via aided AAC; the ratio of nouns to verbs on any given communication display used during the investigation was 8:3 – that is, nearly three times as many nouns as there were verbs. This makes it difficult to interpret the findings, as the increased number of nouns that were available may have influenced the higher ratio of nouns to verbs. With respect to
grammatical morphology, Timmy did not produce any grammatical morphemes; however, he did not have access to any of these structures via aided AAC. With respect to topic-comment structures, children first establish a topic and then provide information about that topic (Gruber, 1967). For example, the child might establish a topic by selecting “balloon” and then comment by selecting “blow.” It is difficult to say whether or not Timmy was, at any point, relying on topic-comment structures. Topic-comment structures typically begin with a noun or proper noun (e.g., doggie big, doggie bite, doggie bed; Owens, 2001). If Timmy had been relying on this type of structure, the majority of his multi-symbol productions likely would have begun with a noun (i.e., agent or object, in structures involving agents, actions, and/or objects). The results presented in Table 6 do not fully support this hypothesis. Approximately one-third of his agent + action productions and one-half of his action + object productions began with an action, which almost exclusively consisted of verbs. Further, the fact that so many of his productions consisted of symbol combinations that were longer than two symbols in length is not typical for children who are relying on pragmatic strategies (Smith & Grove, 2003). Timmy’s use of a pragmatic style of communication, then, is not fully supported by the data.

Another potential explanation for Timmy’s word order difficulties is known as the “recoding argument” (Smith & Grove, 2003). This hypothesis claims that the internal linguistic system is intact, but the individual does not have the metalinguistic skills necessary to re-code speech-based messages into another modality. This may be a viable hypothesis to explain Timmy’s word order difficulties, as Timmy exhibited receptive language skills that were age-appropriate, and he was very young to be
expected to possess metalinguistic skills (i.e., aged 3;5 at the onset of the investigation). According to the recoding argument, lack of metalinguistic skills results in messages formulated via AAC that may be shorter and exhibit different word order patterns. Such word order patterns might be influenced by factors inherent within the system itself. One such pattern, Sutton and Morford have argued, is the object-verb construction (Sutton & Morford, 1998). Object-verb structures have been noted in the manual signs of children who learn Manually Coded English and who have not been exposed to American Sign Language. Sutton and Morford (1998) argued that the same patterns may be found when graphic symbols are used for communication, as both Manually Coded English and graphic symbols are visual modes of communication. To investigate this hypothesis, these researchers examined the performance of typically-developing individuals while using aided AAC. The participants were typically developing children in kindergarten, second, fourth, and sixth grade. The researchers found that many of the children’s responses did not follow typical English word order patterns for 2- and 3-symbol subject-verb-object constructions, but that correct word order increased with age (kindergarten = 34%, 2nd grade = 69%, 4th grade = 76%, and 6th grade = 89%). For those multi-term messages that did not follow the typical subject-verb-object (or agent + action + object) word order, most productions contained object-verb ordering patterns (i.e., SOV, OVS, OV).

Of Timmy’s symbol combinations that contained subjects, verbs, and/or objects (some of which contained additional semantic relations such as recipient), 42% adhered to English word order patterns (derived from Table 6). Of his productions that contained only SV, VO, SO, and SVO combinations with no additional constituents (i.e, agent +
action, action + object, agent + object, and action + agent + object), 50% of his productions adhered to correct word order patterns (derived from Table 7). With both sets of data, Timmy’s accuracy levels were higher than those of the typically developing kindergarteners in the Sutton and Morford (1998) study, despite the fact that Timmy was younger than these children. It should be noted that Timmy did produce a large number of messages containing objects and verbs relative to other two- and three-term relations. However, he produced verb-object structures with about the same frequency that he produced object-verb structures, so he did not appear to be relying primarily on object-verb structures to communicate. Further, both Nathan and Richard produced proportionally more symbol combinations containing actions and objects than combinations containing other semantic-syntactic combinations, and neither demonstrated a preference for OV (i.e., object + action) structures; the vast majority of their action + object productions adhered to English word order patterns.

It is important to point out that the recoding hypothesis does not fully explain precisely where in the re-coding process the word order changes take place, why these changes take place, and how such systematic changes in word order can be explained (Smith & Grove, 2003). This hypothesis leaves as many questions as it answers, and further research is required to further investigate and refine this hypothesis.

Smith and Grove (2003) proposed one final hypothesis that may be useful in explaining word order difficulties. The “modality asymmetry argument,” which is very similar to the “recoding argument,” proposes that spoken input provides the child with all necessary components to help the developing child determine the structure of language; however, the match between these internalized structures and what is possible
on an AAC device may be incomplete. For example, graphic symbol-based systems such as those used in the current investigation are essentially lexically-based systems, and in order to build productive syntax, the child is essentially required to produce chains of lexical items. The fact that such a system contains no inherent syntax of its own, and no intrinsic supra-segmental features, may make it very difficult for the child to map spoken word order onto another system. This hypothesis is somewhat supported by Timmy’s performance with his production of three-term agent-action-object structures. Timmy’s word order with these productions appeared to be entirely random, and he may have had difficulty with determining how to map the internal syntactical structure in his mind onto a string of lexical items that had no inherent word order features. It should be noted that an attempt was made to support the use of agent + action + object structures through the use of a Fitzgerald Key (McDonald & Schultz, 1973), with the agents, actions, and objects lined up from left to right. Providing such external scaffolds may, in fact, provide more support for word order than unaided modes of communication, given that graphic symbols are permanently displayed. However, the agents often became the objects during play with Timmy, and vice versa. For example, in the vehicles scenario, a finger-puppet bunny and pig were meant to serve as agents (e.g., the bunny driving the car), but Timmy enjoyed using them as objects (e.g., the car hitting the bunny). Thus, the right-to-left ordering for selecting symbols was often violated.

There are several possible, plausible reasons, then, for Timmy’s difficulties with word order. He may have been relying on topic-comment structures with some of his messages, he may have experienced difficulties with re-coding messages from spoken
language to fit the constraints within his aided AAC device, and he may have had
difficulty determining how to map his mental model for various semantic structures onto
an aided AAC system that was essentially a lexical, and not a syntactic, system.
Whatever the reasons for his difficulties with word order, Timmy was able to overcome
them within a brief period of time and did learn to use correct word order with his aided
AAC device. Sutton and Morford (1998) found that the older typically developing
children in their study demonstrated far fewer word order problems using graphic-
symbol based aided AAC systems than the younger children did, so it does appear that
children are better able to follow English syntax rules when using aided AAC as their
language skills become more sophisticated. Whatever strategies Timmy was using (such
as using topic-comment structures) or difficulties he was experiencing (such as
difficulties with re-coding and coping with using a lexically-based AAC system), he was
able to overcome these issues with a relatively brief period of instruction. Additionally,
it is critical to note that Timmy was the only participant in the current investigation who
demonstrated significant word order difficulties, indicating that challenges with word
order, at least at this initial stage of generative language development, are not
necessarily present for all children who rely on aided AAC to communicate.

Efficiency of the Intervention

The intervention appeared to be an efficient means for teaching four of the five
preschoolers who use AAC to produce multi-symbol messages. It took the four
participants who successfully completed intervention between 4 and 15 intervention
sessions to reach criterion (i.e., three consecutive sessions producing at least 12 multi-symbol combinations). Each intervention session was 15 minutes long; therefore, the total instructional time was between 1.0 and 4.25 hours. It is not known, however, if other interventions might provide an even more efficient means for teaching this skill. It is possible that changes to the content or contexts of intervention might yield more efficient results for some preschoolers who use AAC.

**Promoting Generative Language**

One of the most important findings of this investigation is that aided AAC modeling, when used within the context described above, seemed to facilitate the preschoolers’ productions of generative language, at least for four of the five participants. Promoting linguistic skills with these children often has been mentioned as critical in the literature (e.g., Light, 1997; Nelson, 1992; Paul, 1997), yet no studies could be located that specifically targeted the production of early symbol combinations with children who use AAC. Promoting early language development is just as important for children using AAC as it is for children with language disorders who rely on speech for communication. Putting two symbols together – whether those symbols are spoken words, aided AAC symbols, unaided AAC symbols, or any other types and combinations of symbols – marks the beginning of the production of truly generative language (Bowerman, 1973; Paul, 1997). The results of the current investigation demonstrate that aided AAC modeling can be an effective means for promoting this critical stage of language development. Four of the five preschoolers in the current
investigation produced symbol combinations that contained symbols from a wide range of semantic-syntactic categories, and they also produced combinations across a variety of early two-symbol relations (e.g., agent + action, possessor + possession, etc.). The results, then, indicate that providing aided AAC models that reflect the child’s actions and interests during play are an effective means for supporting this critical stage of language development.

Further, there is evidence that some of the children – specifically, Valerie, Timmy, and Nathan – produced two-term semantic relations for which the investigator never provided aided AAC models; as stated in Chapter 2, the investigator did not use locatives, attributives, or demonstratives as a part of the graphic symbol portion of any aided AAC models. However (a) all three of these participants produced two-term relations that contained locatives, (b) Valerie and Timmy both produced attributive + entity structures, and (c) Nathan produced one symbol combination containing a demonstrative (Hit that car). It appears, then, that these participants generalized the use of two-symbol productions that were modeled to new semantic-syntactic categories. Several explanations may account for these findings. First, it could be that in order to produce a broad range of two-term relations, the participants simply needed be shown (a) that it was possible to put two symbols together using aided AAC, and (b) how to create these relations across a limited subset of two-term relations. They may have been capable, from developmental standpoint, of creating many different types of relations and simply needed to be shown how to do it. Timmy, for example, learned to produce symbol combinations rapidly – he produced 18 multi-symbol messages during his first intervention session – and he produced multi-term semantic relations using aided AAC
that were never modeled. He produced messages such as “spill doll giraffe dog” to indicate that he wanted to spill tea on these three animals (i.e., action + locative + locative + locative), despite the fact that no aided AAC models of locatives were ever provided via aided AAC.

Another related possibility is that the participants may have been able to produce these structures prior to the onset of the investigation, albeit infrequently. Timmy, for example, produced a two-term message containing the semantic relation “recurrence” during a baseline session (i.e., MORE JUICE via manual signs). As he learned to produce multi-symbol messages with greater regularity, it makes sense that he would continue to use the semantic relations that he could already produce.

Finally, it is possible that the spoken models aided the participants. Nathan’s one production of a demonstrative, for example, was spoken: Hit that car. The investigator had provided spoken models for these semantic relations (i.e., action + demonstrative + object) during baseline and also following aided AAC models (e.g., {HIT hit}{CAR car} Hit that car). Thus, Nathan had received linguistic input using the same mode with which he produced this semantic relation.

There are several potential reasons, then, to explain why three participants produced multi-term semantic relations that had not been targeted specifically as aided AAC models. Future research is required to investigate this issue further.
A Special Case: Robyn

Although four of the five children in this study met criterion, one participant, Robyn, did not. Robyn’s data demonstrated a modest increase in the overall means. However, she produced no more than eight multi-symbol messages during any session in Intervention Phase #1. Furthermore, although 81% of the data points during intervention were non-overlapping with baseline, three of the last four sessions during Intervention Phase #1 did not exceed baseline levels. There was no evidence for an increase in the trend of the data over time.

As described in Chapter 3, a second intervention phase was instituted in which the following changes were made: (a) switching from a voice output system to light tech communication boards; (b) increasing the size of the symbols; (c) using a greater variety of play routines, most of which were craft activities; and (d) allowing Robyn to chose the play activities with which she preferred to play. It was anticipated that if factors relating to the voice output system, to the symbol size, or to boredom had been contributing to her relatively limited use of symbol combinations, making these modifications would have resulted in relatively rapid changes in her behavior. However, neither the slope nor the level of her data increased with any consistency during Intervention Phase #2. She produced an average of 5.0 multi-symbol messages per session during this phase, compared to an average of 0.7 during baseline and 4.0 during Intervention Phase #1. A third and final change was made for Intervention Phase #3. As Robyn had been learning signs both in the classroom and at home, and as informal observations of Robyn in both settings indicated that she used signs more frequently
than aided AAC, the modeling procedures were changed to include both aided and unaided AAC modeling. Her performance during this final intervention change was similar to her performance within the other intervention phases; that is, she seemed to demonstrate a modest increase in the means of her performance (mean = 4.5 multi-symbol messages) compared to baseline, but no learning curve was apparent.

Overall, then, Robyn demonstrated a small increase in her production of symbol combinations, but she failed to meet criterion, even when a number of changes were made to the intervention. It is important to attempt to determine why Robyn did not achieve criterion, and to also determine next steps for her. There are a number of variables that may have affected her performance, including both intrinsic and extrinsic factors (Romski et al., 1997). Intrinsic factors are those factors which relate to what the child brings to the language learning task, and extrinsic factors are the factors external to the child. Intrinsic variables include the child’s cognitive abilities, language/communication abilities, motor capabilities, sensory capabilities, and psychosocial variables (such as motivation and persistence). Extrinsic variables include factors relating to the communication partner, the intervention, and the AAC system. Any of these factors or combinations of factors may have affected Robyn’s performance; the potential influence of each variable is discussed below.
**Intrinsic Variables**

**Cognition and Communication**

First, it is possible that Robyn’s cognitive and receptive language abilities had some impact on the data. If Robyn’s cognitive skills were below the level at which a child typically would begin producing symbol combinations, it might help to explain her relatively poor performance; children’s expressive language capabilities seldom exceed their cognitive abilities, and in fact, children with cognitive disorders often have language levels that are below their cognitive levels (Kamhi, 1981). The Battelle Developmental Inventory had recently been administered to Robyn, Nathan, and Richard (no cognitive test scores were available for Valerie and Timmy). Robyn received the lowest score on the cognitive subtest; the age equivalent scores for Robyn, Nathan, and Richard were 28 months, 33 months, and 37 months, respectively. However, Robyn’s overall score on the Battelle was very similar to Nathan and Timmy’s scores (28, 27, and 27, respectively), and her scores on the communication subtest were similar to Nathan’s score (22 and 21 months, respectively). With respect to receptive language, Robyn received the lowest raw scores of the five participants on both the Vocabulary Subtest and the Elaborated Phrases and Sentences Subtest of the TACL-3. The former subtest examines comprehension of single words, and the latter examines comprehension of various syntactic structures. To obtain further measures of her receptive vocabulary, the PPVT (Dunn & Dunn, 1981) was administered near the end of the investigation. She was age 4;11 when tested and received a percentile score of
<1 and an age equivalent score of 2;5, suggesting that Robyn did experience difficulties with receptive vocabulary.

It is difficult to say for sure what impact her cognition and language comprehension may have had on her performance. Typically developing children begin combining words by approximately 18 months, but even with typically developing children, there is much variability with the onset of symbol combinations. Some typically developing children do not begin to combine words until they are 24 months of age (Bates, Dale, & Thal, 1995). Robyn’s communication subtest scores on the Battelle, at 21 months, fall within this range. Her age equivalent score on the TACL-3, however, was 3;4, which should have been more than sufficient for expressing symbol combinations, and her PPVT score, although much lower than this, was still over the 24 month mark (i.e., 29 months). Her comprehension scores on the informal assessment of two-symbol utterances (Miller & Paul, 1995) indicated that she was able to understand agent + action, action + object, and possessor + possession structures. Overall, then, Robyn seemed to demonstrate cognitive and communication abilities commensurate with children who produce symbol combinations.

Although cognition and language comprehension appeared adequate to support production of multi-symbol messages, Robyn’s performance may have been affected by variables related to her expressive communication skills. Specifically, her rate of turn-taking may have impacted the outcome of the investigation. Turn-taking rates are often lower for children who use AAC than for developing children (e.g., Light et al., 1994). Robyn did produce some multi-symbol messages, but not enough to meet criterion. If her overall turn-taking rates were low, this might help explain her performance. An
analysis of Robyn’s symbolic turn-taking rates showed that she produced a mean of 38 symbolic turns per session during baseline and a mean of 37 symbolic turns during Intervention Phase #1. However, closer analysis of the data revealed that the majority of her symbolic turns consisted of expressing either affirmations (e.g., yeah, ‘kay, ‘yes’ [head nod]) or negations (e.g., no, ‘no’ [head shake]). This pattern has been observed with children when communication partner ask a preponderance of yes/no questions (Light et al., 1985a); however, the investigator did not ask yes/no questions during the investigation, except to occasionally request clarification from the participants. Once the turns that consisted only of an affirmation and/or negation were excluded, it became apparent that rates of symbolic turns were markedly low: Robyn produced a mean of 7.5 symbolic turns in 15 minutes in both the baseline phase and Intervention Phase #1, or less than one turn per minute (baseline range = 2-19; Intervention Phase #1 range = 1-15). Thus, Robyn’s rates of symbolic turn-taking even with the inclusion of single symbols were still below the criterion level for nearly all intervention sessions. Her turn-taking rate, then, may have had an impact on the outcomes.

It is important to note that there was some evidence that Robyn demonstrated improvement with symbolic turn-taking rates during the last phase of the investigation, once models were provided using both her light tech communication boards and signs: she produced an average of 19 symbolic turns during Intervention Phase #3 (see Figure 2 in Chapter 3). Caution must be taken in interpreting these results, however, as Robyn exhibited a high degree of variability with this measure (especially during the baseline phase), and further, there were only four data points during Intervention Phase #3. However, the increase in her mean level of performance provides an indicator that the
use of signs may have assisted her with increasing her turn-taking rate. Nearly half of her symbolic productions during Intervention Phase #3 consisted of signs, suggesting that a multimodal modeling approach may be more beneficial for her.

Motor

Another intrinsic variable the may potentially have impacted Robyn’s outcome was motor skills. Many children who require AAC have significant motor impairments (e.g., Goossens', 1989; Light et al., 1985a; von Tetzchner & Martinsen, 1996), and the presence of such motor impairments can impact factors such as communication rates (e.g., Light et al., 1994), including the production of multi-symbol messages. As discussed in Chapter 2, Robyn did demonstrate some delays with her fine and gross motor skills, but she was ambulatory and could easily manipulate toys and make selections using an index finger on her AAC device. Thus, Robyn’s motor skills did not appear to have an impact on the results.

Sensory/Perceptual

The presence of vision and/or hearing impairments can significantly impact communication development (e.g., Goossens', 1989). However, as discussed in Chapter 2, Robyn did not have any vision or hearing impairments. Thus, her sensory/perceptual skills did not appear to have an impact on the outcomes.
Psychosocial factors such as motivation and persistence (Fey, 1986) as well as a drive for communication efficiency (Smith & Grove, 2003; Sutton et al., 2002) can all impact a child’s expressive communication. With respect to motivation and persistence, Fey presented a classification for children with language disorders which included a group of children called “inactive communicators” (p. 70) who are neither as assertive (i.e., taking conversational turns without prompting) nor responsive as typically developing children, and who exhibit reduced motivation to communicate with others and to sustain interactions. These children talk very little in comparison with their peers and do not appear to be very interested in conversation. Fey noted that for these children, their responses are often less complex than they are capable of producing. Robyn demonstrated all of these behaviors. Informal classroom observations by the investigator and discussions with Robyn’s classroom teacher indicated that Robyn seldom communicated with others while at school. Her behaviors during the investigation indicated that, at times, she was not interested in communicating with the investigator and indicated displeasure with play. Robyn demonstrated the following behaviors at mean rate of 9 behaviors per 15 minute session (range = 5-16): (a) laying her head on the table or floor; (b) moving aided AAC system away from play area, or crumpling the aided AAC system (once light tech communication boards were used); (c) leaving the play area in the middle of a session; (d) sitting with her back to investigator; (e) gesturing for the investigator to go away; and (f) throwing toys. The other four participants demonstrated these behaviors much less frequently; these behaviors
occurred at rates ranging from 0.1 to 1.6 times per session. As one potential reason for Robyn’s relatively high rates of these behaviors may have been boredom with the play routines, a broader range of activities was introduced during the 2nd intervention phase, and Robyn was permitted to choose among them. However, there were no significant changes in her productions of multi-symbol messages during these latter phases, compared with the first intervention phase. It may be, then, that Robyn was an inactive communicator, and as Fey pointed out, “attempts to get children with this type of problem to learn a new syntactic structure or new vocabulary items are typically unproductive” (p. 93). Fey went on to point out that having the ability to produce grammatical structures is not useful for a child who rarely initiates and who is not motivated to maintain social contact with others. Instead, Fey recommended developing skills for establishing and managing social contact, including broadening the range of conversational acts that they express, for children who are inactive communicators.

Another psychosocial factor that may have come into play was Robyn’s drive for communicative efficiency. Smith and Grove (2003) state that this is one potential reason for the limited use of multi-symbol structures typically observed with children who require AAC. The rate of communication for many individuals who use AAC is significantly lower than for those who do not (Beukelman & Mirenda, 1998), and in the interest of communicative efficiency, many individuals may rely more heavily on unaided communication modes and on single symbol productions. Table 15, below, lists the average amount of time that it took Robyn to complete two-symbol messages across
various modes of communication. Times within each category are a mean of 10 different, randomly selected turns/symbol combinations.

Table 15

<table>
<thead>
<tr>
<th>Mode</th>
<th>Time (in sec.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unaided</td>
<td>1.3</td>
</tr>
<tr>
<td>Voice output device</td>
<td>6.5</td>
</tr>
<tr>
<td>Communication board</td>
<td>0.9</td>
</tr>
</tbody>
</table>

It is apparent from Table 15 that it took Robyn less time to complete two-symbol messages when she used unaided modes and light tech communication boards than when she used her voice output device. In other words, the voice output device was a less efficient mode of communication for her. It was possible, then, that Robyn preferred to rely on modes of communication other than the voice output system, as these other modes were more efficient means of communication. However, this does not explain the fact that Robyn did not produce significantly more multi-symbol messages once intervention was modified to include the use of (a) light tech communication boards, and (b) a multimodal approach that included signs. Further, productions via any mode were accepted as multi-symbol messages throughout the investigation. Also, while it is feasible that Robyn was not willing to produce multiple symbols when she could convey her message with one symbol, her rate of symbolic message production (see Figure 2 in Chapter 2, and also the discussion earlier in this section) were also relatively low. Thus, it does not appear that the drive for communication efficiency provides an adequate explanation for her performance.
Extrinsic Variables

In addition to intrinsic factors, a number of external factors may have impacted Robyn’s outcomes, including factors relating to the communication partner, the intervention, and the AAC system. Each of these factors is discussed below.

Communication Partner

It is possible that factors relating to the communication partner – that is, the investigator – impacted Robyn’s data. Children may demonstrate different behaviors with different communication partners or interventionists (Law, 1997), and Robyn may have been more successful with another interventionist or with a wider range of interventionists. As all sessions took place with the investigator, it is not possible to determine if she would have been more successful with someone else. Robyn did appear to enjoy interacting with the investigator. At times, when the investigator came into the classroom to get Robyn for a play session, Robyn would initially indicate that she did not wish to leave (e.g., she shook her head ‘no’ or said no); however, Robyn would agree to join the investigator within a very short period of time (usually less than a minute) and would willingly walk to the other room. Robyn often demonstrated this same behavior when it was time to return to her classroom – that is, indicate a desire to stay and then willingly agree to leave within a minute or two. Robyn’s teacher indicated that this behavior was typical of Robyn; she initially resisted changing activities but quickly agreed after a short period of time. Once she was in the sessions, Robyn demonstrated a range of negative behaviors (as discussed previously), but she also had
periods during every session where she appeared to enjoy being with the investigator (e.g., looking at the investigator and laughing and/or smiling, requesting to sit on the investigator’s lap, etc.). However, it cannot be ruled out that Robyn’s outcome might have been better with a different interventionist.

**Intervention**

Various factors relating to the intervention might have impacted Robyn’s outcome, including the types of models that were provided, the joint attention requirements for the intervention, the context of the intervention, the amount of control over the toys that Robyn had, and the child-centered nature of the play. Two factors involving the types of models must be considered: the variability within the types of models in the current investigation, and the types of models that were not provided within this investigation. First, the current investigation did not control for types of models; that is, models could take the form of comments, expansions, imitations, etc. It is possible that particular types of models, such as expansions, may have facilitated Robyn’s acquisition of multi-symbol messages, if more of these types of models had been provided. Research has indicated that expansions have been used successfully to facilitate the early grammar learning of children with language disorders (Law, 1997). Future research with carefully controlled models is required to further investigate the impact of various types of models on the acquisition of multi-symbol messages for preschoolers who use AAC.
The fact that certain types of models were not included in this investigation must also be considered. One intervention technique that has been successfully used to teach early linguistic structures to children with language disorders is the use of mands followed by models (Rogers-Warren & Warren, 1980; Warren, McQuarter, & Rogers-Warren, 1984). With mand-models, the researcher *mands* a response from the child (e.g., *Tell me what you want*) and then either praises a correct response from the child (e.g., *Great, you said {want WANT} {giraffe GIRAFFE}, and here he is*) or models an appropriate response for the child to imitate (e.g., *You {want WANT} the {giraffe GIRAFFE}*). It is possible that Robyn’s performance might have improved if this intervention technique had been used; at no point during the investigation was Robyn required to produce a multi-symbol message. Future research is required to evaluate the impact of mand-models on the multi-symbol message development of children who use AAC.

It is also important to consider the joint attention skills required for successful completion of the intervention. Learning to shift attention back and forth between an object or activity and a communication partner is a critical stage of communication development (Bakeman & Adamson, 1984). Children who use aided AAC experience higher joint attention demands, as they must shift their attention not only between the partner and activity, but also to their aided AAC device (Cress, 2002). It is possible that Robyn had difficulties with this complex process. However, the joint attention demands were lessened significantly during Intervention #3, when many of the models were provided via manual signs. Robyn still needed to shift focus from the investigator’s hands to the investigator’s face for these types of models, but the gaze shifts were
smaller, compared to having to shift between the investigator’s face and a separate aided AAC system. Robyn failed to show improvements in her productions of symbol combinations following the implementation of manually signed models, suggesting that joint attention demands did not appear to be a major factor in her outcome. It should be noted, however, that Robyn’s mean rate of symbolic productions did increase (i.e., when single-symbol productions were also counted) once models were provided using signs (see Figure 2 in Chapter 3), so it is possible that Robyn had difficulties with joint attention that were somewhat alleviated once manual signs were used.

The context of the intervention included both the types of play activities and the setting of the intervention. With respect to the types of play activities, during Intervention Phase #1, Robyn played with only two different play scenarios (i.e., fast food and tea party), and she may have become bored with these activities. However, a wide variety of play activities were provided during the latter portion of the investigation, and her performance did not improve. The setting remained fairly constant throughout the investigation; the vast majority of sessions took place in the same quiet room at school – in fact, the same room in which intervention with Richard and Nathan took place. It is not known if Robyn’s performance would have improved in another setting, although this seems unlikely. Thus, the context of the intervention did not appear to have an impact on Robyn’s outcome.

Two other external variables pertaining to the intervention that may have affected Robyn’s performance were the degree of control Robyn had over the materials and the degree of directiveness of the play (Fey, 1986). The degree of control Robyn was given over the materials shifted throughout the investigation; initially, the
investigator attempted to retain control over some of the materials, in order to set up situations where Robyn might be motivated to request items. However, Robyn quickly became frustrated with this approach and refused to participate, so for the majority of sessions, Robyn largely retained control over the toys, and, as a result, many of the models consisted of comments on her play. The play was child-centered in nature (Fey, 1986), with models being provided based on Robyn’s actions during play. It is possible that a more adult-directed approach to intervention, with scenarios set up to teach Robyn specific targets pre-determined by the interventionist, might have assisted Robyn with learning to produce multi-symbol messages. Given Robyn’s strong preference to maintain control over play materials and her frequent insistence on performing actions in her own way, however, it is doubtful that Robyn would tolerate a highly structured, adult-directed approach to intervention.

**AAC System**

Sutton and colleagues have argued that there may be factors that are inherent in using aided AAC system that create differences in output (Sutton et al., 2002). One of these factors is that a graphic symbol often depicts more than the precise concept it is intended to depict. For example, the photograph of Play-Doh on Robyn’s light tech board included two jars of Play-Doh, one blue and one red. On several occasions, Robyn specifically and repeatedly pointed to the red jar of Play-Doh to indicate not only that she wanted Play-Doh but that she specifically wanted the red Play-Doh – despite the fact that a symbol for “red” was also available on the board.
Also, there may be something about aided AAC itself that makes putting symbol combinations together difficult for children. As discussed previously, several researchers have found that even young typically-developing children commonly use single-symbol messages when they use AAC to communicate (Smith, 1996; Sutton & Morford, 1998). One possible reason that has been discussed in the literature to explain this phenomenon is that the use of graphic symbols may not be linguistic in nature (Soto, 1999), as discussed in the above section pertaining to Timmy’s word order difficulties. It is difficult to determine how much these types of factors internal to the aided AAC system itself may have impacted Robyn’s performance. These factors did not, however, prevent the other four participants from achieving success with combining symbols. Future research is required investigate the potential impacts of factors internal to aided AAC systems.

Finally, certain types of aided AAC systems may facilitate the development of symbol combinations more than other types of systems. More specifically, the relative benefits of using voice output systems versus light tech non-electronic systems have been discussed in the literature. Smith and Grove (2003), for example, stated that voice output systems may provide children with benefits such as independent feedback on their productions. However, Robyn utilized a high tech voice output system (using digitized speech) as well as light tech communication boards during the investigation, and she did not demonstrate significant differences in her performance across systems. It is important to note, though, that much variation exists across different types of voice output systems, and there may be other factors relating to aspects of different voice output systems that may impact outcomes for children who use high tech.
communication systems (e.g., quality and type of voice output, dynamic versus static display, etc.).

The above discussion indicates that there are multiple factors that may have contributed Robyn’s limited success with the intervention. One of the factors that differs most strikingly between Robyn and the other participants was her variable (and, overall, relatively low) rate of symbolic turn-taking. If, indeed, this variable was responsible for her relatively poor performance, a more appropriate initial goal for Robyn would be to increase her overall rate of symbolic turns, and perhaps expand the range of concepts that she can reliably express. Such a goal is also suitable for children who are inactive communicators (Fey, 1986). As an initial step for these children, Fey suggests increasing the child’s rate of positive social bids – both verbal and nonverbal – within a variety of social contexts. Although caution must be taken with interpreting the results of Intervention Phase #3 (i.e., there were no experimental controls in place and there were relatively few data points), the positive changes in the means during the last intervention phase suggested that using multi-modal models should be explored as well.

Generalization of Multi-Symbol Messages

Four of the five participants – Valerie, Timmy, Nathan, and Richard – completed this portion of the investigation; as Robyn did not meet criterion during the intervention phase, no generalization data were taken for her. Valerie, Timmy, Nathan and Richard completed the GEN W/O phase; Nathan and Richard completed the GEN W/ phase.
Generalization to New Play Scenarios: Without Models (GEN W/O)

For this phase of the investigation, participants engaged in play with the investigator using two new play routines without the support of aided AAC models. All four participants who completed this phase used multi-symbol messages at rates well above baseline levels, with three participants exceeding criterion during both sessions. These three children (Valerie, Timmy, and Richard) produced multi-symbol messages with frequencies that were similar to – and in Richard’s case, superior to – their levels during the last few sessions of the instructional phase. These results indicate not only that the participants used these skills within new play scenarios but also provided evidence that they had truly learned to create generative multi-symbol messages. Only Nathan’s performance was below criterion; he used 10 and 9 multi-symbol messages in these sessions, respectively. These results should not be interpreted to mean that aided AAC modeling should be discontinued for these children, however. Continuing to use aided AAC models for other language development purposes – for example, to promote a broader range of semantic-syntactic relations or expand messages beyond the 2-symbol level – may be highly beneficial.

Several characteristics of the intervention may have helped to support the participants’ success with generalization. First, the participants were exposed to two-symbol aided AAC structures that contained a variety of concepts across a variety of semantic-syntactic categories. Using a broad array of exemplars helps children generalize the use of linguistic forms to new contexts (Fey, 1986). Providing the preschoolers with models of a variety of structures may have enabled them to use
symbol combinations with new vocabulary and play routines more easily than if they had only been exposed to a very narrow class of linguistic structures. Second, the child-centered nature of the intervention was designed to create contexts in which the child’s motivation to communicate was “present and real” (Fey, 1986, p.176), which promotes generalization of newly learned structures. Each child selected his or her play scenarios from a larger pool of toys, which helped ensure that the child would be motivated to communicate within those settings. Further, the fact that intervention was designed to follow the child’s lead may have provided the participants with a high level of motivation to communicate, within both intervention and generalization play scenarios.

It is difficult to say, for sure, why Nathan required the use of ongoing use of models and the other participants did not. His data do not differ markedly from the other participants who were successful with this phase of the intervention, with respect to his performance on any of the measures taken during other phases of the investigation (i.e., number of symbol combinations, number of different symbol combinations, semantic-syntactic categories, and modes of communication). As there are no clear indicators that might explain the difference in his performance in GEN W/O phase, then, it is important from a clinical perspective not to assume that any given child will automatically generalize the use of multi-symbol messages to new contexts without the on-going support of aided AAC models.
**Generalization to New Play Scenarios: With Models (GEN W/)**

The methods stipulated that participants who were not able to meet criterion in the generalization without models phase would then be provided with aided AAC models. Nathan was the only participant required to complete this phase of the investigation. Nathan’s performance was at or exceeded criterion during each of his two GEN W/ sessions; he produced 12 multi-symbol messages during the first session in which aided AAC modeling was used, and 21 symbol combinations in the second session. This finding indicates that the continued use of aided AAC modeling may be required for some children to maintain high levels of multi-symbol productions within novel activities.

Although he was not required to do so (i.e., he met criterion during the generalization without models phase), Richard also completed this phase of the investigation, as he produced relatively few semantic-syntactic categories during the first generalization phase. His frequencies of multi-symbol productions increased during this phase (21 and 24 combinations during GEN W/O phase, and 24 and 28 during the GEN W/ phase), and additionally, he produced messages that contained two semantic-syntactic categories he had not produced during the first generalization phase. Using aided AAC modeling within these new play scenarios, then, appeared to aid in Richard expanding the semantic-syntactic diversity of his messages.
Maintenance of Multi-Symbol Messages

All four of the participants who successfully completed the intervention phase (Valerie, Timmy, Nathan, and Richard) maintained high levels of multi-symbol productions for two full months after intervention ceased. These results suggest the positive long-term effects of aided AAC modeling to support the development of multi-symbol messages, at least for most of the participants, regardless of whether high tech or light tech aided AAC systems are used. Several reasons for the participants’ ongoing success may be hypothesized. First, measures were taken within the procedures to ensure that the participants were consistently producing multi-symbol messages with relatively high frequency before intervention ceased; they were required to produce at least 12 multi-symbol messages across three consecutive sessions. Second, the intervention was designed to promote the participants’ productions of generative language. Once typically developing children begin to enter this stage of language development, their message length increases over time (Miller & Chapman, 1981), and they are not expected to lose this skill. If the participants within the current investigation truly began to use language generatively, it would not be anticipated that they would lose this skill over time. The fact that the four participants who completed this phase not only met the criterion for the number of symbol combinations that they produced but also (a) produced a number of different symbol combinations, (b) produced a number of different semantic-syntactic categories, and (c) generalized use of symbol combinations to new play scenarios indicates that they had begun to generate novel symbol combinations.
Results from the current investigation, then, support the use of aided AAC modeling to assist preschoolers who require AAC in the development of multi-symbol messages, at least for some children. Future research is required to examine the efficacy of using aided AAC modeling to teach other linguistic skills across a variety of contexts with a variety of communication partners.

**Implications of the Findings**

**Clinical Implications**

The results of the investigation provide evidence that aided AAC modeling may be used to support the development of early symbol combinations, at least for some preschoolers who require AAC. The four participants who achieved criterion completed the intervention phase with total instructional times ranging from 4 sessions (i.e., 1 hour) to 15 sessions (i.e., 3.75 hours), indicating that instruction was not only effective for these preschoolers but also efficient.

The present study demonstrated the effectiveness of aided AAC modeling with preschoolers with a wide range of disabilities. The four preschoolers who successfully completed the current investigation had a variety of disabilities, including Prader Willi Syndrome (Valerie), DiGeorge Syndrome (Timmy), and characteristics consistent with a diagnosis of developmental apraxia of speech (Nathan and Richard). These preschoolers ranged in age from 3;5-4;4 and had overall language comprehension age equivalent
scores on the TACL-3 of 3;5-3;11. Aided AAC modeling, then, should be effective for teaching preschoolers to produce multi-symbol messages who have language comprehension skills that fall within this range. Further, results indicate that this technique can be effective for children who use high tech devices as well as those using non-electronic devices.

It is encouraging that all four children who met criterion during the intervention phase successfully generalized use of multi-symbol messages to novel play scenarios. Nathan, however, did require aided AAC models in order to maintain the frequency of symbol combinations he had achieved during the intervention phase. Further, Richard benefited from the use of continued aided AAC modeling within these new scenarios to increase the diversity of the semantic-syntactic relations that he expressed. For some children, then, continuing with aided AAC modeling may be important for promoting the use of symbol combinations within new contexts and to promote the diversity of these combinations.

It is important to note that based on the results, it is not entirely clear which preschoolers may benefit significantly from the use of aided AAC modeling within a child-centered play contexts and which may not. Valerie, Timmy, Nathan, and Richard all demonstrated significant increases in their productions of multi-symbol productions, but Robyn did not. It is unclear what the critical factors are in determining success with the use of aided AAC modeling. Perhaps closer examination of other skills such as overall symbolic turn-taking rates may be warranted before proceeding with symbol combination goals; future research is required to determine what the key factors are for predicting success with aided AAC modeling.
It is also critical to remember that learning to produce multi-symbol messages is only the first step in learning productive grammar. In typical language development, the two-word stage marks the beginning of generative language (Bowerman, 1973; Paul, 1997). Typically developing children rapidly acquire productive morphology and syntax, integrating ever more complex rules for combining and recombining words and morphemes. Children who require AAC also need to use learn the rules of language. Unfortunately, very little is known about how to best support these essential skills with children who require AAC, and future research is required to guide the way.

**Potential Modifications to Aided AAC Modeling**

Although the use of aided AAC modeling was effective with four of the five children, it is still appropriate to consider potential modifications to improve this approach to intervention. The factors affecting Robyn’s relatively poor performance are not known, but it is possible that making modifications to the intervention may have facilitated her production of multi-symbol messages. For example, utilizing enhanced milieu teaching (Kaiser et al., 1997), which takes a child-centered approach to intervention not unlike the current investigation but also requires responses from the child, might be more beneficial for some children.

Timmy’s difficulties with word order indicate that changes might be made so that children who have difficulty with word order can quickly learn to correct their errors. Once Timmy had completed all phases of the investigation, a second brief intervention was implemented to help Timmy learn to adhere to English syntax rules for
agent + action + object combinations. As discussed in Chapter 3, this intervention included the use of various techniques, including adding a “message bar” at the top of each “page” on his AAC device, providing aided AAC models of correct word order for both two and three-symbol messages, providing Timmy with feedback that was both general (e.g., “I’m sorry, I didn’t understand that) and specific (e.g., “No, I think you mean _____”), prompting Timmy to imitate aided AAC models, and asking elicitation questions (e.g., the mouse asks Timmy, “What should I do next?”). No experimental controls were implemented during this intervention, and future research is required to examine best practices for teaching word order to preschoolers who use AAC.

Making modifications to integrate the use of aided AAC modeling within home and classroom settings is also required. All sessions in the current investigation took place within a quiet room, typically with only the investigator present, in order to ensure experimental control. Although this was an appropriate setting for this initial investigation into the effects of aided AAC modeling, using these models within the settings in which children spend most of their time was suggested by one speech-language pathologist during the social validation phase of the investigation and also fits into the best practice recommendations within the field (e.g., Fey, 1986; Light, 1997; Romski & Sevcik, 1996). Examining methods for teaching typical communication partners how to use aided AAC modeling to promote symbol combinations is also required. Kent-Walsh (2003) successfully implemented an instructional model that included the use of aided AAC models to teach educational assistants how to improve the participation levels of children who used AAC; it may be beneficial to adapt such
programs to teach communication partners how to facilitate multi-symbol productions with preschoolers who use AAC.

All four participants who completed the maintenance phase of the investigation continued to use multi-symbol messages at criterion level for two months after instruction ceased, so it appeared that, at least for these four participants, continuing to provide aided AAC models on a consistent basis was not required within specific play scenarios (i.e., aided AAC models were provided during the maintenance checks, but they had not been receiving aided AAC modeling in the interim); no obvious modifications to the intervention are apparent from these results. However, continuing to provide aided AAC models may be critical to support the ongoing linguistic growth of children who use AAC. Future research is required to examine the impact of aided AAC modeling on other linguistic structures.

With respect to generalization, Nathan was not able to generalize use of multi-symbol productions within novel play routines at criterion level until aided AAC modeling was used. For some children, then, it may be necessary to continue to provide aided AAC models to promote the ongoing use of high rates of multi-symbol productions. Another possibility is to provide aided AAC models within a wider range of contexts from the beginning. Some researchers have recommended using aided AAC modeling within a variety of contexts throughout the day (Goossens', 1989; Sevcik et al., 1995), which may help some children to use multi-symbol combinations within a wider range of contexts more readily.
Summary of Contributions

The current investigation differs from other studies that have utilized aided AAC modeling in two critical ways. First, the current investigation is the first study to isolate the impact of aided AAC modeling; previous studies that included aided AAC modeling used this type of modeling as one part of a larger intervention package, without examining the relative importance of modeling per se. Some common techniques that have been used in conjunction with aided AAC modeling have included the following: ensuring access to aided AAC, using wait time and expectant delays to ensure adequate opportunities for communication, and asking open-ended questions (e.g., Basil, 1992; Basil & Soro-Camats, 1996; Bruno & Dribbon, 1998; Kent-Walsh, 2003; McNaughton & Light, 1989).

Second, most studies utilizing models that include the use of aided AAC have focused on improving pragmatic skills and/or building an initial lexicon, not on building generative symbol combinations. Most commonly, studies have aimed to increase participation levels of individuals using AAC (e.g., Basil, 1992; Bruno & Dribbon, 1998; Johnston, Nelson et al., 2003; Kent-Walsh, 2003; McNaughton & Light, 1989; Schlosser, McGhie-Richmond, Blackstien-Adler, Mirenda, & Antonius, 2000), and several studies have focused on building an initial expressive lexicon (e.g., Basil & Soro-Camats, 1996; Goossens', 1989; Romski & Sevcik, 1996). The results of the current investigation have expanded these findings by providing evidence, within an experimentally controlled research investigation, that using aided AAC modeling within
play contexts is an effective technique for promoting early symbol combinations, at least for some children.

**Limitations of the Investigation**

Despite the success of using aided AAC modeling to promote early symbol combinations with four of the five preschoolers who required AAC, a number of limitations for the study must be considered when interpreting the results and identifying future research directions. First, relatively few preschoolers participated in this investigation, and replication of the study is required to strengthen the external validity of the results. Only two children who used voice output systems and two who used light tech communication boards successfully completed the investigation. The results are complicated by the fact that one participant, Robyn, did not meet criterion, and the key factor or factors that affected her lack of progress remain uncertain. Further research in this area is required to determine precisely what variables may or may not predict success when using aided AAC modeling within a child-centered approach to intervention.

Within the current investigation, the participants were not required to produce symbol combinations during the investigation. It is possible that some children may benefit, at least in the initial stages, from more structured approaches to intervention, and that some children may also benefit from the use of direct prompts.

Also, the procedures for this investigation did not control the specific types of aided AAC models that were used. The procedures were set up so that two-symbol
models – and only two-symbol models – were provided following a child’s communicative attempt or action. The aided AAC models, then, sometimes took the form of simple expansions (e.g., \{more MORE\}{milk MILK}, if the child said MILK), imitations (\{more MORE\}{milk MILK} if the child said MORE MILK), recasts (e.g., \{more MORE\}{milk MILK} if the child said WANT MILK), and models of the child’s actions (e.g., \{more MORE\}{milk MILK} if the child pointed to the milk). Given the design of this investigation, it is not known whether certain types of models better facilitated the participants’ acquisition of multi-symbol messages.

Another issue relating to the types of models is the fact that the models presented during the intervention phase contained more elements than the models presented during baseline, and were, in effect, build-ups and breakdowns of linguistic structures. Additionally, although efforts were made to isolate the impact of aided AAC models on the participants’ acquisition of early symbol combinations and to control the modes of communication that were provided (i.e., no manual signs were used), the children were presented with models that included multiple communication modes, including aided AAC, speech, and yes/no head nods/shakes. It is not possible to disentangle the effects of the increased length of the models and the mixture of modes used within the current investigation.

Also, the fact that the same instructor (i.e., the investigator) instituted the use of aided AAC modeling with all of the participants limits the external validity of the investigation (Kazdin, 1982). It is not known how effective or efficient this intervention approach might be with other instructors.
Another limitation is that for the generalization phase, the only measures taken were for other similar contexts – that is, similar types of play scenarios. It is not known if providing these types of models within different types of contexts, such as book sharing, bath time, mealtime, circle time, etc., is efficacious. Although providing aided AAC modeling within these types of settings would further strengthen the generality of the results, the impact of such an approach is unknown.

Several other limitations also relate to the generality of the results. The current investigation took place within one setting – that is, in a quiet room alone with each participant – and it is critical to examine the impact of aided AAC modeling within other settings that reflect the everyday life of children who require AAC, including implementation in both the classroom and at home. Similarly, the types of vocabulary that were used was constrained within the current investigation; some commonly used semantic-syntactic relations, such as demonstratives and attributes, were not included on the participants’ aided AAC systems. Future research is required to examine the impact that including these types of symbols has on the acquisition of multi-symbol messages with children who use AAC.

With respect to maintenance, data were only collected for two months after the generalization phase ended. Tracking children for longer periods of time to ensure that they continue to use multi-symbol messages – and continue to increase the length and diversity of their symbol combinations – is critical.
Directions for Future Research

Several potential directions for future research can be identified based on the results of the investigation. First, the results need to be replicated with a wider variety of participants and interventionists. With respect to participants, all of the preschoolers in the current investigation were preschoolers who (a) had relatively intact motor skills, (b) had language comprehension age equivalent scores that were at least at a 3 year old level, and (c) did not have a PDD spectrum disorder. Although children with significant motor impairments were not excluded from the investigation, none participated in this research project. Certain modifications might need to be made for children who have significant motor impairments; they may, for example, require more time to communicate, and intervention sessions may need to be longer – or be integrated all throughout the day – to ensure that they have time to produce a sufficient number of symbol combinations. With respect to language comprehension, typically developing children begin to combine words by approximately 18 months of age (Owens, 2001; Rescorla, 1989). Replication of the investigation with children who are at the earlier stages of language development, then – including both children who do and do not have suspected accompanying cognitive impairments – is warranted. Similarly, replication with children across a wider age range is also warranted. For example, many school-aged participants with moderate to severe mental retardation who participated in the study by Romski, Sevcik and colleagues (Romski & Sevcik, 1996; Sevcik et al., 1995), which included the use of aided AAC models, began producing symbol combinations during the course of the two year investigation (Wilkinson et al., 1994). Replicating the
results of the current investigation with individuals who have cognitive impairments would add to the generality of the results. Additionally, aided AAC modeling has been recommended for use with children who have autism (Mirenda, 2001), with some initial evidence suggesting that including aided AAC modeling may be beneficial in supporting the early language development of these children (Cafiero, 2001). Investigating the impact of aided AAC models on symbol combinations with individuals who have autism would be beneficial.

Another critical step is to investigate the effects of teaching others how to use aided AAC modeling. Many instructional programs designed for parents, teachers, and educational assistants have recommended and included the use of aided AAC modeling in their programs (e.g., Bruno & Dribbon, 1998; Kent-Walsh, 2003; Sevcik et al., 1995), but little is known as to the most efficient and effective means for teaching these skills to communication partners. Most of the research in this area to date has focused on describing the components of the programs that were taught to the individuals using AAC, with little information provided regarding how this information was provided to the communication partners. One notable exception is a recent investigation by Kent-Walsh (2003), who utilized a strategy instruction program to teach educational assistants to provide better supports for increasing the turn-taking of students using AAC. Following a maximum of only 3.5 hours of instruction to teach a strategy (which included the use of aided AAC modeling, in addition to other components), marked improvements were observed both with the educational assistants’ implementation of the strategy and with the participants’ turn-taking skills. Further investigation into the efficacy of using such instructional techniques to teach others how to support not only
pragmatic skills such as turn-taking but also linguistic skills such as promoting early symbol combinations is desperately needed.

Another area for investigation is research into the factors that influence success with aided AAC modeling. One participant, Robyn, achieved limited success with aided AAC modeling, and it is important to gain understanding as to the key factors that may influence the effects of aided AAC modeling across children. Also, investigations of the efficacy of using aided AAC models versus unaided and multimodal AAC models are needed. For example, it is possible that for some children, using unaided models such as manual signs may be more efficacious. One benefit of using signs is that they do not require the child to shift his focus of attention as much as unaided modes. Children who use aided AAC must shift their attention regularly among the communication partner, the activity, and the aided communication device, which places complex attentional demands on the child (Cress, 2002). For some children, then, modeling signs – which, unlike aided AAC, are always located in the same place as the partner and do not require as much shift of attention – may be a better approach for supporting early language development. Another approach that may also help limit the attentional demands placed on the child is to bring aided AAC symbols in line with the communication partner. For other children, using a variety of modes or only aided modes may be best. Research is required to answer these complex questions.

Research into adapting and using various types of modeling techniques (e.g., recasts, expansions, and direct imitations) is also warranted. The child language disorders literature is replete with discussions and research investigations into the relative effects of various types of modeling techniques (e.g., Camarata et al., 1994;
Connell, 1987; Leonard, 1981). It is interesting to note that recent intervention approaches within the child language disorders field typically recommend and include the use of various modeling techniques within the same intervention package (e.g., Fey et al., 1997; Fey et al., 1993; Fey et al., 2003; Hemmeter & Kaiser, 1994; Kaiser & Hester, 1994). It is important, nonetheless, to carefully examine various modeling techniques with children who use AAC.

Another critical area for further research is comparing the effectiveness and efficiency of aided AAC modeling with and without the use of explicit prompts. For the current investigation, no explicit, direct prompts were used to elicit symbol combination productions from the participants. Research has shown, however, that the use of such prompts within child-centered approaches to intervention can facilitate the production of early linguistic structures from children with language disorders (see Kaiser et al., 1997, for a review), and it is important to examine the effects of these techniques with children who use AAC.

Finally, further investigation into the use of aided AAC modeling to teach other linguistic structures – and to remediate linguistic structures when required, as in the case of Timmy with word order patterns – is required. Remarkably little research exists pertaining to interventions to facilitate the language skills of children who require AAC. Results from the current investigation indicate that aided AAC modeling, when used within a child-centered approach to intervention, is a promising technique for facilitating symbol combinations with children who use AAC, but it is not known what the impact of using this technique to teach other linguistic structures would be. Future research is required to fill this critical gap in the literature.
Conclusions

The current investigation contributes important information on the effects of using aided AAC modeling on preschoolers’ use of early multi-symbol messages. Overall, the results provide initial evidence that aided AAC modeling is an effective method for teaching this skill to at least some preschoolers, but that the use of aided AAC modeling may not dramatically improve the frequency of symbol combinations for all preschoolers. The findings also indicate that the preschoolers learned generative language skills; they demonstrated diversity in both their different symbol combinations and also the number of different semantic-syntactic categories expressed. Results also indicate that some preschoolers generalized use of symbol combinations to new contexts (specifically, to new play scenarios) without being provided with aided AAC models, at least in the short term, but that some children may benefit from the continued use of such models to maintain high levels of production and diversity across semantic-syntactic relations. Finally, the data suggests that preschoolers who successfully learn to produce multi-symbol messages continued to do so for up to two months after intervention ceased. The use of aided AAC modeling, then, when used within a child-centered context for intervention, can be an effective means for helping preschoolers who require AAC with the first stages of generative language production.
REFERENCES


Appendix A
Comprehension of Spoken Two- and Three-Word Relations

Materials
- objects and actions that were used during instruction (Miller & Paul, 1995)
- people child knew (comprehension of names)

Stimuli
- Action-object, possessor-possession, and agent-action-object relations

Procedures
Action-object
- Make several objects available from which the child has to choose (Miller & Paul, 1995), including two toy animals or figurines and two objects such as a washcloth and cookie
- Ask the child to perform an action on an object he/she is not already attending to (Miller & Paul, 1995)
  E.g., “Wash the dog.”
- Use actions participants are physically capable of performing
- Perform actions on unusual objects, when possible; for example, bite the cow, not the cookie (Miller & Paul, 1995)
- Items
  o Wash the dog
  o Dry the horse
  o Brush the chicken
  o Bite the cow
  o Hide the giraffe
  o Drop the lady
  o Spill the tea
  o Feed the dog
  o Bite the chicken
  o Clean the boy

Possessor-possession
- Make several objects available from which the child has to choose (Miller & Paul, 1995), including two possessors and four possessions (e.g., a teacup and spoon for both giraffe and alligator)
- Ask the child a question using the carrier phrase, “Where’s the ______” (Miller & Paul, 1995).
  E.g., Place a teacup and plate in front of the giraffe and alligator and ask, “Where’s giraffe’s tea?”
- Items
  1. [Child’s] cup
  2. [Researcher’s] plate
  3. Giraffe’s tea
4. Alligator’s milk
5. Fish’s plate
6. Dog’s spoon
7. Giraffe’s spoon
8. Alligator’s balloon
9. Lady’s present
10. Child’s present

Agent-action-object
- Made several objects available from which the child had to choose (Miller & Paul, 1995), including two toy animals or figurines and two objects such as a washcloth and cookie
- Asked the child to perform an action on an object to which the child was not already attending (Miller & Paul, 1995)
  - E.g., “Show me, ‘The dog is eating a cookie.’”
- Instructions were not be semantically reversible
- Items
  o The dog is eating a cookie
  o The giraffe is drinking milk
  o [child] is spilling the milk
  o [child] is cleaning the table
  o Grandpa is feeding the horse
  o The lady is riding the chicken
  o Grandpa is brushing the cow
  o [Child’s name] is washing the horse
  o The fish is blowing the balloon
  o The giraffe is giving the present
Appendix B
Comprehension of Target Graphic Symbols

Purpose
- Ensure participants’ ability to pair referents and spoken labels of target vocabulary with the graphic symbols that were used during the investigation

Procedures
- Determine best way for child to make selection (pointing w/ index finger, open hand, etc.)
- Present child with the vocabulary items on grids that are identical to the ones used during instruction.
- Show child the referent and say, “Show me [target]”
  o For agents and objects, show child target item
  o For actions, demonstrate target action
- Child indicates symbol (via direct selection)
- Teach symbols that participants do not identify correctly (see below)

Teaching Graphic Symbols
- Goal: ensure child understands symbols
  o Taught via paired instructional paradigm (e.g., Hunt-Berg, 1996; Schlosser & Lloyd, 1997)
    ▪ Objects
      ▪ Show child real object and symbol simultaneously, while providing spoken label
      ▪ Explicitly point between the object and symbol while labeling to visually link the object and symbol (Hunt-Berg, 1996)
    ▪ Actions
      ▪ Show child the action and symbol simultaneously, while providing a spoken label
      ▪ Have symbol “follow” the action while labeling to visually link the action and symbol (e.g., for “drop,” the graphic symbol for “drop” was dropped along with an object
- Label each item/action 3-4 times
- Retest items, with a minimum of 10 items presented during re-testing, once all missed items are taught via paired instructional paradigm
  o Include all items child missed
  o If child missed fewer than 10, randomly select remaining items from pool of symbols that child correctly comprehended

Passing Criterion
- participants had to achieve at least 90% accuracy across all symbols to move on to the baseline phase
Appendix C – Participants’ Aided AAC Display Samples

Copy of Birthday Play Scenario (Nathan)

- Child signing "MORE"
- Child signing "ALLDONE"
- Child shaking head
- Head and shoulders photo of child
- Child signing "WANT"
Copy of Fast Food Play Scenario (Richard)

Child signing MORE

Child signing ALLDONE

Child shaking head

Richard

Child and shoulders photo of child

Child signing WANT
Copy of Tea Party Play Scenario (Richard)
Copy of Kitchen and Baby Play Scenarios (Robyn)
## Appendix D

### Vocabulary Items for Play Scenarios

<table>
<thead>
<tr>
<th>Semantic Role</th>
<th>Type of Representation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Available for Each Scenario</strong></td>
<td></td>
</tr>
<tr>
<td>[Child’s name]</td>
<td>Agent</td>
</tr>
<tr>
<td>[Researcher’s name]</td>
<td>Agent</td>
</tr>
<tr>
<td>want</td>
<td>State</td>
</tr>
<tr>
<td>more</td>
<td>Recurrence</td>
</tr>
<tr>
<td>allgone</td>
<td>Action</td>
</tr>
<tr>
<td>no</td>
<td>Negation</td>
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### Tea Party

<p>| | |</p>
<table>
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<tr>
<td>Dog</td>
<td>Agent</td>
</tr>
<tr>
<td>Giraffe</td>
<td>Agent</td>
</tr>
<tr>
<td>Doll</td>
<td>Agent</td>
</tr>
<tr>
<td>Bite</td>
<td>Action</td>
</tr>
<tr>
<td>Drink</td>
<td>Action</td>
</tr>
<tr>
<td>Spill</td>
<td>Action</td>
</tr>
<tr>
<td>Cookie</td>
<td>Object</td>
</tr>
<tr>
<td>Tea</td>
<td>Object</td>
</tr>
<tr>
<td>Milk</td>
<td>Object</td>
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### Farm

<p>| | |</p>
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<tr>
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<tr>
<td>Grandpa</td>
<td>Agent</td>
</tr>
<tr>
<td>Lady</td>
<td>Agent</td>
</tr>
<tr>
<td>Ride</td>
<td>Action</td>
</tr>
<tr>
<td>Brush</td>
<td>Action</td>
</tr>
<tr>
<td>Feed</td>
<td>Action</td>
</tr>
<tr>
<td>Horse</td>
<td>Object</td>
</tr>
<tr>
<td>Cow</td>
<td>Object</td>
</tr>
<tr>
<td>Chicken</td>
<td>Object</td>
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</tbody>
</table>

### Washing baby

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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<td>Alligator</td>
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<td>Agent</td>
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<td>Frog</td>
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<td>Wash</td>
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<td>Dry</td>
<td>Action</td>
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<tr>
<td>Splash</td>
<td>Action</td>
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<tr>
<td>Face</td>
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<td>Ear</td>
<td>Object</td>
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<td>--------</td>
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<td><strong>Vehicles</strong></td>
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<td>Hit</td>
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<td>Drive</td>
<td>Action</td>
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<tr>
<td>Chase</td>
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<td>Truck</td>
<td>Object</td>
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<tr>
<td>Bus</td>
<td>Object</td>
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<td><strong>Kitchen</strong></td>
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<td>Bear</td>
<td>Agent</td>
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<td>Mouse</td>
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<td>Clean</td>
<td>Action</td>
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<td>Carry</td>
<td>Action</td>
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<td>Drop</td>
<td>Action</td>
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<td>Table</td>
<td>Object</td>
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<tr>
<td>Cup</td>
<td>Object</td>
</tr>
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<td>Plate</td>
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<td><strong>Fast Food</strong></td>
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<td>Squirrel</td>
<td>Agent</td>
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<td>Sheep</td>
<td>Agent</td>
</tr>
<tr>
<td>Cat</td>
<td>Agent</td>
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<td>Eat</td>
<td>Action</td>
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<tr>
<td>Lick</td>
<td>Action</td>
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<tr>
<td>Help</td>
<td>Action</td>
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<td>Object</td>
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<td>Ice cream</td>
<td>Object</td>
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<td>Chicken nuggets</td>
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<td><strong>Birthday party</strong></td>
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<tr>
<td>Lion</td>
<td>Agent</td>
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<td>Tiger</td>
<td>Agent</td>
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<td>Monkey</td>
<td>Agent</td>
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<td>Blow</td>
<td>Action</td>
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<tr>
<td>Give</td>
<td>Action</td>
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<td>Play</td>
<td>Action</td>
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Appendix E
Procedural Standard

GOALS AND CONTENT OF INVESTIGATION PHASES

<table>
<thead>
<tr>
<th>Session Type, Number, &amp; Length of Sessions (in minutes)</th>
<th>Goals</th>
<th>Content</th>
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I. BASELINE PHASE
<table>
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<tr>
<th>Baseline Sessions</th>
<th>Setup</th>
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<tr>
<td>3 minimum (15 min. each)</td>
<td>- Researcher sets up camcorder so that child, researcher, and AAC device are all within view</td>
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<td>- AAC device available to and facing participant</td>
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<tr>
<td></td>
<td>- Child sits at ninety degree angle from the researcher, with the AAC device in front of the researcher facing the child; or</td>
</tr>
<tr>
<td></td>
<td>- Child and researcher sit opposite each other, with the AAC device facing the child but at a slight angle for better viewing on the video recording</td>
</tr>
</tbody>
</table>

**Provide Two Initial Spoken Models**

- Instructor provides two spoken models at the beginning of each play scenario
  - e.g., The researcher had the doll pour and then spill the tea
    - *The doll is pouring the tea.*
    - *He spilled the tea!*
- Instructor pauses to allow the child an opportunity to communicate
  - Length of pause = (a) the mean of each child’s turn transfer time (over 10 turns); or (b) one second, whichever was higher.
- If child communicates or completes an action during spoken models
  - Provide a spoken model that reflects the child’s symbolic message or action during play
  - Move on to “Provide Spoken Models during Play”
- If the child does or says nothing
  - Provide an expectant delay (i.e., gazing at child with expectant facial expression; normal turn transfer time + 5 seconds)
  - Move on to “Provide Spoken Models during Play”

**Provide Spoken Models during Play**

- Provide spoken models using the vocabulary that is represented graphically on the child’s AAC device
- After the child takes a symbolic turn or completes an action
  - Pause for at least one second to ensure child has completed his/her turn
  - Provide spoken model
- Provide a spoken model that reflects the symbolic turn or action for each symbolic turn or action that the child completes; e.g.,
  - Child: *TIGER*
  - Researcher: *Tiger gives monkey the present*
  - OR:
    - Child: (Points to tiger and to the present)
    - Researcher: *Tiger gives monkey the present.*
  - OR:
    - Child: (Has tiger play the game) (at least one sec. pause)
    - Researcher: *Tiger played the game*
- After the spoken model
208

Pause to provide the child with an opportunity to communicate
Length of pause = (a) the mean of each child’s turn transfer time (over 10 turns); or (b) one second, whichever is higher
Provide and expectant delay (i.e., gazing at child with expectant facial expression) if the child says or does nothing (typical turn transfer time + 5 seconds)
Provide another spoken model if the child still does or says nothing after the expectant delay

Length of Play Scenarios
- Each play session is 15 minutes in length

Off-task behaviors
- Respond to the child without providing a model if
  - the child is hurting someone
  - the child is causing damage to the materials
  - the child is communicating about things outside of the play scenarios (e.g., pointed to the stairs to indicate a desire to get a doll from her bedroom)
  - the researcher requests clarification from the child

II. INTERVENTION PHASE

Intervention Sessions
- Taught participant to express multi-symbol messages by modeling use of aided AAC

Setup
- Researcher sets up camcorder so that child, researcher, and AAC device are all within view
- AAC device available to and facing participant
  - Child sits at ninety degree angle from the researcher, with the AAC device in front of the researcher facing the child; or
  - Child and researcher sit opposite each other, with the AAC device facing the child but at a slight angle for better viewing on the video recording

Provide Two Aided AAC Models and Spoken Models
- Provide two models using two-symbol aided AAC models whenever a new play scenario is introduced
  - e.g., The researcher has the doll pour and then spill the tea
    - \{DOLL doll\} \{POUR pour\} The doll is pouring the tea.
    - \{SPILL spill\} \{TEA tea\} He spilled the tea!
- Pause to allow the child an opportunity to communicate
  - Length of pause = (a) the mean of each child’s turn transfer time (over 10 turns); or (b) one second, whichever is higher.
- If child communicates or completes an action during models
  - Provide an aided AAC model that reflects the child’s symbolic message or action during play
  - Move on to “Provide Aided AAC Models during Play”
- If the child does or says nothing
Provide an expectant delay (normal turn transfer time + 5 seconds)
- Move on to “Provide Aided AAC Models during Play”

Provide Aided AAC Models and Spoken Models during Play
- After the child takes a symbolic turn or completes an action
  - Pause for at least one second to ensure child has completed his/her turn
  - Provide an aided AAC model
- Provide a two-symbol aided AAC model that reflects the child’s symbolic turn or action, followed by a brief grammatically complete spoken utterance; e.g.,
  - Child: (Points to tiger and to the present)
  - Researcher: {TIGER tiger}{GIVE give} Tiger gives monkey the present.

OR:
- Child: (Has tiger play the game) (at least one sec. pause)
- Researcher: {TIGER tiger}{PLAY play} Tiger played the game
- After the two-symbol aided AAC model and spoken model
  - Pause to provide the child with an opportunity to communicate
    - Length of pause = (a) the mean of each child’s turn transfer time (over 10 turns); or (b) one second, whichever is higher
  - Provide and expectant delay (i.e., gazing at child with expectant facial expression) if the child says or does nothing (typical turn transfer time + 5 seconds)
  - Provide another spoken model if the child still does or says nothing after the expectant delay, following the procedures above

Length of Aided AAC Models
- Two symbols are selected on the aided AAC system, regardless of the length of the child’s previous message
  - Light tech: the researcher labels each symbol while pointing to them (see examples above)
  - High tech: Voice output provided is by the device
- After the two symbols are selected on the AAC device, the investigator provides a brief, grammatically complete spoken model (see examples above and sample script in Appendix F)

Length of Play Scenarios
- Each play session is 15 minutes in length

Off-task behaviors
- Respond to the child without providing a model if
  - the child is hurting someone
  - the child is causing damage to the materials
  - the child is communicating about things outside of the play scenarios (e.g., pointed to the stairs to indicate a desire to get a doll from her bedroom)
o the researcher requests clarification from the child

III. GENERALIZATION WITHOUT AIDED AAC MODELS

| Generalization without Models | - Determined if participant generalized use of multi-symbol messages to new play contexts without the benefit of aided AAC models |
| Sessions | - Procedures were identical to Baseline Sessions guidelines |
| 2 minimum (15 min each) | - The two play scenarios chosen for generalization were used |

IV. GENERALIZATION WITH AIDED AAC MODELS

| Generalization with Models | - Determined if participant generalized use of multi-symbol messages to new play contexts with the benefit of aided AAC models, if participant was not at criterion without the aid of aided AAC models |
| Sessions | - Procedures were identical to Intervention Sessions guidelines |
| 0-2 (15 min each) | - The two play scenarios chosen for generalization were used |
| | - Only completed if participant fell below criterion in Phase III |

V. MAINTENANCE SESSIONS

| Maintenance Sessions | - Determined if participant continued to produce multi-symbol messages after instruction ceased |
| 3 sessions (15 min each) | - Procedures were identical to Intervention Sessions guidelines |
| | - The same two play scenarios that were used for Intervention Sessions were used |
| | - Conducted “booster sessions” if fewer than 12 multi-symbol messages were produced |

Appendix F

Sample Transcript of Intervention Session

| RICHARD | INVESTIGATOR |
| Symbolic Messages | Actions | Symbolic Messages | Actions |
| (Points to bus) WANT [0.0]BUS | [1.3] |
\{WANT \  want\} \{ BUS \ bus\}
You want the bus

(Takes bus)

\{WANT \} \{ CAR \}
\{ GIRL \}
\{ GIRL \  girl\} \{ CAR \  car\}
You want the girl and the car

(Gives R the girl and the car)

(Crashes car and bus)
(Laughs)

\{CAR \  car\} \{ HIT \  hit\}
Car hit the bus

(Laughs, looks at bus)

\{MORE \  more\} \{ HIT \  hit\}
You want more hitting

(Points to bus)

\{WANT \  want\} \{ BUS \  bus\}
You want the bus

(Puts bunny in bus)

\{BUNNY \  bunny \} \{ DRIVE \  drive\}
Bunny drives the bus
## Appendix G
### Procedural Reliability Form

Child’s initials: ____________  Session #: ____________
Session type (circle):  Baseline  Ix  Gen w/  Gen w/o  Maintenance
Play scenarios: _____________________

<table>
<thead>
<tr>
<th>Task</th>
<th>Counter</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>__ Setup: Sets up in quiet space; AAC system placed in front of researcher facing child</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>__ Provides total of at least 15 aided AAC models</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>__ Two play scenarios used; min 2 min/scenario</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Provides initial models appropriately for Play Scenario #1 (Check one)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>__ two massed models w/ speech + AAC, OR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>__ moves on to next step if child takes turn</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Provides initial models appropriately for Play Scenario #2 (Check one) |         |     |    |
| __ two massed models w/ speech + AAC, OR                             |         |     |    |
| __ moves on to next step if child takes turn                         |         |     |    |

| Provides appropriate model                                          |         |     |    |
| __ pauses at least 1 sec. after child produces symbolic message or completes action |         |     |    |
| __ selects 2 symbols on child’s aided AAC device                    |         |     |    |
|   - high tech: voice output provided by system                       |         |     |    |
|   - light tech: researcher labels each symbol while pointing to them |         |     |    |
| __ provides grammatically complete message based on child’s prior message/action |         |     |    |
| __ pauses at least 1 sec.                                           |         |     |    |
| __ provides expectant delay if child says/does nothing              |         |     |    |

| Provides appropriate model                                          |         |     |    |
| __ pauses at least 1 sec. after child produces symbolic message or completes action |         |     |    |
| __ selects 2 symbols on child’s aided AAC device                    |         |     |    |
|   - high tech: voice output provided by system                       |         |     |    |
|   - light tech: researcher labels each symbol while pointing to them |         |     |    |
| __ provides grammatically complete message based on child’s prior message/action |         |     |    |
| __ pauses at least 1 sec.                                           |         |     |    |
| __ provides expectant delay if child says/does nothing              |         |     |    |

<p>| Provides appropriate model                                          |         |     |    |
| __ pauses at least 1 sec. after child produces symbolic message or completes action |         |     |    |
| __ selects 2 symbols on child’s aided AAC device                    |         |     |    |
|   - high tech: voice output provided by system                       |         |     |    |
|   - light tech: researcher labels each symbol while pointing to them |         |     |    |
| __ provides grammatically complete message based on child’s prior message/action |         |     |    |
| __ pauses at least 1 sec.                                           |         |     |    |
| __ provides expectant delay if child says/does nothing              |         |     |    |</p>
<table>
<thead>
<tr>
<th>Task</th>
<th>Counter</th>
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<th>No</th>
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<tbody>
<tr>
<td><strong>Provides appropriate model</strong></td>
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<tr>
<td>___ pauses at least 1 sec. after child produces symbolic message or completes action</td>
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<tr>
<td>___ selects 2 symbols on child’s aided AAC device</td>
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<td>- high tech: voice output provided by system</td>
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<td>- light tech: researcher labels each symbol while pointing to them</td>
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<td>___ provides grammatically complete message based on child’s prior message/action</td>
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<td>___ pauses at least 1 sec.</td>
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<tr>
<td>___ provides expectant delay if child says/does nothing</td>
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</tbody>
</table>

**Total # correctly implemented component / Total # Correctly Implemented Components + Total # Incorrectly Implemented Components:**

\[
\text{_______ / _______ TOTAL = ________}
\]
### Appendix H

**Multi-Symbol Messages Data Collection Form**

Child’s initials: ____________  Session #: _________
Session type (circle):  Baseline  Ix  Gen w/  Gen w/o  Maintenance
Play scenarios: _____________________

<table>
<thead>
<tr>
<th>Msg #</th>
<th>Counter #</th>
<th>Multi-Symbol Message</th>
<th>Semantic-syntactic categories</th>
<th>Modes</th>
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Number of different multi-symbol utterances: ______________
Number of different semantic-syntactic categories: ____________
Appendix I
Video Feedback Form

Please answer the following videos, based on the two videos that you watched

1. In which tape do you think your child/student used better language skills?
   a. The FIRST tape you watched
   b. The SECOND tape you watched

   Why?

2. In which tape do you think your child/student communicated more effectively?
   a. The FIRST tape you watched
   b. The SECOND tape you watched

   Why?

3. Would you like to add any additional thoughts about the videotapes you watched?
Cathy A. Binger, M.S., CCC-SLP
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EDUCATION
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PUBLICATIONS


SELECTED PRESENTATIONS


