Enhancing the Language Skills of Toddlers with Severe Communication Difficulties Who Benefit from AAC: A Comparison of Two Language Intervention Approaches

by

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Albert Schweitzer

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ABSTRACT

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Toddlers who demonstrate significant speech impairments and use augmentative and alternative communication (AAC) often demonstrate concomitant expressive language impairments. These toddlers receive AAC intervention due to difficulties with speech production at the motor level, and receive language intervention due to difficulties with vocabulary development at the linguistic level. One language intervention approach with a large base of evidence supporting efficacy in young children who have language delays, but do not use AAC, is responsivity education combined with focused stimulation. Another language intervention approaches with a large base of evidence supporting efficacy in young children who use AAC is responsivity education combined with aided AAC modeling. However, the effectiveness of responsivity education and focused stimulation has not been systematically studied, nor has the approach been compared to responsivity education and focused stimulation with the addition of AAC modeling in toddlers who use AAC.

A challenge of language intervention is to provide effective and efficient treatment for the expressive language impairment. To address this critical challenge with toddlers who use AAC, the current investigation compared the effectiveness and efficiency of these language intervention approaches in teaching new vocabulary production to toddlers between the ages of two and three who received AAC intervention. Specifically, the study examined the possible added value of including AAC modeling to an intervention involving responsivity education and focused stimulation. The study used an adapted alternating treatment design across participants. Four 2-year-old toddlers, who used AAC to communicate, participated in the study. One toddler used a visual grid, manual sign, and word approximations/words to communicate; one toddler used manual sign and word approximations/words to communicate; one toddler used a communication board, manual sign, and word approximations/words to communicate; and a final toddler used a flip chart and word approximations/words to communicate.

The results of the study provided preliminary evidence that the language intervention approach of responsivity education and focused stimulation was more effective for improving the

vocabulary production in three of four participants in the study. The added value of including AAC modeling in the intervention resulted in more effective vocabulary production with the fourth participant. In addition, the results of the investigation provided preliminary evidence that the language intervention approach of responsivity education and focused stimulation was more efficient for improving the vocabulary production in two of the four participants in the study. The added value of AAC modeling in the intervention resulted in more efficient vocabulary production for the third participant. Neither intervention approach was efficient with the fourth participant. Possible factors affecting the results of the study, theoretical and clinical implications, limitations, and future directions for research are discussed.

CHAPTER 1 Introduction

Augmentative and alternative communication (AAC) is defined by the American Speech-Language-Hearing Association (ASHA) Augmentative and Alternative Communication Special Interest Division 12 as:

> …an area of research, clinical and educational practice. AAC involves attempts to study and when necessary compensate for temporary or permanent impairments, activity limitations, and participation restrictions of persons with severe disorders of speech-language production and/or comprehension, including spoken and written modes of communication. (ASHA, 2005, p. 1).

The prevalence of young children with severe speech impairments who receive AAC services has been difficult to establish (Beukelman & Mirenda, 2005). Binger and Light (2006) determined that approximately 12% of preschoolers receiving special education services in Pennsylvania required augmentative and alternative communication services, based upon a survey completed in 2003. The Binger and Light (2006) prevalence data suggests that a large number of preschoolers obtaining special education services receive some form of AAC intervention.

Toddlers are defined as between the ages of two years and three years and are considered a subset of the preschool population, which is broadly defined as between the ages of birth to five years. This definition of toddlers was used in the present investigation. Toddlers who have severe communication difficulties and receive AAC intervention are a heterogeneous group using a range of AAC systems because of their inability to speak or speak intelligibly. A variety of congenital or acquired conditions can cause the inability to speak without AAC assistance, including intellectual disability, cerebral palsy, autism, and developmental apraxia of speech (Binger & Light, 2006). In addition to severe speech difficulties, toddlers with these conditions often times demonstrate delays in other domains including language development (Beukelman & Mirenda, 2005).

The children in this study demonstrated both speech production difficulties and expressive language delays and their communication skills were consistent with what is described as beginning communicators. Beginning communicators produce expressive vocabularies of 50 or fewer words or symbols and are learning to use unaided and/or aided symbols to represent basic communication functions. Unaided symbols do not require an external source for communication and consist of facial expressions, manual signs, gestures, and natural speech and vocalizations. Aided symbols require an external source for communication and include real objects, photographs, black-and-white line drawings, and graphic symbols. Aided symbols can be used in combination with low technology devices such as visual grids, topic boards and flip charts, as well as with higher technology voice output communication aids and high technology speech generating devices (Beukelman & Mirenda, 2005; Lloyd, Fuller, & Arvidson, 1997; Reichle, Beukelman, & Light, 2002). Visual grids consist of aided symbols of a variety of sizes temporarily attached to a board which can be removed and changed. Topic boards are permanent and consist of aided symbols which are placed on a board that is designed for use with a specific activity such as singing a song or eating a snack. Children using these boards typically have a different board for each context in which speech is not sufficient to meet their communication

needs (Hustand, Morehouse, & Gutmann, 2002; Lloyd, et al., 1997). Flip charts are also permanent and consist of aided symbols placed on a number of pages that can be turned, similar to a book. The category for each page of the flip chart, such as places or feelings, is indexed on the page margin or the front of the chart. A flip chart can be used across contexts throughout the day (Lloyd, et al., 1997).

Beginning communicators with severe communication difficulties frequently adopt a multimodal approach to produce language. They may use a combination of unaided natural speech, gesturing, and manual sign, as well as aided communication such as visual grids, topic boards, flip charts, and voice output communication aids. These children frequently require language intervention to facilitate language development (Beukelman & Mirenda, 2005). The toddlers in this study demonstrated a multimodal approach to producing language and required language intervention to facilitate their expressive language development.

Two language intervention approaches with a large base of evidence supporting efficacy towards improving language production in young children who have language delays, but do not use AAC, are responsivity education (Girolametto, 1988; Tannock, Girolametto & Siegal, 1992; Girolametto, Pierce & Weitzman, 1996a, 1996b; Girolametto, Weitzman & Clements-Bartman, 1998) and focused stimulation (Cleave & Fey, 1997; Fey, Cleave, & Long, 1997; Fey, Cleve, Long & Hughes, 1993; Robertson & Ellis Weismer, 1999). Responsivity education is a child-centered approach which takes place within naturalistic contexts. The adult allows the child to lead, adapts to share the moment with the child, and stimulates language production by adding language to what the child is doing and saying through interpreting and modeling, repeating, expanding, and extending the child's language (Manolson, 1992). Focused stimulation is also a child-centered approach which takes place within naturalistic contexts. The child is presented with concentrated exposure to specific vocabulary or linguistic structures either with or without attempts to evoke production of the target form (Ellis Weismer & Robertson, 2006). Pennington, Thomson, James, Martin, and McNally (2009) recently determined that responsivity education may be associated with positive changes in interactions between caregivers and children with cerebral palsy who used AAC, but the study did not address changes in language production. Therefore, while the language intervention approaches of responsivity education and focused stimulation have been studied with young children demonstrating a variety of disorders including language delays, developmental delays, Down syndrome, and cerebral palsy, the combination of responsivity education and focused stimulation has not been studied with young children benefitting from AAC to determine changes in language production skills.

The language intervention approaches of aided AAC modeling, and responsivity education combined with AAC modeling, have been studied with children who use multimodal AAC. Both approaches have been found to be efficacious in facilitating language production skills (Binger, Kent-Walsh, Berens, Del Campo, & Rivery, 2008; Binger & Light, 2007; Bruno & Trembath, 2006; Dada & Alant, 2009; Harris & Reichle, 2004; Kent-Walsh, Binger, & Hasham (2010); Romski & Sevcik, 1996; Romski, Sevcik, Cheslock, & Barton, 2006; Romski, et al., 2010; Rosa-Lugo & Kent-Walsh, 2008). However, the effectiveness of responsivity education and AAC modeling with the addition of focused stimulation has not been studied in toddlers who use multimodal AAC to determine changes in language production skills.

A challenge of language intervention is to provide effective and efficient treatment for the expressive language impairment. The speech-language pathologist is interested in implementing language intervention approaches that both facilitate language production skills and affect improvement as quickly as possible (McCauley & Fey, 2006). To address these critical challenges with toddlers who are beginning communicators and receive AAC intervention, the current investigation compared the effectiveness and efficiency of two language intervention approaches in teaching new vocabulary production to toddlers who benefitted from AAC. Specifically, the study examined the possible added value of including AAC modeling to an intervention involving responsivity education and focused stimulation.

CHAPTER 2 Review of the Literature

Theoretical Frameworks for Language Acquisition in AAC

Nativist theories of language acquisition and AAC. There are numerous theories describing what, how, and why language acquisition occurs which inform how to facilitate language development in children. For example, proponents of nativist frameworks claim that language acquisition is innate and domain specific, and is based upon inborn linguistic rules. The process for language development is relatively automatic and perception driven while the environment plays a minor role (Chomsky, 1957, 1965; Fodor, 1983). According to the nativist framework, syntactic development is of primary importance. Children with language delays are taught specific omitted syntactic structures such as verb tense and the extended optional infinitive, often within a structured setting (see Rice, 2000, 2003; Rice & Wexler, 1996; Rice, Wexler, & Cleave, 1995; Rice, Wexler, & Hershberger, 1998; Rice, Wexler, Marquis, & Hershberger, 2000). An important concern when applying nativist theory to children who benefit from AAC is that these children use an alternate form of language system. While most children with language delays use spoken language to communicate, children who benefit from AAC use unaided symbols such as manual sign, or aided symbols in the form of graphic symbols, which are presented visually. These children are not routinely exposed to linguistic input in the alternative visual form outside of training sessions. Lack of exposure to use of the child's unaided and aided AAC system may severely limit the child's opportunity to innately develop use of the alternative form/s. It is not known to what degree the effect of this impoverished AAC language environment can be compensated by using more structured instructional activities, such as those implemented by Rice and colleagues in their studies with children who produce spoken language (von Tetzchner & Grove, 2003).

Behaviorist theories of language acquisition and AAC. Proponents of behavioral frameworks argue that language is a learned behavior similar to learning any other behavior. Language learning is largely determined by the course of classical, operant, and imitative training. An adult language model is provided such as production of specific vocabulary, a child imitates the language behavior by repeating the specific vocabulary, and successive approximations of language production are shaped by negative reinforcement, positive reinforcement, or punishment so that the child produces the specific vocabulary and expands the production to a short phrase. While the environment plays a key role in learning to produce language, this role is not related to social interactions (Skinner, 1957, 1984). The behaviorist approach has been applied to learning AAC, particularly with severely intellectually impaired individuals, and has been a powerful approach to establish the connection between communicative behavior and reward (Remington, 1994; Remington & Clark, 1983). However, the ultimate success of language learning with children who benefit from AAC using the behaviorist approach has been mixed due to limited opportunities for declarative communication and limited generalization of newly developed language skills. Perhaps this is because the framework fails to provide an explanation for how and why language develops and how language learning can generalize to novel settings and people when using AAC (von Tetzchner & Grove, 2003).

Emergentist theories of language acquisition and AAC. Proponents of the theoretical framework of emergentism hypothesize that domain-specific language is linked to domain general processes because language is grounded by interactions between the body, brain, and the social situation. For example, sentence processing is grounded by interactions between acoustical perception (the body), working memory (cognition), morphological constructions (language), and perspective-taking (pragmatics), all of which are grounded in brain functioning as neural mechanisms build and connect (MacWhinney, 2000). In contrast to the nativist approach, language is driven by experiences rather than pulled by predefined nativist goals (Plunkett, Karmioloff-Smith, Bates, Elman, & Johnson, 1997). The impairments demonstrated by children with severe speech and language impairments suggest that distinct alternative paths to language development must take place in comparison to children with typical language development and processes due to atypical body, brain and social situations, as well as atypical neural mechanisms. Factors which could contribute to successful versus unsuccessful language development with children who use alternative forms such as graphic symbols, include the child's speech perception skills, memory capabilities and other cognitive processes, the communication partner's sensitivity and style, as well as other environmental characteristics. Proponents of emergentist theory argue that the more atypical the child's speech perception skills, the more limited the child's memory and cognitive processes, the more inadequate the communication partner's skills during interactions, and the fewer environmental adaptations to accommodate the child's limitations, the more challenging it will be for the child to produce language using aided and unaided AAC. Adult intervention supports must be in place to overcome the limitations in speech perception, memory and cognitive processes, communication partner skills and/or environmental adaptations to allow for successful language learning (von Tetzchner & Grove, 2003). For example, in the current investigation, the language intervention approach of responsivity education focuses on supports for limitations in communication partner skills, focused stimulation focuses on supports for limitations in speech perception, and AAC modeling focuses on supports for limitations in memory and cognitive processes.

Social constructivist theories of language acquisition and AAC. In the current study, social constructivist theory provided the most theoretically sound framework supporting the two language intervention approaches of responsivity education and focused stimulation, and responsivity education and focused stimulation with the addition of AAC modeling, with toddlers who benefitted from multimodality AAC. According to Vygotsky (1962), all cognitive processes have their roots in social interactions as each function in the child's development appears initially at the social level and eventually is internalized. Vygotsky believed development is a process whereby the child internalizes shared cognitive processes obtained in collaboration with more highly skilled partners. This "zone of proximal development" (ZPD) is the social context in which a child becomes more capable with the help of an adult. When the adult is sensitive to the child's ZPD, interactions are structured in ways that facilitate the child's understanding and increase the child's participation in the activity.

Proponents of ZPD hypothesize that language is learned through guidance from more competent language users. ZPD is the "distance" between what the child is able to do by him or herself and what he/she is able to do with the support of a more competent peer. The child must understand the nature of the task but cannot solve the task alone (Bruner, 1975, 1983; Service, Lock & Chandler, 1989). Language competence emerges through joint construction of meaning and

repeated exposure to language before internalization can occur and generalization can take place across settings, individuals, and time (von Tetzchner & Grove, 2003). The ZPD supports the importance of multiple exposures to new vocabulary through use of adult modeling during meaningful activities, thereby facilitating the preschooler's ability to internalize and spontaneously produce the vocabulary. ZPD provides a foundation for the importance of repeated exposure to vocabulary and modeling use of the child's AAC system.

Scaffolding is another contribution that social constructivist theory has made to our understanding of language development. Scaffolding occurs when an adult jointly engages in activities, gives communicative meaning to the child's actions, and guides the child in negotiating meaning and expressing him/herself (Tomasello, 2003; Wood, 1988; Wood, Bruner & Ross, 1976). Scaffolding not only helps the child communicate better but influences underlying language acquisition (von Tetzchner & Grove, 2003). An adult may follow the child's lead by using the child's immediate interests and preferences or an adult may direct the child. Following the child's attentional lead, however, may have a more positive effect on very early acquisition of vocabulary than directing the child, which is a hallmark of the responsivity education intervention approach (Clibbens & Powell, 2003). Scaffolding implies that when an adult plans and adapts the language environment of a child using AAC, he/she should provide models of language using the child's AAC system to support language learning. In addition, language modeling with the child's AAC system should be used for genuine communicative purposes, should be introduced when the child is very young and should not only be provided for educational purposes, but also during all types of everyday activities (Renner, 2003). Scaffolding provides a sound theoretical framework for the importance of adult responsiveness and modeling the child's AAC system.

The importance of cultural learning is another foundation of social constructivist theory and plays a significant role in the development of language. The relationship between culture and language development is exemplified through cross-cultural variations in interactional styles between caregivers and children, the amount and type of responsive child-centered language input provided by caregivers, the relative importance of preschooler language initiation, how correct language responses are reinforced by caregivers, and the role of family in the treatment of children with language delays, Children begin learning culturally appropriate language at a very young age partially because adults structure linguistic content in culturally specific ways to facilitate understanding and use, and partially because adults believe that is the appropriate way to act (Tomasello, 1995, 1999).

Tomasello believes that typical language development occurs as a result of extensive expressive modeling from an adult partner, an extended and piecemeal route to obtaining grammatical competence, and a need to functionally communicate intent. Language development requires functional interactions between the adult and child within a rich cultural and social environment. Imitative, interactive learning is necessary and critically important to language acquisition, particularly from the perspective of cultural learning. The language children acquire initially is almost completely concrete and is not based upon abstract linguistic constructs, but rather the particular words and phrases of the child's specific language. The linguistic forms children acquire via imitative learning through social interactions are not only small units, such as words, but also larger units such as phrases, clauses and entire speech acts. In many cases children's

creative linguistic combinations are imitations of other linguistic units that vary in complexity and abstractness from one another, based upon the children's social environment embedded within their cultural society (Tomasello, 2000, 2003). Language development concerns arise with children who use AAC because there are few competent AAC users to act as models for these children. Adults do not sufficiently provide models of competent AAC use for children, and therefore, children who use AAC have no cultural learning model to imitate and no cultural model of AAC as an accepted form of communication (Oxley, 2003; von Tetzchner & Grove, 2003). The importance of expressive modeling of the AAC system by an adult partner, and repeated exposure to use of the AAC system by the adult partner, provides social acceptance of unaided and aided AAC as a means for linguistic interaction.

In summary, social constructivist theories for language acquisition support the importance of sensitivity to the child's linguistic ZPD through responsive adult interactions, repeated exposure to targeted vocabulary, AAC modeling as foundations for language learning, and acceptance of AAC as a means of communication from a cultural perspective, for preschoolers who benefit from multimodal AAC. These social constructivist foundations form the basis for the language intervention approaches utilized in the current study including responsivity education which includes responsive adult interactions, focused stimulation which includes repeated exposure to targeted vocabulary, and AAC modeling which includes demonstrating use of the child's AAC system in context. These language intervention approaches will be described in greater detail later in the chapter.

Social constructivist models of development reflect a view that adults support a child's development by providing timely and developmentally appropriate situations and models for learning language, including children with atypical development who benefit from AAC (Vygotsky, 1978). Part of the adult role as a facilitator includes understanding what makes language learning potentially challenging, which can guide the adult in identifying when, where, and what types of support are needed. Several critical language learning challenges facing young children who use AAC include the cognitive issues of joint attending (Hunt Berg, 1996) memory and attention (Oxley, 2003; Wilkinson & Hennig, 2009) and the asymmetry existing between linguistic input and output which occurs with AAC (Blockberger & Johnston, 2003; Blockberger & Sutton, 2003; Smith & Grove, 2003; Soto, 1999; Sutton, Soto & Blockberger, 2002). The next section of the paper describes these challenges and their impact on AAC language intervention.

Joint Attending Issues, Memory and Attention Issues, and Input-Output Asymmetry in AAC

Joint attending issues in AAC. One mechanism known to increase a child's ability to learn the meanings of words is joint attending between the child and adult. Joint attention is achieved when both the child and adult simultaneously attend to the same thing. During social and communicative interactions, both the adult and child adjust their behavior to achieve joint attention by trying to determine their partner's point of reference. Very young children actively monitor and use cues in adults' behavior to determine the attentional focus that differs from their own, but can only do so only in limited ways due to developmental constraints (Butterworth & Cochran, 1980).

The importance of joint attention in early language acquisition was highlighted by research discovering a strong relationship between the amount of time spent in joint attention and subsequent language growth. Specifically, diary studies of six mothers and their 12 months to 13 months old infants revealed that the more time a mother spent in joint attentional episodes with her infant, the greater the infant's subsequent vocabulary growth (Tomasello & Todd, 1983). There was also a strong relationship between following a child's attentional lead and vocabulary growth. Studies comparing toddler's vocabulary growth between the ages of 15 months and 21 months revealed that following a toddler's attentional focus facilitated word learning while directing the toddler's attention while speaking resulted in production of smaller vocabularies (Tomasello, 1988; Tomasello & Farrar, 1986). Interactions in which the mother was sensitive and willing to engage in joint attention also required that the child engage in joint attention. The studies further demonstrated that how well language learning occurred depended on how the child achieved joint attention during interactions. When hearing the object labels, word learning was most robust when the toddlers spontaneously focused on the objects rather than their mother's face (Tomasello & Farrar, 1986). In the present study, following the child's lead during play, rather than directing the child, was emphasized, as was labeling vocabulary when the toddler was focused on the object.

Unlike typically developing children, young children with severe communication difficulties who use AAC methods to communicate, such as topic boards or electronic voice output communication aides, must jointly attend to two sources of visual information while hearing the spoken label. They must coordinate their attention to the object of interest and to the AAC graphic symbol when the adult presents the spoken label. There are now three sources of information rather than two sources: seeing the object, hearing the word produced by the speaker, and *seeing the graphic symbol*. This requires the young child to jointly attend to and process symbolic information in both the visual and auditory modalities rather than solely in the auditory modality. In addition, when the adult is providing a model of how to use the AAC system during the communicative interaction, the adult must also accommodate joint attention in two modalities, auditory and visual, at the same time (Hunt-Berg, 1996). When the adult simultaneously points to the graphic symbol and names the symbol during an episode of joint attention, this is known as augmented AAC modeling (Goosens, 1989).

An issue of concern is what process is most beneficial in helping young children learn language with augmented AAC modeling. When learning the meaning of a graphic symbol, is it best to only point to the symbol while saying the label, or is it best to point to the object first and then point to the symbol while saying the label? In a study of 22 children between the ages of three to ten years who used AAC, Hunt-Berg (1996) demonstrated that sequential pointing first at the object followed by pointing to the symbol while simultaneously saying the label, maintained joint attending between the adult and children and also facilitated graphic symbol learning. By pointing first at the object, joint attending was enhanced for language learning purposes as was learning how to produce language using graphic symbols. In the present study, the language intervention approach of AAC modeling consisted of pointing to the object followed by pointing to the symbol or signing while simultaneously saying the label to facilitate both joint attending for word learning as well as graphic symbol and/or sign use.

Memory and attention issues in AAC. In addition to maintaining joint attention, the cognitive skills of working memory and declarative long term memory are critical for successful mastery of aided communication, in particular when using more complex unaided communication boards containing multiple pages, as well as electronic devices with speech output. Working memory is the part of the memory system that is responsible for maintaining temporary information during mental operations. It has a limited capacity which constrains the performance of overall cognition (Baddeley, 1986; Baddeley & Hitch, 1974). Working memory is required to operate and recall how to access the various symbols on electronic devices. Declarative long term memory contains memory for factual or conceptual information, which is also called semantic memory, and includes world knowledge, language, rules and concepts (Baddeley, 1986). Declarative long term memory is used to remember the location of the graphic symbols on multipage communication boards and electronic devices. The more complex the AAC system, the more sophisticated the symbol representation can be in abstractness, known as translucency, and the more complicated the organization of symbols can be on the AAC device. Using a more complex AAC system requires working memory and declarative long term memory skills that may be too demanding for young children and individuals with cognitive impairments (Oxley, 2003).

While working and declarative memory limitations impact choices for AAC device representation, children who benefit from AAC can also have physical and/or sensory limitations which impact AAC device access and stress attentional resources. Accessing vocabulary on AAC devices may be physically challenging and time consuming, which requires greater amounts of attentional resources. For example, children who are not able to directly select symbols on their AAC devices due to physical limitations such as motor impairment, and/or sensory limitations such as visual impairment, may need to rely indirectly on a partner, known as partner-assisted scanning. During partner assisted scanning, a partner reads or names the available choices while allowing time for the child to choose a response. A high level of attentional resources are required to use partner assisted scanning. An alternative to partner assisted scanning, switch activators can be also be used to access AAC devices when there are physical challenges. While switches allow for independence in communicating, the price of this independence is the need to learn individual procedures including scanning and switch activation patterns, and coordination and timing for the device operations. These procedures are initially cognitively and physically challenging and also serve as distractions to communicative interactions. The younger the AAC user, the more likely these activities will also tax the child's working memory and long term declarative memory, in addition to attentional resources, resulting in more challenging communication exchanges (Oxley, 2003).

Although direct selection of symbols on an AAC device requires lesser amounts of attentional resources in comparison to partner-assisted scanning, direct selection nonetheless requires more sustained, selective, and divided attention versus verbal communication. Sustained attention is the ability to maintain attention across time or effort during a task, such as scanning an AAC display. Selective attention is the ability to focus on a relevant target, such as the desired AAC symbol, and exclude attention to distracters. Divided attention is the ability to attend to multiple tasks or stimuli, either simultaneously or by rapidly alternating attention between two tasks (Benjafield, 2007). In aided communication, the AAC user must sustain attention for longer periods of time in comparison to unaided communication while scanning items on an AAC

display, must selectively search for and attend to a desired AAC symbol which is unneeded in verbal communication, and must divide attention between the AAC display and the communication partner to whom the message is directed which does not occur in unaided speech (Wilkinson & Hennig, 2009).

The current investigation consisted of four toddlers who are two-year-olds and, due to their young age, have limited working memories, declarative memories, and attention resources. One preschooler used a visual grid, one preschooler used manual sign, one preschooler used a single page activity board, and one preschooler used a multi-page flip book, rather than more complex electronic devices, to limit working memory, declarative memory, and attention demands. All of the participants directly selected symbols on their AAC systems. However, one of the language intervention approaches required more attention resources for successful use than the other. During input, responsivity education and focused stimulation with the addition of AAC modeling required both auditory and visual attention, while responsivity education and focused stimulation required only auditory attention. Therefore, responsivity education and focused stimulation with the addition of AAC modeling required more sustained, selective, and divided attention to successfully learn target vocabulary. This issue will be further explored in the discussion section of the study.

Input-output asymmetry in AAC. In addition to requiring attention resources for learning target vocabulary, responsivity education and focused stimulation with the addition of AAC modeling also provided an example of input-output asymmetry in AAC. As with joint attending in AAC, language learning in AAC is bimodal. AAC users hear and understand language in an auditory environment but produce language, in part, through a visual environment such as manual and/or graphic signs. This is a highly complicated process which involves both working memory to immediately retain and translate auditory information into manual and/or graphic signs, and long term declarative memory to recall the manual sign and/or locate appropriate graphic signs on the AAC device. As mentioned in the previous section, cognitive loads are therefore greater for AAC use in comparison to typical language production (Oxley, 2003). In the present study, the language intervention approach of responsivity education and focused stimulation required less cognitive load than responsivity education and focused stimulation with the addition of AAC modeling due to asymmetry issues. During responsivity education and focused stimulation, the preschooler attended solely to auditory input before responding. Alternatively, the addition of AAC modeling required the preschooler to shift attention from auditory input to modeling of the AAC system before responding. While, from a theoretical social constructivist framework, a competent model was provided to enhance language learning through AAC modeling, the AAC model nonetheless increased cognitive load during dyadic exchanges, in part due to input-output asymmetry.

The impact of input-output asymmetry affects not only cognition but many aspects of language production, including lexical and semantic development. Lexicon, which is the vocabulary available for use on an AAC system, and semantics, which is the language concepts available on the AAC system, may be highly pictorial and resemble the item represented, or may be more abstract, depending on the translucency of the symbol choice. Many lexical and semantic concepts cannot be readily pictured, such as feelings, for example “hungry” and prepositions, for example “up”, making the symbol choices difficult for young children to learn. Graphic

representations are also not articulated with voice, but rather are selected from a predetermined array on the AAC system through pointing, scanning, or using a partner for assistance. The symbols are not accessible to direct manipulation or systematic change that originates from the young child, but are dependent on the adult designer of the system (Smith & Grove, 2003). The vocabulary choices, how the vocabulary is represented by symbols, and how the vocabulary is arranged on the AAC display, are all predetermined by an adult. Until the child is sufficiently literate to generate new vocabulary via spelling and word prediction, the only vocabulary available for production is within the existing AAC system (Blockberger & Sutton, 2003; Smith & Grove, 2003). Lastly, when young children select a word from their communication display, they might not receive similar symbol feedback from the communication partner. For example, if they choose the symbol "cat" rather than "dog" when labeling an item in a storybook, they might be told "That's a dog, not a cat" by their communication partner, but the correct symbol may not be modeled on the child's communication system (Smith & Grove, 2003). These input-output asymmetries limit lexical and semantic development when using AAC.

Input-output asymmetry also impacts the morphologic development of children who use AAC. Morphology is the rules for grammatical markers such as plural endings and verb tense. Children who use AAC frequently demonstrate delayed morphological development, partially related to input-output asymmetry. For example, use of temporal markers in AAC may require several extra steps which may be ignored for speed, resulting in fewer opportunities to learn how to produce this type of grammatical marker. The child may need to locate the symbol for "yesterday" on the AAC device, and then navigate to a different page to locate "eat" and "hamburger" before stating "I ate a hamburger." Because individual graphic symbols are often not equivalent to morphologic words endings, using graphic symbols can complicate the acquisition of morphology. There is also limited space on a graphic display to include all possible morphology. Asymmetry persists as children with AAC needs live in spoken language environments where they hear and receive speech input but rarely observe graphic symbols being used outside of structured teaching situations. Finally, co-construction becomes common, when both the AAC user and communication partner contribute to the meaning established for the message. Through co-construction, children who use AAC often depend on the willingness and experience of the communication partner to interpret, expand, and add morphology to selected symbols when morphology is absent (Sutton, et al., 2002).

Evidence supporting the impact of input-output asymmetry on morphological production was studied by Blockberger and Johnston (2003). They compared the acquisition of three grammatical morphemes across three groups of children, one with typical development, one with extremely limited speech that resulted in AAC needs, and one with typical speech but delayed language development who demonstrated specific language impairment. On the comprehension task, children with AAC needs had significantly more difficulty than the children with normal language development and the speaking children with language delays. On the structured output task, children with AAC needs were much more likely to omit grammatical morphemes than were children in the typical development group. The authors concluded that children with AAC needs demonstrated difficulty acquiring use of grammatical morphemes, and that this difficulty may be due, in part, to the lack of opportunities for language production when learning language. The authors suggested four differences in the language input provided to children with AAC needs. First, caregivers may provide input that is less finely tuned to a child's developmental

level because of the constraints of the AAC output system. Second, caregivers may receive less cuing from AAC users to determine their situational interests and therefore provide input that is less finely tuned to the child's focus of attention. Third, whereas caregivers of typically developing young child will expand and recast their utterances to facilitate grammatical development, caregivers of AAC users co-construct information over several turns. The AAC user tends to contribute much less linguistic information, and many turns are taken up with establishing message content or repairing misunderstandings. Finally, difficulties with grammatical morphology may result from the AAC user's limited ability to explore and experiment with language due to the output limitations of the AAC system. Blockberger and Sutton (2003) suggested four explanations for why AAC users experience problems with production of morphology: a) the symbols needed to indicate morphemes on the symbol display are not always available, b) AAC users choose efficiency over accuracy as a strategy for enhancing the speed of communication, c) AAC users are not taught morphological rules that apply to various situations or how to apply these rules when using their AAC systems, and d) the graphic symbol precludes the need for conventional English morphology, for example, the graphic symbol for "I am sitting on a chair" is a line drawing of a girl sitting on a chair, so there is no need to combine the graphic symbols for GIRL, SIT, ON, CHAIR.

Lastly, input-output asymmetry impacts the development of the AAC user's syntactic production. Syntax is the rules for ordering words in sentences to produce a variety of sentence types. Blockberger and Sutton (2003) summarized the most commonly reported expressive syntax characteristics demonstrated by AAC users: a) AAC users produce a predominance of one-or-two-word messages, both in spontaneous and elicited conversation; b) AAC users produce a prevalence of simple clauses with limited use of complex structures such as questions, commands, negatives, and auxiliary verbs; c) word order production with graphic symbols is challenging and graphic symbol users do not typically follow the word order of the spoken language. For example, words such as verbs and articles are frequently omitted, even though they are available on the graphic display. An example would be when the AAC user states "GIRL PUSH CLOWN HAT WEAR rather than "The girl pushes the clown who wears a hat;" and d) use of multimodal combinations such as gestures combined with word approximations and graphic symbols are used to compensate for lack of needed symbols on the AAC system.

Two possible explanations exist for these morphologic and syntactic characteristics. The compensation hypothesis states that the omission and/use of inaccurate morphology and syntax occurs because of the cognitive, physical, and linguistic constraints of the AAC user's communication system and the role of communication partner co-construction. For example, if the word "the" is not immediately available on the communication display, the AAC user might state BOY WILL PUSH GIRL TO STORE rather than search for THE on the device to state "The boy will push the girl to the store." In addition, the AAC user might expect the communication partner to have needed background information and might expect the communication partner to co-construct the verbal exchange by asking clarifying questions and providing morphologically and syntactically correct productions of the AAC users incomplete productions. Alternatively, the modality-specific hypothesis states that the morphologically and syntactically incorrect messages produced by the AAC user reflects the input-output asymmetry between what the AAC user hears via spoken language, and how communication actually takes

place during output. Because the output modality is slower than speech production, this may lead to unconscious omission of morphology and syntax. (Sutton, et al, 2002).

Smith and Grove (2003) suggested that one way to restore symmetry during AAC use, and thus facilitate language development with AAC users, is to match the structural characteristics of the communication system as closely as possible for both input and output. AAC modeling is one such approach which increases the symmetry between input and output, and has been frequently used as a part of language intervention programs with children who use AAC (Binger & Light, 2007; Bruno & Trembath, 2006; Dada & Alant, 2009; Harris & Reichle, 2004). The present investigation compared the effectiveness of reducing input-output asymmetry by adding AAC modeling to the use of responsivity education and focused stimulation, to the less cognitively demanding, but asymmetric approach of responsivity education and focused stimulation, to determine whether both approaches were effective and, if so, which was more efficient in learning new vocabulary with preschoolers who used AAC. The next section explores the effectiveness of these language intervention approaches in language delayed toddlers and older preschoolers through a review of existing research.

Language Intervention Approaches for Language Delayed Toddlers and Older Preschoolers

Responsivity education. Responsivity education is one language intervention approach with a large base of evidence supporting its efficacy with young children who have language delays. A variety of responsivity education programs exist which train caregivers to be more effective communicators with their young children by adapting a more responsive approach to interaction, for example, observing the child closely for signs of communication and following the child's lead, teaching the care giver to stimulate children's communication by structuring conversation and the physical environment, and coaching caregivers to prompt the production of specific linguistic and nonverbal communication targets. Examples of these training programs include Responsive Prelinguistic Milieu Teaching for children who are at the prelinguistic language level and are learning to produce their first words (Fey, Warren, Brady, Finestack, Bredin-Oja, Fairchild, et al., 2006; Warren, Fey, Finestack, Brady, Bredin-Oja, & Fleming, 2008; Yoder & Warren, 2002) and Enhanced Milieu Teaching for children who produce single word vocabulary and are learning to increase the phrase length and complexity of their language productions (Hancock, Kaiser, & Delaney, 2002; Hemmeter & Kaiser, 1994; Kaiser & Hester, 1994; Kaiser, Hancock, & Niefeld, 2000).

Another responsivity education program that has been researched across a variety of populations is It Takes Two to Talk – The Hanen Program for Parents (Manolson, 1992). This program has been studied with late-talking children under the age of three and children ages three to five with specific language impairment, as well as children under age five with cognitive and developmental delays and children under age three with cerebral palsy (Girolametto, 1988; Tannock, Girolametto & Siegal, 1992; Girolametto, Pierce, & Weitzman, 1996a, 1996b; Girolametto, Weitzman, & Clements-Baartman, 1998; Pennington, Thomson, James, Martin, & McNally, 2009). The goal of It Takes Two to Talk – The Hanen Program for Parents is to empower parents to become their child's primary language facilitator, thereby maximizing the

child's opportunities for communication development in everyday situations within the natural environment.

It Takes Two to Talk – The Hanen Program for Parents (Manolson, 1992) teaches parents three clusters of responsive interaction strategies: a) child-oriented behaviors, b) interaction promoting strategies, and c) language modeling strategies. Child-oriented behaviors encourage the child to initiate interaction, thereby fostering frequent episodes of joint attention around the child's interests. The strategies for this cluster consist of "Wait and Listen" - wait for the child to respond to you and listen to what he/she says; "Follow the Child's Lead" - allow the child to lead during play activities; "Join in and Play" -after allowing the child to lead during play, actively join in the play rather than observing; and "Be Face to Face" - play at face to face level with the child. Interaction promoting strategies are designed to foster balanced turn-taking between caregivers and children. Strategies include "Use a Variety of Questions" - ask many types of questions such as what, where, how; "Encourage Turn-Taking" - wait expectantly for the child to respond, tell the child it's your turn; and "Scan to Match Your Turns to the Your Child's Turns" - respond to the child by taking a turn in a similar way to your child. Language modeling strategies are designed to expand the child's receptive and expressive language skills. Strategies include "Imitate the Child's Verbalizations" - repeat exactly what the child says; "Use a Variety of Labels" - name many items while playing; "Expand on What the Child Says" - imitate what the child says and then add one or two additional words; and "Extend the Topic" - expand what the child says and then add a comment or two more about the topic. In addition to learning general language facilitation strategies, parents also target specific interaction and communication goals selected jointly by the clinician and family, such as prelinguistic skills, vocabulary development, and two-word phrase production.

Evidence-based research has been completed since 1988 supporting the effectiveness of responsive intervention strategies found in the It Takes Two to Talk – The Hanen Program for Parents. Initially, two studies looked at the effects of the training program on children with language delays and their mothers who attended the program without implementation of other language intervention approaches (Girolametto, 1988; Tannock, et al., 1992). The Girolametto (1988) study consisted of twenty preschool children ranging from age 22 months to 62 months with developmental delays of mixed etiology and their mothers. The Tannock, et al., 1992 study consisted of 32 preschool children, ranging from age 14 months to 60 months with developmental delays of mixed etiology. Changes in the interactive behavior of mothers and children who participated in It Takes Two to Talk, the experimental group, were compared with those of a matched group of mothers and children in a delayed treatment group. The results of both studies revealed decreased directiveness and increased responsiveness in mothers in the experimental groups, and the 1992 study found that mothers in the experimental group maintained their gains four months post-treatment. Children in the experimental groups demonstrated increases in social assertiveness and joint attention, as well as showed improvements in ability to take turns, both verbally and non-verbally, when compared to children in the control groups. Mother-child interactions in the experimental groups were more balanced, frequent, and longer-lasting and the mothers in the experimental groups also reported improved family well-being including positive changes in the children's behavior and enhanced parent-child relationships. The authors concluded that decreased directiveness and increased

responsiveness were considered positive qualitative changes for this group of middle class English-speaking Canadian mothers.

More recently, the effects of It Takes Two to Talk – The Hanen Program for Parents were studied with preschoolers diagnosed with cerebral palsy. Pennington, et al. (2009) observed eleven children ages 19 months to 36 months and their mothers four months and one month before attending training in It Takes Two to Talk, as well as one month and four months after receiving training in It Takes Two to Talk, during 10 minutes of play with a box of toys. The results of this study revealed significant changes in parental responsivity and preschooler interactions occurring one month after the training, which were maintained four months after the training. Maternal responsivity changes consisted of fewer initiations, more responses, and fewer requests. Child interactive changes consisted of more initiations, mores requests, and more provisions of information. Because the purpose of the study was to determine the effects of training on mother-child interactions, the effects of training on communication were not studied. The authors suggested future research explore the effects of program training on the children's communication skills.

Focused stimulation. Focused stimulation is another language intervention approach with a large base of evidence supporting its efficacy with young children demonstrating language delays. Focused stimulation is intended for children under age three who are late talkers, as well as three-to-five year old and early school-age children who demonstrate specific language impairment or developmental delays with need for specific language goals. Children are exposed to multiple examples of targeted specific words and grammatical constructions within meaningful interactions so that their content, form, and use are as transparent as possible. Following exposure to models, the child may be given opportunities to produce the linguistic construction, although this is not obligatory. Imitation procedures are not used, but rather an attempt is made to elicit spontaneous productions of the target by taking advantage of naturalistic conversational contexts promoting the use of the target. Potential language targets, such as specific vocabulary or grammatical morphemes, are chosen and practiced a minimum of ten times per session. Natural conversational contexts are used but modified to increase the salience of the target form (Cleave & Fey, 1997).

In an early study of focused stimulation, Fey, et al. (1993) researched the effectiveness of focused stimulation to facilitate the grammatical development of 30 children between the ages of 3 years, 8 months and 5 years, ten months, with marked delays in expressive grammar. Fifteen children received the intervention package with a speech-language pathologist, fifteen children received an intervention package solely with their parents who were trained by speech-language pathologists, and a control group received no therapy. Both parents and speech-language pathologists modeled targeted grammatical forms frequently, recast – also known as expanded - the children's utterances in ways that highlighted the grammatical targets, and created activities that maximized opportunities for the children to create sentences obligating use of the grammatical target. Using a cyclical goal attack strategy, at least four specific grammatical forms were targeted at all times for each participant. After the specific grammatical form goals were treated over a four-week cycle, the same goals were recycled from the beginning in the same order. A total of five months of therapy was provided with two hours per week of group therapy and six hours per week of individual therapy. The results revealed large treatment

effects on three of four measures of grammatical expression for the treatment groups in comparison to no gains in grammatical expression for the control group. The effects of the clinician treatments were more consistent than the effects of the parent treatments, although direct comparisons could not be made because the two interventions differed in some characteristics.

Fey, et al. (1997) extended the Fey, et al. (1993) study with five additional months of treatment for 18 of the original 30 participants using focused stimulation and the same cyclical goal attack strategy as was used in the Fey, et al. (1993) study. The results of the extended intervention revealed that although participants improved during Phase 2, improvements were generally not as strong as during Phase 1. Gains were larger for the speech-language pathologist led intervention group in comparison to the parent led intervention group. The authors concluded that growth in grammatical expression was not linear.

More recent research by Robertson and Ellis Weismer (1999) investigated the effects of focused stimulation on the linguistic and social skills of twenty one late-talking children under the age of three. The treatment group received a 12-week clinician implemented intervention program focused on promoting vocabulary skills and use of two-word and three-word combinations while the delayed treatment group served as a control group. Structured routines and theme-based activities incorporated use of parallel talk and recasts, as well as focused repetition of specific language targets. Focused repetition of vocabulary was used more frequently than recasts during intervention sessions. Following treatment, post-testing revealed significant gains in lexical variety, total number of words produced, number of different words, and mean length of utterance.

Choosing vocabulary for use with focused stimulation can be challenging with young children demonstrating limited single word vocabularies, such as the children in the current investigation. A protocol for determining the first vocabulary to be introduced with young children demonstrating specific language impairment was developed by Lederer (2002). Specific language impairment is characterized by delays in receptive and/or expressive language development in the absence of cognitive, neurological, hearing loss, or other known etiologies (Leonard, 1998). Lederer described a four step approach to identifying initial vocabulary in which: a) parents/caregivers and professionals generate a master list of vocabulary words produced spontaneously or in imitation, b) ten to twelve words are selected that contain sounds the child already produces; are developmentally appropriate; include a combination of nouns such as foods, animals, toys, people, body parts, and relational words such as greetings, verbs, adjectives, prepositions, quantities and pronouns; can be represented or gestured easily; and reflect the child's interests, c) preselected materials and activities are used which target the words, each target word is presented a minimum of five times in single words and short phrases, and parent/caregiver training is provided, and d) new words are added when 50% of the words are spontaneously produced across three contexts. Lederer concluded that further research was needed to determine whether the protocol could be used effectively with other groups of children with language delay such as children with cerebral palsy. The present study incorporated the initial three steps described by Lederer and extended the population base to children with developmental disabilities other than specific language impairment.

Responsivity education combined with focused stimulation. Focused stimulation can be can be used as a standalone intervention approach or can be incorporated into broader intervention approaches such as the previously described responsivity education. Several studies have been completed exploring the efficacy of responsivity education combined with focused stimulation on learning language in late talking children under the age of three years and children ages three to five years. Girolametto, et al. (1996a, 1996b) investigated the efficacy of the It Takes Two to Talk program adapted to include a focused stimulation component. The study consisted of parents and 32 children ages 2 to 3½ years, all of whom had severe expressive language delays with no more than 50 single words in their vocabulary. The program included training in responsive interaction strategies in combination with learning ten target words per child. The results revealed that mothers in the experimental group used target words spontaneously and repetitively, and they reduced their mean length of utterance. The children in the experimental group demonstrated accelerated vocabulary and language development compared to the control group as they used significantly more utterances and a higher rate of words per minute, larger vocabularies and a greater variety of words, more target words in structured and play situations, greater spontaneous use of words not targeted, and more sentences containing two or more words.

In a later study, Girolametto, et al. (1998), also used responsivity education and focused stimulation as the language intervention approach. This study consisted of twelve children with Down syndrome, ages 29 months to 46 months, and their mothers. The children communicated with single words or signs and no word combinations. Ten vocabulary words were targeted for learning. The results were consistent with previous studies demonstrating that children in the experimental group used more target words, either signed or spoken, during free play with their mothers. However, the results were less robust in comparison to previous studies as there were no significant differences between the treatment and control groups following administration of standardized vocabulary measures. The researchers concluded that the study provided preliminary evidence supporting responsivity education combined with focused stimulation as an effective intervention approach for children with both cognitive and language disorders.

In summary, both responsivity education (Girolametto, 1988; Tannock, Girolametto & Siegal, 1992; Pennington, Thomson, James, Martin, & McNally, 2009) and focused stimulation (Cleave & Fey, 1997; Fey, Cleave, & Long, 1997; Fey, Cleve, Long & Hughes, 1993; Robertson & Ellis Weismer, 1999) have been found to be effective language intervention approaches for young children with language impairments. While these language intervention approaches have been studied with children demonstrating language delays, developmental delays, and Down syndrome, they have not been explicitly studied with children demonstrating severe communication difficulties who benefit from AAC other than to examine parent-child interactions. The current study investigated responsivity education and focused stimulation and included participants with severe communication difficulties who benefitted from AAC, as well as examined language production skills. However, there is also a large base of evidence targeting children with severe communication difficulties who benefit from AAC. The next section of the chapter describes language intervention approaches that have specifically been implemented with this population.

Language Intervention Approaches for Children with Severe Communication Difficulties

Aided AAC modeling. One language intervention approach that has been comprehensively studied with children who have severe communication difficulties and benefit from AAC is aided AAC modeling. Aided AAC modeling occurs when an interventionist points to a graphic symbol on a child's AAC device while simultaneously producing the corresponding spoken word during natural communication exchanges. The intervention technique was initially developed by Goossens in 1989 while working with a 6-year old AAC user who was learning English as a second language. During this case study, both the interventionists and the child's parents concurrently pointed to key graphic symbols on the child's communication display in conjunction with ongoing verbal language stimulation. The results revealed emergence of self-initiated graphic symbol communication accessed through eye gaze and functional speech through production of intelligible single words and 2-and 3-word combinations. Following Goosens' (1989) introduction of this language intervention approach specifically designed for AAC users, additional researchers have incorporated use of aided AAC modeling in their language intervention approaches. A number of recent studies provide empirical support for the use of aided AAC modeling as an efficacious language intervention approach for children with severe communication difficulties (Binger & Light, 2007; Bruno & Trembath, 2006; Dada & Alant, 2009; Harris & Reichle, 2004).

The use of aided AAC modeling was implemented with three preschoolers between the ages of 3 years, 10 months and 5 years, 4 months who were functionally nonspeaking and demonstrated moderate cognitive disabilities in a study completed by Harris and Reichle (2004). Twelve new vocabulary words which were neither understood nor produced were introduced by pairing the name with the object followed by use of aided AAC modeling during scripted routines designed for a preferred activity. Intervention consisted of placing a communication board in front of the preschooler during the scripted routine. The experimenter pointed his finger to a referent in the environment and sequentially pointed to the graphic symbol on the communication board while saying the name of the referent four times for each target vocabulary word during the session. The results revealed that all three children displayed increased symbol comprehension - correctly responding to "show me the _," and production - correctly responding to "what is this?," following implementation of aided AAC modeling which was maintained following completion of intervention. The authors concluded all of the children demonstrated fast mapping skills prior to implementation of aided language stimulation which may have facilitated comprehension and production of the targeted vocabulary. They recommended future AAC intervention research explore the role of more naturalistic intervention procedures and that the effectiveness of aided AAC intervention be compared to the effectiveness of other language training programs, which was basis of the current study.

A pilot study exploring the benefits of aided AAC modeling for increasing syntactic complexity was completed by Bruno and Trembath (2006). Nine children ranging in age from 4 years, 8 months to 14 years, 5 months, and their parents, participated in a weeklong summer camp program for children who used AAC systems. All of the participants produced single words to 3-word phrases absent of morphology. The intervention took place during two 45-minute sessions per day with trained speech-language pathologists. During one session the participants used a manual communication board while completing an arts and crafts project and during the other session the participants used their own voice output communication aides while playing

with a magnetic town. Clinicians used aided AAC modeling to model messages at one step above the mean utterance length that the children demonstrated during pre-testing. The results for using the communication board revealed increases in mean utterance length for 4 of 9 participants and increases in syntactic complexity for 7 of 9 participants when comparing pre and post testing. The results for using the voice output communication aids revealed increases in mean length of utterance for 5 of 9 participants and increases in syntactic complexity for 1 of 9 participants. The authors concluded the there were a greater number of turns to use the manual communication boards each session, ranging from five to eight times per camper, versus the voice output communication aides, ranging from three to five times per camper, which allowed more practice using the manual communication board condition and perhaps resulted in the greater progress producing syntactic complexity during post testing. The authors recommended additional research explore the frequency and duration of the intervention needed to maximize performance changes in mean length of utterance and syntactic complexity.

The effect of using aided AAC modeling with five preschoolers ranging from age 3 years, 5 months to 4 years, 6 months who had severe communication difficulties was studied by Binger and Light (2007). This study evaluated the impact of using aided AAC modeling to support multi-symbol message production during imaginative play scenarios such as washing a baby, having a tea party, playing with vehicles, playing with a farm, and cleaning the kitchen. Participants demonstrated early linguistic skills with production of at least 25 word symbols, of which 90% were single-word productions. Three participants used a voice output communication aid to communicate and two participants used a communication board. Aided AAC models were provided by pointing to two symbols on the child's aided AAC system, and then providing a grammatically complete spoken model while engaging in the play activities. The results revealed that four of the five preschoolers learned to consistently produce multi-symbol messages; the fifth did not demonstrate consistent gains. The four preschoolers who met criterion all evidenced long-term use of symbol combinations and generalized use of symbol combinations to novel play activities. The authors concluded that using AAC modeling increased the symmetry between linguistic input and output, using breakdown, defined as pointing to and labeling the two symbols, followed by buildup, defined as providing a grammatically complete utterance, facilitated multi-symbol message production. They also concluded modeling aided AAC slowed down the communication process and provided salience to the modeled symbols. The authors recommended future investigations address the use of aided AAC with and without explicit prompts and across a greater variety of natural contexts.

Most recently, the effect of aided language stimulation on vocabulary comprehension with school-aged children demonstrating little or no functional speech was investigated by Dada and Alant (2009). Participants consisted of four students between the age of 8 years and 12 years who were diagnosed with cerebral palsy or Down syndrome, were unintelligible, and had never received prior AAC intervention. This study consisted of three activities, arts and crafts, food preparation, and story time, which were completed within a group setting. During each activity, the participants observed a single, large communication board which contained sixteen of the same core symbols across activities and eight fringe vocabulary symbols specific to each of the three activities. The participants comprehended 0% of the twenty four total fringe vocabulary at baseline. During intervention, the therapist pointed to available symbols on the communication board while providing ongoing verbal language stimulation throughout the activity. .Results of

the study revealed that aided language stimulation facilitated comprehension of the twenty four target vocabulary across participants, and comprehension was maintained one to two weeks post intervention for the initial two sets of vocabulary in the study. The authors concluded that frequent use of aided language stimulation within a natural context was a facilitative factor in the receptive learning of new vocabulary. The authors suggested future research compare the outcomes of different approaches in teaching vocabulary to young children within a group context. The authors further suggested carefully considering the relationship between symbols taught during the activity and objects used for probes, to ensure that comprehension of vocabulary was actually taught.

Responsivity education combined with aided AAC modeling. A number of recent investigations have studied the effects of responsivity education combined with aided AAC modeling on turn-taking skills, multi-utterance productions, and vocabulary production with children demonstrating severe communication difficulties who benefit from AAC (Binger, et al., 2008; Kent-Walsh, et al., 2010; Romski & Sevcik, 1996; Romski, et al., 2010; Romski, Sevcik, Cheslock, & Barton, 2006; Rosa-Lugo & Kent-Walsh, 2008).

Responsivity education combined with aided AAC modeling was the intervention approach used in a study that investigated the effects of a parent instruction program on communicative turn taking during a storybook reading activity with children who use AAC (Rosa-Lugo & Kent-Walsh, 2008). The study consisted of two sets of parent-child dyads from Latino backgrounds. The children were ages 6 years, 10 months and 6 years, 8 months, who had AAC systems with at least 10 symbols and produced one to three word phrases. Parents were taught to use the responsivity education techniques of expectant delay, open-ended questions with AAC modeling, and language expansion, while reading a storybook with their child. The results revealed that both parents accurately demonstrated the intervention strategies resulting in a 100% increase in communicative turn taking between baseline and intervention probes which were maintained eight weeks following completion of intervention. The authors concluded that future research should address the effectiveness of these intervention strategies using additional types of play activities, when introducing new vocabulary, and with other culturally and linguistically diverse groups.

Responsivity education combined with aided AAC modeling was also the intervention approach used in a study that evaluated the effectiveness of a parent instructional program on multi-symbol utterance productions with preschoolers who used AAC (Binger, et al. 2008). This study consisted of three parents and their children who were Latino. The children were ages 4 years, 1 month, 3 years, 4 months, and 2 years, 11 months, and all produced unintelligible speech, did not consistently produce two-word phrases, and demonstrated age appropriate receptive language skills. None had used AAC prior to the study. Two children used voice output communication aids during the study and one child used a low tech communication board. During a storybook reading activity, parents were taught to read, ask a question, and answer the question if the child didn't respond using expectant delays between each element. In addition, parents were taught to model two-word productions on the child's AAC device and respond to their child's productions using AAC imitations, expansions, and recasts. The results revealed that the parents consistently used the strategies and the children consistently used multi-symbol productions with a 100% increase in these behaviors between baseline and intervention. Parent use of the strategies and

children's use of multiword symbols were maintained eight weeks after completion of the intervention. The child who used the low tech communication board took longer to combine symbols in comparison to use of the voice output communication aids. The authors suggested future research include participants who were less acculturated Latino families, children with cognitive impairments or severe physical impairments, and future research address the effectiveness of the strategies with more complex linguistic forms.

Romski and Sevcik have been studying the use of aided AAC modeling since 1996 (Romski & Sevcik, 1996). Their intervention approach, the System for Augmenting Language, was originally developed as part of a longitudinal research study of the language development of school-aged AAC users. The System for Augmenting Language consists of five components: 1) a voice output communication aid, 2) individually chosen graphic symbols, 3) use of graphic symbols in natural everyday environments that encourage, but do not require, children to produce symbols, 4) models of symbol use by communicative partners during input to the child to provide a model for how AAC can be used successfully in real world experiences, which is augmented AAC modeling, and 5) an ongoing resource and feedback mechanism. The System for Augmenting Language has been effectively used with school-age children with moderate to severe cognitive abilities who are at the emerging or early linguistic stage of language development and have at least primitive intentional communication skills, a spoken language vocabulary of less than 10 intelligible words or word approximations, and gross pointing skills (Romski, & Sevcik, 1996; Romski, Sevcik, Cheslock, & Barton, 2006).

The System for Augmenting Language was recently adapted for use with young children under the age of five years. Romski and colleagues (2010) compared the effects of three communication intervention strategies with 62 preschoolers ranging between the ages of 21 months and 40 months and their caregivers. Participants were diagnosed with genetic syndromes such as Down syndrome, cerebral palsy, or unknown conditions. All children produced less than 10-word vocabulary at the start of intervention. Intervention consisted of four components: a) choosing targeted vocabulary that the child did not comprehend or produce, b) parent coaching, c) using a voice output communication aid and gesturing, but no signing, for the augmented treatment conditions or speech only for the non-augmented treatment condition, and d) using naturalistic intervention strategies to facilitate learning of targeted vocabulary. Children were randomly assigned to three intervention strategies: a) use of augmented communication input based on the System for Augmenting Language, in which the interventionist and parent modeled augmented and spoken word use of targeted vocabulary with the child's voice output communication aid while symbols were positioned in the environment to mark referents. No direct demands were made for the child to communicate but positive reinforcement was provided if the target vocabulary was produced; b) use of augmented communication output in which the interventionist and parent did not model augmented communication but visually, verbally, and physically prompted the child to produce the targeted vocabulary using augmented communication. For example, the adult prompted the child to "tell me what you want using your device" while pointing to the direction of the voice output communication aid; and c) spoken communication interactions without use of AAC. The results revealed that children in the augmented treatment groups produced significantly more augmented and spoken vocabulary than the non-augmented group at sessions 18 and 24 of intervention. In addition, the augmented output group produced significantly more vocabulary than the augmented input group at session

18 but not at session 24. Regarding spoken vocabulary, the effects were modest across all three groups, but the children who received augmented output intervention were more likely to produce spoken words at session 18 and maintain the words at session 24 in comparison to the two other interventions. The authors concluded that augmented language interventions which included parent coaching had a positive communication effect on young children with developmental delays and fewer than 10 spoken words. Augmented communication did not hinder, but rather aided speech production abilities with this population. Unlike the current study, in the Romski et al. (2010) study, participants did not comprehend targeted vocabulary during pretesting, and the intervention approaches did not include repeated exposure to targeted vocabulary as is found in the focused stimulation intervention approach.

Finally, responsivity education combined with aided AAC modeling was investigated in a study that evaluated the effectiveness of a parental instruction program on turn-taking and expression of semantic concepts with children who used AAC (Kent-Walsh, et al., 2010). This study consisted of six children and their parents who were European American and African American. The children ranged in age from four years to eight years and were diagnosed with either cerebral palsy or Down syndrome. All children were multimodality communicators who used natural speech and gestures, with one participant also using manual sign. Five of the six participants used voice output communication aids and one participant used a low tech communication board. Materials for the study consisted of storybooks with individualized communication boards developed for each different storybook. Each parent was instructed to: a) read a page of the story, b) provide an aided AAC model, c) ask a WH question and then provide an aided AAC model, and d) answer the WH question and provide an aided AAC model. Use of expectant delay was taught between steps. The results revealed that all six parents learned to implement the communication strategies accurately. All six children increased their communicative turn taking and their language use as reflected by a greater variety of semantic concepts expressed after only three intervention sessions. While individual differences existed, as a whole the children's skills improved quickly. The authors suggested future studies target intervention beyond storybook reading to include other contexts such as play and snack activities, as well as target communication and language skills beyond turn-taking.

In summary, aided AAC modeling has been found to be an effective language intervention approach for improving the single word vocabulary of preschoolers with moderate cognitive delays using communication boards during structured activities (Harris & Reichle, 2004), for developing the early syntax of children using communication boards and voice output communication aids during camp activities (Bruno & Trembath, 2006), for developing two-word combinations with preschoolers using voice output communication aids during play scenarios (Binger & Light, 2007), and for improving vocabulary comprehension in school-aged with cerebral palsy and Down syndrome with no prior exposure to AAC (Dada & Alant, 2009). Parental responsivity education combined with aided AAC modeling has also been found to be an effective combination during story book reading for increasing communicative turn-taking between kindergartners and their parents and for increasing two-word production in preschoolers and school-aged children with cerebral palsy and Down syndrome who use AAC (Binger, et al., 2008; Kent-Walsh, et al., 2010; Rosa-Lugo & Kent-Walsh, 2008), as well as for developing early word production of children with severe cognitive impairments and preschoolers with limited vocabularies using voice output communication aids during naturalistic activities (Romski, et al.,

1996, 2010). Table 1 provides a comparative synthesis of the above studies addressing language intervention for children with severe communication difficulties across age ranges, types of disorders, types of AAC used, language intervention approaches, intervention activities, the dependent variables in the studies, and study results.

Table 1: Studies Addressing Language Intervention for Children with Severe Communication Difficulties

Study	Age Range of Participants	Types of Disorders	Types of AAC	Language Intervention Approaches	Activities	Dependent Variable	Results
Harris and Reichle (2004)	3 yrs. 10 mos. – 5 yrs. 4 mos.	Moderate cognitive impairments	Manual communication board	Aided AAC modeling	Scripted routines	1. Vocabulary comprehension 2. Vocabulary production	All 3 participants increased vocabulary comprehen-sion and production
Bruno and Trembath (2006)	4 yrs. 8 mos. – 14 yrs. 5 mos.	Cerebral palsy, apraxia, Down syndrome	1. Manual communication board 2. VOCA*	Aided AAC modeling	1. Arts and craft project 2. Magnetic town	1. Mean length of utterance (MLU) 2. Syntactic complexity	1. 4 of 9 increased MLU and 7 of 9 increased syntax with board 2. 5 of 9 increased MLU and 1 of 9 increased syntax with VOCA*
Binger and Light (2007)	3 yrs. 5 mos. – 4 yrs. 6 mos.	Prader-Willie, DiGeorge, and Down syndromes; development-al delays	VOCA*; manual communication board	Aided AAC modeling	Play activities	Two-word symbol use	4 of 5 participants began using two-word symbols

Dada and Alant (2009)	8 yrs. – 12 yrs.	Cerebral palsy; Down syndrome	Group manual communication board	Aided AAC modeling	Arts and crafts; food preparation; story time	Vocabulary comprehension	All 4 participants increased vocabulary comprehen-sion
Rosa-Lugo and Kent-Walsh (2008)	6 yrs. 8 mos. – 6 yrs. 10 mos.	Cysuchygro-ma; development-al delay	Manual communication board	Responsivity education; aided AAC modeling	Parent-child storybook reading	Communicative turn-taking	Communica-tive turn-taking increased for both sets of parent-child dyads
Binger, et al. (2008)	2 yrs. 11 mos. – 4 yrs. 1 mos.	Cleft palate; VPI**; severe speech disorder	VOCA*; manual communication board	Responsivity education; aided AAC modeling	Parent-child storybook reading	Two-word symbol use	All 3 participants increased use of two-word symbols
Romski, et al. (2010)	21 mos. – 3 yrs. 4 mos.	Cerebral palsy; Down syndrome; other conditions	VOCA*	Responsivity education; aided AAC modeling	Play; storybook reading; Snack	Vocabulary production	Augmented groups produced more vocabulary vs. non-augmented group
Kent-Walsh, et al. (2010)	4 yrs. – 8 yrs.	Cerebral palsy; Down syndrome	VOCA*; manual communication board	Responsivity education; aided AAC modeling	Storybook reading	1. Turn-taking 2. Vocabulary production	Turn-taking & vocabulary increased for all six sets of parent-child dyads

* VOCA = Voice Output Communication Aid ** VPI = Velopharyngeal insufficiency

While aided AAC modeling, as well as parental responsivity education combined aided AAC modeling, have been found to be efficacious language intervention approaches for children with severe communication difficulties, these approaches have not been compared to other language intervention approaches, such as focused stimulation, to determine which approach is more efficient, resulting in more rapid language learning. The current study compared the language intervention approaches of responsivity education and focused stimulation to responsivity education and focused stimulation with the addition of AAC modeling. In addition, the studies in this section have described the effectiveness of AAC modeling as an intervention approach to facilitate language comprehension and production in children over the age of three years, with the exception of Romski and colleagues (2010) and one participant in the Binger, et al. (2008) study who was age 2-years. The participants in the current study were all 2 years old at the start of the study. Therefore, the next section of the paper reviews research addressing the evidence base of AAC intervention targeted children under the age of three years with disabilities.

AAC Intervention with Children under Age Three Years

A research review of the use of augmentative and alternative communication methods with children under the age of three-years demonstrating disabilities was completed by Branson and Demchak (2009). The importance of focusing on AAC use with children under the age of three years is emphasized by the National Scientific Council on the Developing Child (2007), stating that early learning experiences during the first three years lay the foundation for later brain development and by ASHA (2008), stating that children are likely to make the greatest gains in communication skills when intervention is begun during the early stages of development. Early access to AAC intervention can assist a young child in developing intentional communication behaviors recognizable to caregivers who, in turn, can respond and reinforce early communication behaviors leading to additional communicative and language development (Cress & Marvin, 2003).

Branson and Demchak (2009) required studies to include specific criteria to qualify as methodologically vigorous research studies. The research review inclusion criteria consisted of: a) studies conducted between 1982 and 2007 involving children between birth to three years, b) individuals with developmental disabilities with significant communication delays, and c) reporting data on the implementation of either unaided or aided AAC methods. Methodological details required for inclusion consisted of stating study identification, study goals, number of participants, participant's age, participant's gender, participant's disability classification, target of intervention, study design, setting, type of AAC, treatment integrity measures, and percentage of non-overlapping data or effect size for group designs. Appraisal of certainty of evidence was confirmed by examining methodological vigor for demonstration of treatment effects claimed, adequate inter-observer reliability data, operationally defined dependent and independent variables, and study procedures that were sufficiently described to allow for replication. Seven single subject studies involving a total of 32 participants, and five group designs involving a total of 158 participants, met the inclusion criteria over the period of 25 years. However, only seven of the twelve studies provided certainty of evidence such that the design provided experimental control, the dependent variable was reliable, and the treatment integrity was solid, clearly demonstrating a paucity of well designed AAC intervention studies with infants and toddlers (Branson & Demchak, 2009). It should be noted that the present investigation included all

required methodological details and demonstrated the required methodological vigor for certainly of evidence described by Branson and Demchak (2009).

A variety of intervention procedures were researched across the twelve studies of AAC use with children under the age of three. Nine studies targeted child behavior, two focused on training caregivers, and one evaluated inclusive preschool studies. Targeted child behavior skills included increasing intentional communication acts; increasing prelinguistic acts such as vocalizing, body movements, and gestures; increasing spontaneous and responsive communicative acts such as producing conventional gestures, signing, using line drawing symbols, and using voice output communication aids; increasing requesting behavior; and increasing multiple functions such as requesting, choice making, protesting, and/or commenting (Branson & Demchak, 2009). None of the studies targeted production of specific vocabulary as is the case in the current investigation.

Three studies of AAC use with children under the age of three years incorporated AAC modeling as an intervention approach (DiCarlo, Stricklin, Banajee, & Reid, 2001; Iacono & Duncum, 1995; Kouri, 1998). DiCarlo and colleagues (2001) evaluated the effects of manual signing by a classroom teacher on the verbalizations of preschoolers in an inclusive classroom. Participants consisted of twelve infants and toddlers, ages 15 to 36 months, with autism, cerebral palsy, and Down syndrome, as well as 12 children of the same age range without disabilities. Modeling of manual signing was introduced sequentially by the teacher during ongoing verbal interactions with the preschoolers across three play activities. Environmental arrangements in the classroom were created to facilitate communicative interactions with intervention provided over 25 sessions. The results revealed teacher signing was accompanied by a small increase in frequency of sign use during the signing program by both groups of children, and use of verbalizations did not decrease for either group during the signing program. The authors concluded that use of signing in an inclusive program was not detrimental to the verbal skills of children without disabilities.

Iacono and Duncum (1995) compared the use of sign alone and sign in combination with a voice output communication aid (DynaVox™) in a two-year-old child with Down syndrome. Sessions alternated between pretend cooking and dressing up using scripts and child-directed play. The researcher modeled target vocabulary according to the treatment condition with one treatment condition consisting of simultaneous signing plus speech and the other treatment condition consisting of randomly presented signing plus speech plus the DynaVox™. The results demonstrated that the toddler produced more spontaneous/responsive productions during the signing plus speech plus DynaVox™ condition in comparison to the signing condition for single word productions. In addition, the toddler was also more likely to produce two-word and three-word utterances using the DynaVox™. The authors concluded that AAC facilitated early language skills in children with Down syndrome and suggested that signing might not be as effective an approach for facilitating language production beyond the single word level.

Kouri (1988) studied whether a child-directed treatment focus and use of simultaneous signing plus speech was facilitative in increasing interactions and sign use in two toddlers, ages 34 mos. and 36 mos., diagnosed with autism and Down syndrome. AAC consisted of child signing and informal gesturing. Individual and group treatments were provided twice weekly over eight

months. The results revealed that higher levels of interaction with informal meaningful gestures and sign use occurred during the phase consisting of a child-directed focus combined with use of sign plus speech intervention compared to the withdrawal phase which was not child-directed and did not include simultaneous sign plus speech.

The three studies provide additional evidence that the intervention approach of AAC modeling is effective in increasing production in toddlers who use unaided signing and voice output communication aids. The current study extended the results of previous research to include use of non-electronic aided communication boards and flip charts. Unlike the more similar Iacono and Duncum (1995) study, the current study included more than one participant, three of four participants did not demonstrate cognitive impairment, and the study did not use voice output communication aids.

Three research studies of AAC use with children under the age of three years were comparative studies such as the present study, and used alternating treatment design methodology similar to the present study. One study compared signing plus speech to signing plus speech plus voice output communication aid use to determine total number of words produced and number of different words produced (see Iacono & Duncum, 1995 above), the second study compared use of Picture Exchange Communication Symbols (PECS) to manual signing when requesting (Anderson, 2001), and the third study compared three models of adult prompting to promote communication acts (Salmon, Rowan, & Mitchell, 1998).

Anderson (2001) studied whether use of PECS or use of manual sign was more effective for requesting toys and foods. Participants consisted of five preschoolers, ages 23 to 35 months, and one participant over age 3 years, diagnosed with PDD and autism. Treatment was provided three times weekly for 90 minutes each over approximately ten weeks, alternating between the PECS and sign conditions. Child directed strategies were implemented throughout the study. The findings revealed that the five preschoolers mastered more requests for toys and food using the PECS conditions versus the sign condition, the rate of acquisition was faster using PECS for the majority of children, and the there was better generalization to novel requesting. Participants with a preference for signing demonstrated higher levels of functional play, imitation, and language age-equivalents pre treatment, and higher levels of initiation, eye-contact, and vocalizations post treatment.

Salmon and colleagues (1998) compared a responsive interaction model, a didactic approach, and a milieu model to elicit intentional requesting and commenting. Participants consisted of three preschoolers, ages 17 to 30 months, diagnosed with Down syndrome and agenesis of the corpus callosum. AAC consisted of gesturing, signing, or vocalizing during treatment. The trainer used six situations to elicit intentional requesting and commenting following a multi-level hierarchy of prompts. The three types of adult prompting began with a responsive interactive model using commenting and expanding which avoided explicit prompting; followed by a didactic approach with removal/stopping the activity followed by explicit prompts to request and comment; and lastly a milieu model with visual cueing and physical prompts to elicit requesting and commenting. The findings revealed more intentional behaviors occurred using explicit prompting with the didactic and milieu approaches versus avoiding explicit prompting using the responsive interactive model. Responsive acts occurred more frequently than initiation acts.

However, study design and appraisal were inconclusive, as baseline measures, graphic representations, and treatment integrity measures were not reported.

Like the Salmon, et al. (1998) study, the current study also focused on the type of adult prompting, in this case responsivity education and focused stimulation compared to responsivity education and focused stimulation with the addition of AAC modeling. The dependent variable was vocabulary produced rather than initiating, requesting, and commenting. Unlike the Salmon, et al. (1998) study, the current study design and appraisal was conclusive with completion of baseline measures, graphic representations, and treatment integrity measures.

Based on a total of seven conclusive studies, Branson and Demchak (2009) concluded that AAC methods can be used effectively with children under the age of three with disabilities. They reported that many different types of AAC methods could be used to improve intentional communication such as unaided methods (DiCarlo, et al., 2001), non-electric aided methods (Anderson, 2001), and voice output communication aids (Iacono & Duncum, 1995). In addition, the authors concluded a variety of AAC methods can be effective when adult communication partners respond consistently and contingently, and they encouraged clinicians to try multimodal AAC with young children Table 2 provides a comparative synthesis of the studies addressing language intervention with children under the age of three years across age ranges, types of disorders, types of AAC used, language intervention approaches, intervention activities, dependent variables, and study results.

Table 2 Studies Addressing AAC Intervention with Children under the Age of Three and Comparative AAC Intervention

Study	Age Range of Participants	Types of Disorders	Types of AAC	Language Intervention Approaches	Activities	Dependent Variables	Results
DiCarlo, et al. (2001)	15 mos. – 36 mos.	Autism; cerebral palsy; Down syndrome; typical development	Manual sign	AAC modeling	Play activities in inclusive preschool	1. Manual signing 2. Amount of verbalization	Small increase in signing in both populations; no decrease in verbalizations
Iacono and Duncum (1995)	2 yrs.	Down syndrome	1. Manual sign alone 2. Manual sign and VOCA	AAC modeling	Pretend cooking; dressing up	1. Number of productions 2. 2-3 word phrases; Compared across sign vs. sign + VOCA	Child produced more productions and phrases with sign + VOCA vs. sign alone
Kouri (1998)	34 – 36 mos.	Autism; Down syndrome	Manual sign; gestures	1. Not child directed 2. Responsivi-ty education + AAC modeling using simultaneous sign & speech	Play	1. Interactions 2. Sign use	Increased interaction and use of sign with RE + AAC modeling with both participants
Anderson (2001)	23 mos. – 35 mos.	Autism	1. Manual sign 2. PECS*	AAC modeling with either manual sign or	Requesting for toys and food	Number of requests; Compared manual sign vs.	PECS* was more effective and efficient for requesting

				PECS*		PECS*	toys and food vs. sign for the 5 participants
Salmon, et al. (1998)	17 mos. – 30 mos.	Down syndrome; agenesis of corpus callosum	Manual sign; gesturing; speech	1. Interaction approach 2. Didactic approach 3. Milieu approach	Play	1. Intentional requesting 2. Commenting; Compared across three approaches	All 3 children used more intentional requesting and commenting with didactic and milieu approaches
Remington and Clark (1983)	10 yrs. – 15 yrs.	Autism	Manual sign	1. Behavioral training 2. AAC modeling without verbal model 3. AAC modeling with verbal model	Structured activities	Labeling; Compared AAC modeling with and without a verbal model	Both approaches were effective and equally efficient in increasing labeling for the 2 participants
Iacono, et al. (1993)	3 yrs. 6 mos. – 4 yrs. 6 mos.	Mild to moderate cognitive impairment	1. Manual sign 2. VOCA	Structured training; AAC modeling	Structured activities	2-word phrases; Compared use of manual sign vs. use of VOCA	Both types of AAC were effective for the 2 participants but efficiency varied across the types of AAC

*PECS = Picture Exchange Communication System

Branson and Demchak (2009) also identified gaps in the literature, including a need to move research from university clinics to home and childcare centers where functional use of AAC methods can be investigated during daily routines, as well as a paucity of studies comparing the effectiveness of various types of AAC interventions for children with specific disabilities. Clearly, more research in AAC with children under the age of three is needed. The current study added to the literature from a home/center based perspective and a comparative AAC intervention perspective. The final section of the chapter addresses comparative AAC intervention studies using single-subject experimental designs, which was the methodology used in the current study.

Comparative AAC Intervention Studies Using Single Subject Experimental Designs

A synthesis of comparative AAC intervention studies using single-subject experimental designs that involved participants with developmental disabilities was completed by Schlosser and Sigafoos (2006). Fourteen criteria were deemed essential for determining the certainty of the evidence stemming from comparison studies: 1) bias of participants towards a particular condition due to prior experiences, 2) adequate control of sequence effects and carry-over effects by using an appropriate design, 3) the design allows for within-subject replication of effects, 4) carryover effects/sequence effects are further minimized through procedural safeguards, 5) a learning criterion was set, 6) a teaching criterion was set, 7) the equivalence of instructional sets is demonstrated and based on current knowledge of sets, 8) treatments are randomly assigned to instructional sets, 9) the functional independence of sets is demonstrated, 10) inter-observer agreement data for the dependent measure(s) is/are adequate for the particular target behaviors, 11) treatment integrity is comparable across conditions, 12) procedures are held constant except for to be examined differences across conditions, 13) effectiveness of conditions is demonstrated unequivocally through the attainment of a learning criterion, and 14) efficiency comparisons are based on attainment of an a priori learning criterion for all conditions compared (Schlosser, 1999, 2003). These fourteen criteria were incorporated in the present study to assure certainty of evidence.

The categories in the systematic review of comparative AAC intervention studies (Schlosser & Sigafoos, 2006) included: a) studies involving unaided AAC modes such as comparisons of signing with simultaneous communication, b) studies involving necessary conditions for simultaneous communication such as comparing methods for teaching signing, c) studies involving instructional strategies and format for aided approaches such as comparing computer versus teacher presentations of graphic symbols, d) comparisons of types of aided graphic symbols, e) comparisons of selection techniques and device displays using aided AAC, f) comparisons of components of AAC systems such as natural speech versus synthetic speech output, g) comparisons of use of communication board versus voice output communication aids, and h) comparisons of aided versus unaided approaches such as manual signing versus PECS. A total of fifty seven studies were reviewed between the years 1980 and 2004. None of the categories in this comprehensive review compared the effectiveness and efficiency of types of language intervention approaches such as responsivity education, focused stimulation, and/or AAC modeling on language enhancement.

Two studies used an alternating treatment design, similar to the design of the present study, to compare intervention approaches for learning language (Remington & Clark, 1983; Iacono, Mirenda, & Beukelman, 1993). The Remington and Clark (1983) study compared two methods for training autistic children to use manual signs. The study consisted of two children, ages 10 years and 15 years, one of whom was non-verbal and other who produced a limited number of verbal imitations. Speed of sign acquisition was compared using highly structured behavioral training conditions in which signs were presented either accompanied by the verbal label (AAC modeling) or without the corresponding verbal label. Both conditions were effective as teaching techniques for learning signs but the results revealed no clear difference in speed of learning signs across conditions. In addition, the simultaneous condition (AAC modeling) facilitated the receptive language skills of the child who demonstrated verbal imitation skills but did not facilitate the receptive language skills of the non-verbal child. While the study compared AAC modeling to no modeling, the study explicitly addressed signing rather than other types of AAC, the participants were elementary and high-school aged, the participants were diagnosed with autism, and the intervention approach was highly structured. The focus of the present study was not on explicit use of signing, did not include older children diagnosed with autism, and did not utilize structured behavioral methodology.

The second study compared the effectiveness of unimodal AAC, consisting of speech and manual sign, with multimodal AAC, consisting of speech, manual sign, and voice output communication aids, in preschoolers with intellectual impairments (Iacono, et al., 1993). Two preschoolers, ages 3 years, 6 months, and 4 years, 6 months, who produced single word signs and demonstrated mild to moderate cognitive impairments, were taught two-word semantic combinations using a structured intervention approach which compared speech and signs with speech, signs, and a voice output communication aid. The results revealed that, overall, treatment resulted in increases in the number of spontaneous productions of the target two-word combinations. However, the participants showed differences in their rates of learning, the comparative effectiveness of the two AAC conditions, and their tendencies to use signs verses the voice output communication aids. The child with more severe cognitive impairment learned two-word combinations more slowly and relied more on sign while the child with less severe cognitive impairment learned two-word combinations more quickly and relied more on voice output communication aid use. While the study compared AAC modeling to no modeling in preschoolers, the present study differed from the Iacono, et al. (1993) study in a number of ways. In the present study, the participants were younger, voice output communication aids were not used during intervention, the intervention approach was naturalistic rather than structured, and the target stimuli was repeatedly modeled through use of focused stimulation.

Two studies which were reviewed in the previous section about AAC intervention with children under the age of three years were also included in the Schlosser and Sigafoos (2006) comparative AAC intervention single subject review. Anderson (2001) studied whether use of PECS or use of manual sign was more effective for requesting toys and foods across five preschoolers under that age of three and one preschooler over the age of three, all diagnosed with autism. The study utilized a single subject, alternating treatment design. Iacono and Duncum (1995) compared the use of sign alone and sign in combination with a voice output communication aid in a two-year-old child with Down syndrome, also using an alternating treatment design. The present study used an adapted alternating treatment design. The advantages of the adapted alternating

treatment research design over the alternating treatment design are described in the next section, as well as other limitations of past research. Table 2 provides a comparative synthesis of the two additional studies addressing comparative AAC intervention (Remington & Clark, 1983; Iacono, et al, 1993) across age ranges, types of disorders, types of AAC used, language intervention approaches, intervention activities, dependent variables, and study results.

Limitations of the Alternating Treatment Design and of Past Research

Limitations of the alternating treatment design. Alternating treatment design was initially introduced in the late 1970's by Barlow and Hayes (1979). In this design, two or more treatments are alternated randomly as they are applied to a single subject. The results are examined to determine whether one or more of the treatments is more effective than the others. In a Barlow and Hayes (1979) study of two alternating treatments, the more effective intervention was carried into a third phase. Kazden (1982) described the differing interventions as occurring concurrently, usually on the same day. The interventions are to be balanced such that each intervention is administered under each of the conditions an equal number of times. The limitations of the alternating treatment design are that confounding can occur between the treatments and the order of the treatments can result in one treatment effect carrying over to another (Satake, Jagaroo, & Maxwell, 2008).

The adapted alternating-treatment design attempts to eliminate the two limitations of the alternating treatment design, confounding and order effects (Sindelar, Rosenberg, & Wilson, 1985). Each intervention is assigned to a unique set of instructional items which limits the confounding that can occur between treatments. This requires the identification of two, or as many treatments which exist, equivalent and functionally independent sets of instructional sets. Order effects in the adapted alternating treatment design are also controlled by counterbalancing or randomizing the order of the interventions (Sindelar, et al, 1985). The vast majority of AAC treatment comparison studies have relied on the use of the adapted alternating treatment design (Schlosser, 2003).

Limitation of past research. Although the research to date investigating intervention with young children who use AAC has been promising, there are serious limitations to the findings. First, there have been no studies investigating the use of responsivity education combined with focused stimulation as a language intervention approach with young children who use AAC. Rather, responsivity education combined with focused stimulation was found to be an effective language intervention approach for young children with language impairments (Girolametto, 1988; Tannock, et al., 1992) and was found to be particularly effective with children producing less than 50 word vocabularies (Girolametto, et al., 1996a, 1996b; Girolametto, 1998) in studies consisting of children demonstrating language delays, developmental delays, and Down syndrome. Only parent-child interactions were studied with children demonstrating severe communication difficulties who benefitted from AAC (Pennington, et al., 2009).

Second, there have been no studies investigating the use of responsivity education and focused stimulation with the addition of AAC modeling. Instead, AAC modeling without responsivity education or focused stimulation has been found to be an effective language intervention

approach for improving the single word vocabulary of preschoolers with moderate cognitive delays using communication boards during structured activities (Harris & Reichle, 2004), for developing the early syntax of children using communication boards and voice output communication aids during camp activities (Bruno & Trembath, 2006), for developing two-word combinations with preschoolers using voice output communication aids during play scenarios (Binger & Light, 2007), and for improving vocabulary comprehension in school-aged with cerebral palsy and Down syndrome with no prior exposure to AAC (Dada & Alant, 2009). In addition, responsivity education and aided AAC modeling, but not including focused stimulation, has been found to be an effective combination during story book reading for increasing communicative turn-taking between kindergartners and their parents and for increasing two-word production in preschoolers and school-aged children with cerebral palsy and Down syndrome who use AAC (Binger, et al., 2008; Kent-Walsh, et al., 2010; Rosa-Lugo & Kent-Walsh, 2008), as well as for developing early word production of children with severe cognitive impairments and toddlers with limited vocabularies using voice output communication aids during naturalistic activities (Romski, et al., 1996, 2010).

Third, there is a paucity of investigations focusing on children under the age of three who benefit from AAC. Following a research review of studies with children under that age of three who used AAC from 1982 to 2007, Branson and Demchack (2009) identified a total of seven conclusive studies. They concluded that AAC methods can be used effectively with children under the age of three with disabilities and reported many different types of AAC methods could be used to improve intentional communication such as unaided methods (DiCarlo, et al., 2001), non-electric aided methods (Anderson, 2001), and voice output communication aids (Iacono & Duncum, 1995). The authors also identified gaps in the literature, including a need to move research from university clinics to home and childcare centers where functional use of AAC methods can be investigated during daily routines, and a paucity of studies comparing the effectiveness of various types of AAC interventions for children with specific disabilities.

Finally, as Branson and Demchak (2009) indicated, there are few comparative studies examining the effectiveness of various types of AAC interventions with children under the age of three years. Schlosser and Sigafoos (2006) completed a synthesis of comparative AAC intervention studies using single-subject experimental designs that involved participants with developmental disabilities and identified fifty seven studies between the years 1980 and 2004. Only two studies included children under the age of three years, Anderson (2001), who studied whether use of PECS or use of manual sign was more effective for requesting toys and foods across five preschoolers under age three and one preschooler over age three diagnosed with autism, and Duncum (1995), who compared the use of sign alone and sign in combination with a voice output communication aid in a two-year-old child with Down syndrome. Both studies utilized an alternating treatment design rather than an adapted alternating treatment design.

The above limitations point to the critical need to investigate the effectiveness of the well-accepted language intervention approach, focused stimulation, with children who use AAC. The above limitations further point to the critical need to study the use of AAC with children under that age of three, and in particular, to compare various types of AAC interventions to determine whether decreasing input-output asymmetry results in more effective and efficient learning of new vocabulary, or whether decreasing attentional and memory resources results in more

effective and efficient learning of new vocabulary. Finally the above limitations point to the importance of implementing an effective research design, the adapted alternating treatment design.

Research Questions

The current investigation used an adapted alternating treatment design to compare the effectiveness and efficiency of two language intervention approaches in teaching new vocabulary production to toddlers who receive AAC. Specifically, I examined the possible added value of including AAC modeling to an intervention involving responsivity education and focused stimulation. Research questions were as follows:

1) Is responsivity education and focused stimulation an effective language intervention approach in facilitating the vocabulary growth of toddlers with severe communication difficulties who receive AAC?
2) Is there an added value to including AAC modeling to the intervention involving responsivity education and focused stimulation in facilitating the vocabulary growth of toddlers with severe communication difficulties who receive AAC?

It was hypothesized that responsivity education and focused stimulation would be an effective language intervention approach. It was further hypothesized that the addition of AAC modeling would be both effective and more efficient in facilitating the vocabulary growth of toddlers with severe communication difficulties who receive AAC. Responsivity education and focused stimulation has been found to be an effective intervention approach with young children demonstrating language delays who do not use AAC, and requires fewer attentional and memory resources for learning new vocabulary in comparison to AAC modeling. Alternatively, input-output asymmetry is decreased with the addition of AAC modeling. I hypothesized that the added value of AAC modeling in decreasing input-output asymmetry would outweigh the additional attentional and memory resources required for learning new vocabulary with the approach. The importance of adult modeling, from a social constructivist theoretical perspective, would be supported by the results of the investigation.

CHAPTER 3 Methods

Research Design

This investigation utilized a single subject, adapted alternating treatment, nonconcurrent multiple baseline multiprobe research design (Sindelar, et al., 1985). Single-subject research refers to the study of a single subject over a period of time, or phase, to determine whether or not a given treatment or intervention is effective. The investigator obtains a pretreatment measure, called a baseline, and then introduces an intervention. The investigator continues to measure the participant's progress after the intervention or treatment is introduced to determine whether or not there is an evident change in the dependent variable between baseline and treatment. If there is a change in the dependent variable between baseline and treatment, maintenance and generalization probes are completed which are identical to the baseline phase, to determine the effectiveness of the treatment across time, people, and settings (Kazdin, 1982; Kennedy, 2005; Satake, et al., 2008). Single-subject experimental design represents the most prominent experimental designs option found in the augmentative and alternative communication research literature because of the low incidence and the heterogeneity of individuals with complex communication needs who benefit from AAC (Schlosser, 2003; Schlosser & Raghavendra, 2004).

As mentioned in the previous chapter, the adapted alternating-treatment design (AATD) is a variant of the alternating treatment design which attempts to eliminate the two limitations of the ATD, confounding and order effects. Each intervention is assigned to a unique set of instructional items to limit the confounding that can occur between treatments, which requires the identification of two equivalent and functionally independent sets of instructional sets. Order effects are controlled by counterbalancing or randomizing the order of the interventions (Sindelar, et al, 1985).

A nonconcurrent multiple baseline multiprobe design was also utilized in the study. The study was a noncurrent multiple baseline design as the participants did not begin the baseline phase at the same time. A benefit of noncurrent design is that it controls for most threats to internal validity such as maturation, test-retest sensitivity, and instrumentation changes (Kennedy, 2005). The design was multiprobe as data was collected intermittently during the execution of the experiment at times required for estimating trends and related patterns in the data within and between tiers rather than every session. The multiprobe approach was introduced by Horner and Baer (1978) as a way of making multiple baseline design more efficient for researchers (Kennedy, 2005).

This study consisted of four participants, all of whom used multimodal AAC to communicate including facial expressions; gestures and pointing; natural speech consisting of word approximations and words; manual signs; and aided non-electric communication boards, visual grids, and flip boards. The independent variables were the two language intervention approaches: a) responsivity education and focused stimulation and b) responsivity education and focused stimulation with the addition of AAC modeling. The dependent variable was the percentage of targeted vocabulary words produced during twenty minute play sessions. The

study involved five phases for two of the participants including assessment, baseline, intervention, generalization across all phases, and maintenance. The study involved four phases for the other two participants including assessment, baseline, intervention, and generalization across all phases. The maintenance phase was not completed for these two participants because they did not meet the established learning criterion during the intervention phase within the predetermined number of teaching criterion sessions.

Participants

Toddler participants and inclusion criteria. Participants consisted of four toddlers who produced unintelligible speech and benefitted from AAC. The toddlers were recruited from the caseloads of speech-language pathologists participating in the study who met the inclusion criteria. Inclusion criteria for the participants in the study was as follows: (a) between 2 -5 years of age, (b) demonstrated severe communication difficulties and unintelligible speech as reported by their speech-language pathologists, (c) communicated via multi-modal AAC consisting of a combination of unaided means such as facial expression, gesturing and pointing, manual sign, word approximations, limited word production; and/or low technology aided AAC such as visual grids, communication boards, and flip charts (d) demonstrated intentionality, (e) produced vocabularies of 50 or fewer words, (f) demonstrated, at worst, moderate cognitive delays as reported by their speech-language pathologists and special education teachers, (g) demonstrated hearing and vision within normal limits, with or without correction, and (h) their families were monolingual English speakers.

The policies and procedures instituted by the University of California, Berkeley Committee for Protection of Human Subjects (CPHS) were followed in order to ensure proper protection of the toddler participants. A parent or guardian for each participant provided informed consent for participation in the study and video-taping of the participants during the study before the investigation began.

Adult participants and inclusion criteria. Adult participants in the study consisted of the following: two treating speech-language pathologists, one secondary special education teacher and one secondary speech-language pathologist, one parent, the investigator, and a research assistant. Treating speech-language pathologists were recruited via email, phone, and face-to-face meetings from public school, community agency, and private practice employment settings in San Mateo County and were the participants' treating speech-language pathologists. The secondary special education teacher and speech-language pathologist were recruited from the same employment settings as the treating speech-language pathologists and were the special education teacher and the infant/toddler program teacher of the toddler participants. The parent was the mother of one participant and was recruited because the infant/toddler teacher who taught in the participant's classroom left the employment setting and the participant aged out of the infant/toddler program upon completion of the baseline phase.

The treating speech-language pathologists completed the following phases of the investigation: assessment, baseline, intervention, intervention probes, and maintenance probes. Only speech-language pathologists who met the following criteria were invited to be participants: (a) California licensed and American Speech-Language-Hearing Association certified speech-

language pathologists, (b) minimum of two years experience working with toddlers with severe communication difficulties who received AAC services, and (c) provided individual speech and language therapy to the toddlers participating in the study.

The special education teachers, secondary speech-language pathologist, and the parent completed the generalization probes throughout the study. Only special education teachers who meet the following criteria were invited to participate: (a) California credentialed early childhood special education teacher, (b) minimum of two years experience working with toddlers with severe communication difficulties who received AAC services, and (c) taught the toddlers participating in the study in a group program. The speech-language pathologist inclusion criteria were the same as the treating speech-language pathologists stated in the previous paragraph except the adult taught the toddler in a group setting rather than individually. The parent was the mother of one of the participants in the study.

I attended 99% of the sessions during the study including assessment, baseline, intervention, intervention probes, maintenance probes, and generalization probes. I instructed the adult participants, collected data during each session, and video-taped the assessment, baseline sessions, treatment integrity sessions, intervention probes, maintenance probes, and generalization probes.

The research assistant attended 1% of the sessions during the study consisting of intervention sessions and generalization probes. She collected data and video-taped during these sessions. The research assistant's primary function was to complete data reliability measures.

The policies and procedures instituted by the University of California, Berkeley Committee for Protection of Human Subjects (CPHS) were followed in order to ensure proper recruitment of the adult participants. The speech-language pathologists, special education teachers, and the parent were given a letter detailing the purpose, procedures, and extent of participant involvement in the investigation before the investigation began.

Assessment of toddler participant inclusion criteria. Two participants received services from a multi-professional community agency while the other two received services from a multi-professional private practice. Community agency and private practice records were reviewed for each participant to confirm that inclusion criteria were met for age range, communication difficulties and methods of multi-modality AAC, use of intentionality, amount of cognitive impairment, hearing and vision with or without correction, and language spoken in the household. The records provided detailed information about the age; nature of the speech disorder including type of disability; vision status; hearing status; developmental status including cognitive, fine and gross motor, social/emotional and adaptive/self-help status; and communication status including receptive language, expressive language, speech production, multimodality communication, and pragmatic/social communication.

To ensure that participants met the expressive vocabulary criterion, that is, that they were producing 50 or fewer words, caregivers completed the MacArthur-Bates Communicative Development Inventories Words and Gestures or MacArthur-Bates CDI (Fenson, Marchman, Thal, Dale, Reznick, & Bates, 2007). The tool is a comprehensive checklist of early words and

gestures to identify phrases understood consisting of 28 total items, verbal imitation and labeling in a yes/no format, vocabulary understood and produced consisting of 396 total items, and early/later gestures used consisting of 63 total items. Caregivers were instructed to identify all the words their child produced consistently, regardless of communication modality, including manual sign, word approximations, intelligible speech, and aided AAC. The criterion of 50 or fewer words was chosen to ensure the participant's expressive language was at the early stage of single word production and without production of phrases or grammatical markers. Typically developing children begin to combine words and produce grammatical markers when their expressive vocabulary reaches approximately 50 words (Rescorla, 1989; Rescorla & Achenbach, 2002). The results of the MacArthur CDI were also used to assess receptive and expressive language skills at the beginning of the study and to create vocabulary lists for the assessment of vocabulary which will be described later in this chapter.

In addition to caregiver completion of the MacArthur-Bates CDI (Fenson, et al., 2007), I observed each participant across a variety of settings including infant/toddler classrooms, occupational and physical therapy sessions, and speech/language therapy sessions, for one to two hours per child. The purpose of the observations was to ensure that the participants presented with unintelligible speech, defined as less than 10% intelligible within a known context, used multimodal means to communicate, and demonstrated intentionality. All participants were observed to be less than 10% intelligible in a known context, used multimodal communication, and were intentional communicators.

Based on the above assessment activities, the four children initially identified by the primary speech-language pathologists met the selection criteria and were deemed appropriate for the investigation.

Participant demographics. Three males and one female participated in the study. From this point forward I will refer to the children by the pseudonyms Karl, Carol, Mick, and Marty. Karl was Asian, Carol and Mick were Caucasian, and Marty was mixed Latino/Caucasian. All families were monolingual and spoke English as the primary language. All participants were from middle class backgrounds with the exception of Carol, who came from an upper middle class background. All participants lived in central San Mateo County. All participants came from two parent families. Three of the four mothers were stay-at-home mothers while Karl's mother worked part-time for approximately 16 hours monthly. All four mothers were college educated and had completed four-year degrees. Karl's father and Carol's father were college educated and Carol's father had also completed graduate school, while Mick's father and Marty's father completed high school and attended some college. Appendix A summarizes the parental demographics.

Table 3 lists the characteristics of the participants. The participants ranged in age from 2 years., 2 months to 2 years, 9 months at the start of the study. All four were enrolled in an early intervention infant/toddler program as well as individual speech and language therapy, although following hospitalization at the end of the baseline phase of the investigation, Karl began receiving all services in the home setting and no longer participated in an early intervention infant/toddler program.

The investigation was completed by a speech-language pathologist and a special education teacher in the home setting shortly after beginning the intervention phase of the study with Karl. The investigation was completed by a speech-language pathologist and special education teacher at a community agency for Carol. The investigation was completed by two speech-language pathologists in a private practice setting with Mick. The investigation was completed by a speech-language pathologist in a private practice setting and by a parent in the home setting with Marty.

Participants had the following diagnoses: (a) Karl demonstrated extreme prematurity resulting in multisystem dysfunction including respiratory distress requiring use of oxygen and gastrostomy tube feeding, developmental speech and language delays, and left vocal cord paralysis; (b) Carol demonstrated developmental delays in speech and language and associated ataxic gross motor characteristics of unknown etiology; (c) Mick demonstrated a developmental delay across all areas of development, including cognition, of unknown etiology; and (d) Marty demonstrated developmental delays in speech, language, and fine motor skills with an associated developmental apraxia of speech.

All four participants demonstrated significant speech impairments and, as mentioned previously, were less than 10% intelligible when producing verbal productions in known contexts. On the MacArthur CDI (Fenson, et al., 2007), the number of words that parents indicated their children comprehended ranged from 163 to 369, the number of words that parents indicated their children produced ranged from 27 to 50, and the number of gestures that parents indicated their children demonstrated ranged from 25 to 63. See Table 3 for a summary of child participant characteristics.

Table 3. Toddler Participant Characteristics

Participant Age Gender	Disability	*CDI Words Understood (Max of 396)	*CDI Words Produced (Max of 396)	*CDI Gestures Demonstrated (Max of 63)	Communication Modalities	Developmental Levels
Karl **2;3 Male**	Extreme prematurity; multisystem dysfunction; developmental speech and language delays; paralyzed left vocal cord	163/369	50/369	27/63	Facial expressions; pointing/gesturing; manual sign; word approximations; natural speech; visual grid display	Age level receptive language; Severely delayed verbal expressive language/mildly delayed manual sign; Severely impaired speech
Carol **2;4 Female**	Developmental speech and language delays; ataxic gross motor characteristics	340/369	40/369	51/63	Facial expressions; pointing/gesturing; manual sign; word approximations; natural speech; visual grid display	Age level receptive language; Severely delayed verbal expressive language/mildly delayed manual sign; Severely impaired speech

Mick **2;2** **Male**	Developmental delay across all domains of unknown etiology	190/369	27/369	25/63	Facial expressions; pointing/gesturing; manual sign; word approximations; natural speech; communication board	Moderate cognitive impairment; Moderately delayed receptive language; Severely delayed verbal expressive language and manual sign; Severely impaired speech
Marty **2;9** **Male**	Developmental speech, language, and fine motor delays; developmental apraxia of speech	369/369	46/369	63/63	Pointing/gesturing; word approximations; natural speech; flip chart	Moderately delayed receptive language; Moderately delayed verbal expressive language and minimal use of manual sign; Severely impaired speech

* CDI = MacArthur-Bates Communicative Development Inventories: Words and Gestures (Fenson, et al., 2007)

Toddler participant profiles. All four participants used non-electronic, low technology aided AAC systems to facilitate unaided multimodal communication. Karl and Carol used visual grids, Mick used a communication board, and Marty used a flip chart. The specific profile for each child follows.

Karl. Karl was age 2 years, 3 months at the onset of the investigation. He was diagnosed with extreme prematurity resulting in multisystem dysfunction. He was born at 22.5 weeks gestation due to placental abruption requiring an emergency C-section, weighed 1 lb. 4 oz., and was hospitalized for six months. Current diagnosis included chronic lung disease, pulmonary vein stenosis, and gastroesophageal reflux. Laser surgery at age two months resolved retinopathy and he presented with normal visual acuity. Auditory Brainstem Response (ABR) testing at age five months indicated normal hearing acuity. During a surgical procedure to remove a subglottic mass at age 18 months, he was noted to demonstrate left vocal fold paresis. Additional surgeries were completed to repair a hernia and correct cardiac stenosis. Hospitalization during the intervention phase of the investigation included completion of an MRI, which revealed a history of several strokes. There was a familial history of speech and language delay with Karl's four-year-old brother receiving therapy for speech and language delays since age 3 years. As a result of multisystem dysfunction, Karl relied on a nasal oxygen tube for respiration and was dependent on a gastrostomy tube for nutrition. His mobility was limited by the length of the nasal oxygen tube attached to an oxygen tank and he had difficulty producing voice due to limited vocal fold vibration.

Karl was initially evaluated for early intervention services at an adjusted age of 8 months and began receiving home based occupational and physical therapy. At an adjusted age of 15 months a developmental assessment revealed personal-social skills at the 12 month to 15 months developmental level, cognition at the 6 to 9 month developmental level, and communication at the 3 to 6 month developmental level. Early intervention services were expanded to include home based weekly physical therapy, occupational therapy, feeding therapy, and special education services, as well as participation in a weekly center based infant/toddler program.

A more recent developmental evaluation was completed at an adjusted age of 20.5 months. At that time most skills were at approximately the 12 months to 15 months developmental levels for cognition, communication, and fine/gross motor skills. In the area of receptive language, Karl followed simple directions and pointed to five of nine pictures of common objects. In the area of expressive language, Karl pointed, produced gutteral sounds, demonstrated intentionality, signed five words, shook his head "no", and approximated the word "more." He received one hour weekly of speech therapy, two hours weekly of physical therapy, three hours weekly of occupational therapy, 2½ hours weekly of special education services, and attended a center based infant/toddler program three hours weekly.

Karl completed a speech and language evaluation at age 2 years, 2 months just prior to beginning the investigation. The Preschool Language Scale, Fourth Edition (Zimmerman, Steiner, & Pond, 2002) was administered and revealed an auditory comprehension standard score of 91 and an age equivalent of 25 months, indicating within normal limits receptive language skills. Karl obtained an expressive communication standard score of 64 and an age equivalent of 12 months without manual sign considered, and an expressive communication standard score of 83 and age

equivalent of 21 months with manual sign considered, indicating a severe verbal language delay but suggesting a mild verbal/manual sign language delay. Expressively, Karl was a multimodal communicator and used facial expressions, gestures and pointing, manual sign, and vocalizations to communicate a variety of communicative intentions such as gaining attention, answering yes/no questions, responding to requests, greeting, protesting, and commenting. He was beginning to use photos and line drawings of graphic symbols as a piece of his AAC system to communicate during play routines. Photos consisted of photos of people and objects such as a photo of Karl to refer to himself. Alternatively, line drawings of graphic symbols consisted of Picture Communication Symbols (Johnson, 1994). Photos are considered more concrete than line drawings of graphic symbols (Beukelman & Mirenda, 2005). Appendix B is a sample of Karl's AAC system which provides an example of a photo of Karl and the other symbols which are Picture Communication Symbol (PCS) line drawings. In addition to pointing to photos and PCS symbols for communication output, Karl presented with limited ability to produce vowel and consonant sounds. He produced short bursts of open vowel such as /ah/ and /uh/. He was beginning to learn lip closure with emerging production of /b/. Vocal quality was strident and hoarse. Speech/language therapy focused on a) improving use of manual sign, b) improving use of non-electric visual grids with Picture Communication System line drawings for graphic symbols, c) introducing use of more advanced non-electronic flip charts with Picture Communication System line drawings, d) producing vowels, consonants, VC words (e.g. up), CVCV words (e.g. mama, dada), and other vowel/consonant combinations, and e) exploring use of a higher technology electronic AAC system.

I observed Karl during speech/language therapy and the MacArthur-Bates CDI Words and Gestures (Fenson, et al., 2007) was completed by Karl's mother, both at age 2 years, 3 months. Expressive communication consisted of facial expressions, gesturing and pointing, and shaking his head "yes" and "no." He signed a variety of single words including "more", "open", "get", "book", and "yes", "no" and "all done." In the area of speech, he produced the vowels /ah/, /ih/, and /oo/, and the consonants /b/ and /m/. He was beginning to produce "mama" and "baba." His volume was soft and vocal quality was strident and hoarse. Speech was less than 10% intelligible. On the MacArthur-Bates CDI, Karl's mother reported he understood 163 words, consistent with an age equivalent of 15 mos., and he produced 50 words via sign and word approximations, consistent with an age equivalent of 16½ months. He reportedly produced 27 gestures, consistent with an age equivalent of 12 months. The MacArthur-Bates CDI age equivalents were not consistent with speech and language testing completed a month earlier, particularly in the area of receptive language. The results of the Preschool Language Scale, Fourth Edition (Zimmerman, et al., 2002) testing would be considered more reflective of Karl's language skills as the results were based on large normative samples using standardized procedures.

Overall, at the start of the investigation, Karl presented with within normal limits receptive language skills, mildly delayed expressive language with manual sign and severely delayed expressive language with verbal productions, and severely impaired speech production skills. Unaided multimodal communication consisted of facial expressions, pointing and gesturing, manual sign, word approximations, and limited intelligible word production. Karl's aided communication system consisted of photos and line drawings on a visual grid containing ten symbols. A more detailed description of Karl's aided communication system will be described

later in this chapter. Karl primarily communicated through a combination of manual sign and directly pointing to line drawings. Prompting was required for production of natural speech, which consisted of a limited number of word approximations and words.

Carol. Carol was 2 years, 4 months at the start of the investigation. She was diagnosed with developmental delays in speech and language and associated ataxic gross motor characteristics of unknown etiology. She was born full-term at 39 weeks gestation and weighed 8 lb. 3 oz. The pregnancy and birth were unremarkable. Medical history was unremarkable for illness, disease, or surgery, with approximately two to three ear infections annually. A familial history of speech delay existed. Carol's five-year-old brother demonstrated a speech delay and had been enrolled in speech therapy since age three years. Developmental milestones were delayed with Carol babbling at age 12 to 13 months, crawling at age 13 months, and walking alone at age 21 months.

Carol was initially evaluated for early intervention services at age 17 months. Vision and hearing were found to be within normal limits. Carol demonstrated moderate hypotonia in both legs and mild hypotonia of the head. Gross motor skills were moderately delayed at the 10 to 11 months developmental level. In the area of language, the Preschool Language Scale, Fourth Edition (Zimmerman, et al., 2002), was administered and revealed an auditory comprehension standard score of 81, consistent with an age equivalent of 10 months, and an expressive communication standard score of 83, consistent with an age equivalent of 11 months. Carol was pointing, was quiet but babbled with short strings of syllables, produced "uh", signed "more" and "all done", and was beginning to imitate single syllable consonant-vowel combinations. She began receiving physical therapy once weekly and attending an infant/toddler program for late-talking children.

Another early intervention evaluation was completed at age 21 months. Cognitive and personal/social skills were within normal limits at the 18 to 21 months developmental level. Receptive language skills were within normal limits at the 18 to 21 months developmental level and expressive language skills were at the 18 to 21 months level for manual sign although Carol's verbal productions were limited. Services were increased to include twice weekly participation in the infant/toddler program for late talking children, as well as once weekly special education and physical therapy services.

A neurological evaluation was completed at age 22 months. An audiology evaluation revealed fluid in one ear but adequate hearing for speech development. Fine motor skills and social skills were within normal limits for age. Receptive language skills were nearly within normal limits with ability to follow simple commands, identify eight body parts, and identify 20 to 30 familiar objects. Expressive language skills were delayed with signing of 20 words and production of a total of two word approximations. Carol was diagnosed with mildly low tone bilaterally resulting in a significant gross motor and speech delay. An MRI was recommended to rule out genetic disorders and malformations.

An annual review of early intervention services was completed at age 24 mos., four months prior to beginning the investigation. Carol now produced 30 manual signs. She was quiet and continued to produce only a couple of word approximations. Services were increased to include

one hour weekly of speech/language therapy in addition to one hour weekly of physical and occupational therapy, and six hours weekly participation in the preschool program. Speech production goals included imitating consonant-vowel combinations containing the consonants /p/, /b/, /m/, /d/, and expressive language goals included producing five to ten word approximations.

I observed Carol during speech/language therapy and while attending the infant/toddler program, and Carol's mother completed the MacArthur CDI (Fenson, et al., 2007), both at age 2 years, 4 months. Expressively, Carol produced five intelligible words spontaneously: "mama", "no", "yah" "me", and "mine." Nonverbally, she pointed and shook her head "yes" and "no." She signed a variety of words in combination with word approximations including "open", "out", "baby", "sit", and "eat." In the area of speech, Carol imitated a variety of words containing the consonants /w/, /h/, /m/, /p/, /b/, /d/, /n/, and /y,/ which consisted of distorted vowels and omitted final consonants. Speech was less than 10% intelligible. On the MacArthur CDI, Carol's mother reported she understood 340 words, consistent with greater than age 18 mos. which was the upper limit of the checklist, signed 57 words and produced word approximations for 40 words, consistent with an age equivalent of 14 mos., and produced 51 gestures, consistent with greater than age 18 mos. which was the upper limit of the checklist.

Overall, at the start of the investigation, Carol presented with within normal limits receptive language skills, mildly delayed expressive language skills with manual sign and severely delayed expressive language skills with verbal production, and severely impaired speech production skills. Unaided multimodal communication consisted of facial expressions, pointing and gesturing, manual sign, and natural speech. Aided communication included photos and line drawings on a visual grid of ten items. A more detailed description of Carol's aided communication system will be described later in the chapter. Carol primarily communicated with manual sign and natural speech consisting of word approximations and a limited number of unintelligible words. She did not use aided line drawings. During the end of the baseline phase of the study, Carol abandoned use of manual sign with a preference for natural speech, consisting of word approximations and a limited number of intelligible words.

Mick. Mick was age 2 years, 2 months at the onset of the investigation. He was diagnosed with a developmental delay across all domains of unknown etiology. He was born at 37 weeks gestation with a weight of 4 lb. 1 oz. The pregnancy was complicated by a small placenta and birth was complicated with a vaginal delivery induced due to low amniotic fluid levels. Mick remained in a level II nursery for ten days due to infection requiring two spinal taps and antibiotics. Minor dysmorphic features at birth included webbing of the second and third toes of each foot, right toes that turned out diagnosed as talipas varus, flattening of the head, bilateral ptosis of the eyelids, and microcephaly. Genetic testing was in process to rule out Stickler syndrome. Mick passed a newborn hearing screening and wore corrective lenses for nearsightedness. A familial history of learning problems existed for the maternal grandmother and maternal uncle, and Mick's father was born prematurely, with a weight of 3 lb. at birth. Developmental milestones were delayed with Mick sitting at age 10 months, crawling at age 18 months, walking unassisted at age 2 years, 5 months, babbling at age 16 months, and saying his first word at age 16 months.

Mick was initially referred for early intervention services at age 6½ months. He was initially diagnosed with a gross motor delay and qualified for physical therapy services. Eventually, occupational therapy services were added and Mick began attending an infant/toddler program for children with developmental delays at age 18 months. A developmental evaluation was completed at age 19 months. Cognition and self-help skills were at the 12 to 18 months developmental level, while social/emotional, fine and gross motor, play, and receptive/expressive language skills were at the 6 to 12 months developmental levels. Receptively, Mick responded to his name and intermittently followed simple directions. Expressively, he reached and vocalized. He did not produce word approximations, sign words, or verbally imitate.

At age 24 months, cognitive skills, fine/gross motor skills, personal/social skills, play skills and receptive/expressive language skills were found to be at the 12 to 18 months developmental level. Receptively, Mick was beginning to follow simple directions but was not yet pointing to objects, body parts, or pictures. Expressively, he was quiet with occasional babbling/vocalizing. He did not imitate social/functional words such as “hi” and “bye” and did not produce manual sign. Early intervention services were expanded to include individual speech/language therapy for one hour weekly in addition to two hours weekly of individual physical therapy, one hour weekly of individual occupational therapy, and four hours weekly attending an infant/toddler program for children with developmental delays.

A speech/language progress note was completed at the beginning of the investigation when Mick was age 2 years, 2 months. Mick’s attention span was increasing but he was slow in processing information. He did not consistently follow simple requests. With prompting, he used a switch to produce recorded repeated phrases during storybook reading. He was beginning to make choices when shown three photos using a pointing response. He nodded his head “no” and “yes.” He was beginning to sign “more”, “book”, “hi” and “bye” in combination with word approximations. With prompting, he produced word approximations for “go”, “more”, “up”, “all done”, “hi”, “bye”, “bubble”, “book” and “open” which consisted of distorted single consonant or single vowel sounds.

I observed Mick during occupational and speech/language therapy sessions and his mother completed the MacArthur CDI (Fenson, et al., 2007), both at age 2 years, 2 months. He produced the vowels /uh/, /ih/, /i/, /a/, /ah/, and /oo/ and the consonants /h/, /w/, /p/, /b/, /m/, and /g/. He imitated word approximations for “hi”, “bye” “up”, “all done” and “me”, produced “go” spontaneously given the prompt “ready, set, __” and shook his head “yes.” He signed “more” spontaneously. He was less than 10% intelligible. He had an 8 inch by 11½ inch AAC communication book which contained multiple pages of eighteen photos and Picture Communication Symbols line drawing graphic symbols per page, organized by categories including foods, toys, clothes, body parts, etc. Mick did not spontaneously use the communication book, but rather the speech-language pathologist turned to the appropriate page in the book during play. Following clinician modeling and prompting, Mick subsequently pointed to photos and graphic symbols using an index finger to make choices. Often times he paged through the communication book as if looking at a storybook. Processing was slow during all activities and attention span was decreased in comparison to same-aged typically developing toddlers. On the MacArthur Bates CDI, Mick’s mother reported he understood 190 words, consistent with an age equivalent of 17 months, and produced word approximations for 27

words, consistent with an age equivalent of 14 months. He produced a total of 25 gestures, consistent with an age equivalent of 12 months. MacArthur Bates CDI age equivalents appeared to be accurate based on prior testing and observation.

Overall, at the start of the investigation, Mick presented with a moderate to severe developmental delay across all modalities, including a moderate cognitive impairment at approximately the 12 months to 18 months developmental level. Receptive language skills were moderately delayed, verbal and manual sign expressive language skills were severely delayed, and speech production was severely impaired. Unaided multimodal communication consisted of facial expressions, gesturing and pointing, limited manual sign, and limited natural speech. Aided communication initially consisted of a multipage 8.5 inch by 11½ inch communication book containing eighteen photos and line drawings of graphic symbols per page which was organized by categories. During the intervention phase of the study, it was determined the multipage communication book was too complicated an aided system. The system was simplified to a single 8 inch by 11½ inch communication board containing twelve line drawings. A more detailed description of Mick's aided communication system will be discussed later in this chapter. Mick communicated with a combination of manual sign, directly pointing to line drawings/photos with prompting, and natural speech consisting of a limited number of word approximations and words. During the intervention phase of the study, a greater emphasis was placed on unaided manual sign versus directly pointing to line drawings as Mick demonstrated a preference for signing. Prompting was required for natural speech production.

Marty. Marty was 2 years, 9 months at the start of the investigation. He was diagnosed with speech, language, and fine motor delays, and developmental apraxia of speech. He was born at 39½ weeks gestation and weighed 8 lb. 2 oz. The pregnancy and birth were unremarkable. Vision and hearing were within normal limits. A familial history of speech and language delay was present. Marty's maternal aunt was born with cerebral palsy and was non ambulatory. His 8-year-old sister had auditory processing difficulties and a learning disability and received resource specialist and speech/language services at school. His 6-year-old brother had a developmental delay and attended a special education kindergarten class and received speech/language services at school. Developmental milestones were within normal limits for gross motor skills with Marty standing alone at 7 months and walking unassisted at 12 months. Speech and language development was delayed with Marty babbling at age 12 months and saying his first word at age 18 months.

Marty initially completed a speech and language evaluation at age 21 months. Receptive language skills were consistent with an age equivalent of 14 months while expressive language skills were consistent with an age equivalent of 17 months based upon parent report. Marty was reported to produce a limited number of single words and was not yet producing two-word phrases. Speech production was delayed with a limited inventory of consonant sounds consisting of /p/, /b/, /m/, /n/ and, /d/ and poor verbal imitation skills. Speech/language therapy was recommended and Marty was referred for early intervention services.

Marty was evaluated for early intervention services at age 23 months. Cognition, fine/gross motor, and adaptive/social emotional skills were found to be within normal limits while receptive and expressive language skills were found to be moderately delayed. Marty began attending an

infant/toddler program for children with communication and developmental delays for four hours weekly. At age 25 months he was referred for an occupational therapy evaluation and was found to be 1 to 2 standard deviations below the mean in the areas of auditory, visual, and vestibular processing, resulting in difficulties in the areas of fine motor, visual-perceptual, and sensory integration skills. Individual occupational therapy was introduced for 45 minutes weekly.

Marty began individual speech/language therapy at age 2 years, 6 months. Receptive language skills were moderately delayed at the 18 months to 21 months developmental level with Marty following one step directions, beginning to follow multistep directions, inconsistently identifying familiar objects and body parts, and inconsistently answering yes/no questions. Expressive language skills were moderately delayed at the 18 months to 21 months developmental level with less than a 20 single word vocabulary and no production of two-word phrases or grammatical forms. Speech production skills were severely impaired with limited vowel production consisting of /eh/, /oo/, /ow/, /ah/, /e/, and /o/ and limited consonant production consisting of /p/, /b/, /m/, /n/, and /d/. Marty was beginning to imitate verbally. He produced the words "mommy", "dada", "boo-boo" and "papa" intelligibly with all other productions consisting of word approximations.

I observed Marty during speech/language therapy and his mother and treating speech-language pathologist completed the MacArthur CDI (Fenson, et sl., 2007), all at age 2 years, 9 months. He demonstrated an age appropriate attention span and play skills. He was highly verbal but less than 10% intelligible. Multimodal communication consisted of facial expressions, gesturing and pointing, environmental sounds such as "beep-beep", word approximations, and a limited number of intelligible productions. Intelligible productions included animal sounds and single words such a "baby", "okay", "up", "go", and "me." Throughout the session the speech-language pathologist also modeled use of an aided flip chart which consisted of Picture Communication Symbols line drawings of symbols. The flip chart contained core vocabulary on the front and back pages of a binder including "my", "your", "good", "bad", "help", "want", "open", "all done", a variety of adjectives, a variety of prepositions, and other words, along with multiple pages of fringe vocabulary organized into categories including a transportation page, art page, farm page, clothes page, play items page, and other pages. Each page was 5 inches by 7 inches and contained 18 line drawings. Marty did not use the flip chart to communicate, but rather, the speech-language pathologist pointed to appropriate symbols on the flip chart during play, called Marty's attention to the symbols, and modeled word production. Marty infrequently imitated these words. However, he was observed to produce words more intelligibly following imitation when presented with a graphic symbol combined with a verbal model in comparison to when presented with only a verbal model. On the MacArthur Bates CDI, Marty's mother reported he understood 369 words, which was higher than the estimate of the speech-language pathologist, and was consistent with an age equivalent of greater than 18 months which was the upper limit of the checklist. Marty's speech-language pathologist reported he produced 46 words and word approximations, which was higher than the estimate of his mother, and consistent with an age equivalent of 14 months. Both mother and speech-language pathologist reported he produced all 63 gestures, consistent with an age equivalent of greater than 18 months which was the upper limit of the checklist.

Overall, at the start of the investigation, Marty presented with a moderate receptive language delay, a moderate verbal expressive language delay with minimal use of manual sign or aided communication, and severely impaired speech production. Unaided multimodal communication consisted of facial expressions, gesturing and pointing, and natural speech. Aided communication consisted of a multipage 5 inch by 7 inch flip chart containing thirty six line drawings of symbols per page with core vocabulary on the front and back inside pages of the binder and fringe vocabulary pages organized by categories. A more detailed description of Marty's aided communication system will be described later in this chapter. Marty did not use the aided flip chart to communicate unless prompted, relying on natural speech consisting of environmental sounds, word approximations, and a limited number of intelligible words.

Adult participant profiles. There were seven adults who participated in the investigation consisting of two treating speech-language pathologists, three adults who completed the generalization phase of the study, the investigator, and a research assistant. The specific profile for each adult follows. The adults have been given pseudonyms to protect their privacy with the exception of the investigator and research assistant.

Katherine. Katherine was the treating speech-language pathologist for Karl and Carol and worked at a community agency in Burlingame, California consisting of speech-language pathologists, special education teachers, and occupational and physical therapists. She obtained her Master of Arts degree in Communication Disorders in 1973, was certified by the American Speech-Language Hearing Association, and was licensed as a speech-language pathologist in California by the California Speech-Language Pathology and Audiology and Hearing Aid Dispensing Board. She had a California Assistive Technology Certification and had been working in the area of AAC since 1987. She began working at the community agency in 2006, providing speech/language therapy and AAC intervention to children from birth to five years of age. She provided individual therapy and parent training, taught a 2-year-old infant/toddler program for children who were late talkers, and consulted and completed AAC assessments for school districts. She provided services at the community agency, in homes, and at schools. Katherine began working with Karl and Carol two months before the start of the investigation.

Nancy. Nancy was the special education teacher completing the generalization phase of the investigation with Karl and Carol. She obtained a Master of Arts degree in Special Education in 2005, obtained a Level I Credential in Early Childhood Special Education in 2008, and obtained a Level II Clear Professional Credential in Early Childhood Special Education in 2010. She had been working in the area of AAC since 2005. She began working at the community agency in 2005, and provided individual therapy for children ages birth to five, taught an infant/toddler special education class, and taught a preschool inclusion class. She provided services at the community agency and in homes. Nancy had worked with Karl for four months and Carol for ten months before the start of the investigation.

Elizabeth. Elizabeth was the treating speech-language pathologist for Mick and Marty and worked at a private practice in Redwood Shores, California, consisting of speech-language pathologists, special education teachers, occupational therapists, and behavior therapists. She obtained her Master of Arts degree in Communication Disorders in 2000, was certified by the American Speech-Language Hearing Association, and was licensed as a speech-language

pathologist in California by the California Speech-Language Pathology and Audiology and Hearing Aid Dispensing Board. She had a California Assistive Technology Certification and had been working in the area of AAC since 2000. She began working at the private practice in 2006, providing speech/language therapy and AAC intervention to children and adults of all ages. She provided individual therapy and parent training, taught an infant/toddler program for children diagnosed with autistic spectrum disorder, and consulted and completed AAC assessments for school districts. She provided services at the private practice, in homes, and at schools. Elizabeth had been working with Mick for two months and Marty for three months before the start of the investigation.

Susie. Susie was the speech-language pathologist completing the generalization phase of the investigation with Mick. She obtained her Master of Arts degree in Communication Disorders in 1990, was certified by the American Speech-Language Hearing Association, and was licensed as a speech-language pathologist in California by the California Speech-Language Pathology and Audiology and Hearing Aid Dispensing Board. She had been working in the area of AAC since 2005. She began working at the private practice in 2005, providing individual therapy and parent training for children ages birth to five, as well as teaching an infant/toddler program for children with developmental delays. Services were provided at the private practice and in homes. She had been working with Mick for eight months before the start of the investigation.

Deena. Deena was Marty's mother and completed the generalization phase of the investigation with Marty. Deena was familiar with speech and language delays and speech/language therapy, as Marty was the third of her children to receive speech and language services. Deena was a stay-at-home mother and was attending college to obtain a Montessori teaching credential in early childhood education.

Patti. I was the investigator of the study. I obtained my Master of Arts degree in Communication Disorders in 1980, was certified by the American Speech-Language Hearing Association, and was licensed as a speech-language pathologist in California by the California Speech-Language Pathology and Audiology and Hearing Aid Dispensing Board. I have been working in the area of AAC since 2006. I have been an instructor at the Communicative Disorders and Special Education Department at San Francisco State University since 2006 teaching courses in AAC, language disorders, language development, and introduction to communication disorders, as well as supervising the Communicative Disorders diagnostic clinic and off-campus clinical internships.

Brenna. Brenna was the research assistant for the study. Brenna was a graduate student in the Communicative Disorders Program at San Francisco State University. She received her Bachelor of Arts degree with a major in Psychology in 2008. She was a research assistant with the Child Language Lab in the Department of Psychology at University of California, San Diego as an undergraduate student.

Procedures

Settings. The investigation took place at a community agency, a private practice, and the homes of the participants. Assessment, baseline, intervention, intervention probes, and maintenance probes were completed in quiet therapy rooms at the community agency and the private practice for Carol, Mick, and Marty. Generalization probes were completed in quiet therapy rooms at the community agency and the private practice for Carol and Mick. Marty's generalization probes were completed in a bedroom at his house because Marty's mother completed these probes. Initially, Karl's sessions were completed in therapy rooms at the community agency. Karl was hospitalized after the baseline phase of the study, and following the hospitalization, all subsequent sessions took place in the family room at Karl's house.

Activities and materials. A number of activities were completed during each session depending on the attention span and interest of the participant, ranging from three to eight activities per session. Activities consisted of naturalistic play appropriate for the developmental level and interests of each participant. These types of activities have been used successfully in past research (Binger, et al., 2008; Binger & Light, 2007; Cleave & Fey, 1997; Dada & Alant, 2009; Fey, et al., 1997; Fey, et al., 1993; Girolametto, 1988; Girolametto, et al., 1996a, 1996b; Girolametto, et al., 1998; Kent-Walsh, et al., 2010; Pennington, et al., 2009; Robertson & Ellis Weismer, 1999; Romski & Sevcik, 1996; Romski, et al., 2006; Romski, et al., 2010; Rosa-Lugo & Kent-Walsh, 2008; Tannock, et al., 1992). For example, Karl enjoyed story books, bubbles, and pretend play with people, action figures, and animals at a park setting. Carol enjoyed story books and pretend play with baby dolls participating in various household activities such as eating and bathing. Mick enjoyed story books, bubbles, Mr. Potato Head, and stacking blocks. Marty enjoyed story books, cars and trucks, and pretend play with kitchen items. These activities were completed during a 20-minute session at least once weekly.

The adults working with the participants chose materials for the activities during each session from the assortment of preschool materials available at their work settings. Materials were chosen based on the developmental level and interests of the participant, as well as usefulness in encouraging production of the target vocabulary during the session. For example, if the target vocabulary consisted of the words "big" and "little", a story book might be chosen that described big and little animals. If the target vocabulary consisted of the words "dirty" and "clean", the activity with a baby doll might include changing the baby's dirty diaper. If the target vocabulary consisted of the words "hungry" and "eat", play with Mr. Potato Head might include feeding him something to eat because he was hungry. If the target vocabulary was "hot" and "cold", the activity with kitchen items might include preparing hot and cold pretend foods.

Unaided and aided AAC systems. Each participant's unaided and aided AAC system in the study was the same system used by the participant prior to the start of the investigation. Target vocabulary for each of the two language intervention approaches was determined during the assessment phase, to be described later in the chapter, and was added to the aided system if the vocabulary was not already included in the aided AAC system. Details about the unaided and aided AAC systems for each participant follow.

Karl's AAC system. Karl's unaided AAC system consisted of facial expressions, pointing and gesturing, manual sign using Signing Exact English (Gustason & Zawolkow, 1993), and natural speech. Aided AAC consisted of a visual grid of ten individual line drawings

containing Picture Communication System (PCS) symbols whenever possible (Johnson, 1994). Picture Communication System symbols were chosen because Karl had already been exposed to these line drawings prior to the onset of the study, and these symbols were commonly used in research with young children who used AAC (Binger, et al., 2008; Binger & Light, 2007; Bruno & Trembath, 2006; Dada & Alant, 2009; Harris & Reichle, 2004; Kent-Walsh, et al., 2010; Romski & Sevcik, 1996; Romski, et al, 2006; Romski, et al., 2010; Rosa-Lugo & Kent-Walsh, 2008). The layout of each of the two visual grid displays consisted of two rows of five symbols each which were placed on a black flannel board using Velcro. This is a common arrangement for visual grids when displaying ten symbols (Lloyd, et al. 1997). The vocabulary arrangements were consistent for each session and were matched across the two vocabulary sets used in the study. Specific information about the vocabulary sets will be described later in the chapter. Appendix A contains photos of Karl's aided AAC displays.

Carol's AAC system. Carol's unaided AAC system consisted of facial expressions, pointing and gesturing, manual sign using standard Signing Exact English (Gustason & Zawolkow, 1993), and natural speech. Aided AAC consisted of a visual grid of ten individual line drawings using Picture Communication System (PCS) symbols whenever possible (Johnson, 1994). Picture Communication System symbols were chosen because Carol had already been exposed to these line drawings prior to the onset of the study, and these symbols were commonly used in research with young children who used AAC (Binger, et al., 2008; Binger & Light, 2007; Bruno & Trembath, 2006; Dada & Alant, 2009; Harris & Reichle, 2004; Kent-Walsh, et al., 2010; Romski & Sevcik, 1996; Romski, et al, 2006; Romski, et al., 2010; Rosa-Lugo & Kent-Walsh, 2008). The layout of each of the two visual grid displays consisted of two rows of five symbols each which were placed on a black flannel board using Velcro. This is a common arrangement for visual grids when displaying ten symbols (Lloyd, et al. 1997). The vocabulary arrangements were consistent for each session and were matched across the two vocabulary sets used in the study. Specific information about the vocabulary sets will be described later in the chapter. Appendix B contains photos of Carol's aided AAC displays. It should be noted Carol did not use the aided communication system with a preference for manual sign during the beginning of the study. Carol abandoned use of manual sign with a preference for natural speech at the end of the baseline phase of the study.

Mick's AAC system. Mick's unaided AAC system consisted of facial expressions, pointing and gesturing, manual sign using standard Signing Exact English (Gustason & Zawolkow, 1993), and natural speech. Aided AAC initially consisted of an eight-page, two-sided 8 inch by 11½ inch communication book containing twelve Picture Communication System (PCS) symbols (Johnson, 1994) and photos of objects per page. Picture Communication System symbols were chosen because Mick had already been exposed to these line drawings prior to the onset of the study, and these symbols were commonly used in research with young children who used AAC (Binger, et al., 2008; Binger & Light, 2007; Bruno & Trembath, 2006; Dada & Alant, 2009; Harris & Reichle, 2004; Kent-Walsh, et al., 2010; Romski & Sevcik, 1996; Romski, et al, 2006; Romski, et al., 2010; Rosa-Lugo & Kent-Walsh, 2008). Each page was organized by category such as toys, body parts, and foods, and each page included core vocabulary such as "help" and "more." During the intervention phase of the investigation, it was determined the communication book was too complex for Mick and the two sets of five vocabulary used in the study were placed on a single page activity communication board with the

core vocabulary “help” and “more” for a total of twelve line drawings. This type of communication board is commonly used for specific activities (Lloyd, et al. 1997). Detailed information about the vocabulary sets will be described later in the chapter. Appendix C contains a photo of Mick’s aided AAC display. It should be noted that when the aided communication system was modified during the intervention phase of the study, Mick also demonstrated a preference for manual sign. Manual sign was emphasized over line drawings for the duration of the study. In addition, the manual signs for “car” and “truck” were modified from standard Signing Exact English to differentiate and simplify the two signs.

Marty’s AAC system. Marty’s unaided AAC system consisted of facial expression, pointing and gesturing, and natural speech. He did not use manual sign. Aided AAC consisted of a sixteen page, two-sided 5 inch by 7 inch flip chart binder containing thirty six Picture Communication System (PCS) line drawing symbols (Johnson, 1994) per page. Picture Communication System symbols were chosen because Marty had already been exposed to these line drawings prior to the onset of the study, and these symbols were commonly used in research with young children who used AAC (Binger, et al., 2008; Binger & Light, 2007; Bruno & Trembath, 2006; Dada & Alant, 2009; Harris & Reichle, 2004; Kent-Walsh, et al., 2010; Romski & Sevcik, 1996; Romski, et al, 2006; Romski, et al., 2010; Rosa-Lugo & Kent-Walsh, 2008). Each set of pages was organized by a category such as farm, feelings, and clothes, with tabs on the edge of each page to allow the user to flip to the correct page of the binder. The front and back inside covers of the binder contained thirty six core vocabulary such as “my”, “good”, “want”, “feel”, “more”, “all done”, “on”, “big”, etc. to allow for more complex productions. This type of flip chart is commonly used as an introduction to higher technology electronic AAC devices and as a back-up when electronic AAC devices are in need of repair (Lloyd, et al., 1997). Detailed information about Marty’s vocabulary sets will be described later in the chapter. Appendix D contains a photo of a sample page from Marty’s aided AAC display.

Language intervention approaches. Two language intervention approaches, the independent variables in the investigation, were compared to determine whether both were effective approaches for teaching new vocabulary to the participants, and if so, whether one approach was more efficient for learning to produce the new vocabulary. The language intervention approaches were implemented by the treating speech-language pathologists during separate 20-minute sessions with the participant in the previously described settings, using the activities, materials, and AAC systems previously described. The two language intervention approaches consisted of: a) responsivity education and focused stimulation, and b) responsivity education and focused stimulation with the addition of AAC modeling. Table 5 compares the two language intervention approaches and a description of each language intervention approach follows.

Responsivity education and focused stimulation. This language intervention approach was consistent with the responsivity education procedures described in the Hanen Program for Parents (Manolson, 1992) and the focused stimulation procedures described by Fey and Cleave (Cleave & Fey, 1997; Fey, Cleave, & Long, 1997; Fey, Cleve, Long & Hughes, 1993). During the 20-minute session, the treating speech-language pathologist implemented the following responsivity education procedures: 1) waited for the participant to respond and listened to what the participant said, 2) allowed the participant to lead during play activities, 3) after allowing the

participant to lead during play, actively joined in, 4) played at a face to face level with the participant, 5) asked many types of questions such as "what", "where" and "how", 6) waited expectantly for the participant to respond and told the participant "it's your turn", 7) responded to the participant by taking a turn in a similar way to the participant, 8) imitated the participant's verbalizations by repeating exactly what the participant said, 9) used a variety of labels by naming many items during play, 10) expanded what the participant said by imitating the participant and adding one to two additional words, and 11) extended what the participant said by expanding and then adding a comment of two about the topic.

During the 20-minute session, the treating speech-language pathologist implemented the following focused stimulation procedures: 12) produced the participant's target vocabulary ten times each during the session, and 13) did not model use of the participant's AAC system during play. Item twelve, "produced the participant's target vocabulary ten times during the session", differentiated the intervention sessions from the baseline, intervention probes, maintenance probes, and generalization probes described later in the chapter as the vocabulary was produced three times, rather than ten times, during probe sessions. Item thirteen, "did not model use of the participant's AAC system during play", differentiated this language intervention approach from responsivity education and focused stimulation with the addition of AAC modeling as the participant's AAC system was not modeled during this approach. Appendix E lists the procedures for implementing responsivity education and focused stimulation.

Responsivity education and focused stimulation with the addition of AAC modeling. This language intervention approach followed the responsivity education procedures described in the Hanen Program for Parents (Manolson, 1992) and the focused stimulation procedures described by Fey and Cleave (Cleave & Fey, 1997; Fey, Cleave, & Long, 1997; Fey, Cleve, Long & Hughes, 1993). In addition, this language intervention approach also added AAC modeling procedures described by Goosens (1989). During the 20-minute session, the treating speech-language pathologist followed the same twelve procedures listed above, but also modeled each target vocabulary on the participant's AAC system after saying the vocabulary orally during play. Item twelve above, "producing the participant's target vocabulary ten times during the session", differentiated the intervention sessions from the baseline, intervention probes, maintenance probes, and generalization probes described later in the chapter as the vocabulary was produced three times, rather than ten times. Also, "modeled each target vocabulary on the participant's AAC system after saying the vocabulary orally," differentiated the language intervention approach from responsivity education and focused stimulation as the AAC system was modeled during this approach. Appendix F lists the procedures for implementing responsivity education and focused stimulation with the addition of AAC modeling.

Vocabulary sets. The vocabulary sets were the dependent variables in the investigation. Two sets of unique, equivalent and functionally independent vocabulary sets were used in the study to control for carryover effects from instructional sets. Unique vocabulary sets meant that none of the vocabulary in one set was repeated in the other set. Equivalent instructional sets indicated that the symbols used for the aided communication systems, as well as unaided gestures and signs and natural speech, were equivalent across vocabulary sets. Functionally independent sets meant that the items chosen for the vocabulary sets did not aid in the acquisition of the other vocabulary sets of the study (Schlosser, 1999a, 2003; Sindelar, et al., 1985). Each

vocabulary set consisted of five to ten vocabulary words that the participant understood, based on results from the MacArthur Bates CDI Words and Gestures (Fenson, et al., 2007), but did not produce during assessment when using his/her unaided and aided AAC systems. One vocabulary set was used for the language intervention approach of responsivity education and focused stimulation, while the second vocabulary set was used for the language intervention approach of responsivity education and focused stimulation with the addition of AAC modeling. In addition, objective methods were used to determine that the two sets were unique, equivalent, and functionally independent (Schlosser, 1999a, 2003). For example, the vocabulary sets contained the same number of nouns, verbs, and descriptors; all vocabulary were chosen from lists of early developing and frequently used word sets from the MacArthur-Bates CDI Words and Gestures; and symbol iconicity was deemed similar by the treating speech-language pathologists who had a minimum of ten years working in the area of AAC. Detailed information about the vocabulary sets for each participant will be discussed in the next section of the chapter.

Phases of the study. In accordance with single subject research design, the investigation consisted of the following phases: a) assessment, b) baseline, c) language intervention, d) intervention probes, e) generalization probes, and f) maintenance probes (Kazdin, 1982; Kennedy, 2005; Satake, et al., 2008). Sessions took place between one and four times weekly although there were occasions when a participant was ill or out-of-town, negating the ability to complete a session that week. A description of the assessment phase follows along with Table 4, which lists the participant vocabulary sets. Next, Table 5 provides a comparison of the baseline, intervention, intervention probe, generalization probe, and maintenance probe procedures followed by a description of each phrase.

Assessment. The purpose of the assessment phase was to determine the two vocabulary sets, the dependent variables in the investigation, to be used with each of the two language intervention approaches, the independent variables in the investigation. The vocabulary sets consisted of two sets of ten unique, equivalent and functionally independent words for Karl, Carol, and Marty, and two sets of five unique, equivalent and functionally independent words for Mick. Ten vocabulary words per set were chosen for Karl, Carol, and Marty, as was consistent with prior research studying language delayed preschoolers using the language intervention approaches of responsivity education and focused stimulation (Girolametto, et al., 1996a, 1996b; Girolametto, 1998). Five vocabulary words per set were chosen for Mick because he processed more slowly than the other three participants and demonstrated a moderate cognitive delay, suggesting it would be challenging to learn to produce ten new words within the teaching criterion constraints discussed later in this chapter.

Vocabulary chosen for the assessment procedure met the following inclusion criteria: a) the participant understood the vocabulary and b) the participant did not produce the vocabulary using unaided or aided communication modalities. Two sets of twenty-five vocabulary each which were unique, equivalent and functionally independent were chosen from the MacArthur-Bates CDI Words and Gestures (Fenson, et al., 2007) results completed by the participant's mothers. The participant's mother indicated the participant understood the vocabulary but did not produce the vocabulary through natural speech, manual sign, or Picture Communication Symbols line drawings on the MacArthur Bates CDI Words and Gestures checklist.

To assess vocabulary production, one set of twenty-five Picture Communication Symbol line drawings, or a photo of the child for personal names, was placed in front of the participant to determine whether the participant could name the item using natural speech, manual sign, or by pointing directly to the line drawings. The treating SLP pointed to the line drawing and first asked the participant "tell me what this is with your words." Next, the treating SLP asked the participant "tell me (vocabulary word) with your hands." After asking the participant to name the twenty five line drawings using natural speech and manual sign, the treating SLP then asked the participant to "tell me (vocabulary word) with your pictures" which required the participant to point directly to the line drawings. The same process was completed for the second set of twenty five vocabulary words. The participant needed to obtain a production score of 0% across natural speech, manual sign, and Picture Communication Symbols line drawings for the pairs of matched unique, equivalent and functionally independent vocabulary to be included in the two sets of targeted vocabulary for the study. Appendix G provides a sample of the assessment procedures and results for Mick.

Following completion of the assessment, I created pairs of matched unique, equivalent and functionally independent vocabulary for each participant and prioritized the lists based on combinations of core and fringe vocabulary that would be commonly be produced by same-aged, typically developing peers within the context of therapy room play activities (Beukelman & Mirenda, 2005). The treating SLP chose ten sets of vocabulary pairs from the prioritized lists to be used with Karl, Carol, and Marty, and five sets of vocabulary pairs from the prioritized lists to be used with Mick. Table 4 lists the vocabulary sets for each participant across the two language intervention approaches.

Table 4. Participant Vocabulary Sets

Participant	Responsivity Education and Focused Stimulation Vocabulary Set	Responsivity Education and Focused Stimulation with the addition of AAC Modeling Vocabulary Set
Karl	Walk	Stand
	Look	Get
	Blow	Push
	Up	Off
	You	That
	Boy	Karl
	Bed	Chair
	Lamb	Mouse
	Bear	Tiger
	Ear	Nose
Carol	Drink	Feed
	Jump	Walk
	Look	Read
	Yucky	Good
	Thirsty	Hungry
	Clean	Dirty
	Carol	Brother
	Window	Chair
	Brush	Comb
	Cup	Dish
Mick	Car	Bed
	Truck	Chair
	Push	Drink
	Ride	Eat
	Sleepy	Hungry
Marty	See	Stop
	Drink	Read
	Big	Hot
	Little	Cold
	On	In
	Under	Out
	Nose	Foot
	Elephant	Monkey
	Home	Park
	Zoo	Farm

Table 5. Comparison of Baseline, Intervention, Intervention Probe, Generalization Probe, and Maintenance Probe Procedures

Procedures	Baseline Intervention Probe Generalization Probe Maintenance Probe	Language Intervention: RE + Focused Stimulation	Language Intervention: RE and AAC Modeling + Focused Stimulation
Wait to respond and listen to what participant says.	X	X	X
Allow participant to lead.	X	X	X
After allowing participant to lead, actively join in play.	X	X	X
Play at a face to face level.	X	X	X
Ask many types of questions such as what, where, how.	X	X	X
Wait expectantly for the participant to respond and tell the participant "it's your turn."	X	X	X
Respond by taking a turn in a similar way to the participant.	X	X	X
Imitate the participant's verbalization by repeating exactly what he/she said.	X	X	X
Use a variety of labels by naming many items during play.	X	X	X
Expand what is said by imitating the participant and adding 1 to 2 additional words.	X	X	X
Extend what is said by expanding and then adding a comment or two about the topic.	X	X	X
Produce the target vocabulary three times during play.	X		
Produce the target vocabulary ten times during play		X	X
Do not model use of the participant's AAC system during play.	X	X	
Model each target vocabulary on the participant's AAC system after saying the vocabulary orally.			X

Baseline. Three baseline sessions were completed for each set of two target vocabularies, for a total of six baseline sessions, to establish the initial percentages of target vocabulary production and ensure there was little variability in the data with no evident trend of increasing performance (Kazdin, 1985; Kennedy, 2005). The initial choice of the two possible target vocabulary sets for the session was randomly determined for counterbalancing purposes (Schlosser, 2003). I told the treating SLP which vocabulary set would be used in advance of each session.

The treating SLP played with the participant for a 20-minute period choosing activities that were developmentally appropriate and materials that were interesting to the participant and also encouraged production of the target vocabulary set. For example, to encourage production of the vocabulary "look", "blow", and "up" on Karl's vocabulary list for responsivity education and focused stimulation, Katherine chose to play with bubbles. To encourage production of "drink", "thirsty" and "yucky" on Carol's vocabulary list for responsivity education and focused stimulation, Katherine chose to give a baby doll a drink of pretend milk that was spoiled. To encourage production of "eat" and "hungry" on Mick's vocabulary list for responsivity education and focused stimulation with the addition of AAC modeling, Elizabeth asked Mick if he was hungry and wanted to eat a cracker. To encourage production of "hot", "in", and "out" on Marty's vocabulary list for responsivity education and focused stimulation with the addition of AAC modeling, Elizabeth chose to put pretend pizza in a toy oven and take it out once it was hot.

The treating SLP implemented the language intervention approach of responsivity education (Manolson, 1992) during the baseline sessions consisting of: 1) waiting for the participant to respond and listened to what the participant said, 2) allowing the participant to lead during play activities, 3) after allowing the participant to lead during play, actively joining in, 4) playing at a face to face level with the participant, 5) asking many types of questions such as "what", "where" and "how", 6) waiting expectantly for the participant to respond and told the participant "it's your turn", 7) responding to the participant by taking a turn in a similar way to the participant, 8) imitating the participant's verbalization by repeating exactly what the participant said, 9) using a variety of labels by naming many items during play, 10) expanding what the participant said by imitating the participant and adding one to two additional words, 11) extending what the participant said by expanding and then adding a comment of two about the topic, 12) saying the target vocabulary three times, and 13) not modeling use of the participant's AAC system. In comparison to the intervention sessions, the treating SLP produced the target vocabulary three times rather than ten times and did not model use of the participant's AAC system during the session. Katherine and Elizabeth, while familiar with responsivity education, were trained in the above procedures prior to onset of baseline sessions by the investigator. Appendix H lists the probe procedures, which were the procedures followed during baseline, as well as during the intervention probes, maintenance probes, and generalization probes described later in this section of the chapter.

I video-taped all baseline sessions and collected data regarding participant autonomous production of target vocabulary. Autonomous production of target vocabulary was defined as: a) spontaneous production, b) while imitating an adult production, c) with or without prompting (i.e. "tell me what you want using your pictures"), d) with or without the adult providing a choice

that included the target vocabulary (i.e. “do you want ___ or ___?”, or e) in response to an adult questions (i.e. “which do you want?”), consistent with definitions of autonomous production from prior single subject studies assessing language intervention approaches in preschoolers (Kaiser & Hester, 1994). The definition of autonomous production and data collection procedures will be described in greater detail later in this chapter.

Language intervention. Following completion of the six baseline sessions, language intervention sessions began. The purpose of the intervention sessions was to teach participants the target vocabulary using the two intervention approaches, responsivity education combined with focused stimulation compared with responsivity education and focused stimulation with the addition of AAC modeling, to determine: a) the effectiveness of the approach in learning new vocabulary, and b) whether one approach was more efficient for learning the new vocabulary (Schlosser, 2003). Three intervention sessions were completed for each set of vocabulary for a total of six intervention sessions during each round of intervention sessions. As with baseline sessions, the treating SLP played with the participant during a 20-minute period using developmentally appropriate materials that were interesting to the participant and targeted the specific vocabulary set. The initial vocabulary set for the session was randomly determined each week for counterbalancing purposes across the two intervention approaches. I informed the treating SLP which vocabulary set to use prior to the session.

As was described previously, the independent variables of the study were the two language intervention approaches. The procedures for the language intervention approach of responsivity education and focused stimulation were the same as for baseline except each targeted vocabulary word was produced ten times during the intervention session. The procedures for the language intervention approach of responsivity education and focused stimulation with the addition of AAC modeling were the same for baseline except each targeted vocabulary word was produced ten times and each targeted vocabulary word was modeled using the participant’s AAC system directly after being producing orally. During intervention using responsivity and focused stimulation with the addition of AAC modeling, the treating SLP initially looked at or gestured the target vocabulary, and then simultaneously produced the word orally and signed the word for Karl, Carol, and Mick, followed by pointing to the line drawing of the word using aided AAC for Karl, Mick, and Marty. The target vocabulary was not signed for Marty, who did not use manual sign as a piece of his AAC system. The SLP did not point to line drawings of the word using aided AAC for Carol, who did not use aided AAC as a piece of her AAC system. Katherine and Elizabeth, while familiar with both intervention approaches, were trained in the procedures prior to onset of intervention sessions by the investigator. Appendix F and Appendix G describe the intervention session procedures in detail.

I collected data regarding participant autonomous production of target vocabulary during all intervention sessions to determine whether the learning criterion was reached, defined as 80% autonomous production of the target vocabulary across two intervention sessions. Learning criterion and data collection procedures will be described in greater detail later in the chapter. The second set of the three language intervention sessions was video-taped and treatment integrity forms were completed by the treating SLP and myself. Treatment integrity sessions will also to be described later in the chapter.

Intervention probes. Following completion of the six language intervention sessions, intervention probes were completed for the set of target vocabulary for a total of two total sessions to determine the effectiveness of the intervention sessions (Kazdin, 1985; Kennedy, 2005). Procedures for intervention probes were identical to the procedures described under baseline using counterbalancing to control for ordering effects. Appendix H describes the procedures for the intervention probes.

I video-taped all intervention probes and collected data regarding participant autonomous production of target vocabulary. Data collection procedures will be described in greater detail later in the chapter.

Generalization probes. Continuous generalization probes were completed during baseline, intervention, and maintenance phases of the investigation to determine whether the participants were generalizing production of the target vocabulary from both vocabulary sets across people, settings, and activities/materials (Schlosser, 1999a, 2003). The first set of generalization probes was completed directly after completion the three baseline sessions but prior to onset of the intervention sessions. The next set of generalization probes was completed directly following the first and third rounds of intervention sessions but before the second and fourth rounds of intervention began. These probes were not completed for Karl and Carol after the third round of intervention because both participants reached the learning criterion prior to the third round of intervention. These probes were completed for Mick the after the first and fourth rounds of intervention sessions, rather than after the first and third rounds of intervention, due to scheduling difficulties. These probes were also only completed for Marty after the first round of intervention because he dropped out of the study prior to completion of the third round of intervention. The final set of generalization probes was completed directly after the last maintenance session. Theses probes were only completed for Karl and Carol because Mick and Marty did not complete the maintenance phase of the study.

The generalization probes were completed with adults other than the treating SLP, using different activities and materials, and in a different setting for one participant, Marty. Karl completed generalization probes with his special education teacher, Nancy, in the family room of his house using materials found in Karl's house. Carol completed generalization probes with her special education teacher, Nancy, in a quiet therapy room at the community center using preschool materials from the center. Mick completed generalization probes with his preschool program speech-language pathologist, Susie, in a quiet therapy room at the private practice using materials from the preschool program. Marty completed generalization probes with his mother, Deena, in a bedroom at his house using materials found in Marty's house.

The generalization probe procedures were identical to the baseline phase using each set of target vocabulary with counterbalancing to control for order effects. I informed Nancy, Susie, and Deena which set of vocabulary would be used in advance of the sessions. Nancy, Susie, and Deena were familiar with responsivity education procedures prior to the investigation but were trained in the specific procedures prior to completion of the generalization probes. Appendix H describes the procedures for the generalization probes.

I video-taped all generalization probes and collected data regarding participant autonomous production of target vocabulary during the probes. Data collection procedures will be described in greater detail later in the chapter.

Maintenance probes. Maintenance probes were completed to determine whether the production of the target vocabulary in both vocabulary sets was maintained after the learning criterion was reached, defined at 80% autonomous production of vocabulary across two sessions (Schlosser, 2003). Learning criterion will be discussed in greater detail in the next section of the chapter. Once learning criterion was reached, intervention sessions ended for the specific vocabulary set and three maintenance probes were conducted at two weeks, four weeks, and eight weeks after reaching learning criterion as was customary in single subject AAC studies with preschoolers (Binger, et al., 2008; Kent-Walsh, et al., 2010; Rosa-Lugo & Kent-Walsh, 2008). Maintenance probes were only completed with Karl and Carol because learning criterion was not reached for either vocabulary sets with Mick or Marty. Maintenance procedures were identical to the baseline phase with counterbalancing used to control for order effects. I informed Nancy which vocabulary set to use prior to the generalization session.

I video-taped all maintenance probes and collected data regarding participant autonomous production of target vocabulary during the probes. Data collection procedures will be described in greater detail later in the chapter.

Learning criterion. Learning criterion is defined as a predetermined measurable level of performance that indicates mastery. Learning criterion in comparative studies serves three important functions. First, the learning criterion defines when the intervention will be terminated. Second, the learning criterion permits an unequivocal demonstration of effectiveness for the condition in which the criterion is obtained rather than relying on a visual analysis of slope change from baseline to intervention in the graphic representations of results. Third, the learning criterion sets the stage for efficiency comparisons in terms of the number of sessions required to meet the learning criterion (Schlosser, 2003).

The learning criterion for the investigation was autonomous production of 80% of the targeted vocabulary across two consecutive intervention sessions which is a common learning criterion when completing language therapy with language-disordered children (McCauley & Fey, 2006). As previously stated, autonomous production was defined as: a) spontaneous production, b) while imitating an adult production, c) with or without prompting (i.e. “tell me what you want using your pictures”), d) with or without the adult providing a choice that included the target vocabulary (i.e. “do you want ___ or ___?”, or e) in response to an adult questions (e.g. “which do you want?”), consistent with definitions of autonomous production from prior single subject studies assessing language intervention approaches in preschoolers (Kaiser & Hester, 1994). When the learning criterion was reached for vocabulary production in one approach, training with that vocabulary set was discontinued while training with the other vocabulary set was continued until either the learning or teaching criterion was reached (Schlosser, et al., 1998; Schlosser, 2003). An intervention probe was completed directly after reaching learning criterion with the vocabulary set, and if the participant also produced 80% of the targeted vocabulary during the intervention probe, the maintenance phase of the study was introduced. If the participant did not produce 80% of the targeted vocabulary during the intervention probe,

language intervention sessions were reintroduced until the participant produced 80% of the targeted vocabulary across two consecutive sessions again or reached the teaching criterion.

Teaching criterion. A teaching criterion is defined as a predetermined maximum number of teaching sessions. Setting a teaching criterion permitted the termination of training even if the learning criterion was not attained for a particular language intervention approach (Schlosser, 1999a, 2003). A teaching criterion of twelve intervention sessions per language intervention approach and twenty-four total language intervention sessions was set for this study to allow for completion of data collection within a period of six to eight months per participant.

Controlling threats to internal validity. There are two threats to internal validity in adapted alternating treatment design methodology: carryover effects and ordering effects (Schlosser, 1999a, 2003; Sindelar, et al., 1985). To control for carryover effects across activities, as much as possible, alternating language intervention approaches were used during two different days within a week. This procedure consistently occurred with Karl, Carol, and Mick, but did not occur with Marty due to parental scheduling constraints. In addition, the participants were informed of which treatment they were receiving at the beginning of each intervention session. For example, the treating SLP said "Today, I'm going to say your special words a lot but I'm not going to use your pictures or signs when I'm saying your words" during language intervention sessions for responsivity education and focused stimulation. Alternatively, the treating SLP said "Today, I'm going to say your special words a lot and use your pictures and signs for the words when I talk" during intervention sessions for responsivity education and focused stimulation with the addition of AAC modeling with Karl and Mick. The phrase "use your pictures" was omitted for Carol, who did not use line drawings in her AAC system, and the phrase "use your signs" was omitted for Marty, who did not use manual sign in his AAC system.

To control for ordering effects across activities, the two vocabulary sets were counterbalanced by randomizing which vocabulary set would be used first each week across all phases of the study (Schlosser, 1999a, 2003; Sindelar, et al., 1985).

Finally, two sets of unique, equivalent and functionally independent vocabulary sets were used to control for carryover effects from instructional sets. As stated previously in the chapter, unique vocabulary sets meant that none of the vocabulary in one set was repeated in the other set. Equivalent instructional sets indicated that the Picture Communication Symbols, as well as gestures, manual signs, and words, were equivalent across the two vocabulary sets. Functionally independent sets meant that the items chosen for the vocabulary sets did not aid in the acquisition of the other vocabulary sets of the study (Schlosser, 1999a, 2003; Sindelar, et al., 1985). In addition, objective methods were used to determine that the two sets were unique, equivalent, and functionally independent (Schlosser, 1999a, 2003). For example, the vocabulary sets consisted of the same number of nouns, verbs, and descriptors; all vocabulary were chosen from lists of early developing and frequently used word sets listed in the MacArthur Bates CDI Words and Gestures (Fenson, et al., 2007); and symbol iconicity across pairs of line drawings were be deemed similar by the treating SLP.

Controlling threats to external validity and generality. There were three threats to external validity in this study: the extent to which the results could not be generalized across

participants, settings, times, and other professionals; pretest sensitization; and multiple treatment interference (Kazdin, 1982). Generality referred to the degree to which the findings of the study could be extrapolated to other circumstances (Kennedy, 2005; Schlosser, 2003). Generalization probes controlled for threats to external validity and also addressed generality as multiple generalization probes were completed during the baseline phase, the intervention phase, and after completion of the intervention phase during the maintenance phase. The generalization probes were completed across participants, at different times, with different materials and activities, and with different adults. Pretest sensitization was controlled as the baseline phase did not begin until a minimum of one week after assessment. Multiple treatment interferences were controlled though use of unique, equivalent and functionally independent vocabulary sets across the two language interventions with the order of the vocabulary sets randomized each week across all phases of the study.

Measures

Dependent measures. As mentioned previously, the dependent variable for the investigation was the percent of targeted vocabulary produced autonomously by the participants during each 20-minute play session. Autonomous productions were defined as vocabulary produced by unaided means including word approximations, intelligible word production, and manual sign; as well as vocabulary produced by aided means using Picture Communication Symbols line drawings and photos on the participant's aided AAC systems. As the participants were multimodal communicators, vocabulary was produced using multiple methods such as concurrent use of manual sign and word approximations. As the participant's speech was often unintelligible, word approximations were counted as autonomous productions only if both the adult and the investigator agreed the production was a close approximation of the target vocabulary rather than an undifferentiated vocalization. Autonomous productions could be produced in a variety of ways including: a) spontaneously, b) while imitating an adult production, c) with or without adult prompting (e.g. "tell me what you want"), d) with or without the adult providing a choice that includes the target vocabulary (e.g. "do you want __ or __"), or e) in response to an adult question (e.g. "which do you want?").

Data collection. Baseline probes, intervention probes, generalization probes, and maintenance probes were video-taped for data reliability analysis and data was collected to determine the percent of target vocabulary produced. Data for the dependent variable was collected during every language intervention session to determine whether learning criteria was reached. Every second session of the three intervention sessions across vocabulary sets was video-taped for treatment integrity analysis, and treatment integrity forms were completed by the adult and the investigator.

A variety of data collection forms were used to collect data. Appendix I is a sample of the data collection form used to collect data for the percent of target vocabulary autonomously produced, which, in this case, was collected during Mick's baseline, intervention probe, generalization probe, and maintenance probe sessions using the responsivity education and focused stimulation vocabulary set. Appendix J is a sample of the data collection form used to collect data for the percent of target vocabulary autonomously produced during language intervention sessions to obtain learning criterion results, which, in this case, was collected during Mick's responsivity

education combined with focused stimulation intervention session. Appendix K is another sample of the data collection form used to collect data for the percent of target vocabulary autonomously produced during language intervention session to obtain learning criterion results, which, in this case, was collected during Mick's responsivity education and focused stimulation with the addition of AAC modeling intervention session. Similar forms were created for each of the four participants. Additional data collection forms for data reliability analysis and treatment integrity will be described in the next section.

Data analysis. A variety of data analysis was completed for the dependent variable, treatment integrity and date reliability. Detailed information about data analysis follows.

Dependent variable. Dependent variable analysis was completed for: a) percent of targeted vocabulary words autonomously produced across conditions per each participant, b) number of training sessions to meet learning criterion, c) percent of nonoverlapping data (PND), and d) percent of overlapping data (POD). Details of the dependent variable analysis follow.

Two dependent measures were used to determine the effectiveness and efficiency of the two language intervention approaches: a) percent of target vocabulary produced autonomously each session, and b) number of training sessions to reach learning criterion. The percent of target vocabulary produced autonomously using the participant's unaided and aided AAC system during each session measured the effectiveness of the two interventions (Schlosser, et al., 1998). This measure was obtained during all probe sessions including baseline, intervention probes, generalization probes, and maintenance probes. The percent was obtained by dividing the number of targeted vocabulary autonomously produced during the session by the total number of targeted vocabulary words and multiplying the number by 100 and was listed on each data collection form Appendix L provides a sample of a completed data collection form listing the percent of target vocabulary produced autonomously for Mick during an intervention probe session.

The number of training sessions needed to reach learning criterion was used to measure efficiency (Schlosser, et al., 1998; Schlosser, 1999a, 2003). This number provided a measure of how quickly the two language interventions resulted in the acquisition of the targeted vocabulary. The numbers were obtained by totaling the number of intervention sessions required for the participant to reach the learning criterion for each set of vocabulary. The learning criterion was 80% of targeted vocabulary autonomously produced across two consecutive intervention sessions. Appendix M provides a sample of a completed data collection form listing the percent of target vocabulary produced autonomously for Mick during an intervention session. This data was used to determine the number of training sessions needed to reach learning criterion. The results of the number of training sessions needed to reach learning criterion will be reported in a table across participants in the next chapter.

Measures of the percentage of nonoverlapping data (PND) were completed for each language intervention approach across participants to assess treatment effectiveness during the language intervention phase. PND is a nonparametric statistical method that evaluates treatment outcomes in single case design studies. PND entails computing the percentage of nonoverlapping data between baseline and treatment conditions. The PND is calculated as the number of data points

in the intervention phase which exceeds the highest point in the previous baseline phase divided by the total number of data points in the intervention phases. The result is multiplied by 100 to obtain a percentage. PND scores of over 90% are regarded as very effective, scores between 70% and 90% are considered as effective, scores of between 50% and 70% are considered as questionably effective, and scores below 50% are regarded as ineffective treatments (Schlosser & Lee, 2000; Scruggs & Mastropieri, 1993, 1998, 2001; Scruggs, Mastropieri, & Castro, 1987). The results of the PND measures will be reported in a table across participants in the next chapter.

Measures of the percentage of overlapping data (POD) will also be completed for each intervention across participants to assess treatment effectiveness during the maintenance phase for those participants completing the maintenance phase of the study. POD is the percentage of maintenance data points within or above the last three intervention data points (Schlosser, 2000). The results of the POD measures will be reported in a table across participants the next chapter.

Treatment integrity. Treatment integrity is the extent to which the language intervention approaches were implemented as intended by the adults participating in the study (Schlosser, 1999a, 2003). A checklist was developed listing the procedures to be followed for successfully implementing each phase of the study including baseline, intervention probes, generalization probes, and maintenance probes, as well as the two language intervention sessions. The sessions were video-taped and the adult and the investigator completed the checklist directly following the specific session. An agreement was scored when the investigator and the adult both record the same response. Inter-observer agreement was calculated by taking the number of agreements divided by the number of agreements plus disagreements and multiplying by 100%. Inter-rater agreement checks were completed on 33% of the probes across each phase of the study including baseline, intervention probes, generalization probes, and maintenance probes, as well as 33% of the intervention sessions (Schlosser, 1998, 2003). Appendix N provides a sample treatment integrity checklist for Mick used during probes for baseline, intervention probe, generalization, and maintenance sessions with the responsivity education and focused stimulation vocabulary set. Appendix O provides a sample treatment integrity checklist for Mick used during an intervention session with responsivity education and focused stimulation vocabulary set. A similar form was created for the responsivity education and AAC modeling combined with focused stimulation vocabulary set. Identical treatment integrity forms were used across the four participants. Treatment integrity results will be reported in the next chapter.

Data reliability for the dependent variable. Inter-rater agreement checks were completed to assure data reliability for the dependent variable in this study across assessment, baseline, intervention probes, generalization probes, and maintenance probes. The purpose of the checks was to assess the consistency to which the percentage of target vocabulary autonomously produced by the participant was measured (Schlosser, 1999a, 2003; Kazdin, 1982; Kennedy, 2005). The investigator trained an independent observer, research assistant Brenna, on the procedures for each phase of the study, the response definitions, and the use of data recording sheets. An agreement was scored when the investigator and the independent observer both recorded the same response. Inter-observer agreement was calculated by taking the number of agreements divided by the number of agreements plus disagreements and multiplying by 100%. Inter-rater agreement checks were completed on 33% of the probes during each phase of the

study using videotapes from the sessions (Schlosser, 1998, 2003). Appendix P provides a sample inter-rater reliability form for Mick using the responsivity education and AAC modeling combined with focused stimulation vocabulary set. Identical forms were used by the independent observer and the investigator. A similar form was created for Mick's other vocabulary set and the other three participants. Inter-rater reliability results will be reported in the next chapter.

Social validity. Social validity is a dynamic process which assesses whether the goals, methods, and outcomes of this study, comparing language intervention approaches for preschoolers who benefit from AAC, are socially valid. One method to determine social validation is through use of subjective evaluation which consists of soliciting the opinions of persons who have a special position due to their expertise or relationship to the participant (Schlosser, 1999b, 2003). The adults participating in the study, including the treating SLPs and the SLP and special education teacher completing the generalization probes, were given a questionnaire to determine whether the goals of the study, the language intervention approaches, and the outcomes of the study were appropriate and reasonable for the participants. The questionnaire was completed prior to the study to allow for modification of the procedures if indicated, as well as after completion of the study to determine whether the intervention approach was socially valid (Schlosser, 1998). Appendix Q is the Social Validity Questionnaire completed by the SLPs, the special education teacher, and Marty's mother. Results of the questionnaire will be reported in the next chapter.

Ecological validity. Ecological validity is the extent to which the therapy room and home settings, the SLP and special education teachers and parent implementing the interventions and probes, and the materials used in the study could be easily implemented in typical daily practice (Schlosser, 2003). Upon completion of the study, a questionnaire was given to the participating adults to determine whether the settings, materials, and adult participation in the study were considered to be ecologically valid. Appendix R is the Ecological Validity Questionnaire completed by the adult participants at the end of the study. Results of the questionnaire will be reported in the next chapter.

CHAPTER 4 Results

Quantitative data and qualitative description of the results of the investigation are presented for: a) reliability measures, b) treatment effectiveness measures of the intervention phase through percentage of nonoverlapping data, c) treatment effectiveness measures of the maintenance phase through percentage of overlapping data, d) treatment effectiveness measures for both intervention approaches across each participant, e) treatment efficiency through number of sessions to reach learning criterion, f) social validation measures, and g) ecological validation measures.

Reliability

Data reliability measures were completed to assure that the data collection results were consistent for the dependent variable, which was the percent of target vocabulary produced for each vocabulary set, as well as assure treatment integrity was upheld for the independent variables, which were the two language intervention approaches.

Dependent variable. As stated in the previous chapter, inter-rater agreement checks were completed to assure data reliability for the dependent variable across assessment, baseline, intervention probes, generalization probes, and maintenance probes. The purpose of the inter-rater agreement checks was to assess the consistency to which the percent of target vocabulary autonomously produced was measured (Schlosser, 1999a, 2003; Kazdin, 1982; Kennedy, 2005). Inter-rater checks were completed for 33% of the probes for each participant during each phase of the study. A sample inter-rater reliability form is provided in Appendix P.

The results revealed that the mean inter-rater reliability across the four participants was 94%. Individually, inter-rater reliability for Karl ranged from 80% to 100% with a mean of 89%. Inter-rater reliability for Carol ranged from 90% to 100% with a mean of 96%. Inter-rater reliability for Mick ranged from 80% to 100% with a mean of 97%. Inter-rater reliability for Marty ranged from 80% to 100% with a mean of 93%. Inter-rater reliability was highest for Mick possibly because he was the quietest of the four participants, produced fewer target vocabulary and the least variety of vocabulary during sessions in general, and had fewer target vocabulary to collect data with five words per session versus ten words per session for the other participants. Inter-rater reliability was second highest for Carol. While highly verbal with poor intelligibility, Carol frequently imitated SLP and special education teacher productions which aided identification of target vocabulary production. Inter-rater reliability for Marty was third highest. Marty was highly verbal with poor intelligibility, but unlike Carol, did not frequently verbally imitate either the treating SLP or his mother. In addition, he was not a multimodal communicator and therefore did not use manual sign and rarely used his flip chart to communicate, making it more challenging to identify production of target vocabulary. Inter-rater reliability for Karl was lowest, possibly because he was a multimodal communicator who occasionally used manual sign to communicate. Neither myself nor the research assistant, Brenna was fluent in SEE sign, which could have impacted ability to identify production of target vocabulary when using manual sign, particularly when Brenna was viewing video-tapes to complete reliability measures.

Treatment integrity. Also as stated in the previous chapter, treatment integrity checks were completed to assure data reliability for the independent variable across all phases of the investigation (Schlosser, 1999a, 2003). The purpose of the treatment integrity checks was to assess that the adults were consistently implementing the intervention approach of responsivity education as intended during baseline, intervention probes, generalization probes, and maintenance probes across both vocabulary sets, as well as to assess that the treating SLPs were consistently implementing the intervention approaches of responsivity education and focused stimulation, and responsivity education and focused stimulation with the addition of AAC modeling, as intended during intervention sessions with each vocabulary set. Adults completing treatment integrity checklists included the investigator, the two treating SLPs, and the adults completing the generalization probes consisting of the special education teacher, the secondary SLP, and the participant's parent. Inter-rater treatment integrity checks were completed during 33% of the probe sessions and 33% of the intervention sessions. Sample treatment integrity checklists are provided in Appendix N and Appendix O.

The mean percent of inter-rater agreement for treatment integrity across the four participants was 99%. Individually, the mean was 98% for Karl across the intervention approaches and was 100% for Carol across the intervention approaches. While there was strong agreement between myself and the adults implementing the interventions, this did not mean the intervention procedures were consistently implemented as indicated. For example, Karl's and Carole's treating SLP found implementing the intervention procedures during treatment sessions was more challenging than implementing the intervention procedures during the probe sessions as the treatment sessions required target vocabulary production ten times each versus three times each during the probes. Because the treating SLP focused on producing the target vocabulary ten times each during the twenty minute session, she often times variably allowed the toddler to lead during the play activities, variably waited expectantly for the toddler to respond, and variably expanded and extended the toddler's productions. An additional challenge arose when implementing the responsivity and focused stimulation with the addition of AAC modeling intervention as the treating SLP variably modeled each target vocabulary using the child's AAC system. One challenge also occurred during the probe sessions as, infrequently, the treating SLP modeled the target vocabulary more than three times. The special education teacher who completed generalization probes with Karl and Carole demonstrated two areas of variable implementation of the intervention procedures, waiting expectantly for the toddler to respond and not producing the target vocabulary more than three times during play. Overall, during sessions in which treatment integrity data was collected, the adults consistently implemented the intervention procedures a mean of 77% of the time, variably implemented the intervention procedures a mean of 23% of the time, and forgot to implement the intervention procedures 0% of the time.

The mean percent of inter-rater agreement for treatment integrity was 97% for Mick across both intervention approaches and was 100% for Marty across both intervention approaches. Once again, while there was strong agreement between the investigator and the adults implementing the interventions, this did not mean the intervention procedures were consistently implemented as indicated. Unlike the treating SLP working with Karl and Carole, the treating SLP working with Mick and Marty did not find the treatment sessions more challenging than the probe sessions. Rather, she demonstrated variability asking many types of questions with Mick, as

Mick did not yet understand wh-questions such as “where” and “how.” During probe sessions with Mick, she occasionally produced the target vocabulary more than three times. Regarding Marty, on occasion she variably modeled use of Marty’s AAC system during treatment sessions, as Marty’s AAC system required turning the pages of his flip chart. On occasion, she also produced the target vocabulary more than three times during probe sessions with Marty. The secondary SLP completing generalization probes with Mick demonstrated variability for allowing Mick to lead, asking many types of questions, and producing the target vocabulary no more than three times. Marty’s mother, who completed generalization probes with Marty, variably produced the target vocabulary more than three times. Overall, during sessions in which treatment integrity data was collected, the adults consistently implemented the intervention procedures a mean of 85% of the time, variably implemented the intervention procedures a mean of 15% of the time, and forgot to implement the intervention procedures 0% of the time.

In summary, the intervention procedures were consistently followed a mean of 81% of the time, were variably followed a mean of 19% of the time, and were not followed 0% of the time across adults implementing the intervention procedures. Examples of variably following treatment integrity guidelines included occasionally leading the participants during play activities, occasionally not joining actively joining in play after allowing the participant to lead, occasionally not asking many types of wh-questions, occasionally not waiting expectantly for the participant to respond and saying “it’s your turn”, occasionally not imitating and repeating exactly what the participant said, and occasionally not expanding or extending what the participant was saying, It should be noted that during any one session, variability occurred on approximately three out of a total of thirteen treatment integrity items. Discussion of treatment integrity follows in the next chapter.

Treatment Effectiveness

Treatment effectiveness is evaluated on the basis of whether a change occurs in the dependent measure when the intervention is introduced (Schlosser, 2003). In the present investigation, treatment was considered effective when the percent of target vocabulary produced increased following the introduction of the intervention approach of responsivity education and focused stimulation, as well as following the introduction of the intervention approach of responsivity education and focused stimulation with the addition of AAC modeling. As mentioned in Chapter 3, the research design of the study was multiprobe because the percent of target vocabulary produced, which was the probe data, was collected intermittently during the execution of each phase of the study at times required for estimating trends and related patterns within and between phases (Kennedy, 2005).

To determine treatment effectiveness, the percent of target vocabulary produced was collected: a) during each of the three sets of baseline sessions for a total of six baseline data points, b) directly after the first and third round of intervention sessions for a total of four intervention probe data points, c) during each of the three sets of maintenance sessions for a total of six data points, and d) during each set of generalization sessions directly after the third baseline session but before treatment, directly after the first and third round of treatment, and directly after the final maintenance sessions for a total of eight data points. As was mentioned in Chapter 3, the number of probes obtained varied across participants as Mick did not complete the maintenance

phase, and Marty did not complete a third round of treatment or the maintenance phase. In addition, probe data for Karl and Carol was obtained directly after the second round of treatment rather than the third round of treatment as neither participant completed a third round of treatment. Lastly, Mick's second intervention probe was obtained directly after the fourth round of intervention rather than the third round of intervention due to scheduling difficulties.

The treatment effectiveness of the two intervention approaches varied across participants. The two intervention approaches were equally highly effective for Karl, who also demonstrated generalized production of both target vocabularies with novel communication partners, and activities and materials and maintained target vocabulary production eight weeks following completion of intervention. The intervention approach of responsivity education and focused stimulation was highly effective for Carol, while the intervention approach of responsivity education and focused stimulation with the addition of AAC modeling was effective. In addition, Carol demonstrated generalized production of both target vocabularies with novel communication partners, activities and materials which was maintained eight weeks following completion of intervention. The intervention approach of responsivity education and focused stimulation was effective for Mick while responsivity education and focused stimulation with the addition of AAC modeling was questionably effective. Both approaches resulted in generalized target vocabulary production to novel communication partners, activities, and materials, however, Mick failed to reach vocabulary production learning criterion during intervention with either approach. The intervention approach of responsivity education and focused stimulation with the addition of AAC modeling was highly effective with Marty, while responsivity education and focused stimulation was ineffective. Target vocabulary production generalized to novel communication partners, activities, and materials with the highly effective approach, however, Mark dropped out of the study prior to reaching vocabulary production learning criterion during probe sessions for both sets of vocabulary. The next section of the chapter provides nonparametric statistical data which quantifies the variable results.

Percentage of nonoverlapping data. The percentage of nonoverlapping data (PND), as was described in the previous chapter, is a nonparametric statistical method to evaluate the effectiveness of treatment outcomes in single case design studies during the intervention phase. PND is determined by computing the number of data points in the intervention phase which exceeds the highest point in the previous baseline phase divided by the total number of points in the intervention phase. For example, using the data from Figure 1, page 86, and using Karl's vocabulary set for responsivity education and focused stimulation, the highest percent of vocabulary produced during the baseline phase was 30%. During the treatment phase, Karl completed four treatment probes, with all four probes demonstrating percent of vocabulary produced greater than 30%. Therefore, 4/4 X 100 = 100% indicating a PND of 100%. PND scores of over 90% are regarded as very effective, scores between 70% and 90% are considered as effective, scores of between 50% and 70% are considered as questionably effective, and score below 50% are regarded as ineffective treatments (Schlosser & Lee, 2000; Scruggs & Mastropieri, 1993, 1998, 2001; Scruggs, Mastropieri, & Castro, 1987). Table 6 lists the PND for each participant.

Table 6. Percentage of Nonoverlapping Data (PND) Across Participants

Participants	PND: RE and FS*	PND: RE and FS + AAC**
Karl	100%	100%
Carol	100%	85%
Mick	83%	66%
Marty	33%	100%

*Responsivity Education and Focused Stimulation
** Responsivity Education and Focused Stimulation with the Addition of AAC Modeling

The results of the PND quantified that both language intervention approaches were very effective for Karl with 100% nonoverlapping data between baseline and intervention probes for both approaches. Responsivity education and focused stimulation was very effective, while responsivity education and focused stimulation with the addition of AAC modeling was effective for Carol with 100% nonoverlapping data for the former and 85% nonoverlapping data for the later between baseline and intervention probes. Responsivity education and focused stimulation was effective, while responsivity education and focused stimulation with the addition of AAC modeling was questionably effective for Mick with 83% nonoverlapping data for the former and 66% nonoverlapping data for the later when comparing baseline and intervention probes. Lastly, responsivity education and focused stimulation was not effective, while responsivity education and focused stimulation with the addition of AAC modeling was very effective for Marty, with 33% nonoverlapping data for the former and 100% nonoverlapping data for the later between baseline and intervention probes. It is important to note that the PND for Karl, Carol, and Mark was based on learning to produce ten target vocabulary, while the PND for Mick was based on learning to produce five target vocabulary. A discussion of these results will follow in the next chapter.

Percentage of overlapping data. The percentage of overlapping data (POD), as was described in the previous chapter, is another nonparametric statistical method to evaluate the effectiveness of treatment outcomes in single case design studies, this time during the maintenance phase. POD is determined by computing the number of data points in the maintenance phase within or above the last three data points in the intervention phase divided by the total number of points in the maintenance phase (Schlosser & Lee, 2000). For example, using data from Figure 2, page 90, and Carol's vocabulary set for responsivity education and focused stimulation, the range of the last three data points in the intervention phase was between 30% and 90%. The number of data points between 30% and 90% in the maintenance phase consisted of all four data points. Therefore, 4/4 X 100 = 100%. It should be noted that Mick and Marty did not complete the maintenance phase of the study and, therefore, POD was computed solely for Karl and Carol. Table 7 states the POD for each participant.

Table 7. Percentage of Overlapping Data (POD) Across Participants

Participants	POD: RE and FS*	POD: RE and FS + AAC**
Karl	100%	100%
Carol	100%	100%

*Responsivity Education and Focused Stimulation
** Responsivity Education and Focused Stimulation with the Addition of AAC Modeling

The results of the POD indicated target vocabulary production was maintained following completion of both intervention approaches for Karl and Carol with 100% overlapping data between intervention and maintenance probes. A discussion of these results will follow in the next chapter.

The next sections provide detailed descriptions of the treatment effectiveness of responsivity education and focused stimulation, as well as the treatment effectiveness of responsivity education and focused stimulation with the addition of AAC modeling, for each participant across each phase of the study.

Karl. Karl participated in the study from August 3, 2009 through March 5, 2010, for a period of seven months. During that time, he completed a total of thirty two sessions across assessment, baseline, intervention sessions, intervention probes, generalization, and maintenance phases of the investigation. As was mentioned in Chapter 3, there were occasional breaks from the study during the seven month period as Karl was hospitalized or was out-of-town on several occasions, and there were times when the treating SLP was not available due to illness, holidays, and vacations. A total of twenty two probes were completed for Karl, consisting of eleven probes for each vocabulary set. Six probes were collected during the baseline phase; four probes were collected during the treatment phase; six probes were collected during the maintenance phase; and two generalization probes each were collected after the third baseline probe before treatment began, after the first round of treatment, and after the final maintenance probe for a total of six generalization probes.

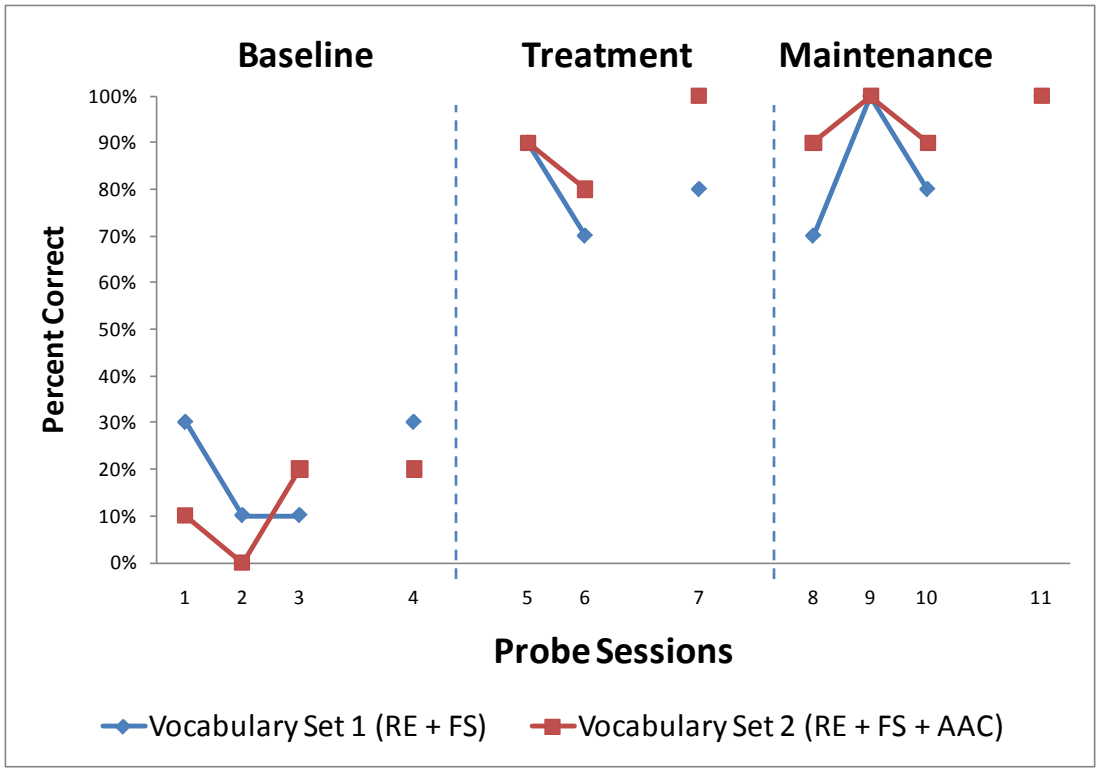
The results revealed that both intervention approaches were highly effective in teaching target vocabulary production. Production of both sets of target vocabulary was maintained eight weeks after completion of intervention and production of both sets of target vocabulary generalized across differing people, materials, and activities. Table 8 lists the percent of target vocabulary produced during each probe across the two vocabulary sets. Figure 1 shows Karl's percent vocabulary produced across baseline, treatment, and maintenance phases with the two vocabulary sets.

Table 8. Percent of Target Vocabulary Produced during Karl's Probe Sessions

Treatment	Baseline Probe 1	Baseline Probe 2	Baseline Probe 3	General-ization Probe 4	Treat-ment Probe 5	General-ization Probe 6	Treat-ment Probe 7	Mainte-nance Probe 8	Mainte-nance Probe 9	Mainte-nance Probe 10	Generali-zation Probe 11
Vocabulary Set 1: (RE* + FS)**	30%	10%	10%	30%	90%	70%	80%	70%	100%	80%	100%
Vocabulary Set 2: (RE* + FS+ AAC***)**	10%	0%	20%	20%	90%	80%	100%	90%	100%	90%	100%

*RE = Responsivity Education **FS = Focused Stimulation ***AAC = AAC Modeling

Figure 1. Karl's Percent of Target Vocabulary Produced Across Baseline, Treatment, and Maintenance Phases



Baseline. Probes completed during the baseline sessions revealed that Karl produced the target vocabulary between 10% and 30 % of the time using the responsivity education and focused stimulation vocabulary set and produced the target vocabulary between 0% and 20% of the time using the responsivity education and focused stimulation with the addition of AAC modeling vocabulary set. The SLP produced each target vocabulary three times during the baseline sessions, which were completed prior to intervention sessions. As can be seen in Table 8 and Figure 1, there was no upward trend across the sessions indicating Karl was not learning to produce the target vocabulary prior to implementation of treatment.

Qualitatively, Karl demonstrated multimodality communication during baseline sessions when producing the target vocabulary. For example, when using the vocabulary sets for responsivity education and focused stimulation sessions during baseline sessions which were completed prior to intervention, he pointed to a PCS symbol to say "blow", used a manual sign to say "you", and produced word approximations to produce "up" and "boy". When using the vocabulary sets for the responsivity education and focused stimulation with the addition of AAC modeling baseline sessions, which were completed prior to intervention, he pointed to a PCS symbol to say "tiger", and used manual signs to say "nose" and "off."

Intervention probes. Probes obtained during the intervention phase, after completion of three intervention sessions, revealed that Karl produced the target vocabulary between 80% and 90% of the time using the responsivity education and focused stimulation vocabulary set and produced the target vocabulary between 90% and 100% of the time using the responsivity education and focused stimulation with the addition of AAC modeling vocabulary set. As is evident in Table 8 and Figure 1, Karl very quickly learned to produce the target vocabulary with both of the intervention approaches.

Qualitatively, Karl continued to demonstrate multimodality communication during target vocabulary production but now used fewer manual signs and, more often, paired PCS symbols with word approximations. For example, Karl paired symbols with word approximations during 58% of productions, produced word approximations alone on 18% of productions, pointed to symbols alone on 12% of productions, and used manual sign alone for 12% of productions. These findings were similar across both vocabulary sets. Karl most likely used fewer signs and more PCS symbols because the treating SLP prompted Karl with "tell me with your pictures" during the sessions. It should also be noted that Karl produced all of the target vocabulary spontaneously rather than imitatively during the four probe sessions which would be considered a deeper level of vocabulary learning. Lastly, during probe five using the responsivity education and focused stimulation set, Karl named 30% of the PCS symbols when asked "What is this?" but named 90% of the target vocabulary during familiar play routines with prompting to "tell me with your pictures." This difference underlies the importance of context and play routines to facilitate vocabulary production in toddlers, which will be further discussed in the final chapter.

Maintenance. Probes completed during the maintenance phase revealed that Karl produced the target vocabulary between 70% and 100% of the time using the responsivity education and focused stimulation vocabulary set and produced the target vocabulary between 90% and 100% of the time using the responsivity education and focused stimulation with the addition of AAC modeling. As is evident in Table 8 and Figure 1, Karl maintained production of

target vocabulary in both vocabulary sets two weeks, four weeks, and eight weeks after completion of the intervention sessions across vocabulary sets.

Qualitatively, Karl continued to rely on PCS symbols paired with word approximations as the primary means of multimodal communication although there were differences in production between the two vocabulary sets. Regarding the responsivity education and focused stimulation set, he produced 88% of the vocabulary pairing PCS symbols and word approximations across the three probes. Regarding the responsivity education and focused stimulation with the addition of AAC modeling set, he produced 71% in this manner but also used manual sign during 29% of the productions across the three probes. During the final maintenance probe with this vocabulary set, Karl used all three modalities of communication with 50% of the target vocabulary - PCS symbols, word approximations, and manual sign. This suggested strong multimodality communication skills across graphic, verbal, and manual modalities. In addition, Karl required less SLP prompting when producing the set of target vocabulary which included the addition of AAC modeling. As occurred during the intervention probes, nearly all of the target vocabulary was produced spontaneously during the maintenance probes across vocabulary sets.

It should be noted that Karl's AAC system was modified during the maintenance phase of the study. Shortly after the first maintenance probe, the treating SLP began training Karl in the use of a multipage flip chart consisting of PCS symbols. Between the second and final maintenance probe, the treating SLP began training Karl in the use of a voice output communication aid, the Springboard™[1]. However, the treating SLP excluded the twenty target vocabulary words from the flip chart and the Springboard™ until completion of the final maintenance probe.

Generalization. Generalization probe results were generally consistent with the treating SLP baseline, treatment, and maintenance probe results, although the target vocabulary was produced with slightly lower percentages during treatment probes, and, alternatively, the target vocabulary produced was produced with slightly higher percentages during the final maintenance probe. As can be seen in Table 8 and Figure 1, Karl did not learn to produce target vocabulary during the baseline phase, and he generalized production of both vocabulary sets across people, activities, and materials, which was maintained eight weeks after completion of intervention sessions.

During generalization probes, the special education teacher used materials found in Karl's house during sessions while the treating SLP brought materials with her from the community center. In addition, the special education teacher did not prompt Karl as often as the treating SLP so there Qualitatively, similar to the treating SLP baseline sessions, Karl used only sign to produce the target vocabulary during the baseline generalization probe. During the intervention generalization probe, also similar to the SLP intervention probe sessions, Karl modified his communication modalities to consist of primarily PCS symbols and word approximations which were spontaneously produced. Interestingly, during the maintenance phase, Karl rarely used the were differences in teaching styles. Nonetheless, differences in materials and teaching styles did not result in differences in Karl's production of target vocabulary.

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[1] Springboard™ is a product of Prentke Romich Company, 1022 Heyl Road, Wooster, Ohio 44691, www.prentrom.com

PCS symbols but produced word approximations for 100% of the target vocabulary. He also paired manual sign with 20% of the word approximations for the responsivity education and focused stimulation set and paired manual sign with 40% of the responsivity education and focused stimulation with the addition of AAC modeling set, all produced spontaneously. It should be noted the special education teacher did not use PCS symbols with Karl during sessions outside of the investigation but rather paired manual sign with verbal productions as her preferred method of multimodality communication. Therefore, it was not surprising that Karl had a preference for using manual sign over PCS symbols during interactions with the special education teacher eight weeks after intervention sessions with the PCS symbols had concluded.

Carol. Carol participated in the study from August 13, 2009 through February 24, 2010 for a period of just over six months. During that time she completed a total of thirty four sessions across assessment, baseline, intervention sessions, intervention probes, generalization, and maintenance phases of the study. There were occasional breaks from the study when Carol and/or the treating SLP were not available due to illness, holidays, and vacations. A total of twenty two probes were completed for Carol, consisting of eleven probes for each vocabulary set. Six probes were collected during the baseline phase; four probes were collected during the treatment phase; six probes were collected during the maintenance phase; and two generalization probes each were collected after the third baseline probe before treatment began, after the first round of treatment, and after the third maintenance probe for a total of six generalization probes.

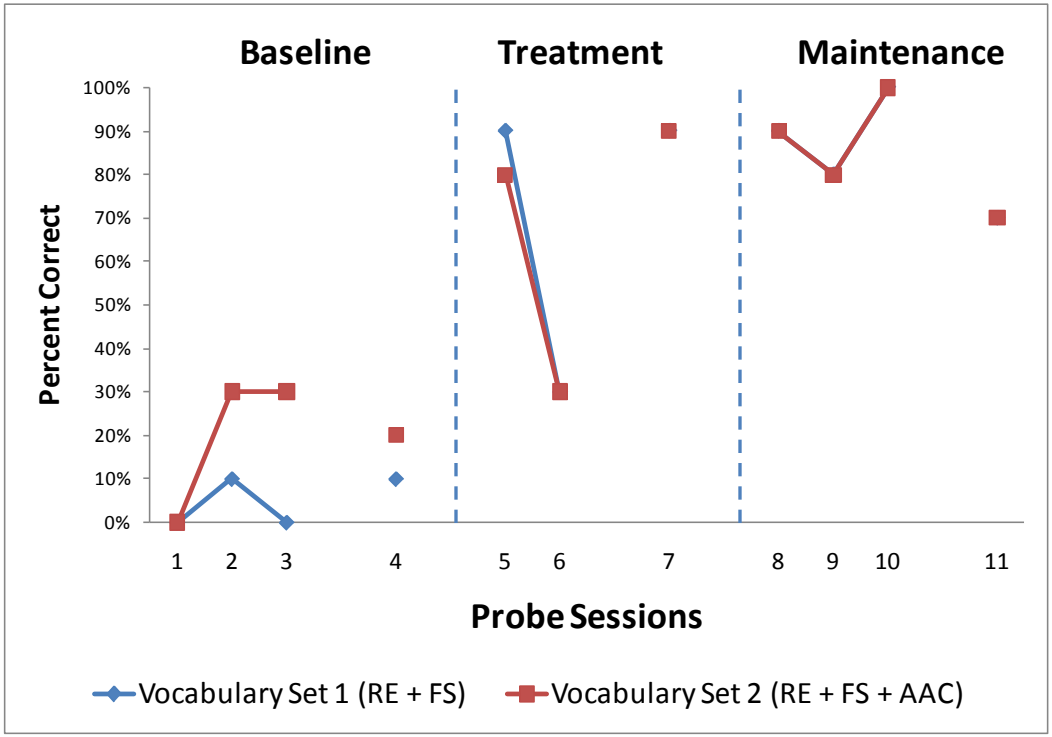
The results revealed that responsivity education and focused stimulation was highly effective in teaching target vocabulary production while responsivity education and focused stimulation with the addition of AAC modeling was effective. Production of both sets of target vocabulary was maintained eight weeks after completion of intervention and production of both sets of target vocabulary generalized across communication partners, materials, and activities. Interestingly, the approach of responsivity education and focused stimulation with the addition of AAC modeling, despite being slightly less effective, resulted in more spontaneously, rather than imitatively, produced target vocabulary in comparison to the other vocabulary set. Table 9 lists the percent of target vocabulary produced during each probe across the two vocabulary sets. Figure 2 provides a visual representation of the probe results in graphic format for Carol's percent of vocabulary produced across baseline, treatment, and maintenance phases with the two vocabulary sets.

Table 9. Percent of Target Vocabulary Produced during Carol's Probe Sessions

Treatment	Baseline Probe 1	Baseline Probe 2	Baseline Probe 3	General-ization Probe 4	Treat-ment Probe 5	General-ization Probe 6	Treat-ment Probe 7	Mainte-nance Probe 8	Mainte-nance Probe 9	Mainte-nance Probe 10	Generali-zation Probe 11
Vocabulary Set 1 (RE* and FS**)	0%	10%	0%	10%	90%	30%	90%	90%	80%	100%	70%
Vocabulary Set 2 (RE* and FS**+ AAC***)	0%	30%	30%	20%	80%	30%	90%	90%	80%	100%	70%

*RE = Responsivity Education **FS = Focused Stimulation ***AAC = AAC Modeling

Figure 2. Carol's Percent of Target Vocabulary Produced Across Baseline, Treatment, and Maintenance Phases



Baseline. Probes completed during the baseline sessions revealed that Carol produced the target vocabulary between 0% and 10% of the time using the responsivity education and focused stimulation vocabulary set and produced the target vocabulary between 0% and 30% of the time using the responsivity education and focused stimulation with the addition of AAC modeling vocabulary set. As can be seen in Table 9 and Figure 2, there was no upward trend across the sessions with the responsivity education and focused stimulation vocabulary set indicating Carol was not learning to produce the target vocabulary prior to implementation of treatment, but there was an upward trend across sessions with the responsivity education and focused stimulation with the addition of AAC modeling vocabulary set, indicating she might have been learning to produce that target vocabulary prior to implementation of treatment.

Qualitatively, Carol used multimodality communication during the initial two baseline sessions, which consisted of manual sign and word approximations. However, by the third baseline session, Carol abandoned use of manual sign and relied solely on word approximations to communicate. The word approximations were approximately 10% intelligible within a known context and consisted of CV combinations such as "me", VC combinations such as "up", and CVCV combinations such as "baby." Word approximations consisted of vowel distortions and consonants which were substituted, omitted, or distorted, contributing to poor intelligibility. Carol's sound inventory was limited to early developing consonants consisting of /m/, /y/, /b/, /d/, /w/, /n/, and /h/. In addition, during the second set of baseline sessions, Carol began producing two-word phrases such as "my house", "more house", "no baby" and "that one." During the third set of baseline sessions, Carol began producing early grammatical markers including the "ing" as in "flying" and "swinging." While Carol's speech remained severely impaired, language production skills were improving with the emergence of two word combinations and beginning morphology. Nonetheless, the investigator determined Carol would remain in the study and the treating SLP would use manual sign as the unaided form of AAC during the language intervention approach of responsivity education and focused stimulation with the addition of AAC modeling. The implications of Carol's manual sign abandonment will be discussed in the next chapter.

Intervention probes. Probes completed during the intervention phase revealed that Carol produced target vocabulary 90% of the time using the responsivity education and focused stimulation vocabulary set and produced the target vocabulary between 80% and 90% of the time using the responsivity education and focused stimulation with the addition of AAC modeling vocabulary set. As was evident in Table 9 and Figure 2, Carol very quickly learned to produce the target vocabulary with both of the intervention approaches.

Qualitatively, during the probes Carol often imitated target vocabulary production rather than spontaneously produced target vocabulary as the treating SLP often prompted Carol to "tell me ___" when Carol did not produce the target vocabulary following expectant waiting. For example, during treatment probe five, Carol imitated 78% of the target vocabulary for responsivity education and focused stimulation set, and she imitated 50% of the set with the addition of AAC modeling. During treatment probe seven, Carol imitated 55% of the responsivity education and focused stimulation set, and she imitated 44% of the set with the addition of AAC modeling. However, as can be seen by these percentages, Carol was slightly more likely to spontaneously produce the vocabulary set with the addition of AAC modeling.

Speech intelligibility continued to improve as Carol was approximately 20% intelligible within a known context during treatment probe five, which increased to approximately 33% intelligible within a known context during treatment probe seven. During probe seven, she was beginning to produce more final consonants in words, a greater variety of two syllable sequences such as "Mommy," "diaper," and "backpack," vowels were less distorted, and her inventory of sounds produced was increasing, all adding to improved intelligibility. Language skills were also improving with the emergence of three word phrases such as "I want baby", "take it off", "that dirty apple", the emergence of concepts such as negations as in "that not duck" and question asking such as in "what?" Emerging grammatical markers included production of contracted auxiliary verbs such as "I'm good."

Maintenance. Probes completed during the maintenance phase revealed that Carol produced target vocabulary between 80% and 100% of the time using both vocabulary sets. As is seen in Table 9 and Figure 2, Carol maintained production of the target vocabulary in both vocabulary sets two weeks, four weeks, and eight weeks after completion of the intervention sessions.

Qualitatively, there were slight differences between productions of the target vocabulary sets as Carol continued to produce more target vocabulary spontaneously using the responsivity education and focused stimulation with the addition of AAC modeling vocabulary set. For example, during maintenance probe nine, Carol spontaneously produced 75% of the target vocabulary in the addition of AAC modeling set compared to 50% with the other set, and during maintenance probe ten, Carol spontaneously produced 80% of the target vocabulary in the addition of AAC set compared to 50% with the other set. As such, it appeared that treatment which incorporated manual sign, and added a visual cue, facilitated a deeper learning of the target vocabulary which will be discussed in the next chapter. Speech intelligibility also improved during the maintenance phase with speech initially approximately 33% intelligible in a known context during the initial maintenance probe, improving to up to 50% intelligible during the final maintenance probe. Carol continued to produce more final consonants in words such as "up", "dog", and "read", was more accurately sequencing two and three syllable words such as "another" and "turtle", and increased her phonetic inventory to include /z/. However, intelligibility remained decreased with the substitution of /d/ for later developing consonants such as /s/, /s blends/, /j/, and /th/. Language production skills also were improving with the emergence of four and five word sentences such as "I go get purse", "no, this my purse" and "this go on board", an increase in production of wh-questions such as "where another baby? and "why baby need clothes?", and the addition of grammatical markers such as "wanna" in "I wanna read this one" and "baby wanna read." Upon completion of the study at age 35 mos., Carol presented with a mild to moderate expressive language delay at the 27 mos. to 30 mos. developmental level and a mild to moderate speech delay with spontaneous speech up to 50% intelligible, as compared to a severe verbal expressive language impairment and a severe speech impairment at the start of the study.

Generalization. Generalization probe results were consistent with baseline probes during the baseline phase. However, Carol produced a much lower percentage of target vocabulary across the generalization probes during the treatment phase in comparison to treatment probes, with 30% production during generalization probes in comparison to 80% and 90% production

during intervention probes. She produced a slighter lower percentage of target vocabulary across both generalization probes during the maintenance phase with 70% production in comparison to 80% to 100% production during the maintenance probes. Nonetheless, as evidenced in Table 9 and Figure 2, Carol generalized production of both vocabulary sets across communication partners, activities, and materials, which was maintained eight weeks after completion of the intervention sessions.

During the generalization probes, the special education teacher used materials from the community center which differed from the materials used by the treating SLP. As was also the case with Karl, the special education teacher did not prompt Carol as often as the treating SLP. In addition, she rarely requested Carol imitate target vocabulary by stating "tell me __." It appeared this was the primary reason Carol produced so few target vocabulary during the treatment phase generalization probes, as much of the target vocabulary was produced imitatively during the treating SLP treatment probes. However, by the maintenance phase, Carol was spontaneously producing the target vocabulary more often which was reflected in the results of the generalization probes. While there were differences in materials and teaching styles, Carol generalized production of target vocabulary, although not the extent that Karl generalized his target vocabulary. Discussion of why Carol did not generalize vocabulary production as successfully as Karl during the maintenance phase will follow in the next chapter.

Qualitatively, similar to the treating SLP baseline sessions, Carol abandoned manual sign during the generalization probe of the baseline phase. She was also observed to be quieter with the special education teacher during all generalization probes in comparison to the treating SLP. During the maintenance probe, she spontaneously produced 86% of the target vocabulary from the responsivity education and focused stimulation with the addition of AAC modeling set, and spontaneously produced 57% of the target vocabulary from the other set. Despite being less effective, it appeared that the addition of AAC modeling facilitated spontaneous production of the target vocabulary during all maintenance probes, suggesting a deeper learning of the vocabulary.

Mick. Mick participated in the study from October 30, 2009 through May 6, 2010 for a period of just over six months. During that time he completed a total of 47 sessions across assessment, baseline, intervention sessions, intervention probes, generalization, and maintenance phases of the investigation. There were very few breaks from the study during the six plus month period due illness, holidays, and/or vacations. A total of twenty probes were completed for Mick, consisting of ten probes for each vocabulary set. Six probes were collected during the baseline phase; eight probes were collected during the intervention phase; and two generalization probes each were collected after the third baseline probe before treatment began, and after the first and fourth rounds of intervention sessions, for a total of six generalization probes. It should be noted that unlike the other children in the study, Mick's two vocabulary sets consisted of five words each rather than ten words each. Mick was slow in processing information and demonstrated a moderate cognitive impairment. The treating SLP and I agreed that Mick would not be able to learn to produce twenty new vocabulary words within four rounds of intervention and it was determined that a total of ten new vocabulary words was a more achievable target.

The results revealed that the intervention approach of responsivity education and focused stimulation was effective in learning to produce target vocabulary, and the intervention approach of responsivity education and focused stimulation with the addition of AAC modeling was questionably effective in learning to produce target vocabulary, but Mick failed to reach the learning criterion of 80% autonomous vocabulary production during intervention with either approach following four rounds of intervention sessions. Because learning criterion was not reached within the predetermined teaching criterion of four rounds of intervention, the maintenance phase of the study was not completed. Generalization probes were generally consistent with baseline and treatment probes. Table 10 lists the percent of target vocabulary produced during each probe across vocabulary sets. Figure 3 provides a visual representation of the probe results in graphic format for Mick's percent of vocabulary produced across baseline and treatment phases with both vocabulary sets.

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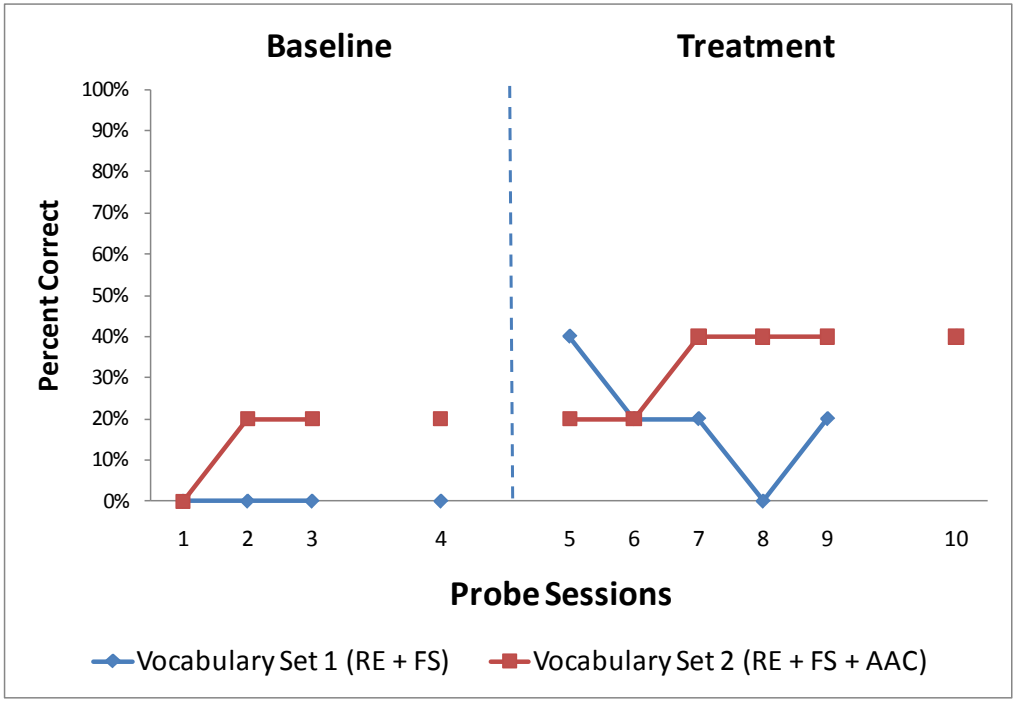
Table 10. Percent of Target Vocabulary Produced during Mick's Probe Sessions

Treatment	Baseline Probe 1	Baseline Probe 2	Baseline Probe 3	General-ization Probe 4	Treat-ment Probe 5	General-ization Probe 6	Treat-ment Probe 7	Treat-ment Probe 8	Treat-ment Probe 9	General-ization Probe 10
Vocabulary Set 1 (RE* and FS**)	0%	0%	0%	0%	40%	20%	20%	0%	20%	40%
Vocabulary Set 2 (RE* and FS**+ AAC***)	0%	20%	20%	20%	20%	20%	40%	40%	40%	40%

*RE = Responsivity Education **FS = Focused Stimulation ***AAC = AAC Modeling

Figure 3. Mick's Percent of Target Vocabulary Produced Across Baseline and Treatment Phases



Baseline. Probes completed during the baseline sessions revealed that Mick produced the target vocabulary 0% of the time for the responsivity education and focused stimulation vocabulary set and between 0% and 20% of the time for the responsivity education and focused stimulation with the addition of AAC modeling vocabulary set. As can be seen in Table 10 and Figure 3, there was no upward trend across sessions using the responsivity education and focused stimulation vocabulary set indicating Mick was not learning to produce the target vocabulary prior to implementation of treatment, but there was an upward trend across sessions using the responsivity education and focused stimulation with the addition of AAC modeling vocabulary set, suggesting Mick learned to produce the target vocabulary prior to implementation of treatment.

Qualitatively, Mick was a quiet child with a short attention span who primarily communicated with word approximations during baseline sessions. Target vocabulary produced during baseline sessions 2 and 3 was a word approximation for "bed." During the sessions, he also produced word approximations for "bye", "yah", "go", "up", "open" and "more" following prompting such as "ready, set, __ (go)," and modeling of word productions. He also shook his head "yes" and produced animal sounds such as "moo."

Intervention probes. Probes completed during the intervention phase revealed that Mick produced target vocabulary between 0% and 40% of the time using the responsivity education and focused stimulation vocabulary set and between 20% and 40% of the time using the responsivity education and focused stimulation with the addition of AAC modeling vocabulary set. As can be seen in Table 10 and Figure 3, Mick demonstrated much difficulty learning to produce the target vocabulary from both sets.

Mick remained quiet and demonstrated a variable attention span during the treatment probes with a range of three to eight activities implemented within a twenty minute session. During round two of the intervention sessions, I suggested Mick's AAC system of a multiple page communication book be simplified for the target vocabulary in the study. The target vocabulary for the two vocabulary sets was on multiple pages of the book, Mick was not using the PCS symbols in the book to communicate, and he paged through the book as a storybook rather than a communication book. The treating SLP agreed to simplify the system for the study to a single page containing both sets of target vocabulary, and also decided to focus on manual sign more than PCS symbols as Mick consistently spontaneously signed several words including "eat", "more", and "want." Following simplification of the AAC system, Mick increased the variety of modalities used to communicate the target vocabulary during the intervention probes to include PCS symbols, increased use of manual sign, and production of additional word approximations. For example, Mick added the sign "hungry" to his repertoire, pointed to the PCS symbol for "chair", and produced a word approximation for "push." Nonetheless, while qualitative changes occurred, target vocabulary production during treatment probes seven, eight and nine, completed after the modification of the AAC system, did not increase for the responsivity education and focused stimulation set, and only slightly increased for the set with the addition of AAC modeling.

Generalization. Generalization probe results were consistent with baseline probes for both vocabulary sets and with treatment probes using the responsivity and focused stimulation

with the addition of AAC modeling set, but not with treatment probes using responsivity education and focused stimulation. As can be seen in Table 10 and Figure 3, Mick did not learn to produce target vocabulary for the responsivity education and focused stimulation set at 0% production, but did appear to learn to produce target vocabulary for the responsivity education and focused stimulation with the addition of AAC modeling set during the baseline phase at 20% production. During treatment, he generalized production of both vocabulary sets across communication partners, activities, and materials, but produced more target vocabulary during the final generalization probe using responsivity education and focused stimulation at 40% in comparison to 20% during treatment probes.

The secondary SLP worked with Mick in a different room and used different materials than the treating SLP during the generalization probes. She also prompted Mick more often than the treating SLP with statements such as "tell me what you want" or questions such as "what do you want?" As a result, in general, Mick was more verbal during sessions with the secondary SLP which might have contributed to higher percentages during the final generalization probe using the responsivity education and focused stimulation set.

Qualitatively, Mick only used signs and word approximations to produce the target vocabulary and did not use PCS symbols during the generalization probes. For example, he signed "drink" and "eat" and produced word approximations for "bed", "car", and "push." He did not simultaneously produce manual sign with word approximations. It should be noted that the secondary SLP did not use PCS symbols with Mick during sessions outside of the investigation but rather paired manual sign with verbal productions as her preferred method of multimodal communication, similar to the special education teacher working with Karl and Carol. Therefore, it was not surprising that Mick would have a preference for manual sign over PCS symbols during interactions with the secondary SLP. In addition, generalization probe 10 was completed after Mick's AAC system was modified with an emphasis placed on use of manual sign versus PCS symbols.

Marty. Marty participated in the study from November 10, 2009 through April 16, 2010 for a total of just over five months. During that period of time, he completed a total of thirty sessions across assessment, baseline, intervention sessions, intervention probes, and generalization probes. As was mentioned in Chapter 3, there were occasional breaks from the study due to illness, holidays, and missed sessions. When Marty aged out of the infant/toddler program at the beginning of the treatment phase, sessions were modified from taking place on two different days during the week to taking place on the same day for parental scheduling convenience. In addition, Marty's mother ceased participation in the study during the beginning of the third round of intervention due to increased scheduling difficulties. As a result, a total of fourteen probes were completed for Marty, consisting of seven probes for each intervention approach. Six probes were collected during the baseline phase; four probes were collected during the treatment phase; and two generalization probes each were collected after the third baseline probe before treatment began, and after the first round of treatment.

The results revealed that the intervention approach of responsivity education and focused stimulation with the addition of AAC modeling was highly effective in learning target vocabulary production, with Marty reaching the learning criterion during the first round of

intervention, while the intervention approach of responsivity education and focused stimulation was ineffective. However, because the learning criterion was not demonstrated following the initial round of intervention during probe five, nor during generalization probe six, intervention continued using the responsivity education and focused stimulation with the addition of AAC modeling vocabulary set rather than moving forward to the maintenance phase. The next chapter will discuss possible factors as to why the learning criterion was not carried over from the intervention sessions to the intervention probes using responsivity education and focused stimulation with the addition of AAC modeling. In addition, it appeared that the intervention approach of responsivity education and focused stimulation was beginning to be more effective when Marty dropped out of the study. Table 11 lists the percent of target vocabulary produced during each probe across vocabulary sets. Figure 4 provides a visual representation of the probe results in graphic format for Marty's percent of vocabulary produced across baseline and treatment phases with the two vocabulary sets.

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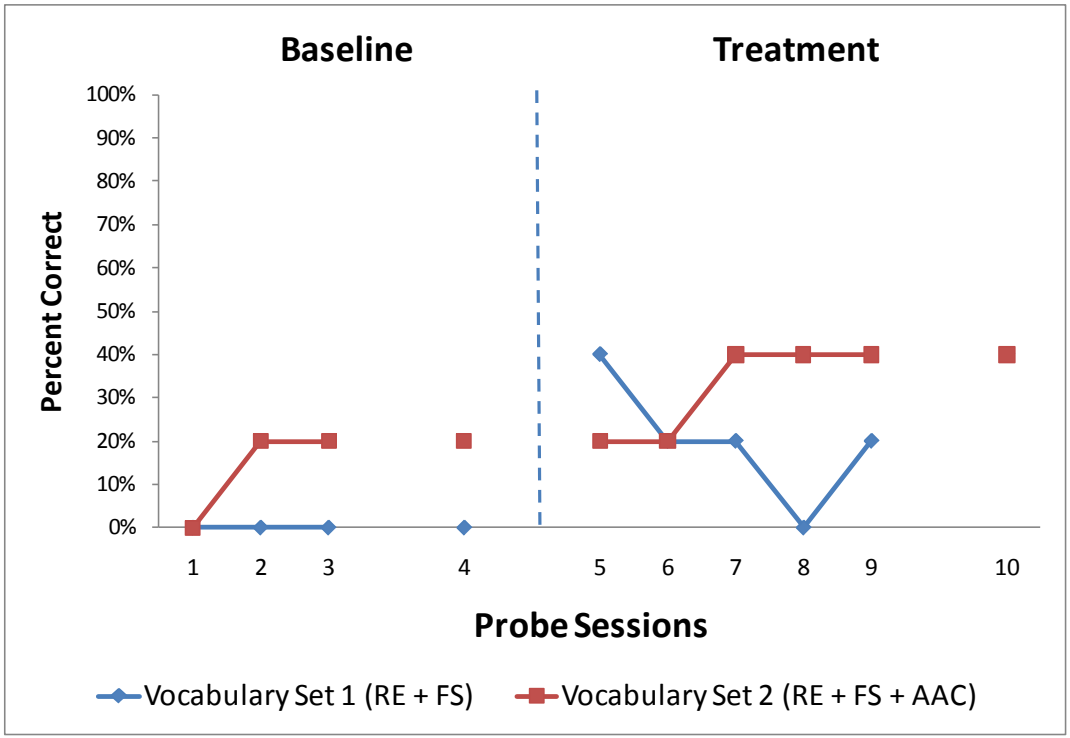
Table 11. Percent of Target Vocabulary Produced during Marty's Probe Sessions

Treatment	Baseline Probe 1	Baseline Probe 2	Baseline Probe 3	Generalization Probe 4	Treatment Probe 5	Generalization Probe 6	Treatment Probe 7
Vocabulary Set 1 (RE* and FS**)	0%	0%	10%	10%	0%	10%	30%
Vocabulary Set 2 (RE* and FS**+ AAC***)	0%	10%	10%	10%	30%	40%	50%

*RE = Responsivity Education **FS = Focused Stimulation ***AAC = AAC Modeling

Figure 4. Marty's Percent of Target Vocabulary Produced Across Baseline and Treatment Phases



Baseline. Probes completed during the baseline phase revealed that Marty produced the target vocabulary between 0% and 10% of the time using both vocabulary sets. As can be seen in Table 9 and Figure 4, there was no upward trend across the sessions, indicating Marty was not learning to produce the vocabulary prior to implementation of treatment.

Qualitatively, Marty was highly verbal and produced word approximations, words, and many environmental sounds during the initial two baseline sessions. During the third baseline sessions he used PCS symbols twice for non-target vocabulary, one time during each session. Speech was less than 10% intelligible with production of a limited number of sounds including /w/, /m/, /b/, /p/, /d/, /n/, and /g/. Most words were single syllables with the exception of "wawa" for "water", "bye-bye", "Mommy", and "baby." Most final consonants were omitted. In the area of language, Marty produced single words with emerging production of two and three-word phrases during the third baseline session including "gunna play", "that baby", "there wa-wa", "no mine", "that mine" and "that my choo-choo."

Intervention probes. Probes completed during the intervention phase revealed that Marty produced the target vocabulary between 0% and 30% of the time using the responsivity education and focused stimulation vocabulary set, and between 30% and 50% of the time using the responsivity education and focused stimulation with the addition of AAC modeling vocabulary set. As is evident in Table 11 and Figure 4, the intervention approach of responsivity education and focused stimulation with the addition of AAC modeling was more effective for learning target vocabulary but did not reach learning criterion levels during probe sessions despite reaching learning criterion levels during intervention sessions. This discrepancy will be discussed later in this chapter.

Qualitatively, Marty remained verbal and produced target vocabulary using words and word approximations. He produced target vocabulary using a PCS symbol only one time for "monkey." Target vocabulary productions were imitated more than they were spontaneously produced across vocabulary sets, as Marty imitated target vocabulary 66% of the time using the responsivity education and focused stimulation set, and imitated target vocabulary 63% of the time using the addition of AAC modeling set. In the area of speech, his sound inventory increased to include /h/, /k/, /y/, and he continued to omit final consonants. He remained less than 10% intelligible. Two syllable word productions increased to include words such as "okay", "open", "helmet", and "bubbles." In the area of language, he began producing a greater variety of two and three-word phrases such as "where go?" "open it", "no drink", "blow bubbles", "I pop it", "what that?" "my baby", and "want this."

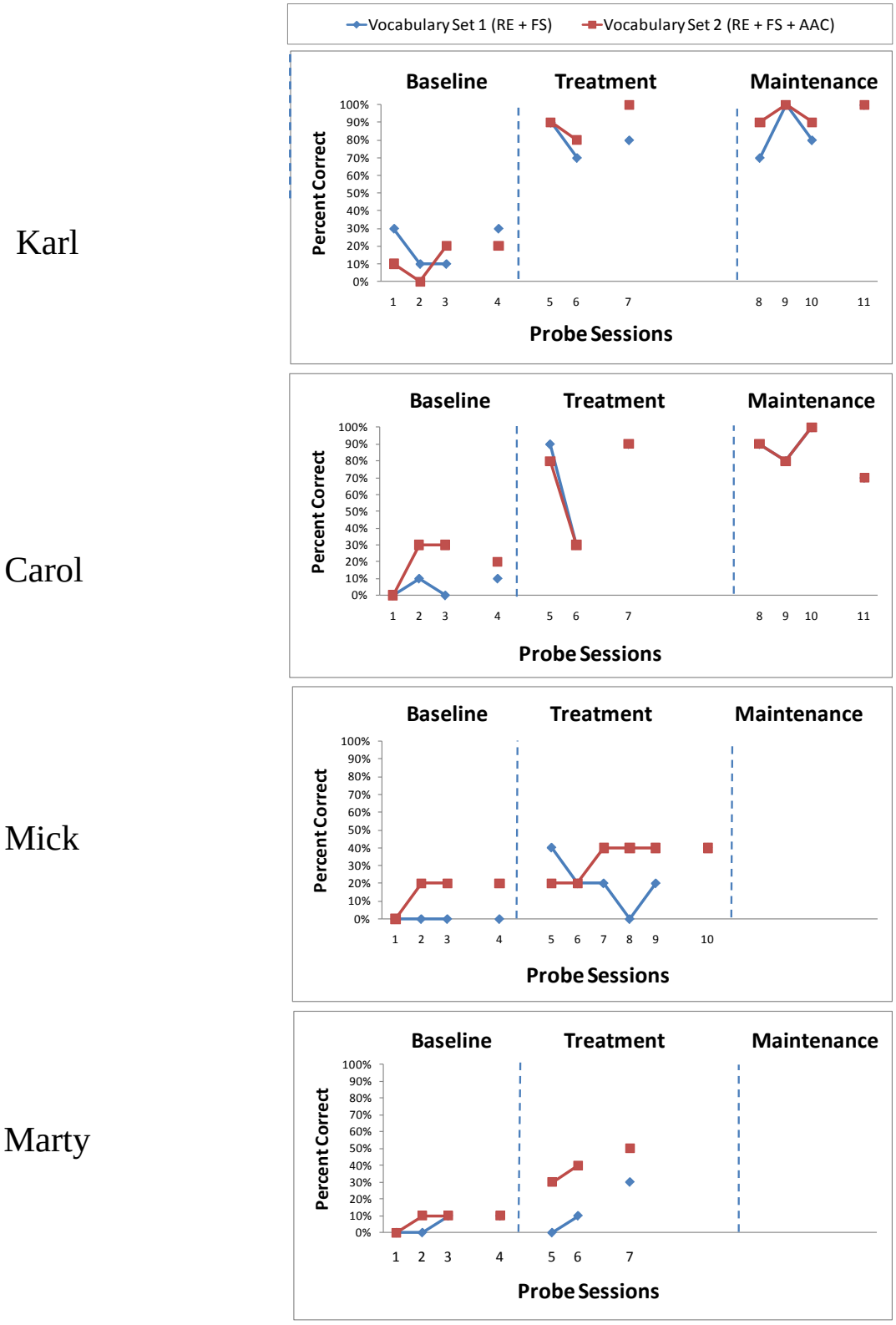
Generalization. Generalization probe results were consistent with baseline and treatment probe results. As is indicated in Table 11 and Figure 4, Marty did not learn to produce target vocabulary during the baseline phase, and the upward trend in target vocabulary production during the treatment phase was also reflected in the generalization probe results. The intervention approach of responsivity education and focused stimulation with the addition of AAC modeling was more effective during the treatment phase and Marty generalized production of that vocabulary set across communication partners, settings, activities, and materials.

During the generalization probe, which took place in Marty's bedroom, Marty's mother used materials from home and relied heavily on storybook reading activities. Her interactive style was similar to the treating SLP. The differences in settings, activities, and materials did not result in differences in Marty's production of target vocabulary.

Qualitatively, Marty was more verbal with his mother than the treating SLP. As with the treating SLP, all productions were words and word approximations with no use of PCS symbols. It should be noted that although Marty's AAC communication book was available for use in the home setting, Marty's mother did not use the flip book during communicative interactions with Marty. As such, it was not surprising that Marty produced solely words and word approximations with this mother. Interestingly, all production of target vocabulary was imitative across both vocabulary sets during both generalization probes. In the area of speech, Marty remained less than 10% intelligible during both sets of probes and produced the same sounds as during the baseline and intervention probes. He was highly verbal during the second generalization probe using the responsivity education and focused stimulation with the addition of AAC modeling set, producing many two syllable words including "happy", "water", "daddy", and "apple." In the area of language, he produced several two word phrases during this same session including "boo-boo okay", "baby hand" and "a book."

The above section described the treatment effectiveness results in detail, comparing the effectiveness of intervention approaches in learning to produce target vocabulary. Figure 5 provides a comparison of the target vocabulary produced across each phase for the four participants. The next section addresses the treatment efficiency results, that is, how quickly the participants learned to produce the target vocabulary across interventions.

Figure 5. Comparison of Percent of Target Vocabulary Produced Across Study Phases and Participants



Treatment Efficiency

Treatment efficiency was defined as how quickly participants learned to produce target vocabulary during treatment sessions with the two language intervention approaches, responsivity education and focused stimulation, and responsivity education and focused stimulation with the addition of AAC modeling. Data was collected during each treatment session to determine the number of sessions needed to reach the learning criterion of 80% autonomous production across two consecutive sessions.

The results were once again variable. Both intervention approaches were equally efficient for Karl, while responsivity education and focused stimulation was slightly more efficient for Carol. Neither intervention approach was operationally defined as efficient for Mick as he did not meet learning criterion following four rounds of intervention sessions. However, the responsivity education and focused stimulation with the addition of AAC modeling intervention resulted in higher vocabulary production during the later rounds of intervention indicating he did learn this vocabulary more quickly. Responsivity education and focused stimulation with the addition of AAC modeling was very efficient for Marty, although these results did not carryover to probe sessions, while responsivity education and focused stimulation was not efficient. Discussion of treatment efficiency will follow in the next chapter. The next section reviews the specific number of sessions completed to reach learning criterion across participants.

Number of sessions to reach learning criterion. The number of training sessions needed to reach the learning criterion was used to measure treatment efficiency (Schlosser, et al., 1998; Schlosser, 1999a, 2003). The numbers were obtained by totaling the number of intervention sessions required for each participant to produce that target vocabulary autonomously with 80% accuracy across two consecutive intervention sessions. Table 12 lists the number of training sessions needed to reach the learning criterion for both intervention approaches across participants.

Table 12. Number of Training Sessions to Reach Learning Criterion across Participants

Participants	RE and FS*	RE and FS + AAC**
Karl	4	4
Carol	5	6
Mick	Not applicable	Not applicable
Marty	Not applicable	3

*Responsivity Education and Focused Stimulation
** Responsivity Education and Focused Stimulation with the Addition of AAC Modeling

The results revealed that Karl learned to produce the target vocabulary with 80% autonomous production across two sessions very quickly, requiring only four twenty-minute intervention sessions per intervention approach. Carol also learned to produce the target vocabulary very quickly, requiring only five sessions for the responsivity education and focused stimulation

approach, and only six sessions for the responsivity education and focused stimulation with the addition of AAC modeling approach. Mick did not reach learning criterion for either intervention approach following twelve sessions of intervention for each approach. Marty learned to produce the target vocabulary more quickly than Carol or Karl using the intervention approach of responsivity education and focused stimulation with the addition of AAC modeling, requiring only three intervention sessions. It should be noted, however, that Marty's results were not maintained during intervention probes. In addition, Marty did not reach learning criterion with the responsivity education and focused stimulation approach following six intervention sessions before leaving the investigation.

The next section provides detailed descriptions of the treatment efficiency for each participant during the intervention sessions.

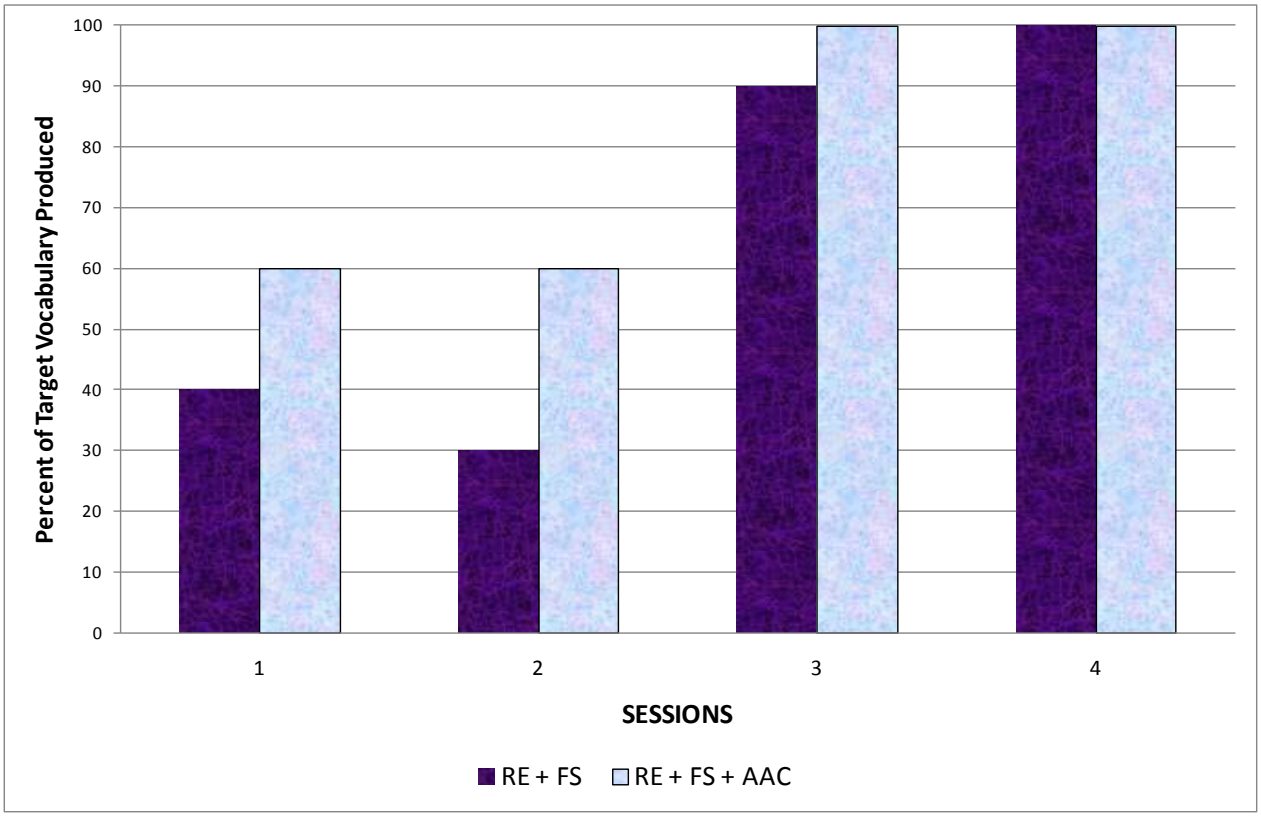
Karl. The two intervention approaches were equally efficient for Karl with learning criterion reached by session four. Table 13 lists the percent of target vocabulary produced during each intervention session across intervention approaches and Figure 6 presents the data in bar graph format.

Table 13. Karl's Percent of Target Vocabulary Produced During Treatment Sessions

Session	*RE and FS**	*RE and FS + AAC***
1	**40%**	**60%**
2	**30%**	**60%**
3	**90%**	**100%**
4	**100%**	**100%**

*Responsivity Education and Focused Stimulation
** Responsivity Education and Focused Stimulation with the Addition of AAC Modeling

Figure 6. Karl's Percent of Target Vocabulary Produced During Treatment Sessions



As can be seen in Table 13 and Figure 6, while both intervention approaches were equally efficient, Karl produced a higher percentage of target vocabulary during earlier sessions with the responsivity education and focused stimulation with the addition of AAC modeling intervention approach, suggesting the addition of AAC modeling facilitated vocabulary learning during these intervention sessions. Similar to the intervention probes, Karl used multimodality communication to produce the vocabulary for both sets, consisting of PCS symbols, manual sign, and word approximations. Spontaneous productions, versus imitative productions, increased from session one to session three, with all vocabulary produced spontaneously produced across the two intervention approaches during session four. Discussion of these results will follow in the next chapter.

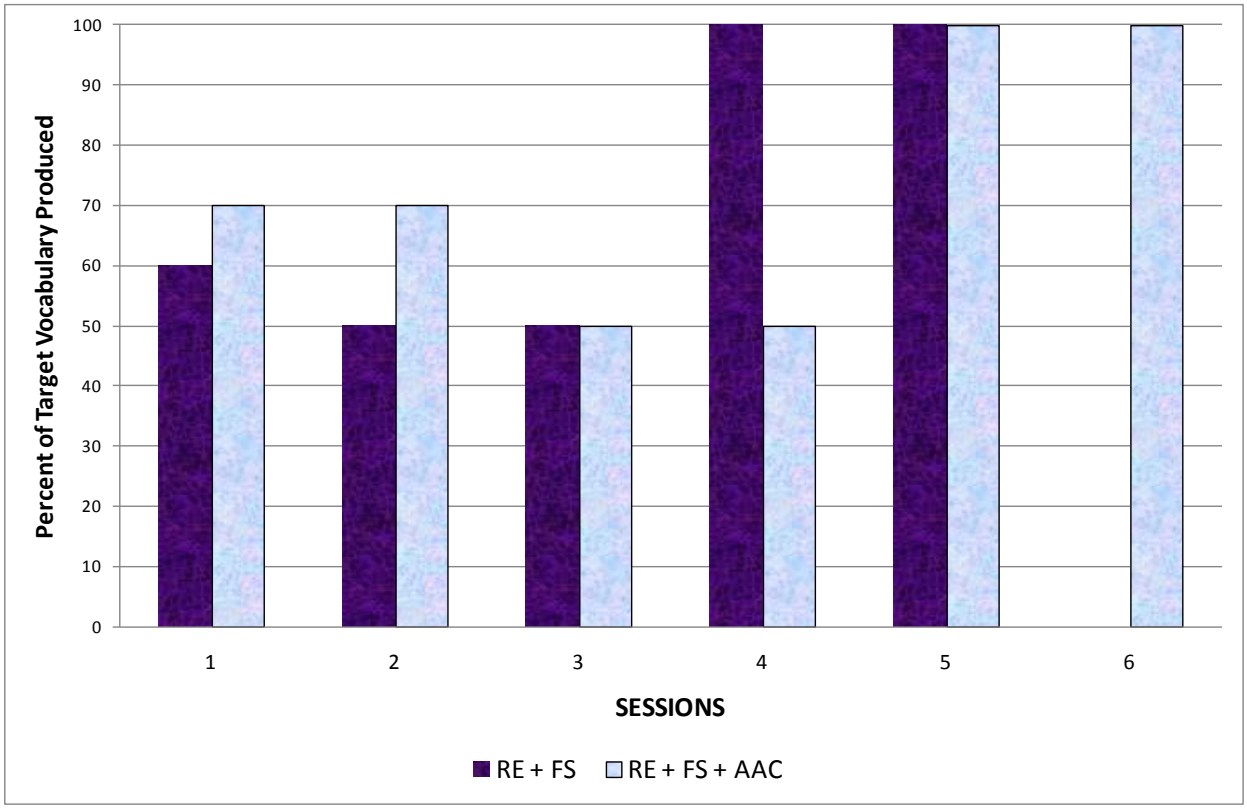
Carol. The intervention approach of responsivity education and focused stimulation was slightly more efficient for Carol with learning criterion reached by session five with that intervention approach and session six with the addition of AAC modeling intervention approach. Table 14 lists the percent of target vocabulary produced during each intervention session across intervention approaches and Figure 7 presents the data in bar graph format.

Table 14. Carol's Percent of Target Vocabulary Produced During Treatment Sessions

Session	*RE and FS**	*RE and FS + AAC***
1	**60%**	**70%**
2	**50%**	**70%**
3	**50%**	**50%**
4	**100%**	**50%**
5	**100%**	**100%**
6	**Not applicable**	**100%**

*Responsivity Education and Focused Stimulation
** Responsivity Education and Focused Stimulation with the Addition of AAC Modeling

Figure 7. Carol's Percent of Target Vocabulary Produced During Treatment Sessions



As can be seen in Table 14 and Figure 7, production of target vocabulary increased quickly across both vocabulary sets, initially slightly higher with the addition of AAC modeling but ultimately reaching learning criterion more quickly with the responsivity education and focused stimulation vocabulary set. Most vocabulary production was word approximations. During the

initial few sessions, most productions were verbal imitations. However, spontaneous vocabulary production increased with 80% spontaneous production during session five using responsivity education and focused stimulation, and 40% spontaneous production during session six using the addition of AAC modeling vocabulary set. Discussion of these results will follow in the next chapter.

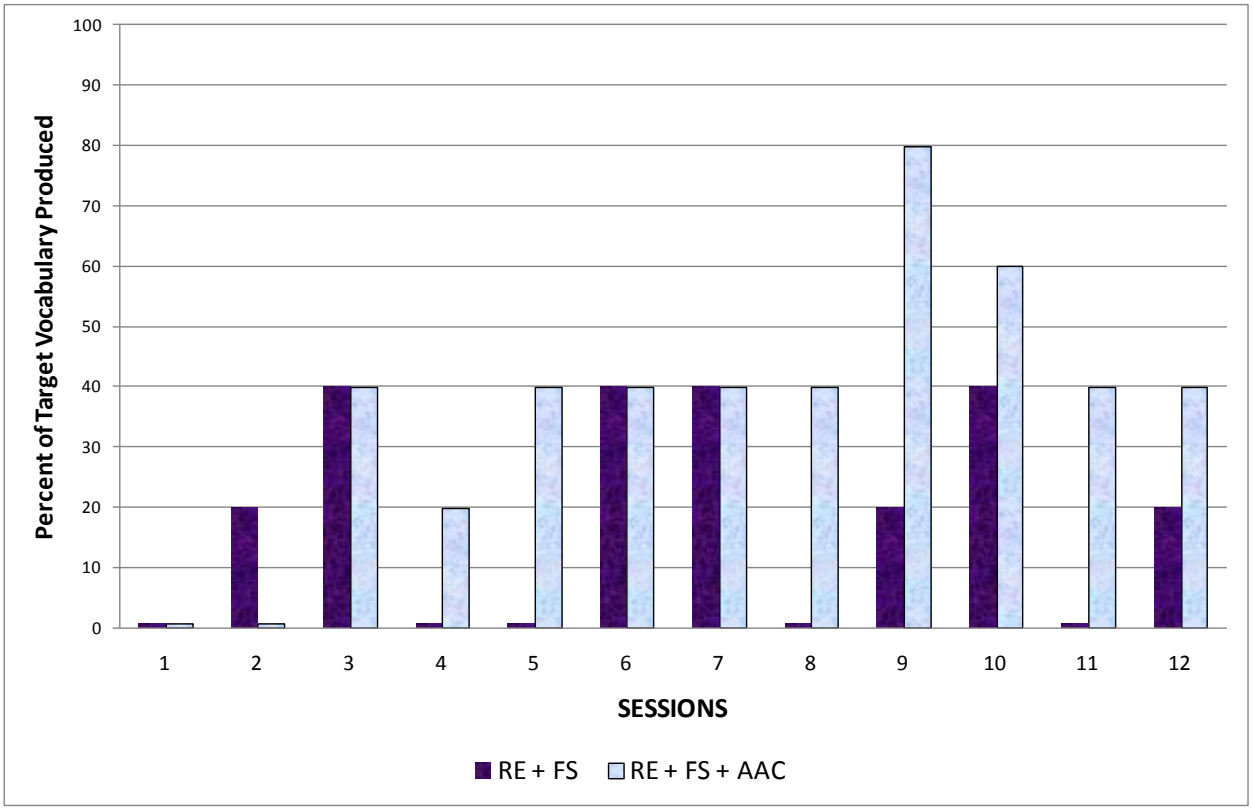
Mick. Neither intervention approach was efficient for Mick, as the learning criterion not met following completion of the maximum teaching criterion of twelve intervention sessions for each vocabulary set. Table 15 lists the percent of target vocabulary produced during each intervention session across intervention approaches and Figure 8 presents the data in bar graph format.

Table 15. Mick's Percent of Target Vocabulary Produced During Treatment Sessions

Session	*RE and FS**	*RE and FS + AAC***
1	0%	0%
2	20%	0%
3	40%	40%
4	0%	20%
5	0%	40%
6	40%	40%
7	40%	40%
8	0%	40%
9	20%	80%
10	40%	60%
11	0%	40%
12	20%	40%

*Responsivity Education and Focused Stimulation
** Responsivity Education and Focused Stimulation with the Addition of AAC Modeling

Figure 8. Mick's Percent of Target Vocabulary Produced During Treatment Sessions



As can be seen in Table 15 and Figure 8, Mick did not produce target vocabulary with more than 40% autonomous production following twelve treatment sessions using the responsivity education and focused stimulation intervention approach, indicating this intervention was not an efficient approach. Mick did reach 80% autonomous production during session nine using the

approach of responsivity education and focused stimulation with the addition of AAC modeling. However, he did not carryover consistent production to session ten, producing 60% autonomous production, which then decreased to 40% autonomous production during sessions eleven and twelve. Nonetheless, the use of AAC modeling was a comparatively more efficient intervention approach during the intervention sessions, although the approach did not result in consistent vocabulary production and the effectiveness of the approach did not carryover to probe sessions. Discussion of these results will follow in the next chapter.

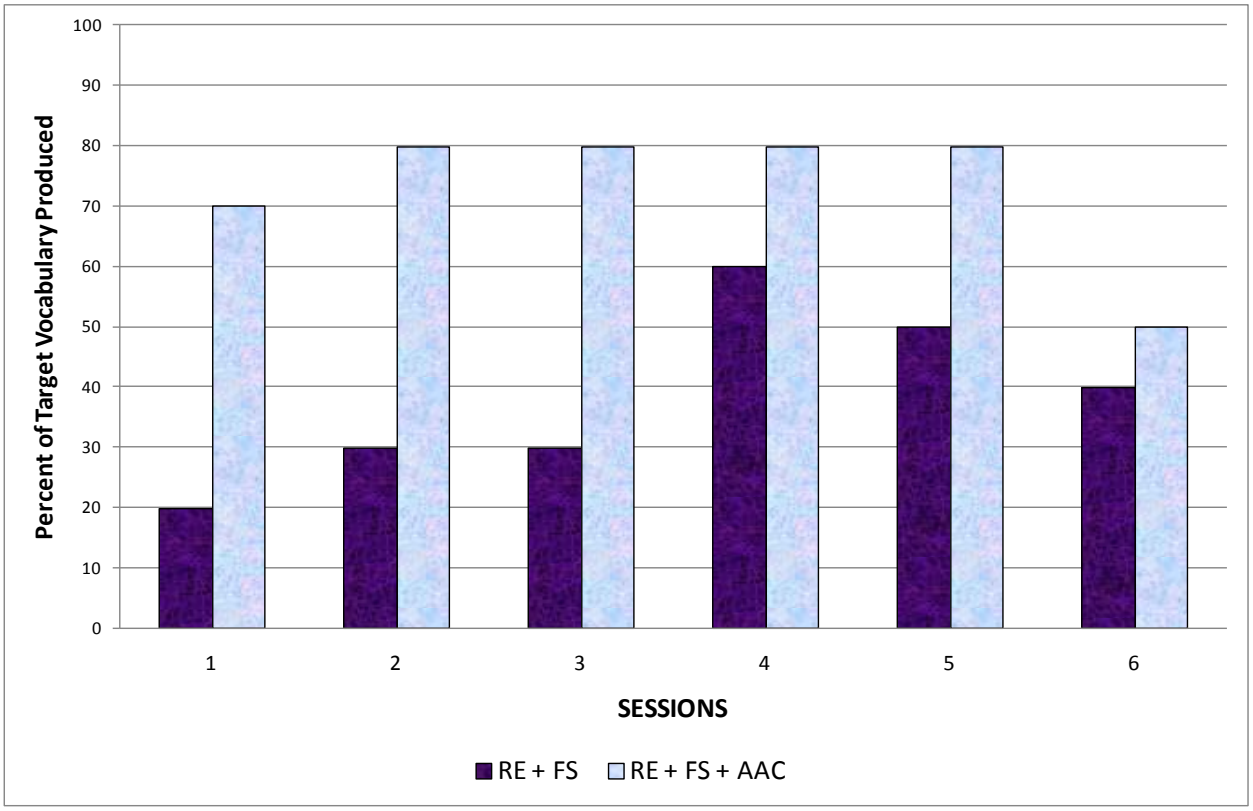
Marty. The intervention approach of responsivity education and focused stimulation with the addition of AAC modeling was highly efficient for Marty, with learning criteria reached by session three. Alternatively, the intervention approach of responsivity education and focused stimulation was not efficient for Marty as he did not reach learning criteria following completion of six intervention sessions before withdrawing from the investigation. Table 16 lists the percent of target vocabulary produced during each intervention session across intervention approaches and Figure 9 presents the data in bar graph format.

Table 16. Marty's Percent of Target Vocabulary Produced During Treatment Sessions

Session	*RE and FS**	*RE and FS + AAC***
1	**20%**	**70%**
2	**30%**	**80%**
3	**30%**	**80%**
4	**60%**	**80%**
5	**50%**	**80%**
6	**40%**	**50%**

*Responsivity Education and Focused Stimulation
** Responsivity Education and Focused Stimulation with the Addition of AAC Modeling

Figure 9. Marty's Percent of Target Vocabulary Produced During Treatment Sessions



As can be seen in Table 16 and Figure 9, the intervention approach of responsivity education and focused stimulation was not efficient with variable autonomous vocabulary production ranging from 20% to 60% production across sessions. During these sessions, Marty produced words and word approximations with the exception of use of PCS symbols for the only three syllable word on the list, "elephant." The intervention approach of responsivity education and focused stimulation with the addition of AAC modeling was highly efficient with 80% autonomous production during sessions two, three, four, and five, dropping to 50% autonomous production during session six. Marty used PCS more often with this vocabulary set during session one through session four, consisting of PCS symbol production for one to two vocabulary per session, although he solely used word approximations and words to produce target vocabulary

during session five and session six. Vocabulary production was more often imitated versus spontaneously produced across both vocabulary sets. Discussion of these results will follow in the next chapter.

Social Validity

As was stated in the previous chapter, the adults participating in the study, consisting of the treating SLPs and the adults completing generalization probes, completed a Social Validity Questionnaire to determine whether the goals of the study, the language intervention approaches, and the outcomes of the study were appropriate and reasonable for the participants (Schlosser, 1999b, 2003). Appendix Q is the Social Validity Questionnaire. The questionnaire was completed twice, prior to the study to allow for modifications to the procedures, as well as after completion of the study to determine whether the intervention approach was socially valid. The results of the questionnaire indicated the goals of the study, the language intervention approaches, and outcomes of the study were appropriate and reasonable for the participants.

The pre-study results revealed that 100% of the adults reported the goals, intervention approaches, and outcomes of the study were reasonable for the specific toddler they would be working with during the study. Therefore, no modifications were made to the study procedures.

The post-study results also revealed that 100% of the adults continued to report that the goals, intervention approaches, and outcomes of the study were reasonable for the specific toddler they worked with. Three of the five adults included comments in addition to responding "yes" to the social validity questions. The treating SLP working with Karl and Carol expressed concern about the responsivity education procedures of following the child's lead, repeating exactly what the child said, expanding the child's productions, and extending the child's productions. She stated that following the child's lead was difficult during the treatment sessions because it was challenging to produce target vocabulary ten times each during a twenty minute session without directing the child. She reported it was also difficult to repeat, expand, and extend the child's productions for the same reason. The special education teacher working with Karl and Carol expressed satisfaction with the incorporation of AAC modeling and concern about vocabulary set selection. She reported the responsivity education and focused stimulation with the addition of AAC modeling intervention approach was particularly effective with Karl because he was a visual learner. She further reported it was difficult to focus on a specific vocabulary set without using vocabulary from the other set due to similarities across vocabulary sets. She also reported it was difficult to omit proper names and pronouns when they were target vocabulary on the other vocabulary set. The treating SLP working with Mick and Marty expressed concern about the eligibility criteria for the toddlers in the study. She reported the language intervention approach of responsivity education and focused stimulation with the addition of AAC modeling would be more successful with participants who did not demonstrate cognitive impairment, and the results of the study would have more strongly supported this outcome if none of the participants demonstrated cognitive impairment. Discussion of the social validity of the study will follow in the next chapter.

Ecological Validity

As was stated in the previous chapter, the adults participating in the study, consisting of the treating SLPs and the adults completing generalization probes, also completed an Ecological Validity Questionnaire at the completion of the study to determine whether the settings, materials, and adult participation in the study could be easily implemented in typical daily practice (Schlosser, 2003). Appendix R is the Ecological Validity Questionnaire. The results of the questionnaire indicated that 100% of the adults reported the settings, materials, and adult participation could be easily implemented in typical daily practice. Four of the five adults provided additional comments. Karl and Carol's treating SLP commented on the adult instruction used in the study, stating the conflict between child directed and adult directed intervention needed to be resolved. The special education teacher working with Karl and Carol also commented on the adult instruction used in the study. She restated that the difficulty with omitting target vocabulary from the other vocabulary set needed to be resolved. Mick and Marty's treating SLP praised the ecological validity of the study, stating the design was straightforward and easy to understand. She further stated any SLP could learn the intervention approach with a session or two of training. Lastly, the secondary SLP working with Mick commented on the limitations of the probe intervention approach. She stated the probe intervention approach was challenging because the procedures required a maximum of three repetitions per target vocabulary and did not allow for modeling of the child's AAC system. Discussion of the ecological validity of the study will follow in the next chapter.

Overall, the results of the study supported the treatment effectiveness and treatment efficiency of responsivity education and focused stimulation with some participants, and the added value of AAC modeling with other participants, towards learning to produce new vocabulary. The two intervention approaches were equally highly effective and equally efficient for Karl, who also demonstrated generalized production of both target vocabularies with novel communication partners, activities and materials, and maintained target production eight weeks after intervention ended. The intervention approach of responsivity education and focused stimulation was highly effective and more efficient for Carol, while the intervention approach of responsivity education and focused stimulation with the addition of AAC modeling was also effective. She demonstrated generalized production of both target vocabularies with novel communication partners, activities and materials, and maintained target production of both vocabulary sets eight weeks after intervention ended. However, it should be noted Carol abandoned use of AAC in favor of only verbal output towards the end of the baseline phase. The intervention approach of responsivity education and focused stimulation was effective for Mick, while responsivity education and focused stimulation with the addition of AAC modeling was questionably effective. In addition, using the operational definition for efficiency, neither intervention approach was efficient as Mick failed to reach vocabulary production learning criterion during intervention with either approach, although he did produce a higher percent of vocabulary from the addition of AAC modeling vocabulary set. The intervention approach of responsivity education and focused stimulation with the addition of AAC modeling was highly effective and efficient, while responsivity education and focused stimulation was ineffective and inefficient with Marty, however he left the study prior to reaching vocabulary production learning criterion during probe sessions. The next chapter discusses the implications of these results from both the theoretical and clinical perspectives, as well as discusses limitations of the investigation and directions for future research.

CHAPTER 5 Discussion

The results of this investigation provide preliminary evidence that both the language intervention approach of responsivity education combined with focused stimulation, and the language intervention approach of responsivity education combined with focused stimulation and the addition of AAC modeling, were effective for improving the vocabulary production in children who experience significant communication difficulties and use AAC. In addition, the results of this investigation provide preliminary evidence that both language intervention approaches facilitate rapid production of vocabulary, as three of the four participants who experienced significant communication difficulties and used AAC learned to produce the vocabulary following six or fewer intervention sessions.

To explain the results, it is useful to return to the hypothesized results discussed at the end of Chapter 2. I hypothesized that responsivity education and focused stimulation would be an effective language intervention approach. I further hypothesized that the addition of AAC modeling would be both effective and more efficient in facilitating the vocabulary growth of the toddlers participating in the study. I stated that responsivity education and focused stimulation have been found to be an effective intervention approach with young children demonstrating language delays who do not use AAC, and require fewer attentional and memory resources for learning new vocabulary in comparison to AAC modeling. Alternatively, I stated input-output asymmetry is decreased with the addition of AAC modeling. I hypothesized that the added value of AAC modeling in decreasing input-output asymmetry would outweigh the additional attentional and memory resources required for learning new vocabulary with the approach. I lastly stated the importance of adult modeling, from a social constructivist theoretical perspective, would be supported by the results of the investigation.

The results of the study provide evidence supporting the importance of adult modeling, as both focused stimulation and focused stimulation with the addition of AAC modeling provided intensive modeling of the target vocabulary. However, the results of the study also suggest that the added value of decreasing input-output asymmetry for learning new vocabulary did not outweigh the additional attentional and memory resources required for learning new vocabulary, as the language intervention approach of responsivity education and focused stimulation was a more effective approach for three of the four participants, while the addition of AAC modeling resulted in increased vocabulary production for only one participant. This chapter describes why the results did not fully support the hypothesis through a discussion of possible factors which affected the effectiveness and efficiency of the two intervention approaches, the theoretical and clinical implications of the findings, limitations of the current investigation, directions for future research, and conclusions.

Effectiveness and Efficiency of the Two Intervention Approaches

There are a number of factors which could help explain why responsivity education and focused stimulation was a more effective approach for three of the four participants, why the addition of AAC modeling was a more effective approach for only one participant, and why both intervention approaches resulted in rapid vocabulary production for three of the four participants, yet was not efficient for the fourth participant. These factors are discussed below, consisting of

differences in SLP linguistic input between the intervention approaches, the context of the interventions, the importance of systematic vocabulary selection, and differences in toddler participation during the study. Included in the discussion are the conditions under which the two language intervention approaches are effective or ineffective for facilitating vocabulary production, as well as conditions under which the two language intervention approaches are efficient or inefficient for acquisition of vocabulary production. Table 17 provides a summary of the possible factors contributing to the study results including each factor, the impact of the factor, the participants impacted, and the language intervention approaches impacted. A detailed discussion of the factors listed in Table 17 follows.

Table 17. Possible Factors Contributing to Study Results

Factor	*Impact*	*Participant Impacted*	*Language Intervention Approach Impacted*
Linguistic Input During Intervention			
Input-output asymmetry	No effect	No participants	Both
Increased memory and attentional resources	Ineffective vocabulary production	Mick: -	RE and FS + AAC
Increased emphasis and stress/slower speech rate during intervention sessions	Increased vocabulary production	All participants: +	Both
Repeated vocabulary modeling	Increased vocabulary production	All participants: +	Both
Intervention Approach Context			
Facilitative language environment	Increased vocabulary production	All participants: +	Both
Play routines	Increased vocabulary production	All participants: +	Both
Child-centered approach	Increased vocabulary production	All participants: +	Both
Systematic Vocabulary Selection	Increased vocabulary production	All participants: +	Both
Toddler participation			
Cognitive impairment	Inefficient vocabulary production	Mick: -	Both
Moderately delayed receptive language	Decreased vocabulary production	Mick: - Marty: -	Both Both
Variable authentic engagement	Decreased vocabulary production	Mick: - Marty: -	Both Both
Variable learning styles	Auditory Visual Auditory and visual Kinesthetic	Carol: + Marty: + Karl: + Mick: -	RE and FS RE and FS + AAC Both Both

*RE and FS = Responsivity Education and Focused Stimulation
*RE and FS + AAC = Responsivity Education and Focused Stimulation with the Addition of AAC Modeling
* + = positive impact *- = negative impact

Linguistic input during intervention. Several hypotheses related to linguistic input during the interventions may help explain the results of the investigation. From the onset, this

investigation was based on the premise that the linguistic input children receive is critical for the early stages of language development (Tomasello 2000, 2003). It was the intention of the investigation to explore how SLP linguistic input impacted input-output asymmetry, as input-output asymmetry was exacerbated during responsivity education and focused stimulation, while input-output asymmetry was decreased during the addition of AAC modeling. The study also explored the impact of SLP linguistic input on memory and attentional resources, as increased memory and attentional resources were required during the addition of AAC modeling, while fewer memory and attentional resources were required during responsivity education and focused stimulation. In addition, the study explored differences in SLP linguistic input during intervention sessions with the two intervention approaches in comparison to the baseline phase, which consisted solely of responsivity education. Finally, the study explored the importance of repeated modeling of vocabulary during linguistic input as a strategy to facilitate vocabulary production. The next sections discuss the impact these linguistic input factors might have had on the effectiveness and efficiency of the intervention approaches.

Impact of linguistic input on input-output asymmetry. Children who use AAC for expressive communication experience an inherent asymmetry between the linguistic input they receive from communication partners and the output they are expected to produce. During typical daily interactions, these children primarily receive linguistic input from the spoken models of language surrounding them, and the communication partners of children who use AAC seldom use the child's AAC system when communicating with them. However, these children are expected to use other modes of communication, such as picture symbols, for expressive language. This is problematic for young language learners because they do not receive models using the modes of communication they are expected to use (Blockberger & Johnston, 2003; Blockberger & Sutton, 2003; Smith & Grove, 2003; Sutton, et al., 2002).

This investigation intended to explore the impact of input-output asymmetry, which assumes that the child uses unaided or aided communication for output and does not rely on speech production (Blockberger & Johnston, 2003; Blockberger & Sutton, 2003; Smith & Grove, 2003; Sutton, et al., 2002). However, the participants in this study were multimodal communicators who did not rely solely on unaided or aided AAC for communication, but rather also produced word approximations and words to communicate. In addition, the definition for coding the dependent variable, target vocabulary production, included any form of multimodal production, be it unaided, aided, or verbal production. Therefore, the issue of input-output asymmetry did not appear to be a contributing factor to the results of the study, particularly as the study evolved. Specifically, two of the four participants, Carol and Marty, primarily communicated with verbal production during the intervention phase of the study, and Carol during the maintenance phase of the study as well, thus nullifying the impact of decreasing input-output asymmetry with the addition of AAC modeling. The two other participants, Karl and Mick, used a combination of unaided manual sign and/or aided graphic symbols with word approximations/words to communicate during the intervention phase of the study, and Karl during the maintenance phase of the study, again limiting the impact of increasing input-output symmetry with the addition of AAC modeling. While the addition of AAC modeling was found to be an equally effective intervention approach with Karl who demonstrated a PND of 100%, an effective approach with Carol who demonstrated a PND of 85%, and a superior intervention approach with Marty who demonstrated a PND of 100%, the reasons for the effectiveness most likely were not related to an

increase in input-output symmetry. Rather, as will be discussed later in this chapter, the reasons for the effectiveness of the addition of AAC modeling appeared to be related to the importance of repeated vocabulary modeling and the learning styles of the participants.

In summary, increasing input-output symmetry did not appear to be a factor impacting the successful learning of target vocabulary because the participants were multimodal communicators who did not rely on unaided or aided AAC as their primary means for communication, particularly as the study evolved. Specifically, Carol and Marty became increasingly verbal following the baseline phase of the study and relied solely on verbal means to communicate, nullifying the role of input-output asymmetry. Karl and Mick, while remaining multimodal communicators, were not pure AAC users, as they also communicated with word approximations and words. The next section discusses the impact of linguistic input on memory and attentional resources, which was most salient for Mick.

Impact of linguistic input on memory and attentional resources. The complexity of an AAC system from a linguistic perspective, and the use of AAC modeling, can both impact a child's memory and attentional resources. Regarding AAC systems, children who use more complex AAC systems must expend additional working memory and declarative long term memory skills when locating specific vocabulary which may be too demanding for toddlers and children with cognitive impairments (Oxley, 2003). Children using more complex aided systems such as flip charts and communication books, rather than simple visual grids and unaided systems such as manual sign, must sustain attention for longer periods of time while scanning and selectively searching for desired AAC symbols (Wilkinson & Hennig, 2009). The use of AAC modeling also requires increased attentional resources as the child must first attend to the adult communication partner and the AAC system prior to producing communicative output using the AAC system. However, numerous studies have demonstrated that, despite the additional attentional resources required, AAC modeling is an effective technique for facilitating language development (Bruno & Trembath, 2006; Dada & Alant, 2009; Harris & Reichle, 2004), and responsivity education combined with aided AAC modeling is also an effective technique for facilitating language production (Binger, et al., 2008; Binger & Light, 2007; Binger, Maguire-Marshall, & Kent-Walsh, 2010; Kent-Walsh, et al., 2010; Romski & Sevcik, 1996; Romski, et al., 2010; Rosa-Lugo & Kent-Walsh, 2008).

In the present investigation, these attentional and memory considerations - more complex AAC systems versus less complex AAC systems, and AAC modeling – appeared to have primarily impacted the effectiveness and efficiency of the interventions for one participant, Mick, who was also the only participant to demonstrate a cognitive impairment. Regarding AAC systems, Karl used a simple visual grid for an AAC system, Carol initially used simple manual sign for an AAC system, Mick used a more complex multi-page communication book which was modified to a single page for an AAC system, and Marty used a complex multi-page flip chart for an AAC system. The complexity of the AAC systems did not appear to affect vocabulary learning for Karl, Carol, or Marty, as per Table 12, the number of training sessions needed to reach learning criterion with at least one vocabulary set ranged from three to six sessions. However, the complexity of the AAC system appeared to affect vocabulary learning with Mick as he did not meet learning criterion with either vocabulary set within the predetermined teaching criterion.

Regarding the addition of AAC modeling, three of the four participants demonstrated effective treatment outcomes with PNDs of 85% for Carol and 100% for Karl and Marty. However, the treatment approach including the addition of AAC modeling was questionably effective for Mick with a PND of 66%.

It is possible that the role of attention and memory impacted Mick primarily due to his moderate cognitive impairment and short attention span. Not surprisingly, the intervention with the addition of AAC modeling, which requires more attentional resources, was questionably effective with a PND of 66%. Alternatively, the intervention of responsivity education and focused stimulation was effective with a PND of 83%. Neither intervention approach was efficient with Mick as he was unable to reach learning criterion following twelve intervention sessions for each vocabulary set. Regarding memory resources for the AAC system, Mick's AAC system initially consisted of a multipage communication book which appeared to tax his memory resources. While Mick was interested in the communication book, and he frequently paged through the book while looking at the PCS symbols and photos, he did not understand that the book was to be used as an aided output communication device. He did not point to PCS symbols in the book unless the SLP turned to a specific page in the book and prompted him with a question such as "What toy do you want to play with?" or "What do you want to put on Mr. Potato Head – an arm or a foot?" or "Do you want juice or a cracker?" Because it was observed that Mick was not learning to use the communication book to produce the target vocabulary after the initial round of intervention, the investigator asked the SLP to simplify the need for memory resources by modifying AAC system for the investigation to a single page. In addition, the SLP further decided to simplify attentional resources by focusing on manual sign rather than using the single page communication board. While fewer memory resources were now needed to use the modified AAC system, Mick still did not learn to produce the target vocabulary during the course of the intervention phase. Specifically, following twelve intervention sessions each, Mick learned to produce a maximum of two target vocabulary with the responsivity education and focused stimulation vocabulary set, and learned to produce one target vocabulary with the addition of AAC modeling vocabulary set. These results suggest how challenging it is for toddlers with cognitive impairments who use multimodal communication, to learn to produce vocabulary. Further discussion of the impact of cognitive impairment will follow under the discussion of toddler participation.

In summary, the impact of linguistic input on attention and memory appeared to affect vocabulary learning for only one participant in the study, Mick. Mick had a moderate cognitive impairment and a short attention span, and as such, might have had greater difficulty understanding and remembering how to use a multipage communication book as an output device, and also might have had more difficulty maintaining attention with the intervention approach including AAC modeling. The next section discusses another factor which might have contributed to intervention effectiveness and efficiency, the use of increased emphasis and stress and a slower speech rate when modeling target vocabulary during intervention sessions.

Impact of increased emphasis and stress/slower speech rate on linguistic input during intervention sessions. During intervention sessions throughout the study, both SLPs commented about, and were observed by the investigator, to both increase emphasis and stress and decrease speech rate when modeling target vocabulary. This is not surprising regarding the addition of

AAC modeling, as the use of AAC modeling changes the nature of the SLPs linguistic input during intervention in several ways. When a communication partner communicates uses AAC modeling, the communication process is slowed down, and greater emphasis is placed on the vocabulary that is communicated via the AAC system (Binger & Light, 2007; Hustad & Beukelman, 2000). This slower rate of input provides the listener with greater processing time, and the additional stress that is placed on the input provided by AAC modeling may also assist the listener. Thus, the slower rate of input and the increased stress on the target vocabulary, when provided with AAC models, may have impacted the participants' acquisition of the target vocabulary. For example, if the target vocabulary was "push" during play with a miniature boy sitting a small swing, the SLP pointed to the boy who was to be pushed and sequentially pointed to the graphic symbol for "push" while simultaneously producing the spoken words "Push, push the boy" (Hunt-Berg, 1996). The AAC model of pointing to the PCS symbol and the simultaneous production of the spoken target vocabulary were produced at a slower rate than had there been no graphic symbol. There was also increased stress placed on pointing to the graphic symbol and saying the spoken label. The slower rate and stress were present during all sessions involving the intervention approach of responsivity education and focused stimulation with the addition of AAC modeling.

What might be surprising, however, is that the SLPs providing intervention during the study also demonstrated a slower speech rate and increased stress and emphasis when modeling target vocabulary using the intervention approach of responsivity education and focused stimulation, although they reported and were observed to place greater emphasis and use an even slower rate with the addition of AAC modeling. In addition, both SLPs agreed a slower speech rate and increased emphasis and stress were useful and powerful strategies for teaching vocabulary production. Therefore, it is possible that use of either intervention approach increased target vocabulary salience which, in turn, facilitated production of target vocabulary across vocabulary sets. The next section builds upon the importance of vocabulary salience by discussing the impact of repeated vocabulary modeling during intervention sessions.

Impact of repeated vocabulary modeling during linguistic input. Finally, there was a fundamental difference in linguistic input regarding the amount of vocabulary modeling during the baseline phase of the study in comparison to intervention sessions. Recall that Table 5 compares the differences between the baseline phase of the study and the intervention sessions. The only differences were that target vocabulary was repeated three times during the baseline phase and ten times during intervention sessions, in addition to modeling vocabulary using the participants AAC system with the addition of AAC modeling. Also, recall that none of the participants demonstrated gains in vocabulary production during the baseline phase of the study, as Table 6 Percent of Nonoverlapping data demonstrates. Therefore, responsivity education alone was not sufficient to improve vocabulary production. Rather, responsivity education and focused stimulation was an effective intervention approach with the exception of Marty, who benefitted from both repeated vocabulary modeling and the addition of AAC modeling. The impact of repeated vocabulary modeling during both intervention approaches appeared to facilitate increased vocabulary production across all participants.

How does the present study contribute to our research base regarding responsivity education? The baseline phase procedures were similar to procedures implemented during prior studies

which addressed responsivity education with young children. The results of those studies found improved parental responsiveness but did not address vocabulary production (Girolametto, 1988; Tannock, Girolametto & Siegal, 1992; Pennington, Thomson, James, Martin, & McNally, 2009). There are no prior studies with AAC users that incorporate only use of responsivity education. Per Table 1, prior studies with AAC users implemented either aided AAC modeling alone (Binger & Light, 2007; Bruno & Trembath, 2006; Dada & Alant, 2009; Harris & Reichle, 2004), or combined responsivity education with AAC modeling (Binger, et al., 2008; Kent-Walsh, et al., 2010; Romski, & Stevcik, 1996; Romski, et al., 2010; and Rosa-Lugo & Kent-Walsh, 2008). These studies found that AAC users demonstrated improved vocabulary comprehension, improved vocabulary production, improved two-word production, improved syntax, and/or improved turn-taking with the use of AAC modeling alone, or with the use of responsivity education combined with AAC modeling. Only the Romski, et al. (2010) study included one of three conditions similar to responsivity education alone, and vocabulary production results under this condition were found to be significantly less effective in comparison to the other two conditions which consisted of two forms of AAC modeling. Therefore, the present study provides additional evidence that responsivity education alone does not facilitate vocabulary production in toddlers who receive AAC.

How does the present study contribute to our research base regarding responsivity education and focused stimulation? None of the above studies incorporated repeated vocabulary modeling in the form of focused stimulation. However, the intervention session procedures of the present study were similar to procedures implemented during other studies which addressed responsivity education and focused stimulation in young children who did not receive or use AAC. The results of these prior studies found significantly improved vocabulary production with late talking toddlers Girolametto, et al., 1996a, 1996b), as well as increased vocabulary production, but no significant differences in standardized vocabulary tests, with toddlers demonstrating Down syndrome (Girolametto, et al., 1998). The present study provides preliminary evidence that the combination of responsivity education and repeated vocabulary modeling in the form of focused stimulation, results in improved vocabulary production with toddlers who receive AAC. In order for children to produce vocabulary, they benefit from repeated exposure to the vocabulary by communication partners. It further provides preliminary evidence that repeated vocabulary modeling during intervention sessions may be an important factor in facilitating the production of new vocabulary with this population of toddlers. It also provides additional evidence that, despite repeated vocabulary modeling, toddlers with cognitive impairment learn to produce vocabulary more slowly than children without cognitive impairment.

Context of the interventions. From a social constructivist framework, adults support a child's language development by providing timely and developmentally appropriate situations and models for language learning (Vygotsky, 1978). The context of the intervention becomes an integral piece for effective and efficient language learning. As such, in addition to the linguistic input during interventions, the context of the interventions for the current investigation may have had an impact on the findings, keeping in mind the contexts were the same for both interventions, as well as the probes throughout the study. The context of the interventions for the current investigation may be divided into three factors: (a) the use of communication techniques that were designed to create a facilitative language environment; (b) the use of play routines; and (c) the use of a child-centered approach to intervention. Each factor is discussed below.

Facilitative language environment. It is important to note that the two language intervention approaches in the study took place within a specific framework of responsivity education that included the use of a variety of communication supports which have been previously validated in the literature. As mentioned in the previous section, responsivity education has been found to be an effective framework for facilitating language production in young children with language delays when used alone (Girolametto, 1988; Tannock, et al., 1992; Pennington, et al., 2009); in combination with focused stimulation (Girolametto, 1996a, 1996b; Girolametto, et .al., 1998); and in combination with AAC modeling (Adamson, Romski, Bakeman, & Sevcik, 2010; Binger, et al., 2008; Binger & Light, 2007; Binger, et al., 2010; Kent-Walsh, et al., 2010; Romski & Sevcik, 1996; Romski, et al., 2010; Rosa-Lugo & Kent-Walsh, 2008).

The framework for responsivity education is listed in Table 5 and consists of providing a facilitative language environment including expectant waiting, allowing the child to lead, actively joining in play, playing at a face-to-face level with the child, asking many types of questions, taking similar turns to the child, imitating child verbalizations, using a variety of labels during play, expanding what the child has said, and extending the topic of conversation (Manolson, 1992). This facilitative language environment was implemented during all probe sessions, including baseline, intervention, generalization, and maintenance, with adult productions of target vocabulary limited to three productions, and with no modeling of the toddler's AAC system. The framework for responsivity education and focused stimulation is also listed in Table 5 and consists of production of each target vocabulary increased to ten times. Likewise, the framework for the addition of AAC modeling is listed in Table 5 and consists of production of each target vocabulary increased to ten times in combination with modeling the toddler's AAC system.

As stated in the previous section, the results of the study provides preliminary evidence that the combination of responsivity education and focused stimulation and the combination of responsivity education and focused stimulation with the addition of AAC modeling were more effective than use of responsivity education alone. The results also provide additional evidence that responsivity education alone is not sufficient to promote vocabulary production in toddlers who receive AAC intervention (Romski, et al., 2010). However, the results of this investigation should *not* be interpreted to mean that responsivity education is not an important component of the intervention approaches. Rather, the results of the study suggest that focused stimulation and focused stimulation with the addition of AAC modeling should be implemented within the context of responsivity education for effective and efficient vocabulary production to occur.

Play routines. In addition to a facilitative language environment, age appropriate play scenarios were used as contexts for intervention. Such play routines have been widely used as successful contexts in intervention studies with preschoolers demonstrating language disorders for teaching vocabulary and various grammatical structures (Cleave & Fey, 1997; Fey, et al., 1997; Fey, et al., 1993; Girolametto, 1988; Robertson & Ellis Weismer, 1999; Tannock, et al., 1992), and have also been used with children demonstrating severe communication disorders who use AAC (Adamson, et al., 2010; Binger & Light, 2007; Romski, et al., 2010). Within the current investigation, the play scenarios were loosely organized and largely driven by the child's

interactions and interest in toys presented by the adult communication partner. Using this type of facilitative play is designed to create a responsive environment in which the child is motivated to communicate spontaneously with the communication partner (Manolson, 1992). However, the effects of using focused stimulation and focused stimulation with the addition of AAC modeling in other contexts, such as during snack time, or during other more structured activities, is unknown. The types of play routines used in the investigation relate closely to the last consideration of the context for intervention approaches, that of child-centered intervention.

Child-centered intervention. The interventions during the investigation were primarily child-centered in nature, in contrast to adult-directed approaches in which the adult chooses and imposes the intervention activities and materials on the child to meet the specified intervention goals (McCauley & Fey, 2006). While most of the adult communication partners chose materials that would facilitate production of target vocabulary, they largely allowed the child to choose which of those materials to play with and how to play with the materials by following the child's lead and taking similar turns to the child. It should be noted that two of the adult communication partners, Carol's SLP and Mick's secondary SLP, reported that their sessions were occasionally adult-directed in an effort to include the specific target vocabulary. In addition, if needed towards the end of the twenty-minute sessions, adult communication partners would introduce specific materials in an effort to target specific vocabulary.

Taken as a whole, the results of the investigation indicate that the intervention approach of responsivity education and focused stimulation, as well as the intervention approach of responsivity education and focused stimulation with the addition of AAC modeling, are effective means for teaching vocabulary production when the approaches are provided in the following contexts: (a) a facilitative language environment consistent with the framework of responsivity education ; (b) during play routines; and (c) within a child-centered approach to intervention. Future research is required to investigate the effects of both interventions in other intervention contexts. The next section discusses the importance of systematic and careful vocabulary selection when providing intervention using either approach.

Systematic vocabulary selection. Vocabulary selection for the investigation was chosen for the purpose of communicating essential messages rather than developing language skills, as the participants understood the vocabulary receptively, but did not yet produce the vocabulary. This type of vocabulary is referred to as coverage vocabulary, as the vocabulary is essential for communicating the individual's basic needs (Beukelman & Mirenda, 2005; Vanderheiden & Kelso, 1987). In addition, the vocabulary consisted of core vocabulary which encourages use of two- and three- word combinations, including "more" and "no", prepositions such as "in", and actions such as "want", if the toddlers were not yet producing this core vocabulary (Banajee, Decarlo, & Stricklin, 2003), as well as fringe vocabulary specific to play activities, such as "hot" and "boy" (Beukelman & Mirenda, 2005). Finally, all vocabulary was chosen from words frequently produced by typically developing and late talking toddlers (Rescorla, Alley, & Christine, 2001).

The careful, systematic selection of vocabulary may have contributed to effective vocabulary production across the four participants. Recall that each participant's mother completed the MacArthur-Bates Communicative Development Inventories, Second Edition (Fenson, et al.,

2007) prior to completion of an assessment. The results of the MacArthur-Bates CDI were used to identify vocabulary for the assessment that the toddlers understood receptively but did not produce through natural speech, manual sign, or PCS line drawings. Next, during the assessment, PCS line drawings were placed in front of the participants, who were asked to "tell me what this is with your words", followed by "tell me what this is with your hands." Lastly, the PCS line drawings were placed in front of the participant and SLP asked the participant to "tell me (vocabulary word) with your pictures," requiring the participant to point directly to the PCS pictures. The participant needed to obtain a production score of 0% across natural speech, manual sign, and PCS line drawings for the pairs of matched unique, equivalent, and functionally independent vocabulary to be included in the two sets of targeted vocabulary for the study.

The investigator then created pairs of matched unique, equivalent, and functionally independent vocabulary for each participant. These lists were prioritized based on combinations of core and fringe vocabulary that would commonly be produced by same-age, typically developing peers within the context of therapy room play activities. The treating SLPs chose ten sets of vocabulary pairs from the prioritized lists to be used with Karl, Carol, and Marty, and five sets of vocabulary pairs from the prioritized list to be used with Mick.

In summary, vocabulary selection required a careful receptive language analysis and systematic vocabulary choices which consisted of developmentally appropriate target vocabulary. This process of systematic vocabulary selection appeared to facilitate increased vocabulary production for all participants across both language intervention approaches. The next section addresses how toddler participation during the study may have impacted vocabulary production and production efficiency.

Toddler Participation. The four toddlers participating in the investigation demonstrated individual differences in the areas of cognition, receptive language skills, authentic participation, and learning styles. Factors which might have contributed to either less efficient vocabulary production, or decreased production of target vocabulary during probe sessions, include moderate cognitive impairment in the case of Mick, moderately delayed receptive language skills in the cases of Mick and Marty, and variable authentic participation in the cases of Mick and Marty. In addition, variable learning styles across the participants might have contributed to more effective vocabulary production with one intervention approach over the other. The next sections discuss the impact of these four factors in greater detail.

Cognitive impairment. One participant in the study, Mick, demonstrated a moderate cognitive impairment. The results of the study revealed that neither intervention approach was efficient as Mick did not reach the learning criterion of 80% production of target vocabulary across two sessions after completing the predetermined teaching criterion of four rounds of treatment, for a total of twelve treatment sessions per vocabulary set. In fact, Mick learned to produce only two words from the responsivity education and focused stimulation vocabulary set, and only one word from the addition of AAC modeling vocabulary set, after twelve sessions of intervention each. It is possible that Mick's cognitive impairment, in combination with his short attention span, contributed to inefficient vocabulary production.

Several studies have demonstrated that toddlers with intellectual disabilities may benefit from more intense and prolonged treatment when learning to intentionally communicate and produce early vocabulary (Fey, et al., 2006; Warren, et al., 2008; Yoder & Warren, 2002). These studies incorporated the use of responsivity education and prelinguistic milieu teaching, which was labeled RPMT. Responsivity education procedures were similar to It Takes Two to Talk – The Hanen Program for Parents (Manolson, 1992). Prelinguistic milieu teaching consisted of arranging the environment to increase opportunities for communication, following the child's attentional lead, building social routines in which the child and adult play predictable roles, and using prompts such as time delays and elicitation to encourage communicative interactions and verbal productions (Yoder & Warren, 2002). The Yoder and Warren (2002) training consisted of four weekly sessions for 20 minutes each over six months. The results revealed improved parental communicative interactions and increased toddler verbalizations, but only in those toddlers who were not verbal at the beginning of the study and did not have Down syndrome.

Fey, et al. (2006) replicated Yoder & Warren (2002) with several procedural changes which included solely using toddlers who were not verbal at the beginning of the study. The RPMT intervention was again provided four times weekly for 20 minutes over six months. The results revealed significant improvements in use of intentional communication but not in verbal production. Recommendations included delivering services at a higher rate of intensity level to increase intervention effectiveness.

Warren, et al. (2008) extended the Fey, et al. (2006) study by collecting longitudinal data six months and twelve months after the conclusion of the initial treatment condition. The results revealed no long term benefit from the intervention and no significant differences between the treatment and non-treatment groups in the areas of intentional communication and verbal production. Recommendations included further investigation of RPMT at higher intensity levels and for longer periods of time.

While the three studies above did not focus on toddlers who received AAC, the participants in the studies were similar to Mick in age, level of cognitive impairment, and communicative status receptively and expressively. The intervention in the present study was provided twice weekly for 20 minutes over six months, which was less frequent, but of similar duration, to the above studies. The interventions in all studies included responsivity education. However, rather than prelinguistic milieu teaching, the interventions in the present study consisted of focused stimulation and focused stimulation with the addition of AAC modeling. Despite these differences, the present study provides further evidence that, for toddlers with moderate cognitive impairment, intervention may need to be more intense and of longer duration than the present study to result in efficient production of target vocabulary, even with the introduction of focused stimulation and the addition of AAC modeling.

Moderately delayed receptive language skills. It is interesting that the two toddlers who produced a high percentage of target vocabulary during treatment probes across both intervention approaches, Karl and Carol, also demonstrated age appropriate receptive language skills. Alternatively, the two participants who produced lower percentages of target vocabulary during treatment probes across intervention approaches, Mick and Marty, demonstrated moderate receptive language delays. Karl and Carol produced between 70% and 90% of target vocabulary

during treatment probes across interventions while Mick and Marty produced between 0% and 50% of target vocabulary during treatment probes across interventions. Although Mick and Marty demonstrated receptive knowledge of the target vocabulary chosen for each vocabulary set, overall receptive language growth was slower in comparison to Karl and Carol. It is possible that the moderate receptive delays were a factor impacting both participants' abilities to produce higher percentages of target vocabulary during probe sessions.

Regarding Mick, it is possible that the combination of a moderate receptive language delay and a moderate cognitive impairment and a shorter attention span, as discussed in previous sections, required a more intense and lengthier period of exposure to facilitate production of target vocabulary, then was provided in the current investigation. This issue will be considered under the future directions section of the chapter.

Regarding Marty, recall that responsivity education and focused stimulation with the addition of AAC modeling was a highly effective intervention as evidenced by a PND of 100%. Alternatively, responsivity education and focused stimulation was an ineffective intervention as evidenced by a PND of 33%. In addition, the learning criteria of 80% production of target vocabulary across two sessions was met following only three sessions using the vocabulary set associated with the addition of AAC modeling. However, production of this same target vocabulary during probe sessions ranged between 30% and 50%. Why was there such a discrepancy between what appeared to be an effective and efficient intervention approach and production of vocabulary during probe sessions? It is possible that the receptive language delay, in combination with difficulties with auditory processing, impacted Marty's ability to carryover target vocabulary production to probe sessions. It appeared that Marty benefitted from the combination of repeated vocabulary modeling and visual input from the PCS symbols which was found in AAC modeling. It is possible that, while this intervention was highly effective, because of receptive language delay and auditory processing difficulties, vocabulary production had not yet stabilized following two rounds of intervention. It is possible Marty would have benefitted from additional rounds of intervention sessions but, unfortunately, left the study following two rounds of intervention. It is possible that, like Mick, additional intervention sessions were needed to achieve higher percentages of vocabulary production during probe sessions. The issue of participant attrition will be further discussed in the limitations section of the chapter.

In summary, Mick and Marty's moderate receptive language delays might have been a factor which impacted their ability to produce target vocabulary during probe sessions. Another difference between Mick and Marty, in comparison to Karl and Carol, was consistency of authentic participation during probe sessions. The next section addresses the impact of variable authentic participation on vocabulary production skills during probe sessions.

Variable authentic participation. In is interesting that the investigator observed Karl and Carol to be fairly consistently and authentically participating with adult communication partners throughout all phases of the study. However, Mick and Marty demonstrated varying levels of authentic participation when completing intervention and probe sessions, which might have impacted the results of the study.

What is authentic participation? Nelson (2007) describes the importance that authentic participation plays in facilitating word production in toddlers. Authentic participation is a social, pragmatic perspective in which children use their emerging biologically enabled skills, including locomotor skills, categorical skills, verbal skills, imitative skills, gestural skills, play skills, and memorial skills, to advance their experience and find and share its meaning with others. Nelson (2007) states that children seek to match their understanding of a situation with the words used by others in that situation resulting in word production. This process cannot effectively occur if the child is not authentically engaged in social interactions with the communication partner.

Regarding Mick, the investigator observed increased focus and a higher level of authentic participation during several intervention sessions when Mick completed an occupational therapy session with a specific occupational therapist directly prior to the SLP session. During these sessions Mick was more verbal and more imitative. Alternatively, there was a period of several weeks when Mick was learning to walk, and his ability to focus and engage authentically during sessions decreased. During these sessions he was less verbal and rarely imitated the SLP. While Mick participated in the study for just over six months, which allowed for a leveling of variable periods of focus and authentic engagement, nonetheless, if probes were collected during these specific periods, it is possible Mick produced more target vocabulary or less target vocabulary during the sessions due to a combination of focus, authentic participation, and intervention approaches, rather than only due to the intervention approaches.

Regarding Marty, the investigator and SLP observed that Marty became less authentically participative during intervention sessions as time progressed in the study, which was most evident during the second round of intervention. His behavior was less compliant, and he was less verbal. Both the investigator and the SLP were concerned that factors outside of the intervention sessions were impacting Marty's decreased engagement, including issues in the home and preschool setting. It is possible that decreased authentic engagement during later sessions resulted in less rapid progress towards producing target vocabulary during both intervention and probe sessions.

In summary, Mick and Marty demonstrated varying levels of authentic participation during the course of the investigation. There were periods when Mick was both more engaged and less engaged which affected amount of verbalization and imitation. This variability might have contributed to decreased vocabulary production during probe sessions beyond the impact of intervention approaches. Marty was observed to be less engaged during the second round of intervention in comparison to the baseline phase and initial round of intervention. This variability might also have impacted Marty's progress towards producing target vocabulary during both intervention and probe sessions. In addition to variations in authentic participation, there were also toddler differences in learning styles. The next section reviews the possible impact of learning styles on the effectiveness and efficiency of the intervention approach of responsivity education and focused stimulation with the addition of AAC modeling.

Variable learning styles. This section of the chapter has discussed individual differences between the four participants which might have contributed to the above study results, including differences in cognition, receptive language skills, and consistency of authentic participation. A fourth factor should also be considered, related to learning styles. SLPs and special education

teachers recognize that young children do not all respond equally well to the same intervention methods, and therefore, it is possible learning could be enhanced by providing intervention in a style that matches the child's learning preferences.

Learning styles was first cited in the literature more than 50 years ago (Thelen, 1954) although there remains little agreement about a precise definition (Leite, Svinicki, & Shi, 2010). For this investigation, learning styles is informed by the VARK definition, which describes four different perceptual preferences for the input of information: visual (V), aural (A), read/write (R), and kinesthetic (K). The VARK definition was influenced by research in neurolinguistic programming, suggesting that individuals receive information through sensory modalities and have sensory modality preferences (Leite, et al., 2010). According to VARK, visual individuals prefer to learn information presented in charts, graphs, and other symbolic devices instead of words, which would include manual sign and PCS symbols and would be found in the intervention approach with the addition of AAC modeling. Aural individuals prefer to learn from spoken lessons and talking, as would be found in intervention approach of responsivity education and focused stimulation. Read/write individuals prefer to learn from printed text which is unrelated to the investigation. Kinesthetic individuals prefer to learn through direct practice, which may also involve the other perceptual modes (Fleming, 1995; Fleming & Mills, 1992).

How does the VARK definition of learning styles apply to the results of the investigation? Regarding Carol, the addition of AAC modeling was effective with a PND of 85%, while the use of responsivity education and focused stimulation was very effective with a PND of 100%. In the area of efficiency, the addition of AAC modeling was slightly less efficient, as it took Carol five sessions to reach learning criterion with the responsivity education and focused stimulation approach, while it took six sessions to reach learning criterion with the addition of AAC modeling. Carol was observed to be an aural learner as evidenced by her frequent verbal imitation of SLP productions and her rapid abandonment of manual sign as soon as verbal production capabilities increased sufficiently without need for reliance on manual sign. As an aural learner, it would make sense that AAC modeling, in the form of manual signing, was a less effective strategy for learning vocabulary production, although it was not ineffective. During the maintenance phase of the study, however, it should be noted that Carol consistently produced more target vocabulary spontaneously, versus imitatively, when using the vocabulary set with the addition of AAC modeling. This suggested that although Carol demonstrated a preference for aural learning, perhaps the addition of visual cueing, which also included production of target vocabulary with an even slower rate and increased stress and emphasis, facilitated a deeper learning of the vocabulary and resulted in increased spontaneous production of the target vocabulary.

Learning style preferences may have also impacted the effectiveness of the interventions with Marty. The addition of AAC modeling for Marty was a very effective intervention with a PND of 100%, while the use of responsivity education and focused stimulation was an ineffective intervention with a PND of 33%. The addition of AAC modeling was also highly efficient for Marty, as he reached learning criterion in only three sessions, while not reaching learning criterion using responsivity education and focused stimulation prior to leaving the study. Marty was observed to be a poor aural learner and a stronger visual learner as indicated by poor

phonological skills and verbal apraxia. For example, Marty's sound system was limited to early developing phonemes, he had difficulty initiating and sequencing sounds and syllables in words, and he frequently presented with inaccurate verbal imitation skills when attempting to verbally imitate based solely on auditory input. Alternatively, verbal imitation skills were more accurate when paired with a PCS symbol or another visual cue such as a picture in a book or an object during play. As a stronger visual learner, it would make sense that AAC modeling with PCS symbols was an effective strategy to help Marty initiate and sequence sounds and syllables in words during verbal production.

Learning style preferences did not seem to impact Karl as much as Carol and Marty. The interventions were equally effective with Karl, who obtained a PND of 100% for both interventions. The interventions were also equally efficient, with four intervention sessions completed to reach learning criterion for both vocabulary sets. Karl was not observed to be either a strongly visual or a strongly aural learner, but rather demonstrated a multi-perceptual learning style throughout the study, appearing equally comfortable learning with either visual or aural input. Regarding output, multimodal communication was adapted to the preferences of his communication partner. For example, because his SLP prompted him to "tell me with your pictures," he often times produced target vocabulary by pairing PCS symbols with vocalizations. Alternatively, because his special education teacher used manual sign to produce vocabulary, he often times paired manual sign with vocalizations to produce target vocabulary, even though the PCS symbols were directly in front of him. Regardless of the type of input, Karl increasingly spontaneously produced the target vocabulary as both intervention and probe sessions progressed during the investigation, suggesting a deep learning of the target vocabulary. It is possible that having a more well-rounded learning style facilitated this deeper level of learning and contributed to equally effective and efficient production of both vocabulary sets.

Learning style preferences did not seem to impact Mick as much as Carol and Marty either. Mick appeared to have a preference for kinesthetic learning as he preferred to learn through direct practice which also involved other perceptual modes. His poor attention span and slow auditory processing precluded him from being an auditory learner, and his visual acuity difficulties, with need for prescription lenses, impacted his ability to learn visually. However, he enjoyed participating in activities and established routines as a method for learning. It is possible that, as cognitive skills matured, learning style preferences would change. However, because neither auditory nor visual learning styles was a strength during the study, it is possible that a factor contributing to Mick not reaching learning criterion was that the intervention approaches were not sufficiently suited to his learning style and the approaches needed further adaptation.

In summary, learning styles might have affected participant abilities to learn to produce target vocabulary effectively and efficiently. Carol was an auditory learner and benefitted from responsivity education and focused stimulation, which complimented an auditory learning style. Marty was a visual learner and benefitted from responsivity education and focused stimulation with the addition of AAC modeling, which complimented a visual learning style. Karl was equally comfortable with auditory and visual learning, and benefitted equally from each language intervention approach. Finally, Mick was a kinesthetic learner and did not benefit from either language intervention approach, with neither of the intervention approaches complementing a kinesthetic learning style without further adaptations.

Summary of factors contributing to study results. In summary, there are a number of factors which might have contributed to the results of the study, all of which are listed in Table 17. First, several factors regarding SLP linguistic input during the interventions might have contributed to the effective production of target vocabulary. Input-output asymmetry was not found to be a factor contributing to the study results. Two participants primarily produced verbal output during intervention and later phases, while the two other participants were multimodal communicators who did not primarily use aided communication for output, thus neutralizing the impact of asymmetry. Increasing attention and memory demands with the addition of AAC modeling appeared to only impact Mick, as he demonstrated both a moderate cognitive impairment and a short attention span. A slower rate of input in combination with greater emphasis/stress placed on PCS symbols and/or manual sign, as well as spoken production of the target vocabulary during both interventions, may have facilitated target vocabulary production for all participants. Finally, repeated vocabulary modeling provided during focused stimulations across both intervention approaches may also have facilitated target vocabulary production across participants.

The context of the intervention approaches is another factor which might have contributed to increased vocabulary production. Both intervention approaches were effective for teaching vocabulary production across participants when the approaches were provided within the context of a facilitative language environment, during play routines, and when incorporating a child-centered approach to intervention.

Systematic vocabulary selection is also a factor which might have contributed to increased vocabulary production for all participants across intervention approaches. Vocabulary was chosen based upon a careful receptive language analysis, using developmentally appropriate vocabulary targets, and incorporating systematic choices across intervention approaches.

Finally, variations in toddler participation might have contributed to the efficiency and percent of target vocabulary produced based upon individual differences in cognition, receptive language, authentic participation, and learning styles. Mick demonstrated a moderate cognitive impairment which might have negatively impacted ability to efficiently produce vocabulary. Mick and Marty demonstrated moderate receptive language delays and varying levels of authentic participation during the course of the investigation, which also might have negatively impacted vocabulary learning. Regarding learning styles, Carol was an auditory learner and benefitted from responsivity education and focused stimulation, which complimented an auditory learning style. Marty was a visual learner and benefitted from responsivity education and focused stimulation with the addition of AAC modeling, which complimented a visual learning style. Karl was equally comfortable with auditory and visual learning, and benefitted equally from each language intervention approach. Mick was a kinesthetic learner and did not benefit from either language intervention approach, with neither intervention approaches complementing a kinesthetic learning style without further adaptations.

Taken as a whole, the factors which might have contributed to successful intervention outcomes resulting in effective and efficient target vocabulary production included: a) increased emphasis/stress, and using a slower speech rate, during SLP linguistic input, b) incorporating

repeated vocabulary modeling during intervention in multiple representation modalities, c) providing a facilitative language environment which includes play routines and a child-centered approach, d) systematically selecting target vocabulary, e) consistent authentic participation between the participant and adult communication partner, and f) selecting an intervention approach that is compatible with the toddler's learning style. If the participant demonstrates a shorter attention span, a cognitive impairment and/or delayed receptive language skills, it is possible a more intense intervention schedule for a longer duration is needed for successful intervention outcomes.

While it is important that the participants demonstrate effective and efficient vocabulary production with the treating SLP, it is also important that vocabulary production generalizes outside of the treatment setting. The present study investigated the effects of AAC intervention in a real world setting using two SLPs employed in community settings, which increases the likelihood that the results will be generalized to actual clinical and educational practice under various circumstances (Calculator, 1999; Light, 1999). The next section discusses the generalization of the interventions across circumstances including differing adults, settings, and materials.

Generalization of the Interventions

Continuous generalization probes were collected during all phases of the study rather than after completion of intervention, which is particularly useful for studying generalization processes (Kennedy, 2005; Tawney & Gast, 1984). Continuous generalization probes represent the most sophisticated of design options available for unequivocal demonstration of experimental control and generalization effectiveness, yet this design option has been severely underutilized in the AAC intervention literature (Schlosser, 2003; Schlosser & Lee, 2000). In the present study, continuous generalization probes were collected after completion of the three baseline probes, after the first intervention probe, and after the final maintenance probe. In the case of Mick, a generalization probe was also collected after the fourth intervention probe, and in the cases of Mick and Marty, there were no maintenance probes and therefore, no generalization probes obtained after the maintenance probes.

The results of the generalization probes are graphically depicted in Figure 5 and revealed that, during the baseline phase, all of the participants demonstrated generalization results consistent with baseline results across interventions. During the intervention phase, three of the four participants demonstrated generalization probe results either slightly higher, the same, or slightly lower – but higher than baseline probe results – in comparison to intervention probe results across interventions. During the maintenance phase, one participant obtained similar results, and the other slightly lower results, in comparison to maintenance probe results across interventions. With the exception of Carol, generalization of target vocabulary production was demonstrated across three of the four participants using different adult partners, different materials, and different rooms/settings, although Karl was seen in the same room for generalization probes. Therefore, the effectiveness and efficiency of the two intervention approaches was continuously generalized within three of four participants across adults, materials and activities, and settings.

Regarding Carol, the treating SLP prompted Carol more than the special education teacher, and a higher percentage of Carol's target vocabulary productions with the SLP were imitative following prompts to "say __." While there was a large gap in probe comparisons during the intervention phase, 80% to 90% for the intervention probe versus 30% for the generalization probe, this gap decreased during the maintenance phase with Carol obtaining 100% production for the maintenance probe and 70% production for the generalization probe across interventions. The closing of the gap suggested that vocabulary production was increasingly internalized despite differences in prompting between the two adult communication partners.

In summary, within group results strongly support generalization of the effectiveness and efficiency of the interventions across people, materials and activities, and settings, with slightly less support for one participant, which most likely was due to differences in adult communication partner prompting. Those interventions that were effective and efficient remained so with different adults, and those interventions that were not effective or efficient remained so with different adults.

The generalization results also provide support for the social and ecological validity of the study. The goals, intervention approaches, and outcomes of the study appeared appropriate and reasonable for both the child and adult participants; and the settings, materials, and adult participation in the study appeared to be easily implemented in typical daily practice which allowed for generalization within participants (Schlosser, 2003).

In addition to vocabulary production generalization across adult participants, settings, and materials, it is also important that vocabulary production skills be maintained over time. The next section of the chapter discusses the maintenance of target vocabulary production following completion of intervention phase.

Maintenance of the Interventions

Two of the four participants, Karl and Carol, completed the maintenance phase of the study. The results of this phase revealed that both participants maintained production of target vocabulary across interventions two weeks, four weeks, and eight weeks after completion of the intervention phase of the study. The POD statistic confirms maintenance following completion of the two intervention approaches with 100% overlapping data between intervention and maintenance probe, as is seen in Table 7. These results suggest the positive long-term effects of responsivity education and focused stimulation, as well as the positive long-term effects of responsivity education and focused stimulation with the addition of AAC modeling, for the two participants.

Several reasons for the participants' ongoing success may be hypothesized. First, measures were taken within the study procedures to ensure that the participants were consistently producing the target vocabulary, with a learning criterion of 80% production across two consecutive sessions. Second, the intervention was designed to promote production of target vocabulary through use of a) repeated exposures to target vocabulary, which has been found to be effective with language delayed children who do not use AAC, and b) AAC modeling, which has been found to be effective with language delayed children who use AAC. As the two participants were not typical AAC users, with Carol using verbal production output as the study progressed, and Karl using

multimodal communication including unaided manual sign, PCS symbols, and word approximations/word production, it appears that the repeated exposure to vocabulary using multiple representation modalities, in combination with consistent authentic participation, might have been the key to vocabulary production maintenance. Lastly, the social and ecological validity of the study design, and the use of continual generalization probes across people, materials, and settings, might have contributed to internalization of target vocabulary production for both participants.

Summary of the Findings

In conclusion, the results of the study revealed that the language intervention approach of responsivity education and focused stimulation was effective for improving the vocabulary production in three of four participants in the study. The added value of including AAC modeling in the intervention resulted in effective vocabulary production with the fourth participant, and was also effective with two other participants, but was questionably effective with the fourth participant. In addition, the results of the investigation revealed that the language intervention approach of responsivity education and focused stimulation was efficient for improving the vocabulary production in two of the four participants in the study. The added value of AAC modeling in the intervention resulted in efficient vocabulary production for another participant and the added value of AAC modeling in the intervention also resulted in efficient vocabulary production with the other two participants. Neither intervention approach was efficient with the fourth participant.

The results of the study also revealed that those interventions which were effective and efficient generalized across different adults, materials and settings; and those interventions that were not effective or efficient remained so across different adults, materials and settings.

Finally, the results of the study revealed that production of target vocabulary was maintained across interventions two weeks, four weeks, and eight weeks after completion of the intervention phase of the study for two of the four participants.

The factors which might have contributed to successful intervention outcomes resulting in effective and efficient target vocabulary production include: a) increasing emphasis/stress and using a slower speech rate during SLP production of target vocabulary during intervention sessions, b) incorporating repeated vocabulary modeling during intervention in multiple representation modalities, c) providing a facilitative language environment which includes play routines and a child-centered approach, d) systematically selecting target vocabulary, e) consistent authentic participation between the participant and adult communication partner, and f) selecting an intervention approach that is compatible with the toddler's learning style. If the participant demonstrates a shorter attention span, a cognitive impairment and/or delayed receptive language skills, it is possible a more intense intervention schedule for a longer duration is needed for successful intervention outcomes.

The participants in the study were not typical AAC users as two participants produced primarily verbal productions as the study evolved, while the other two were multimodal communicators who produced vocabulary using a combination of manual sign, PCS symbols, and word

approximations/word production, in comparison to the more typical AAC user who communicates primarily with graphic symbols. As a result, AAC modeling did not result in decreased input-output asymmetry, thereby nullifying the premise for its effectiveness. In addition, it is possible the participants benefitted from repeated exposure to vocabulary in multiple representations, be it verbal, manual, or graphic symbols, because of the increased emphasis, stress, and the slower speech rate used when modeling the target vocabulary. The theoretical implications of these findings are discussed in the next section.

Theoretical Implications of the Findings

Social constructivist theories for language acquisition provide the theoretical framework for the language intervention approaches utilized in the study. Social constructivist models of development reflect a view that adults support a child's development by providing timely and developmentally appropriate situations and models for learning language, including children with atypical development who receive and use AAC (Vygotsky, 1978). More specifically, social constructivist theories for language acquisition support the importance of sensitivity to the child's linguistic zone of proximal development, as described in chapter 2, through responsive adult interactions, repeated exposure to targeted vocabulary, modeling as a foundation for language learning, and acceptance of AAC as a means of communication from a cultural perspective. These social constructivist foundations form the basis for the language intervention approaches utilized in the current study including responsivity education which includes responsive adult interactions, focused stimulation which includes repeated exposure to targeted vocabulary, and AAC modeling which includes demonstrating use of the child's AAC system in context. The results of the study provide evidence supporting social constructivist theories for language acquisition as both language intervention approaches were found to be effective towards learning to produce vocabulary for the participants in the study. In addition, the language intervention approaches were found to be efficient towards learning to produce vocabulary for three of the four participants, with one participant demonstrating a cognitive impairment which might require more intensive intervention for a longer duration.

However, an alternative possible explanation for the results of the study can be found in the experiential perspective of Nelson (2007). Nelson (2007) proposes that young children learn vocabulary through the type of environment that the vocabulary is presented. Authentic participation in the environment is the key, which encourages selective and sustained attention, active engagement, a desire to participate, and an understanding of the goal of the activity. According to Nelson, what ultimately matters in learning to produce vocabulary is that appropriate supports are in place, such as focused stimulation and AAC modeling, during authentic participation between the young child and adult participants. Authentic participation allows for meaning to occur, as well as a memory of that meaning within the social and, ultimately, cultural setting.

How can Nelson's (2007) experiential perspective be applied to the investigation? It is possible that Karl and Carol effectively and efficiently learned to produce the target vocabulary across both language intervention approaches because they were more consistently supported in authentic participation during probe and intervention sessions. An understanding of the goal of the activity, to produce target vocabulary, was clear, as supports such as "say __" or "tell me

with your pictures" were concretely presented during child-centered, desirable activities using favored materials. Karl and Carol internally presented with strong attention spans, intact memory skills, consistent engagement, and learning styles which matched the supports used during the study, all of which facilitated generalization and maintenance of target vocabulary production.

Alternatively, Mick demonstrated a cognitive impairment which contributed to a limited attention span, slow processing and engagement, and a poor memory for retaining information. Authentic participation with appropriate supports may not have been consistently achieved possibly due to factors such as learning to walk, a lack of clear understanding of the goal of the activity due to cognitive impairment, and a mismatch between his learning style and the supports used for the intervention approaches. It is possible that more intensive training over a lengthier duration may have facilitated authentic participation.

Finally, authentic participation between Marty and the SLP decreased as the study continued, possibly due to extrinsic factors occurring in the home and preschool settings. As a result of the lack of selective and sustained attention, active engagement, and a desire to participate, it is possible the supports of focused stimulation with the addition of AAC modeling were not sustained from the intervention sessions, which consisted of multiple vocabulary exposure, to probe sessions, which consisted of less intense vocabulary exposure. Therefore, the meaning and the memory of that meaning for target vocabulary production was not sufficiently internalized during intervention sessions, which in turn, was not carried over to probe sessions.

In summary, social constructivist theories for language acquisition with toddlers who receive and use multimodal AAC are supported by the results of the study. In addition, the experiential perspective of Nelson (2007) may also explain the importance of authentic participation during intervention and probe sessions, which allows for supports such as the language intervention approaches, to be facilitative, as well as meaning and memory of target vocabulary production to be internalized, generalized, and maintained. The next section of the chapter moves from theoretical implications to the more practical clinical implications of the findings.

Clinical Implications of the Findings

As was mentioned previously in the summary of the findings section, the results of the study revealed that the language intervention approach of responsivity education and focused stimulation was effective for improving the vocabulary production in three of four participants in the study. The added value of including AAC modeling in the intervention resulted in effective vocabulary production with the fourth participant, and was also effective with two other participants, but was questionably effective with the fourth participant. In addition, the results of the investigation revealed that the language intervention approach of responsivity education and focused stimulation was efficient for improving the vocabulary production in two of the four participants in the study, as they produced at least 80% of the vocabulary after only five or fewer intervention sessions. The added value of AAC modeling in the intervention resulted in efficient vocabulary production for another participant and the added value of AAC modeling in the intervention also resulted in efficient vocabulary production with the other two participants as they produced at least 80% of the vocabulary after six or fewer intervention sessions. Neither

intervention approach was efficient with the fourth participant as he did not learn to produce at least 80% of the vocabulary after twelve intervention sessions. The results of the study revealed that those interventions which were effective and efficient generalized across different adults, materials and settings; and those interventions that were not effective or efficient remained so across different adults, materials and settings. Finally, for two participants, production of target vocabulary was maintained across interventions two weeks, four weeks, and eight weeks after completion of the intervention phase of the study.

How can these results of the study inform clinical decision making? First, SLPs might consider incorporating the procedures for responsivity education and focused stimulation, and responsivity education and focused stimulation with the addition of AAC modeling, in their treatment sessions with toddlers who receive and use AAC and are learning to produce new vocabulary. In addition, SLPs should consider the factors which might have contributed to successful intervention outcomes resulting in effective and efficient target vocabulary production, and should consider incorporating these factors during intervention sessions with toddlers who receive and use AAC. These factors include: a) systematically selecting target vocabulary for vocabulary production, b) selecting an intervention approach that is compatible with the toddler's learning style, c) providing a facilitative language environment which includes play routines and a child-centered approach, d) providing consistently authentic participation in the environment which encourages selective and sustained attention, active engagement, a desire to participate, and an understanding of the goal of the activity, e) incorporating repeated vocabulary modeling during intervention using multiple representation modalities, and f) increasing emphasis/stress and using a slower speech rate during target vocabulary production. If the participant demonstrates a shorter attention span, a cognitive impairment and/or delayed receptive language skills, it is possible a more intense intervention schedule of more than two sessions weekly for 20 minutes, for a period of greater than six months, will be needed for successful intervention outcomes.

The study demonstrates the effectiveness of both focused stimulation and AAC modeling with toddlers with a range of disabilities. The two toddlers who successfully completed the investigation demonstrated a multisystem dysfunction with developmental speech and language delays as well as a paralyzed left vocal cord (Karl), and developmental speech and language delays with ataxic gross motor characteristics (Carol). The toddlers ranged in age from 2 years, 3 months at the start of the study to 3 years, 1 month at the end of the study. Both demonstrated age appropriate receptive language skills, severely impaired speech production skills, severely delayed verbal expressive language production skills, and mildly delayed manual sign production at the start of the study. Further, the results indicated that both intervention approaches can be effective for toddlers who use both non-electric AAC devices and manual sign to communicate. Additional research is needed to determine the effectiveness and efficiency of using the interventions to learn to produce new vocabulary with different populations of participants, as well as with use of higher tech AAC devices containing voice output.

It is encouraging that the children who met learning criterion during the intervention phase successfully generalized vocabulary production to novel adults, activities and materials, and, in Carol's and Marty's case, settings as well. In addition, two children maintained vocabulary

production two weeks, four weeks, and eight weeks after completion of the intervention phase of the study.

It is also encouraging that the adults completing the study, as a whole, found the goals, intervention approaches, and outcomes of the study were reasonable for the specific toddlers they worked with. While they expressed minor concerns with following the child's lead and repeating/expanding/extending productions during intervention sessions, and having difficulty omitting vocabulary from the other vocabulary set during probe sessions, the social validity of the study was strongly supported.

From an ecological validity perspective, it is also encouraging that the adults completing the study, as a whole, found the settings, materials, and adult participation in the study could be easily implemented in typical daily practice. Minor concerns were expressed about the difficulties with allowing the child to lead during intervention sessions and not saying target vocabulary more than three times during probe sessions. Nonetheless, one of the treating SLPs praised the study, stating the design was straight forward and easy to understand. She cautioned that children with cognitive impairment would take longer to reach learning criterion, which is consistent with prior research (Fey, et al., 2006; Warren, et al., 2008; Yoder & Warren, 2002).

It is important to note that, based on the results of the study, responsivity education alone is not enough to facilitate vocabulary production, as intervention with focused stimulation and focused stimulation with the addition of AAC modeling was needed before vocabulary production increased across all four participants.

It is also critical to remember that learning to produce single word vocabulary is only the first step to learning to produce two-word phases and productive grammar. In typical language development, the two-word stage marks the beginning of generative language (Brown, 1973). Typically developing children quickly acquire vocabulary, two-word phrases, and productive morphology and syntax, integrating ever more complex rules for combining and recombining words and morphemes. Children who receive and use AAC also need to learn the rules of language. However, little is known about how to support these essential skills with children who use AAC, and future research is required beyond the single word vocabulary level (Binger, et al., 2010; Trudeau, Sutton, Dagenais, Broeck, & Morford, 2007).

A question remains as to why AAC modeling alone, and responsivity education with AAC modeling, have been effective language intervention approaches in prior studies, while the addition of AAC modeling in the present investigation was not as consistently effective, or consistently more efficient. One could argue that none of the previous studies included focused stimulation, and the additional repeated exposure to target vocabulary was a more effective strategy than AAC modeling alone. In addition, none of the participants in the study were typical AAC users. As the study evolved, Carol and Marty used only verbal production for communication output. Karl and Mick were multimodal communicators who used a combination of unaided manual sign and aided graphic symbols and words/word approximations for communication output, rather than more typical aided AAC.

Alternatively, the dependent variable in several studies was pointing to graphic symbols for single word and multi-symbol messaging, rather than using multimodal single-word production (Binger, et al., 2008; Binger & Light, 2007; Binger, et al., 2010; Bruno & Trembath, 2006; Dada & Alant, 2009; Harris & Reichle, 2004; Kent-Walsh, et al., 2010; Romski, et al., 2010; Rosa-Lugo & Kent-Walsh, 2008). It is likely that the use of AAC modeling is a more effective strategy for teaching single words and multi-symbol combinations when output messaging consists of pointing to graphic symbols, as AAC modeling truly decreases input-output asymmetry for graphic symbol output.

Several studies chose storybook reading as the activity used for AAC modeling (Binger, et al., 2008; Binger, et al., 2010; Kent-Walsh, et al., 2010; Rosa-Lugo & Kent-Walsh, 2008). While storybook reading was an activity used in the present study, there were also many other activities incorporated into the child-centered probe and intervention sessions. It is possible that limiting the intervention activity to storybook reading was superior in facilitating language production using AAC modeling, although this is unlikely as several studies included multiple activities (Binger & Light, 2007; Bruno & Trembath, 2006; Dada & Alant, 2009; Romski, et al., 2010).

Finally, several studies used only voice output communication aids during AAC modeling (Binger, et al., 2010; Dada & Alant, 2009; Romski, et al., 2010; Rosa-Luga & Kent-Walsh, 2008). It is possible that AAC modeling paired with voice output is a more facilitative AAC system for enhancing language production, although once again this is unlikely as several studies included both voice output and non-electronic AAC systems with similar results (Binger & Light, 2007; Binger, et al., 2008; Bruno & Trembath, 2006; Kent-Walsh, et al., 2010).

It appears that the introduction of focused stimulation is the most likely explanation as to why the addition of AAC modeling did not consistently result in more effective and efficient vocabulary production in the present study, in particular when participants are not typical AAC users who do not rely on aided AAC in the form of graphic symbols as the primary means for output, and who do not primarily point to graphic symbols for communication output. It appears that repeated modeling and exposure to target vocabulary should be considered an important strategy in facilitating vocabulary production in toddlers who receive and use AAC.

Potential modifications to the two language intervention approaches. As the language intervention approaches were effective and efficient for two of the four children, it is appropriate to consider potential modifications to the independent variables in an effort to improve results for future research. For example, increasing intervention intensity to more than two twenty minute sessions weekly, and increasing the duration of the teaching criterion beyond four rounds of intervention, might facilitate vocabulary production for children with cognitive impairment, shorter attention spans, slower processing skills, and receptive language delays, as has been suggested by Fey, et al. (2006), Warren, et al. (2008), and Yoder and Warren (2002).

In addition, utilizing enhanced milieu teaching (Kaiser & Hester, 1994; Kaiser, et al., 2000), which incorporates the practices of responsivity education similar to the two intervention approaches, but also uses prompts to require responses from the child, might be more beneficial for some children. As an example, Karl's and Carol's SLP used more prompting than the special education teacher to elicit vocabulary production and encourage use of the child's AAC system.

In the case of Carol, this resulted in increased vocabulary production during intervention probes in comparison to generalization probes. The SLP's prompting, in the form of "tell me with your pictures" and "tell me ___" was similar to enhanced milieu teaching and was allowed within the coding guidelines for vocabulary production in the study. Therefore, it might be useful to specify treatment fidelity guidelines for vocabulary prompting and encourage more consistent use of prompting in future research.

The use of more consistent AAC modeling is another potential modification to consider for future research. Although none of the participants were typical AAC users, and therefore the importance of AAC modeling to decrease input-output asymmetry was not an important consideration in the present study, this may not be case in future studies. While the treating SLPs were very experienced and highly competent in the area of AAC, they occasionally variably modeled the toddler's AAC systems during intervention sessions, suggesting AAC modeling would be even more variable with less competent adult communication partners. Training in consistent AAC modeling is therefore essential when participants are typical AAC users. The use of AAC modeling outside of the study should also be encouraged across settings, as has been suggested by Goosens' (1989) and Sevcik, et al. (2010).

Finally, use of voice output communication aids should be considered with the participant AAC systems. Using higher tech AAC devices, which include voice output communication, could be a factor in more effective and efficient vocabulary production, and is sometimes used with toddlers who use AAC to communicate (Hidecker, 2010; Wishart, 2010). Therefore, it might be useful to incorporate higher tech AAC devices which include voice output in future studies.

Summary of contributions. The current study differs from other studies with toddlers who receive and use AAC in two critical ways. First, the current investigation is the first study to assess the effectiveness and efficiency of focused stimulation as a language intervention approach. Previous studies of AAC intervention with children under the age of three assessed the effectiveness and efficiency of responsivity education, AAC modeling, and responsivity education plus AAC modeling, but none of the studies chose specific vocabulary with repeated adult modeling of the vocabulary a minimum of ten times as a language intervention approach (Anderson, 2001; DiCarlo, et al., 2001; Iacono & Duncum, 1995; Kouri, 1995; and Salmon, et al., 1998).

Second, no comparative AAC intervention studies using single subject experimental designs compared the added value of AAC modeling to the language intervention approaches of responsivity education and focused stimulation. Rather, studies have compared manual signing to PECS, manual sign alone compared to manual sign paired with a voice output device, and behavioral training compared to AAC modeling with and without verbal modeling (Anderson, 1995; Iacono & Duncum, 1995; Iacono, et al., 1993; Remington & Clark, 1983). Only one study, Remington and Clark (1983), compared intervention approaches, but that study was structured and adult directed, rather than play based and child centered.

As a result of these two differences between the current study, other studies with toddlers who receive and use AAC, and other comparative AAC intervention studies, the following are possible contributions of the study:

1) Additional evidence has been provided to suggest that responsivity education, alone, might not be sufficient to facilitate vocabulary production in toddlers who receive and use AAC.
2) Repeated modeling, through use of focused stimulation, might be considered an important factor in facilitating vocabulary production. Multiple representations of vocabulary modeling might be useful, such as verbal production, manual sign, and graphic symbols, depending on the learning style of the child.
3) Modeling of vocabulary might be provided with a decreased speech rate and increased stress/emphasis to increase target vocabulary salience.
4) Additional evidence has been provided to suggest the context for effective and efficient vocabulary learning should consist of a facilitative language environment which incorporates play routines and a child-centered approach.
5) Systematic vocabulary selection might be an important consideration. A careful receptive language analysis is suggested. Vocabulary choices should be considered if they are within the child's receptive language repertoire, are developmentally appropriate, include core vocabulary, and consist of fringe vocabulary which is of high interest to the participant.
6) Additional evidence has been provided to suggest cognitive impairment might impact how easily and how quickly toddlers who receive and use AAC learn to produce vocabulary. Increases in session intensity and duration might need to be considered.
7) The importance of consistent, authentic participation between the child and adult communication partner, which encourages selective and sustained attention, active engagement, a desire to participate, and an understanding of the goal of the activity, should not be overlooked.
8) Language intervention approaches might attempt to be compatible with the child's learning style.

In summary, the results of the current investigation have expanded our knowledge of language intervention with toddlers who receive and use AAC to include responsivity education and focused stimulation as an effective and efficient intervention approach for promoting vocabulary production for some children. The results of the study also provides preliminary evidence supporting the experiential theoretical perspective which proposes that, rather than the specific supports provided within the environment, it is more important that young children are supported during authentic participation, as it is the authentic participation in the environment which facilitates a young child's production of new vocabulary (Nelson, 2007).

Limitations of the Current Investigation

Despite the success of implementing the two language intervention approaches to promote vocabulary production with two of the four toddlers who received and used AAC, a number of limitations for the study must be considered when interpreting the results and identifying future research directions. First, relatively few toddlers participated in this study, and replication of the study is required to strengthen the external validity and generality of the results (Kazden, 1982). Only two of the four participants successfully completed the investigations. The results were complicated by participant attrition with Marty leaving the study prior to reaching teaching criterion. In addition, as the study evolved, two of the participants relied on verbal production

for output, resulting in communication output not typical for AAC users. Further research should include additional participants, and also include participants who are more typical AAC users, such as children diagnosed with cerebral palsy.

A second limitation of the study addresses the AAC systems that the participants used to facilitate communication. As has been mentioned previously in the chapter, all of the participants used low tech AAC systems, and none of the AAC systems contained voice output communication aids. Further research is needed to determine whether the use of voice output communication aids would impact ability to learn to produce vocabulary with the two language intervention approaches in the study.

Another limitation of the study addresses the lack of success of the interventions with the toddler demonstrating a shorter attention span, cognitive impairment, and delayed receptive language skills. Further research is needed to determine whether a toddler with these difficulties might benefit from more intense weekly sessions and a study of longer duration. Replication of the study is needed which includes a comparison of more intense to less intense weekly sessions with a teaching criterion of greater duration.

A final limitation of the study addresses the variable learning styles demonstrated by the participants, which might have resulted in better or worse matches with specific language intervention approaches. For example, Karl was both an auditory and visual learner which matched both language intervention approaches. Carol was an auditory learner which was a better match with responsivity education and focused stimulation. Mick was a kinesthetic learner which did not match well with either intervention approach. Marty was a visual learner which was a better match with responsivity education and focused stimulation with the addition of AAC modeling. Further research is needed to determine how to modify the language intervention approaches to adapt to the individual toddler's learning style.

Taken as a whole, the above limitations render replication and directions for future research imperative. The next section discusses directions for future research.

Directions for Future Research

Several potential directions for future research can be identified based on the results of the study. First, the results need to be replicated with a wider variety of participants and adults. With respect to participants, all of the toddlers in the current study (a) had intact visual and auditory skills with correction, (b) had relatively intact motor skills, in that they did not present with cerebral palsy, (c) did not present with autistic spectrum disorder or pervasive developmental disorder, and (d) were monolingual English speakers. Eligibility criteria for the investigation excluded toddlers with visual and/or auditory impairment that could not be corrected. Certain modifications to AAC systems might need to be made for children with visual impairments, such as using real objects or larger photographs and PCS symbols with black and white contrasts, as well as less complex AAC systems with a small number of items per page (Beukelman & Mirenda, 2005). Certain modifications to the intervention approach might also need to be made for children with auditory impairments, such as use of FM systems or a greater emphasis on manual sign (Beukelman & Mirenda, 2005). It would be beneficial, however, to investigate the

impact of the two language intervention approaches with this population of toddlers with visual and/or auditory impairments.

Although children with significant motor impairments were not excluded from the investigation, none participated in the research project. Certain modifications might need to be made for children with significant motor impairments as well. For example, these children might require more time to communicate, necessitating that sessions be longer than 20 minutes. It would be useful to investigate the impact of the two language intervention approaches with this population of toddlers with motor impairments who greatly benefit from AAC.

With respect to language comprehension, two of the four participants demonstrated age appropriate receptive language skills and two of the four participants demonstrated moderate receptive language delays. Repetition of the investigation with children demonstrating mild language impairment is warranted. Similarly, one of the participants demonstrated a moderate cognitive impairment. Repetition of the investigation with children demonstrating mild cognitive would add to the generality of the results, as well as other children who typically demonstrate cognitive impairment, such as children with Down syndrome.

Additionally, eligibility criteria for the investigation excluded children diagnosed with autistic spectrum disorder (ASD) or pervasive developmental disorders (PDD). The use of AAC with these populations has been promoted as a promising practice, but there is limited research supporting the efficacy of AAC with children diagnosed with ASD or PDD (Mirenda, 2003), and more specifically, with infants and toddlers diagnosed with ASD (Boyd, Odom, Humphreys, & Sam, 2010). It would be beneficial to investigate the impact of the two language intervention approaches with toddlers diagnosed with ASD and PDD.

Finally, the eligibility criteria for the investigation excluded children who were bilingual or non-English speaking. There remains a paucity of research with bilingual and non-English speaking participants in the area of AAC intervention in the United States. Additional modifications might need to be made for multicultural/multilingual participants such as use of trained interpreters and considerations for culturally appropriate symbols and AAC systems (Robinson & Solomon-Rice, 2009). It would be beneficial to investigate the impact of the two language intervention approaches with toddlers who are bilingual and/or non-English speaking who receive and use AAC.

Regarding adult participants, replication with a larger number of SLPs and other adults would add to the external validity and generality of the findings. Future research should also consider adding treatment integrity guidelines for amounts and types of prompting. Specifically, it would be beneficial to encourage SLPs to request verbal imitations with “tell me ___” and to prompt use of AAC systems with “tell me using your pictures,” as is found in enhanced milieu teaching (Hemmeter & Kaiser, 1994; Kaiser & Hester, 1994). It might also be interesting to compare the use of prompts versus no prompts within participants who use AAC to determine whether prompting is a factor when implementing the two language intervention approaches. In addition, the treating SLPs occasionally variably used AAC modeling during intervention sessions. Future research should include guidelines beyond monitoring consistent/variable/omitted use of AAC modeling, to increase consistent use of AAC modeling.

As mentioned in the limitations section of the chapter, future research should consider the types of AAC systems used by the participants. The use of higher tech voice output communication aids is fairly common with young children who use AAC in the United States and Canada (Hidecker, 2010; Wishart, 2010), but this type of AAC device was not used in the present study. Use of AAC modeling with voice output communication aids has been found effective in increasing vocabulary production in toddlers with developmental delays whose parents receive training in AAC modeling (Romski, et al., 2010). Therefore, it would be beneficial to compare the two language intervention approaches using electronic AAC devices. It might also be interesting to compare non-electronic to electronic devices within participants to determine whether vocabulary production using the two language intervention approaches is impacted by the type of AAC device used.

Also, as mentioned in the limitations section of the chapter, future research should consider the intensity and duration the study with participants who demonstrate shorter attention spans, cognitive impairment and/or receptive language delay. Prior research has suggested increased intensity and duration of treatment is needed with children with cognitive impairment (Fey, et al., 2006; Warren, et al., 2008; and Yoder & Warren, 2002). Future research should increase the intensity of weekly sessions with and expand the number of sessions allowed to reach teaching criterion with toddlers demonstrating these issues.

Also mentioned in the limitations section of the chapter, future research should consider modifications to the intervention to provide better matches with participant learning styles. For example, a kinesthetic learner might benefit from explicit prompting such as “tell me __” which encourages practice, or an AAC system containing visual scene displays which is more concrete and can potentially be reenacted during play routines (Beukelman & Mirenda, 2005). Future research should consider these types of modifications with participants who are kinesthetic learners.

Regarding intervention contexts, future research should consider contexts beyond play routines to add to the external validity and generality of the results. It would be interesting to compare the two language intervention approaches in preschool settings such as circle time, or in home settings during bath time or mealtime. While these settings might be more adult directed rather than child-centered, the use of facilitative language development techniques would remain the same.

Finally, the investigation provides a framework for comparative language intervention studies with children who receive and use AAC. The same framework could be implemented with future studies comparing other intervention approaches and/or using other dependent variables, with young children who are multimodal communicators. For example, research supports the use of responsivity prelinguistic milieu teaching (RPMT) with developmentally delayed toddlers who use multimodal communication and produce less than 10-word vocabularies (Fey, et al., 2006; Yoder & Warren, 2002). However, the longitudinal effects of this intervention approach were not supported six and twelve months after the conclusion of the initial six-month treatment/no-treatment conditions during the 2006 Fey, et al. study (Warren, et al., 2008). The current framework could be used to compare RPMT and focused stimulation to RPMT and

focused stimulation with the addition of AAC modeling to determine whether either are effective, and if so, which is more efficient. Dependent variables could be the same used in Warren, et al. (2008) - rate of intentional communication acts per minute, lexical density per minute of sampling, and total number of words spoken, or it could be the same as used in the present investigation – percent of target vocabulary autonomously produced during a 20-minute probe session. Future research comparing language intervention approaches in toddlers who receive and use AAC is required to fill this critical gap which persists in the literature.

Conclusions

The current investigation contributes preliminary evidence about the effectiveness and efficiency of two language intervention approaches in teaching new vocabulary production to toddlers who receive and use AAC. Specifically, the investigation contributes preliminary evidence about the effectiveness and efficiency of responsivity education and focused stimulation, as well as the added value of including AAC modeling to the intervention involving responsivity education and focused stimulation. Overall, the results provide initial evidence that both language intervention approaches are effective and efficient with toddlers who a) consistently, authentically participate and are actively engaged in activities with selective and sustained attention providing for recall of vocabulary and understand of the goals of the session. However, the implementation of these intervention approaches might not as effective or efficient with toddlers who do not easily authentically participate in activities. For these toddlers, it is possible that additional supports may be needed to increase authentic participation, such as increased prompting, more intensive sessions, and a longer duration of treatment, when shorter attention spans, cognitive impairment, and/or receptive language delays exist.

The results also suggest that toddler learning style may contribute to the effectiveness and efficiency of the intervention approaches. It may be important to match the intervention approach with the toddler's learning style, such as pairing focused stimulation with auditory learners, pairing focused stimulation with the addition of AAC modeling with visual learners, and pairing target vocabulary with a more concrete AAC system for kinesthetic learners.

The data provides preliminary evidence that responsivity education and focused stimulation is an effective and efficient intervention approach for learning to produce new vocabulary with toddlers who are multimodal communicators and/or produce verbal output. Vocabulary production with these participants was generalized across adult communication partners, activities and materials, and in some instances settings, as well as maintained two months following completion of intervention.

Finally, the data provides preliminary evidence of the added value of AAC modeling to responsivity education and focused stimulation for toddlers who are not typical AAC users, possibly due to the importance of repeated vocabulary modeling and use of multiple representations which facilitate specific learning styles. Vocabulary production with these participants was also generalized across adult communication partners, activities and materials, and in some instances settings, as well as maintained two months following completion of intervention.

The use of responsivity education and focused stimulation, as well as the use of responsivity education and focused stimulation with the addition of AAC modeling, then, when used within a child-centered context for intervention with toddlers who consistently, authentically participate and engage in activities, might be an effective and efficient means for helping toddlers who receive and use AAC to produce new vocabulary.

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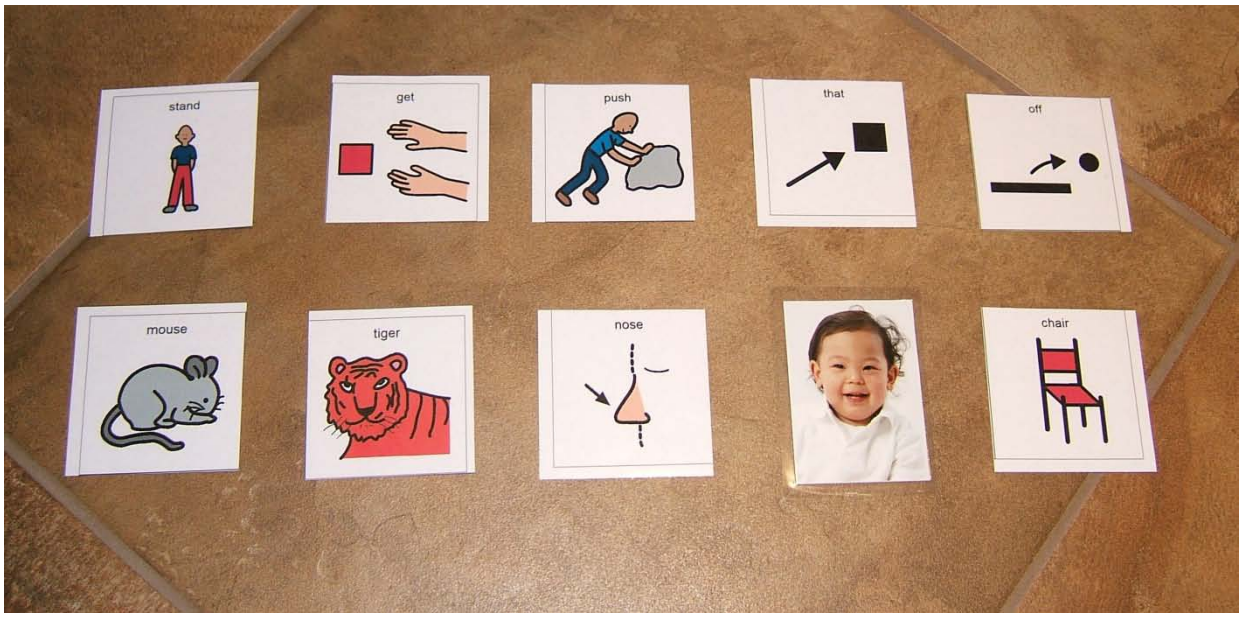
APPENDICES

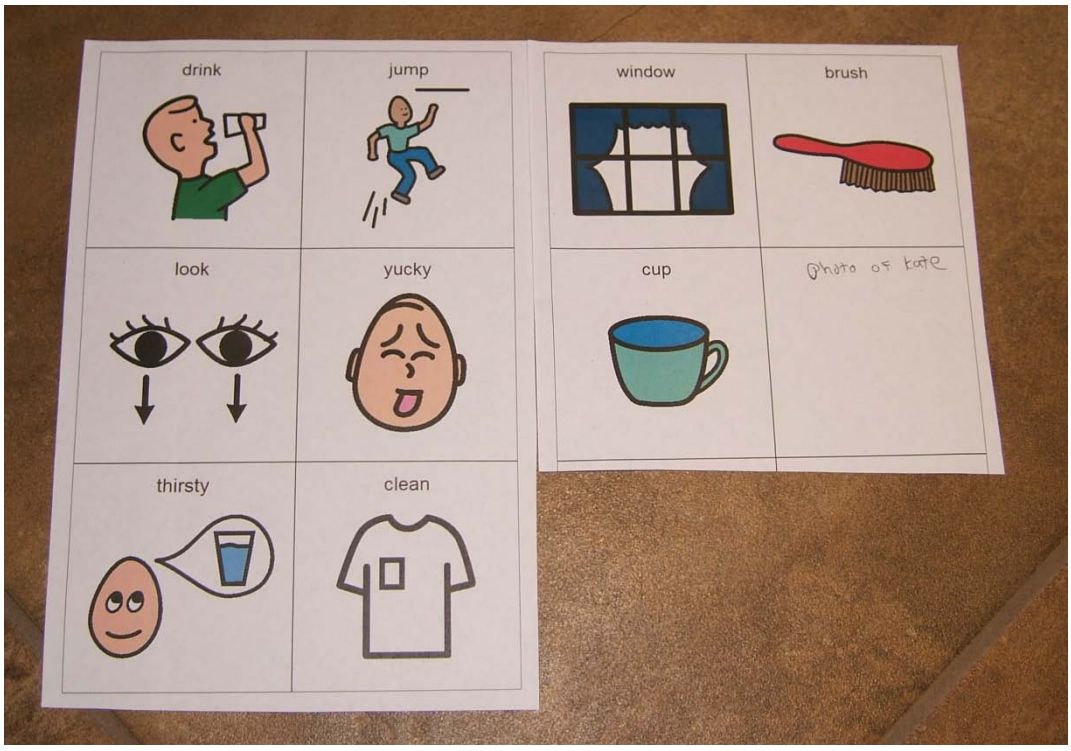
Appendix A: Parental Demographics

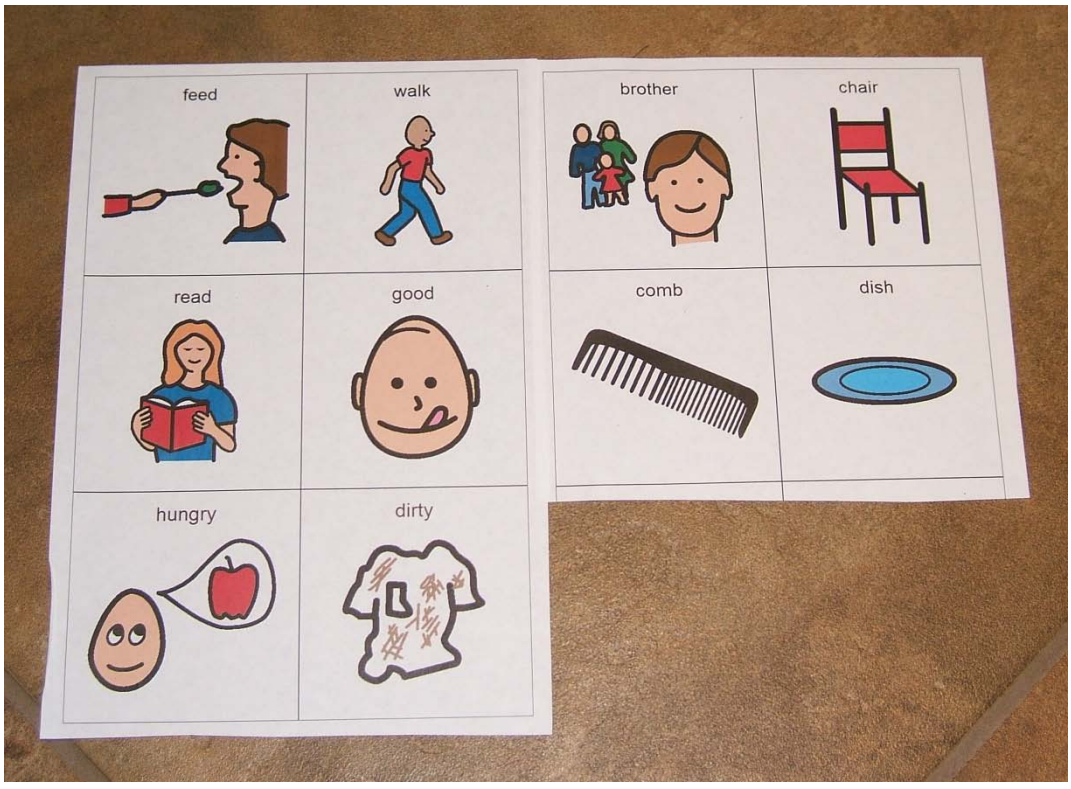
	Karl	Carol	Mick	Marty
SES	Middle Class	Upper Middle Class	Middle Class	Middle Class
Family Structure	Two-Parent Household	Two-Parent Household	Two-Parent Household	Two-Parent Household
Educational Level	Mother: 4-year college degree Father: 4-year college degree	Mother: 4-year college degree Father: Graduate school	Mother: 4-year college degree Father: High school graduate with some college	Mother: 4-year college degree; attending graduate school Father: High school graduate with some college
Mother's Employment	Part-time RN	Stay-at-home Mom	Stay-at-home Mom	Stay-at-home Mom

Appendix B: Karl's Aided AAC Displays

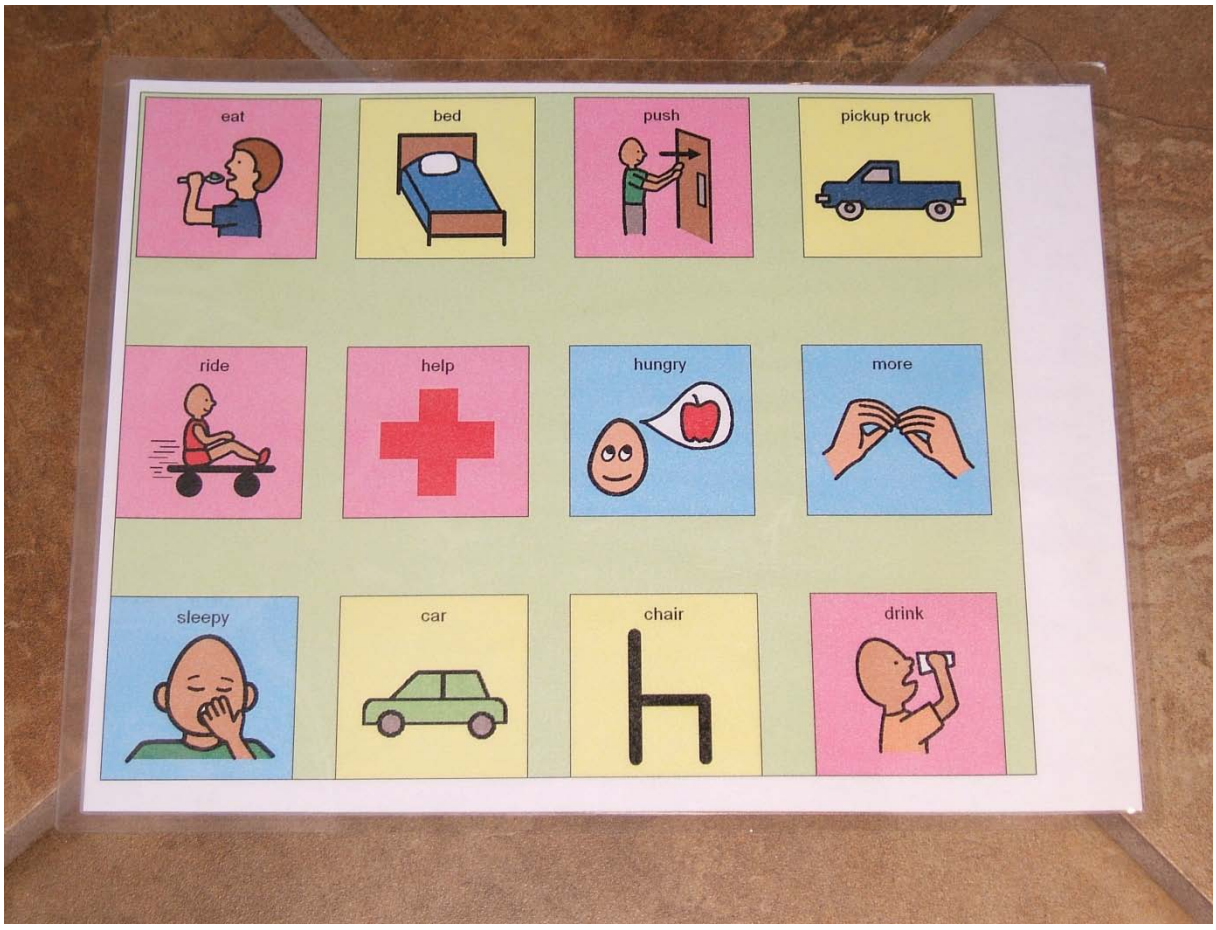


Appendix C: Carol's Aided AAC Displays

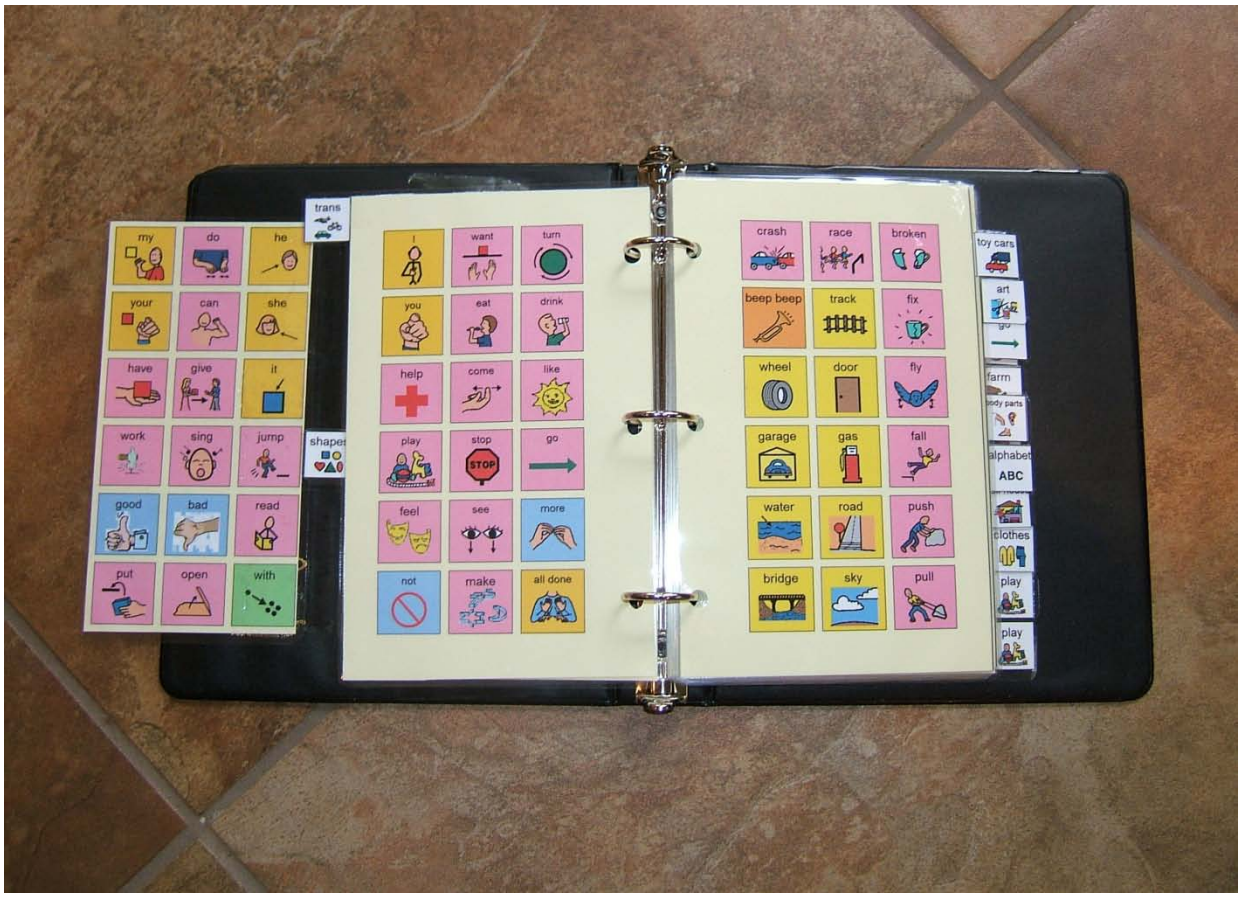




Appendix D: Mick's Aided AAC Display



Appendix E: Marty's Aided AAC Display Sample



Appendix F: Intervention Procedures for Responsivity Education and Focused Stimulation

Intervention Procedures for Responsivity Education and Focused Stimulation
1) SLP waits for the toddler to respond and listens to what the preschoolers says.
2) SLP allows the toddler to lead during play activities.
3) After allowing the toddler to lead during play, SLP actively joins in play.
4) SLP plays at a face to face level with the toddler.
5) SLP asks many types of questions such as what, where, how.
6) SLP waits expectantly for the toddler to respond and tells the toddler "it's your turn."
7) SLP responds to the toddler by taking a turn in a similar way to the preschooler.
8) SLP imitates the toddler's verbalizations by repeating exactly what the preschooler says.
9) SLP uses a variety of labels by naming many items during play.
10) SLP expands what the toddler is saying by imitating the toddler and adding 1 to 2 additional words.
11) SLP extends what the toddler is saying by expanding and then adding a comment or two about the topic.
12) SLP produces the toddler's target vocabulary ten times during play.
13) SLP does not model use of the toddler's AAC system during play.

Appendix G: Intervention Procedures for Responsivity Education and Focused Stimulation with the Addition of AAC Modeling

Intervention Procedures for Responsivity Education and Focused Stimulation with the Addition of AAC Modeling
1) SLP waits for the toddler to respond and listens to what the preschoolers says.
2) SLP allows the toddler to lead during play activities.
3) After allowing the toddler to lead during play, SLP actively joins in play.
4) SLP plays at a face to face level with the toddler.
5) SLP asks many types of questions such as what, where, how.
6) SLP waits expectantly for the toddler to respond and tells the toddler "it's your turn."
7) SLP responds to the toddler by taking a turn in a similar way to the preschooler.
8) SLP imitates the toddler's verbalizations by repeating exactly what the toddler says.
9) SLP uses a variety of labels by naming many items during play.
10) SLP expands what the toddler is saying by imitating the toddler and adding 1 to 2 additional words.
11) SLP extends what the toddler is saying by expanding and then adding a comment or two about the topic.
12) SLP produces the toddler's target vocabulary ten times during play.
13) SLP models each target vocabulary on the toddler's AAC system after saying the vocabulary orally during play.

Appendix H: Assessment Procedures and Results Sample

Child's Name: Mick **SLP:** Elizabeth
Dates: 10/30/09, 11/2/09, 11/6/09

Assessment Procedures

Language Comprehension

- Caretaker to complete MacArthur-Bates CDI Words and Gestures
- Identify target vocabulary based on 100% language comprehension from MacArthur CDI Words and Gestures results

Language Production

1) Materials

- Table with vocabulary lists
- SEE signs for each vocabulary item
- Line/photo symbol for each vocabulary item

2) Procedures

- Verbalizations: SLP says "Tell me what this is with your words."
- Signs: SLP says "Tell me ___ with your hands."
- Symbols: SLP says "Tell me ___ with your pictures."
- Determine % vocabulary produced for each set of targeted vocabulary

Assessment Results for Mick
Responsivity Education and Focused Stimulation

- MacArthur CDI Percent Vocabulary Understood: 100%
- Percent Vocabulary Verbalized: 4%
- Percent Vocabulary Signed: 12%
- Percent Vocabulary Produced with Line/Photo Symbols: 0%

RE and Focused Stimulation	Understands	Verbalizes	Signs	Line/Photo Symbols
1.pig	+	-	-	-
2. car	+	-	-	-
3. toy	+	+	-	-
4. water	+	-	-	-
5. diaper	+	-	-	-
6. nose	+	-	-	-
7. mouth	+	-	-	-
8. chair	+	-	-	-
9. comb	+	-	-	-
10. fork	+	-	-	-
11. star	+	-	+	-
12. brother	+	-	-	-
13. night-night	+	-	-	-
14. drink	+	-	-	-
15. blow	+	-	-	-
16. get	+	-	-	-
17. kick	+		+	-
18. look	+	-	-	-
19. read	+	-	-	-
20. sleep	+	-	-	-
21. wash	+		+	-
22. hungry	+	-	-	-
23. hot	+	-	-	-
24. his	+	-	-	-
25. off	+	-	-	-

Assessment Results for Mick
Responsivity Education and Focused Stimulation with the Addition of AAC Modeling

- MacArthur CDI Percent Vocabulary Understood: 100%
- Percent Vocabulary Verbalized: 4%
- Percent Vocabulary Signed: 0%
- Percent Vocabulary Produced with Line/Photo Symbols: 4%

RE and FS + AAC Modeling	Understands	Verbalizes	Signs	Line/Photo Symbols
1.sheep	+	-	-	-
2. truck	+	-	-	-
3. block	+	-	-	-
4. milk	+	-	-	-
5. sock	+	-	-	-
6. eye	+	-	-	-
7. ear	+	-	-	-
8. bed	+	-	-	+
9. brush	+	-	-	-
10. spoon	+	-	-	-
11. tree	+	-	-	-
12. teacher	+	-	-	-
13. peek-a-boo	+	-	-	-
14. eat	+	-	-	-
15. cry	+	-	-	-
16. push	+	-	-	-
17. jump	+	-	-	-
18. play	+	+	-	-
19. ride	+	-	-	-
20. walk	+	-	-	-
21. kiss	+	-	-	-
22. sleepy	+	-	-	-
23. cold	+	-	-	-
24. her	+	-	-	-
25. off	+	-	-	-

Appendix I: Probe Procedures for Baseline, Intervention, Maintenance, and Generalization

Probe Procedures for Baseline, Intervention, Maintenance, and Generalization
1) Adult waits for the toddler to respond and listens to what the toddler says.
2) Adult allows the toddler to lead during play activities.
3) After allowing the toddler to lead during play, adult actively joins in play.
4) Adult plays at a face to face level with the toddler.
5) Adult asks many types of questions such as what, where, how.
6) Adult waits expectantly for the toddler to respond and tells the toddler "it's your turn."
7) Adult responds to the toddler by taking a turn in a similar way to the preschooler.
8) Adult imitates the toddler's verbalizations by repeating exactly what the toddler says.
9) Adult uses a variety of labels by naming many items during play.
10) Adult expands what the toddler is saying by imitating the toddler and adding 1 to 2 additional words.
11) Adult extends what the toddler is saying by expanding and then adding a comment or two about the topic.
12) Adult produces the toddler's target vocabulary three times during play.
13) Adult does not model use of the toddler's AAC system during play.

Appendix J: Data Collection Form Sample for Probes

Data Collection: Responsivity Education and Focused Stimulation
Baseline, Intervention Probes, Generalization Probes, Maintenance Probes

Child's Name: Mick **Adult: _____**
Date: _____

Type of Data Collection Session

Baseline: ____
Intervention Probe: ____
Maintenance: ____
Generalization: ____

Definition of Autonomous Target Vocabulary Production

Producing the target vocabulary using the toddler's AAC system (e.g. communication board, sign, word approximation, word) in any of the following manners:

- Spontaneously
- While imitating adult production
- With or without prompting (e.g. "tell me what you want with your pictures")
- With or without adult providing a choice that includes the target vocabulary (e.g. "Do you want __ or ___")
- In response to an adult question (e.g. "Which do you want?")

Percent Vocabulary Autonomously Produced

Start Time: _____ **End Time: _____**
Please say each vocabulary word no more than 3 times during a 20 minute play period.
Please do not use signs or point to PCS symbols with the target vocabulary word.

Target Vocabulary	Target Vocabulary Autonomously Produced	Target Vocabulary Not Produced
1. Car		
2. Truck		
3. Push		
4. Ride		
5. Sleepy		

Percent Vocabulary Autonomously Produced: _____
(Target Vocabulary Autonomously Produced/Total Target Vocabulary = % Autonomously Produced

Appendix K: Data Collection Form Sample for Intervention Session with Responsivity Education and Focused Stimulation

Data Collection: Responsivity Education and Focused Stimulation Intervention Session

Child's Name: Mick **Adult: _____**
Date: _____

Definition of Autonomous Target Vocabulary Production

Producing the target vocabulary using the toddler's AAC system (e.g. communication board, sign, word approximation, word) in any of the following manners:

- Spontaneously
- While imitating adult production
- With or without prompting (e.g. "tell me what you want with your pictures")
- With or without adult providing a choice that includes the target vocabulary (e.g. "Do you want __ or ___")
- In response to an adult question (e.g. "Which do you want?")

Percent Vocabulary Autonomously Produced

Start Time: _____ **End Time: _____**
"Today I'm going to say your special words a lot but I'm not going to use your pictures or signs for the words when I talk."

***Please say each vocabulary word 10 times during the 20 minute play period. Please do not use signs or point to PCS symbols on the communication board when saying the target vocabulary word.**

Target Vocabulary	Target Vocabulary Autonomously Produced	Target Vocabulary Not Produced
1. Car		
2. Truck		
3. Push		
4. Ride		
5. Sleepy		

Percent Vocabulary Autonomously Produced: _____
(Target Vocabulary Autonomously Produced/Total Target Vocabulary = % Autonomously Produced)

Appendix L: Data Collection Form Sample for Intervention Session with Responsivity Education and Focused Stimulation with the Addition of AAC Modeling

Data Collection: Responsivity Education and Focused Stimulation with the Addition of AAC Modeling Intervention Session

Child's Name: Mick **Adult: _____**
Date: _____

Definition of Autonomous Target Vocabulary Production

Producing the target vocabulary using the toddler's AAC system (e.g. communication board, sign, word approximation, word) in any of the following manners:

- Spontaneously
- While imitating adult production
- With or without prompting (e.g. "tell me what you want with your pictures")
- With or without adult providing a choice that includes the target vocabulary (e.g. "Do you want __ or ___")
- In response to an adult question (e.g. "Which do you want?")

Percent Vocabulary Autonomously Produced

Start Time: _____ **End Time: _____**
"Today I'm going to say your special words a lot and I'm going to use your signs and pictures for the words when I talk."

***Please say each vocabulary word 10 times during the 20 minute play period, first pointing to the target vocabulary (or gesturing), and then saying, signing, and pointing the line drawings on Mick's communication board.**

Target Vocabulary	Target Vocabulary Autonomously Produced	Target Vocabulary Not Produced
1. Bed		
2. Chair		
3. Drink		
4. Eat		
5. Hungry		

Percent Vocabulary Autonomously Produced: _____
(Target Vocabulary Autonomously Produced/Total Target Vocabulary = % Autonomously Produced

Appendix M: Completed Data Collection Form Sample for Probes

Data Collection: Responsivity Education and Focused Stimulation with the Addition of AAC Modeling
Baseline, Intervention Probes, Generalization Probes, Maintenance Probes

Child's Name: Mick **Adult:** Elizabeth
Date: 4/30/10

Type of Data Collection Session

Baseline: ____
Intervention Probe: X
Maintenance: ____
Generalization: ____

Definition of Autonomous Target Vocabulary Production

Producing the target vocabulary using the toddler's AAC system (e.g. communication board, sign, word approximation, word) in any of the following manners:

- Spontaneously
- While imitating adult production
- With or without prompting (e.g. "tell me what you want with your pictures")
- With or without adult providing a choice that includes the target vocabulary (e.g. "Do you want __ or ___")
- In response to an adult question (e.g. "Which do you want?")

Percent Vocabulary Autonomously Produced

Start Time: 10:30 **End Time:** 10:50
Please say each vocabulary word no more than 3 times during a 20 minute play period.
Please do not use signs or point to PCS symbols with the target vocabulary word.

Target Vocabulary	Target Vocabulary Autonomously Produced	Target Vocabulary Not Produced
1. Bed		X
2. Chair	X (word approximation)	
3. Drink		X
4. Eat	XXXX (sign)	
5. Hungry		X

Percent Vocabulary Autonomously Produced: 40%
(Target Vocabulary Autonomously Produced/Total Target Vocabulary = % Autonomously Produced

Appendix N: Completed Data Collection Form Sample for Intervention

Data Collection: Responsivity Education and Focused Stimulation with the Addition of AAC Modeling Intervention Session

Child's Name: Mick **Adult:** Elizabeth
Date: 4/6/10

Definition of Autonomous Target Vocabulary Production

Producing the target vocabulary using the toddler's AAC system (e.g. communication board, sign, word approximation, word) in any of the following manners:

- Spontaneously
- While imitating adult production
- With or without prompting (e.g. "tell me what you want with your pictures")
- With or without adult providing a choice that includes the target vocabulary (e.g. "Do you want __ or ___")
- In response to an adult question (e.g. "Which do you want?")

Percent Vocabulary Autonomously Produced

Start Time: 10:00 **End Time:** 10:20
"Today I'm going to say your special words a lot and I'm going to use your signs and pictures for the words when I talk."

***Please say each vocabulary word 10 times during the 20 minute play period, first pointing to the target vocabulary (or gesturing), and then saying, signing, and pointing the line drawings on Mick's communication board.**

Target Vocabulary	Target Vocabulary Autonomously Produced	Target Vocabulary Not Produced
1. Bed		X
2. Chair		X
3. Drink	XX (sign)	
4. Eat	XXXX (sign; word approximations)	
5. Hungry	X (sign)	

Percent Vocabulary Autonomously Produced: 60%
(Target Vocabulary Autonomously Produced/Total Target Vocabulary = % Autonomously Produced)

Appendix O: Treatment Integrity Form for Probes

Responsivity Education and Focused Stimulation

Date: _____ Adult: _____
Child: _____ Observer: _____
Following the session, please complete this checklist:

Intervention Procedures	Consistently	Variably	Forgot
Adult waits for the toddler to respond and listens to what the preschooler says.			
Adult allows the toddler to lead during play activities.			
After allowing the toddler to lead during play, adult actively joins in play.			
Adult plays at a face to face level with the toddler.			
Adult asks many types of questions such as what, where, how.			
Adult waits expectantly for the toddler to respond and tells the toddler "it's your turn."			
Adult responds to the toddler by taking a turn in a similar way to the toddler.			
Adult imitates the toddler's verbalizations by repeating exactly what the toddler says.			
Adult uses a variety of labels by naming many items during play.			
Adult expands what the toddler is saying by imitating the toddler and adding 1 to 2 additional words.			
Adult extends what the toddler is saying by expanding and then adding a comment or two about the topic.			
Adult does not produce the toddler's target vocabulary more than three times during play.			
Adult does not model use of the toddler's AAC system during play.			

Percent Inter-Observer Agreement for Session: _____
(Number of Agreements/Number of Agreements plus Disagreements)

Appendix P: Treatment Integrity Form for Intervention

Responsivity Education and Focused Stimulation

Date: _____ Adult: _____
Child: _____ Observer: _____
Following the session, please complete this checklist:

Intervention Procedures	Consistently	Variably	Forgot
Adult waits for the toddler to respond and listens to what the preschooler says.			
Adult allows the toddler to lead during play activities.			
After allowing the toddler to lead during play, adult actively joins in play.			
Adult plays at a face to face level with the toddler.			
Adult asks many types of questions such as what, where, how.			
Adult waits expectantly for the toddler to respond and tells the toddler "it's your turn."			
Adult responds to the toddler by taking a turn in a similar way to the preschooler.			
Adult imitates the toddler's verbalizations by repeating exactly what the toddler says.			
Adult uses a variety of labels by naming many items during play.			
Adult expands what the toddler is saying by imitating the toddler and adding 1 to 2 additional words.			
Adult extends what the toddler is saying by expanding and then adding a comment or two about the topic.			
Adult produces the toddler's target vocabulary ten times each during play.			
Adult does not model use of the toddler's AAC system during play.			

Percent Inter-Observer Agreement for Session: _____
(Number of Agreements/Number of Agreements plus Disagreements)

Appendix Q: Data Collection Form Sample for Inter-Rater Reliability

Inter-Rater Reliability: Responsivity Education and Focused Stimulation with the Addition of AAC Modeling

Child's Name: Mick **Adult:** _____

Date: _____

Type of Data Collection Session

Baseline: ____
Intervention Probe: ____
Maintenance: ____
Generalization: ____

Definition of Autonomous Target Vocabulary Production

Producing the target vocabulary using the toddler's AAC system (e.g. communication board, sign, word approximation, word) in any of the following manners:

- Spontaneously
- While imitating adult production
- With or without prompting (e.g. "tell me what you want with your pictures")
- With or without adult providing a choice that includes the target vocabulary (e.g. "Do you want __ or ___")
- In response to an adult question (e.g. "Which do you want?")

Percent Vocabulary Autonomously Produced

Start Time: _____ **End Time:** ____

Please say each vocabulary word no more than 3 times during a 20 minute play period.
Please do not use signs or point to PCS symbols with the target vocabulary word.

Target Vocabulary	Target Vocabulary Autonomously Produced	Target Vocabulary Not Produced
1. Bed		
2. Chair		
3. Drink		
4. Eat		
5. Hungry		

Percent Vocabulary Autonomously Produced: _____
(Target Vocabulary Autonomously Produced/Total Target Vocabulary = % Autonomously Produced)

Inter-Rater Reliability Agreement: _____

Appendix R: Social Validity Questionnaire

SLP/Special Education Teacher: _____
Date: _____
___Pre-Study
___Post-Study

1) Are the goals of the study appropriate and reasonable for the target toddlers?

2) Are the language intervention approaches appropriate and reasonable for the target toddlers?

3) Do you think the outcomes of the study will be/are important for the target toddlers, for example do you feel that improved vocabulary production will impact the toddler's everyday life, participation in the classroom and school activities, their relationships with peers and adults, and so forth?

4) Other comments?

Appendix S: Ecological Validity Questionnaire

SLP/Special Education Teacher: _____
Date: _____

1) Could the materials and activities used in the study be easily implemented in typical daily practice?

2) Were the SLP and teacher settings used in the study practical for typical daily practice?

3) Could the SLP and teachers instruction used in this study be easily implemented in typical daily practice?

4) Other comments?