AN INTEGRATED MULTIMODAL INTERVENTION APPROACH TO SUPPORT SPEECH AND LANGUAGE DEVELOPMENT IN CHILDREN WITH SEVERE SPEECH IMPAIRMENTS

BY

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DISSERTATION

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Abstract

Augmentative and alternative communication (AAC) is often viewed as a "last resort" for children with severe speech sound impairments, with AAC consideration only occurring after years of failed traditional speech therapy. Two main reasons this occurs is because (a) parents view AAC as "giving up" on speech, and (b) parents and speech-language pathologists (SLPs) often believe that implementing AAC will negatively affect natural speech development. These views have consequently led SLPs to dichotomize intervention for these children; either work on natural speech *or* implement AAC. Recent research has suggested this may not have to be a choice SLPs have to make. This study's purpose was to examine the effects of an *integrated multimodal* intervention designed to increase the quantity and quality of natural speech production in children who are multimodal communicators due to severe speech sound impairment. A hybrid research design was used to determine the treatment's effectiveness, including single-subject design methodology and qualitative methodology. Three children served as participants, with each child participating in a series of baseline and intervention sessions. The data obtained from the participants suggested the intervention had positive effects on their speech production abilities. Theoretical and clinical implications of these findings are discussed.

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Chapter 1: Introduction

Speech-sound impairment (SI); including dysarthria, childhood apraxia of speech, and phonological impairment (Strand & McCauley, 2008); is a prevalent speech and language disorder occurring in children (Law, Boyle, Harris, Harkness, & Nye, 2000; Shriberg, Tomblin, & McSweeny, 1999). For some children, the speech-sound impairment may be so severe that it negatively impacts the child's ability to communicate functionally and can be referred to as a severe speech-sound impairment (SSI). Speech impairments can occur in conjunction with primary diagnoses such as cerebral palsy, mental retardation, or autism (Allaire, Gressard, Blackman, & Hostler, 1991), or they can occur as a primary deficit in itself (Shriberg, 1994). It has been proposed that 0.2%-0.6% of the school-aged population is non-speaking from a severe communication impairment (Blackstone, 1990), which includes children with SSIs.

Standard practice used to facilitate communication skills in children with SSIs focuses on impairment-based models of interventions targeting verbal natural speech production, with successful outcomes measured by accurate use of spoken communication. Such interventions include a variety of approaches which can be broadly categorized as linguistic approaches, motor approaches, or combined approaches. For some children with SSIs, these traditional types of interventions may yield slow, laborious or inadequate progress; may not be feasible due to the nature of the disorder; or may be limited in scope (DeThorne, Johnson, Walder, & Mahurin-Smith, 2009; McLeod & Bleile, 2004; Strand, Stoeckel, & Bass, 2006). Consequently, augmentative and alternative communication (AAC) may be recommended for some children with SSIs to compensate for, or replace, severely deficient natural speech. Approximately 12% of children between the ages of 3 years and 6 years who receive special education services (including speech and language services) require AAC (Binger & Light, 2006). According to a

survey of speech-language pathologists (SLPs), 47.4% who work in school systems serve individuals who use AAC (Simpson, Beukelman, & Bird, 1998). In the preschool population, children with developmental delay, autism/PDD, speech/language impairments, and multiple disabilities are the most common populations who will require AAC (Binger & Light, 2006). A variety of AAC systems are commonly used with children who have SSIs. Based on caregiver report, 56% of children with significant speech and language impairments did not use symbolic communication; 5% used speech; and 38% used a combination of speech, sign, and aided AAC (Allaire et al., 1991).

Because of its potential to provide children with a means to participate communicatively in social and educational settings, American Speech-Language-Hearing Association (ASHA) has adopted a zero-exclusion policy for AAC eligibility that advocates consideration of AAC for any individual who has a discrepancy between communication needs and abilities (ASHA, 2004). Consideration of AAC, however, is often a "hard sell" for parents of, and speech-language pathologists (SLPs) working with, children who have SSIs (Hustad, Morehouse, & Gutmann, 2002), and is exemplified in the following fictional vignette:

> Johnny has been receiving traditional speech therapy for remediation of a severe speech-sound impairment. Johnny has received a variety of interventions, including motor-based and phonologically-based programs for approximately 60 minutes a week for four years. Johnny is currently 7 years old, and his mother reportedly understands only about 10% of his speech, and he is 100% unintelligible to unfamiliar listeners. Johnny has recently been placed in a special education classroom because his lack of ability to verbally communicate has led to difficulties performing tasks required in his first grade curriculum. Johnny's SLP recommended consideration of AAC in an effort to help

> Johnny become a more effective communicator. Johnny's mother and teacher vehemently oppose this recommendation because they feel that since Johnny can speak some, giving up on speech and implementing AAC would be detrimental to his ability to ever learn to be a natural-speech communicator. Johnny's SLP doesn't feel that she has any other option other than to follow the wishes of Johnny's mother, and she subsequently continues to target natural speech for the next three years, with limited progress. When Johnny reaches fifth grade, his mother and teacher decide that it is time to consider more options for Johnny, since his speech really hasn't gotten much better over the years. They reluctantly agree to get Johnny an AAC system. Although Johnny understands his AAC system, he continues to be a passive communicator, speaking only when he has to in order for his wants and needs to be met, speaking in one-word utterances, and using his AAC system only when prompted to by his SLP. Johnny's speech therapy now consists of working on AAC for one session a week.

This vignette raises two important points (a) AAC is usually considered only after years of failed traditional speech therapy (Weitz, Dexter, & Moore, 1997), or in other words, AAC is viewed as the "last resort" and (b) parents, educators, some SLPs share the concern that implementing AAC will interfere with natural speech production abilities (e.g., Beukelman & Mirenda, 2005; Hustad, Morehouse, & Gutmann, 2002; Millar, Light, & Schlosser, 2006). The consequence of these views sets up a dilemma for SLPs; that is, the choices SLPs face are to either work on natural speech or to implement AAC. This dilemma places these two treatment choices on each side of a coin, where natural speech is pitted against AAC, and clinicians are forced to choose between targeting effective speech production or effective functional communication.

Although this dichotomous view of intervention may be pervasive among SLPs and parents, research suggests that it may not have to be the case. Clinicians generally understand that as a primary function, AAC systems are viewed as a means to provide individuals with communication impairments, including those with SSIs, the opportunity to engage in meaningful communication and participate in diverse activities (Beukelman & Mirenda, 2005) for a variety of functions, including expressing wants and needs, transferring information, social closeness, and social etiquette (Light, 1988). Recent research suggests though, as a secondary function, there may be potential for AAC to have positive outcomes on the natural speech development of children with SSIs. Millar, Light, and Schlosser (2006) and Schlosser and Wendt (2008) conducted two meta-analyses that provided evidence to suggest that AAC does not negatively affect natural speech production, and that implementation of AAC may in fact facilitate its development. Although these two research analyses provide important preliminary data to ease initial concern, there is a primary limitation to the literature reported on this topic. The previous studies were not designed to investigate the effects of an intervention that targeted natural speech production; in fact, natural speech was not directly targeted in these previous research studies. There is a significant gap in the literature that provides any information regarding the potential of integrating AAC and traditional speech interventions, or more specifically, how SLPs can integrate multimodal communication to help an individual child become a skilled communicator while improving their natural speech production skills.

The current study presents a therapy approach that does not dichotomize AAC and natural speech, but integrates them in a multimodal intervention protocol. Specifically, this study explores practical and theoretical issues related to speech development and the use of AAC, and examines the effectiveness of an integrated multimodal intervention specifically designed to

increase the quality and quantity of natural speech in children who use AAC. A hybrid research design was used to answer the questions presented in this study. Single-subject design methodology was used to examine the effects of integrating speech-generating AAC systems with traditional speech treatments on the quantity and quality of natural speech production. Qualitative methodologies were also utilized to socially validate the integrated multimodal intervention's effectiveness through exploration of parental impressions of the intervention and effects of the intervention on participants' communicative practices.

Chapter 2: Literature Review

This chapter reviews treatment literature for children with SSI and uses it to design an integrated multimodal intervention that targets natural speech production and communicative competence in children with SSIs. The first section reviews common intervention approaches designed to target speech production in children with SSIs. The second section reviews literature that specifically addresses how AAC for children with SSI may impact their natural speech development. The final section summarizes techniques that clinicians and researchers have identified as critical components of successful intervention programs to support successful speech and communication in children with SSI.

Traditional Treatments for Children with SSIs

Children with severe speech impairments (SSIs) represent a diverse group. Many children in this group are simply referred to as having an SSI, and do not receive a more specified diagnosis. Some children, however, may have received a specific diagnosis depending on the characteristics of their SSI. Common diagnoses associated with SSIs include childhood apraxia of speech (CAS) and phonological impairment (PI). Although both disorders can result in significant speech and communication impairments, they have been described as distinct impairments which have traditionally utilized distinct intervention techniques. Childhood apraxia of speech has been described as a motor speech disorder characterized by, "…the inability or difficulty with the ability to perform purposeful voluntary movements for speech, in the absence of a paralysis or weakness of the speech musculature" (Caruso & Strand, 1999, p. 15-16). Some characteristics of CAS included difficulty with articulation, prosody, initiating and maintaining speech movements, effortful phoneme sequencing, groping, and vowel distortions (Caruso & Strand, 1999). There is a scant amount of evidence-based treatment data regarding CAS. A 2008

Cochrane review of evidence-based practice for CAS determined that there were no high-level randomized controlled trials or quasi-experimental studies to support interventions for CAS (Morgan & Vogel, 2008). However, consistent with an evidence-based practice framework (e.g., Dollaghan, 2007), the research provided, in addition to consideration of clinical expertise and stakeholder values, can and should be used to support treatment decisions. Some of the techniques that have been proposed as effective treatment of CAS include: integral stimulation methods (Strand & Debertine, 2000; Strand, Stoeckel & Baas, 2006; Strand & Skinder, 1999); tactile-kinesthetic methods (Square, 1999); melodic intonation therapy (Helfrich-Miller, 1994), and Prompts for Restructuring Oral Muscular Phonetic Targets (PROMPT) (Chumpelik, 1984). Although each treatment is distinct, these types of CAS treatments typically stress the importance of speech development through a variety of gestural, tactile, and prosodic cues, follow a hierarchy of skills (Hayden & Square, 1984), and reference a motor-learning theoretical framework (see Maas et al., 2008 for review).

Another impairment that potentially results in an SSI is a phonological impairment (PI). Geirut (1998) described a phonological disorder as affecting "…a speaker's production and/or mental representation of speech sounds of the target language" (p. S85). Phonological impairments not only take into account the motoric component of articulating speech sounds, but also stress the importance of underlying language and cognitive components associated with correctly patterning the sound system of the language (Fey, 1992; Geirut, 1998), theoretically placing phonology higher on the speech chain. Phonological therapy is characterized by targeting groups of sounds as opposed to individual phonemes, less emphasis is placed on correct sound productions and more emphasis is placed on producing a phonological pattern, and the use of speech for communicative purposes is stressed (Fey, 1992). Techniques or interventions

associated with PIs include cycles (Hodsen & Paden, 1991), minimal pair treatment (Weiner, 1981), and metaphon (Dean, Howell, Waters, & Reid, 1995). Geirut (1998), Ruscello (2008), and Bankson and Bernthal (2004) provided comprehensive reviews of each of these PI intervention techniques.

Although both of these types of interventions for children with SSIs have an evidence-base to support use, they are not without drawbacks. One primary drawback with these approaches is that speech production is viewed separate from meaningful functional communication. Interventions are typically led by speech-language pathologists who divide speech production into discrete skills within a clinician-directed activity. Reinforcement is administered in a scheduled manner and is dependent on the accuracy of the speech production and is again, clinician-directed. A social learning framework would dictate that for learning to be facilitated, speech must be practiced in meaningful, interesting, and relevant contexts (Hoffman, 1993) as opposed to discrete trial opportunities. Not only is a natural and meaningful social communication opportunity lacking from these traditional types of treatments, multimodal communication is also not considered within these frameworks. Multimodal communication intervention was described as an intervention that "…provides the individual with various communication modality options, such as natural speech, gestures, sign language, low-technology symbol boards, and high-technology voice output technology" (Cumley & Swanson, 1999, p. 111). Since focus is on accurate speech production within traditional treatments, multimodal communication that focuses on overall effective functional communication in general would not be viewed as a viable or valuable treatment option.

A second drawback to traditional treatments for children with SSIs is that for intervention to be implemented, the child must have some ability to imitate a clinician-modeled production of

a target word or sound. Many children diagnosed as having an SSI may not readily be able to imitate speech productions, or may not be stimulable for the speech sound or pattern that is developmentally appropriate to target. When this occurs, there are very few opportunities to reinforce correct productions, and the child may experience a significant amount of failure during intervention. These adverse experiences related to communication could potentially lead to a form of learned nonuse (Brady & Garcia, 2009; Taub, Uswatte, Mark, & Morris, 2006). In this situation, the child's negative experiences with using natural speech to communicate could potentially lead to reduced communication in general. This is a potential outcome when traditional interventions were utilized and the child may not be capable of producing the intervention targets.

A final drawback to the traditional treatments described for treating SSIs in children is that language and communication may not be supported throughout the intervention process. For many children with SSIs, traditional treatment can be slow and difficult and progress may not be evident for a significant period of time. How will the child communicate in the meantime? Certainly the child with an SSI needs to communicate much more than the speech system allows. Traditional treatments fail to provide support for communication during the speech production system-change period. Traditional treatments are limiting in their ability to provide immediate support for communication.

Although drawbacks are evident with traditional treatments for children with SSIs, there is an evidence-base to support their use. What this research study proposes is not a discontinuation of these traditional treatments, but considering them within the larger context of communicative competence. Augmentative and alternative communication is used to support communication for a variety of purposes, and may also provide a potentially more favorable

context in which natural speech production can be targeted. The following section presents the relevant research literature related to AAC and natural speech development and also provides a description of the potential therapeutic mechanisms that may be responsible for behavior changes expected from participation in an integrated multimodal intervention.

Augmentative and Alternative Communication Intervention for Children with SSIs

Two published meta-analyses served as a basis to begin reviewing the literature on AAC use and natural speech development. The first published meta-analysis (Millar, Light, & Schlosser, 2006) included a systematic review of previous research conducted in the area of AAC and natural speech development in individuals with various developmental disabilities. The authors initially identified 23 studies which met their inclusion criteria (primarily based on population; use of AAC in treatment; and the inclusion of speech production data before, during, and after the intervention). However, only 6 of the 23 studies demonstrated experimental control; meaning 17 of the 23 studies were excluded because the effects on natural speech could not be reliably attributed to the treatment implemented. The methodological quality of each of the 6 studies was also determined by the review authors according to the certainty of the evidence provided in the study. There were four proposed levels of evidence certainty based on the study's level of experimental control, reliability of the dependent variable, and fidelity. These levels of evidence include conclusive evidence, preponderant evidence, suggestive evidence, and inconclusive evidence. The review authors determined that none of the six studies reported data on treatment integrity; therefore, the evidence from these studies did not reach an evidence level of conclusive, meaning that none of the outcomes presented in the articles "…were undoubtedly the result of the AAC intervention" (p. 251). These six studies, however, represented the most rigorous designs and provided the "best evidence available" (p. 254). Based on the results of

these studies, natural speech increases were observed in 89% of the cases; and 11% showed no change in speech production. None of the included cases revealed a decrease in speech. The average increase of natural speech was 13 words (Millar, Light, & Schlosser, 2006).

To further consider the effects of AAC on speech production specifically in children with autism, Schlosser and Wendt (2008) published an additional meta-analysis which included nine single-subject methodology studies and two group studies. In similar results to the earlier meta-analysis, the authors determined that no decreases in natural speech occurred, and indeed some gains were reported in association with the AAC interventions.

Since publication of these meta-analyses, one additional study has been published that also investigated natural speech development in children who used AAC. Ganz, Parker, and Benson (2009) investigated the use of pictures, intelligible words, and maladaptive behaviors after three participants with autism were trained in the Picture Exchange Communication System (PECS) (Frost & Bondy, 2002). In addition to gains in other areas, results indicated that two of the three participants increased the number of spoken words during the intervention as compared to the baseline sessions.

As a whole, the articles included in the meta-analyses and Ganz at al. (2009) yielded three factors most apparent and applicable to this research project. First, it was apparent that a variety of interventions (e.g., drill-type and naturalistic) and AAC systems (e.g., sign language, picture exchange, speech-generating devices) could be successfully used to help facilitate increases in natural speech (e.g., Olive et al., 2007). The second theme is related to the importance of participants having access to a speech model, whether that model is naturally or synthetically produced. In the studies where speech was manipulated (i.e., the inclusion of a speech model), the participants typically produced more speech when speech was used as a

stimulus (either verbalizations from the clinician or synthetic verbalization from the AAC device) (e.g., Parsons & LaSorte, 1993; Yoder & Layton, 1988). Finally, it appeared that providing an opportunity or an expectation of a speech production during treatment or AAC use was necessary for the child to consistently produce speech. This was especially apparent in studies that showed significant increases in speech when a time delay, which provided an opportunity and expectation for natural speech, was implemented (e.g., Charlop-Christy et al., 2002; Ganz, Simpson, & Corbin-Newsome, 2008; Tincani, Crozier, & Alazetta, 2006).

Although these research studies are considered to provide the best-evidence in natural speech development in children who use AAC, there were several limitations to generalizing these research findings to this current study. First, virtually all of the participants who were included in the meta-analysis studies and the Ganz et al. (2009) study had a diagnosis of autism, mental retardation, or a hearing impairment. Second, in the majority of these studies, natural speech changes were not the primary dependent variable. Although the authors described the effects of each of their implemented interventions on natural speech, it was unclear as to if this was a pre-planned question or a result of post hoc data analysis. Since speech was not actually the target in these treatments, it may not be too surprising that any reported gains were generally low; occurring as a by-product of implementing the AAC system. Third, none of the research studies investigated the quality, or accuracy, of natural speech production following implementation of AAC. Information was only provided for the quantity, of the number of words used that resulted from the interventions. Finally, the communication context for most of these studies occurred in a naming or requesting activity. This could have resulted in limited opportunities for communication, and therefore possibly limited opportunities to produce natural speech.

Following a more extensive search for articles that more directly applied to the implementation of the integrated multimodal intervention proposed in this study, only three additional case studies were identified from the research base. Culp (1989) implemented an AAC training program with an 8-year old participant with CAS, named Terri. Terri's pre-training intervention primarily consisted of drill and practice activities focused on improving speech production. The intervention training implemented in the study incorporated development of functional and rewarding communications for the AAC user and her communication partners. Speech production was not a component of the intervention. Terri used facial expressions, gestures, vocalizations, signs, and a picture communication system as primary means of communication. Terri also produced approximately 10 words with her natural voice. After completion of the 3-day intervention, Terri's overall amount of communication did not change, however, her mother reported that the amount of spontaneous communications increased and her number of communication partners increased (Culp, 1989). Terri's speech-language pathologist also modified intervention goals to support communication, not just speech, after the training. The author (Culp, 1989) stresses the importance of clinicians understanding that "…speech facilitation, alone, may not ensure speech success" (p. 32) and that other interventions, such as AAC, may prove beneficial.

Cumley and Swanson (1999) provided case study information on three participants who were diagnosed as having CAS and who were making minimal improvements in traditional speech interventions targeting accurate speech production. These authors rationalized the implementation of AAC with these three participants due to their limited ability to participate in communicative interactions and the potential for AAC to facilitate other forms of communication, including natural speech. The first participant, Ann (age 3;7), received a

multimodal AAC system including low-tech overlays and a speech generating device. Her treatment consisted of strategies used to facilitate language production and communicative competence. Subsequent to receiving the AAC, Ann's mean length of utterance increased from 2.6 to 4.6, and included both verbal and symbolic speech. The second participant with CAS, Kelly (age 8;0), was provided a low-tech AAC system (e.g., communication boards). Her treatment consisted of using AAC to repair communicative breakdowns and to initiate communication, and also implementation of the Hodson approach (e.g., cycles approach) while incorporating traditional CAS treatments (e.g., touch-cues, self-monitoring). Her treatment sessions were divided equally between AAC and CAS targets. The intervention reportedly resulted in greater ability to engage in a variety of communication interactions, but no specific data were provided on her speech and language production post-treatment. The final participant, Carl (age 12:9), received high- and low-tech AAC systems (e.g., communication boards, Sharp Memo Writer). Similar to Kelly, Carl was trained to use his AAC systems primarily to initiate communication and to repair communication breakdowns. Changing his goals from speech production to communication production allowed Carl to develop confidence in his communication and to take a more active role as a communicator (Cumley & Swanson, 1999).

An additional case study by Watson and Leahy (1995) described a multimodal intervention for Edward (age 3;1 at beginning of study), who was diagnosed as having CAS. Edward's initial intervention consisted of teaching sign language and fingerspelling, as well as targeting oral speech. It was noted that Edward responded most successfully to production requests when the clinician utilized oral productions and a sign or fingerspelling. Although improvements were observed in Edward's communication ability, his clinician decided to reduce emphasis on the sign and fingerspelling interventions, and focus more on natural speech

production. Edward subsequently became resistant to therapy activities which required him to make an oral production in repetitive practice format. More naturalistic activities, including book reading and telling stories, were implemented in an attempt for Edward to produce longer utterances, and also work on modifying speech production. Edward willingly corrected his sound errors when this type of intervention was implemented. By the time Edward reached school-age, he no longer required speech services. The authors attributed Edward's success to providing him with several communication modes, using meaningful activities, and a de-emphasis on oral speech production practice tasks (Watson & Leahy, 1995).

These three case studies provided a foundation of evidence to support the potential of incorporating AAC and traditional treatments for children with SSIs. Although little quantitative data were provided to measure speech production accuracy as a result of the multimodal communication treatment, all three of these articles consistently reported that communicative competence in general, whether in the form of increased initiations, increased communication partners, increased amount of speech production, or an increased ability to repair breakdowns, resulted for all of the participants. Taken together, these three case studies provide support for the multimodal treatment suggested in this current research study. It is anticipated that this study's results will add to the limited research base that presently exists, and will also provide additional experimentally controlled quantitative data implemented to support the combined use of AAC and traditional speech interventions to increase the overall communication growth in children with SSIs.

The base of research has shown initial support for a multimodal AAC intervention to enhance natural speech. There is still however, little methodologically robust data that directly supports the use of an integrated multimodal intervention presented in this study. Considering

this paucity of empirical evidence, information derived from theoretical frameworks can be utilized to provide further support for treatment options (Ylvisaker, Hanks, & Johnson-Green, 2003). Additionally, plausible hypotheses grounded in theory to support "why" this type of intervention may work are necessary in order for the community of researchers and practitioners to begin advocating its use. Numerous authors have provided such hypotheses, primarily in the form of post-hoc speculation or explanation, in an attempt to answer this question. The hypotheses presented reasonable suggestions as to why AAC might facilitate natural speech. Several broad reviews have been published in an attempt to synthesize these hypotheses (Blischak, Lombardino, & Dyson, 2003; Kangas & Lloyd, 1998, 2002). Four hypotheses regarding the therapeutic mechanisms that may potentially be responsible for expected behavior changes produced by participating in an integrated multimodal intervention (i.e., increases in the amount of communication produced and also the accuracy of speech targets produced) are presented.

Development of interactions. It has been suggested that in order for children to learn to communicate, they need to engage in social interactions where the child is an equal and active participator (e.g., MacDonald, 2004; Norris & Damico, 1990). Traditional speech interventions are inconsistent with this proposition, consisting of limited conversation opportunities and one-sided attempts at eliciting communication through sound production practice. Augmentative and alternative communication, however, can provide a child with limited speech capabilities the opportunity to become an active partner in communication. Research has shown that parents of AAC users reported increases in participation in several areas after AAC systems have been implemented. Angelo (2000) reported that the majority of parents reported increases in their child's ability to communicate with family, peers, and professionals; reported increases in their

ability to convey and express emotions; and reported that their AAC-using child had more opportunities educationally and socially as a result of using an AAC device. Renner (2004) stressed the absolute necessity of alternative language users being active participants in an environment that contained the desired language form if any component of the desired form is expected of the alternative language user. From this perspective, participation in meaningful social interactions, which AAC often permits one to be able to do, is necessary for learning to take place. Providing children with this necessary social interaction through AAC could then be viewed as the required mechanism that allows speech to also be learned.

Operation within the child's ZPD. Children with communication disorders are often functioning within a mismatch; a mismatch between their communication skills and the communication that is occurring in their environment; or between their communication skills and the communication that is expected of them (MacDonald, 2004). This mismatch could be one reason that traditional speech interventions used with children with SSIs often yield limited or slow-achieving results; the speech production expectations simply may not be within the child's zone of proximal development. Vygotsky (1978) defined the zone of proximal development: "It is the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (p. 86). Augmentative and alternative communication may provide the appropriate level of scaffold needed in order for the child to succeed during traditional intervention, in this case accurate natural speech production. In other words, AAC may allow speech production to now be in the child's zone of proximal development.

Demand reduction. Several authors have suggested that a reduction in the pressure to speak might facilitate natural speech in AAC users (Blischak et al., 2003; Kangas & Lloyd, 1998; Millar et al., 2006; Schlosser & Wendt, 2008). When a child is not speaking, or has not developed communicative competence, there is a substantial amount of stress placed on parents and professionals to "get the child to start talking". With intensive attempts to try and encourage natural speech; including, bombarding children with limited speaking skills with questions, providing requests to label and name, and requests for imitation, children are receiving the message and the pressure that they need to talk (Blischak et al., 2003). These procedures may indeed yield speech in children who are typically developing, but in our children with severe speech sound disorders, there is the possibility that these attempts are exerting too much pressure on them to speak. Kangas and Lloyd (1998) suggest that "…because expected performance may exceed the capacity or readiness to produce speech, the pressure may become detrimental to further speech and language development" (p. 529). However, when AAC is implemented, the pressure to speak may be reduced due to the fact that the child has been given an alternative means to "speak" or communicate. In essence, once the big pressure to start talking with words is reduced or eliminated as a result of the AAC, speech subsequently has a chance to develop and often does (Blischak et al., 2003; Kangas & Lloyd, 1998; Millar et al., 2006; Schlosser & Wendt, 2008).

Opportunities for reinforcement. Targeting natural speech in children who have a limited ability to imitate, which is common in children with complex severe speech sound disorders, poses a difficult challenge. According to behaviorism principles (Skinner, 1957), the ability to imitate is critical for language learning to take place. This is further exemplified in the AAC and natural speech studies that noted participants who were able to imitate made the most

gains in natural speech (Schlosser et al., 2007; Yoder & Layton, 1988). If there are no, or very few, productions to shape and reinforce, it is anticipated that increases in natural speech would be minimal. It could be suggested that a speech-generating AAC system provides an opportunity for a production, in the form of the synthetic acoustic signal, which is necessary in order to apply reinforcement to the desired verbal behavior. While a lack of natural verbal imitation precludes direct reinforcement of a participant's natural speech, at the very least the synthesized speech produced by a participant can be reinforced and increases in communication should result.

These proposed hypotheses provided a broad range of viable possibilities to account for why increases in natural speech may be observed as a result of combining AAC and traditional intervention techniques in an integrated multimodal intervention. Consideration of potential therapeutic mechanisms serves two purposes. First, although these potential therapeutic mechanisms were not directly tested in this research study, the importance of proposing and considering "why" an intervention may work, in addition to showing that an intervention is effective, is necessary for operation within an evidence-based practice framework. Second, if these therapeutic mechanisms are thought to be responsible for expected behavior change, then they must guide the intervention. Interventions are not only required to have evidence to prove its effectiveness, but must also operate within and be consistent with established learning frameworks. The following section describes specific intervention components derived from the research base and from the hypothesized therapeutic mechanisms considered to be necessary for the integrated multimodal intervention proposed to increase the quantity and quality of speech production.

Intervention Components

A number of successful, accepted intervention practices have been identified in the field of speech-language pathology. This section describes several intervention components that have been pulled from the literature and are based on positive research findings and sound theoretical support from research into childhood speech and language impairments and also AAC use. These intervention techniques or procedures are viewed as being critical for a multimodal intervention that integrates natural speech development and AAC use, such as the intervention proposed in this study.

These intervention practices presented can be categorized or classified according to their degree of naturalness, that is the degree to whether the intervention techniques are considered more clinician-directed (i.e., more unnatural), more client-centered (i.e., more natural), or somewhere in between the two (i.e., hybrid approaches) (Fey, 1986; Paul, 2007). Within this naturalness continuum, the activity (e.g., drill or daily activities), the physical context (e.g., clinic or home), and the social context (clinician or parents) all contribute to determining the naturalness of an intervention (Fey, 1986).

The naturalness continuum also provides a framework to consider theoretical perspectives of learning. Two prominent learning theories used in speech-language pathology are operant behaviorism (Skinner, 1957) and social learning theories (Vygotsky 1978, 1986). Social learning theories support the idea that for learning to occur, it should be situated in the activity, context, and culture in which the individual participates (McLellan, 1996). Translated to speech and language intervention, social learning theorists would support treatments that occur in a naturalistic environment with topics centered on genuine communication (Hewitt, 2000). The client-centered end of the naturalness continuum would be supported by social learning theory.

On the other end of the continuum, clinician-directed, is best supported by operant behavioral learning theory (Skinner, 1957). For learning to occur, behaviorists shape a produced behavior into the desired final behavior and subsequently provide reinforcement in an effort to increase the desired behavior (Holland, 1967).

There is evidence to support speech and language interventions associated with both ends, as well as the middle, of the continuum of naturalness (e.g., Bellon-Harn, Hoffman & Harn, 2004; Camarata, 1993; Eikeseth & Nesset, 2003; Halle, 1982; Hart & Risley, 1975, 1980; Hoffman, Norris, & Monjure, 1990; Kroeger & Nelson, 2006; Strand, Stoeckel & Bass, 2006; Tyler, 2008). While some researchers and clinicians have a strong preference for one side of the continuum, as well as one theoretical framework, others have used this continuum to utilize interventions most appropriate for the specific desired behavior. The behaviors targeted for this intervention, increasing the quantity and quality of speech production through traditional speech interventions combined with AAC, warrant interventions that range from one side of the naturalness continuum to the other. A description and rationale of the selected intervention components will be discussed in detail.

Natural language based activities. A natural language-based approach requires active participation of learning which integrates all areas of speech and language in the context of meaningful and natural interactions (Norris & Damico, 1990). Treatment should therefore occur in a natural social context in which speech and language is produced as a communicative act, not simply as an isolated production to satisfy the therapist (Hoffman, 1993). Researchers suggest a cohesive thematic unit, potentially centered on children's storybooks, be used as the context for speech and language intervention. Thematic units facilitate recurring ideas, provide opportunities for a consistent and repeatable experience, and provide an opportunity to include collaborative

activities, all of which have been proposed as necessary for learning within a natural language approach (Norris & Damico, 1990). Use of genuine contexts and activities to target speech and language has been supported by a number of empirical and theoretical studies (Bellon, Ogletree, & Harn, 2000; Bellon-Harn, et al., 2004; Camarata, 1993; Hoffman, 1993; Hoffman, Norris, & Monjure, 1990; Norris & Hoffman, 1993; Pierce & McWilliams, 1993). Cohesive, naturally occurring, conversationally based activities also provide an opportunity to ensure that generalization to spontaneous speech and language can occur. Use of learned speech and language targets in natural speaking environments are imperative to determining an intervention's success. Natural language based activities allow opportunities for generalization practice to occur throughout the intervention.

Target redundancy. Redundancy has been described as "…the same information is encountered numerous times, but in slightly different ways or in slightly different contexts each time" (Norris & Hoffman, 1993, p. 194). Norris and Hoffman (1993) stress the importance of providing multiple opportunities for the same information to be presented in a multitude of contexts. Redundancy is related to the concept of repeated engagement, which refers to language-learning as a result of conversational use and repeated engagement in complex activities (Hengst, Duff, & Dettmer, 2010). Clinician provision of multiple meaningful models is one method used to naturally elicit repetitions without drill through repeated and redundant repetitions of targets during a variety of conversational acts. Hengst et al. (2010) showed that client repetitions can occur at a high rate in a genuine communication act without the use of drill activities. The authors claim that this type of repetition is preferred to repetition that occurs from decontextualized drill activities due to the memory systems involved, the goal-directed

communicative activity, and the important role of the clinician acting as a communication partner as opposed to a drill leader (Hengst et al., 2010).

Multiple discrete trial practice. Discrete trial format intervention (DTI), commonly referred to as drill activities, are used in a variety of speech and language interventions. Drill activities require multiple opportunities to shape imitated and spontaneously produced speech targets (Tyler, 2008). Drill activities are clinician-directed and facilitate high rates of production practice. Rooted in operant behaviorism drill activity is often described as unnatural and lacks generalization of skills. Supporters of imitation instruction, however, contend that it is within this unnaturalness that improvements for some learners, specifically those with impairments, may best be supported (Connell, 1987).

Discrete trial opportunities also provide a context for implementing specific intervention techniques. Relevant to this research study, discrete trial training can provide an opportunity to implement integral stimulation methods, which are techniques commonly used in children with CAS. Integral stimulation methods refer to treatment approaches that require the client to imitate utterances provided by the clinician, with particular attention placed on auditory, tactile, and visual cues (Strand & Skinder, 1999). Procedures such as physically manipulating articulators, providing a verbal description of the articulators, placing emphasis on articulatory positioning, and shaping produced sounds into targeted sounds were all common procedures used in integral stimulation methods (Strand & Skinder, 1999; Strand, Skinder, & Bass, 2006). Discrete trial activities provide an opportunity to use various tactile, visual, and auditory shaping cues in an attempt to promote accurate production in a context that does not disrupt the natural flow of communication (e.g., “feel the back of your tongue pushing to the top of your mouth for the /k/ sound”, “look at my lips, they need to be round like this for the /ʃ/ sound”).

Speech-generating dynamic-display AAC device. Research suggests that speech-generating AAC systems provide the following added benefits to unaided AAC (e.g., sign language): (a) the acoustic output of SGDs, (b) the opportunity to provide reinforcement to speech produced (even if synthetic speech), and (c) the SGDs provide greater opportunities for participation in the intervention activities. Researchers have suggested that when synthesized words are produced with the AAC device, the user benefits by being exposed to an immediate, clear, and consistent model of the word each time the device is activated (Blischak et al., 2003; Romski & Sevcik, 1993, 1996; Schlosser & Blischak, 2001; Schlosser & Wendt, 2008). According to Romski & Sevcik (1993) "…one may speculate that the consistency of the synthetic speech output preserved dimensions of the auditory signal that permit the listener to segment the stream of speech more easily" (p. 283). The greater ability to segment and process speech may in turn facilitate the production of speech. The clear and accurate acoustic signal may also have potential to strengthen acoustic neurologic connections due to the repeated experiences of hearing the auditory representations of speech from the frequent activations of the SGD. These multiple opportunities for perceptual training may allow a significant amount of auditory "practice" which could in turn facilitate natural speech production (Schmidt & Lee, 2005; Schmidt & Wrisberg, 2008).

An additional hypothesis related to acoustic output in speech-generating AAC systems is the AAC user's ability to control the frequency or the number of times a word is produced synthetically. In the motor learning literature, self-control of receiving a model has been shown to be more advantageous than when a model is presented on a specific schedule (Wulf, Raupach, & Pfeiffer, 2005). It is possible that speech-generating AAC systems allow the precise amount

of modeling for a given AAC user that is needed to facilitate production of their own speech (Parsons & LaSorte, 1993).

Clinician provision of AAC modeling. Aided modeling refers to the practice of the clinician or the communication partner accessing symbols on the AAC system the child is using while typically providing a spoken model. Goossens' (1989) used the term aided language stimulation to describe the process of augmenting verbal models and verbal output with visual representation during communication. Romski and Sevcik (1996) described a similar technique within the System for Augmented Language (SAL) that used clinician verbal models in conjunction with clinician activation of the client's speech-generating AAC system. These methods have been shown to increase language production in AAC users (Goossens', 1989; Harris & Reichle, 2004; Romski & Sevcik, 1996).

Aided AAC modeling may serve several purposes for AAC users. First, AAC modeling provides instruction of AAC use through clinician models and examples. For beginning communicators or beginning AAC users, this instruction may promote use. Second, AAC modeling may imply to the user that AAC use is a valued, respected, and authentic form of communication; one that the partner is willing to use (Romski & Sevcik, 1996). Third, AAC modeling may facilitate the relationship between spoken words and their symbolic representation. For example, hearing the word "phone" while pointing to a picture of a "phone" may help match the symbol to its referent (Romski & Sevcik, 1996). Finally, AAC modeling supports multimodal communication. By directly modeling multiple modes of communication, the AAC user can observe the effectiveness of multimodal communication occurring in natural contexts.

Therapeutic conversation components. When providing client-centered intervention, many techniques are used in an attempt to elicit, shape, and encourage speech and language production and development. Many of these techniques naturally occur in the *ordinary talk* of a skilled communicator; the primary difference between *therapeutic conversation* and *ordinary talk* is conscious maximization and facilitative use of these techniques (Paul, 2007). The intervention research base provides several evidence-based therapeutic conversation procedures that are commonly used during quality speech and language intervention including; self-talk and parallel-talk, direct and gentle questioning, imitation, cloze techniques, expansions, recasts, focused stimulation, time delay, following the child's lead, and milieu strategies (e.g., Bellon-Harn et al., 2004; Bradshaw, Hoffman, & Norris, 1998; Halle, 1982; Kaiser, Yoder, & Keetz, 1992). Paul (2007) provided a summary description of common therapeutic conversation techniques used in interventions with children who have speech and language impairments.

The Current Research Study

The purpose of this study was to examine the effects of a novel integrated multimodal intervention program that *incorporated* AAC and traditional speech interventions, with the goal of increasing the quantity and quality of natural speech production in these children with SSIs. The intervention proposed in this research study was based on the literature review of traditional interventions used in children with SSIs, literature presenting the effects on AAC on natural speech development, consideration of proposed potential therapeutic mechanisms of a multimodal intervention, and a review of effective intervention components found in the literature. This intervention was developed following an evidence-based practice framework, where the integration of research findings, clinical expertise, and stakeholder values (Dollaghan, 2007; Schlosser & Raghavendra, 2003) was considered. The evidence reviewed has provided

sufficient data to support the implementation of an intervention specifically designed to integrate traditional speech therapy techniques with AAC therapy techniques in an attempt to facilitate natural speech development in children with SSIs through a multimodal intervention. The evidence also supports the prediction that increases in natural speech should occur in children with SSIs who receive this intervention.

In summary, this research aimed to examine the effectiveness of a treatment program designed to increase the quantity and quality of natural speech production in children with SSIs who use speech-generating dynamic display AAC systems. The specific research questions asked in this study were as follows:

1. Does participating in the treatment result in increases in the quantity of natural speech and AAC-generated speech production of words containing the target phonological patterns?
2. Does the integrated speech intervention result in increases in quality, or the accuracy, of natural speech production of words which contain target phonological patterns?
3. Does the treatment program support generalization to words that contain the targeted phonological patterns which were not targeted in the intervention?
4. Are the results achieved through the intervention maintained over time?
5. Are the intervention outcomes socially validated based on qualitative data obtained from the parents of the participants?

Chapter 3: Methods

This intervention study consisted of a hybrid design utilizing single-subject and qualitative data collection and analysis methodologies. At the core of this investigation was a multiple-baseline across participants design with three participants and a multiple-baseline across behaviors for one participant. These methodologies were useful in determining the effects of an integrated multimodal intervention program on a heterogeneous population by documenting the level of the target behavior in a no-treatment, or baseline condition, and comparing data obtained in a treatment condition (Kazdin, 1982). To delve deeper into the communication practices, opinions, and experiences related to receiving the treatment, qualitative methods provided additional data to socially validate the intervention's effectiveness. In addition to researcher notes and observations, data based on pre-treatment, during-treatment, and post-treatment semi-structured interviews were obtained from the parent participants. The semi-structured interviews provided the opportunity to ask pre-formulated questions and probe related topics of interest, with the flexibility to ask unscripted questions as the interviewer deemed appropriate (Schensul, Schensul, & LeCompte, 1999).

Hybrid, or mixed-method design, was necessary to effectively answer the research questions posed in this study. Greene, Caracelli, and Graham (1989) summarized five purposes for implementing a mixed-method design: (a) triangulation, (b) to provide complementary data, (c) to inform a sequential analysis, (d) facilitate discovery of unexpected or conflicting findings, and (e) to expand the breadth and range of the research. The goals of this study were to use qualitative and quantitative methods to compensate for the limitations or biases inherent to each methodology, to ascertain and strengthen the validity of the results, and to elaborate or clarify the research findings. Within this hybrid design, the quantitative methodology was the primary

methodology used and the qualitative methodology guided data collection and analysis and provided social validation information. Data for both methodologies were collected simultaneously.

Participants

The child participants were recruited through a public-source generated list of professionals who routinely work with the target population (e.g., speech-language pathologists, AAC company representatives). These professionals were asked to supply a research flyer detailing the study to potential participants' families. Four interested families contacted the primary researcher and expressed interest in participating in the study. Prior to participation, informed consent and assent were obtained from each participant and their parents. (See Appendices A, B, and C for recruitment letters, consent form, and assent form). The selection criteria for inclusion were as follows: (a) primary impairment of a severe speech sound disorder; (b) between the ages of 4 and 9 years; (c) no report of hearing impairment; (d) primary form of communication is spoken English; (e) was currently using or has had trial experience with a dynamic display speech-generating AAC device; (f) received a severity rating of severe or profound on the Hodson Assessment of Phonological Patterns-3rd Edition (HAPP-3; Hodson, 2004) and/or received a severity rating of severe or profound on the speech subtest of the Functional Communication Profile-Revised (FCP-R; Kleiman, 2003); and (h) had parents willing to participate as interview informants throughout the treatment. Participants who had additional secondary impairments in social communication, expressive or receptive language, cognitive skills, or deficits in literacy skills had potential to be included in this study and were considered on a case-by-case basis.

Four children who ranged in age from 4:1 to 8:6 and their parents demonstrated an interest in participating in the study. After the initial evaluation, three of the four participants met the inclusionary criteria and participated in the standard treatment used in this study. The fourth participant was excluded from receiving the standard treatment due to; (a) additional profound language impairments, and (b) the primary mode of communication was not natural speech.

The three participants were males who attended public school in central Illinois. All of the participants were reported by their parents to have normal hearing. Each participant had previously received speech and/or language services, although none had participated in a treatment program similar to the intervention used in this study. A detailed description regarding each participant, which is based on parent report and information gained from the formal and informal assessments, is provided in subsequent sections. See Table 1 for participant demographics.

Assessment of participant skills. Natural speech was assessed using the Hodson Assessment of Phonological Processes-3rd Edition (HAPP-3; Hodson, 2004). This assessment was selected based on its design for children with "highly unintelligible speech" (Hosdon, 2004, p. v). Since the purpose of the research assessment was not to determine the presence of a phonological impairment, but to document types and characteristics of speech errors, this assessment was determined to be appropriate to provide this information. Consistent with test protocol, miniature items and line-drawings were presented to the participants to elicit a verbal production of 50 target words. A verbal model of the stimulus was provided if the participant indicated the stimulus was unknown to them or did not provide a production of the stimulus after a several second pause. This assessment yielded a phonological deviancy score and a severity

rating. Descriptive data regarding the participant's natural speech were also obtained through an initial parent interview.

Table 1

Demographic Information

Participant	Age	Sex	Speech Diagnosis	Communication Modes	Informant
John	8;6	Male	CAS	Natural speech Gestures Sign Spelling Dynavox V	Mother Father
Thomas	4;1	Male	CAS	Natural speech Gestures Spelling Vantage Lite	Mother
Luke	5;8	Male	CAS	Natural speech Gestures Dynavox V	Mother Father

Note. CAS = childhood apraxia of speech

Communicative competence was assessed via two procedures. The Functional Communication Profile-Revised (FCP-R; Kleiman, 2003) was administered to the parents of the participants and solicited information regarding eleven areas; sensory, motor, behavior, attentiveness, receptive language, expressive language, pragmatic/social, speech, voice, oral, and fluency skills. The initial parent interview process also yielded information regarding overall communication patterns, communication competence, AAC systems used, a summary of previous/current therapy, and communication goals. See Table 2 for a summary of assessment data obtained for each participant. A detailed description of each participant's presenting and assessment information follows.

Table 2

Assessment Information

Participant	HAPP-3 Phonological Deviancy Score	HAPP-3 Rating	FCP-R[a] Receptive	FCP-R[a] Expressive	FCP-R[a] Speech
John	204	Profound	Mild	Severe	Profound
Thomas	127	Severe	Mild	Severe	Profound
Luke	65	Moderate	Moderate	Severe	Severe

Note. HAPP-3 = Hodson Assessment of Phonological Processes (3rd ed.); FCP-R = Functional Communication Profile-Revised. [a]Only three select subtest of the FCP-R were reported.

Participant Profiles

John's profile. John was an 8;6 year-old boy when he entered the study. John has a diagnosis of Opitz FG Syndrome. Opitz FG syndrome is an X-linked genetic syndrome which causes a wide range and variety of physical abnormalities, developmental delays, obsessive-compulsive tendencies, and communication deficits (FG Syndrome Family Alliance Inc., 2009). John's FG Syndrome presented primarily in severe speech delays and mild-moderate fine motor delays. John's school-based speech-language pathologist (SLP) diagnosed him as having CAS. John's hearing and vision were both reported as being normal. John attended second-grade in an elementary school in central Illinois and was placed in the regular education classroom for most of the school day. He received limited services in the cross-categorical life-skills classroom where he received support for activities of daily living. Academically, John's strengths were in reading and his weaknesses were in math. John also received occupational therapy to improve his handwriting skills. John's speech therapy centered on combining early occurring consonants

(e.g., /b, p, m/) and vowels during target-drill activities and occurred for 15 minutes a day. Overall, John's parents reported being pleased with his academic and therapeutic services.

John's expressive communication modes consisted of natural speech, gestures, sign, spelling, and a DynaVox V dynamic-display speech-generating AAC system. Since early-intervention services, John was first instructed on use of the Picture Exchange Communication System (Frost & Bondy, 2002) and subsequently sign language. When John was near completion of kindergarten, he received his DynaVox V. Although John was highly unintelligible to unfamiliar listeners, especially when the topic was unknown, he preferred to use natural speech as his primary means of communication. John rarely used the DynaVox V at home or at school, although he reported that he liked his "talker". John was characterized as a persistent communicator, he usually wouldn't give-up until he was understood employing his multiple modes of communication. He rarely became frustrated with his inability to be understood, although his communication negatively impacted his ability to socially communicate with peers. John was also characterized as a passive communicator; he did not spontaneously initiate communication as often as would be expected, and his communication function was primarily to express wants and needs. Primarily, John's parents wanted his words to be more recognizable by other people, develop skills to carry-on conversations, and communicate more freely with others.

Assessment data collected prior to intervention revealed John presented with profound speech impairment. Results from the HAPP-3 (Hodson, 2004) indicated a greater than 80% error rate when attempting to produce consonant sequences (120%), post-vocalic singletons (100%), liquids (100%), stridents (93%), and velars (100%). John's lack of speech intelligibility also negatively affected his expressive language, primarily in the form of reduced output and a lack of morphological markers--potentially accounted for by deletion of final consonants. It was

reported that John was capable of speaking in five-word sentences. John was described as only having mild impairments in receptive language, attentiveness, and motor/sensory (e.g., deficits in fine motor skills particularly for handwriting) areas based on the FCP-R (Kleiman, 2003). John's assessment data indicated that he met the qualifications for inclusion in the study.

Thomas's profile. Thomas was a 4;1 year-old boy at the beginning of the study. Thomas's only diagnosis was CAS obtained from a speech-language pathologist and a child neurologist. Thomas participated in a regular-education preschool where he received 80 minutes of speech-therapy a week using procedures outlined in the Kaufman Speech Praxis Treatment Kit for Children (Kaufman, 1998). Thomas also attended outpatient speech treatment at a nearby university-based speech and language clinic one time per week for one hour where speech was also the target of therapy. Both treatments were treating early developing sounds (e.g., /b, p. m/) primarily in syllables and simple words. The university-based clinic facilitated acquisition of Thomas's AAC system by providing professional reports, although Thomas' mother was the primary individual who sought the AAC device. Thomas had received the device approximately one month before the beginning of the study; although he had trialed the device for six weeks during the spring of his pre-school year. Thomas' mother was generally not pleased with the lack of interest the school and the school-based speech-language pathologist exhibited toward the AAC device. There were no specific goals to develop communicative competence using the AAC device in his Individualized Educational Plan. Thomas's mother reported that the school thought Thomas talked less when he had the device. It should also be noted that just prior to beginning the study, Thomas's school-based speech therapy was suspended due to the summer vacation and his speech therapy time at the university-based clinic was modified to one time per week for two hours with a continued emphasis on production of early developing speech sounds.

Thomas' expressive communication was characterized by natural speech, gestures, spelling, and a Vantage-Lite dynamic-display speech-generating AAC system. Thomas was a highly unintelligible communicator; with his mother reporting she only understood about 10% of what he said and speculated that strangers understood even less. Thomas had not received any direct therapy on the use of his AAC device and would not be considered an overly proficient AAC user. The language software used on a Vantage Lite required unique training and practice to learn the nature of the system in order to locate vocabulary. Thomas had received no such training. Thomas was using the device mainly to request certain food items and spell the names of his favorite train toys. Thomas's severe expressive communication disorder did not necessarily preclude him from attempting to communicate with family, peers, and teachers; however, he would become increasingly frustrated when his messages were not understood. Thomas was not a persistent communicator, it was reported he would often just put his head down when others were not able to understand his messages.

Assessment data revealed a severe speech impairment was present. Results from the HAPP-3 (Hodson, 2004) indicated significant error rates on consonant sequences (112%), liquids (94%), velars (59%), stridents (57%), and prevocalic singletons (43%). Thomas's speech errors resulted in limited intelligibility, even by his mother and other family members. Thomas mainly spoke in one-word utterances and used communication primarily for wants and needs and to name objects. Thomas had no significant impairments in receptive language, gross/fine motor skills, attentiveness, or pragmatic/social skills based on the FCP-R (Kleiman, 2003), and sufficiently met the qualifications for inclusion in the study. Strengths were noted in Thomas's pretend play skills.

Luke's profile. Luke was a 5;8 year-old male when he began the study. Luke had a diagnosis of CAS at the beginning of the study, and later received a diagnosis of pervasive developmental disorder-not otherwise specified (PDD-NOS). Luke's PDD-NOS and CAS presented in moderate deficits in receptive language, social communication, and attentive behavior with more severe impairments in fine motor/handwriting, expressive language, and speech production. It was determined that the diagnosis of PDD-NOS did not significantly impair his ability to participate in the activities of the treatment. Luke's hearing and vision were reported as being normal. Luke attended pre-school in an early childhood preschool for at-risk children, where an emphasis was placed on learning pre-academic skills (e.g., colors, shapes). During the summer months, Luke attended a local day care/early learning center. It was anticipated that he would be placed in a regular-education kindergarten with special education support when the fall school-year began. He received occupational therapy as well as speech and language services targeting speech production and functional communication use. Luke's mother was a speech-language pathologist and was greatly involved with his educational and therapeutic programs.

Luke's expressive communication consisted of natural speech, gestures, and a DynaVox V dynamic-display speech-generating AAC system, which he had been using for approximately a year and a half. Luke's communication preference was natural speech and his DynaVox V was used primarily when his natural speech failed in relaying his intended message. Luke presented with reduced communicative output, with requesting being his most common function of communication. He was, however, beginning to use communication more often to gain attention, protest, comment, and to narrate play routines with action figures. Luke's father reported that he understood approximately 80% of his verbal communication, but that unfamiliar listeners who

did not realize he had a communication problem would probably understand much less. Luke was described as a patient child who rarely became frustrated with his communication difficulties. Luke's father was concerned that failed communication attempts might be discouraging him from attempting more communication, especially with peers.

Results from the initial assessment showed that Luke had a moderate speech impairment based on the HAPP-3 (Hodson, 2004) with error rates as follows: liquids (79%), consonant sequences (54%), stridents (43%). Luke was unique in the fact that he was able to produce a significant amount of intelligible speech when two conditions were present; a verbal model was provided and productions were in single words, such as during administration of the HAPP-3 (Hodson, 2004).. Luke's speech was highly unintelligible to unfamiliar listeners during conversational speech, especially when the topic was unknown. Overall, Luke's expressive communication was severely delayed due to reduced communicative output and unintelligibility of speech. Strengths were reported and/or noted in Luke's imaginative play abilities, computer skills, and his sense of humor.

Design Overview

A multiple-baseline across participants design was used to quantitatively evaluate the effectiveness of the integrated multimodal intervention (Kazdin, 1982) for all three participants. The multiple-baseline across participants study began with the collection of baseline data for all participants: John, Thomas, and Luke. When a stable pattern was evident for John, the intervention was implemented with him while Thomas and Luke continued in the baseline condition. When the data began to show a positive treatment effect with John, the intervention was subsequently implemented with Thomas. This process continued for the third participant of the study, Luke. Additionally, a multiple-baseline across behaviors design (Kazdin, 1982) was

used for one participant of this study, Thomas. For Thomas, treatment was first implemented on one target sound while a second target sound remained in the baseline condition. When treatment on the first target sound was completed for Thomas, treatment on the second target sound began. For the multiple-baseline across participants study (i.e., John, Thomas, and Luke), and for the multiple-baseline across behaviors study (i.e., Thomas), an additional target sound remained in baseline for the duration of the study and provided control data. The intervention concluded after participation in a maximum of 12 intervention sessions, or if accuracy of a speech target reached 90% over two consecutive sessions. The research study included three stages; baseline, intervention, and maintenance.

Procedures

The independent variable of this research study was the integrated multimodal intervention. As an overview, the intervention sessions consisted of implementing several components in an attempt to increase overall speech production and also the accuracy of specified natural speech targets. All baseline and intervention sessions contained three activities. The baseline sessions provided data on the participants' speech production when no intervention components were included. Specific details of the baseline, treatment, and maintenance sessions are provided. Table 5 provides a summary of the differentiation between baseline and intervention sessions.

Baseline. Data were obtained from multiple baseline sessions for each participant to monitor potential changes prior to treatment. One or two storybooks that contained a high number of speech target words were selected for the participants, dependent on the number of baseline sessions that were needed. Ten baseline words which contained a target sound and were used with high frequency in the selected storybooks were chosen for each participant. The 10

words were programmed into each participant's AAC device, along with additional messages specific to the session activities. At the beginning of the session, participants were briefly oriented to the new page that was created on their device. The AAC device was present and near the participants (e.g., sitting on the table or floor next to the participants), however the researcher made no additional effort or encouragement to elicit AAC use. Each baseline session consisted of the following three activities; a storybook reading, presentation of target word stimulus cards, and structured play activity. These activities were the same activities used during the treatment sessions; however the baseline activities only included clinician use of ordinary talk, that is, no therapeutic conversation took place (i.e., no purposefully intense use of self-talk and parallel-talk, direct and gentle questioning, imitation, cloze techniques, expansions, recasts, focused stimulation, time delay, following the child's lead, milieu strategies, and integral stimulation methods). Consistent with ordinary talk, and to encourage opportunities for communication, the storybook reading and the structured play activity included a rich, but ordinary communicative environment (see Chapter 2 for a further description of *ordinary talk* and *therapeutic talk*). In other words, the storybook reading and structured play activity did not occur in a "sterile" communicative environment where communication was not opportune. Various forms of interaction that occur during ordinary conversations were used in order to provide opportunity for communication. Other than typical and appropriate conversational responses, the researcher provided no specific acknowledgement or praise for verbal or AAC-produced communicative acts.

The target word stimulus card presentation activity consisted of presenting the participants with the pictures of the target words in anticipation of a verbal production. A verbal model was provided if the participant expressed a lack of knowledge of the word or did not

respond immediately. Researcher responses only consisted of generic praise for completing the task. There was no acknowledgement of correct or incorrect production of target sounds, and no correction procedure was used when an incorrect production was made. See Table 3 for examples of ordinary talk communication exchanges between the researcher and the participants.

Table 3

Example of Baseline Communication Exchanges

Transcript Excerpts Number	Excerpt
1	E And here's the little girl. E She's got her glasses on because it's so bright on Venus. E My place in space [model]. E Beautiful Earth. E It is the third planet closest to the sun. E And the only one in our solar system where living things grow. E Where do you think we live? C [ges] {points to page in the book}. E Mhm we live right up in here.
2	E Is it my turn now? C [ns.nt] Yup. E Okay, hmm I found spaceship [model], no match. C [ns.nt] Nope.
3	E Look at the kitty cat. E It's swimming [model] in space [model]! E Looks like she's swimming [model]. E And then here's Venus next to Mercury. E Spinning [model] around the sun. E What does it do? C [ns.nt] I [ns.nt] don't [ns.nt] know.

Note. E = researcher; C = child; ns = natural speech, nt = non-target word; model = verbal model; ges = gesture. Data codes are further explained in following sections.

Intervention. A novel (i.e., set of words different from the baseline target words) set of 10-20 target words were programmed into the participant's AAC device, which was readily available and placed near the participant and the clinician. In addition to the programming of the

target words, target sounds were also programmed into the AAC device based on each participant's individual targets (e.g., /f/ sound represented by letter f). The number of target words programmed was dependent on the progression of treatment (e.g., five unique words were introduced when a new storybook was introduced for a maximum of 20 words). The quality, or accuracy, of natural speech productions of the target sounds was targeted within the context of all treatment activities. The quantity of speech produced was targeted within the context of 2 of the 3 intervention activities. The target drill activity was not conducive to targeting quantity of speech production. A detailed description of techniques and activities are presented.

Chapter 2 provided a thorough rationale of selected of treatment components, procedures, and activities included in the study. There were several components that occurred during the intervention and formed the integrated multimodal treatment package: the participants' AAC device use was encouraged and received attention by the researcher; aided modeling was used with the AAC devices; target words were produced with a high number of meaningful repetitions; storybooks were shared using elicitation techniques and therapeutic conversation; therapeutic conversations were used during the structured play activity; and the target drill activity used correction procedures and numerous repetition requests. All of the communication between the researcher and the participants used therapeutic conversation techniques, which included intense and purposeful use of techniques such as self-talk and parallel-talk, direct and gentle questioning, imitation, cloze techniques, expansions, recasts, focused stimulation, time delay, following the child's lead, and milieu strategies. Additionally, the researcher also administered praise for correct productions and used a correction procedure following an incorrect production. Finally, the researcher administered a very high rate of meaningful target

word repetitions. See Table 4 for examples of therapeutic conversation techniques used during the intervention sessions.

It is important to note that even though there were two variables being targeted in this treatment; both were targeted concurrently throughout the treatment activities. In other words, the integrated nature of the treatment allowed for targeting quality and quantity of speech production simultaneously. Treatment procedures were conducted within the context of three activities: (a) a repeated shared storybook reading, (b) a target drill activity, and (c) a structured play activity, the same activities that were included in the baseline sessions. The repeated shared storybook readings were conducted in manner consistent with common practice (e.g., Bellon & Ogletree, 2000) and lasted approximately 10 minutes. In addition to therapeutic conversation techniques, additional common basic scaffolding procedures shown to be effecting in eliciting speech and language during repeated shared storybook readings were used. These included labeling and commenting, verbal dialogue, sentence recasting, use of tag questions, use of direct questioning, and pointing to pictures and print (Justice & Kaderavek, 2002; Kaderavek & Sulzby, 1998). These repeated shared storybook readings allowed the opportunity to encourage an increase in the quantity of speech production in general and also to practice accuracy of target productions.

The target drill activity consisted of presenting a visual stimulus (i.e., picture of word and orthographic representation of word) of each of the target words in anticipation of a verbal production. The target drill activity was used to provide an opportunity for multiple production practice in an effort to increase the accuracy of the target words and also to implement integral stimulation techniques outside of conversational communication. The target word drill lasted approximately 10 minutes.

The structured play activity consisted of a play activity that provided a naturalistic setting to facilitate overall speech productions and also provided opportunities for natural production of the target words. The structured play activities were centered on the thematic context of the storybook and the participants' preferences for certain activities. Therapeutic conversation techniques were used during the structured play activity.

Three techniques were used during all of the activities of the integrated multimodal intervention sessions. First was aided modeling. The researcher activated the participant's AAC device to provide an AAC model and as an indirect attempt to elicit a target production. Second, praise was administered to the participants when a correct target was produced, and finally a correction procedure occurred following an incorrect production of a target sound. When a target word was produced correctly using natural speech, the researcher administered praise (e.g., "great job", "that was a good one", etc.). Early in the treatment sessions, when speech productions containing the correct targets were limited, praise was administered essentially each time a correct verbal production was made. The praise was faded-out as the accuracy of target productions increased. When target words were produced using the AAC device, an acknowledgement of production occurred and was responded to in a communicatively relevant manner (e.g., "yeah, that's a cap"). Additional prompting was randomly used in an effort to provide an opportunity for a natural speech attempt after an AAC production. When an incorrect target was produced with natural speech, a correction procedure occurred; (a) an acknowledgment of the incorrect production was given (e.g., "I heard tap and this is a cap"), (b) a verbal, visual, and/or auditory cue was provided as necessary in an attempt to shape the target speech pattern (e.g., "put your finger back here, remember our /k/ sound comes from the back of our tongue, remember we want to hear the /k/ /k/ /k/ sound-not the /t/ sound"), and (c) the

participant was requested to retry with natural speech. In general, if after two attempts of the acknowledgment, cueing, and retry correction sequence a correct production did not result, the participant was then asked to try the word again using the AAC device. Upon producing the word with the AAC device, praise was administered, and the communication exchange continued.

For all three treatment activities, attempted production of target words was elicited using a variety of techniques used in the integrated multimodal intervention package. The treatment activities, participant characteristics, and progress in the treatment each guided how the speech targets were elicited. In general, an attempt was made to utilize a technique that elicited the highest level of spontaneously produced speech initially (e.g., close technique, "that spider looks really ___"), while more direct techniques were utilized as needed (e.g., verbal or AAC model, question, direct request for production). The responses and reactions of the participants also dictated the type of technique used; some participants responded to some techniques more favorably than others.

Maintenance. A follow-up session was scheduled to occur approximately one month after the completion of the final treatment session. Maintenance data were based on participants' production of the target words, generalization words, and control words obtained during a stimulus picture presentation probe. Percentages of correct target productions across each of these three categories of produced words were calculated by dividing the number of correct productions by the total number of productions multiplied by 100. During the same session, post-test maintenance data were also obtained from re-administration of the HAPP-3 (Hodson, 2004). Additional descriptive data regarding maintenance of skills were acquired from the post-treatment parent interview.

Table 4

Example of Intervention Communication Exchanges

Transcript Excerpts Number	Excerpt
1	E Water [model]. E We say you have to [aacmod] soak soak [model]. C [ns.cor.t] Soak. E Soak [model] the bean [model] very good. E He couldn't see his bean [model] under all of the. C [ns.cor.t] Dirt. E Very good. E But he watched [model] it everyday. E You have to watch [model] watch [model] those beans [aacmod] beans [model]. E and you have to wait [model] for those beans [model] don't you? C [ns.nt] Yeah. E Mhm. E And then something happened. E Just like in the story Jack and the Bean Stalk a greenish white. C [ns.cor.t] Plant.
2	C [ns.err.t] stuck. E Ah let me hear that snakey sound. C [ns.err.t] stuck. E Stuck [model]. C [ns.cor.t] stuck. E There it was perfect.
3	E Ruben is playing in the attic he is quite alone but he has a visitor. C [ns.cor.t] spider. E good job the spider is his visitor [model].
4	C [ns.err.t] Spins ( ). E Look at me Thomas. E Watch my mouth. E Watch my mouth. E Spin [model]. C [ns.cor.t] Spin. E There is it say it again.
5	E Baby birds and this one's the? C [ns.nt] bird. E The mommy bird. C [ns.nt] mommy [ns.nt] bird.

Table 4 (cont).

6	C [ns.nt] Uhoh [ns.nt] look! E Uhhuh. C [ns.nt] it's [ns.nt] a [ns.nt] mouse. E Is that the mouse that's the mouse home you're right that's where he lives. C [ns.nt] that [ns.nt] the [ns.nt] home.

*Note***.** E = researcher; C = child; ns = natural speech, err = error; cor = correct; t = target word; nt = non-target word; model = verbal model; aacmod = aided modeling. Data codes are further explained in following sections.

Materials and Setting

Materials. All speech stimuli were selected based on each participant's unique speech errors and/or speech error patterns as determined from the HAPP-3 results (Hodson, 2004) in relation to severity and developmental appropriateness. See Table 6 for a list of the participants' speech targets. The specific words chosen for intervention were based on the word's occurrence in association with the selected storybooks, were not considered to be highly phonologically complex, and contained one or two syllables. At a minimum for each participant, a corpus of 10 words containing the speech targets were used in baseline, 20 words containing the speech targets were used in treatment, 10 words containing the speech targets were used for generalization probes, and 10 words that contained a non-targeted speech sound were used as control probes. For the purpose of drill-type practice activities, the majority of stimulus words were represented as 1" x 1" color pictures produced with Boardmaker Software Version 6.0 attached to a white notecard. Occasionally, pictures were not represented in Boardmaker and were subsequently downloaded from Google Images (Google, 2009). A list of all words used in the study can be found in Appendix D.

Table 5

Summary of Baseline and Intervention Sessions

Activity	Baseline Sessions	Intervention Sessions
AAC Device Preparation/Use	AAC device was present Vocabulary used for baseline sessions was programmed into the device Researcher did not reference device	AAC device was present Vocabulary used for intervention sessions was programmed into the device Researcher referenced and encouraged use of the device (e.g., "use your talker, "try with your device") Researcher used aided modeling
Target Word Use	Researcher produced target words as they naturally occurred	Researcher produced a high level of target words production redundancy in a meaningful manner.
Shared Storybook Reading	Storybook was read using ordinary talk	Reading included therapeutic conversation techniques Praise was given for accurate speech production Error correction procedure following incorrect production
Stimulus Picture Drill	Participants were presented target word stimulus pictures to say verbally	Integral stimulation methods were used Praise was given for accurate speech production Error correction procedure following incorrect production
Structured Play	Activity/game was played with researcher using ordinary talk	Activity/game included therapeutic conversation techniques Praise was given for accurate speech production Error correction procedure following incorrect production

Note. AAC = augmentative and alternative communication

Table 6

Speech Targets

Participant	Primary Target	Secondary Target	Control
John	final consonants	n/a	velar /k,g/ (initial)
Thomas	/s/ consonant cluster (initial)	strident /f/ (initial)	liquid /l/ (all positions)
Luke	/s/ consonant cluster (initial)	n/a	liquid /l/ (all positions)

A variety of children's storybooks were used during the baseline and treatment sessions. Each participant was exposed to a minimum of four different storybooks, depending on the number of baseline and treatment sessions implemented. The storybooks were selected based on three factors: (a) they contained a high number of the participant's target sounds, (b) had presumed topics of interest for young school-aged males, and (c) were written at a linguistic level suitable for single word productions. A complete list of storybooks used during this study is provided in Appendix E. A number of diverse games and activities were implemented during the baseline and treatment sessions. Games and activities which were presumed to be conducive to facilitating communication were selected. Additionally, the opportunity for potential use of the participant's target sounds was considered when games and activities were chosen. Finally, individual preferences for certain games and activities were also taken into account.

Each participant's personal speech-generating AAC device was present during all baseline and treatment sessions. The researcher programmed target words, target sounds, messages related to storybook reading (e.g., turn page, all done, I' don't like that), and messages related to a specific game or activity (e.g., my turn, your turn, I win) into the SGD at the beginning of each baseline and treatment session. The participants were oriented to the location of the programmed vocabulary. In addition, the participants had access to any messages which

were already programmed into their SGD. Keyboard pages for spelling were also used by some participants on a limited number of occasions. Participants were not discouraged from searching on their SGD for any messages at any time during the sessions.

Setting. All baseline, intervention, and maintenance sessions took place in one of three settings: (a) The University of Illinois Speech-Language Pathology Clinic, (b) a local preschool, or (c) in participants' homes. The location was determined on an individual basis for each participant and was based on parent preference and availability of the facility. Sessions were conducted with the researcher and participant sitting on the floor, seated in chairs at a small table, or while the participant was seated on a platform swing. Parents were permitted and encouraged, although not required, to observe the baseline and treatment sessions. Occasionally, parents partook in the structured play activity as an additional play and communication partner. Sessions were scheduled to occur twice weekly for approximately 30-45 minutes. Due to scheduling and parent preference, on some occasions, participants received treatment only one time per week. Each participant attended baseline and treatment sessions over a 9-14 week period. The researcher conducted all assessment, interview, baseline, treatment, and follow-up sessions.

Generalization

Generalization measures were taken during baseline and treatment sessions to determine the extent to which the newly acquired speech production skills transferred to untrained words during the treatment sessions and to natural conversation. Data on generalization were obtained through; (a) picture naming probes, (b) the percentage of correct productions of untrained target words that occurred during the treatment sessions, and (c) parental report. The picture naming probes consisted of presenting the participants with 10 pictures of untrained words that contained

the target sound and asking for a production. A verbal model was provided only if the participant indicated that he did not know the word or if he did not provide the label spontaneously. The picture naming probe occurred at approximately every third treatment session. A percent accuracy was obtained by dividing the number of correct productions of the target pattern by the total number of targets presented and multiplying by 100. Generalization data were also obtained by tallying the occurrence of spontaneous target sounds produced in non-target words during the shared reading and structured play activities of the treatment sessions. Similar to the treatment naming probe, a percent accuracy was determined by dividing the number of correct productions of the target sound in untrained words by the total number of untrained words produced and multiplying by 100. Additional generalization data, in the form of parent report, were also obtained through the weekly semi-structured interviews. Parents provided information related to the use of the target patterns in natural speech.

Dependent Variables

In order to guide treatment decisions (e.g., evidence of a stable baseline, when to implement the intervention for each participant), the researcher collected online during each baseline and treatment session. Data were collected specifically regarding the accuracy of the speech productions during the target drill activity. Increase in the accuracy of natural speech during the target drill activity was the primary benchmark used to suggest effectiveness of the intervention in order to move the next participant into the intervention phase.

To capture and track the complex behavior of multimodal productions, each of the baseline, intervention, and maintenance sessions were videotaped, which allowed for verbatim transcription. Communicative acts of the participants and researcher in baseline, treatment, and maintenance sessions were transcribed orthographically using the Systematic Analysis of

Language Transcription (SALT) Version 2008.0.4 (Miller, 2008) from the video data by a research assistant. Specifically, three measures of communicative acts were coded for each uttered word in order to provide data on the quantity and quality of speech production. These three measurements were *category* of communication, the *type of target* when speech was produced, and the *accuracy* of speech containing the participants' individual targets. These measurements provided data on the two dependent variables of quality and quantity of speech. Each of these three measures will be described in detail.

The data coding was a two-step process. First, a research assistant orthographically transcribed the speech (natural and AAC produced) produced in the sessions. Second, a consensus check was performed on each coded transcript with the primary researcher and the initial transcriber/coder (i.e., the research assistant) to ensure accuracy of the transcription and coding. The initial transcriber and researcher viewed the video together and made agreed upon changes to the transcription or the codes. The coded data were tallied from each of the measures using SALT (Miller, 2008).

Category. *Category* of communication referred to the form or the manner of the communication. There were two primary categories of communication, naturally produced speech and AAC-produced speech. All of each participant's speech produced during each of the three treatment activities was coded according to the *category* measurement. For the purpose of this study, speech was described as any word or sounds of words produced, with no distinction regarding the intelligibility of the production. A frequency count of the two main categories of speech production (AAC and natural speech) was tallied for all speech produced by the participants.

Additional types of communications measured included vocalizations, sign language, gestures, and multimodal communications. A vocalization was distinct from speech in that no recognizable words or sounds of words were produced. Vocalizations included speech-like sounds or sound-effects (e.g., yelling /ah/ in protest). Sounds related to body functioning, such as coughing or sneezing, were not considered vocalizations. Although none of the participants of this study were advanced or predominant sign language communicators, they did occasionally produce signs (e.g., signs for *mom* and *dad*). Obvious communicative gestures (e.g., pointing to a picture on the storybook) were also tallied based on participant use. Multimodal communications were those communications which used more that one communication category (e.g., AAC and natural speech, natural speech and a gesture). For a communication to be considered multimodal, the two communications must have occurred either simultaneously or have occurred immediately following each other (i.e., no other utterance was produced between the two communications). Each additional *category* measurement was tallied based on frequency of occurrence.

Type. Words produced during all three activities of the treatment session, either by speech or AAC, were categorized as a target word, a generalized word, a target sound, or a non-target word. Target words were further defined as being any production of the 20 words selected as targets for each participant. Generalized words were those words which contained the speech target, but were not one of the participants' target words. A target sound code occurred when only the target sound was produced in isolation (e.g., participant said /sp/). Finally, a non-target word was any word produced that did not contain a speech target. Each production was coded as one of these specific speech *types* and subsequently tallied.

Accuracy. The *accuracy* measure pertains to the three *types* of natural-speech productions: target words, generalized words, and target sounds. When any of these three word

types were produced with natural speech, the word was coded as a correct production or an error. A word was considered correct if the target sound was produced correctly, even if other patterns in the word were produced incorrectly. A word was considered incorrect if the target sound was not produced correctly. The frequency of natural speech productions across all three treatment activities was coded as either correct or an error and tallied. See Table 7 for a summary of the measurements obtained in the study.

Table 7

Measurement Summary

Measurement	Description	Occurrence
Category	Natural speech, AAC speech vocalization, sign, gesture, multimodal communication	All participant communications
Type	Target word, generalized word, non-target word	All speech (natural and AAC)
Accuracy	Correct, error	Target words, target sounds, non-target words

Note. AAC = augmentative and alternative communication.

Data Analysis

To answer the first four research questions, the data for the dependent variables, that is, the quantity and quality of natural speech production were represented in graphic form based on the three codes described. For the quantity variable (Research Question 1), baseline and intervention data were represented in graphic form for each *category* of communication (i.e., natural speech and AAC speech; each in a separate graph) for all three participants. Additional *category* data representing vocalizations, sign, gesture, and multimodal communication were not

reported due to their extremely low occurrence throughout the intervention. For the quality variable (Research Question 2), the percent of accurate natural speech production was reported in graphic form for the baseline and intervention sessions for words that contained the speech targets and for the control sounds. Data pertaining to the maintenance of accurate speech production (Research Question 4) were represented in this same graph. Finally, data regarding generalization skills (Research Question 3) were represented in separate, graphic form. Generalization data, including data obtained from the picture naming probes and the percentage of correct productions on untrained target words, were presented for all three participants.

This study included a multiple-baseline across participants (i.e., for John, Thomas, and Luke), with each participant receiving intervention on one speech target. Individual data are represented in a set of four graphs (quantity of natural speech graph, quantity of AAC speech graph, quality of natural speech and maintenance data graph, and a generalization graph) for these three participants for their one speech target. This study also included a multiple-baseline across behavior component for Thomas, who received intervention on two speech sounds. Data for this component of the study is represented separately in a set of four separate graphs (quantity of natural speech graph, quantity of AAC speech graph, quality of natural speech and maintenance data graph, and a generalization graph).

Fidelity and Reliability

Fidelity. In order to ensure the baseline sessions were implemented in accordance with research protocol, baseline fidelity data were obtained. All baseline sessions for each participant were reviewed by a research assistant to record the presence or absence of required components. These required components consisted of the presence on their AAC device, conversationally based activities lasting a minimum of 6 minutes each, discrete trial practice activity (i.e., drill),

researcher provision of a minimum of 50 meaningful models, and no researcher use of aided modeling. All of these data were obtained from the orthographically transcribed and coded verbatim transcripts of the sessions using the Systematic Analysis of Language Transcripts Version 2008.0.4 (SALT; Miller, 2008). A baseline fidelity score was calculated by dividing the total number of included required components by the total number of required components. An average baseline fidelity score of 95% (range = 75%-100%) was maintained across all participants. These scores indicated the baseline treatments were consistently implemented. Individual fidelity scores for each required component for the baseline sessions are provided in Table 8.

Table 8

Baseline Fidelity Data

Participant	AAC Present	Researcher Model	Drill Activity	Length Conv. Activities	No Aided Modeling
John	100%	100%	100%	80%	100%
Thomas	100%	83%	100%	100%	83%
Luke	100%	100%	100%	75%	100%

*Note***.** AAC = augmentative and alternative communication; Conv. = conversational.

An assessment of the independent measures, or the intervention, was included to ensure adherence to the treatment protocol. Each treatment session was reviewed by a research assistant to identify and document inclusion of the following intervention components; presence of the AAC device; inclusion of discrete trial practice (drill); inclusion of conversationally based activities; target redundancy; and provision of aided modeling. The first two components were

considered correct if they occurred during the treatment session. Conversationally based activities were scored as correct if they occurred for a minimum of 8 minutes each. Target redundancy and aided modeling were scored as correct if they occurred a minimum of 90 and 15 times, respectively, during the sessions. The treatment fidelity data were obtained from the orthographically transcribed and coded verbatim transcripts of the sessions using the SALT Version 2008.0.4 (SALT; Miller, 2008). A treatment fidelity score was calculated by dividing the number of correctly completed intervention components by the total number of possible intervention components. An average treatment reliability score of 93% (range = 64%-100%) was maintained across all participants. This high fidelity score indicated the treatment was implemented consistently across participants and treatment sessions. Individual fidelity scores for each required component of the intervention sessions are provided in Table 9.

Table 9

Intervention Fidelity Data

Participant	AAC Present	Researcher Model	Drill Activity	Length Conv. Activities	Aided Modeling
John	100%	100%	100%	95%	64%
Thomas	100%	100%	100%	93%	86%
Luke	75%	100%	100%	75%	100%

*Note***.** AAC = augmentative and alternative communication; Conv. = conversational.

Reliability. Measures were taken to ensure that the participants' speech productions were coded accurately. Reliability measures were taken on one baseline and one treatment session for each participant, resulting in a total of six sessions (12% of total sessions). An undergraduate

research assistant served as the independent observer. The research assistant was first trained on the coding procedures involved in data analysis (i.e., the codes used for *type, accuracy,* and *category*). An agreement occurred when the independent observer agreed with each code separately used to describe the participants' productions during the initial data analysis and coding procedure. A disagreement occurred when the independent observer did not agree with any portion of the code (i.e., the *type, accuracy,* or *category*). For example, if a production contained the following code, [ns.cor.t] (meaning the word was produced with natural speech, was correct, and was a target), the independent observer either agreed or disagreed with each code separately. The percentage of agreement was calculated by dividing the total number of agreements by the total number of agreements and disagreements and multiplied by 100. The average reliability score was 99% (range = 98%-100%). This high percentage indicated the data was analyzed consistently and accurately.

Social Validity Measures

Information regarding the social validity of the intervention was obtained from the videotaped series of semi-structured interviews that was conducted with the parent participants. The interviews included questions regarding the parents' perceptions of the treatment and the perceived treatment effects. All interview questions can be found in Appendix F. All parents provided descriptive information regarding the perceived value of the treatment. The semi-structured interviews took place in a setting which was mutually convenient for the participants and the researchers. The interviews took place in the University of Illinois Speech-Language Pathology Clinic, the participant's homes, and a local coffee shop. The pre-treatment interview lasted approximately 30 minutes and occurred in conjunction with the initial assessment, the during-treatment interviews often coincided with a treatment session or were conducted at a time

convenient for the researcher and parent participant, and the post-treatment interview was conducted during the follow-up session. The interviews were transcribed orthographically either by the primary researcher or by a research assistant using SALT Version 2008.0.4 (SALT; Miller, 2008).

The pre-treatment interview contained questions related to topics of background, education, general communication, AAC use, natural speech, and additional parental opinions regarding treatments their child was receiving. During the interview, a questionnaire was used as a guide to ensure all topics were covered sufficiently (see Appendix F); however, parents' comments directed the course of the interview.

Throughout the duration of the treatment, parents participated in a semi-structured interview at various points throughout the treatment. The goal of the interviews was to gather data on the therapeutic and communicative experiences of the child based on the parents' perspectives. The parents were encouraged to provide any specific examples of treatment effects they had observed or bring up any questions or concerns they had regarding their child's communication. The during-treatment interview lasted approximately 5-15 minutes.

Approximately 1 month after the final treatment session, a final semi-structured interview took place during the follow-up session. The purpose of this interview was to obtain information regarding the parents' impressions of the treatment program, document any observed changes in communication practices of the child, and obtain their overall opinions of the treatment program. Discussion also included speech and AAC treatment their child was going to be receiving in the future. This interview lasted approximately 20 minutes.

Chapter 4: Results

Results from the intervention are presented for the dependent variables (i.e., quantity and quality of speech), for the generalization measures, and for the maintenance measures. Because this study contained a multiple-baseline (MB) across participants component (i.e., John, Thomas, Luke, one sound target each) and a multiple-baseline across behaviors component (i.e., Thomas, two sound targets), there are two separate sets of data graphs presented. Figures 1, 2, 3, and 4 represent data from Thomas' multiple-baseline across participants component; and Figures 5, 6, 7, and 8 represent data from the multiple-baseline across behaviors component. Data pertaining to research question 1 (quantity of natural and AAC speech produced) are represented in Figures 1 and 2 (MB across participants) and Figures 5 and 6 (MB across behaviors); data for research question 2 (quality of natural speech productions) are represented in Figures 3 (MB across participants) and 7 (MB across behaviors); data for research question 3 (generalization) are represented in Figures 4 (MB across participants) and 8 (MB across behaviors); and finally, data for research question 4 (maintenance) are represented in Figures 3 (MB across participants) and 7 (MB across behaviors).

Single Subject Methodology

Quantity of speech production. Based on the frequency of words (i.e., non-target speech, target speech, and generalized speech) produced during the three intervention activities, increases were observed in the total amount of natural speech produced for all of the participants as compared to participation in the baseline sessions. See Figures 1 and 5 for graphic representation of the quantity of natural speech variable. A high level of experimental control was evident for the three participants of the MB across participants component, as visual inspection of the data from Figure 1 showed very little overlap of data in the baseline and

intervention sessions. Experimental control was not maintained for Thomas in the MB across behaviors component, where some overlap of data occurred; however mean differences in baseline and intervention were apparent for both of Thomas's targets based on visual inspection of Figure 5.

There were little changes observed in AAC-produced speech from the baseline condition to the intervention condition. See Figures 2 and 6 for graphic representation of the frequency of AAC-produced speech. Two participants, John and Luke, generally produced fewer than 10 words with their AAC device in the baseline or treatment conditions, as can be seen in Figure 2. Figures 2 and 6 show that for Thomas, AAC-produced speech was greater than the other two participants. However, his AAC use was quite variable in the baseline and treatment conditions.

Quality of natural speech production. All of the participants produced their target speech words more accurately during the intervention sessions as compared to the baseline sessions, as can be seen in Figures 3 and 7. Thomas was the only participant who met the accuracy criterion (90% over two consecutive sessions) before the twelfth intervention session, and he did so on both of the sounds that were targeted. Visual inspection suggested that experimental control was maintained for the four data sets as significant increases in accurately produced natural speech were not observed until implementation of the intervention. For two participants, John and Luke, experimental control was also observed based on the control sound probe data, represented in Figure 3. There was no increase in the accuracy of production of the control sound words for John and Luke throughout the duration of the study. This same control was not evident for either of the sounds produced by Thomas, seen in Figure 7. There was an increase in accurate productions of his control sound in baseline and treatment conditions.

Maintenance. Maintenance data were obtained from the follow-up session that occurred approximately one month following the final treatment session. See Figures 3 and 7 for graphic data representing maintenance of production abilities of target words. Each participant was probed to determine whether progress on production of target words was maintained over time. Overall, all three participants had maintained target word production accuracy levels similar to, or greater than the accuracy levels that were obtained near the conclusion of the intervention. None of the participants decreased their accuracy levels during the maintenance period. During this session, the HAPP-3 (Hodson, 2004) was also re-administered. All of the participants decreased their phonological deviancy score, which is indicative of increased accuracy of phonological skills. Table 10 represents the phonological deviancy scores obtained on the initial and follow-up administration of the HAPP-3 (Hodson, 2004). Table 11 represents the percentage of phonological patterns that were produced with errors at the initial and follow-up administration of the HAPP-3 (Hodson, 2004) (results were only reported for those phonological patterns occurring above 20%). Improvements were observed across all targeted sounds, and also observed in some non-targeted sounds.

Table 10

HAPP-3 Phonological Deviancy Scores

	Pre-Test		Post-Test	
Participant	Phon. Dev. Score	Severity	Phon. Dev. Score	Severity
John	204	Profound	169	Profound
Thomas	127	Severe	21	Mild
Luke	65	Moderate	42	Mild

Table 11

HAPP-3 Percentage of Patterns with Errors

		Pre-Test	Post-Test
Participant		Percent of Occurrence	Percent of Occurrence
John	Clusters	120%	115%
	Final consonants[a]	100%[a]	63%[a]
	Liquids	100%	100%
	Velars	100%	95%
	Stridents	93%	93%
	Nasals	76%	71%
	Glides	60%	50%
	Medial consonants	57%	36%
	Anterior nonstridents	47%	n/a
Thomas	Clusters[a]	112%[a]	n/a[a]
	Liquids	94%	47%
	Velars	59%	n/a
	Stridents[b]	57%[b]	n/a[b]
	Initial consonants	43%	n/a
	Medial consonants	29%	n/a
	Anterior nonstridents	27%	n/a
Luke	Liquids	79%	95%
	Clusters[a]	54%[a]	26%[a]
	Stridents	43%	31%
	Glides	30%	n/a

Note. n/a = less than 20% occurrence.
[a]Intervention target. [b]Only strident /f/ was intervention target.

Generalization. Generalization data were obtained through (a) analysis of spontaneously produced untrained words that contained the target sounds that were produced correctly during the sessions, and (b) during structured probes. See Figures 4 and 8 for graphic representation of the generalization data obtained. All of the participants showed some evidence of generalization of skills to untrained words that contained the target sound. Although improvements appeared to

generalize to untrained target words, the levels of accuracy were generally less than the targeted words and were substantially more variable. The spontaneously produced generalization data should be interpreted with an understanding that the total number of generalized words produced across two of the three participants was low (i.e., Luke-56, Thomas target 1-52, Thomas target 2-41, for all treatment sessions combined). John produced many more generalized words, 478, due to his speech target (i.e., words containing final consonants are likely to occur much more often than the other participants' targets). For all participants, there was no generalization to untrained words that occurred during the baseline phase. More generalizations occurred during the intervention and maintenance phase.

Social Validation

Social validation data pertaining to the final question posed in this research study are presented. The following results were obtained from the semi-structured interviews with parent participants that occurred during the intervention and at the maintenance session. The semi-structured interview occurred at approximately midpoint of the intervention. Each participant's parent answered interview questions a minimum of one time during the intervention. The follow-up interview occurred at the maintenance session, which was approximately one month after the final treatment session. Information regarding the parent's perceptions of their child's speech and communication progress, their overall impression and opinions of the intervention, and the degree of consistency with the quantitative results are presented.

John. John's father served as the primary informant for all of the interviews that took place. John's father was also an observer of each therapy session. After the sixth intervention session a semi-structured interview took place. John's father reported noticing improvements in John's speech; specifically that he was beginning to put ending sounds on some words, primarily

in isolated productions. He remarked that they practiced the target words when they were in the car. When asked about any noticed carry-over to conversation speech, John's father reported that he was producing some final sounds during conversational speech. His father also reported that John was talking a lot using his natural voice, and was using the AAC device only minimally at home (John's father, interview, July 22, 2009).

During the follow-up interview, John's father commented that since the treatment, John was verbalizing a lot more and was better at finishing his sounds, even in words that had not been practiced. He said that use of the final consonants had lead to his family having a much better understanding of John's speech. He reported that John's "talker" had taken a backseat, and that they were not using it at school too much anymore. When it was being used at school, it was primarily for keyboarding purposes (e.g., typing out a spelling word list). John's father reported that he was being understood much more in the classroom environment, which had led to the decreased use of the AAC device. He felt that now, John's voice was more of the primary means of communication and that AAC (i.e., sign and SGD) was a secondary means of communication, although John still remained a multimodal communicator. There was some concern expressed by John's father regarding expectations of school personnel. He reported that the school wanted him to use his talker more, but that he wanted John to use his voice. He further stated that the school was pushing for John's talker to be his primary communication mode, but that John has too many other ways that he can talk. He was hoping that the school would work more on John's speech and the AAC would be used as a back-up. John's father acknowledged that John was still unintelligible at times to unfamiliar listeners, and he will occasionally resort to the AAC device, but that he was trying more often to use his natural voice to communicate. He commented that

when they would go to a restaurant now, John would order with his natural voice, whereas before a family member typically ordered for him (John's father, interview, September 22, 2009).

When asked about opinions of the intervention, John's father felt that the high frequency of productions that were produced by John were important to his progress. He was pleased that the intervention he received as part of the study was focused on speech, and that AAC was still available to him when it was needed for clarification. He stressed the importance of not wanting John to be frustrated when trying to communicate, and how he wanted a tool to be available for help. He reported no difficulties with participating in the treatment, and that "we are tickled to death" with the results (John's father, interview, September 22, 2009).

Thomas. Thomas's mother served as the informant for all of the interview sessions. She also observed each therapy session. Thomas's first semi-structured interview took place after his eighth intervention session. Thomas's mother reported that she had noticed lots of changes with his communication since the intervention had begun. Specifically, she reported how Thomas was putting two and three words together with his natural voice and just talking so much more. With regards to his target sounds, she reported that he was sometimes using them correctly spontaneously, but that you still had to remind him to put his "snakey" sound on (Thomas's mother, interview, August 10, 2009). Thomas's mother also reported that his communicative functions were also expanding. He was beginning to use communication for more than just requesting; he was beginning to initiate conversation with strangers (i.e., during a trip to the zoo). His communications, however, were not generally successful. His mother reported that she often would have to interpret what Thomas was saying. Thomas's mother also reported that she was better able to understand what he was saying, but that he was still unintelligible to unfamiliar listeners. She reported that she thought the intervention was doing "good", and that

she likes how we target a core set of words instead of targeting a few words this week and different ones the next week. She also reported that she liked putting the AAC and the speech practice together and thinks that Thomas may use it as a model. Regarding AAC use, Thomas's mother reported that they don't often need to use it at home, and that Thomas usually requests using his natural speech. She also commented that Thomas "plays" with his AAC device often, for example spelling out words and pressing animal sounds and other funny sounds (Thomas's mother, interview, August 10, 2009).

During the follow-up interview, which took place on October 12, 2009, Thomas's mother reported that his speech and communication were dramatically better and that about 90% of the time Thomas successfully communicates with his natural voice. She noted that not only can the family understand everything he says, but that people who don't see him very often can also understand him. His communication improvements were noted at his school, where his teachers had made comments about his speech improvements. His mother reported that Thomas's classmates were coming up and talking to him now, and felt like this occurred because he could now communicate with them. Thomas returned to his other venue for receiving services at the beginning of the school year, where significant improvements were also noticed. His goals at the university clinic now included working on early literacy skills, as opposed to simply speech production. His AAC use had decreased significantly since the final therapy session, and his mother felt like he was using the device primarily for "playing" and that he was using his natural speech for all of his communication. One example of how Thomas "played" with his AAC device is that when he encountered a word he did not know (e.g., in written text), he would type it in his AAC device to know what the word was. Thomas's mother reported that although she

was still sending the device to school with him on a daily basis, she would probably phase it out sometime during the school year (Thomas's mother, interview, October 12, 2009).

Thomas's mother felt like the treatment implemented was very successful with his type of disorder. She reported that in her opinion, it was the only thing that she had seen that had that much success. Thomas's mother also reported that when she was first introduced to the treatment, that she had her doubts that this treatment would work any differently than the other therapy that he had received (i.e., traditional CAS treatments). She was however, amazed about the way this intervention did work. Thomas's mother also reported that she had given permission for the school SLP to provide her name and number to parents of children in Thomas's class that had limited verbal communication skills and were maybe concerned with using AAC. She agreed that it is a big concern for parents if they think that professionals are giving up on speech. She wanted to let parents know how well AAC worked for Thomas and that he made progress with his speech that she didn't think he would have made without it. Thomas's mother reported no concerns or difficulties participating in the intervention (Thomas's mother, interview, October 12, 2009).

Luke. Luke's mother served as the informant for his during-treatment and follow-up semi-structured interviews. She did not directly observe any of the intervention sessions, however, observed a video of one session. Luke's during-treatment interview took place after his fifth intervention session, which occurred on August 10, 2009. In regards to use of his target sounds, Luke's mother reported that he was not using them much spontaneously, although on occasion she hears an accurate production. Luke's mother also commented that Luke was already on a huge upward growth trajectory before he started the study intervention, and that he is still on an upward trajectory. She also reported that his spontaneous AAC device use was going down,

but that this was also occurring before Luke began the study intervention. Luke's mother also commented that his quantity of natural speech use had not changed much since the beginning of the intervention (Luke's mother, interview, August 10, 2009).

The follow-up interview with Luke's mother occurred on October 22, 2009. She reported limited change in Luke's target sound production since the cessation of treatment, and thought that he had hit a plateau. During the intervention, Luke had over-generalized his target sound (e.g., putting a /s/ sound on words that did not require an initial /s/) when his mother asked him to revise a word that did not contain the target approximately two times. Luke's mother also reported that she noticed some spontaneous accurate productions of the target sound, and felt like they occurred more often when the words shared articulatory placement (i.e., /sn/ and /st/ were produced more often possibly because the sounds in the cluster shared alveolar placement.), if the words were produced in isolation, if the word was one syllable, and was also dependent on other sounds within the word. She thought that /s/-blends in the final position of words emerged during the therapy, although they were not directly targeted. With regards to overall natural speech production, Luke's mother reported that he is continuing on an upward progression, which began before he started the intervention study. No change was reported in Luke's AAC use since entering the study; his mother reported that he will use it when it's there and she models its use, but he rarely uses it for basic communication needs. She also reported that he rarely uses it to repair communication breakdowns, possibly due to the words not being programmed in his device or not knowing where the words are in his device. Luke's mother did report that she programmed a page of vocabulary in his device based on a storybook and that Luke has requested his "talker" while reading the book. In this situation, Luke used the device to predict what was next in the story (Luke's mother, interview, October 22, 2009).

In terms of impressions of the intervention, Luke's mother felt that the treatment didn't result in any global changes, but that treatment was beneficial due to Luke having a positive interaction with a new person who understood, acknowledged, and used his AAC device. She commented that Luke has not always wanted to attend various therapies, but that he did not resist going to this therapy and was not "super eager" to leave. Luke's mother also felt that focusing on specific phonemes was not a high priority goal for him right now. She still thought he could benefit from speech goals. She felt that multisyllabic words and phrases were more important to target. Although more language functions were her priority for Luke, she expressed that the framework for working on speech sounds used in the study was positive and that she used it as an example for his school personnel. Luke's mother also appreciated that the treatment was not either/or in regards to speech or AAC, which is what she had typically encountered with therapists in the past.

Figures

Figure 1. Quantity of Natural Speech: MB across Participants

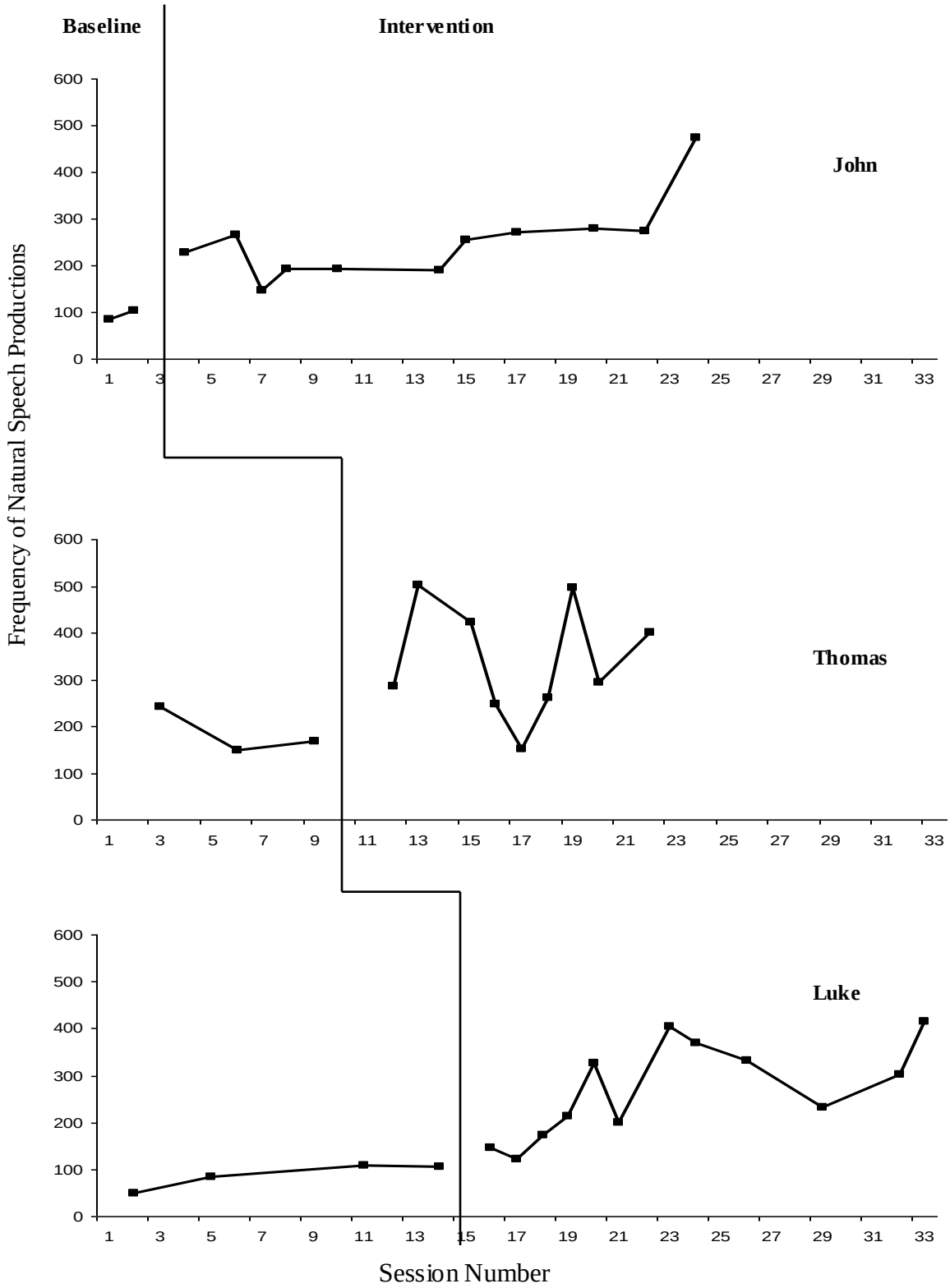


Figure 2. Quantity of AAC Speech: MB across Participants

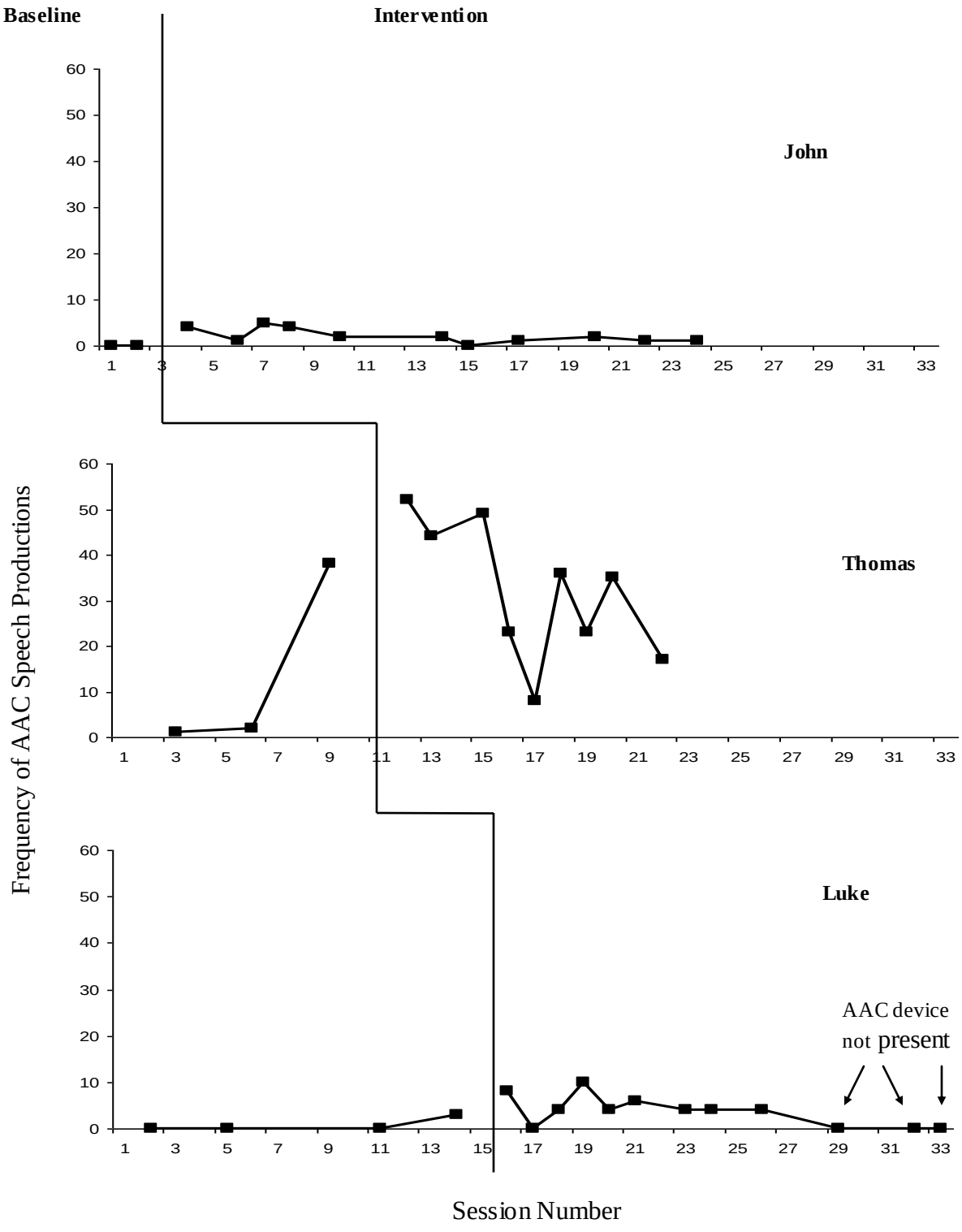


Figure 3. Quality of Natural Speech: MB across Participants

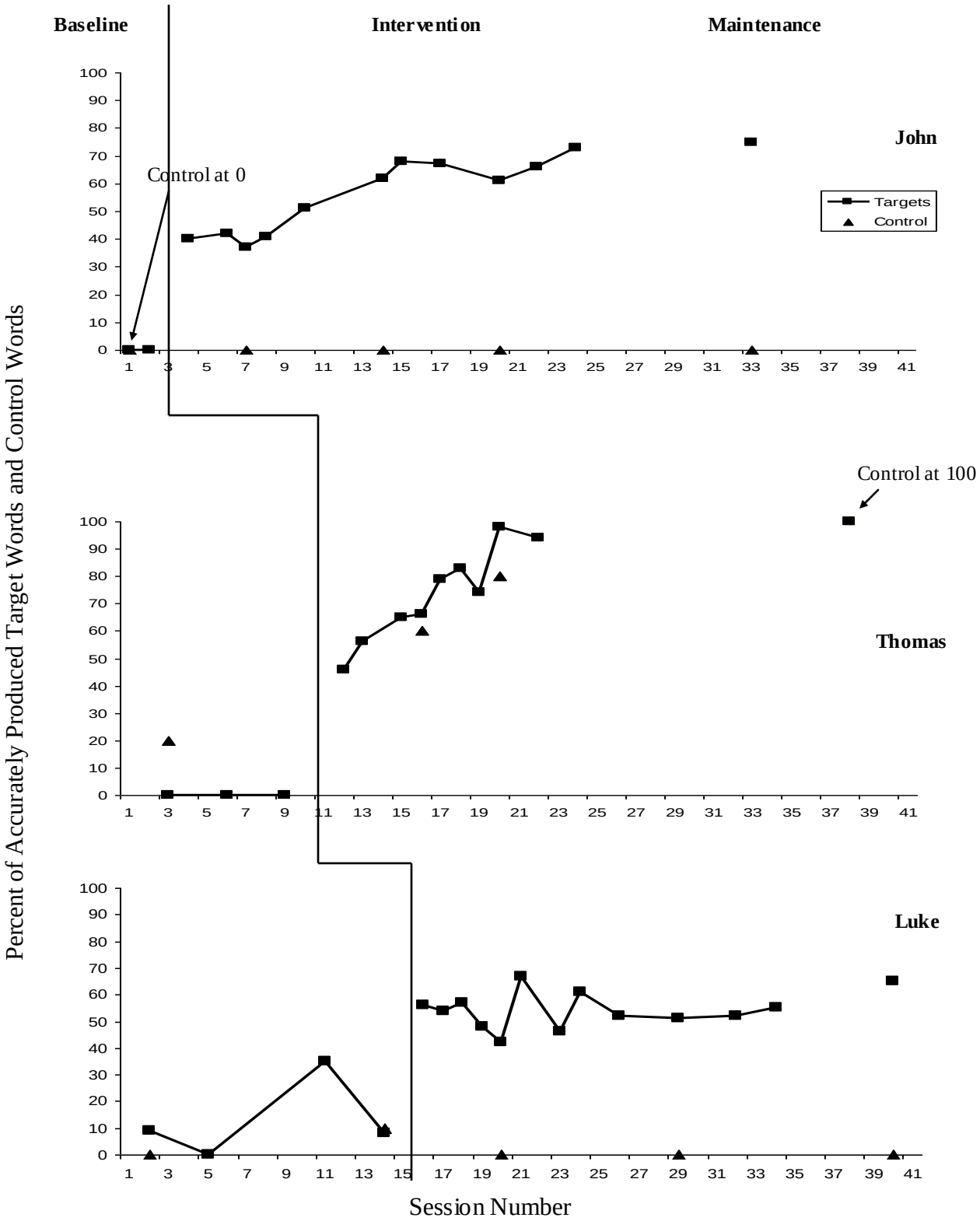


Figure 4. Generalization-Quality of Natural Speech: MB across Participants

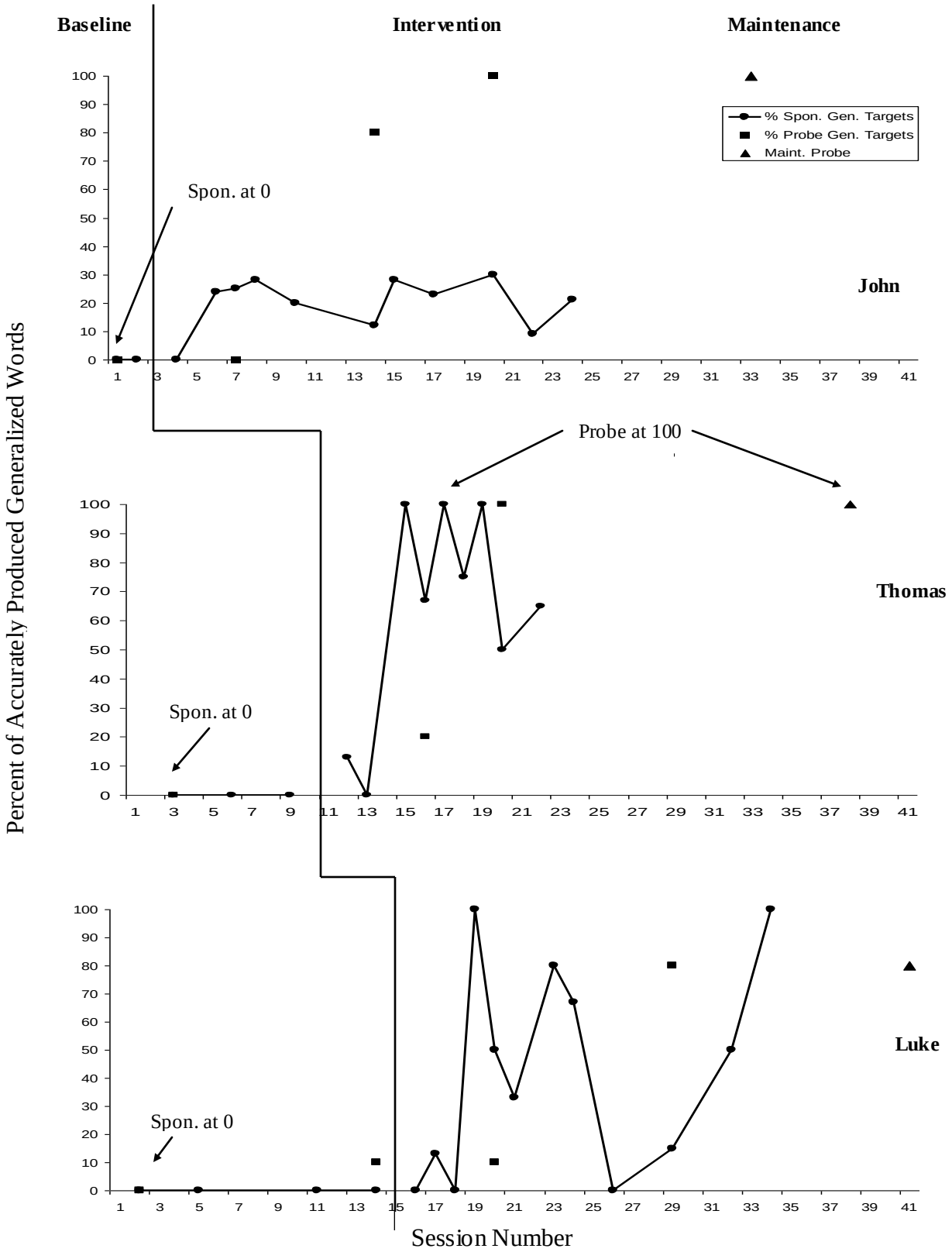


Figure 5. Quantity of Natural Speech: MB across Behaviors

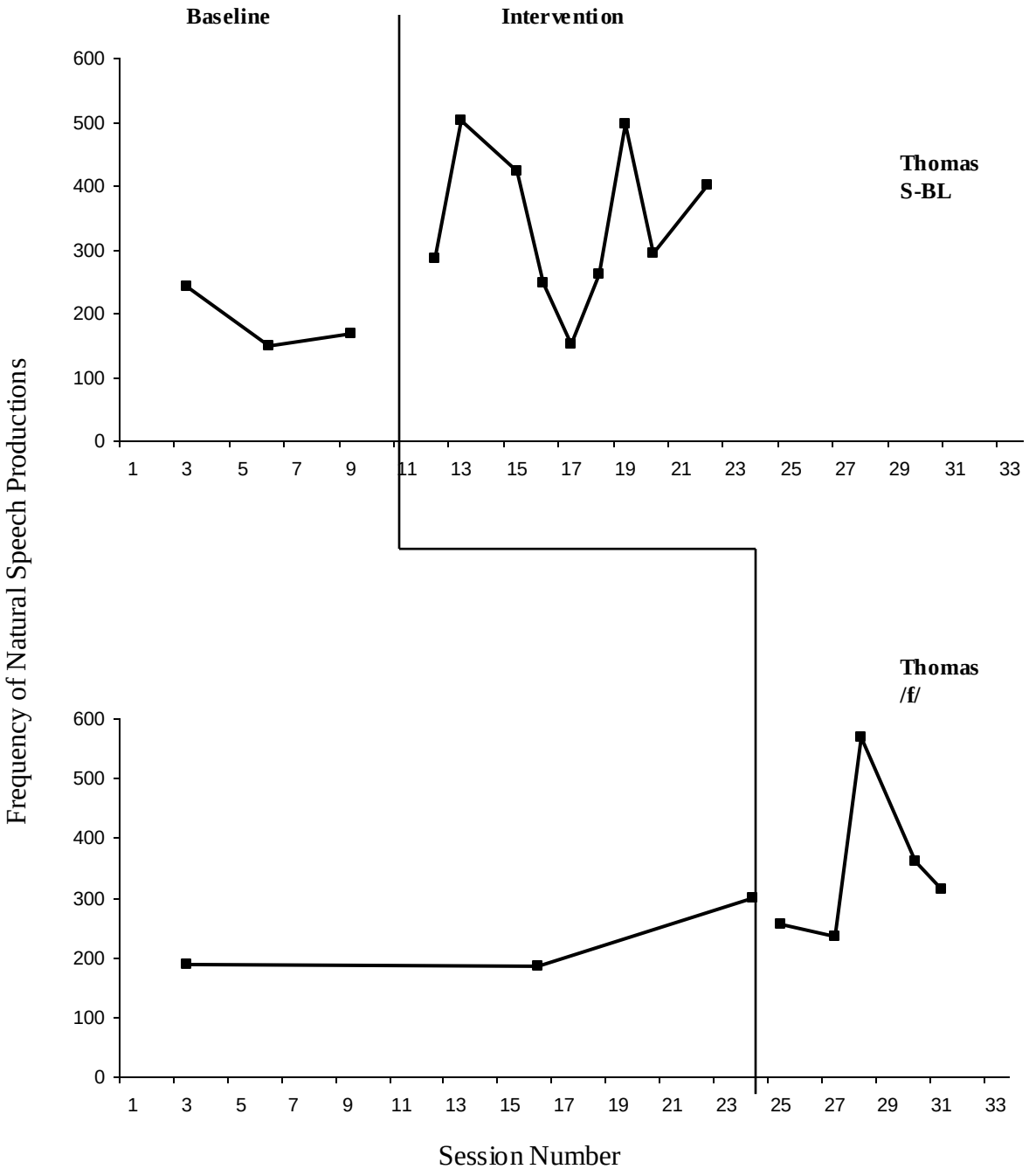


Figure 6. Quantity of AAC Speech: MB across Behaviors

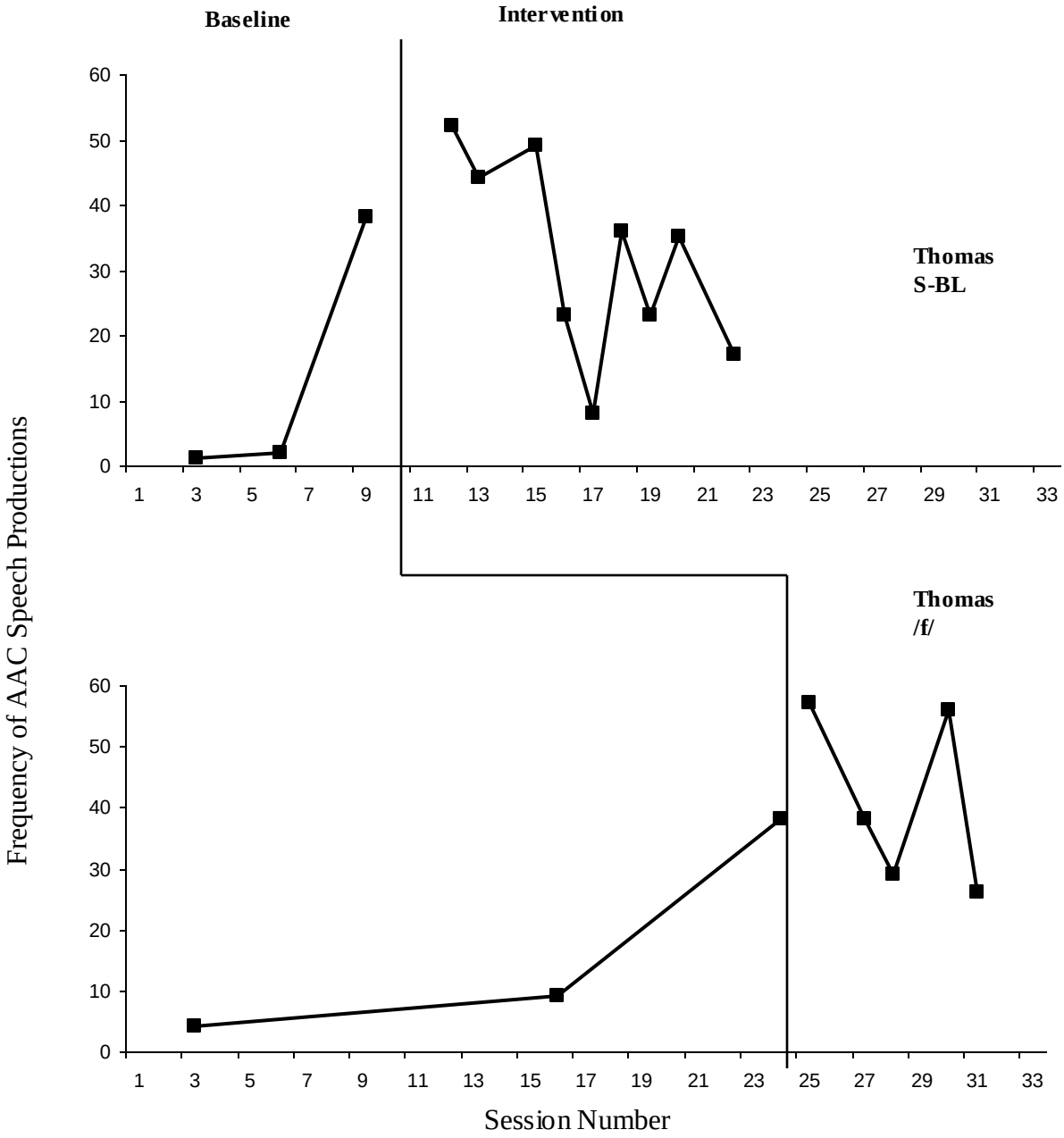


Figure 7. Quality of Natural Speech: MB across Behaviors

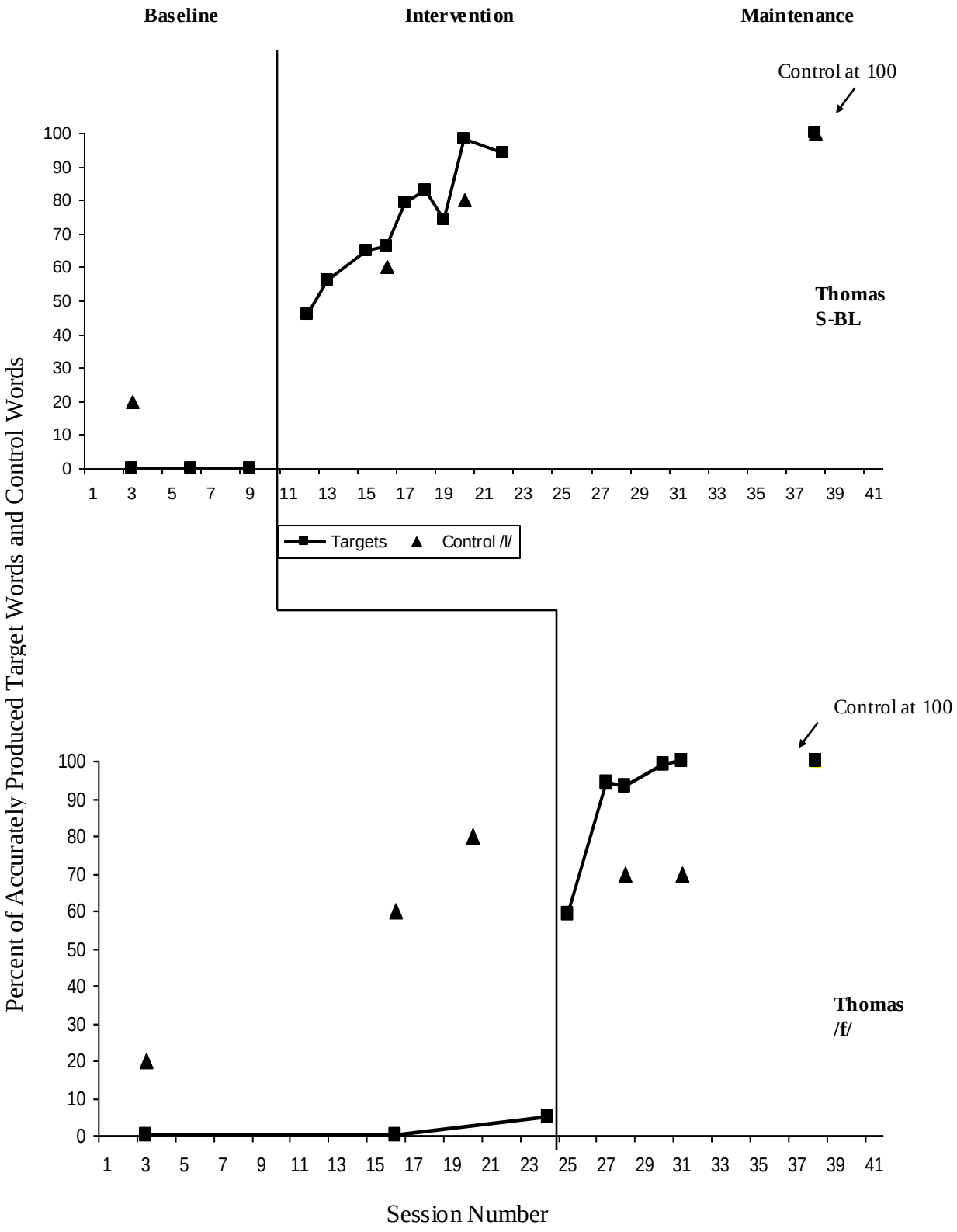
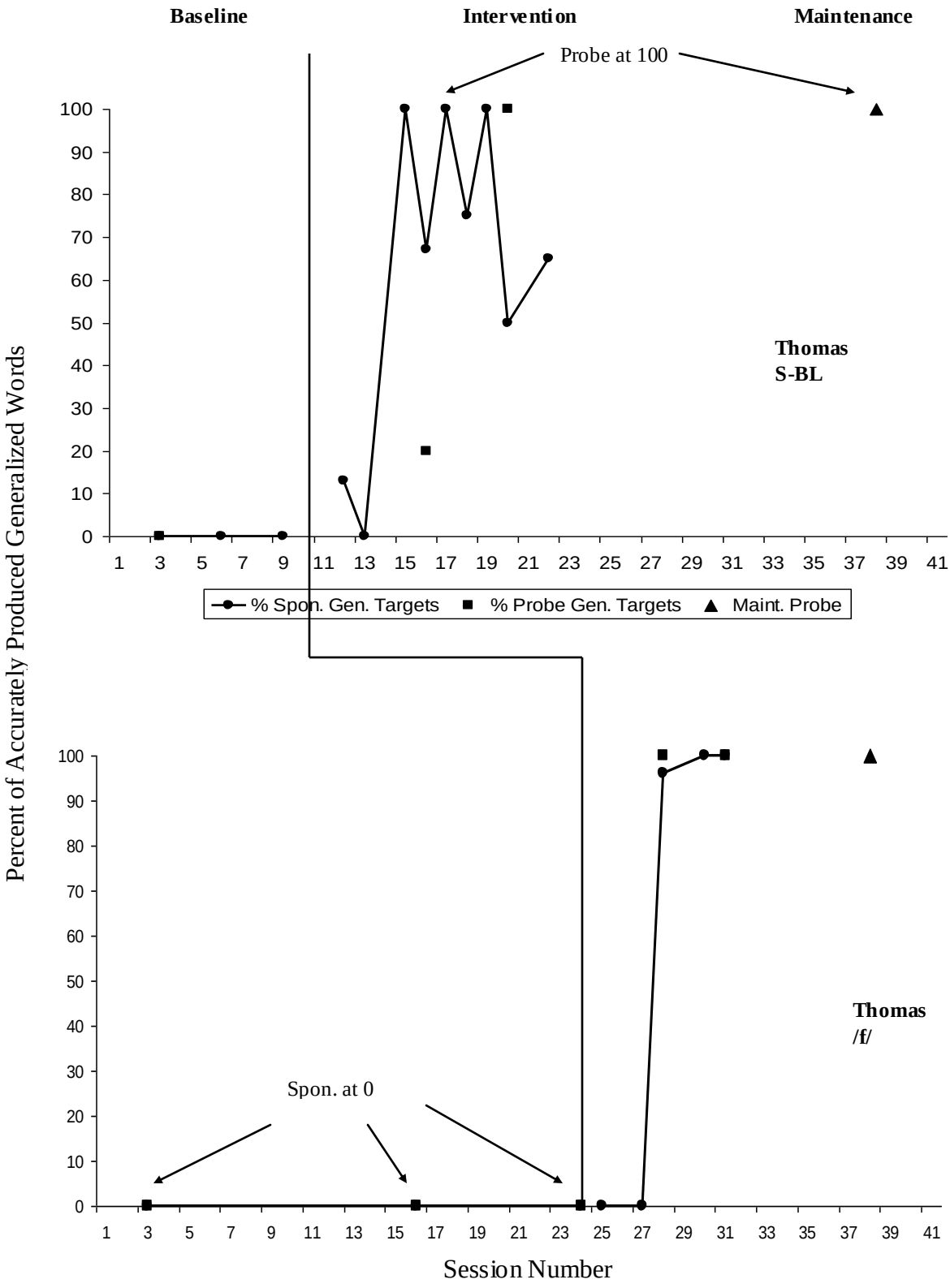


Figure 8. Generalization-Quality of Natural Speech: MB across Behaviors



Chapter 5: Discussion

Implementing AAC in children with SSIs can be a "hard sell". Stakeholders are often apprehensive about implementing AAC in this population due to the fear that AAC might inhibit or negatively affect natural speech production (e.g., Beukelman & Mirenda, 2005; Hustad, Morehouse, & Gutmann, 2002; Millar, Light, & Schlosser, 2006). The purpose of this study was to examine the effects of a novel intervention program that *incorporated* AAC, with the goal of increasing the quantity and quality of natural speech production in these children with SSIs. Each of the three participants demonstrated an increase in the amount of natural speech production and an increase in the production accuracy of their speech sound targets after participating in the intervention. These results are based on improvements observed from the baseline sessions to the intervention sessions, which included the integrated multimodal intervention components. Interview data from the parents of the participants revealed that parents for the most part thought the intervention was effective or at the very least, was a positive experience for their child, providing social validation of the intervention. These findings suggest an intervention that integrates multimodal speech-generating AAC and traditional speech intervention techniques was not detrimental to natural speech, and in fact supported natural speech production on several levels.

Effects of the Intervention on the Quantity of Speech Production

Natural speech. As compared to the baseline sessions, the data show that the amount of natural speech produced by the participants increased during participation in the intervention activities. This is consistent with previous research that had reported increases in the amount of natural speech production when AAC was implemented (Millar, Light, & Schlosser, 2006; Schlosser & Wendt, 2008). This research, however, contributes significantly to this previous

literature. First, natural speech output was a primary dependant variable in this research study, as opposed to a collateral effect of an intervention that targeted other behaviors. Because of this, intervention decisions were based solely on the dependent variable. Second, natural speech was elicited during a meaningful variety of communication exchanges, not merely during a requesting or naming activity. This intervention provided numerous opportunities to use natural speech for a variety of functions in a meaningful context. Finally, although the participants were heterogeneous in several regards, each of these children had a diagnosis of CAS and began the study with the ability to produce some natural speech; additionally, all of the participants had the ability to imitate natural speech. Potentially because of this, the increases observed were fairly consistent across participants.

These results are not overly surprising, based on the integrative multimodal nature of the intervention. When parents and SLPs show concern for implementation of AAC in children with SSIs, as exemplified in the vignette provided at the beginning of the study, the automatic assumption is that AAC therapy will now take over speech therapy. The primary fact that these two interventions *can* be integrated, and further, that they result in positive outcomes in natural speech production, support that these interventions need not be considered as competition. These results suggest that integrating AAC has a supportive role, as opposed to a hindering role, for natural speech.

AAC speech. For two of the three participants, limited differences were observed from baseline to intervention regarding the amount of AAC produced speech. For John and Luke, there were very few occurrences of AAC speech throughout the duration of the study. In addition, when AAC speech was produced, it was usually a result of a direct request from the researcher (e.g., “Why don’t you try with your talker?”). Further, there was no guarantee that

even a direct request for AAC activation would result in either of them activating the AAC system. For the most part, John and Luke's device did not seem to be a preferable mode of communication. For John in particular, his device was used only after numerous failed attempts at communication repair. The AAC modeling seemed to result in more AAC activation from Luke in particular, but this still only occurred rarely.

Even though John and Luke were highly unintelligible to familiar and unfamiliar listeners, they were still fairly limited AAC users. One possibility for this is that they may have had limited abilities with their AAC systems, either due to a lack of direct instruction or through limited opportunities to learn their AAC system during natural conversational experiences. Each of these participants was receiving intervention on various speech and language targets, but there was no information provided as to whether any specific interventions were taking place to increase AAC competence. Although this intervention indirectly encouraged the development of AAC competence through AAC modeling, there was limited exposure to other programmed pages and vocabulary in the AAC system that occurred from this intervention. Perhaps this intervention may have facilitated more AAC productions if it had included more direct opportunities to develop communicative competence with the AAC system. For example, the target vocabulary could have been placed on more than one page to increase opportunities to search and locate vocabulary words.

Thomas, on the other hand, seemed much more motivated to use his AAC device, particularly in the intervention condition when AAC modeling was occurring. Thomas also seemed to have much more AAC competence than Luke or John. This was interesting because Thomas only had received his device approximately one month before his intervention began. His increased competence with his device may have resulted from his constant "playing" with

the device. Thomas's mother commented that Thomas often "played" with his device, as opposed to using it for communicative purposes. Although his actions appeared to be play-like to his mother, this voluntary exploration with the AAC system may have resulted in a better understanding of the AAC system, better ability to know the sequence of buttons to generate a specific message, and ultimately, greater AAC competence.

The effects of natural speech ability increases on AAC use also appeared to affect Luke and John differently than natural speech increases affected Thomas's AAC use. One possibility is that AAC-produced speech did not increase significantly for John and Luke because their production of more intelligible natural speech paved the way for less use of the AAC systems. This is difficult to determine from this research study, however, because neither of these two participants was producing many AAC communications in the baseline condition. Thomas's data, however, show some support for this hypothesis. Although Thomas experienced the greatest increases in natural speech development and also experienced the greatest increases in AAC-produced speech, subtleties can be observed in the natural speech and AAC-produced relationship. By close examination of Figure 6, graphic representation of Thomas's amount of AAC-produced speech had more of a bell-shape curve, indicating an increase and a subsequent decrease in his amount of AAC-produced speech. Figure 7 shows that his accuracy data only steadily increased, and showed no decrease. The continued increases in Thomas's speech may have also prompted the downward trend of AAC-use. These data suggest that this intervention may result in increases and decreases in the amount of AAC-speech produced. Interestingly, increases and decreases in AAC use can both be desirable, as long as decreases are occurring in conjunction with increases in natural speech production.

Effects of the Intervention on the Quality of Natural Speech Production

Increases in speech production accuracy of target sounds were observed for all three participants. These results provide novel information to the research base of AAC and natural speech production. As previous research in the area has investigated the quantity of natural speech production, to the author's knowledge, this research is the first to investigate how multi-modal AAC intervention can be used to target speech production accuracy. Based on visual inspection of data presented for the quality of natural speech, the changes in accuracy from baseline to intervention were quite noticeable for all four data sets. John and Thomas (s-bl) produced no accurate production of their target sounds in baseline condition, and Thomas (f) produced less than 10% of target words accurately in baseline condition. Luke was the only participant with more than minimal ability to produce the target sound in the baseline condition; however, there was no overlap of data points even in Luke's data between the baseline and intervention conditions. Similarities exist in John and Luke's data, leading to a discussion of their results separate from discussion of Thomas' results.

The improvements in natural speech production accuracy are significant in two primary ways. First, for participants John and Luke, the improvements in speech accuracy were observed in the target sounds while there were no improvements observed in the production accuracy of the control sound. The lack of improvement observed in the control sound provides support for the specific effectiveness of *this* intervention for these two participants. Data from the post-intervention HAPP-3 (Hodson, 2004) also support this claim. For Luke and John, although some decreases in phonological processes were evident in patterns that were not targeted during intervention; the most significant decreases were evident in the targeted speech sounds (e.g., a 37% decrease for John and a 28% decrease for Luke in the targeted sounds class). Second, both

participants had been receiving a variety of traditional speech and language services for an extended period of time before participation in this intervention was initiated. John and Luke in particular had previously received intervention on the specific speech sounds that were targeted in this intervention. John's baseline data show no indication that these previous interventions had an effect on his production of the target sound. Luke's data show that even though his previous interventions may have had some effectiveness on his production of the target sound, there were still noticeable improvements in his productions while participating in this intervention. When considering these two levels of experimental control evident for Luke and John, the data are convincing that this intervention program led to significant increases in their ability to produce targeted speech.

Although Thomas' data show the greatest improvements in speech production accuracy, some considerations must be made when interpreting his data. As was stated, although his production accuracies increased dramatically from baseline to treatment, there were also dramatic increases observed in his control sound. Even during the baseline condition, Thomas increased accurate control sound productions in spite of the fact that it was never directly targeted. His results are further complicated in light of his post-intervention assessment results obtained on the HAPP-3 (Hodson, 2004). There were decreases in the occurrence of phonological processes from the pre-test to the post-test. Improvements in stridents (which included the /f/ sound) could be expected since stridency was also a component of s-blends. In other words, improvements from targeting s-blends may have generalized to all strident sounds. This same generalization could have also been a factor in the increases in initial consonant production. All of Thomas's targets were treated in the initial position, and therefore these skills could have carried-over to all initial consonants. This rationale, however, cannot be applied to

other phonological processes that showed a significant decrease, such as liquids, velars, and medial consonants.

An additional concern with Thomas's data is the relatively fast rate of acquisition that occurred with his initial speech sound target (s-blends) and the extremely fast rate of acquisition that occurred with the second speech sounds target (/f/). Thomas reached criterion for s-blends after only seven intervention sessions, and he reached criterion for the /f/ sound after it had been targeted in only one treatment session. Thomas's very low and relatively steady baseline productions for both sounds provide evidence that the intervention may have been the necessary factor that resulted in these improvements; however, the extremely fast rate of acquisition deserves some consideration.

One primary observation with Thomas is that the initial diagnosis of CAS may not have been accurate. In the author's opinion, Thomas's speech production characteristics would classify him as a late-talker with a severe phonological impairment, as opposed to CAS. Although the broad diagnostic category of SSI was used as the basis of this research study, the differences in Thomas's data highlight the potential importance of assigning a child with an SSI to a specific diagnostic sub-category. If Thomas's speech impairment was more characteristic of a severe phonological impairment, this could indicate that the intervention may work differently, based on the specific type of speech sound impairment.

General Comments Regarding the Intervention

Although this study was not conducted to test a specific hypothesis regarding the intervention's theoretical learning mechanisms, the participants' behaviors lead to some speculation. One primary observation is that all of the participants seemed to actually enjoy participation in the intervention. My own clinical experience can speak to the fact that this is not

always the experience children have during speech and language therapy. This enjoyment could be due to several factors. The researcher's role in the intervention was less of a communication director and more of a communication partner, and the participants seemed to respond positively to this. When observing data in each intervention activity separately, although the most accurate speech occurred during the drill activity, the least amount of speech was also produced during this activity. Although many intervention techniques were implemented that required requests for productions, guided production practice, and requests for re-tries, the majority of the "intervention" seemed to be masked by the natural intervention that was occurring between the researcher and the participants, especially in the natural speaking activities (i.e., repeated shared storybook and structured play). Although the conversational aspect is considered to be an integral therapeutic mechanism from my view, the naturalistic communication may have made the intervention not "seem" like intervention to the participants.

Overall, the participants experienced a tremendous amount of success during this intervention. Because virtually all communication attempts were acknowledged, valued, and appreciated, the participants were receiving not only social praise from the researcher during the intervention, but they were also experiencing positive natural consequences from their communication success. This seemed especially relevant for John, who on average produced a fairly low rate of speech, either natural or AAC speech. Consistent with CAS, John has difficulty voluntarily producing target speech sounds. Often times, John was unable to produce the target sound accurately even after several cues and re-tries. John's AAC device always allowed for a correct production, and this production was acknowledged as successful communication (i.e., social praise was given, and natural consequences occurred).

The data also suggest that the integration of the AAC component is not to be underestimated. Each of these children had been receiving a variety of traditional speech and language interventions for several years prior to entering the study. Many of these interventions implemented by speech-language pathologists consisted of traditional phonological therapy and CAS therapy; with some approaches consisting of more clinician-directed activities while some consisted of more client-centered. Yet, these participants entered this study with severe speech sound impairments. Many intervention programs contain some of the critical components utilized in this intervention. The unique factor of this intervention, which was not present in the intervention the participants were receiving, was the integration of the AAC system combined with the additional intervention components. The AAC system seemed to provide the appropriate scaffold needed for natural speech production abilities to advance.

Implication for Clinical Practice

Since this research study is clinical in nature, there are some direct implications for clinicians who are working with children with SSIs. For children with SSIs, it is currently common practice to target speech production for years before a significant lack of progress leads clinicians and stakeholders to consider AAC (Weitz, Dexter, & Moore, 1997). Speech and AAC are not often considered in combination, resulting in communication being viewed as either/or; either children are natural speech communicators or they use AAC. The results obtained in this study can provide clinicians and stakeholders with some confidence that this does not have to be the case. In addition to an expectation of increased quantity of natural speech expected within this multimodal AAC and natural speech framework, clinicians can also effectively target the accuracy of natural speech production within a multimodal framework.

This research study also provides clinicians a blueprint for *how* to implement multi-modal communication practices to target speech production and accuracy in children with SSIs. Even the most experienced clinicians can often struggle with the application of research findings to clinical practice. Intervention studies in general are sorely lacking in our field, and detailed descriptions of intervention methods can be valuable for speech-language pathologists.

Finally, speech-language pathologists can also anticipate that parents may be likely to accept this type of multimodal intervention. The qualitative data should provide clinicians with confidence that this type of intervention can be accepted and viewed as valuable by their clients' parents, in other words, is socially valid. These data can also be provided to parents, if necessary, in order to increase their acceptance of this type of intervention. Parents may be more willing to accept an intervention if they are presented with other parents' impressions of the intervention who have children who are similar to theirs.

Limitations of the Study

The results from this study provide important information regarding a multimodal AAC and natural speech intervention; however, there are several limitations of the study. A primary set of limitations pertains to participants selected to receive the intervention. All of the participants had received a diagnosis of CAS from a speech-language pathologist or other medical provider. This diagnosis, however, was not confirmed by the researcher at the beginning of the study. Childhood apraxia of speech is a disorder that is difficult to differentially diagnose. There is no research to date that provides a valid list of CAS features that differentially diagnose CAS from phonological impairments or dysarthria (ASHA, 2007). Further, although a set of core CAS features exist to help guide clinicians in the diagnosis, it is often difficult to determine how the core features contribute to the diagnosis; that is, the specific features that were used and how

they were integrated to generate the CAS diagnosis (ASHA, 2007). Although the intervention implemented in this research study incorporated elements of recommended practice for CAS and also for phonological impairment, a confident diagnosis is necessary and may influence whether certain components of the intervention should be stressed or possibly modified.

The participants of the study were also a relatively homogeneous group of children in several ways. They were all males, had received a diagnosis of CAS, they all imitated natural speech, and, in general, AAC was not a preferred mode of communication. The ability to imitate has been shown to be a significant predictor of natural speech development (Yoder & Layton, 1988). Since all of the participants were imitators, it is unclear whether this type of treatment would be effective in populations of children who did not have imitation skills. All of the study participants used their AAC systems on a very limited basis. For John and Luke, extensive cueing and prompting from the researcher was needed to elicit any AAC productions; thus it was not surprising that increases in the quantity of AAC speech were generally not observed. Thomas used his AAC system more than the other participants, but it was used primarily during his intervention sessions, and reportedly used rarely outside this setting. This study fails to provide information on the effects of the intervention on AAC use of individuals who were active or primarily AAC speakers.

The AAC systems used by the participants also provided some limitations. Two of the participants used an AAC system with a grid-type layout where messages were organized primarily by semantic category (i.e., page for home, school, lunch time, etc.). This type of layout was convenient for the development of "intervention pages" that were programmed into their devices. In Thomas's device, messages were organized by their frequency of use (i.e., core versus fringe vocabulary) and the locations of messages were consistent across pages (i.e., verb

words are placed in the same grid location, regardless the page). For this study, it was preferred that target vocabulary was available on one page, in an attempt to eliminate excessive searching for messages. This was however, inconsistent with the standard use of Thomas's device. By programming category pages, Thomas's device was used in a way that was not consistent with the intended use.

From a speech production standpoint, the targets selected for intervention may not have been the most appropriate targets. Speech targets were primarily selected from a phonological processing framework, as opposed from a CAS framework or an articulation framework. Because of this, targets were based on phonological patterns and not individual phonemes (i.e., targeting all final consonants as opposed to an individual sound in final position). Childhood apraxia of speech therapy typically utilizes a syllable and sound hierarchy approach, where more complex sounds are added and syllabic length is sequentially increased as progress is observed. This type of hierarchical approach, as opposed to a phonological process approach, could have led to greater observed improvements in participants' speech accuracy.

Future Research Directions

Specific to current research study. There are several additional analyses that are anticipated to be conducted with the data set. First, the qualitative data obtained from the parent interviews and observational data obtained from the individual baseline and treatment sessions can be further analyzed to provide more in-depth description of the communication practice and discourse patterns of the participants and their parents. It is anticipated that from these data, an additional coding scheme can be developed to provide this information.

An additional immediate goal is to provide more specific information on how the participants' speech productions were elicited, or how spontaneous the productions were.

Although every effort was made to reduce the number of direct requests for speech productions in an attempt to facilitate more spontaneous use of speech and target sounds, the current data analysis does not provide direct evidence of these values. It is anticipated that a level of spontaneity or naturalness can be determined based on the events that preceded the participants' communications. Based on the work of Carter and colleagues (e.g., Carter, 2003; Carter & Hotchkis, 2002), a continuum of communicative spontaneity can be developed to facilitate more detailed description of the participants' communication productions. This will require an additional coding procedure that can be determined to be reliable in order to accurately describe the level of spontaneity of the productions.

Overall directions. This research provides preliminary information regarding the implementation of a multimodal intervention approach to target quantity and quality of speech production in children with SSIs who are multimodal communicators. There are many questions to guide future research in this area. One pressing issue is the learning mechanism at work that is resulting in behavioral changes. Although potential therapeutic mechanisms are presented in this study and are also available in additional reviews (e.g., Blischak, Lombardino, & Dyson, 2003; Kangas & Lloyd, 1998, 2002), specific, hypothesis-driven investigations are needed to clarify the mechanisms that are responsible for behavior changes. A better understanding of these learning mechanisms can potentially lead to more refined and effective intervention.

An investigation of the effectiveness of this intervention implemented with different types of participants is warranted. Different outcomes are possible when the intervention is implemented in children with speech sound impairments other than CAS. One primary concern is how the intervention affects children who do not imitate or have extremely limited abilities to produce natural speech. Although it is anticipated that the treatment protocol may require

modifications if implemented in children without imitation skills, the results of this study indicate that the intervention might not have a positive effect on the speech production of these children. Further, research is needed to determine if short-term AAC use may facilitate natural speech development in children who are expected to eventually be natural speech communicators, for example with the late-talker population or with children who have severe phonological impairments.

Finally, it would be interesting to investigate changes in the speech production patterns of children who are primarily AAC communicators that receive this intervention. Although changes in the AAC use of the participants in this study were not great, changes may be more evident in a population of primarily AAC communicators. It seems possible that if the intervention was truly facilitating natural speech production, a decrease in AAC use would be observed while increases in natural speaking ability are occurring. Direct investigations of the intervention's effects on this population are needed to provide evidence to support this hypothesis.

Conclusions

The goal of this study was to provide information concerning the effectiveness of a unique intervention program that incorporated AAC and traditional intervention techniques aimed at improving the quantity and quality of speech production in children with SSIs. Results support previous literature that suggests an integrated intervention that incorporates AAC does not inhibit natural speech production, and these results provide novel information that this type of integrated intervention may result in increases in the amount and accuracy of natural speech production. In addition, the participants' generalization to words containing the target sound and also to non-targeted sounds suggests that this intervention may lead to changes in the speech production system as a whole. It is anticipated that the information obtained from this study will

lead to continued research in the area of natural speech development in children who use AAC. It is primarily important to specify the learning mechanisms responsible for the changes observed during the intervention. Additional evidence is needed to determine the intervention's effectiveness with children who have other speech sound impairments, who do not have imitation abilities, and who use their AAC systems in a different manner than the participants in this present study. Hopefully, the overall results of this study will make implementation of AAC in children with SSIs an "easier sell". More specifically, it is anticipated that this study will provide speech-language pathologists an innovative intervention they can potentially implement with children who use AAC and have some natural speech.

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Appendix A

University of Illinois at Urbana-Champaign
Department of Speech and Hearing Science
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Dear Speech-Language Pathologist:

This letter is to inform you of an exciting opportunity available to children with severe speech sound impairments who currently use or have had experience with dynamic display speech-generating augmentative and alternative communication (AAC) devices.

The purpose of the project is to investigate a treatment program for children between the ages of 4-8 which combines traditional speech therapy and the participant's speech-generating AAC device to enhance the quality and quantity of natural speech production. We are also interested in gathering data about the participant's experiences associated with the treatment program.

The research involves parents and children participating in 1 hour therapy sessions 2 times a week either at the University of Illinois campus or at the participant's home with the goal of increasing the child's quality and quantity of speech production. One cycle of therapy (meaning one class of speech sound) is required for participation in the study and will last approximately 3-6 weeks. Two additional cycles will be offered to the participants, if they would like to continue the treatment program. The research study also requires participation of the children and their parents in interviews, an initial assessment, and one follow-up session.

I am asking that you please administer the enclosed flyer to parents of children you work with and who you think might qualify for or be interested in participating in this research project. If have any questions about the research project, please feel free to contact either of the project investigators.

This research project is being conducted by Amie King, Doctoral Candidate and Julie Hengst, Responsible Project Investigator. Both investigators are licensed and certified speech-language pathologists with expertise in AAC.

Thank you,
Amie King
Contact information:
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"The Use of Augmentative and Alternative Communication (AAC) Intervention to Enhance Natural Speech Production"

Research Flyer

Who is conducting the research project?

This research is taking place under the direction of Dr. Julie Hengst, Associate Professor at the University of Illinois at Urbana-Champaign and Amie King, Doctoral Candidate at the University of Illinois at Urbana-Champaign.

Who can participate?

We are looking for children ages 4-8 with a primary impairment of severe speech sound disorder who currently use or have had exposure to a dynamic display speech-generating augmentative and alternative communication (AAC) device.

What is the purpose of the research project?

The purpose of the project is to investigate a treatment program which combines traditional speech therapy and the participant's speech-generating AAC device to enhance the quality and quantity of natural speech production. We are also interested in gathering data about the participant's experiences associated with the treatment program.

What does the research involve?

The research involves participating in 1 hour therapy sessions 2 times a week either at the University of Illinois campus or at your home with the goal of increasing the quality and quantity of speech production of your child. One cycle of therapy (meaning one class of speech sound) is required for participation in the study and will last approximately 3-6 weeks. You may participate in 2 more treatment cycles if you choose. The research study also requires participation in an initial interview and assessment, weekly phone interviews, and a follow-up session.

How can I find out more?

You may email or call either of the investigators to hear more about the research study.

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Appendix B

University of Illinois at Urbana-Champaign
Department of Speech and Hearing Science
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PARENT CONSENT FOR PARTICIPATION OF A MINOR IN TREATMENT RESEARCH

Purpose of the study:
The primary purpose of this treatment research project being conducted by Amie King and Julie Hengst of the University of Illinois Urbana-Champaign is to: (1) investigate a treatment program which uses traditional speech therapy in addition to the participant's speech-generating Augmentative and Alternative Communication (AAC) device to enhance the quality and quantity of natural speech production, and (2) provide a detailed qualitative description of the participant's experiences associated with the treatment program.

Voluntariness:
I understand that participation in this research study is completely voluntary and I may discontinue at any time without penalty.

The decision to participate, decline, or withdraw from participation will have no effect on my current or future relations with the University of Illinois.

Procedures:
Before the study begins:

- My child will participate in assessment sessions consisting of formal speech and language assessments to determine eligibility and determine appropriate speech sound targets (2-3 sessions, 3 hours total).
- I will participate in a case history interview to determine eligibility, determine appropriate speech sound targets, and gather information about communication experiences (45 minutes, to take place during assessment sessions).
- The results of the assessment procedures (including the formal assessments and informal interview) will determine the eligibility of my child to participate in this intervention study. I understand that I may spend up to 3 sessions (up to 3 hours) and it may then be determined that my child does not meet the eligibility criteria to be in the study. If this occurs, as an alternative therapy option, I will be provided contact information for the University of Illinois Speech-Language Pathology Clinic.

What my child will be asked to do:

- Participate in baseline sessions which will consist of probing speech sounds and participating in a storybook activity (4 sessions, 30 minute sessions).
- Participate in treatment sessions which will utilize my child's AAC device in common speech therapy activities aimed at increasing the quality and quantity of natural speech production. One cycle of intervention (i.e., one class of speech sounds) will be required for

participation in the study. Two additional cycles (i.e., two additional classes of speech sounds) will be offered, but are not required (2 sessions per week, 60-minute sessions, duration of 3-6 weeks).
- Participate in follow-up sessions to assess progress, maintenance, and generalization consisting of standardized speech and language assessments (2 sessions, 3 total hours, to occur one month post treatment).

What I will be asked to do:
- Provide transportation for my child for assessment, baseline, treatment, and follow-up sessions if the treatment is not being conducted in my home.
- Participate in a segment of the therapy sessions which will include a shared storybook reading activity (10 minutes of each treatment session).
- Participate in weekly phone interviews assessing progression/problem solving/answering questions related to the treatment program (weekly, 15 minutes, duration of 3-6 weeks).
- Participate in a follow-up interview to gather information about the treatment program and progression of communication skills (30 minutes, to take place during follow-up sessions).

I understand that all sessions will be conducted at the Speech and Hearing Science Building, the University of Illinois Speech Language Pathology clinic, The Early Learning Center, or in my home, based on preference and availability. I understand that all interviews and the assessment and treatment of the required cycle will be conducted by Amie King, M.A., CCC-SLP. If I choose to participate in additional cycles of treatment, this may be provided by supervised students in the Speech and Hearing Science Department at the University of Illinois Speech Language Pathology Clinic. All student administered treatment will be supervised by a certified and licensed speech-language pathologist.

Dissemination of results and confidentiality:
I understand that to participate in this study, I will be required to have all sessions and interviews audio-and/or video-recorded for the purpose of data analysis. I understand that I have a choice as to whether I will allow the video and/or audio-recordings be used for dissemination of results, including for example, journal publications and oral presentations. Results may be disseminated in both written and oral form and may include excerpts from the sessions and the interviews. The excerpts may include written transcripts and/or video images of me and/or my child while participating in the therapy activities. Safeguards will be used to ensure confidentiality, including the use of a research number and pseudonym and deleting references to names or address from transcripts and video-clips.

I understand that all personal information about me and my child will be kept confidential (e.g., names, addresses, family member names, dates of birth). All records will be stored in a locked cabinet with access only by the investigators and will be kept for a period of three years, and indefinitely thereafter. I will be given an identification number and a pseudonym and will be referred to by this identification number in publications, presentations, written records, and in stored data (e.g., field notes, interview notes, assessment protocols, and media). The data key and consent form which contain my identifiable information will be kept in a separate locked filing cabinet.

Risks and benefits:

The risks anticipated in this research project are not greater than those ordinarily encountered in daily life. There is the possibility that someone (e.g., family, friends, health care workers) may be able to identify me from the videotapes and the transcript excerpt information used in research reports. The low incidence of individuals who use AAC may also increase the possibility of identification. As previously described, several procedures will be taken to safeguard my identity (including the use of a research number and pseudonym, deleting references to names or addresses from transcripts and videotapes).

My child may benefit by having the opportunity to participate in weekly therapeutic sessions. Increased competence in communication and AAC use, in additional to increases in speech and language skills are specific expected benefits of receiving this treatment. In addition to subject benefits, the researchers hope the information obtained from this research project will result in increased general scientific knowledge which will benefit researchers and clinicians working in this area.

I understand that the experimental component of this research study is using elements of traditional intervention techniques commonly used in therapeutic settings (e.g., cyclical approaches, minimal pair contrasts, motor-based treatments, parent-facilitated communication), in conjunction with the individual's AAC device, to increase speech communication skills. Although it is reasonably expected that these types of therapies implemented without the AAC device may provide increases in the quantity and/or quality of speech and language communication skills, I understand that this intervention differs in regards to the availability and use of the AAC device throughout the therapy program. I also understand that my child may experience some level of frustration while attempting the therapy activities; although no more frustrating than challenges they occur in their daily life. The intervention is designed to limit frustration by providing the child with multiple ways of successfully producing the target sounds and words. Attempts will be made to minimize this risk through the use of proper cueing and elicitation techniques throughout the intervention.

The University of Illinois does not provide medical or hospitalization insurance coverage for participants in this research study nor will the University of Illinois provide compensation for any injury sustained as a result of participation in this research study, except as required by law.

Cost:
I understand that I am responsible for any travel fees to the University of Illinois associated with the research project. The project staff will provide parking during the project related visits to the University of Illinois at no cost to me.

I acknowledge that I am 18 years of age or older; have read and understand the above consent form; voluntarily agree for my child to participate in this study and to provide information on my child's behalf; and understand I will be given a copy of this consent form. I understand that I have a right to a 4-day waiting period before consent is to be provided to the research staff. I understand that consent is only required from one parent/guardian.
I am consenting to participate at the level checked below:

_____I consent to let the videotape of my child and/or me be used fully as outlined above.

_____I consent to let the videotape of my child and/or me be used in data analysis, but I do not want transcripts or video-clips of my child be used in any research reports.

If you have any more questions about this research project, please call me, Amie King, M.A., CCC-SLP at 618-246-3301 or email me at amking2@illinois.edu. You may also call the responsible project investigator, Julie Hengst, PhD, CCC-SLP at 217-333-2230 or email her at hengst@illinois.edu if you feel you have been injured or harmed by this research, or have any additional questions or concerns.

_____	_____
Amie King, MA, CCC-SLP Date	Signature of Parent/Guardian Date

If you have any questions about your rights as a participant in this study, please contact the University of Illinois Institutional Review Board at 217-333-2670 (collect calls will be accepted if you identify yourself as a research participant) or via email at irb@illinois.edu.

Appendix C

University of Illinois at Urbana-Champaign
Department of Speech and Hearing Science
901 South Sixth Street
Champaign, IL 61820
Telephone: (217) 333-2230

What this form is:
This is a form we use to let you know about being in the research study; it is called an assent form. We use these forms for children aged 4-8 and we read it with you to make sure you understand the research study.

Purpose of the Study:
We would like to better understand how children who use AAC devices like yours can talk more and speak more clearly.

Procedures:
We will read books, play games, and do other fun activities with a speech-language pathologist. You will practice saying words with your voice and your AAC device. You and the speech-language pathologist will be videotaped so we can be sure about what you say.

Benefits:
You will get individual time to work on your talking and communicating with a speech-language pathologist.

Confidentiality:
Everything we do is confidential, which means we use number codes and fake names to try and make sure no one will know who you are. Unless you tell us it is okay, no one besides the people working with you and your mom or dad will know about what you say or do in the sessions.

Voluntariness:
You are helping us because you want to and you can quit the study any time you want. You can also quit an activity any time you want. You can ask any questions you want to and you can ask for your mom or dad at any time. Even if your mom or dad have said it is okay for you to be in the study, you can still quit the study or any activities in the study without getting into trouble. Even if you say yes to be in the study now and you change your mind later and don't want to be in the study anymore, you can stop by letting me, Amie, or your mom or dad know.

Dissemination of results:
When you are finished helping us, we will write a research report and give a talk about what we did for other people to learn. If it is okay with you and your mom or dad, we may use video-clips of you and write down parts of what you say.

Risks:

There is a chance that someone might know who you are when we show video-clips of you and parts of what you say when we write our research report. We do things to try and make sure this won't happen like giving you a research code and a fake name. Although sometimes the activities may be a little bit hard and you might get a little frustrated, I will do lots of things to try and make sure this won't happen.

Consent to Participate:
I understand what has been read with me. I understand that I will have to come to the University of Illinois, or you will come to my home or the Early Learning Center and work on communication with me for about 2 hours a week for a couple of months.

I volunteer to be a part of this study just like what we have read together and at the level I am checking below.

_____I agree to be a part of the study, and I think it is okay to let the use of videotapes be used like we talked about.

_____I agree to be a part of the study, and I think it is okay to let you videotape me to make sure you know what I say, but I don't want my video or parts of what I say to be used in research reports for other people to see.

_____I do not agree to be part of the study.

Appendix D

John

- Target sound is Final Consonants (FC)
    - Baseline target words (FC)
        - Old, brown, hat, look, mouse, goat, took, duck, boat, round
    - Treatment target words (FC)
        - Sun, wait, green, sprout, bud, seed, dig, hot, cup, pat, bird, ground, cold, soak, bean, watch, wind, root, dirt, plant
    - Generalization words (FC)
        - Hop, road, bat, bed, log, moon, heart, bush, tent, globe
- Control words (k, g)
        - Comb, cow, car, can, corn, gum, gold, gorilla, golf, girl

Luke

- Target sound is S-blends
    - Baseline target words (s-bl)
        - Star, swim, smile, strange, sky, space, smoke, spin, spot, spaceship
    - Treatment target words (s-bl)
        - Snake, stuck, scorpion, spinner, swing, skirt, sneaky, sweater, sponge, star, splash, spider, spin, smack, sticky, speak, scary, swim, sleep, smooth
    - Generalization words (s-bl)
        - Stinky, slip, school, sweater, snail, sting, snowing, spoon, stop, slide
- Control words (l)
        - Leaf, log, library, flower, block, clown, lift, love, balloon, police

Thomas

- Target sound is S-blends (s-bl)
    - Baseline target words (s-bl)
        - Star, swim, smile, strange, sky, space, smoke, spin, spot, spaceship
    - Treatment target words (s-bl)
        - Snake, stuck, scorpion, spinner, swing, skirt, sneaky, sweater, sponge, star, splash, spider, spin, smack, sticky, speak, scary, swim, sleep, smooth
    - Generalization words (s-bl)
        - School, slide, string, stinky, stop, slip, snail, sweater, spoon, snow
- #2 Target sound is (f)
    - #2 Baseline target words (f)
        - Friend, fish, fishing, float, fin, flower, food, fun, frog, feel
    - #2 Treatment target words (f)
        - Firefly, flew, fun, flash, fast, fireworks, find, friend, flicker, feel, float, farm, fly, flame, field, fred, fit, face, figure, forest
    - #2 Generalization words (f)
        - Fall, fox, fan, fries, feet, fur, finger, food, fair, flute
- Control words (l)

  Love, balloon, log, lake, black, lion, playdoh, lift, police, block

Appendix E

John

- Baseline books (FC)
  - *Who Took the Farmer's Hat* by Joan A. Nodset
- Treatment books (FC)
  - *How a Seed Grows* by Helene J. Jordan
  - *Tiny Seed* by Eric Carle
  - *Zinnia's Flower Garden* by Monica Wellington
  - *One Bean* by Anne Rockwell

Luke

- Baseline books (s-bl)
  - *My Place in Space* by Joan Sweeney
  - *Frog in Space* by Tedd Arnold
- Treatment books (s-bl)
  - *Itsy Bitsy Spider* by Iza Trapani
  - *Spinning Spiders* by Melvin Berger
  - *Miss Spider's Tea Party* by David Kirk
  - *Tidy Up Spider* by Monique Hagen and Hans Hagen
  - *The Very Busy* Spider by Eric Carle

Thomas

- Baseline books (s-bl)
  - *Frog in Space* by Tedd Arnold
  - *My Place in Space* by Joan Sweeney
- Treatment books (s-bl)
  - *Itsy Bitsy Spider* by Iza Trapani
  - *Spinning Spiders* by Melvin Berger
  - *Miss Spider's Tea Party* by David Kirk
  - *Tidy Up Spider* by Monique Hagen and Hans Hagen
  - *The Very Busy Spider* by Eric Carle
- Baseline books (f)
  - *Fidgety Fish* by Ruth Galloway
  - *Fish is Fish* by Leo Leoni
- Treatment books (f)
  - *Firefly Fred* by Todd Porter
  - *The Very Lonely Firefly* by Eric Carle
  - *Ten Flashing Fireflies* by Philemon Sturges

Appendix F

Pre-Treatment Interview Questions

A. Background/Educational Information

1. What is your child's primary communication impairment? As determined by?
2. Describe any additional medical/educational diagnoses.
3. What services is he/she receiving?
4. What are your child's cognitive abilities?
5. What is his/her educational placement?
6. How does your child function at school? (primary causes of any difficulties)

B. Communication Information

1. Describe how your child communicates (primary and all additional modes, settings). Wants and needs, information transfer, social closeness, social etiquette
2. Describe a typical communication interaction with your child.
3. Describe your child's speech attempts (effectiveness, strengths, weaknesses).
4. What happens when communication breaks-down?
5. How much do you and others understand of your child's communication (natural and AAC generated)?
6. What does your child usually talk about?
7. How often do you practice communicating at home (natural speech or AAC)?
8. What are the effects of your child's communication impairment?
9. Do you think your child says all that he/she wants to say?

C. AAC Information

1. How long has AAC been used?
2. How much does he/she communicate with the AAC system?
3. Describe the process in obtaining your AAC system (primary reason for implementation, how device was decided on).
4. Tell me about your child's AAC services (goals, progress).
5. How do you feel about the effectiveness of your child's AAC device?
6. What do you think is the purpose of your child's AAC system?

D. Natural Speech Information

1. Describe your child's natural speech (attempts, errors, effectiveness).
2. How much does he/she communicate with natural speech?
3. How long has your child worked on his/her natural speech?
4. About how may intelligible words does your child use (imitate, spontaneous, elicited)?
5. Is speech currently a target of therapy (goals, time, procedures, use of AAC, improvements)?
6. Tell me how you feel about targeting natural speech (importance to you).

E. Parent Perspectives

1. Tell me your short and long term communication goals for your child?
2. How do you see your child communicating in 5 years?

3. What are your views of the services he/she is receiving (alignment of goals with professionals)?
4. What are your main communication concerns for your child?

During-Treatment Interview Questions

A. Therapy/Communication Experiences

1. How has communication been this week (more or less words, examples, have others commented)?

2. How about production of the target words (observed any accurate speech productions of target or non-target words)?

3. Have you noticed any differences in his/her communication practices (with family, friends, others)?

Post-Treatment Interview Questions

A. Impressions of therapy

1. Tell me if/how you feel your child's communication has changed since the conclusion of therapy (i.e., changes in natural speech, AAC use, amount of communication, effectiveness of communication).

2. Would you like to continue with additional cycles of treatment? (review data from study, match parent perspectives to data)

B. Opinions of Treatment

1. What are your opinions of the treatment? (is this the kind of therapy you envisioned for you child)

2. Is there anything about the treatment that was difficult for you?