Signing to Maintain Joint Attention with Children with Down Syndrome

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SIGNING TO MAINTAIN JOINT ATTENTION WITH CHILDREN WITH DOWN SYNDROME

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SIGNING TO MAINTAIN JOINT ATTENTION WITH CHILDREN WITH DOWN SYNDROME

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“Being confident of this, that he who began a good work in you will carry it on to completion until the day of Christ Jesus,” Philippians 1:6.
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The current study examined the role of two different methods of sign presentation on signed and spoken language acquisition of toddlers aged two to four years with Down syndrome (DS). The aim of this study was to determine if a method commonly used by native signers/Deaf mothers (referred to in this study as signing to maintain joint attention (SMJA)) was more effective than the method commonly used by hearing mothers and speech-language pathologists (referred to in this study as the triangular method of signing). Both methods were compared in a within-subject design for effects on the participants’ total number of words signed and/or spoken, unique words signed and/or spoken, and parent report of novel word acquisition. Although the sample size was small, clear trends were seen suggesting SMJA may result in greater increases in early language acquisition for toddlers with DS. These results are consistent with considerations regarding the DS phenotype. The use of signing takes advantage of strengths in gesture and visual-spatial short-term memory. More specifically, the use of SMJA addresses weaknesses in attentional capacity by allowing the child to attend to the object and referent without disruption, thereby maintaining joint attention and supporting language acquisition.
INTRODUCTION

Research has shown that children with Down syndrome (DS) evidence specific deficits in expressive language beyond what is expected based on their cognitive functioning (Miller & Miller, 1999; Mundy, Kasari, Sigman, & Ruskin, 1995) making early language intervention for this population of particular importance. The specific behavioral profile, or phenotype, associated with DS includes mild to moderate cognitive delays (Chapman & Hesketh, 2000) with additional deficits in expressive language and auditory short-term memory (Næss, Lervåg, Lyster, & Hulme, 2015), and attentional capacity (Berger, 1990; Landry & Chapieski, 1989). Relative strengths in visual-spatial memory (Vanvuchelen, 2016) and the use of gestures are exhibited (Capone & McGregor, 2004; te Kaat-van den Os, Jongmans, Volman, & Lauteslager, 2015).

Research has shown that one type of language intervention, the use of signs with verbal input, is particularly effective with children with DS as it takes advantage of visual and gestural preferences (Carbone, Sweeney-Kerwin, Attanasio, & Kasper, 2010; Dunst, Meter, & Hamby, 2011; Launonen, 1996).

However, limited attentional capacity continues to be a concern, especially considering the important role joint attention plays during language acquisition (Adamson, Bakeman, Deckner, & Romski, 2009; Pickard & Ingersoll, 2015). Studies have shown attempts to attend to an object and the caregiver, who is providing a verbal referent for that object, overwhelms the attentional abilities of children in this population (Landry & Chapieski, 1989). Further, redirection of attention by caregivers is negatively associated with future language gains (Abbeduto, Evans, & Dolan, 2001; Harris, Kasari, & Sigman, 1996). This information is concerning when the manner in which hearing
mothers and speech-language pathologists commonly present signs often requires redirection of attention (Burns, Haynes, & Russell, 2015; Clibbens, Powell, & Atkinson, 2002). In what will be referred to as the triangular method I, signs are made in the canonical position (the location typically used by an adult signer) while sitting next to the child. A triangle is formed between the child, the sign, and the object of attention as the child’s attention is called to the sign. For example, a child is playing with a ball with the adult sitting nearby. The adult comments, “Ball! You see the ball?” while signing BALL. The child turns from the ball to look at the adult and his hand motions.

Other researchers have suggested that another method of signing employed by native signers/Deaf mothers, referred to here as signing to maintain joint attention (SMJA), may reduce attentional demands placed on the child as well as disruptions in joint attention (Burns et al., 2015; Harris, 2001). In this method, signs are presented in the child’s line of sight with the object of attention, either by displacing (moving) the signs from their canonical position into the child’s signing space or line of sight, or moving the object of attention so that the sign is presented in the child’s line of sight. For example, a child is playing with a ball and the adult reaches around the child into his signing space and signs BALL, placing the sign between the child and the ball while commenting. Another example: if a child is reading a book with a picture of a horse, instead of making the sign for horse in the technically correct canonical position on his head, the adult moves his hand so that it is between the child and the picture of the horse and makes the sign in the adjusted location.

This study aims to compare the effects of TM and SMJA on the language acquisition of toddlers with DS. Previous research has established the effectiveness of
modeling, delayed physical and verbal prompts, and the immediate reinforcement of
signs on acquisition for this clinical population (Carbone, Sweeney-Kerwin, Attanasio, &
Kasper, 2010; Dunst, Meter, & Hamby, 2011; Goodwyn & Acredolo, 2000; Thompson,
Mckerchar, & Dancho, 2004; Thompson, Cotnoir-Bichelman, McKerchar, Tate, &
Dancho, 2007). To date, no studies have compared the effects of maintaining joint
attention during signing on language outcomes. This information is important to guide
clinicians in planning language intervention with children with DS.

LITERATURE REVIEW

Down Syndrome

Approximately 6,000 babies are born each year in the United States with an extra
copy of the 21st chromosome resulting in a diagnosis of Down syndrome (National Down
Syndrome Society, 2012). Down syndrome (DS), the leading cause of intellectual
disability, effects people of all races and economic levels. DS diagnosis is on the rise as
the number of babies born with DS has increased by around 30% between 1979 and 2003
(Shin, et al., 2009). The increased genetic material of a third copy of chromosome 21
leads to a myriad of effects in physical and cognitive development, brain structure, and
behaviors for the individual (Chapman & Hesketh, 2000). Rather than viewing an
individual’s potential communication profile through the limited lens of IQ, many
researchers have considered the behavioral profile, or phenotype, characteristic of
specific genetic conditions to develop a more comprehensive understanding (Abbeduto et
al., 2001; Chapman & Hesketh, 2000; Vanvuchelen, 2016).

Language development. The phenotype for individuals with DS includes mild to
moderate cognitive delays with additional deficits in expressive language, auditory short-
term memory, attentional capacity and relative strengths in visual-spatial memory and the use of gestures. Intelligence quotient scores for persons with DS typically fall between 30-70 (Chapman & Hesketh, 2000), but specific deficits in the development of spoken language skills are present beyond what is expected based on their mental age or nonverbal cognition (Miller & Miller, 1999; Mundy et al., 1995; Næss et al., 2015; Stefanini, Caselli, & Volterra, 2007; Zampini & D’Odorico, 2013) and in comparison to other individuals with cognitive impairments (Mervis & Robinson, 2000). When considering mental age, first words are typically produced at an appropriate age. However, after that point expressive vocabulary growth is significantly slowed (Caselli et al., 1998; Zampini & D’Odorico, 2013). Specifically, Berglund, Eriksson, and Johansson (2001) found that three year olds with DS had a vocabulary commensurate with typically developing children 20 months younger. While 80% had begun to talk by age two, 10-20% still had fewer than ten words in their vocabulary between the ages of three to five. Children with DS evidence a verbal production deficit that becomes increasingly evident after the mental age of 17 months (Miller & Miller, 1999), with one study reporting 92% of participants with DS had an expressive lexicon below the 5th percentile (Mervis & Robinson, 2000). In addition, expressive language abilities are much weaker than receptive language abilities (Caselli et al., 1998; Zampini & D’Odorico, 2009). Language is a fundamental skill and the severe learning difficulties experienced by children with DS in this area has potential widespread influence on their cognitive development, social interaction, and functional living. These language deficits appear to be relatively stable over time, underscoring the importance of early language intervention for this population (Næss et al., 2015). In fact, intervention during the first three years of
life has been shown to positively affect pre-linguistic and early linguistic skills in toddlers with DS (Roberts, 2007). This makes understanding the exceptionality of particular interest to clinicians. Additionally, theories of language development, such as emergentism and the social-interactionist approach, emphasize the relationship between a child’s language environment and basic biological abilities (Abbeduto et al., 2001). It is important to examine the specific characteristics of the DS phenotype that may be negatively impacting language development in order to guide early intervention practices.

**Short-term memory.** One factor of the DS phenotype that may negatively impact language development is an increased impairment in phonological memory and verbal memory in general. Short-term auditory memory for sequences of speech sounds is a notable deficit when compared to individuals with other neurodevelopmental disorders such as Fragile X syndrome and Williams syndrome (Abbeduto, Warren, & Conners, 2007). While substandard results on short-term memory tasks may be an effect of language impairments (even when memory tasks are insensitive to language abilities or controlled for) performance continues to be poor. This indicates a fundamental deficit in verbal, short-term memory (Brock & Jarrold, 2004; Næss et al., 2015). Still, this deficit is not pervasive to all short-term memory tasks or all sequencing tasks. The conclusions of Raining-Bird and Chapman’s 1994 study reported that, while recall on verbal memory tasks is subpar, recall on visual-spatial tasks are comparable to control groups. These findings have been replicated in other studies confirming a selective verbal memory deficit (Jarrold & Baddeley, 1997; Purser & Jarrold, 2005). Interestingly, typically developing children and adults retain auditorily presented information better than visually presented information, meaning that persons with DS have a “reverse
modality effect” (Jarrold & Baddeley, 1997; Purser & Jarrold, 2005). Therefore, visuospatial short-term memory is a relative strength within this population (Launonen, 1996; Vanvuchelen, 2016). One question for researchers is whether visual input can be used to compensate for auditory deficits. A comparative research study in 2000 (Kay-Raining Bird, Gaskell, Babineau, & Macdonald) and a case study in 2011 (Lecas, Mazaud, Reibel, & Rey) indicated compensating with visual input could be a viable option. Early intervention should build on the strengths of the child and, in the case of children with DS, Launonen (1996) recommended advising parents to support visual-motor means of communication. Chan and Iacono (2001) felt that access to the visual input provided by the gestural modality was key to the success of their subjects’ speech development. After the results of their 2015 longitudinal study between language and verbal short-term memory skills in children with DS, Næss, Lervåg, Lyster, and Hulme postulated that the inclusion of visual materials may be helpful to facilitate learning in this population, considering the weakness in short term verbal memory.

**Joint attention.** Another factor within the DS phenotype that may negatively influence the language development of individuals with DS is limited attentional capacity. Joint attention occurs when a child and a caregiver simultaneously attend to the same object; it plays an important role in language acquisition. Originating with the well-known child development theorist, Lev Vygotsky, this idea is based on the premise that children learn best when actively engaged in play with input from a caregiver to scaffold their learning (Vygotsky, Cole, John-Steiner, & Scribner, 1978). In an early study on joint attention, Tomasello & Farrar (1986) determined that these states of focus between the caregiver and child provide important scaffolding for early linguistic
interactions and are of special importance for acquiring new language. Response to joint attention is a unique predictor of language (Morales et al., 2000; Pickard & Ingersoll, 2015) and has been shown to hold true for children with DS as well (Adamson et al., 2009; Zampini, Salvi, & D’Odorico, 2015). In the largest longitudinal study of joint attention to date, measures of initiation and response to joint attention at 12 and 18 months of age predicted language scores at 24 months of age, even when language scores at the preceding ages were controlled for by the researchers (Mundy et al., 2007). A more recent study evidenced that joint attention was positively correlated with vocabulary acquisition – specifically an increase in the *MacArthur Bates Communicative Development Inventory* (CDI) percentile when controlling for age (Williams, 2016). Recent evidence has also shown that within the DS population, initiation of joint attention is a significant predictor of future receptive vocabulary size (Zampini et al., 2015).

Symbol-infused joint engagement is predictive of both expressive and receptive vocabulary (Adamson et al., 2009). Individual differences in joint attention behaviors are directly related to subsequent language and cognitive development in both typical and atypical population samples (Mundy et al., 2007).

Unfortunately, infants with DS demonstrate marked difficulty in maintaining joint attention to their caregivers and objects (Berger, 1990; Landry & Chapieski, 1989). While children with DS attend more readily to their communication partner, they rarely attend to objects during interactions, even at the age of two and a half. This is of particular concern as symbol-infused joint engagement facilitates early language learning (Adamson et al., 2009). Berger (1990) reports that when mothers of infants with DS attempted to direct their attention to a toy, infants would stop playing and direct their
attention to their mother. The attentional capacity of children with DS is more easily disrupted and overtaxed, even when developmental levels are considered (Berger, 1990). Attentional patterns of young children with DS evidence difficulty with noticing, much less attending to, objects in their environment (Landry & Chapieski, 1989). The previous study highlighted attention-directing techniques (that require a shift of attention) overwhelm and distract infants with DS inhibiting, rather than promoting, joint attention. The researchers concluded the use of attention gaining strategies not requiring a shift of attention is critical for maximizing learning opportunities in this population.

Corroborating these findings, Harris, Kasari, and Sigman (1996) found that redirecting attention to a caregiver-selected stimulus is negatively associated with receptive language in the DS group, although not significant in the mental-age matched control group. Not only did the caregiver’s maintaining behaviors impact vocabulary acquisition, but the child’s unique set of attention skills as well (Zampini, Salvi, & D’Odorico, 2015).

Zampini et al. (2015) explained the cognitive load placed on children in this group during an attentional shift may leave them with too few resources to attend to the vocabulary being presented. Since maintenance of joint attention is crucial in language development, reducing demands on attention is particularly important for children with DS during opportunities for lexical growth.

**Use of gesture.** While expressive language is a deficit for individuals with DS, the use of gestures has been shown to be a relative strength within the DS phenotype and even preferred over verbal communication (Capone & McGregor, 2004; te Kaat-van den Os et al., 2015). Gesture, language, and speech overlap in their function, development, and even neural control (Capone & McGregor, 2004). Following a developmental
progression, early gestures serve to gain and maintain adult attention, representational gestures carry meaning in their own form, and supplemental gestures clarify and scaffold both receptive and expressive language (Capone & McGregor, 2004). The use of gestures is significantly positively correlated with total vocal production (Capone & McGregor, 2004; Dimitrova, Özçalıskan, & Adamson, 2016; Mundy et al., 1995; te Kaat-van den Os et al., 2015; Zampini & D’Odorico, 2009). Gestures are eventually replaced by words, but in early language acquisition the purposeful use of gesture facilitates, not impedes, language development and can be utilized to support a myriad of language intervention goals (Capone & McGregor, 2004; Layton & Savino, 1990; Roberts, 2007; Stefanini et al., 2007; Zampini & D’Odorico, 2009). As with typically developing children, the production of gestures in children with DS decreases as verbal production increases (Galeote, Soto, Checa, Gomez, & Lamela, 2008; Galeote, Sebastian, Checa, Rey, & Soto, 2011; Kouri, 1989; Layton & Savino, 1990).

Children with DS have been shown to have a specific propensity for gestural communication when compared to other children with cognitive impairments and typically developing, mental age-matched peers (Chan & Iacono, 2001; Singer Harris, Bellugi, Bates, Jones, & Rossen, 1997; Toret & Acarlar, 2011; Vandereet, Maes, Lembrechts, & Zink, 2011). Caselli et al. (1998) found that the dissociation seen between expression and comprehension was not the case when lexical comprehension was compared to gestural production. Similarly, Stefanini, Caselli, and Volterra (2007) found that children with DS produced more incorrect answers on a picture naming task than either their chronologically or mentally age-matched peers; however, they produced significantly more semantically-related gestures. When nonverbal responses were taken
into account, their percentage of correct answers significantly increased revealing a unique relationship between gesture and speech in this population. An affinity for gesture aligns with their comfort with visuospatial material and potential strength in imitation (Vanvuchelen, 2016). Chan & Iacono (2001) found that the advantage for manual communication was seen in various contexts and across time. Initially, gestural and vocal production between children with DS and their lexical comprehension-matched peers is comparable. However, symbolic communicative gestures continue to increase in children with DS, resulting in nonverbal communication “specialization” (Caselli et al., 1998). Gestural communication serves as an effective means of expressive language for a longer time than in mental age-matched, typically developing children (Galeote et al., 2008; Galeote et al., 2011), and can be used to convey information missing in their speech (Stefanini et al., 2007). In fact, children with DS may be utilizing gestures initially to compensate for their delayed speech development (Chan & Iacono, 2001).

Not only do children with DS adapt to their deficits in expression by using gesture to convey meaning (Stefanini et al., 2007), gesture also offers a clinically effective scaffold for learning (Capone & McGregor, 2004). Parents of typically developing children use gesture to support comprehension, and mothers of children with DS have been shown to employ a gestural motherese that serves to further simplify their communication to the benefit of their child’s receptive language (Iverson, Longobardi, Spampinato, & Caselli, 2006). These findings are consistent with Wang, Bernas, and Eberhard’s 2001 study that demonstrated when teachers used gesture to scaffold their instruction, students with DS were more responsive, successful, and attended to task longer. While it appears that parents of children with DS produce fewer verbal utterances
when interacting with their children, they produce gestures at a similar rate to parents of typically developing children (Iverson et al., 2006). Iverson, Longobardi, Spampinato, and Caselli (2006) postulated that a mother’s sensitivity to her child’s processing leads the child to take advantage of the visuospatial nature of gesture that is particularly accessible to children with DS. The use of gesture maximizes the learning potential of this population (Wang, Bernas, & Eberhard, 2001; Zampini & D’Odorico, 2009).

Parents of typically developing children have been shown to translate their child’s early gestures into words, which supports the acquisition of that same vocabulary. Likewise in a 2016 study, Dimitrova, Özçalışkan, and Adamson, concluded this also holds true for parents of children with DS. Caselli et al. (1998) postulated that the marked preference for gesture may be used to compensate for notable deficits in speech production. In a 2008 study by Galeote, Soto, Checa, Gomez, and Lamela confirmed this assertion. Capone and McGregor (2004) agree, adding that adults in the child’s environment would benefit from training in this modality. Parental input into child gesture has a significant, positive impact on vocabulary development of this population (Dimitrova et al., 2016). In fact, it is not gesture alone, but also the purposeful use of sign language that can play an important role in the communicative development of children with DS (Dimitrova et al., 2016).

**Sign Language**

**Typically developing infants and toddlers.** The last decade has seen a growing trend of hearing parents within the upper middle class exposing their typically developing, hearing children to baby sign language or baby signs (Pizer, Walters, & Meier, 2007). Interest in the field gained momentum after Goodwyn, Acredolo and
Brown (2000) conducted a study following 103 infants over a span of a year and half, and showed that the use of symbolic gestures with babies aided their verbal and receptive language development. However, an evidence review by Johnston, Durieux-Smith & Bloom (2005) found that, due to methodological weaknesses, there were no conclusive findings to support teaching typically developing children sign language positively affects language development. Given present research, Johnston et al. (2005) concluded it is impossible to say whether teaching sign language to typically developing children is harmful, helpful or has no effect on their development. In addition, Paling (2007) stated that the available literature on baby sign language with typically developing hearing children under the age of 36 months with hearing parents is still emerging and inconsistent; therefore, parents should not be persuaded for or against introducing symbolic gestures to their infants. In terms of relational outcomes, a longitudinal, quasi-experimental study conducted by Gongora and Farkas (2009) concluded that the use of baby signs positively influenced mother-infant interactions while strengthening a mode of communication. However, Howlett, Kirk, and Pine (2011) found that mothers who attended baby signing classes had higher levels of stress than those who did not. Nine years after the Johnston, Durieux-Smith & Bloom (2005) review, Fitzpatrick, Thibert, Grandpierre, and Johnston (2014) came to the same conclusions, reporting strong scientific evidence supporting the claimed benefits of baby signs is lacking. Still, no adverse effects have been reported. While common sense may indicate to anyone living with a toddler that it is advantageous to provide him with an alternative to frustrated whining to convey his message before he is able to do so verbally (Goodwyn, Acredolo, & Brown, 2000), a lasting language advantage for typically developing infants has not
been substantiated. Concurrently, a 2013 study reported that while infants did learn the signs and used them to communicate about their respective referents well before they were able to do so verbally, they did not differ significantly in language gains or development (Kirk, Howlett, Pine, & Fletcher, 2013). The authors of this same study, however, did find reason to suggest signing intervention may be clinically viable for groups with language delay or impairment, and they are not alone in this line of thinking.

**Infants and toddlers with DS.** Though the evidence to support baby signs improving communication in the typically developing population has been mostly inconclusive, this is not the case for the special population considered here. Early research in the 1980s began to show a combination of signing and verbal input in adults with cognitive impairments facilitated greater language growth than either method alone (see Layton & Savino, 1990 for a review). Research with children began soon after. Kouri (1989), followed by Layton and Savino (1990), conducted case studies on two non-verbal toddlers with DS as they acquired a large repertoire of signs followed by oral output, and recommended signing interventions be employed with this clinical population. Since then, studies have shown marked gains in early language development for children with DS when speech and the use of signs are integrated (Carbone et al., 2010; Dunst et al., 2011; Launonen, 1996). A longitudinal review comparing early intervention with and without signs for young children with DS from six months to three years of age, showed not only did children who received a combination of signed and verbal input demonstrate significant immediate benefits, but at three, four, and five years of age, children continued to evidence superior language and cognitive skills in comparison to the control group (Launonen, 1996). Cognitive gains may be a result of
earlier opportunities access to communication through an alternative modality provide, as well has having simultaneous visual input to support auditory comprehension (Launonen, 1996).

A 2011 systematic review of 33 studies including 216 children with disabilities, including those with DS, found regardless of the type of sign language used, duration of intervention, and length and frequency of sessions, language interventions using a combination of spoken and signed input had positive effects on oral language production of the children (Dunst et al., 2011). In a 2013 study combining signs and words toddlers with DS increased their signed and spoken words and generalized both to their natural environment (home) with different communication partners (Wright, Kaiser, Reikowsky, & Roberts, 2013). In 2016, Özcaliskan, Dimitrova, Bailey, and Schmuck found baby signs used by children with DS predicted their expressive vocabulary one year later. The study highlighted ‘the facilitative role’ signs can play in the language development for this population. Carbone, Sweeney-Kerwin, Attanasio, and Kasper (2010) reported sign-based interventions increased vocal responses in children with developmental disabilities, including DS. It is not just expressive language that stands to benefit. Dual-modality (both signed and spoken) input also positively impacts comprehension in children with DS as well (Kay-Raining Bird et al., 2000).

These findings should not be surprising considering the DS phenotype. While expressive language is a deficit for individuals with DS, the use of gestures is a strength and even preferred over verbal communication (Caselli et al., 1998; Toret & Acarlar, 2011). Visuospatial information is accessed more easily than auditory within the short-term memory of these children (Jarrold & Baddeley, 1997; Purser & Jarrold, 2005;
Vanvuchelen, 2016). Signing provides an opportunity to take advantage of both the visual and gestural strengths within this group (Launonen, 1996).

**Methods for sign instruction.** Previous researchers demonstrated the language acquisition benefits of using signs with children with DS and identified various approaches to address the specific strengths and weaknesses of this group. Other researchers determined effective methods for baby sign acquisition with typically developing children as well as children with DS. These methods include modeling, delayed physical and verbal prompting, and immediate reinforcement (Carbone et al., 2010; Dunst et al., 2011; Goodwyn et al., 2000; Thompson et al., 2004; Thompson et al., 2007). For example:

1) A communication opportunity would be arranged

2) The caregiver or clinician would model (both verbally and manually) the target word

3) After a progressive delay (starting with a few seconds and increasing to give the child time to respond independently), a hand-over-hand, physical prompt of the manual sign would be provided

4) Either after the physically prompted or independent sign, the caregiver or clinician would immediately provide the signed or spoken object/action as reinforcement.

In one study, children were presented with arbitrary signs for novel words without any physical manipulation to support the sign learning; neither the typically developing nor DS groups evidenced any mastery of the new vocabulary (Kay-Raining Bird et al., 2000). These results may underscore the importance of including physical prompting in
successful sign training as recommended by Thompson, Mckerchar, and Dancho (2004). Similarly, Carbone, Sweeney-Kerwin, Attanasio, and Kasper (2010) found that sign training using prompt delay paired with vocal prompting increased the number of vocal responses and accompanying manual signs. Dunst, Meter, and Hamby (2011) confirmed the use of reinforcement (intrinsic, extrinsic, or a combination) together with interventions using both speech and sign were effective in all instances with children with disabilities, including those with a diagnosis of DS.

**Parental perspectives.** Parental perception is unclear regarding the use of sign language in their children with DS. Some have expressed an initial concern about training their children in the use of gestures fearing that it may hinder their spoken language expression (Galeote et al., 2008). Galeote et al. (2008) recommended explaining to parents that sign language in this population is not a substitute for speech, but rather a method to enhance initial communication and ultimately facilitate greater speech production. In addition to positively impacting future oral language, use of signs early on provides access to functional communication before and during speech acquisition (Carbone et al., 2010). As previously mentioned, a number of studies demonstrated purposeful use of gestures in early language acquisition facilitated language development and growth. Once certain lexical benchmarks were reached, gestures naturally faded and were replaced with oral speech (Capone & McGregor, 2004; Carbone et al., 2010; Galeote et al., 2008, Galeote et al., 2011; Kouri, 1989; Layton & Savino, 1990; Roberts, 2007; Stefanini et al., 2007; Zampini & D’Odorico, 2009). The use of signs during the early learning window provide opportunities for making requests and comments, asking questions, and asking for more information – all functions that would
be not be available to the child otherwise. While the ultimate goal is increased speech output, parents in one study reported that they could not imagine how their child’s communication needs could have been fulfilled without signs during toddlerhood (Launonen, 1996). It is important that caregivers be provided with research-based information because communication partners’ perceptions of manual signs impact their potential success (Vandereet et al., 2011). Speech-language pathologists (SLPs) work with children with DS and their families to support their speech and language development and help them to reach their full potential, and may be in an appropriate position to inform parents. In a 2015 survey of SLPs, Burns, Haynes, and Russell found only 22% of the SLPs surveyed reported parental requests for sign instruction. However, 96% recommended signing at home to families. After their 2015 systematic review on the role of gesture during language acquisition in young children with DS, te Kaat-van den Os, Jongmans, Volman, and Lauteslager recommended clinicians and parents should facilitate the use of gesture in supporting the communication attempts and development of this group. The researchers determined without such efforts, crucial opportunities for language learning may be missed.

**Current practice.** Research provides strong evidence that using sign language with children with DS promotes their language development, but are clinicians in the field implementing these practices? An estimate in the early nineties put the percent of practitioners using sign with this population as high as 85% (Miller, Sedey, Miolo, Rosin, & Murray-Branch, 1991). A 2011 study by Vandereet, Maes, Lembrechts, and Zink included an exploratory survey of speech-language pathologists (SLPs) who, for the most part, reported the use of early signs to be an efficient manner of expression and a benefit
to the expressive vocabulary for children with DS. A more recent sampling of SLPs concurred with these findings, reporting that 87% of clinicians surveyed believed incorporating signs into therapy with children with DS to be either “effective” or “very effective” in promoting their clients’ communication and 85% reported using signs with this population depending on the individual client (Burns et al., 2015). The American Speech-Language-Hearing Association (ASHA) functions as the nationwide professional, scientific, and credentialing association of speech-language and hearing professionals and students. At this time, ASHA has yet to identify the best practices for facilitating language acquisition or signing within this clinical population (ASHA, 2016). In their 2015 survey of SLPs, Burns et al. (2015) reported that between 79-100% of SLPs surveyed utilized four evidenced-based techniques shown to be successful with this population: modeling, physical prompting, verbal prompting, and reinforcement. Displaced signing (where the clinician signs in the child’s own signing space) was the least used method (42%) with clinicians preferring instead (67%) to draw the child’s attention to the sign. For example, if a child was playing with a ball, a greater percentage of clinicians surveyed would get the child’s attention and make the sign for ball as opposed to reaching into the child’s signing space and making the sign for ball while the child continued attending to the ball. The surveyors hypothesized that disrupting and redirecting the child’s focus may not be beneficial for children with DS considering known attention deficits and the importance of maintaining joint attention for language development. The study concluded additional research was needed to more fully understand the role of facilitating joint attention in the use of signing with this population.
Maintaining joint attention during signing with children with DS.

Considering the phenotype of DS, specifically aptitude in the visuospatial domain and preference for gesture, it is not surprising that taking advantage of both characteristics through signing would be beneficial to language development (Vandereet et al., 2011). However, gestural production is not the only preverbal precursor for vocabulary acquisition with children with DS. Maintaining joint attention is another foundational skill for language development (Zampini et al., 2015). The mere presentation of novel words in two modalities (signed and spoken) may serve to better focus attention and thereby facilitate learning (Kay-Raining Bird et al., 2000; Wright et al., 2013).

Interventions for this population should strive to maintain joint attention so children with DS’s access to language rich interactions are not impeded by attention deficits (Adamson et al., 2009). In fact, Zampini, Salvi, and D’Odorico (2015) caution caregivers of children with DS against redirecting their attention during opportunities for language learning.

Strategies employed by a group of signing experts, Deaf mothers, may provide direction. Research has shown Deaf mothers adapt the location, duration, and timing of their signs. They sign about objects in a salient context in order to give their children a greater opportunity to attend to the communication (Harris, 2001). Specifically, these mothers move signs from their canonical location (the location typically used by an adult signer) to sign in the child’s signing space, wait until the child is looking at them to sign, sign more slowly, and sign predominately about objects the child is attending to within the environment (Harris, 2001). A 2002 study by Clibbens, Powell, and Atkinson noted hearing mothers simply did not use these strategies when signing. Strategies used by
Deaf mothers when signing with their infants contributed to maintenance of joint attention and resulted in a much higher percentage of signs perceived by the child within a salient context. Namely, Deaf mothers either moved the sign so that it was presented within the child’s preexisting focus of attention or moved the object the child was attending to so that it was within the line of sight of the canonical sign. The authors concluded these strategies could be very beneficial when signing with children with DS in order to avoid disrupting attention (Clibbens et al., 2002). According to the Intentionality Model for language acquisition, all children developing language have limited resources to meet the demands of cognition, comprehension, object representation, production, movement, and affect must draw. Lessening the potential cognitive demands present during a communicative exchange may allow for greater availability of resources to comprehend the relation between a given symbol and referent, thereby promoting language acquisition (Bloom, Tinker, & Scholnick, 2001).

**Current Study**

Very few experimental language training studies with this population exist (Næss et al., 2015; Roberts, 2007). In addition, although current research clearly shows methods of unaided augmentative communication, such as signing, have many benefits on the language outcomes for children with DS, further studies are needed to guide development of new interventions, specifically in relation to maintaining joint attention (Burns et al., 2015; Clibbens et al., 2002; Roberts, 2007). Methods of signing instruction including modeling, vocal prompting, delayed physical prompting, and immediate reinforcement have been shown to be effective with children with DS (Carbone et al., 2010; Dunst et al., 2011; Goodwyn & Acredolo, 2000; Thompson et al., 2004; Thompson
et al., 2007). The aim of this study was to add to the body of knowledge by determining if presenting signs in a manner that maintains attention was more effective for a small group of children with DS.

This study compared two methods of sign presentation on the expression (signed and spoken) of children ages two to four years with a diagnosis of DS. In the triangular method of presentation, the clinician made the sign in the canonical position (the location typically used by an adult signer) while sitting next to the child, forming a triangle between the child, the sign, and the object of attention. In the signing to maintain joint attention method (SMJA), the clinician made the sign in the child’s line of sight with the object of attention, either by displacing the signs into the child’s signing space or line of sight, or moving the object of attention so the sign was presented in the child’s line of sight. See Figures 1 and 2 for examples of the sign presentation methods.

**Figure 1. Methods of Sign Presentation**

<table>
<thead>
<tr>
<th>Triangular Presentation</th>
<th>Presentation to Maintain Joint Attention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child</td>
<td>Object</td>
</tr>
<tr>
<td>Sign</td>
<td>Child</td>
</tr>
</tbody>
</table>
Figure 1. Examples of Displaced/Line of Sight Signing used in SMJA

Although the TM interrupts the child’s attention to the object and redirects it to the sign, it is the method most commonly used by hearing mothers (Clibbens et al., 2002) and speech-language pathologists (Burns et al., 2015). The goal of this study was to determine if either the TM or SMJA methods of sign presentation correlate with a higher number of (a) total words signed during treatment sessions, (b) number of unique words signed during treatment sessions, (c) total words expressed (signed and spoken) during treatment sessions, (d) total unique words expressed (signed and spoken) during treatment sessions, and vocabulary used at home. The MacArthur Bates Communication Development Inventories (CDI) was completed by parents in order to guide clinicians on their sign interventions with this population. Based on the specific challenges children with DS face, and the documented benefits of joint attention, it was hypothesized that SMJA would be more effective for learning new vocabulary.

METHOD

Participants

Four toddlers between the ages of two and four with a diagnosis of Down syndrome (DS) participated in this study. Participants included three girls and one boy.
All were from two parent homes in the same urban community in central Kentucky. Participants were recruited via a local community outreach organization for persons with DS. Participant parents were fully informed and volunteered for the study. No additional incentives were offered for volunteering beyond the fun experienced in the sessions and the potential language gains. All participants were receiving early intervention services in speech therapy, occupational therapy, and physical therapy. Three out of the four attended daycare part-time. All children were Caucasian. English was the primary language spoken at home for three out of the four; one was a second generation immigrant from Eastern Europe whose family spoke English as a second language.

In addition to child participants, each session included an interventionist, data collector, and an observing supervisor. Both the interventionist and the data collector were graduate students in the speech-language pathology program at an accredited university. The supervisor was a certified speech-language pathologist who serves as faculty in the same program. Similar to other studies (Wright et al., 2013), the interventionists were either familiar with the use of signs or had used signs in therapeutic settings, but not all were fluent in sign language. Interventionists and data collectors completed sign training on the targeted signs provided by a consultant in American Sign Language (ASL) holding the NIC certification with the Registry of Interpreters for the Deaf. Interventionists and data collectors were assessed on their ability to demonstrate and recognize the signs by a faculty member in the university’s ASL program who holds an Intermediate Plus on the Sign Language Proficiency Interview. Data collectors were also trained to recognize and code prompts and responses by both participating children and interventionists.
Materials

Printed information on the study, consent documents, and the CDI were used for each participant. The CDI is a parent inventory measuring vocabulary understood and expressed by young children. This measure takes advantage of parents’ extensive knowledge of their child’s vocabulary. The CDI boasts high reliability and validity. It is efficient in terms of time and cost, and avoids influences that might skew the data including lack of familiarity with an examiner or location (Fenson et al., 1991). The validity of the CDI has been confirmed for assessing the vocabularies of children with DS (Miller et al., 1991; Zampini & D’Odorico, 2009). For this study, parents were asked to include their child’s signed words as they completed the inventory by making a notation when words were signed instead of spoken. Berglund, Eriksson, and Johansson (2001) and Galeote (2008) agreed the signs made by children in this population should be considered in addition to their spoken vocabulary. Stefanini, Caselli, and Volterra (2007) concurred that allowing for both modes of expression provides a more accurate picture of the individual child’s conceptual knowledge. High correlations have also been found between the modality of children’s words as reported by parents on the CDI and those observed during communication samples. This provides preliminary evidence for the measure’s concurrent validity for measurement of modality in expressive language (Vandereet et al., 2011).

The interventionists were provided a novel curriculum detailing activities for five potential themes: Animals, Colors, Clothing, Functional/ Household Items, and Transportation. The curriculum included songs and activities with corresponding materials for each theme (see Appendix A), and a prompting hierarchy. The structure of
the curriculum provided consistency across interventionists. Each interventionist had a “Session Notes” form where completed activities were selected from a predetermined list and interactions were documented. Each data collector had a “Session Data” form where every word signed and every word spoken by the child was noted and coded for the manner of prompting that elicited the response. Codes included responses to clinician model/imitation, verbal prompt, partial physical prompt, question, or spontaneous (non-prompted) output. Full physical prompts, where the sign was made hand over hand, were not counted as signed responses. A video camera was used to record each session.

Materials in each session included age-appropriate books, toys, and other items related to the targeted themes and corresponded to activities outlined in the curriculum. For example, the animal theme included a toy barn, toy replicas of farm animals and pets, puzzles and magnets depicting various animals, Noisy Farm Touch and Feel Soundbook by Tiger Tales, and Brown Bear, Brown Bear, What Do You See? board book by Eric Carle. See Appendix A for images of supplies.

Procedures

All sessions took place at a campus clinical setting. Parents/caregivers were able to observe sessions in an attached viewing room through a two-way mirror. Treatment rooms were individual rooms with carpet, a table, chairs, and toy storage. Each participant was scheduled to attend one baseline session and ten treatment sessions. Sessions were scheduled twice weekly for six weeks and lasted 30 minutes in duration. No sessions were missed during the TM presentation sessions. However, Participant 1 missed Session Number 5 and Participant 2 missed Session Number 3 during the SMJA sessions.
Prior to the first session, parents completed the “Words and Gestures” portion of the CDI, indicating both signed and spoken words. Three thematic units were selected for each participant based on language gaps evidenced by the CDI and the child’s interests. Interventionists conducted baseline sessions using toys, books, and activities from thematic units aligned with each child’s language gaps. After the baseline session, thematic areas were narrowed to two based on the child’s interests and preferences. These two themes were targeted during the subsequent intervention sessions. For example, if a child’s CDI evidenced a lack of expressive vocabulary related to Functional/Household Items, Transportation, and Animals then a baseline session was set up to include toys and books corresponding to these themes (see Appendix A). If the child favored the toy airplanes and animal books during the session, the Animals and Transportation themes were selected for intervention.

During the initial session, baseline data was also gathered on the child’s expressive language related to the thematic toys and books present. The interventionist prompted the child to elicit language based on objects to which the child was attending. For example, if the child was holding the toy cow but remaining silent, the clinician might ask, “What is that?” Clinicians began with the least supportive prompts in the hierarchy and progressed to the most supportive end. Figure 3 provides a visual representation of the prompting hierarchy with examples of each. This baseline data was later compared to the data gathered during the two different methods of sign presentation.
The remaining ten sessions were divided in half. Five sessions focused on one of the thematic units and employed one of the independent variables: TM of sign presentation or SMJA method. The remaining five sessions focused on the other thematic unit chosen for that child and employed the other independent variable. Expressive language acquisition, manual and verbal, under both conditions was then compared in this intra-subject design. Each participant served as his/her own ideal control. Unique words used (signed or spoken) as well as total words used (signed or spoken) were compared.

Half of the children started with the TM and half started with the SMJA method to control for factors such as comfort with the interventionist and setting. In the five sessions using the TM, the clinician made the sign in the canonical position while sitting
next to the child. Using the TM, a triangle was formed between the child, the sign and
the object of attention, and the child’s attention was called to the sign. In the five
sessions using the SMJA method, the clinician made the sign in the child’s line of sight
with the object of attention. This is achieved by displacing the signs into the child’s
signing space or line of sight or moving the object of attention so that the sign was
presented in the child’s line of sight. Expressive language gains (both novel and total
output) in the first five sessions were compared with expressive language gain in the last
five sessions to determine if the SMJA was more effective. Output in each method was
also compared to the baseline to assess method effectiveness across sessions.

Measures

Gains were measured during treatment by comparing (a) total words signed, (b)
number of unique words signed, (c) total words expressed (signed and spoken), and (d)
total unique words expressed (signed and spoken), to the same categories during the
baseline session. Gains were also measured by comparing initial parental reports of
vocabulary with the CDI to parental updates on the same fields after five sessions for
each method were completed. Vocabulary words targeted in each method were related to
different themes to prevent potential overlap. Visual analysis of each participant’s results
for both variables were completed to determine which method, if either, had a greater
effect. Results were also compared using an analysis of variance with repeated measures
to determine statistical significance.

Inter-observer agreement (IOA) was assessed for 20% of sessions selected at
random. The initial observer, or data collector, recorded spoken and signed words and
coded responses during the intervention session. The second observer was a different
data collector who reviewed video recordings of the sessions and noted responses, using the same coding types. In cases with large discrepancies, a third observer reviewed the video to resolve the difference and/or determine a potential explanation. IOA for total number of words signed and total number of words spoken was calculated by dividing the smaller number by the larger number and multiplying by 100. Overall agreement for total number of words signed was 91% and overall agreement for total number of words spoken was 70%. Overall combined agreement for total number of words signed and spoken was 88%. The lower IOA for the number of spoken words was surprising, and a third review of the sessions with the largest discrepancies gave some clues as to why this occurred. While two of the participants never had below 95% IOA in spoken words, two other participants never had above 33%. In a review of these sessions it was noted that the young participants’ intelligibility was significantly impaired along with a very low speaking volume, which likely contributed to the challenge observers faced in recording verbal responses. Another contributing factor may have been observers’ lack of training specific to documenting verbal responses. While a great deal of training was aimed at interpreting and recording signed responses, data collectors only received basic directions regarding verbal responses. All sessions with higher rates of disagreement were earlier in the intervention and the initial challenge of recording all of the participants’ signs while simultaneously listening for, trying to understand, and then recording verbal responses may have initially negatively impacted the reliability of these responses. However, the 70% IOA for total words spoken is well within acceptable limits, and an overall combined IOA of 88% along with the 91% agreement for words signed, evidenced high reliability for the collected data (Schiavetti, Metz, & Orlikoff, 2011).
An additional measure of inter-observer agreement was completed to address the validity of having non-fluent signers record observed signs. An American Sign Language interpreter holding the National Interpreter Certification with the Registry of Interpreters of the Deaf with over 35 years of professional experience reviewed 20% of sessions selected at random recordings looking for any signs that were missed by the data collectors as well as any signs erroneously included. Overall agreement for the signs recorded during the sessions was 93%, evidencing the accuracy for the total number of signs recorded in each session. Of the disagreements between the data collectors and the sign expert, less than 4% of the signs recorded could not be verified as having taken place. This provides assurance that the recorded signs are not over-represented and along with the 93% agreement, provides strong assurance that the signed data collected is a valid representation.

RESULTS

The purpose of this study was to determine if presenting signs to children with Down syndrome (DS) using signing to maintain joint attention (SMJA) resulted in greater language gains than the triangular signing method I during treatment in terms of (a) total words signed, (b) number of unique words signed, (c) total words expressed (signed and spoken), (d) total unique words expressed (signed and spoken), and parental reports of vocabulary used at home on the CDI. These questions were answered using the results from analysis of variance with repeated measures to determine statistical significance, as well as visual inspection of the data for the four participants. Data is displayed in Figures 4-11.
Total Words Signed

All participants increased total number of words signed during both the TM and SMJA methods; however, greater increases were seen during the SMJA sessions. Figure 4 provides a side-by-side visual comparison of both methods. The clear upward trend shows SMJA increases total number of words signed for all participants. Participant 1 increased from one signed word during the baseline session to four words during TM and 23 words during SMJA despite having one fewer session of SMJA due to an absence. Participant 3 went from three signed words during the baseline session to 32 words during TM and to 68 words during SMJA. Participant 4 improved from four signed words during the baseline session to eleven during TM and to 61 words during SMJA. Participant 2 was an exception in the pattern. She increased from 0 signed words during baseline to 52 words during TM but only increased to 41 words during SMJA. Participant 2 also had one absence during the SMJA sessions. Figure 5 shows the results of each participant. Though results must be interpreted with caution due to the missing data sets, ANOVA revealed F=0.1077, meaning there was not a statistically significant difference between the two methods (see Table 1). However, the probability of F across the sessions was <.05 at 0.0014, showing data revealed a significant increase in the total words signed across sessions. Table 2 presents data for the session by method interaction effect.

Table 1

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Table 2

*Total Words Signed by Sessions*

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<td>SMJA</td>
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<td>23</td>
<td>26.25</td>
<td>34.6</td>
<td>36.5</td>
<td>43</td>
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<tr>
<td>TM</td>
<td>2</td>
<td>14.25</td>
<td>19.25</td>
<td>11.75</td>
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</table>

*Figure 4. Total Words Signed by Method*
Table 3

Unique Words Signed by Method

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<th>Source</th>
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<td>4</td>
<td>400.5416667</td>
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</table>

Figure 5. Total Words Signed by Participant
Figure 6. Unique Words Signed by Method

Table 4

Unique Words Signed by Session

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<tr>
<th>Source</th>
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<th>Mean Square</th>
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<th>Pr &gt; F</th>
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<td>Session</td>
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</table>
All participants increased the number of unique words signed during both the TM and SMJA. Yet, some differences between the two methods were observed. Figure 6 shows a side-by-side comparison of both methods. An upward trend can be seen for both methods with SMJA showing more unique words overall. Participant 1 rose from one unique word signed during the baseline session to three unique words during TM and to eleven unique words during SMJA, despite having one fewer session of SMJA due to an absence. Participant 2 increased from zero unique words signed during baseline to twelve unique words during TM and to eleven unique words during SMJA. Participant 2 also had one fewer session of SMJA due to an absence. Participant 3 improved from three unique words signed during baseline to 17 unique words during TM and to 16
unique words during SMJA. Participant 4 went from four unique words signed during baseline to five unique words during TM and to 13 unique words during SMJA. Figure 7 presents results for each participant. Though results must be interpreted with caution due to the missing data sets, ANOVA showed F= 0.3259, meaning there was no statistically significant difference between the two methods (see Table 3). As seen in Table 4, there was no session by method interaction effect. Still, the probability of F across the sessions was 0.0020, indicating a significant increase in the unique words signed across sessions. While the difference between the two methods’ effect on unique words signed was not significant, the number of unique words acquired from baseline to Session 5 was significant. This preliminary evidence underscores the effectiveness of sign intervention with this population.

**Expressive (Signed and Spoken) Total**

All participants increased total expressive output (number of signed and spoken words combined) during both TM and SMJA sessions. Still, some differences between the two methods were noted. Figure 8 provides a visual comparison of both methods. A clear upward trend indicated SMJA results in greater increases in the total number of words (signed and spoken) for the participants as a whole. Participant 1 went from twelve total words during baseline to 25 total words during TM and to 29 total words during SMJA despite having one fewer session of SMJA due to an absence. Participant 2 increased from twelve total words during baseline to 57 total words during TM and to 43 total words during SMJA, and also had one less SMJA session due to an absence. Participant 3 improved from 47 total words during baseline to 56 total words during TM and to 72 total words during SMJA. Participant 4 rose from seven total words during
baseline to eleven total words during TM and to 66 total words during SMJA. Figure 9 shows each participants’ results. Though results must be interpreted with caution due to missing data points, ANOVA revealed F= 0.2748, meaning there was no significant difference between methods (see Table 5). As seen in Table 6, neither the session by method interaction effect nor the sessions across time were statistically significant (F= 0.1977).

Table 5

Expressive (Signed & Spoken) Total by Method

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<tr>
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![Expressive (Signed & Spoken) Total by Method](image)

Figure 8. Expressive (Signed & Spoken) Total by Method
### Expressive (Signed & Spoken) Total by Sessions

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**Figure 9.** Expressive (Signed & Spoken) Total by Participant

### Expressive (Signed and Spoken) Unique Word Total

Participants evidenced varied unique expressive output (number of unique signed and spoken words combined) during both TM and SMJA sessions. Figure 10 gives a
side-by-side visual comparison of each method. An initial decline was observed in both methods followed by increases in SMJA sessions and a plateau in TM. Participant 1 progressed from seven unique words during the baseline session to ten unique words during TM and to 17 unique words during SMJA. Participant 2 went from two unique words during baseline to 20 unique words during TM and to 17 unique words during SMJA. Participant 3 declined from 44 unique words during baseline to 37 unique words during TM and to 31 unique words during SMJA. Participant 4 fluctuated from seven unique words during the baseline session to five unique words during TM and to 16 unique words during SMJA. Figure 11 shows each participant’s results. Though results must be interpreted with caution due to the missing data points, ANOVA yielded F=0.7044, indicating no statistically significant differences between the two methods (see Table 7). As seen in Table 8, neither the session by method interaction effect nor the sessions across time were statistically significant (F= 0.1579).

Table 7

Expressive (Signed & Spoken) Unique Words by Method

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Type III SS</th>
<th>Mean Square</th>
<th>F Value</th>
<th>Pr &gt; F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Method</td>
<td>1</td>
<td>125.347222</td>
<td>125.3472222</td>
<td>0.17</td>
<td>0.7044</td>
</tr>
<tr>
<td>Error</td>
<td>4</td>
<td>3017.791667</td>
<td>754.447917</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 8

Expressive (Signed & Spoken) Unique Words by Sessions

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Type III SS</th>
<th>Mean Square</th>
<th>F</th>
<th>Pr &gt; F</th>
<th>G – G</th>
<th>H-F-L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Session</td>
<td>5</td>
<td>433.7361111</td>
<td>86.7472222</td>
<td>1.80</td>
<td>0.1579</td>
<td>0.2371</td>
<td>0.2151</td>
</tr>
<tr>
<td>Session*Method</td>
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<td>107.7361111</td>
<td>21.5472222</td>
<td>0.45</td>
<td>0.8097</td>
<td>0.6131</td>
<td>0.6851</td>
</tr>
<tr>
<td>Error(session)</td>
<td>20</td>
<td>961.9583333</td>
<td>48.0979167</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 10. Expressive (Signed & Spoken) Unique Words by Method
Parents of all four participants reported their toddlers learned new signs after both signing to maintain joint attention (SMJA) and triangular method of sign presentation. More signs were learned following SMJA sessions, with only one exception. Collectively, parents reported a total of 17 new signs were generalized to the home environment following TM sessions and 26 new signs following SMJA sessions (see Figure 14). Participant 1 evidenced four new signs at home following TM sessions and eight following SMJA sessions. Participant 2 evidenced nine new signs at home following TM sessions and seven following SMJA sessions. Participant 3 evidenced two new signs at home following TM sessions and five following SMJA sessions. Participant
evidenced two new signs at home following TM sessions and six following SMJA sessions.

Two of four parents reported new verbally spoken words learned by their toddlers after both TM and SMJA sessions, but with more words acquired after SMJA sessions (see Figure 14). Participant 1 evidenced one new word spoken at home after TM sessions and six new words after SMJA sessions. Participant 3 evidenced two new words spoken at home after TM sessions and four new words after SMJA sessions. Participants 2 and 4 evidenced no new spoken words at home following either method. Figure 12 compares each method by participant. Visual analysis of the data indicated that SMJA may have been more effective for most participants regarding generalization to the home environment.

![Parent Report - New Word Acquisition](image)

*Figure 12. Parent Report – New Word Acquisition*
The purpose of this study was to determine whether the triangular method of sign presentation or the signing to maintain joint attention method (SMJA) was more effective for language acquisition (signed and spoken) for children with Down syndrome (DS). Both methods evidenced statistically significant growth across the sessions in the total number of words signed and the number of unique words signed. This confirmed results from previous studies concluding that signing is an effective intervention for targeting early language acquisition with toddlers with DS. Visual analysis of the data revealed clear trends suggesting SMJA facilitates greater increases in total number of words signed, total number of words expressed (both signed and spoken), and number of signs and words generalized to the home environment for participants as a whole.

**Clinical Implications**

The results of this study as well as the review of previous research, suggests that early intervention to target language development is key for children born with a
diagnosis of DS. This intervention should be tailored to address the unique DS phenotype, taking into account strengths in gesture and visuospatial short-term memory, as well as weaknesses in attentional capacity and verbal short-term memory to effectively target expressive language deficits. Concurrent use of signs with verbal labels bolsters the gestural preference and visual strengths of children with DS. When those signs are presented using SMJA method, the child is able to attend to the object and referent without disruption, which likely supports language acquisition. Clinicians and parents should consider presenting signs in the line of sight with the child’s object of attention, either by strategic placement of the object or by displacing (moving) signs from their canonical position into the child’s signing space, or between the child and the object. Refer to video demonstrations of SMJA at www.Dssigning.weebly.com (Burns et al., 2015). In addition to using SMJA, modeling, both verbal and physical prompting, and immediate reinforcement have been shown to be effective methods for learning signs. These strategies can be implemented within any signing program to promote sign acquisition. As with any intervention, not all children will respond in the same way. The unique needs of each individual must be prioritized when considering these recommendations.

**Limitations**

The most notable limitation of this study was the small sample size. Missing data on two participants during SMJA sessions due to absences was another limitation. The small N and missing data points resulted in marked differences in the ability of statistical analyses to adequately represent the changes in language expression that were evident upon visual analysis. Accessing a large group of toddlers in a very specific age range,
with a certain diagnosis, in one geographical location, was challenging. While valuable information on how toddlers with DS respond to two different methods of sign intervention can certainly be gleaned from four participants, the limited sample size makes strong generalizations about the clinical population as a whole inappropriate. The small sample also posed a challenge for statistical analysis. For this reason, other studies in this field with a comparable number of participants chose to rely solely on visual representations of the data (Carbone et al., 2010; Wright et al., 2013). Further compounding the problem, two of the participants missed one session of the SMJA method that they were not able to make up. These missing data points within the SMJA sessions likely skewed the results in favor of the TM. The limited sample size combined with the incomplete data, necessitates that all statistical analysis must be interpreted with caution and supplemented with visual inspection and analysis. Additional research with a larger number of subjects and a more flexible time frame allowing for absences without data loss is needed to further explore this intervention method.

In addition to the small sample size, this study took place over a relatively short time frame. Six weeks is a limited time to see large gains in verbal or signed language acquisition and generalization to the home environment. Other studies have reported verbal language gains at time intervals ranging from 4, 5, and 6 months (Capone & McGregor, 2004; Zampini & D’Odorico, 2009) to 1 and 2 years (Dimitrova et al., 2016; Launonen, 1996). Again, results should be interpreted with caution and with acknowledgment of the need for additional research over a longer period of time to provide a more accurate picture of the effects of the sign methods compared here.
Another limitation of this study was the lack of a videographer. Although each session was videotaped, the video camera was mounted on a tripod and remained static throughout the session. Two- to four-year-old toddlers do not remain in one location, therefore, at various times throughout the recordings the participant may have been off screen or he/she may have had his/her back to the camera. This limited the ability of the second observer and the ASL professional during their reviews of the sessions to fully see the participants’ hands at all times.

Finally, extensive data was not collected on the participants’ individual backgrounds or home environments. Parents were not asked to provide information with regard to income or years of education. No home visits were made to observe parent-child interactions or level of sign use in the home. Therefore, these factors were not controlled for or considered in the conclusions presented in this study.

Considerations

While the overall trend within the study was superior effectiveness of the SMJA method, it is important to note that individual human beings with their own set of complex and unique factors at play are being considered. While Participant 2 did show marked gains during the SMJA sessions, she responded better overall to the TM of sign presentation. There are a number of potential explanations for this. Participant 2 completed one more TM than SMJA session, and received SMJA intervention prior to TM. Perhaps she became more comfortable in the environment and with the interventionists. Another factor that could have influenced the results was preference for the theme targeted during the TM session; she simply may have been more motivated to learn and communicate during that theme. While those factors cannot be totally
discounted, subjective reports from the interventionist and the data collector confirmed that Participant 2 responded better to the TM presentation. Although this is not in alignment with previous research on disrupting joint attention (especially with this population) Participant 2’s data underscores the fact that language intervention is not one-size fits all. There is considerable individual variation within the DS phenotype (Abbeduto et al., 2007; Roberts, 2007) and it is important to remember individual differences will affect the appropriateness and effectiveness of any language intervention model (Gibbs, Springer, Cooley, & Aloisio, 1990; Launonen, 1996).

Many studies have shown early sign learning promotes verbal language acquisition (Carbone et al., 2010; Dunst et al., 2011; Galeote et al., 2011), however Participant 3’s total expressive output decreased from the baseline during both methods of presentation and there were minimal verbal gains during this study. As previously discussed, one limitation of this study was its short duration and, as other studies have demonstrated, children are likely to gain a large number of signs over a period of months before replacing those same signs with a verbal mode of expression. In one study, the transfer to oral expression took place after 150 signs were in the child’s repertoire (Layton & Savino, 1990) and others reported verbal language gains at time intervals ranging from 4 months to 2 years (Capone & McGregor, 2004; Dimitrova et al., 2016; Launonen, 1996; Zampini & D’Odorico, 2009), clearly longer than the 6 week duration of this study. So while verbal language gains were modest, manual language gains were significant and, if previous research holds true, it can be assumed that oral expression would eventually follow.
As for Participant 3, the decline in the expressive total may be explained by reviewing the baseline session where an expressive total of 47 was seen. Upon review, almost half (43%) of those verbal utterances were direct imitations of the clinician. For example, the interventionist’s question, “What are we cleaning?” was followed by, “Cleaning,” “Do you eat pumpkin?” was followed by “Pumpkin,” and “Time for bed,” followed by “Bed.” Participant 3 displayed a strength in verbal imitations, however, this parroting did not translate to functional use for her (as evidenced by parental report on the CDI and use within the sessions). Following the baseline session, the interventionist was purposeful in working for non-imitative responses, and while this promoted greater functionality, it reduced output numerically. This example is one reason why data collectors coded the conditions of each response. Although these were not formally analyzed, they provided important supplementary information.

Due to the study’s six-week duration, large gains in language acquisition and generalization to the home environment were not anticipated. However, it was a testament to the effectiveness of sign interventions with this population that significant gains were made in such a short window of time. For Participant 3 to increase from three signs in the baseline session to a total of 68 signs and Participant 1 to generalize eight new signs and six new words to the home environment, after having completed only five sessions of SMJA, is truly astounding. While we cannot extrapolate data from a limited sample, at a minimum, these preliminary findings suggest this is a promising area for future research.
Future Research

Additional studies with larger groups of children and a longer time frame are needed to confirm these findings. As previously addressed, one limitation of this study was its small sample size, which was compounded by missing data resulting from two absences during the SMJA sessions. Although this limited the appropriateness of statistical analysis, the available data shows a strong enough trend to warrant further research exploring the effects of SMJA. Another potential area of research is using these same methods with another clinical population that demonstrates deficits in maintaining joint attention and expressive language such as children with autism (Adamson et al., 2009).

Similar to previous research, the study used measures of each child’s expressive vocabulary as reported on the CDI (Miller et al., 1991; Vandereet et al., 2011; Williams, 2016; Zampini & D’Odorico, 2009). However, utilizing vocabulary targets unique to each child as opposed to using a standardized vocabulary assessment, might capture additional utterances and provide a more accurate indicator of a specific child’s lexicon (Dimitrova et al., 2016). Future researchers may want to consider this approach or a combination.
REFERENCES


Suggested Activities:

- Begin by reading *Brown Bear, Brown Bear* while making the signs for each of the animals. Encourage the client to participate in the reading by asking them “Who’s that?” “Show me bear.” “Do it with me.” Begin with physical prompting if necessary. Provide immediate reinforcement.

- Follow reading activity with the Eric Carle character magnets. Pull out just the characters from *Brown Bear, Brown Bear*. Hold up two at a time and ask the client which one they want. After a sign or verbal response is given, enthusiastically award the magnet. Use physical prompting as needed. Direct the client to put the “bear” (sign&say) on the magnetic white easel board. Repeat. Once all the characters are on the board the client can name (sign or say) who they would like to take down and put into their “home.” Or the clinician can hand the client an animal and once the client names the animal they can put the animal into the “home.” The “home” can be the original container, or other more interesting containers, such as a wipes box or jar with a slit cut into the lid. More interesting containers will be more engaging for clients who enjoying putting in and pulling out.

- Pull up the youtube video, *These Are the Sounds the Animals Make*, on the smartboard or iPad and play the song while signing and saying the animal’s names. Provide direct instruction to the client to name the animals with you. Pause the video as needed to prompt the client to model the sign after you, or ask who the animal is. Use physical prompting as needed.

- Begin by reading *Noisy Farm* while making the signs for each of the animals. Encourage client participate in the reading by asking them “Who’s that?” “Show me cow.” “Do it with me.” Have the client name (sign or say) the animal before pressing its sound. Begin with physical prompting if necessary. Use the sound button as immediate reinforcement.

- Play with the barn and barn animals. Provide the barn toy but keep all the animals in your lap as a communication opportunity. Have the client request what animal they would like. Provide two options at a time (if necessary) and use physical prompting if necessary. Immediately provide the animal after it has been named (sign or say). Narrate the play with the animal names and sounds. Signs may need to be modified (for example just doing the hand motion for horse without the placement on your head) to maintain line of site with the objects and the signs.

- Sing *Old MacDonald had a Farm* but substitute the child’s name for Old MacDonald. For example, “Ellie, Ellie had a farm.” Hold all of the animals in your lap and when you name each animal, hold that animal up and make the sign. Encourage the client to participate in the song by providing a long pause when you first name the animal. “On this farm there was a (hold up animal)….expectant waiting….then provide model and use physical prompting as needed. Immediately reinforce naming (sign or say) by providing the child with the animal.
to hold during the rest of the related verses. Put that animal back in your lap before introducing the next verse and animal.

Choose additional activities based on the child’s personal affinity for puzzles, opening and closing, and/or magnets.

- **Puzzle**: Sign&Say pieces as they are removed. Take control of the pieces (put them in your lap) and attempt to elicit naming. Use modeling, expectant waiting and physical prompting as needed. Immediately provide the animal once it is named so the client can fit it into the puzzle.

- **Doors and latches**: Depending on the client’s problem solving and fine motor skills, you may want to leave the doors unlocked to just be opened or have all of the latches closed. As the client opens each door, sign&say the animal. If the client is interested in counting, name the animal with each number repeated “1 fish, 2 fish, 3 fish.” Play knock, knock: knock on each door and ask the client “Who is it” Encourage naming once the door is opened. Add other animal objects (such as the toy cat or the magnetic frog) to the group of the same animals once the doors are opened. Encourage the client to match and name. “Where are the fish? The fish wants to swim with his friends. Hi fish!”

- **Barn Magnets**: Use the magnets in the same way as the Brown Bear character magnets above. Or, use a baking sheet that can go in the client’s lap and create a farm scene where they can add animals they have named (sign or say). Or sing the personalized variation of *Old MacDonald*, providing the client with the corresponding magnet after each verse.