

# Effects of a Naturalistic Sign Intervention on Expressive Language of Toddlers With Down Syndrome

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**Purpose:** In this study, the authors evaluated the effects of Enhanced Milieu Teaching (EMT; Hancock & Kaiser, 2006) blended with Joint Attention, Symbolic Play, and Emotional Regulation (JASPER; Kasari, Freeman, & Paparella, 2006) to teach spoken words and manual signs (Words + Signs) to young children with Down syndrome (DS).

**Method:** Four toddlers (ages 23–29 months) with DS were enrolled in a study with a multiple-baseline, across-participants design. Following baseline, 20 play-based treatment sessions (20–30 min each) occurred twice weekly. Spoken words and manual signs were modeled and prompted by a therapist who used EMT/JASPER teaching strategies. The authors assessed generalization to interactions with parents at home.

**Results:** There was a functional relation between the therapist's implementation of EMT/JASPER Words + Signs and all 4 children's use of signs during the intervention. Gradual increases in children's use of spoken words occurred, but there was not a clear functional relation. All children generalized their use of signs to their parents at home.

**Conclusions:** The infusion of manual signs with verbal models within a framework of play, joint attention, and naturalistic language teaching appears to facilitate development of expressive sign and word communication in young children with DS.

**Key Words:** early intervention, Down syndrome, language intervention, sign language, simultaneous communication

Children diagnosed with Down syndrome (DS) experience delays in all areas of development; however, they have specific deficits in developing spoken language skills beyond what is expected on the basis of their mental age (Miller, 1999). Children with DS typically have poor speech intelligibility complicated by motor development delays, problems in phonological memory and/or auditory processing, anatomical and physiological differences in the mouth and throat, and, sometimes, hearing impairment (Chapman & Hesketh, 2000; Kumin, 1996; Roberts, Price, & Malkin, 2007; Stoel-Gammon, 2001). Interventions using augmentative and alternative communication (AAC) may help children with DS communicate earlier and more successfully given these deficits.

## *Sign Language Intervention*

One form of AAC is gestures. Children with DS persist in using gestures for communication longer than do children with typically developing language (Caselli et al., 1998; Franco & Wishart, 1995). Caselli et al. (1998) found that children with DS and children with typically developing language matched for language comprehension had similar rates of gesture use early on; however, children with DS used significantly more gestures than did their peers when verbal comprehension was greater than 100 words. Strengths in gesture use for communication may indicate that using sign language in combination with spoken language may be an effective mode of communication.

A small number of studies support this recommendation (see, e.g., Gibbs & Carswell, 1991; Jago, Jago, & Hart, 1984; Kotkin, Simpson, & Desanto, 1978; Le Prevost, 1983; Weller & Mahoney, 1983; Wolf & McAlonie, 1977). Generally, these studies showed that interventions including signs and spoken words appeared to be more effective than interventions that taught spoken words alone. However, all of these studies were conducted more than 20 years ago and lack methodological rigor. Studies that were conducted included case studies (Gibbs & Carswell, 1991; Le Prevost, 1983), pre- and postmeasures only (Jago et al., 1984; Weller & Mahoney, 1983), or inadequate

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replications conducted to determine a functional relation (Kotkin et al., 1978).

Across studies, there is preliminary evidence that teaching sign language may be an effective intervention approach for increasing early communication skills in young children with DS. However, the studies are limited in terms of the measurement of outcomes and quality of research design. Additional research conducted with clear demonstration of experimental control and measures of generalization could contribute to the body of literature on the effects of sign language for children with DS.

### ***Intervention Strategies That Use Social Engagement***

Naturalistic teaching is an appropriate choice for teaching sign language because it builds on specific social strengths of children with DS. This strategy is used in interactions with caregivers and teachers, and it targets functional communication skills in the context of play and everyday routines (Kaiser, Ostrosky, & Alpert, 1993). Naturalistic teaching may also be beneficial for children with DS because it targets increasing the rate of child-initiated communication and includes partners who are highly responsive to child communication attempts (thus moderating children with DS's difficulty with persistence in communication; Fey, 1986). Further, naturalistic teaching offers the opportunity to increase children's engagement and participation in routines, which in turn creates additional opportunities for communication (Kasinath, Woods, & Goldstein, 2006).

Several variations of naturalistic teaching have been evaluated in randomized studies including preschool children with DS in heterogeneous samples of children with intellectual disabilities. These studies reported variable findings related to turn-taking, communicative turns, and spoken words (Fey et al., 2006; Girolametto, 1988; Girolametto, Weitzman, & Clements-Baartman, 1998; Kaiser & Roberts, 2013; Yoder & Warren, 2002). Three studies reported differences in outcomes for children with DS and children with other etiologies, with children with DS performing worse than children with other etiologies do (Kaiser & Roberts, 2013; Warren et al., 2008; Yoder & Warren, 2002). In these studies, prelinguistic communication (gestures, joint attention) or spoken words were the desired child outcomes; signs were not targeted as a communication mode.

To date, the effects of naturalistic communication intervention using signs and words with children who have DS have been examined in only one study. Kouri (1988) studied the use of a naturalistic communication intervention including signed and spoken words with five children in a single-subject design; one of the five children had a diagnosis of DS. Interventionists taught signed and spoken words simultaneously within a naturalistic teaching paradigm that included following the child's lead in play and modifying the environment to promote requesting. The participant with DS showed an immediate increase in use of signs and signs plus words. After about 25 sessions, the use of signs by the child with DS began to decrease somewhat as spontaneous word productions increased throughout the remainder of the intervention.

Taken together, studies of naturalistic language intervention have shown modest positive outcomes for children with DS. Often, outcomes for children with DS have been less strong than those for children with other intellectual disabilities. Modeling manual and spoken words to support learning and use of new language also appears to be a promising mode for children with DS, but additional adaptations to address the specific skills and needs of children with DS may be needed to make naturalistic interventions more effective.

### ***Interventions That Address Object Engagement and Symbol Infusion***

Toddlers with DS spend as much time engaged in supported and coordinated joint states as mental age-matched, typically developing children (Adamson, Bakeman, Deckner, & Ronski, 2009). Although children with DS have strengths engaging with partners, children with DS use and attend to symbols (i.e., words and referent-specific gestures) significantly less often than do children with typically developing language. In toddlers with typically developing language, symbol-infused engagement develops soon after the emergence of coordinated attention to a social partner and to an object. Adamson, Bakeman, and Deckner (2004) reported that symbol-infused engagement was delayed significantly in toddlers with DS, even after these children demonstrated coordinated attention.

In addition, children with DS engage in object play at lower rates than do children with typically developing language and children with autism spectrum disorders (Adamson et al., 2004). Object play may be a valuable prerequisite to learning language (Kasari, Gulsrud, Freeman, Paparella, & Helleman, 2012). Effective language modeling requires children and adults to be jointly engaged in activities. Play with toys, particularly play that involves shared actions with objects and routines, provides a shared topic of conversation. The development of symbolic play also is associated with increases in cognitive representational capacity (Siller & Sigman, 2008). Increasing object play and infusing symbols within joint engagement states may increase language learning in children with DS.

Interventions targeting the development of joint attention and symbolic play (e.g., Joint Attention, Symbolic Play, and Emotional Regulation [JASPER]; Kasari, Freeman, & Paparella, 2006) have been effective for young children with autism spectrum disorders (Kasari, Gulsrud, Wong, Kwon, & Locke, 2010; Landa, Holman, O'Neill, & Stuart, 2011). Kasari et al. (2006) demonstrated that toddlers with autism increased joint engagement and level of symbolic play when therapists and parents implemented JASPER for these behaviors. For children with autism spectrum disorders, increasing the level of social engagement is a primary goal for early communication intervention. In contrast, children with DS are easily socially engaged, but increasing the use of symbols and the number of objects and actions about which the child can communicate is an important goal that might be addressed through use of the JASPER strategies.

## Purpose of Present Study

A small body of research on naturalistic teaching has offered some promising evidence for effective early communication intervention for children with DS. Nevertheless, there is a critical need to develop more effective interventions for this population. Children with DS present a pattern of strengths and weaknesses that may require an approach to intervention that promotes play and use of symbols in social interaction to promote functional use and generalization. Additionally, providing an additional mode addresses difficulties in producing spoken language. Specifically, we posit that a naturalistic communication intervention (Enhanced Milieu Teaching [EMT]; Hancock & Kaiser, 2006) blended with an intervention to increase play and symbol-infused joint engagement (JASPER) including visual as well as spoken forms of language (Words + Signs) might further provide the linguistic, play, social, and symbolic support needed to improve communication development in children with DS. See Table 1 for specific details on how EMT and JASPER strategies specifically address weaknesses of young children with DS.

The purpose of this study was to determine the effects of EMT/JASPER Words + Signs on the expressive language (Words + Signs) of young children with DS. We used a multiple-baseline, across-participants design to address the following research questions:

1. Does EMT/JASPER Words + Signs increase use of expressive signs in young children with DS?
2. Does EMT/JASPER Words + Signs increase use of spoken words in young children with DS?
3. Do children with DS generalize newly learned words and signs to use with their parents at home while participating in EMT/JASPER Words + Signs intervention in the clinic?
4. Do children with DS increase the amount of time spent in joint engagement and symbol-infused joint engagement while participating in EMT/JASPER Words + Signs?

This initial investigation was designed as a controlled experiment; thus, it was less naturalistic than ideal for toddlers. The intervention took place in a clinical setting with interventionists, rather than in the children's typical homes or classroom settings.

## Method

### Participants

Four children (23–29 months of age) with DS were selected for this study on the basis of the following inclusion criteria: (a) a diagnosis of DS verified by medical records; (b) age between 18 and 36 months; (c) vision and hearing

**Table 1.** Components of EMT and JASPER intervention.

Deficit in DS	Child intervention goals	JASPER intervention procedure	EMT intervention procedures
Object engagement	Increase time engaged with objects Increase diversity of object play Increase complexity of object play	Join child's activity and play Imitate child play actions Place new toys in the child's visual field for child choice <sup>a</sup> Hand a toy to the child for them to decide how to expand play <sup>a</sup> Model new play actions in child's visual focus <sup>a</sup> Provide choices Select materials with potential to extend play duration and level <sup>a</sup> Expand child play actions <sup>a</sup>	Choose activities and objects of interest to the child Join child's activity and play Mirror child actions and map with words Provide child preferred activities Actively play with child Follow child's lead in play
Social communication and symbol infusion	Increase rate of communication Increase diversity of words Increase spontaneous initiated verbal communication Increase requesting using specific words Increase commenting using specific words Increase comprehension of words and sentences	Model language at the child's developmental level Model language targets with joint attention skills: point, show, give <sup>a</sup>	Teach specific individualized language targets <sup>b</sup> Mirror child actions and map with words <sup>b</sup> Respond to child communication attempts <sup>b</sup> Use environmental arrangements to create opportunities for use of specific targets <sup>b</sup> Expand child gestures, vocalizations, and words by adding target words <sup>b</sup> Model language at target level <sup>b</sup> Use time delays to promote child communication at target level (choices, assistance, waiting) <sup>b</sup> Use Milieu Teaching prompts to increase diversity and complexity of communication <sup>b</sup>

Note. EMT = Enhanced Milieu Teaching; JASPER = Joint Attention, Symbolic Play, and Emotional Regulation; DS = Down's syndrome.

<sup>a</sup>Specific instructional procedure unique to JASPER. <sup>b</sup>Specific instructional procedure unique to EMT.

normal, or corrected with normal limits, as reported by caregiver; (d) expressive vocabulary of at least one and fewer than 15 spoken words or manual signs as determined by parent report on the MacArthur–Bates Communicative Development Inventories (MCDI; Fenson et al., 2006); (e) ability to imitate placement and action of hand movements as assessed using the Body Imitations section of the Motor Imitation Scale (Stone, Ousley, & Littleford, 1997); (f) English as the primary language spoken in the child’s home; and (g) parental consent for the child’s participation in the study. Table 2 contains participant information.

All four participants were recruited from an ongoing university-based model demonstration project focusing on training parents to use EMT strategies at home. Children participated in the current study before their parents began the parent-training component of the model project. Study procedures were approved by Vanderbilt University’s

Institutional Review Board, and parents of the participants consented to participation.

Participants’ language and cognitive abilities were assessed through use of the Mullen Scales of Early Learning (Mullen, 1995), the Preschool Language Scale—3 (PLS—3; Zimmerman, Steiner, & Pond, 2002), and the MCDI (Fenson et al., 2006). The PLS—3 and MCDI were completed before baseline sessions and after completion of intervention to determine eligibility and to describe the participants at entry and at the conclusion of the study. The results of these assessments are reported in Table 2.

Adult participants included a certified speech-language pathologist studying as a doctoral student in the field of early childhood special education and an interventionist with 7 years’ experience as an early intervention outreach teacher and a service coordinator. Both interventionists had used signs as an intervention technique; however, neither was fluent in sign language.

**Table 2.** Participant demographic and assessment information.

Characteristic/Measure	Ryan	Erin	Jay	Gretchen
Age at entry (months)	29	25	23	23
Gender	Male	Female	Male	Female
Ethnicity	Caucasian	Caucasian	Caucasian	Caucasian
Parent	Mother	Mother	Mother	Father
Parent’s age (years)	34	30	38	46
Parent’s education level	4-year	4-year	4-year	Master’s
Family income (\$)	> 100,000	70–75,000	> 100,000	NR
Screening				
Mullen SS	58	69	77	72
Imitation % correct	80	80	40	0
Testing				
PLS—3 Auditory Comprehension SS				
Pre	61	67	74	67
Post	57	71	75	61
PLS—3 Expressive Communication SS				
Pre	73	73	73	81
Post	72	83	75	89
MCDI # of signs produced				
Pre	0	1	0	0
Post	27	30	21	7
MCDI # of words produced				
Pre	11	7	10	2
Post	33	33	43	26
Services <sup>a</sup>				
Speech therapy				
Pre	4	2	4	8
Post	0	2	4	6
Physical therapy				
Pre	1	1	4	4
Post	0	0	4	4
Occupational therapy				
Pre	1	8	4	8
Post	0	4	4	8

Note. NR = not reported; Mullen SS = Mullen Scales of Early Learning Standard Score; PLS—3 = Preschool Language Scale—3; MCDI = MacArthur Communicative Development Inventory: Words and Gestures.

<sup>a</sup>Therapy hours are reported in hours per month.

## Setting

Baseline and intervention sessions were conducted in a room at a pediatric therapy clinic furnished with a child-sized table and one Rifton chair; however, the child participants and the interventionist sat on the floor during each session. Two of the four parents did not view any intervention sessions. One parent viewed about 25% of the sessions through an observation window without audio. One parent remained in the room for intervention sessions because the child became upset when separated from his mother. The mother sat in the corner of the room facing away from the interventionist and the child.

## Materials

A variety of age-appropriate cause-and-effect, manipulative, construction, and pretend-play toys were used in the baseline and intervention sessions. Examples of toys used were balls; cars and car ramp; baby dolls with clothes, bottles, brushes, and bath accessories; blocks; a farm with animals and two tractors; a shape sorter with matching blocks; two lift-the-flap books; two puzzles; nesting cups; kitchen utensils and cups; and pretend food. All baseline and intervention sessions were video recorded for later data collection.

## Design and Procedures

A single-subject, multiple-baseline, across-participants design was implemented (Gast & Ledford, 2010). This design was selected so that we could demonstrate intersubject direct replication of the effects of EMT/JASPER Words + Signs on the participants' spoken words and manual sign use. Data for each session were graphed daily for visual inspection. The criterion for sequential introduction of the intervention across participants was a shift in level, trend, or variability in the child's total use of signs following the introduction of the intervention. After three to five data points indicated a stable level or increasing therapeutic trend above baseline levels, the intervention was introduced to the next participant.

**Baseline.** Baseline sessions occurred two times per week and lasted 20–30 min. Each baseline session involved interactive play. The interventionist provided a variety of interesting toys and engaged in play with toys selected by the child. The interventionist did not implement any EMT/JASPER strategies or model any signs. When the child initiated communication, the interventionist responded by describing her own play actions and those of the child. If the child did not initiate communication, the interventionist asked questions about toys, directed the child to complete a play act, or commented on the focus of the child's engagement.

**Intervention.** Intervention sessions also occurred two times per week and lasted 20–30 min on the basis of child interest in toys and continued engagement in the interaction. The interventionist engaged in child-directed play and used EMT and JASPER strategies to teach 32 signs paired with spoken words. The interventionist paired signs with at least

80% of her verbal communication with the child in order to model sign-infused verbal communication. The 32 signs were selected from the list of early occurring words on the MCDI and were appropriate for the toys and the actions with toys occurring during the play interactions. The 32 signs included 16 words for objects (e.g., *baby, car, water*), 13 words for actions (e.g., *open, wash, in*), and three request words (e.g., *all done, my/mine, want*). Parents were provided with pictures or drawings and descriptions of the 32 signs; however, they were not trained on how to sign or teach the signs.

The EMT strategies implemented by the interventionist included (a) following the child's lead; (b) responding to the child's communication; (c) mirroring (i.e., contingently imitating) the child's play actions and mapping (describing shared actions with target words and signs); (d) expanding the child's communication; (e) modeling target signs; (f) using time delay to promote child communication; and (g) incorporating milieu prompting episodes to promote child practice of communication targets (see Hancock & Kaiser, 2006, for a full description of EMT).

The JASPER strategies included teaching new play actions and play sequences by modeling and expanding play based on child interests. The interventionist waited for the child to show interest in a toy then imitated the child's play act with the same object. When the play became repetitive or if the child did not initiate productive play or take a turn in play, the interventionist used one or more of the following strategies to nonverbally model and expand play: (a) put a new toy within the child's attentional focus, (b) gave the child a choice between two toys, (c) handed the child a toy, or (d) modeled a new play act. Joint attention skills including pointing, giving, and showing were modeled in conjunction with signed and spoken words to increase symbol-infused joint engagement.

**Home generalization observations.** To assess child generalization of newly learned signs and words to interactions at home with their parents, 10-min observational probes were conducted during the baseline and intervention conditions. Generalization probe sessions took place in each family's living room. All toys (except the parent-selected toys) and other distracting items were removed from a small area where the parent and child sat on the floor. Parents were asked to interact as they typically did when playing with toys and looking at books with their children.

**Procedural fidelity.** Procedural fidelity data for the EMT/JASPER Words + Signs intervention as delivered by the two interventionists were collected during 25% of baseline and intervention sessions for each child participant. Interventionists were naïve to the sessions that were coded for fidelity. Sessions were randomly selected and designated before the study began. Fidelity for EMT strategies and for sign infusion strategies was calculated by transcribing then coding the first 10 min of sessions using the Systematic Analysis of Language Transcripts (SALT) protocol and computer software (Miller & Iglesias, 2008) with specific codes for interventionist behavior. Summaries of each coder's data (i.e., exact number or percentage for each

specific coded measure) were entered into Microsoft Excel and were compared to the criterion levels established in previous research for each behavior (e.g., Roberts & Kaiser, 2012).

Fidelity of JASPER play and joint attention strategies was measured at the same frequency as that used for the EMT strategies. Six indicators of adult behavior supporting play based on the components of the JASPER intervention were examined through use of an occurrence checklist containing the following items:

- Play area is well organized, with toys available at the start of the session
- Toys are available and within reach to the child
- Therapist follows child's lead in play
- Therapist mirrors child's play actions
- Therapist expands and models new play actions
- Therapist introduces different materials to enhance play level

Each of the items was coded as *yes* or *no* on the basis of the coder's review of the video. The score for the checklist was calculated by dividing the number of items scored *yes* by 6 to yield a percentage of fidelity. Joint attention was coded as the percentage of joint attention skills (i.e., *point*, *show*, *give*) that were modeled with a language target.

Fidelity of implementation was consistently above criterion levels during intervention sessions and below criterion levels during baseline session, as planned. Interobserver agreement on fidelity ratings was determined for 25% of fidelity sessions distributed across conditions and participants. Overall agreement on scoring the six EMT interventionist behaviors averaged 98% (range 50%–100%). Agreement was less than 80% in one instance when coders disagreed on the score of one of two time-delay episodes, which resulted in 50% agreement. Agreement for sign infusion measures averaged 99% (range = 97%–100%), and overall agreement on scoring the six JASPER behaviors was 96% (range = 75%–100%).

## Measures

*Child language measures.* The first 20 min of participants' baseline and intervention sessions and the full 10 min of participants' generalization sessions were videotaped and coded. Coders were not informed about the change in experimental phases for each child; however, because coders were familiar with the intervention from coding the therapists' behaviors, it is probable that coders were aware of differences between baseline and intervention sessions. Each video segment was coded using an event recording system. A spontaneous sign was coded if the child used a recognizable sign independent of a model occurring in the previous 5 s as timed on the video recording. An imitated sign was coded if the child used a sign or approximation within 5 s of the interventionist's model. A prompted sign was coded if the child responded to an interventionist's questions (e.g., "What do you want?," "Ball or block?") or if the child responded to

a direct prompt from the interventionist (e.g., "Say *block*."). The same definitions applied for spontaneous, imitated, and prompted words. If a child used a sign and a word simultaneously, both the word and sign were recorded.

*Parent language measures.* Parents' use of signs was measured during home observations using the same event recording system used to record child data. Ten minutes of the home observations (book and play) were coded for total and unique signs modeled by the parent. A model was scored when the parent demonstrated use of a sign with the corresponding verbal label (a) using his or her hands on his or her own body, (b) using his or her hands on the child's body (e.g., signing *mine* while patting the child's chest), or (c) using the child's hands on the child's body (e.g., assisting the child in making the sign for *ball*).

*Joint engagement measures.* The first 10 min of all baseline sessions and 11 intervention sessions were coded for joint engagement. In general, every other intervention session was coded for joint engagement, including the first and the last session. Data were coded for three of the four participants. Jay's videos could not be scored for joint engagement because he was off camera more than 25% of the time observed in every video, and thus data could not be scored reliably.

Joint engagement was measured using a code adapted from Bakeman and Adamson (1984). The code was used to classify the child's activity into four engagement states: (a) supported joint engagement (SJ), (b) coordinated joint engagement (CJ), (c) symbol-infused supported joint engagement (SISJ), and (d) symbol-infused coordinated joint engagement (SICJ). SJ was coded when the child and the adult were actively engaged in the same activity or with the same object and the child was affected by the adult's play but did not overtly acknowledge the adult's role. CJ was coded when the child and adult were actively engaged in the same activity or were communicating about a shared object and the child consistently referenced the adult with eye contact. Symbol infusion was coded when the child provided evidence that he or she was actively attending to symbols or using symbols during the interaction. For example, the child changed his or her actions in response to an adult's comment or the child said a word referring to an object while looking at the adult.<sup>1</sup> For the purposes of this study, total joint engagement with and without symbol infusion (SJ + CJ + SISJ + SICJ) and total time in symbol-infused joint engagement (SISJ + SICJ) were calculated as summary-level measures, consistent with Adamson et al. (2009).

*Interobserver agreement.* Prior to beginning data collection, the first author trained a graduate student coder to criterion on each behavior observed in the language and joint engagement coding. Due to the complexity of the coding, the language and joint engagement data were coded separately during two different viewings of the videos. Training involved reviewing operational definitions and practicing coding using videos of children who use signs but

<sup>1</sup>The complete coding manual can be obtained by e-mailing the first author at courtney.a.wright@vanderbilt.edu

who were not participating in the study. Coders were familiar with the 32 target signs as well as other signs that the child used before the study began. Interobserver agreement (IOA) was assessed for 33% of baseline, intervention, and home observations, selected randomly. The primary coder initially coded the videos for child language, parent language, and joint engagement; then, a second coder independently viewed and coded the three behavior sets.

IOA for child and parent language measures was calculated by dividing the smaller number by the larger number and multiplying by 100. Overall agreement for child language measures averaged 91% ( $SD = 19\%$ , range = 0%–100%; 87% of sessions had IOA above 80%). The  $SD$  and range of IOA are large because of low base rates of some behaviors in some sessions. For example, 0% agreement occurred in three instances when the first observer coded that one sign occurred and the second observer did not code any signs (agreement = 0/1). Agreement for parent language measures during generalization sessions averaged 94% ( $SD = 9\%$ , range = 75%–100%).

Agreement for total joint engagement and symbol-infused joint engagement was calculated by dividing the smaller total number of seconds coded for total joint engagement and for symbol-infused joint engagement by the larger total number of seconds coded for total joint engagement and symbol-infused joint engagement and multiplying the quotient by 100. Overall agreement for total joint engagement was 87% ( $SD = 7\%$ , range = 78%–100%), and agreement for symbol-infused joint engagement was 87% ( $SD = 28\%$ , range = 0%–100%). One instance of 0% IOA occurred when 3% time in symbol-infused engagement was recorded by the first coder and 0% was recorded by the second coder.

## Results

### Primary Outcomes

The first two research questions ask if EMT/JASPER Words + Signs increased the use of expressive signs and spoken words. These questions can be answered by visually analyzing data from each of the four participants. Graphs of total number of signs and number of unique, spontaneous signs are displayed in Figures 1 and 2. The frequency of total words and spontaneous different words are shown in Figure 3.

**Ryan.** Ryan used one spontaneous sign during baseline. With the introduction of the intervention, his total use of signs increased in level, with an upward trend and little variability. He signed between 0 and 11 different words spontaneously and demonstrated an increasing trend in independent signs in the second half of intervention. Ryan did not use any spoken words in baseline sessions and did not demonstrate an immediate change in total words upon introduction of the intervention. He began to use some spoken words in the last seven sessions of the intervention. Of the 18 total words that Ryan learned, 15 were signed, only one was spoken before it was signed, and two were spoken words only. The three words that were spoken first or

only spoken were all words beginning with the /b/ sound, including *ball*, *book*, and *baby*.

**Erin.** Erin's use of signs in baseline was stable, at fewer than five signs per session. Only two signed words were used spontaneously. With the introduction of the intervention, there was a shift in level and an increasing trend of total sign use that continued until Session 13. At this point, Erin's use of signs decreased through Session 21. This decrease in total signs used was the result of less repetitive use of the same sign; however, her number of different signs used was maintained at about nine different signs per session.

During baseline, Erin used five spoken words, three of which were spontaneous and unique. During the intervention, she demonstrated an increasing trend in spoken words for the first half of intervention; her use of spoken words was stable during the second half of intervention. Of the total 23 words that Erin learned, 15 were only signed, six were signed and then spoken, and two were learned in the spoken form and were never signed. Of the two words that were only spoken, both were vowel-consonant (VC) forms (*off* and *out*). Other VC target words ending in /n/ sounds (*in*, *on*) were only signed.

**Jay.** Jay used fewer than two signs per session during baseline, and only one sign was used spontaneously. Following introduction of the intervention, he demonstrated an immediate shift in level, averaging about 17 total signs per session. This level was maintained throughout intervention, with some variability. His spontaneous use of different signs was slightly variable and ranged between two and nine signs.

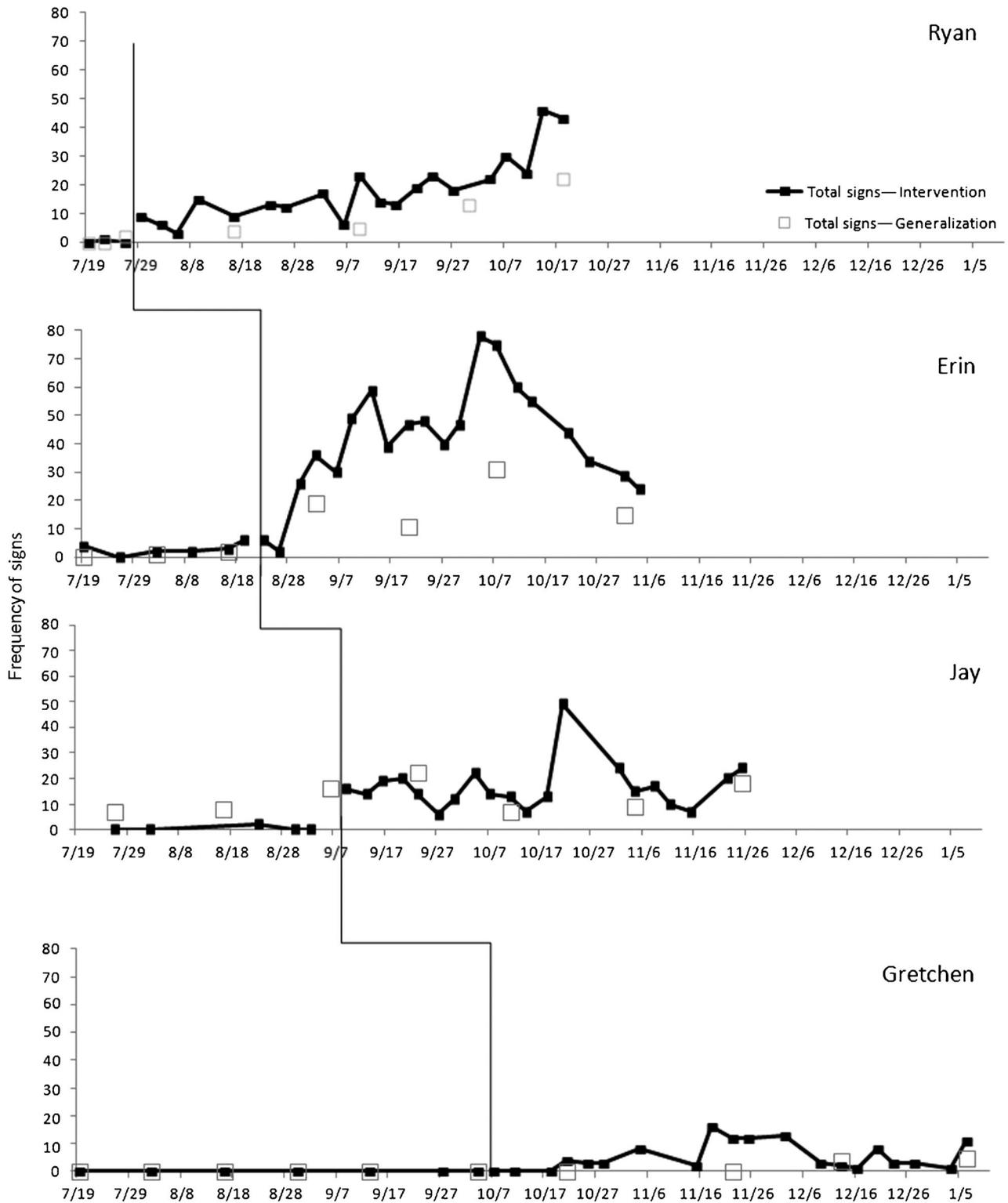
Jay did not use any words in baseline. After the intervention began, he demonstrated increased variability, with an overall higher level of word usage. He used at least one spontaneous different word in 17 of 20 intervention sessions. Jay learned a total of 14 words; nine words were signed only. Only one phrase was first signed and then spoken (*all done*). Two words were spoken and then signed, and both contained /b/ initial sounds (*baby* and *ball*). The two words that were spoken only and never signed independently were not sign targets for the intervention (*mama* and *dad*).

**Gretchen.** Gretchen did not sign during any baseline sessions. Following the introduction of the intervention, her use of signs increased gradually across the intervention phase, but her performance was variable for both total use and independent use of different signs. Gretchen did not use any words during baseline sessions. Similar to Jay, she demonstrated a change in word use, but this change was highly variable. Of the 10 words that Gretchen acquired, five were signed only. Three words were first signed and then spoken. The two words were spoken and then signed (*all done* and *drink*). These words were more likely to be used across routines at home.

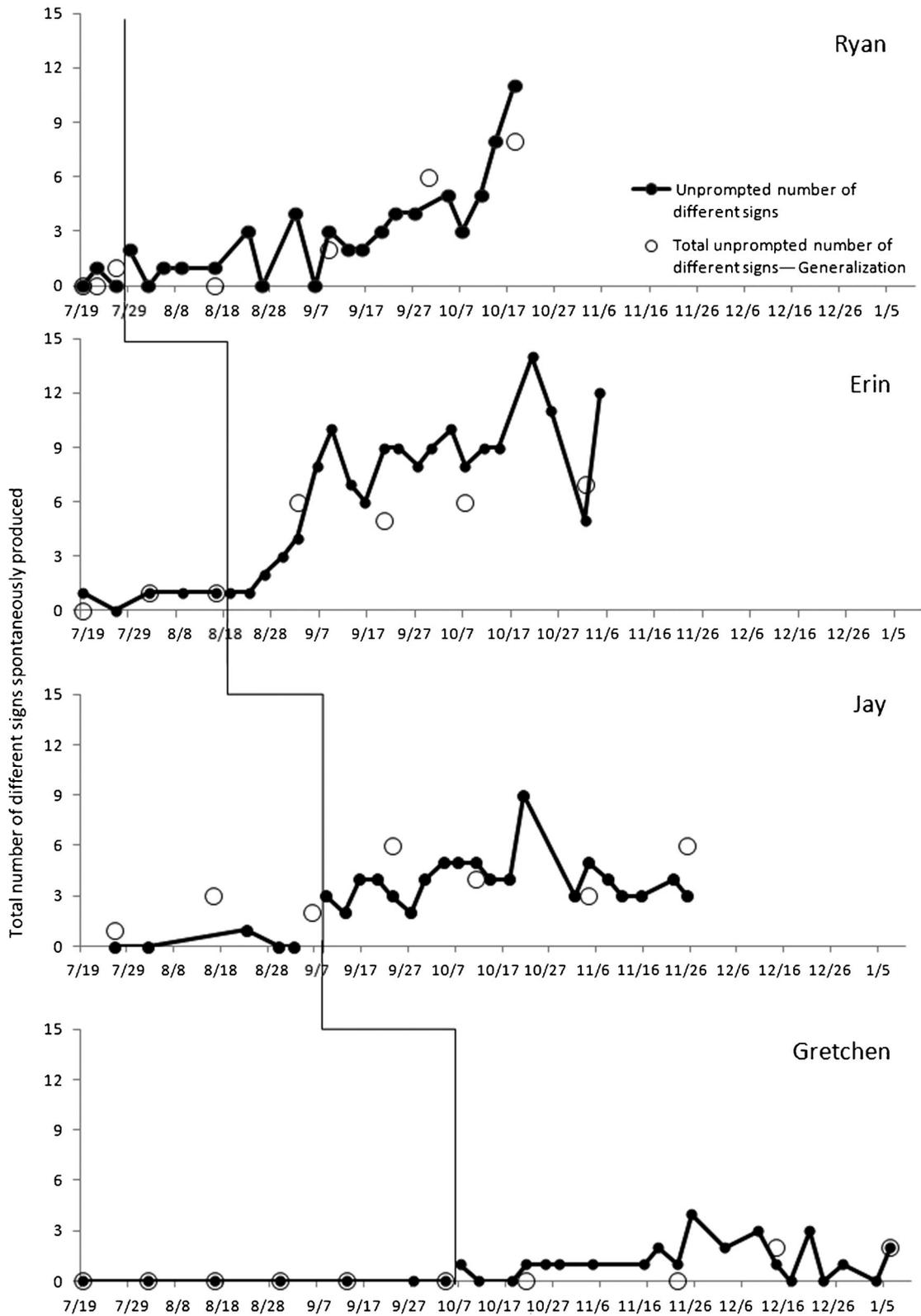
### Generalization Across Adults and Setting

The third research question asked if children generalized newly learned words and signs to use with their parents at home. No training or coaching for signing was included in the intervention; however, parents' use of signing may

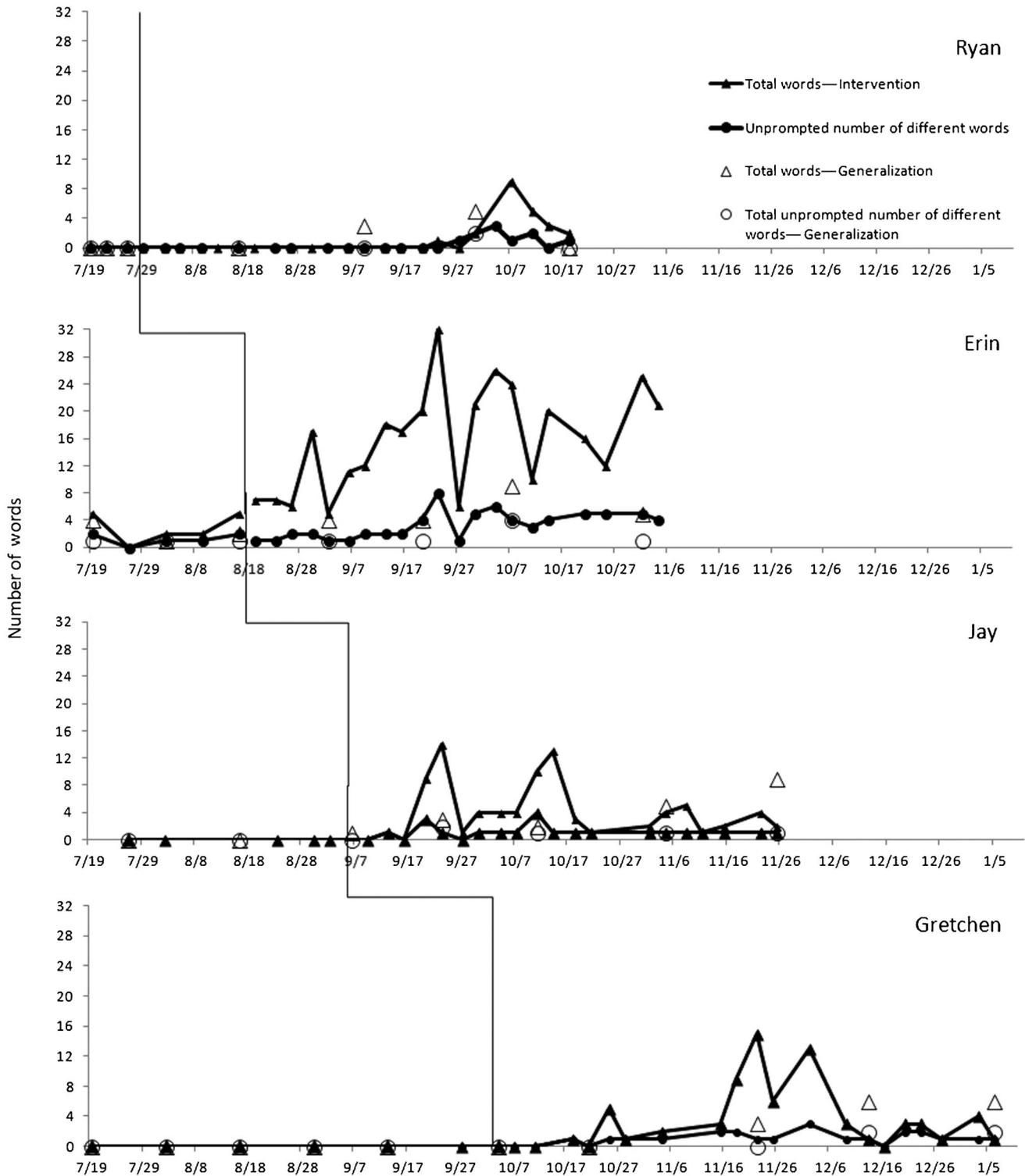
**Figure 1.** Total sign use in intervention sessions and home observations across participants.



**Figure 2.** Number of different spontaneous signs used in intervention sessions and home observations across participants.



**Figure 3.** Total word use and number of different spontaneous words used in intervention sessions and home observations across participants.



have affected the children's use of signs at home. To address this issue, parents' use of signs was recorded, but, unfortunately, it was not possible to systematically evaluate the effects of parents' signing on the children's outcomes.

Generalization data on the participants' total use of (a) signs and words and (b) number of different spontaneous signs and words during home observations are shown in Figures 1, 2, and 3 as well as in Table 3. Additionally, parents' use of signs during home observations are displayed in Table 3.

Ryan's mom signed at a consistent low rate during baseline sessions, using one to three signs. Concurrent with the clinic intervention, there was a systematic increase in her use of signs during home observations. She used between 14 and 30 signs in each of the four sessions. In a similar way, Ryan used zero to two total signs in his home observations during baseline but only one unique sign. During the intervention phase, Ryan's use of signs at home also increased from four signs during the home observation after Session 5 to 22 signs after Session 20. His use of spontaneous different signs increased from zero to eight. Ryan used words in only one home observation during intervention; following clinic session 15, he said two different spontaneous words and three total words.

Erin's mom used a variable number of signs (ranging from two to 12) during baseline home observations. Overall, Erin's use of signs was low, ranging between zero and two signs, and she used only one unique sign. Following introduction of the intervention in the clinic, both Erin and her mom demonstrated an increase in level of signing, with variable results. Erin used between 11 and 31 signs per session, and her use of different spontaneous signs was between five and seven signs per session. Erin's mom used eight and three signs in the first two home observations. She used 24 signs in each of the last two home observations. In addition to signs, Erin used four to nine total words and one to four different spontaneous words during generalization sessions.

Jay's mom signed at a high rate (between eight and 27 signs) compared with other parents (between zero and 12 signs) in baseline home observations. She increased her use of signs in the home observations that occurred during the intervention phase, and she used between 29 and 47 signs in

each of the four sessions. Jay also demonstrated a relatively high rate of signing during home observations during baseline; his total signs ranged between seven and 16, and his spontaneous unique signs ranged between one and three.

Concurrent with the clinic intervention, his rate of total sign use was similar to his baseline levels (range = 7–22); however, his number of different spontaneous signs increased and ranged from three to six signs per session. Jay used between two and nine total words and used one or two spontaneous different words in each home generalization session.

Gretchen's dad had the lowest rate of signing throughout baseline and intervention. He did not sign in the first four home observations during baseline, and he signed two times in baseline observation 5 and one time in baseline observation 6. During the home observation sessions, concurrent with the clinic intervention, he signed two times in the home observation that followed session 15 and three times in the home observation that followed session 20, indicating that his use of signs did not change during intervention with Gretchen. Gretchen did not sign at all during her baseline sessions. She only signed during the home observations that followed clinic sessions 15 and 20; these were the same sessions in which her father had signed. During these two sessions, she signed four and five times, respectively, and used two different spontaneous signs in each session. During the clinic intervention, Gretchen did not use words in the first home observation that followed clinic session 5. She used three, three, and six words, respectively, in the home observations that followed clinic sessions 10, 15, and 20. She also demonstrated a small change (from zero to two words) in her use of different spontaneous words.

### Effect on Joint Engagement

The fourth research question asked if children would increase the amount of time spent in joint engagement and symbol-infused joint engagement as a result of participating in EMT/JASPER Words + Signs. This question was exploratory in nature, as limited data could be coded for this study. Data were collected during half of the sessions for three of the four participants. Some videos, including the majority of Jay's videos, could not be scored for joint engagement due to poor camera angles that prevented

**Table 3.** Total signs modeled by parents, and total signs used by children.

ID	BL 1	BL 2	BL 3	INT 5	INT 10	INT 15	INT 20
Ryan	0	0	2	4	5	13	22
Ryan's mother	1	1	3	27	14	30	27
Erin	0	1	2	19	11	31	15
Erin's mother	2	12	3	8	3	24	24
Jay	7	8	16	22	7	9	18
Jay's mother	21	8	27	47	30	29	43
Gretchen	0	0	0	0	0	4	5
Gretchen's father	0	0	1.5	1	0	0	3

*Note.* BL = baseline; INT = intervention. Gretchen had six baseline sessions. BL 1 represents the average of BL 1 and 2, BL 2 represents the average of BL 3 and 4, and BL 3 represents the average of BL 5 and 6.

the coders from making reliable decisions about engagement state.

Results are displayed in Table 4. During baseline, the average amount of time spent in total joint engagement for all participants was somewhat high, ranging from 42% to 55%. Across the three participants, there were increases in average percentage of time spent in total joint engagement during intervention as compared with baseline levels. Participants spent an average of 60%–65% of the observed segment in joint engagement during intervention. This level is consistent with levels reported in the Adamson et al. (2009) observational study of toddlers with DS. Erin and Gretchen showed clear increases in total joint engagement during intervention (increases of 23% and 16%, respectively). Their increases in total joint engagement occurred after the intervention phase began and appeared to be functionally related to the intervention.

The three participants exhibited very low, stable rates of symbol-infused joint engagement during baseline (range = 0%–5%), consistent with their low rates of spoken word and sign use. During intervention, the average percentage of time spent in symbol-infused joint engagement ranged from 0% to 34% across participants, with all participants demonstrating a small increase in average percentage of time in symbol-infused joint engagement during intervention sessions. Ryan demonstrated a small increase in level, to about 6% symbol-infused joint engagement, until the final two sessions, in which an increase to about 17% symbol-infused joint engagement occurred concurrently with his increased use of words and signs. Erin demonstrated an increasing trend across intervention sessions, averaging 16% symbol-infused joint engagement. Gretchen’s symbol-infused joint engagement remained low throughout intervention, with some sessions reaching 4%. This low percentage of symbol-infusion is a result of her low use of signs and words throughout the intervention.

Additionally, all participants demonstrated an increase in the percentage of sessions in which symbol-infused joint engagement occurred after the introduction of the intervention. During the baseline condition, participants demonstrated symbol-infused joint engagement in 0%–33% of sessions. During intervention sessions, participants demonstrated symbol-infused joint engagement during 36%–91% of

sessions. Gretchen, who had the lowest rates of signs and words, also had the lowest rates of symbol-infused joint engagement throughout the study.

## Discussion

The purpose of this study was to determine the effects of EMT/JASPER Words + Signs implemented by a therapist on the expressive signed and spoken language of young children with DS. All participants demonstrated an increase in their rate of signing and number of different spontaneous signs during intervention. Rate of spoken word use varied across participants. The four participants acquired between 10 and 21 new signs and between three and nine new words during the intervention. In addition, all four participants generalized their use of signs to a new location (home) with an untrained partner (parent). Small changes in use of spoken words were observed at home. Changes in total joint attention and in symbol-infused joint attention occurred concurrent with the intervention for the three children for whom data were collected.

This intervention extends the research on naturalistic communication interventions for children with DS in several ways. First, EMT strategies were used as a way of teaching spoken and signed language simultaneously. Using words and signs as the therapists’ communication mode and providing a high density of models in both modes appear to have helped children learn a moderate number of signs. Teaching sign language through this “immersion” model differs from teaching approaches in which just a few select words are modeled with signs while most words are modeled verbally only.

Teaching spoken words and signs together resulted in increased use of signs and smaller increases in children’s use of words. Although Dunst, Meter, and Hamby (2011) posit that simultaneous use of words and signs did not appear to inhibit the development of spoken language, this study was not designed to confirm this conclusion. All of the children in this study made gains in their use of spoken words during the intervention; however, the pattern of development and use varied greatly. Erin and Gretchen both used about one third of their words first as signs and then as spoken words. However, 50%–80% of the total words

**Table 4.** Average total percentage of time in joint engagement (JE) and in symbol-infused joint engagement (SIJE) during baseline and intervention.

ID	Construct	Baseline %		Intervention %	
		<i>M</i>	<i>Range</i>	<i>M</i>	<i>Range</i>
Ryan	JE	55	46–61	60	35–84
	SIJE	1	0–2	6	0–17
Erin	JE	42	27–57	65	40–82
	SIJE	1	0–5	16	0–34
Gretchen	JE	44	27–58	60	42–83
	SIJE	0	—	1	0–4

*Note.* Measures are averages based on three to five baseline sessions and 11 intervention sessions. Dash represents “no range.” No data were available for Jay.

learned by all of the four participants were only used as signs and did not develop into spoken words during the intervention time. Future research should measure the patterns of acquisition of signs and spoken words and explore the modes in which words are first learned and the transfer across signed and spoken modes. The relative effects of teaching sign plus spoken words compared to teaching spoken words only on word acquisition could not be determined in the current study, but this may be an important area for future research.

Variability in children's acquisition of signs may also have been related to their motor imitation abilities. Erin and Ryan, whose imitation skills were more fluent and who had diverse interests in toys, showed the strongest effects of the intervention. Jay, who imitated only 40% of items assessed, had the second lowest levels of change in the intervention. Gretchen, who did not imitate any assessed items, demonstrated the smallest effects of the intervention. Kouri (1988) reported that all participants were able to imitate, but this claim was not supported by data. Imitation abilities have been correlated to later expressive language in typically developing children (Charman et al., 2000).

Similar to Kouri's (1988) study, the current study was relatively efficient in teaching signs. Participants in this study learned 10–21 new signs in 20 sessions compared to Kouri's participant with DS, who learned 23 new words in 50 sessions. Kouri's participant also acquired 75 new spoken words over the 50 sessions, whereas the children in this study learned between three and nine spoken words. The difference in spoken word use may be attributed to the age of the participants. The DS participant in the Kouri study was 34 months of age at the start of the intervention, and the children in the current study were between 23 and 29 months of age. Neither this study nor Kouri's included measures of the children's sound repertoires. Due to the small samples in both studies, additional research is needed to replicate the effects of the intervention and to explore issues in the efficiency of these teaching methods for both signs and words.

Second, this study provided a preliminary demonstration of the effects of the blended EMT/JASPER intervention on children's total and symbol-infused joint attention. Children in this study began with lower levels of engagement than those levels observed in 30-month-old children with DS and 18-month-old typically developing children in the Adamson et al. (2009) study. During the EMT/JASPER Words + Signs intervention, children's joint engagement increased to levels similar to those reported by Adamson et al. (2009). In addition, children began the study with very low levels of symbol-infused joint engagement comparable to the children in Adamson's study. Two of the three children (Ryan and Erin) demonstrated overall increases in the percentage of time spent in symbol-infused joint engagement. All three children used symbol-infused joint engagement in more sessions as the intervention progressed. Symbol-infused joint attention emerged late in the intervention phase of the study. Children used more words and signs to request and comment while jointly engaged with a partner and a toy

during the last five intervention sessions than earlier in the study. Although these findings are important for children with DS who have difficulties infusing symbols into engaged states, they also indicate that systematic and sustained intervention for both engagement and symbol use could be needed to establish these important behaviors. Replication and further study of the pattern of change in symbol-infused joint attention are needed with this population.

Third, a relatively brief intervention in the clinic resulted in generalization of signed and spoken communication to interactions with parents at home. This is an important finding because young children with DS have shown modest intervention effects in previous naturalistic communication studies. Variability in child outcomes in the home observations may have been affected by parents' use of signs at home. Parents were not taught how to teach signs to their children, but they were provided with the list of words targeted in the therapist intervention sessions. Observations of parents during the home observations indicated different amounts of parent signing across families and increased use of signs over the period of the intervention by three of the four parents. Gretchen, whose parent used the fewest signs at home, showed the least change in her own use of signs in the intervention. Children's use of signs appeared to co-vary with parents' use of signs; however, the direction of this relationship is not clear.

This study provides a systematic analysis of changes in children's use of signed and spoken communication, including a very rigorous measure: spontaneous unique use of signs. Studies typically report total words and spontaneous words; however, these measures fail to capture the diversity of signs used and are less stringent measures of expressive language use. Measuring the number of unique spontaneous words is more conservative because it omits the repeated usage of the same words that may appear to increase rate.

### **Limitations**

This study has some specific limitations. First, it is difficult to interpret results for changes in total joint engagement and symbol-infused joint engagement. These measures were collected for only half of the sessions observed due to the time-consuming nature of this coding. In addition, the changes in joint engagement were modest and variable during the intervention. Although the data were summarized in Table 4, graphs of these data were prepared and examined. Only one child (Erin) showed a systematic shift in level of joint engagement following the introduction of the intervention, although all three children showed increases in both total and symbol-infused joint engagement over the course of the intervention.

Two additional limitations of this study are the relatively brief duration of the intervention and the lack of maintenance data. The intervention lasted only 20 sessions, and maintenance of words and signs was not measured with children and their parents because families began a second phase of the model intervention project that included parent training immediately after this study was completed. A longer intervention would have provided the opportunity to

evaluate whether a child could learn more signs and spoken words in the intervention and to determine patterns of acquisition of signs and spoken words.

### Future Research

Although results indicate that EMT/JASPER Words + Signs is an effective intervention for increasing the expressive use of signs in young children with DS, the study leaves a number of questions unanswered. First, replications are necessary to determine how this intervention can be delivered to maximize outcomes. The number of signs and words introduced within and across sessions should be studied to determine the most efficient means of increasing new language skills while ensuring mastery, generalization, and maintenance of functional use of these skills. More information about the patterns of sign and word acquisition and generalization is needed to design an intervention that allows children with DS to bridge the use of signs to spoken words.

In addition, the relationship between the development of symbol-infused joint attention and other outcomes of EMT/JASPER Words + Signs intervention needs to be examined by coding more aspects of child communication concurrent with recording the interventionists' behaviors (e.g., joint engagement, play, symbol-infused joint engagement, use of words and signs, prompts, models of engagement, play and language). In the current study, the joint engagement measures were coded separately from the primary fidelity and child communication measures, and it was not possible to ascertain the relationship among these behaviors directly.

Second, this intervention needs to be evaluated systematically. Comparisons are needed to determine the individual contributions of each component of EMT, JASPER, and the Words + Signs mode for teaching. The intervention was implemented as a package, and the contributions of each component could not be determined in the current multiple-baseline, across-participants design. In addition, this intervention should be compared with a spoken-word-only intervention to determine the effects on signed and spoken word use. The intervention needs to be studied across contexts and communication partners, including parents at home and teachers in school routines. Further, generalization and maintenance measures are necessary to determine the long-term effects of the intervention outside of the intervention sessions. Examining the generalization and maintenance of effects is especially important because children with DS have significant communication deficits that typically require extended interventions and because children with DS have difficulty with generalization of newly learned skills.

Finally, more research is needed to understand the characteristics of children with DS—characteristics that influence children's response to intervention—and to further adapt the EMT/JASPER Words + Signs intervention to fit their observed communication strengths and weaknesses during implementation of the intervention. For example, for children who are not yet fluent in motor imitation, adding brief practice trials before the play session to shape their

production of signs might improve their spontaneous and accurate use of signs in the intervention. In a similar way, for children with low levels of joint engagement or few play skills, focusing on JASPER intervention strategies to teach these skills until a criterion level of skill is achieved might make teaching new signs and words more successful.

### Conclusion

The results of this study indicate EMT/JASPER Words + Signs is an effective way of teaching new signed and spoken communication skills to young children with DS. During the intervention, children increased their frequency of signing, number of different spontaneous words signed, and use of spoken words. In addition, children generalized signs to parents in home observations. Small changes in amount of symbol-infused joint engagement were observed. The results varied across children. In some children, increases in spontaneous communication using words and signs occurred well after the intervention phase was initiated. Replication and extensions of this intervention approach for children with DS are needed to evaluate its potential as an effective early communication intervention.

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