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Research Article

# Teaching Children Who Use Augmentative and Alternative Communication to Ask Inverted Yes/No Questions Using Aided Modeling

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**Purpose:** This study investigated the effects of a direct intervention program involving aided modeling and the presentation of contrastive targets on the aided production of inverted yes/no questions and possible generalization to other sentence types by children using augmentative and alternative communication (AAC).
**Method:** A single-case, multiple-probe, experimental design across participants was used to evaluate the effects of the instructional program with 3 children who had motor speech disorders and used AAC (ages 4;10 [years;months], 6;2, and 4;9). The treatment involved aided modeling of treatment and contrastive targets through concentrated modeling and interactive play activities. Direct treatment outcomes were examined by measuring the accuracy of producing inverted yes/no questions and *to be* declaratives through probes.
**Results:** All 3 participants showed a direct treatment effect, producing a greater number of inverted yes/no questions and *to be* declaratives within the probes following treatment compared with before treatment. All 3 participants evidenced some generalization to novel sentences.
**Conclusions:** Results provide initial evidence that instruction involving aided modeling with contrastive targets holds promise in targeting specific linguistic rules with children using AAC. Patterns of generalization may depend on participants' specific language deficits and acquisition patterns during intervention.

Children with significant motor speech disorders often experience difficulty in adequately meeting their functional communication needs through natural speech. Even as they are undergoing treatment to address underlying motoric issues, reduced intelligibility and comprehensibility, as well as interference with language development, have been reported to be particularly debilitating for many children with motor speech disorders such as childhood apraxia of speech (CAS; e.g., American Speech-Language-Hearing Association [ASHA], 2007; Cumley & Swanson, 1999; Hall, 2000a, 2000b). Treatment goals for such children have sometimes focused on facilitation of overall communication, with some studies using augmentative and alternative communication (AAC; ASHA, 2007). It has been suggested that interventions designed to directly improve overall communicative functioning through AAC may indirectly improve a child's ability to function within relevant social and educational contexts (ASHA, 2007). A number of studies have reported positive results when using aided AAC interventions (i.e., communication interventions involving communication modalities external to the body, such as communication boards or high-tech voice output devices) with children who have CAS or suspected CAS diagnoses; increases in overall communicative participation measures, as well as in more specific language-focused measures, have been reported in the literature to date (e.g., Binger, Kent-Walsh, Ewing, & Taylor, 2010; Binger & Light, 2007; Harris, Doyle, & Haaf, 1996; Kent-Walsh, Binger, & Malani, 2010).

However, even when aided AAC is used, language-learning expectations often are set too low for these children. Although some practitioners are satisfied if a child with complex communication needs can meet basic communication needs, the child's access to the regular curriculum and to literacy activities are limited without the use of rule-based language, ultimately resulting in poor long-term

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academic and employment outcomes (e.g., McNaughton & Bryen, 2002). Expectations for learning language, therefore, should be the same for children with complex communication needs as for their peers with typically developing speech and language skills.

It is unfortunate to note that children with complex communication needs tend to have poor expressive language outcomes, with relatively few individuals achieving mastery of expressive grammar (Binger & Light, 2008). For example, both children using AAC who have no cognitive impairments and young typically developing children who use AAC for research purposes tend to produce single symbol messages when using aided AAC (e.g., Smith & Grove, 1999; Sutton & Morford, 1998). In addition, multiple researchers have reported word-order difficulties for this population. Adolescents who used AAC in one study demonstrated word-order difficulties when retelling stories (van Balkom & Welle Donker-Gimbrère, 1996), and younger participants in other investigations have demonstrated word-order errors when learning to produce early symbol combinations (Binger, 2004; Nigam, Schlosser, & Lloyd, 2006; Wilkinson, Romski, & Sevcik, 1994). Overall, this body of research indicates that mastering grammar can be challenging for children and adolescents who use AAC.

However, as previously mentioned, recent AAC intervention research has yielded positive outcomes on various expressive linguistic measures for children. Using techniques originally used with children with language disorders who communicate through natural speech, such as modeling and recasting, Binger, Kent-Walsh, and colleagues have demonstrated rapid improvements in productions of multisymbol messages with preschoolers and young school-age children using AAC who have a range of underlying disabilities (Binger, 2004; Binger et al., 2008, 2010; Binger & Light, 2007; Kent-Walsh et al., 2010). These investigations involved the use of aided modeling as a central intervention component; in other words, the interventionists provided both spoken models, as well as models using the children's communication devices, during intervention activities. In one study (Kent-Walsh et al., 2010), nine out of 10 children who participated with their parents in a 5-day instructional program—which included 10 hr of parent instructional time and heavy emphasis on aided modeling, across a 2-week period—produced virtually no multisymbol messages prior to the initiation of parent instruction but averaged 2.5 symbols per message for multisymbol messages following parental intervention. The children in this series of studies exhibited receptive language levels ranging from moderately delayed to within normal limits, indicating that children with a range of profiles have the potential to improve their expressive language skills.

Fewer studies have directly addressed word-order issues with children using AAC. Nigam et al. (2006) reported that two children, both of whom had intellectual impairments, demonstrated similar patterns of word-order errors when producing action–object structures, with both children producing more messages with incorrect word order during the initial stages of intervention and fewer incorrect productions as they neared mastery. Children with no cognitive disorders who use AAC have also been reported to exhibit word-order difficulties. For example, all five of the children in Binger's 2004 intervention study made at least some word-order errors when producing various multiterm semantic relations (e.g., agent–action, action–object), and one participant whose receptive grammar scores were within normal limits produced no agent–action–object sentences with correct word order (out of 11 attempts) until receiving intervention specifically designed to correct these word-order difficulties. Once targeted for intervention, however, the participant quickly began using correct word order for these structures (i.e., 1.75 hr of intervention).

Studies indicate, then, that directly targeting message length and word order can result in positive changes in children's language expression. However, very few AAC studies to date have been designed to teach specific types of sentences. For example, of the studies discussed previously, only one (Nigam et al., 2006) was designed to teach an actual semantic rule (i.e., production of action–object). In contrast, Binger and Kent-Walsh's studies (Binger, 2004; Binger et al., 2008; Binger & Light, 2007; Kent-Walsh et al., 2010) to date have focused on improving general productions of multisymbol messages, not specific sentence types such as particular multiterm semantic relations (e.g., agent–action–object, possessor–entity). In fact, only one known experimentally controlled study in addition to the Nigam study (Nigam et al., 2006) has been designed specifically to teach linguistic rules to children using AAC: Binger et al. (2011) taught three children using AAC to produce various grammatical morphemes by using their speech-generating devices (SGDs). There is a need, then, to further develop such programs, if children who use AAC are to meet their expressive language potential.

Constructing simple inverted questions is a goal that has not been targeted previously in the literature with individuals who use AAC. Teaching this sentence structure offers several distinct clinical and theoretical advantages. One clinical advantage of targeting this goal is that children who use AAC often experience learned passivity. These children tend to take few communicative turns, with the majority of those turns being responses (Light, Collier, & Parnes, 1985). Further, children using AAC seldom ask questions (Soto, 1999). Learning to ask questions can be a powerful tool in assisting these children in taking a more active communication role and providing them with a way to initiate communication. Light, Binger, Agate, and Ramsey (1999) taught individuals using AAC to ask partner-focused questions (e.g., "What have you been up to?"), but the focus was on teaching pragmatic skills rather than linguistic rules. That is, participants learned to convey questions in a socially appropriate manner using messages preprogrammed onto SGDs, but they did not learn how to construct questions. In contrast, teaching children who use AAC to construct simple, novel questions one symbol at a time (e.g., *IS + JESSIE + LAUGHING?*) places the focus on how to build sentences.

Teaching simple yes/no questions containing *to be* verbs (either as auxiliary verbs or as copulas) is a particularly compelling goal. Evidence indicates that early in development, children use auxiliaries in yes/no questions more frequently than in WH questions (Klee, 1985). Also, children using AAC cannot rely on intonation to ask questions in the way that young typically developing children do (e.g., Jessie laughing?); such messages produced on an SGD will be perceived as statements (e.g., *JESSIE LAUGHING.*). Therefore, teaching inversion is essential in order to provide these children with a way to compose yes/no questions. In addition, teaching children to use simple inverted forms, especially when contrasted with declarative forms (e.g., *IS JESSIE LAUGHING?* vs. JESSIE *IS LAUGHING*), highlights two essential properties of rule-based language learning. First, each word in a sentence is important to clearly convey a particular message; leaving one or more words out of these types of sentences is likely to result in a misunderstanding of the child's meaning. Second, word order is important when constructing sentences; for example, if the child says *JESSIE IS LAUGHING* to indicate *IS JESSIE LAUGHING?*, the meaning of the child's intended message will be misinterpreted by communication partners. As discussed previously, both sentence length and word order can be problematic for children using AAC, so teaching these children to ask yes/no questions will highlight both properties of language simultaneously. Focusing on simple yes/no questions, then, teaches clinically relevant question forms while simultaneously highlighting the importance of creating complete sentences using correct word order.

Teaching simple yes/no question inversion has compelling theoretical and practical implications. Children using AAC tend to exhibit various grammatical difficulties. Multiple reasons for the presence of these issues have been posited in the literature (e.g., Soto, 1999; Sutton, Gallagher, Morford, & Shahnaz, 2002; Sutton, Soto, & Blockberger, 2002; Trudeau, Sutton, Dagenais, De Broeck, & Morford, 2007). The two most relevant to the current study are the *modality-specific hypothesis* and the *translation hypothesis.* The modality-specific hypothesis posits that "graphic symbol utterance structures reflect constraints specific to the visual graphic mode" (Sutton, Soto, & Blockberger, 2002, p. 195). One constraint that makes graphic symbols inherently different from spoken language is that graphic symbols and spoken words may not have a one-to-one correspondence for a child using AAC. For example, a line drawing of someone laughing may not represent *LAUGH* to a child, but instead, *JESSIE [or any subject] IS LAUGHING.* If this is true for a child, it negates the need for the child to use multiple symbols; he believes he is conveying his entire message by selecting one symbol. In this particular example, this strategy is in direct opposition to the translation hypothesis, whereby a child first creates a spoken representation of a message and then attempts to transpose that message onto the SGD—in other words, the child's job is to map each spoken word onto the SGD. Teaching children to generate each word in an utterance, at least in some contexts, may facilitate development of generative language.

Teaching a child to produce simple inverted question forms may assist the child in making this shift. When producing such forms, the child is practicing the creation of sentences in which each symbol must match its spoken language equivalent to convey a clear meaning. If this is the case, the intervention may have a more broad effect on the child's expressive language. Fey, Long, and Finestack (2003) discussed the need to address not only closely related targets but also intermediate targets when providing grammar intervention. With regard to closely related targets, by virtue of teaching the child to invert simple yes/no questions, generalization to similar sentences may be expected; for example, generalizing from simple yes/no inversions involving *is* as an auxiliary verb (*IS JESSIE LAUGHING*) to simple yes/no inversions involving *is* as a copula (*IS JESSIE HAPPY*). In addition, given the theory that for some children learning to use AAC the goal is for the child to map messages for which he already has mental representations onto graphic symbols, it might be possible for the child to generalize productions to slightly more complex, or longer, sentences. For example, the child might generalize productions of complement sentences containing the copula *is*, such as *JESSIE IS HAPPY* to using *is* in sentences containing transitive verbs and objects (*JESSIE IS PUSHING BUZZ; BUZZ IS PUSHING JESSIE)*.

The three primary research objectives for this study were to (a) evaluate the impact of an intervention program on the productive use of yes/no questions containing the copula *is* and intransitive progressive verbs (e.g., *IS JESSIE LAUGHING*?) and contrasting simple declaratives containing *is* (*JESSIE IS LAUGHING*) by children who use AAC; (b) evaluate participants' ability to generalize aided AAC productions to other sentences containing the copula *is* (e.g., *WOODY IS HAPPY*); and (c) evaluate participants' ability to generalize aided AAC productions to slightly longer sentences containing *is* as an auxiliary verb, a transitive verb, and an object (e.g., *JESSIE IS PUSHING BULLSEYE*).

# Method

## Research Design

This study was conducted using an experimentally controlled single-case, multiple-probe design across participants. Multiple-probe designs are well suited for AAC intervention studies, as they allow evaluation of experimental control for participants who are from heterogeneous populations (Light, 1999; Schlosser, 2003). Furthermore, single-case designs also have been noted to play an important role in early efficacy studies, which can lead to later efficacy and effectiveness studies including randomized clinical trials (Fey & Finestack, 2009).

## Participants

Families with young children using AAC were recruited to participate through local clinical contacts of the Communication Disorders Clinic at the University of Central Florida. Three children from metropolitan areas of Central Florida were identified, and their parents were invited to provide participation consent. All children were White and were from families of upper middle class backgrounds. Each child lived at home with both parents and one sibling and had either one full-time stay-at-home parent or one parent working part-time and a second full-time working parent employed in a professional capacity. Each participant met the following inclusion criteria: (a) were between 4 and 6 years of age; (b) presented with severe, congenital motor speech impairments (i.e., less than 50% comprehensible speech on No Context condition of Dowden's [1997] Index of Augmented Speech Comprehensibility in Children); (c) had hearing, vision, and fine motor skills within or corrected to be within functional limits; (d) had prior experience with AAC iPad (Apple, Cupertino, CA) application use; (e) had an expressive vocabulary (communicated via speech and/or AAC) of at least 50 words per parent report; and (f) communicated using grammatically incomplete/incorrect messages per parent report. In addition, participants demonstrated adequate receptive syntax skills for the targeted goals as demonstrated through (a) score of 6 or greater on the Elaborated Sentences and Phrases subtest of the Test for Auditory Comprehension of Language–Third Edition (TACL-3; Carrow-Woolfolk, 1999) and (b) at least 80% accuracy on 10 probes designed to assess comprehension of two- and three-word instructions with toys as subjects. These probes were created by the authors of this study on the basis of Miller and Paul (1995). See Table 1 for detailed participant information.

### *Procedure*

Sessions were administered by the first author, who met procedural standards before beginning the study by conducting practice intervention and probe sessions, which were scored by independent graduate assistant observers against the procedural standard (checklist). Sessions took place at the University of Central Florida Communication Disorders Clinic. All sessions were conducted in a quiet clinical setting, with only the interventionist and participant present; observers viewed sessions through a two-way mirror or while seated quietly in the room. All sessions were videotaped for data analysis purposes. Table 2 includes an overview of procedures for each phase of the investigation; accompanying detailed procedural information is provided.

*Baseline phase.* During baseline, the interventionist periodically administered 10 probes each for Dependent Variables 1 and 2 and for Generalization Variables 1, 2, and 3. In consideration of time and ethical concerns relating to delaying intervention, a minimum of three baseline probes (in accordance with the minimum requirements put forth by Kratochwill et al., 2010, to meet design standards) were taken for each measure for each child to ensure stability of the baselines. Stability was defined as no more than 20% fluctuation of performance. Feedback regarding the correctness of responses was not provided on performance during the probes in baseline or in any other phase.

*Intervention phase*. Once a stable baseline was established for dependent measures for the first child, intervention began for Subject + Aux V (is) + Main Ving and Aux V (is) + Subject + Main Ving. The remaining participants stayed in baseline. Once the first child demonstrated a learning effect of the intervention and the second child's baseline was stable, the second child entered the intervention phase; procedures for the third participant followed the same pattern.

The same verbs used in the probes were used during intervention (*clap, cry, jump, fall, hide, laugh, sing, sit, sleep,* and *walk*), but the characters were different. Plastic figurines from Disney Junior's *Mickey Mouse Clubhouse* were used during the play routines: Mickey, Minnie, Pluto, Goofy, and Donald. These characters engaged in various activities using related toys (e.g., Mickey's Clubhouse, Monorail, race cars), which afforded highlighting of the actions. The Proloquo2Go communication display (AssistiveWare, Amsterdam, the Netherlands) used during intervention was set up in exactly the same manner as the earlier described display used during probe administration.

Each intervention session included the following two components: (a) concentrated modeling and (b) interactive play. At the beginning of each intervention session, the first author and a parent provided a series of 20 concentrated models of the targets (10 for each dependent variable). Providing concentrated models has been shown to facilitate production of grammatical rules in children with language disorders (Courtright & Courtright, 1979). This approach was adapted for children using AAC in the present investigation; that is, aided models, consisting of the interventionist providing both a spoken model (e.g., *Is Mickey jumping?*) and a model on the child's SGD (e.g., *IS MICKEY JUMPING?*) were provided (Binger & Light, 2007).

For the concentrated modeling component of the intervention, simple illustrations with stuffed toys were set up to facilitate the use of each target (i.e., declaratives such as "Minnie is falling" and yes/no questions such as "Is Pluto hiding?"). The concentrated modeling activities were explained to the child as a test to see if the parent was a good listener. The interventionist manipulated toys to enact target declaratives and then produced the declaratives through natural speech and using the iPad (e.g., *MICKEY IS SLEEPING*) to describe what the stuffed toy was doing while the parent covered her eyes and listened. After hearing the declarative target produced with the device, the parent then uncovered her eyes and asked the interventionist the associated question using the iPad to confirm what the interventionist had said (e.g., *IS MICKEY SLEEPING*?). In this manner, the child could tell the parent if they were "right" or "wrong," and 10 examples of each dependent variable were provided in a contrastive manner at the beginning of each intervention session. During this intervention component, the children were required to listen attentively and were not permitted to attempt productions of the targets, although they were permitted to verbally respond to the parents' yes/no question (e.g., "Yes" in response to the parent's production of *IS MICKEY SLEEPING*?).

During the interactive play component of the investigation, the children were provided with additional aided

**Table 1.** Demographic information for participants.

| Child (age at onset of participation) | Reported primary disability/diagnoses | Communication modes used prior to participation in current investigation | I-ASCC | PPVT-4 | TACL-3 | | | |
|---|---|---|---|---|---|---|---|---|
| | | | No Context, % | SS (%) AE | Quotient SS (%) | Vocabulary SS (%) | Gramm. Morph. SS (%) | Elaborated Phrases/Sent. SS (%) |
| Adam (4;10) | Childhood apraxia of speech | Natural speech, gestures, Proloquo2Go iPad app | 16 | 113 (81) 6;0 | 106 (65) 5;1 | 11 (65) 5;0 | 11 (65) 5;0 | 11 (65) 5;3 |
| Bella (6;2) | Down syndrome | Natural speech, gestures, Proloquo2Go iPad app | 38 | 81 (10) 5;0 | 76 (5) 4;8 | 7 (15) 4;9 | 5 (5) 3;6 | 7 (16) 4;9 |
| Clay (4;9) | Childhood apraxia of speech and un-identified developmental delay/ possible seizure disorder[a] | Natural speech, gestures, Proloquo2Go iPad app | 13 | 84 (14) 3;8 | 98 (45) 4;7 | 8 (25) 4;0 | 11 (63) 5;0 | 10 (50) 4;9 |

*Note*. Ages and age equivalents (AEs) are in years;months. I-ASCC = Index of Augmented Speech Comprehensibility in Children (Dowden, 1997); PPVT-4 = Peabody Picture Vocabulary Test–Fourth Edition (Dunn & Dunn, 2007); SS = standard score; %ile = percentile; TACL-3 = Test for Auditory Comprehension of Language–Third Edition (Carrow-Woolfolk, 1999); Gramm. Morph. = grammatical morphemes; Elaborated Phrases/Sent. = elaborated phrases and sentences.

[a]A possible seizure disorder was identified in the midst of his participation in this investigation, and he was diagnosed with central auditory processing disorder after the study ended.

**Table 2.** Summary of procedures and activities by investigation phase.

| Phase | Probes: Occurs in this phase? | Probes: Variables probed | CM and Play: Occurs in this phase? | Description of phase and activities |
|---|---|---|---|---|
| BL | Yes | DV1<br>DV2<br>Gen1<br>Gen2<br>Gen3 | No | • Child is familiarized with symbols on device.<br>• Probe sets are administered.<br>• Baseline phase is complete when child's score stabilizes across 3 sets of probes (<20% variability with no ascending baseline). |
| Ix | Yes | DV1<br>DV2 | Yes | • Probes completed first, followed by CM and play session.<br>• Child must achieve score of 80% or better for 3 sessions to achieve mastery.<br>Concentrated modeling component<br>Interventionist and parent:<br>• Produced 10 aided AAC models each for DV1 and DV2 while the child watched and listened.<br>Play component<br>Interventionist:<br>• Engaged the child in play activities for a minimum of 25 min.<br>• Produced a minimum of 20 aided models of DV1 and DV2.<br>• Elicited a minimum of 5 child attempts to produce DV1 and/or DV2 using the SGD via prompting. |
| Gen | Yes | Gen1<br>Gen2<br>Gen3 | No | • Generalization probes initiated following >80% accuracy with DV1 and DV2 across at least 2 sessions. |
| Maint | Yes | DV1<br>DV2<br>Gen1<br>Gen2<br>Gen3 | No | • Maintenance probes administered approximately 4, 8, and 12 weeks after the participant demonstrated mastery of given target (per participant availability) |

*Note*. CM = concentrated modeling; BL = baseline phase; DV1 = Dependent Variable 1 (e.g., *WOODY IS SLEEPING*); DV2 = Dependent Variable 2 (e.g., *IS WOODY SLEEPING*); Gen = generalization phase; Gen1 = Generalization Variable 1 (e.g., *WOODY IS HAPPY*); Gen2 = Generalization Variable 2 (e.g., *IS WOODY HAPPY*); Gen3 = Generalization Variable 3 (e.g., *WOODY IS PUSHING BULLSEYE*); Ix = intervention phase; AAC = augmentative and alternative communication; SGD = speech-generating device; Maint = maintenance phase.

models for Dependent Variable 1 and Dependent Variable 2 and were prompted to produce the targets during play sessions lasting at least 25 min. The interventionist followed the child's lead within play activities involving *Mickey Mouse Clubhouse* characters and toys; the following types of prompts were used to elicit dependent variable productions from the children: expectant delay, open-ended question asking (e.g., "What is Mickey doing?"), direct verbal prompts (e.g., "You tell me." "You ask me what Minnie is doing."), and gestural prompts (e.g., pointing to the device). In addition, in following the child's lead and responding to dependent variable productions, the interventionist employed confirmations of productions, and/or imitations and recasts, using the child's SGD. The intervention protocol included the requirement that the interventionist do the following within each play session: (a) engage the child in play activities for a minimum of 25 min; (b) provide a minimum of 20 models of Dependent Variable 1 and Dependent Variable 2 (not necessarily evenly split between Dependent Variable 1 and Dependent Variable 2), and (c) elicit a minimum of five child attempts to produce Dependent Variable 1 and/or Dependent Variable 2 using the SGD.

*Generalization phases.* To monitor generalization while also taking action to minimize ethical concerns of possible participant fatigue and/or frustration with administration of too many probes per session, generalization probes were not reinitiated until after the participants demonstrated a treatment effect (described as probe scores of at least 80%) for at least one of the dependent measures across at least two separate probe sessions. Five measurements were taken for each generalization variable following demonstration of a treatment effect.

*Maintenance phase*. To ensure the participants maintained use of the targets over time, maintenance probes were administered (schedule permitting) at 4, 8, and 12 weeks after intervention ceased for each dependent variable to track long-term use of targets.

## Materials and Instrumentation

*Stimuli.* Characters and props used for intervention and probes were chosen in consideration of familiarity within the targeted participant age group and of potential appeal to both boys and girls. Given the geographic location of participants, Pixar's *Toy Story* (Arnold, Catmull, Guggenheim, Job, & Lasseter, 1995) and Disney Junior's *Mickey Mouse Clubhouse* (Gannaway & Valdes, 2006) characters and toy props were selected for use in this investigation. *Mickey Mouse Clubhouse* characters—including

Mickey Mouse, Minnie Mouse, Donald Duck, Goofy, and Pluto—were used for intervention activities, and *Toy Story* characters—including Jessie, Woody, Buzz, Bullseye, and Alien—were used for probe stimuli.

As shown in Table 3, dependent measures were AAC productions of the following constructions: Subjects (Jessie, Woody, Buzz, Bullseye, & Alien); the auxiliary verb *is*; and the present progressive form of intransitive verbs (*clapping, crying, jumping, falling, hiding, laughing, singing, sitting, sleeping, and walking*). Generalization 1 and 2 stimuli consisted of the same subjects, the copula *is*, and adjectives (*big/small, cold/hot, dirty/clean, dry/wet,* and *happy/sad*). The last generalization target consisted of subjects and objects (both proper nouns such as Jessie & Woody) and the third person singular reversible verbs *pushing* and *pulling*. These are reversible verbs that have been used in past studies to examine constituent ordering of items in messages constructed on SGDs (e.g., Sutton & Morford, 1998). To ensure the use of stimuli well within range of expected expressive language for the participants, all vocabulary, with the exception of the characters and the intransitive verb *laugh*, was selected from the MacArthur Communicative Development Inventories Words and Sentences Form, which is intended for use with 16 to 30 months of age (Fenson et al., 2007).

For the probes, videos of *Toy Story* characters performing various actions in conjunction with relevant play materials (e.g., chairs for sitting, beds for sleeping, etc.) were shown within short video clips of approximately 10 s on iPads. Photographs portraying the *Toy Story* characters in various states (*big* vs. *small*, *wet* vs. *dry*) were used as stimuli for data collection for the generalization measures.

*SGDs.* Each child in the investigation used an identical SGD with identical displays. The Proloquo2Go iPad app was programmed with one communication page that contained the 28 symbols used in the study: (a) five characters for the probes (Woody, Buzz, Bullseye, Jessie, & Alien), (b) the auxiliary verb *is*, (c) the present progressive form of the 10 intransitive verbs described previously, (d) the 10 adjectives described previously, and (e) the reversible verbs *pushing* and *pulling*. The characters were represented with photographs of action figures, and the remaining symbols were represented using Picture Communication Symbols (Johnson, 1994) line drawings. The display was organized using a Fitzgerald Key color-coding approach (McDonald & Schultz, 1973); that is, each semantic–syntactic category was grouped together (subjects, verbs, etc.) in left-to-right linguistic order (agents/subjects in a column on the left, followed by actions, then adjectives). One exception to the scheme was that items used for objects did not appear in their own column, as the objects also served as subjects (Woody, Buzz, Bullseye, Jessie, & Alien). Each participant was able to accurately identify the vocabulary on the display prior to initiation of the investigation, as measured through a task that involved the examiner verbally asking the children to identify each symbol in response to verbal "show me x" prompts. These symbol identification tasks took place after each child was visually oriented to the display by the examiner labeling each icon.

*Dependent and generalization measures.* A pool of 50 probes was developed for each of the five targets listed in Table 3. The dependent and generalization measures consisted of the percentage of correct productions each child obtained on 10 probes administered at the beginning of each relevant session (see Procedure for details). All vocabulary items within a given category (nouns, verbs, adjectives) were used an equal number of times. In any given probe session, each verb (for Dependent Variables 1 & 2) or adjective (for Generalization Variables 1 & 2) was used once, and each character was used twice. For Generalization Variable 3, *pushing* and *pulling* were each used five times, and each character was used twice as an agent and twice as an object. Any given sentence for Dependent 1 and 2 and for Generalization 1 and 2 was used once every fifth session, and items were randomly ordered within any given session.

Procedures similar to those used in Binger et al. (2011) were used for Dependent Variable 1 and Generalization Variable 1. These procedures were originally adapted from Leonard, Camarata, Brown, and Camarata (2004). To be scored as correct, the participant had to produce all three components using the iPad accurately (Subject + Aux V + Main Ving, or Subject + Copula + Complement). Table 4 provides specific examples of how a puppet was used to present the stimulus videos and to prompt the children to produce the targets.

The procedures for Dependent Variable 2 and Generalization Variable 2 were similar to the procedures used for the previously described measures, except the scenarios were orchestrated to require the participants to ask Piggy questions about the video and photo stimuli. The puppet

**Table 3.** Measures and examples for each stimulus.

| Measure | Stimulus | Example of aided AAC production |
|---|---|---|
| Dependent Variable 1 | Subject + Aux V (is) + Main Ving | *WOODY IS LAUGHING* |
| Dependent Variable 2 | Aux V (is) + Subject + Main Ving | *IS WOODY LAUGHING?* |
| Generalization Variable 1 | Subject + Copula (is) + Complement | *WOODY IS HAPPY* |
| Generalization Variable 2 | Copula (is) + Subject + Complement | *IS WOODY HAPPY?* |
| Generalization Variable 3 | Subject + Aux V (is) + Reversible V + Object | *WOODY IS PUSHING BULLSEYE* |

*Note.* AAC = augmentative and alternative communication.

Table 4. Probes for Dependent Measure 1, Generalization Measure 1, and Generalization Measure 3.

| | Dependent 1 | Generalization 1 | Generalization 3 |
|---|---|---|---|
| Frame | Piggy: Oh no, I think [character] is coming and I think s/he's going to [verb]! | Piggy: Oh no, I think [character] is coming and I think s/he might be [adjective]! | Piggy: Oh no, I think [character] is coming and I think s/he might [verb][character]! |
| Example | Piggy: I think Buzz is coming and I think he's going to sing! | Piggy: I think Bullseye is coming and I think he might be wet! | Piggy: I think Buzz is coming and I think he might pull Bullseye! |
| Actions | Piggy: [hides] Interventionist: [shows Buzz on the iPad and plays the video of him singing] Piggy [hiding]: I'm scared. Please tell me what's happening. | Piggy: [hides] Interventionist: [shows circled photo of wet-looking Bullseye on iPad] Piggy [hiding]: I'm scared. Please tell me what's happening. | Piggy: [hides] Interventionist: [shows Buzz and Bullseye on the iPad and plays the video of him pulling Bullseye] Piggy [hiding]: I'm scared. Please tell me what's happening. |
| Aided target | *BUZZ IS SINGING.* | *BULLSEYE IS WET* | *BUZZ IS PULLING BULLSEYE* |
| Response (regardless of child's production) | Oh ok; that's not so bad. Thanks for telling me. | Oh ok; that's not so bad. Thanks for telling me. | Oh ok; that's not so bad. Thanks for telling me. |

was presented to the participants as follows: "We're going to play a game. This time, Piggy is going to watch the videos and look at the photos and then you will ask him what is happening." To administer each probe, the interventionist positioned the pig puppet in front of the iPad with the video and photo stimuli and said: "Piggy is going to watch the video (or look at the photo) now" and then pressed *play* to begin the stimulus video or swiped the screen to reveal the stimulus photo. The events that followed are depicted in Table 4. To be scored as correct, all three concepts had to be correct (Aux V + Subject + Main Ving, or Copula + Subject + Complement). Further details are in Table 5.

## Coding

As previously described, probe data were collected at the beginning of each session during the baseline, intervention, and maintenance phases of the investigation. The interventionist recorded the child's productions on the iPad during each session to track participant progress. In addition, all sessions were videotaped, and a trained coder, who was naïve to the phase of the investigation, recoded 100% of the probe data (see Data Reliability for details). The interventionist and coder transcribed each word of the participants SGD production verbatim. Self-corrections were scored as accurate if such productions were independently initiated by the participants within 5 s of initial productions.

## Data Analyses

The dependent and generalization measures (i.e., probe data) were graphed and visually inspected for changes in trend, slope, and level of the data (McReynolds & Kearns, 1983). Stable baselines were defined as no more than 20% variability on baseline probes, and mastery of targets were defined as a minimum of 80% accuracy across three consecutive sessions. To compare performance in baseline with the remaining phases, improvement rate differences (IRDs) were calculated in accordance with the following procedures, as described by Parker, Vannest, and Brown (2009). IRD was calculated by subtracting improvement rate (IR) of the baseline phase from IR of the comparison phase

Table 5. Probes for Dependent Measure 2 and Generalization Measure 2.

| | Dependent 1 | Generalization 2 |
|---|---|---|
| Frame | Piggy is going to watch the video now. After he watches it, you can ask him what's happening. I think [character] is coming and I think s/he's going to [verb]! | Piggy is going to look at some pictures on this iPad now. After Piggy looks at the picture in the circle, you can ask him what's in that picture. I think [character] will be in the circle and I think s/he's going to be [adjective]! |
| Example frame | Piggy: I think Buzz is coming and I think he's going to sleep! | Piggy: I think Bullseye is coming and I think he might be sad! |
| Actions | Interventionist: [plays video of Buzz sleeping] | Interventionist: [shows a split screen photograph depicting Bullseye looking happy on one side of the screen and a circled picture of Bullseye looking sad on the other side of the screen] |
| Prompt | Ask Piggy if Buzz is sleeping. | [Pointing to the circled Bullseye]: Ask Piggy if Bullseye is sad. |
| Target | *IS BUZZ SLEEPING?* | *IS BULLSEYE SAD?* |
| Response (regardless of child's production) | Thanks; let's let Piggy look at the next one. | Thanks; let's let Piggy look at the next one. |

(e.g., IR [Intervention] – IR [Baseline]). The IR for each phase was defined as the number of *improved data points* divided by the total number of data points in that phase. Improved data points in the baseline phase were defined as those which tied or exceeded any data point in the comparison phase. Improved data points in the comparison phases were defined as any data points that exceeded all data points in the baseline phase. IRD has been noted to have good discriminability—that is, good differentiation among individual data sets (Parker, Vannest, & Brown, 2009).

### *Treatment Fidelity*

To ensure accurate implementation of the intervention, a speech–language pathology student collected procedural integrity data for 20% of the intervention sessions for each child using a procedural standard. The coder viewed videos for each session and recorded: (a) the number of concentrated models provided by the interventionist per session (target minimum = 20; i.e., 10 for both dependent variables per session); range = 20–20 models; average = 20 models), (b) the length of the play session (target minimum = 25 min; range = 26–36 min; average = 31 min), (c) the number of aided models of Dependent Variable 1 and Dependent Variable 2 provided during each play session (target minimum = 20 models; range = 25–44; average = 28 models), and (d) the number of child attempts elicited for Dependent Variable 1 and Dependent Variable 2 during each play session (target minimum = five of either Dependent Variable 1 or Dependent Variable 2 per session; range = 5–21; average = 12) during each session. Procedural reliability scores were calculated by dividing the number of steps correctly implemented by the total number of correct, incorrect, and absent steps multiplied by 100 for each instructional session. Reliability was 98.5% across the three participants, indicating that the interventionist accurately followed the instructional procedures.

### *Data Reliability*

Data reliability measures were collected for all probe data in all phases of the study. Each probe session was coded verbatim for SGD productions and was compared with the data collected by the first author during each probe session. Cohen's kappa was used to calculate reliability for each target for each participant; that is, each SGD symbol was coded for agreement or disagreement between the original data (collected by the first author) and the data coded via videotape (by a second coder who was blind to the session and phases being coded). Kappa averaged .94 (range = .91–1.0 across participants), indicating almost perfect agreement.

## Results

### *Rate of Acquisition*

As depicted in Figure 1, Participants 1, 2, and 3 (referenced by the pseudonyms Adam, Bella, and Clay) participated in five, eight, and 14 instructional sessions, respectively, before meeting the 80% criterion for accurate implementation of both dependent variables across three sessions. The total instructional time during play sessions (i.e., time spent in concentrated modeling plus play sessions) for Adam, Bella, and Clay was 2.2, 4.9, and 6.8 hr, respectively. Sessions were scheduled on average two times per week, with some variability due to participant vacation schedules and illness; the intervention sessions spanned a period of 3 weeks for Adam, 4 weeks for Bella, and 6 weeks for Clay.

### *Level of Acquisition*

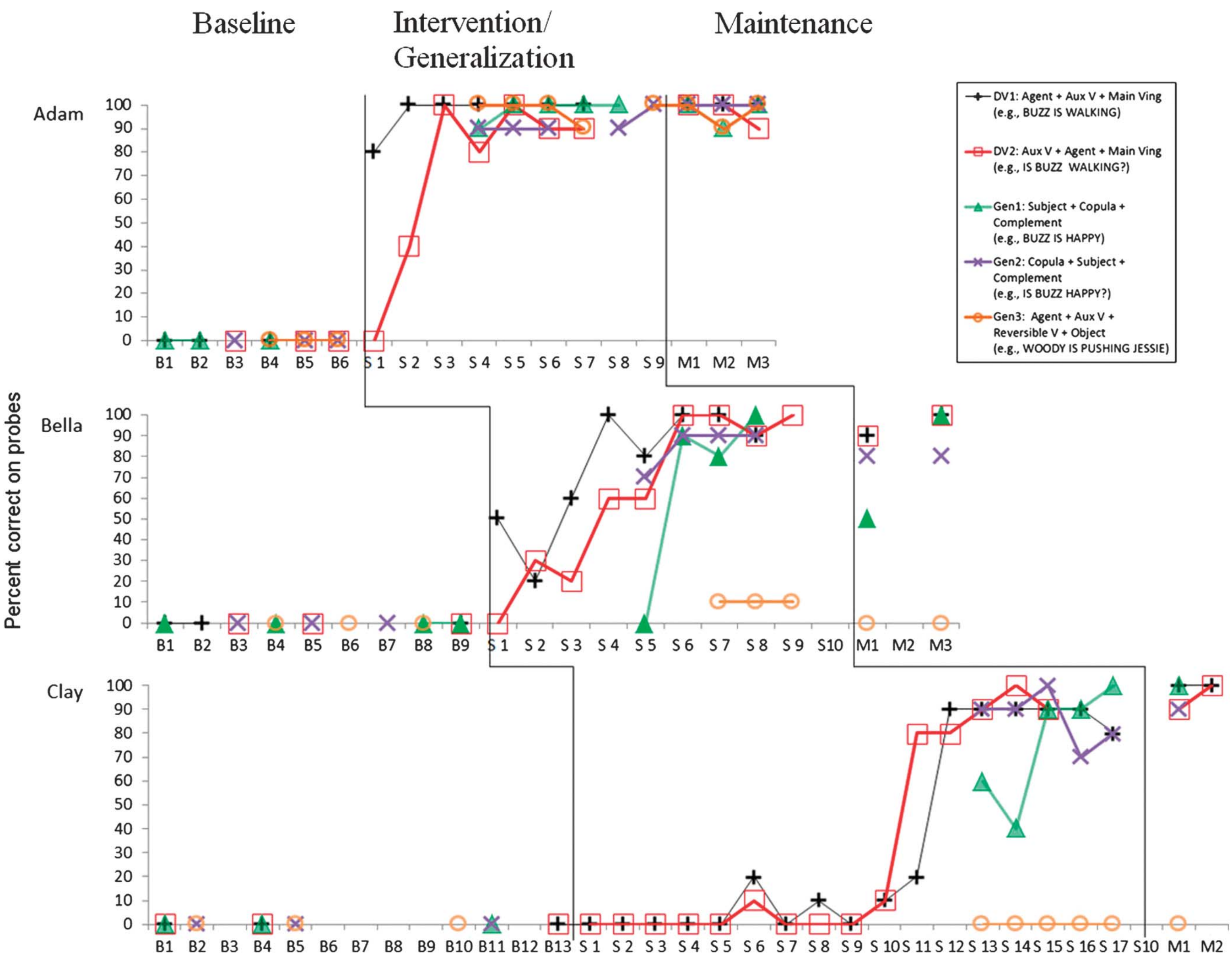
Figure 1 depicts the participants' performance on probe measures throughout the study. None of the children produced the dependent or generalization targets during baseline (0% production for each child across three sessions for Dependent Variables 1 & 2 and Generalization Variables 1, 2, & 3), and all three children mastered the two dependent targets during intervention. All three participants also evidenced high levels of accuracy for Generalization Variables 1 and 2 after achieving mastery of the dependent measures. Adam was the only child to demonstrate generalization to the Generalization Variable 3, Subject + is + Verbing + Object. All participants continued to use the targeted structures and mastered generalization sentences with increased levels of accuracy during the maintenance phase (i.e., 90%–100% accuracy for dependent variables & 50%–100% for generalization variables).

The average IRDs between the baseline phase and the intervention phase for Dependent Variables 1 and 2 was 75.69% across the three participants, indicating that the intervention had a large effect for all children (Parker et al., 2009). The individual IRD scores were as follows for Adam, Bella, and Clay, respectively: 92.86%, 84.21%, and 55.56%. The IRD between the baseline and generalization probes for Generalization Variables 1 and 2 was 97% across participants, indicating that the intervention had a very large effect for all children (Parker et al., 2009). As evidenced in Figure 1, the first participant, Adam, was the only participant who demonstrated generalization to Subject + is + Verbing + Object; IRD scores for Adam, Bella, and Clay were 100%, 0%, and 0%, respectively. The IRD between the baseline and maintenance phase was 100% across the three participants, indicating that the intervention had a lasting effect for all children (Parker et al., 2009). Because of scheduling conflicts related to school vacations and family travel schedules, Bella and Clay completed only two of their three maintenance sessions. In addition, Clay's loss of interest in probe activities did not allow all measures to be collected during his maintenance sessions.

### *Immediacy of Effect and Error Analyses by Participant*

As depicted in Figure 2, the three participants evidenced: (a) similar percentages of dependent variable error

**Figure 1.** Percentage of accurately produced dependent and generalization targets. Each data point represents the percentage of accurately produced targets on the basis of 10 probes per target.



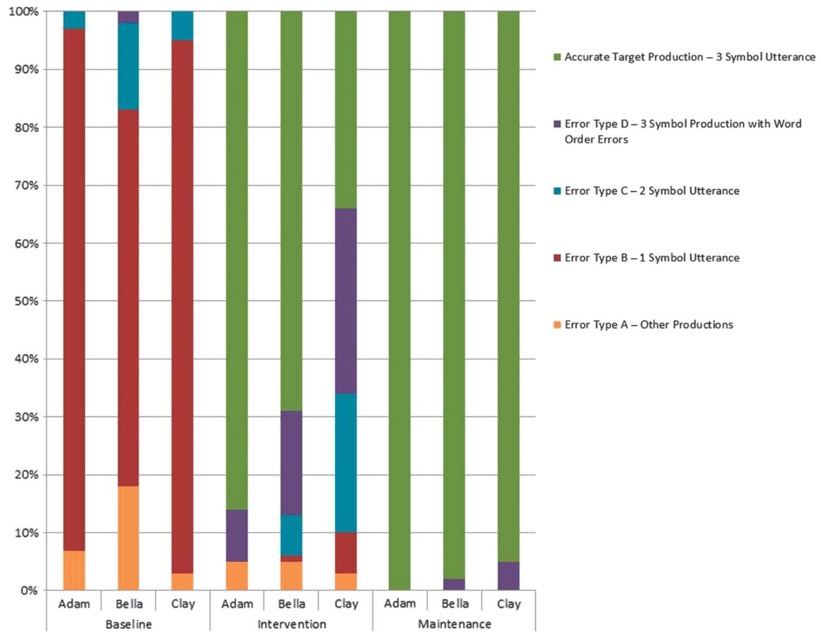

types and accurate SGD productions during baseline (80%–97% one- or two-symbol utterances & 0% accurate target productions) and maintenance phases (<10% three-symbol utterances with word-order errors & >90% accurate target productions), and (b) varying error-type percentages during the intervention phase.

As shown in Figure 1, Adam demonstrated improvements immediately following the commencement of the intervention program; within three instructional sessions, he evidenced consistent mastery at criterion level (minimum of 80% accuracy for Dependent Variables 1 and 2 sentences) as well as all generalization sentences. As depicted in Figure 2, Adam progressed from predominantly producing single-symbol utterances (92% of productions) in Baseline to producing three-symbol utterances during the Intervention Phase for Dependent Variables 1 and 2. During the first few Intervention Phase probe sets, 14% of Adam's productions contained errors, including 9% with word-order errors within three-symbol utterances; Adam then reached criterion levels of accurate target production for Dependent Variables 1 and 2.

The second participant, Bella, also evidenced immediate improvements following commencement of the intervention program (see Figure 1). However, a few more intervention sessions were required before she mastered the intervention targets and the Subject + is + Complement sentences. Bella did not generalize to Subject + is + Verbing + Object sentences. As indicated in Figure 2, Bella progressed from predominantly producing single-symbol messages and two-symbol utterances in baseline to still producing a few two-symbol utterances and then predominantly producing three-symbol messages with word-order errors in intervention prior to reaching mastery of the targets.

As depicted in Figure 1, Clay did not show an immediate effect; performance on probes for the dependent measures began to improve in the sixth probe sessions, with

**Figure 2.** Percentage of dependent variable error types and accurate SGD productions by participant across study phases. Other Productions = perseverative, unrelated, and 4+ symbol SGD productions.




greater than 80% accuracy achieved in the 11th session for Dependent Variable 2 and in 12th session for Dependent Variable 1. Like Bella, Clay did not generalize to the final generalization target (Subject + is + Verbing + Object). Figure 2 shows that Clay exhibited a much higher percentage (66%) of erroneous productions during the intervention probe sessions in comparison to Adam's 14% and to Bella's 31% intervention probe error percentages for the dependent variables. Thirty-four percent of Clay's dependent variable intervention probe productions were accurate, and his erroneous productions were distributed across the examined error types as follows: Type A errors (other productions): 3%; Type B errors (one-symbol utterances): 1%; Type C errors (two-symbol utterances): 24%; Type D errors (three-symbol utterances): 32%.

## Discussion

The instructional program yielded positive results for all participants. Each child progressed from producing none of the targets before entering the intervention phase to producing both of the main dependent variable sentences with high levels of accuracy over an extended period of time. In addition, all participants evidenced high levels of generalization to a sentence target of similar length and structure, and one participant evidenced generalization to a lengthier target. These findings indicate that the participants learned to produce rule-governed sentences using aided AAC. Potential reasons for the success of the program, details of the learning patterns and outcomes for individual participants, overall implications, and future research direction are discussed in the next sections.

### *Instructional Content and Context*

Given that a multicomponent approach was used for intervention, it is not possible to identify the individual impacts of each of the instructional components. However, the literature suggests that each component of the intervention could have potentially contributed to the positive changes in the participants' expressive language.

As indicated previously, providing concentrated models has been shown to facilitate production of grammatical rules in children with language disorders (Courtright & Courtright, 1979); therefore, it is expected that adapting this approach for use with children using AAC through the incorporation of aided models helped with making the targeted sentences highly salient (Binger & Light, 2007). Further, the incorporation of aided modeling, contrastive targets, and systematic prompting within structured play activities that were meaningful to the children and afforded opportunities for the clinician to follow the child's lead and provide scaffolding would be expected to contribute to the effectiveness of the intervention on the basis of previous findings (e.g., Binger & Light, 2007; Binger et al., 2011; Smith & Grove, 2003). Identifying the specific content and context of the instruction implemented in the current investigation could afford significant advances in AAC intervention because previous findings have indicated that children have struggled to produce specified sentences using SGDs when structured instruction is not implemented (e.g., Sutton et al., 2002; Trudeau et al., 2007).

### *Participant Learning Patterns*

The three participants readily learned to produce the targeted sentences, but their learning patterns differed. The first participant, Adam, evidenced improvements immediately following the commencement of the intervention program, and within three instructional sessions he achieved mastery (minimum of 80% accuracy for Dependent Variables 1 and 2 sentences) as well as generalization to generalization targets. This participant had receptive language skills that were well within normal limits (see Table 1) and did not present with any other obvious mitigating factors.

Results indicate that a limited amount of clear and focused instruction was sufficient to teach this participant to translate his existing mental representations of the targeted sentences onto the SGD, yielding the production of accurate aided utterances. The error analyses (see Figure 2) indicated that Adam took a short period of time to resolve word-order issues for the targets requiring three-symbol productions; Adam produced both the declaratives and questions in the same manner (e.g., *BUZZ IS LAUGHING*) during the first probe set following the start of the intervention and then rapidly realized the need to invert word order for the questions (e.g., *IS BUZZ LAUGHING?*).

The second participant, Bella, also evidenced immediate improvements following the start of intervention program. However, it took somewhat longer for her to master the dependent and first generalization targets. Unlike Adam, Bella did not evidence generalization to the longer generalization target. Also unlike Adam, Bella's receptive language skills were below normal limits as evidenced by percentile scores ranging from 5 to 16 on the Peabody Picture Vocabulary Test–Fourth Edition (PPVT-4; Dunn & Dunn, 2007) and TACL-3 (see Table 1). Error patterns evident during the time this participant appeared to be acquiring the targeted sentences suggested she experienced a more gradual progression from producing single symbol utterances and some two-symbol utterances through an experimentation phase with word order for both the targeted question and statements in the form of three-symbol utterances. As indicated in Figure 2, Bella was producing one-symbol and some two-symbol utterances during baseline. She continued to produce some two-symbol messages during the first three intervention probes and then began producing both the declaratives and questions in the same manner (e.g., *BUZZ IS LAUGHING*); following the sixth intervention session, she began changing the word order to produce the targeted question form accurately (e.g., *IS BUZZ LAUGHING?*).

The third participant, Clay, did not evidence immediacy of effect and did not evidence generalization to the lengthier generalization sentences. Initial consideration of Clay's graphed results in Figure 1 may prompt questions relating to intervention effectiveness for this participant. However, Clay's graphed results present an incomplete picture of his learning process. As suggested in Figure 2, error patterns for Clay included a stepwise approach to learning to produce the targets. He moved from producing predominantly single-symbol utterances during baseline through the following production stages during intervention: (a) producing two-symbol utterances (i.e., Subject + Verb; and Verb + Subject), (b) producing three-symbol utterances initially with word-order errors, and then finally (c) accurately producing three-symbol utterances for the targets by the 12th intervention session.

In addition, Clay's PPVT-4 and TACL-3 receptive language scores seemed to indicate some relevant splinter skills with average percentile scores on the grammatical morpheme (63rd percentile) and elaborated phrases and sentences (50th percentile) subtests of the TACL-3. In light of these scores, it might have been expected that Clay would have experienced more rapid learning. However, Clay's standardized test results also revealed significant delays in the area of receptive vocabulary skills (14th percentile on PPVT-4 and 25th percentile on TACL-3), and it should be noted that Clay experienced notable issues with suspected seizure activity during his intervention and probe sessions. During these sessions, Clay frequently experienced extended periods of fixed distant gazing. Clay often then turned to the interventionist with a confused look on his face or asked "What?" when these episodes concluded. At those times, it was necessary to reorient Clay to the tasks at hand. During the study, Clay's family was encouraged to pursue testing relating to the suspected seizure disorder. Several months following conclusion of the investigation, related medical issues were still reported to be under investigation, and an additional diagnosis of central auditory processing disorder was made.

Although participants took varying amounts of time to master the dependent measures, all participants achieved a high level of success across time, providing support for the effectiveness of the implemented intervention approach. Further, the fact that the three participants demonstrated the ability to produce novel sentences is at least suggestive of the children having learned to use the linguistic rule of inversion to generate questions using simple inversion on their SGDs, rather than simply memorizing how to produce only the targeted symbol sequences on a SGD.

### *Overall Relevance and Theoretical Implications*

As described in the introduction, previous studies have indicated that directly targeting message length and word order can result in positive changes in children's language expression. However, very few AAC studies to date have been designed to target rule-governed sentences with children. In addition, the positive results of this investigation are noteworthy because teaching children using AAC to ask novel questions could provide an additional option to help address a frequently noted tendency for these individuals to play passive communication roles (e.g., initiate few interactions, respond only in obligatory contexts; see, e.g., Kent-Walsh & McNaughton, 2005).

Focusing on the two productive language elements inherent in the present investigation (i.e., that both the *individual words selected* and the *order of production* of the selected words affect the message that is ultimately produced via aided AAC) also may have notable implications in assisting children using AAC in taking the necessary step of moving from a modality-specific approach to a translation approach to expressive communication via aided AAC (Sutton et al., 2002). When learning to produce sentences such as those targeted in the present intervention, the children practiced creating sentences in which each symbol matched its spoken language equivalent to convey a clear meaning. The generalization findings of the current intervention suggest that this intervention had a broader effect on the children's ability to express language using an SGD.

That is, two distinct types of generalization were addressed. First, by virtue of teaching the children how to invert simple yes/no questions, each of the three participants generalized productions to untargeted simple declaratives and yes/no questions containing copulas. Also, the first participant produced lengthier subject–verb–object sentences, which contained reversible verbs, such as *BUZZ IS PUSHING BULLSYE.*

Adam's profile may help explain his ease with generalization; his receptive language skills were strong, with language subtest scores exceeding the means for his age. It is possible that consistent with what could be expected in the context of the translation hypothesis, this intervention program seemed to afford him the necessary practice in creating sentences in which each symbol selected using the SGD had to match its spoken language equivalent in the appropriate order to convey a clear meaning. In this manner, Adam was able to map messages for which he already had firm mental representations onto graphic symbols and to generalize to: (a) similar sentences containing copula *is* (e.g., *JESSIE IS HAPPY; IS JESSIE HAPPY?*), and (b) lengthier subject–is–verbing–object sentences with reversible verbs (*JESSIE IS PUSHING BUZZ; BUZZ IS PUSHING JESSIE*).

It is possible, then, that Adam's previously held, strong mental representations of the sentence types under investigation, coupled with his strong overall receptive language skills, set him apart from the other two participants in the study. Some of the nuances evident in Bella and Clay's individual error and learning patterns suggest that individual differences in the profiles of the participants in the current investigation may have influenced the outcomes. In particular, distinctions between age-appropriate receptive language skills and delayed or disordered receptive language skills, in addition to other mitigating factors such as loss of attention due to additional medical diagnoses and/or language processing issues should be considered. Bella and Clay's more stepwise progression from producing one-symbol to two-symbol messages, followed by three-symbol messages that first contained word-order errors before attaining the targets, indicated that they were learning various aspects of aided language production related to the modality-specific hypothesis while also learning the targets themselves through the intervention process. The process appeared to take longer, because they needed to engage in more learning than simply translating what they already knew into aided productions with SGDs. In other words, they may have been learning how to produce the messages using SGDs without the benefit of previously held strong mental representations. Future investigations will require further consideration as to the difference in generalization experienced between the first participant as compared to the second and third participant.

### *Limitations and Future Research Directions*

The limited sample size is a potential limitation of the current investigation in light of only three children using AAC participating. Future research in this area must include replication with a larger number of participants. Findings from the current study indicate the potential importance of clearly differentiating between children with and without receptive language impairments. Further examination of groups of children with primary diagnoses of motor speech disorders, such as CAS and dysarthria, accompanied by age-appropriate receptive language skills (akin to Participant 1 in the current investigation) versus children within more broad disability categories accompanied by delayed/disordered receptive language and/or cognitive skills could afford more finely detailed clinical and theoretical implications.

Further, given that implementation of this type of instructional program has the potential to quite broadly influence approaches to language intervention for children using AAC, future efforts to closely examine potential acquisition of more specifically defined linguistic goals will be important next steps in this line of research. In other words, taking measurements to examine additional dependent variables, which go beyond Subject + is + Main Ving and Subject + is + Complement sentences, would afford more definitive conclusions relative to linguistic rule acquisition. Examining varying linguistic aspects such as tense, person, and number could be helpful in this regard. Empirically validating the effectiveness of targeting specific categories of linguistic rules also would be beneficial. For example, children may quickly learn to produce various common, rule-based sentences containing a range of semantic–syntactic categories, such as agent–action–object and possessor–entity, and then generalize use of these structures to novel sentences types.

## Conclusions

This investigation provides new information on the effects of expressive language-based interventions for children using AAC. This study contributes to the field by validating intervention techniques for teaching children using AAC to use specific sentence structures. Theoretically, this study provides preliminary evidence that highlighting both the necessity of producing each word in a sentence and the importance of word order may have generalizable effects on linguistic output. This investigation is expected to be the first of a line of investigations to evaluate the impact of an intervention approach that could have far-reaching clinical and theoretical implications.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