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Using Dynamic Assessment to Assess Syntax with Five-year-olds Using Augmentative and Alternative Communication

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USING DYNAMIC ASSESSMENT TO ASSESS SYNTAX WITH FIVE-YEAR-OLDS USING AUGMENTATIVE AND ALTERNATIVE COMMUNICATION

by

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BACHELOR OF ARTS

THESIS

Submitted in Partial Fulfillment of the
Requirements for the Degree of

Master of Science
Speech-Language Pathology

The University of New Mexico
Albuquerque, New Mexico

July, 2014

Acknowledgements

This research was supported with funds from the ASHFoundation, NIH, and internal grants at the University of New Mexico: NIDCD R03 Grant 1R03 DC011610-01A1. Foremost, I would like to express my sincere appreciation and gratitude to my thesis advisor, Cathy Binger, whose expertise, knowledge, and continued support throughout all stages of this thesis have been invaluable and have greatly contributed to my graduate experience. I would like to thank her for her confidence in my abilities, her enthusiasm for research, and for helping to inspire and shape my interests and goals. In addition, I owe an enormous debt of gratitude to my thesis committee members, Philip Dale, Barbara Rodríguez, and Janet Patterson for contributing their knowledge, time, and expertise to this thesis. Many thanks also to the exceptional undergraduate and graduate students of the UNM AAC lab: Eliza Webb, Lindsay Mansfield, Elijia Buenviaje, Jamie Ragsdale, Merissa Ekman, Maja Whitaker, Victoria Ortega, Emily Heisler, and Nathan Bickley. Without their dedication and hard work over the last two years, this thesis would not have been possible. I am also deeply indebted to my aunt Carol and my siblings, for their unwavering encouragement, support and love. In addition, I want to express my gratitude to my fellow graduate students in the speech-language pathology program at UNM for their support and for contributing to such a rewarding graduate experience. Finally, I am very grateful for the children who participated in this study and their families whose cooperation and dedication made this research possible.

Using Dynamic Assessment to Assess Syntax with Five-Year-Olds using Augmentative and Alternative Communication

Marika King

B.A., Speech and Hearing Sciences, University of New Mexico, 2012

M.S., Speech-Language Pathology, University of New Mexico, 2014

Abstract

Purpose: The purpose of this study was to examine the readiness of 5-year-old children to produce semantic-syntactic structures via a graphic symbol-based augmentative and alternative communication (AAC) device during a dynamic assessment (DA) task and whether performance during DA was predictive of performance on a subsequent experimental task.

Method: This study included four 5-year old children who demonstrated normal receptive language and limited speech intelligibility. The participants received DA, using a graduated prompting framework, for 6 semantic-syntactic targets followed by a static experimental task. Measures included amount of support required to produce the targets, modifiability within a DA session, and predictive validity of DA.

Results: DA tasks revealed that participants accurately produced target structures with varying amounts of support. In general, participants were successful across all targets with minimal-to-moderate supports. Results indicated that modifiability within DA sessions was evident for some participants, and partial support was provided for the measures of predictive validity.

Conclusions: Findings indicated that DA was a viable measure of preschool children's ability to sequence simple, rule-based messages via aided AAC. Production of multi-symbol messages is a critical step to achieving generative language abilities in children who use AAC. Thus, the findings of this study have significant implications for improving the language outcomes of this population. Further implications and theoretical and clinical applications are discussed.

KEY WORDS: augmentative and alternative communication (AAC), dynamic assessment (DA), graduated prompting, modifiability, semantic-syntactic relations

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Children who require augmentative and alternative communication (AAC) are a heterogeneous population possessing a wide range of speech, language, and cognitive abilities. Typically, these children present with severe congenital motor speech impairments and consequently are faced with significant communication challenges (Binger & Light, 2006). These communication challenges, including difficulties with syntax and morphology, may persist into adulthood (Lund & Light, 2007), thus creating long-term public health problems and compromising future educational and vocational outcomes. Failure to receive appropriate AAC solutions contributes to the aforementioned problems.

Language Profiles of Children who Use AAC

It is widely acknowledged that the generative language abilities of children who rely on AAC are often limited. These limitations frequently manifest through difficulties with expressive syntax. Predominately, one or two word messages are used in both spontaneous and elicited communication (e.g., Binger & Light, 2008; Soto, 1999; Sutton & Morford, 1998). In addition, many children demonstrate difficulties using correct word order when communicating via a graphic symbol-based device (Binger & Light; Sutton, Soto & Blockberger, 2002; Sutton, Trudeau, Morford, Rios & Poirier, 2010). Furthermore, lack of communicative opportunities and an excessive use of yes/no questions by communication partners often restrict the generative language abilities of people who use AAC (Light, Binger & Kelford Smith, 1994). Studies also have found that children who require AAC often demonstrate a wide receptive-expressive language gap—that is, their standardized scores for expressive vs. receptive language often are dramatically different (Binger, Kent-Walsh, Ewing & Taylor, 2010; Kent-Walsh, Binger

& Hasham, 2010). Such a gap indicates that it may be possible to see significant and rapid improvements in expressive language once children are provided with viable communication modes. In order to address this issue, AAC researchers have proposed the modality specific hypothesis and the translation hypothesis (the latter of which is also known as the transposition hypothesis) (Sutton et al., 2002; Trudeau, Sutton, Dagenais, de Broeck, & Morford, 2007). Examination of these hypotheses can help to further explain the unique language production patterns that are often present in people who communicate via graphic symbols.

Modality specific and translation hypotheses. Little is known regarding the language acquisition and production of children who primarily use graphic symbol modalities to communicate, and research in this area is fairly recent compared with spoken or signed languages. However, AAC researchers agree that producing spoken utterances and using graphic symbols to create utterances are inherently different tasks (Soto, 1999). The modality specific and translation hypotheses can help explain why similar communication patterns—such as unconventional word order and telegraphic messages—exist across the diverse population of people who use AAC. Although not mutually exclusive, researchers in AAC have developed these hypotheses to further explain the relationship between spoken and graphic symbol utterance structures. Clearly, more research is needed in this area to help elucidate these questions.

Modality specific hypothesis. The modality specific hypothesis states that there are inherent biases specific to graphic symbol communication modalities which influence the construction of messages and may contribute to language acquisition difficulties in children who use AAC (Smith, 1996; Soto, 1999; Sutton & Morford, 1998). These limitations may include the following: grammatical morphemes are excluded from some AAC devices, a restricted range of vocabulary is available on the device, and message production time is delayed due to a lagging voice output.

Because communication via graphic symbols is considered a visual modality, parallels have been drawn between graphic symbol communication and signed languages (e.g., Nakamura, Newell, Alm & Walter, 1998; Smith, 1996; Soto, 1997; Sutton & Morford, 1998; Trudeau et al., 2007). Structural characteristics of signed language have been studied extensively, revealing differences between the auditory-oral and visual-gestural modalities (e.g., Chamberlain, Morford & Mayberry, 2000; Lepot-Froment, 2000; Petitto, 1987). Observations from these studies suggest that it would be reasonable to expect restrictions in the graphic symbol modality to be similar to constraints typical of signed modalities. For example, under certain conditions, American Sign Language (ASL) uses object-subject-verb constructions, as opposed to the subject-verb-object structures that are common in spoken languages. Using object fronting in ASL, can help to emphasize the object and set the topic when using visual modalities (Braze, 2004).

Similarly, communication via graphic symbols may involve word order effects specific to visuospatial modalities. However, Sutton et al. (2002) noted that although individuals who use AAC to communicate often use nonconventional word order patterns, it is not yet clear whether parallels regarding structural similarities can be drawn between the two modalities. It is important to note that researchers analyzing the word-order patterns of individuals using graphic symbols to communicate have found that while some individuals exhibit consistency with their word order patterns, these patterns may not be consistent across individuals (e.g., Sutton et al., 2010; Trudeau et al., 2007;

Trudeau et al., 2010). In order to gain communicative competence, individuals who rely on graphic symbols to communicate must understand the relationship between symbol sequences and their spoken counterparts. However, the inherent constraints of the visual modality may make this skill more challenging.

Translation hypothesis. The translation hypothesis states that an individual will first construct a mental representation of a message in what would be their spoken language when communicating via graphic symbols. The individual then will "transpose" or "map" the internal representation of the message onto graphic symbols as an external expression (Trudeau et al., 2007). This means that the message will likely be restricted by the semantic limitations of the graphic symbol-based device (Smith, 1996; Smith & Grove, 2003). However, constructing a message using sequences of graphic symbols goes beyond the one-to-one correspondence between graphic representations and their referents. That is, the grammatical relationship of each semantic-syntactic category that makes up the mental representation must be understood as well in order to go beyond the level of single symbols and to convey the complete message using graphic symbols (Sutton et al., 2010). In contrast, the modality specific hypothesis states that graphic symbol modalities may have their own set of linguistic and grammatical rules; that is, as visual-graphic communication modalities, graphic symbol-based speech generating devices (SGDs) may have their own, "aided AAC grammar."

Studies related to the modality specific and translation hypotheses. Although not specifically designed to prove these hypotheses, several studies have been conducted which have implications for both the modality specific and translation hypotheses. These studies have explored the graphic symbol productions of both adults and children with disabilities and those with typical language development (Binger & Light, 2007; Smith, 1996; Sutton, Gallagher, Morford, & Shahnaz, 2000; Sutton & Morford, 1998; Sutton, Morford, & Gallagher, 2004; Sutton et al., 2010;Trudeau et al., 2007). Many of these studies have found that adults and children frequently use different constituent order when producing utterances using graphic symbols.

Two recent studies specifically analyzed the graphic symbol utterances of typically developing individuals. In one of the larger studies of its kind, Trudeau et al. (2007) analyzed the use of SGDs by 30 children (7;0 – 8;11 years old), 30 teenagers (12;0 – 13;11 years old), and 30 adults (age 18 and older) without disabilities. In this study, participants viewed photographs representing both single proposition sentences (e.g., *The girl pushes the clown*) and complex proposition sentences (e.g., *The clown who pushes the girl who wears a scarf*). While viewing each photograph, the researcher read a sentence that described the target photo. Once the sentence was read, the participant was asked to construct the corresponding messages using graphic symbols on an SGD. The graphic scene display included 10 symbols (line drawings) representing the eight target vocabulary items (e.g., *GIRL*[1], *CLOWN*, *PUSH*) and two operational symbols (*NEXT*, *DELETE*). Prior to beginning the experimental condition, participants were first required to correctly identify all symbols on the display and were given a familiarization task. This task was similar to the experimental condition except the configuration of vocabulary differed (e.g., *The boy pushes the girl).* Responses during this phase were not judged for accuracy.

[1] Following standard practice within AAC, spoken messages are italicized and graphic symbol productions are shown in capital letters and italicized (Beukelman & Mirenda, 2013).

Results of the study revealed that all but one participant consistently produced simple sentences (subject-verb-object) using constituent order that adhered to the spoken message. However, it was noted that for all age groups, the variability of constituent order and consistency of patterns increased as sentence complexity increased. High rates of syntactic variability were observed both within and between participants. The authors also noted that the youngest children experienced the greatest difficulty with accurately constructing graphic symbol messages. Thus, they concluded that although 7- and 8-year-olds are able to transpose simple graphic symbol messages, they lack the metalinguistic abilities to do so for more syntactically complex messages.

Sutton et al. (2010) completed a similar study with typically developing preschool-aged children. Participants in this study included 30 children who were native speakers of French between the ages of 3 and 4. The children were asked to describe pictures representing simple agent-action-object messages (e.g., *GIRL PUSH CLOWN*) using Picture Communication Symbols (Johnson, 1994). In order to construct a message, participants were required to select graphic symbols and then sequence the symbols on a Velcro easel. Participants initially received training and familiarization of the task. After ensuring that they could identify the symbols correctly, they received four practice trials using the same vocabulary as in the experimental tasks but in different configurations. Before each practice trial, the examiner demonstrated how to select the symbols that corresponded to a spoken message and then demonstrated how to sequence them. Following the examiner's model, the participants were provided with the same stimuli and asked to imitate the examiner's message. Participants were not required to produce a specific sequence of symbols to pass the familiarization task.

Results from the experimental tasks indicated that for these children, translating the spoken message onto graphic symbols was not a straightforward assignment. Of the symbols that the participants selected, the majority contained the target vocabulary and about half were complete (i.e., contained all appropriate target symbols). However, a wide variety of symbol sequences were observed, with less than one-third following spoken word order. The authors also noted that consistency in constituent sequencing was variable both across and within participants. In addition, the participants who responded consistently did not do so in the same way. For example, some children consistently produced agent-patient structures (e.g., *GIRL CLOWN)* while others consistently produced agent-patient-action structures (e.g., *GIRL CLOWN PUSH).* The authors concluded that preschool children do not possess the metalinguistic skills necessary to produce simple messages using graphic symbols but do demonstrate emerging competence to communicate via the graphic symbol modality. It is important to recognize that although the children did not consistently adhere to semantic-syntactic rules, many children were able to produce ***two***-term utterances using correct word order via the graphic symbol modality. Further, instability in production patterns may be a precursor to developing a new skill (Siegler, 1994). Thus, the variability within some children's response patterns may have indicated that the children were engaged in learning how the spoken words could be represented via graphic symbols.

The findings of Trudeau et al. (2007) and Sutton et al. (2010) offer partial support for both the modality specific and the translation hypotheses. With regard to the modality specific hypothesis, both studies demonstrated that the participants frequently created messages using graphic symbols that did not adhere to spoken word order. Participants did not consistently map graphic symbol messages in a one-to-one correspondence with the spoken counterpart, suggesting that their messages were restricted by the graphic symbol modality. Evidence of a consistent word order pattern reflecting the limitations of the graphic symbol modality would provide support for the modality specific hypothesis. However, a high amount of variability was apparent across and within participants (particularly in the preschool study), indicating that patterns inherent to graphic symbol message construction—a key tenet of the modality specific hypothesis—were not manifested in the data. This finding is consistent with previous studies in this line of research which found no evidence for an inherent aided AAC grammar that is reflective of the restrictions of the graphic symbol modality (Sutton et al., 2000; Sutton et al., 2004).

On the other hand, there is emerging support for the translation hypothesis. This is evidenced by the findings of Trudeau et al. (2010) which demonstrated that older children and adults were consistently able to translate simple sentences into the graphic symbol modality using correct word order. Clearly, this task is not straightforward though: young children had difficulty when presented with simple sentences and older children and adults had difficulties sequencing more complex messages.

The previous studies describe the significant challenges associated with using graphic symbols to create multi-symbol messages that adhere to correct word order. However, findings also indicate that young children can potentially learn to communicate effectively using graphic symbols. Clearly, the development of syntactic skills to support the generative language use of children who rely on AAC is an important goal. Thus, addressing the language difficulties related to multi-symbol message production in these children is a logical initial step towards promoting development of generative language. This brings into question the importance of assessing the generative language abilities of children who rely on AAC. Identifying valid and reliable tools that can predict their future language performance is the first step in the assessment process. In the field of speech-language pathology, a variety of assessment tools are used to measure the language abilities of children, including both formal and informal procedures. As discussed below, static psychometric tests may not be the most appropriate assessment measures for children who rely on AAC.

Dynamic Assessment

Accurate assessment of the language abilities of individuals who use AAC has proven to be challenging (Nelson, 1992; Snell, 2002). For some individuals, assessment of language abilities based on standardized tests may be a questionable practice. Often the normative samples of these tests are not representative of individuals who use AAC in both sample size and participant characteristics (Soto, 1997), and in addition, language ability may be masked by the presence of a severe speech disorder. In contrast, there is emerging evidence that dynamic assessment (DA) may provide an alternative measure of language ability in individuals with severe disabilities (Olswang, Feuerstein, Pinder & Dowden, 2013; McLaughlin & Cascella, 2008). Crais (2011) noted that because DA offers a more holistic approach to assessment of learning and potential to learn, it may be a powerful tool when evaluating children with severe disabilities. However, virtually no studies to date have looked at the use of DA with populations who require AAC.

DA can be defined as “an assessment of thinking, perception, learning, and problem solving by an active teaching process aimed at modifying cognitive functioning”

(Tzuriel, 2000). This can be contrasted with static assessment (SA), which is the format of most psychometric tests, in which the examiner records responses without trying to change, modify or improve the examinee's performance (Tzuriel, 2000). In other words, SA focuses on current (or actual) performance in order to reveal strengths and weaknesses. In this manner, contextual support is minimized so that habitual performance can be isolated and examined (Olswang & Bain, 1996). Although SA can provide valuable information about a child's performance relative to a given age group, it is not designed to evaluate the learning process or to identify possible barriers to learning (Tzuriel, 2000). In addition, SA does not effectively account for learning of behaviors that may be acquired more slowly or in idiosyncratic ways. Thus, the limitations of SA are magnified when used to assess children with severe disabilities (Olswang et al., 2013).

In contrast, DA incorporates active teaching within the assessment procedures in order to observe the child's process of learning. Through implementation of planned and deliberate teaching during the assessment process, the effects of this support can be isolated and examined (Haywood & Tzuriel, 2002; Tzuriel, 2000). Furthermore, DA is designed to measure the examiner effort required to bring about the change in behavior (Peña, 2000). In contrast with SA, which measures actual performance without prompting, DA measures a child's performance or *modifiability* in a *prompt rich* environment (Bain & Olswang, 1995).

Zone of proximal development. DA is rooted in Vygotsky's socio-cultural theory of learning. Vygotsky introduced the theory of the Zone of Proximal Development (ZPD), which he defined as the difference between a child's actual developmental level and level of potential development. According to Vygotsky, this higher level of potential development is achieved through problem solving under adult guidance or in collaboration with more capable peers (Vygotsky, 1978). In other words, Vygotsky hypothesized that children perform above their initial levels when supported by an experienced adult (Tzuriel, 2000). The works of Wertsch (1984, 1985), Rogoff (1990), Feuerstein (1979), and many others provide a basic framework for the application of these principles and for the assessment and treatment of children with language impairments.

Scaffolding. The concept of scaffolding is also related to Vygotskian theory and is an important aspect of DA. Scaffolding was first introduced by Ivanova (1976) and later adopted by contemporary researchers. In this model, the experienced adult gradually changes the degree and quality of support provided to the learner as he/she becomes more proficient (Wood, Bruner & Ross, 1976). This process involves breaking the task into manageable units and fostering independence, self-regulation, and mastery by gradually withdrawing adult support (Tzuriel, 2000). In this way, scaffolding is related to DA because it provides a structured learning experience in which performance can be measured.

Mediated learning experience. Depending on the conceptual framework, scaffolding in DA is commonly achieved by one of two approaches. The mediated learning experience (MLE) is a model in which the examiner uses a variety of strategies that are designed to stimulate cognitive modifiability (Feuerstein, Rand & Hoffman, 1979). In an MLE session, DA is individualized and modified depending on the child's performance on the task. (Rogoff, 1990). Several studies have demonstrated the effectiveness of MLE in differentiating children with language impairment versus typical learners (Peña, Iglesias & Lidz, 2001; Peña et al., 2006; Ukrainetz, Harpell, Walsh, & Coyle, 2000).

A typical MLE session involves a test-teach-retest format. Peña et al. (2001) discussed the use of four integral components of an MLE teaching session first proposed by Feuerstein. These include intentionality, mediation of meaning, transcendence, and competence. An example of an MLE session designed to teach attribute-entity structures (e.g., red car) to a 3-year-old would involve an explanation of the target structure (i.e., intentionality) and its importance in providing specific descriptions (i.e., mediation of meaning). In addition, the examiner would explain to the child how confusion may result if an aspect of the target is omitted (i.e., transcendence), and finally, the examiner would provide opportunities for practice of the target and would provide feedback on the child's attempts (i.e., competence).

Graduated prompting. Graduated prompting is another model for DA, inspired by Vygotsky's socio-cultural theory (Brown & Ferrara, 1985; Campione & Brown, 1987; Resing, 1997). This approach involves helping the individual to gradually problem-solve through scaffolding using a predetermined cueing hierarchy. The amount of support required to accomplish a task is taken as an indication of the child's ZPD. Furthermore, changes in the level of support required across similar tasks are taken as an indication of transfer of learning (Tzuriel, 2000). Although less widely used than MLE, graduated prompting has potential as an effective tool in identifying a child's ability to learn specific behaviors, given a structured teaching experience.

Similar to the example of the MLE teaching session provided above, a graduated prompting session designed to teach attribute-entity structures to a 3-year-old would also involve a play-based format. Initially, an elicitation opportunity would be arranged (e.g., providing the child with several toy cars of different colors). The examiner would then provide prompts to the child, following a specific hierarchy from minimal to maximal support. For example, a prompt with the least amount of support may be an elicitation question (e.g., *Which one would you like?*) and a prompt at the highest level may be a mand/model (e.g., *Tell me, **red car***.).

Applications of DA. Vygotsky argued that measuring potential for change is just as important as measuring actual performance. Using this basic principle, researchers have applied DA to answer a range of assessment questions related to children with language disorders. Broadly speaking, DA can be used to address two main objectives: (1) identification of a disorder and (2) gaining detailed information used to inform intervention decisions (Hasson & Botting, 2010).

In the field of speech-language pathology, the issue of distinguishing language impairment in children from culturally and linguistically diverse (CLD) populations has been widely discussed, as children with CLD backgrounds are often at risk for misidentification due to lack of prior experience and exposure as opposed to possessing an underlying language disorder (Gutiérrez -Clellen & Peña, 2001; Patterson, Rodríguez & Dale, 2013). DA is commonly recommended for use with children from CLD backgrounds as it has been found to be highly useful in assisting with making this distinction (e.g., Patterson et al., 2013).

In an area more closely related to the current project, several studies have indicated that the graduated prompting approach to DA may be predictive of future communication performance in young children, particularly with regard to the productions of early syntactic structures. For example, in two similar studies, Bain and Olswang (1995) and Olswang and Bain (1996) used DA to measure the language abilities of toddlers with specific expressive language impairment. Specifically, the authors assessed whether the amount of support required to elicit two-word semantic-syntactic messages during a graduated prompting session was predictive of language performance during a subsequent intervention phase. The first study included 15 children aged 30-36 months and the second study included 30 children aged 31-36 months. Both studies produced similar results. Overall, the children's performance during DA predicted their rate of language learning during the intervention phase. Specifically, the children with lower DA scores demonstrated lower language gains within the study. Particularly in the second study, the DA outcome measure was highly correlated with language production and success during the treatment phase for the children who required intervention.

Patterson et al. (2013) noted that while graduated prompting approaches show promise for predicting performance on future language and literacy tasks (Bain & Olswang, 1995; Olswang and Bain, 1996; Bridges & Catts, 2011), examination of change within brief trials may provide an additional detailed measure of immediate change in response to prompting, or modifiability. In a study of 32 typically developing 4-year-olds with CLD backgrounds, graduated prompting procedures were used to assess performance across three language tasks. Results indicated that for two of the tasks, language performance was significantly higher on the last two items compared to the first two items among children who required a prompt on the first item (Patterson et al., 2013). These findings provide preliminary evidence for the merits of using this type of microanalysis to examine the within-task modifiability of children's language performance.

Regarding populations who require AAC, Nigam (2001) noted that dynamic methods such as the use of trial teaching in AAC evaluations have been adopted by clinicians. However, to date no known studies have been published that specifically evaluate the use of DA procedures to measure the language abilities of children who are able to communicate using graphic symbols or that examine early syntactic productions via AAC.

Rationale for Current Study

Despite the potential benefits of DA, research addressing its efficacy with populations who use AAC is limited. Specifically, no known studies have looked at its use with children who communicate using graphic symbols. In order to efficiently and effectively support the early syntax of children who rely on graphic symbols to communicate, it is important to gain an understanding of how much support they require to build generative language skills. The purpose of the current study was to examine whether 5-year-old children can produce semantic-syntactic structures via a graphic symbol-based SGD and whether performance during DA was predictive of performance during subsequent experimental task. To address deficits in both theoretical and clinical knowledge, the current study addressed the following aims:

Aim 1: To evaluate the degree of support that 5-year-old children with significant speech disorders require to create accurate semantic-syntactic messages when using single meaning graphic symbols on an SGD. For any given participant, the individual differences in the rate of change across targets were examined. A graduated prompting approach was employed to systematically measure the differences in the children's performance when provided with varying degrees of support.

Rationale: Previous research indicates that children have difficulties using syntax that adheres to spoken word order when communicating via graphic symbols (e.g., Smith, 1996; Sutton & Morford, 1998; Sutton, et al., 2010; Trudeau et al., 2007). However, these studies did not examine whether performance improves as a result of instruction. This aim addresses whether 5-year-old children are able to learn to produce semantic-syntactic structures via aided AAC during a supported learning experience in which graduated prompting is used.

Prediction: Much of the previous research (e.g., Smith, 1996; Sutton & Morford, 1998; Sutton et al., 2010) indicates that preschool children have difficulty producing grammatically complete mutli-symbol messages via graphic symbols. However, more recent studies indicate it may not be so challenging when instruction is provided (Binger, Kent-Walsh, Berens, Del Campo, & Rivera, 2008; Binger et al., 2010; Poupart, Trudeau, & Sutton, 2013). In light of this research, it was predicted that the participants would require a moderate amount of support to correctly produce the target structures.

Aim 2: To determine whether there is evidence of modifiability within brief graduated prompting tasks. The children's productions at the beginning and end of a DA task were examined to evaluate whether correct productions at lower cueing levels increased throughout the supportive experience.

Rationale: Microexamination of children's performance within tasks provides additional information regarding the rate of immediate change (Patterson et al., 2013). If children's performance improves within tasks, this has implications for identifying the child's ZPD.

Prediction: It was predicted that the participants would demonstrate modifiability within the DA sessions for each target. That is, their average performance on the final two trials within a task would be significantly better than performance on the first two trials.

Aim 3: To evaluate whether performance during DA is predictive of performance during a subsequent experimental task. The level of adult guidance required to achieve correct productions during DA was compared to performance on similar language tasks where no adult support was provided.

Rationale: This question addresses the validity of DA as an assessment tool to identify 5-year-old children's ability to create simple sentences using graphic symbols and to determine the impact of adult support on the children's performance. The predictive validity of DA has been demonstrated in other studies teaching children to produce semantic-syntactic messages (Bain & Olswang, 1995; Olswang & Bain, 1996). Determining children's ability to sequence graphic symbols to create rule-based messages is important for selection of intervention targets and for developing language expectations.

Prediction: It was predicted that the participants' performance during the DA sessions would predict their performance on a subsequent experimental task in which no additional prompting was provided. That is, children who required overall minimal levels of support during DA for a given target would be expected to have relatively high levels of success during the experimental task for the same target.

Method

General Procedures

This research was part of a larger study in the Department of Speech and Hearing Sciences at the University of New Mexico. The primary aim of this larger study was to investigate the effect of using aided modeling and contrastive targets on the productions of semantic-syntactic relations produced by preschool children via graphic symbol-based SGDs. The current study was a retrospective analysis of four children from the larger study who participated in DA prior to completing a post-DA experimental task in which no additional prompting was provided. Participants were originally recruited through contacts at the University of New Mexico Speech-Language and Hearing Clinic and through contacts in the Albuquerque and Rio Rancho Public Schools. Initial static assessments to determine eligibility included a battery of standardized tests to assess speech, language, and cognitive abilities.

Participants

The current study included the first four children enrolled in the larger study. These children were aged 5;0 to 5;11 and met the following entrance criteria: receptive language within normal limits, as defined by standard scores $\leq$ 1.5 SD below the mean (i.e., $\geq$ 78) on the *Test of Auditory Comprehension of Language-3* total score *(TACL-3;* Carrow-Woolfolk, 1999), and presence of severe speech impairments as defined by less than 50% intelligible speech in the “no context” condition of the *Index of Augmented Speech Comprehensibility in Children* (*IASCC;* Dowden, 1997). In addition, participants were required to have an expressive vocabulary of at least 25 words/symbols on the *MacArthur Communicative Development Inventories* (CDI; Fenson et al., 1993) via any communication mode (speech, sign, AAC). See Table 1 for a list of participant characteristics.

In addition to meeting criteria for speech and language abilities, the participants: (a) were monolingual English speakers; (b) demonstrated comprehension of target semantic-syntactic relations with at least 90% accuracy, based on Miller and Paul’s (1995) guidelines; (c) received no prior intervention targeting semantic-syntactic relations; (d) had vision and hearing functional for viewing graphic symbols and participating in study activities; (e) had no diagnosis of autism spectrum disorder; (f) had motor skills adequate to direct select with at least one finger on an SGD. Additional measures collected purely for descriptive purposes included: (1) *Mullen Scales of Early Learning* (Mullen, 1995), a test measuring various developmental domains including visual reception, fine motor skills, gross motor skills, receptive language, and expressive language; (2) *Peabody Picture Vocabulary Test 4th Ed.* (Dunn & Dunn, 2006), a test of receptive vocabulary; (3) *Leiter-R* (Roid & Miller, 1997), a test of nonverbal intelligence; (4) *Vineland Adaptive Behavior Scales* (Sparrow, Cicchetti & Balla, 2005), a parent interview which measures functional adaptive behaviors across various domains. Test results for static assessments are reported in Table 2. Of the four participants included in the current study, only Amy and Ben (pseudonyms used) had prior AAC experience. For the larger study, DA was conducted purely for descriptive purposes and did not affect inclusion/exclusion in the study.

Table 1

Participant Characteristics Including Chronological Age, Sex, Disability, and Prior AAC Experience

	Amy	Ben	Carmen	Darryl
Chronological age (mo.)	5;10	5:0	5;1	5;9
Sex	Female	Male	Female	Male
Disability	Suspected ataxia Severe speech disorder Suspected CP	Severe speech disorder History of TBI; Microdeletion of 7q11.22[a]	Severe speech disorder	Severe speech disorder
CDI (expressive vocabulary)	657	115	514	>86[b]
I-ASCC (no context/context)	13%/52%	0%/3%	16%/55%	35%/68%

Note. CDI = Communication Development Inventory; CP = Cerebral Palsy; I-ASCC = Index of Augmented Speech Comprehensibility in Children; TBI = Traumatic Brain Injury

[a]This deletion has been associated with autism, but data are incomplete in the research literature at this time. Ben does not demonstrate symptoms of autism.

[b]The CDI was not completed for Darryl. This number is a measure of the number of different words used in a 20-minute language sample taken at the beginning of the study and likely is a gross underestimate of his expressive vocabulary.

Table 2

Static Test Results for all Participants

	Amy			Ben			Carmen			Darryl		
	SS/TS	%ile	AE	SS/TS	%ile	AE	SS/TS	%ile		SS/TS	%ile	AE
PPVT-4	87	19	4;10	99	47	4;10	88	21	4;1	109	73	6;5
TACL-3 vocab	*7*	16	4;6	*11*	63	5;0	*7*	16	4;0	*13*	84	6;9
TACL-3 GM	*9*	37	5;3	*13*	84	6;0	*8*	25	4;3	*9*	37	5;6
TACL-3 ESP	*10*	50	5;9	*11*	63	5;3	*9*	37	4;6	*13*	84	7;0
TACL-3 total	91	27	5;3	111	77	5;5	87	19	4;5	111	77	7;7
Vineland-II Comm	100	50	--	87	19	--	83	13	--	95	37	--
Vineland-II DLS	90	27	--	101	53	--	87	19	--	95	37	--
Vineland-II Soc	90	25	--	90	25	--	75	5	--	90	25	--
Vineland-II MS	75	5	--	97	42	--	91	27	--	91	27	--
MSEL VR	**53**	62	5;9	**47**	38	4;9	**53**	62	5;6	**46**	46	5;6
MSEL FM	**35**	7	4;5	**39**	14	4;3	**43**	24	4;9	**46**	42	5;5
MSEL RL	**32**	4	4;7	**39**	14	4;3	**27**	1	3;8	**44**	38	5;5
MSEL EL	**26**	1	3;7	--	1	1;5	**22**	1	3;3	**27**	1	2;5
Leiter-R FR	98	45	--	88	21	--	103	58	--	122	93	--
Leiter-R FV	94	34	--	97	42	--	108	70	--	128	97	--
Leiter-R full IQ	94	34	--	101	53	--	106	66	--	117	87	--
Leiter-R MS	103	58	--	93	32	--	81	10	--	106	66	--
Leiter-R RM	81	10	--	84	14	--	83	13	--	81	10	--

Note. Italicized scores indicate a mean of 10, bolded scores indicate a mean of 50, and standard scores are regular font. Dashes indicate that the score was not available for the test in question. SS = standard score; TS = T-score %ile = percentile; AE = Age Equivalent; PPVT-4 = Peabody Picture Vocabulary Test—4th Edition; TACL-3 = Test of Auditory Comprehension of Language—3rd Edition; Vocab = vocabulary; GM = grammatical morphemes; EPS = elaborated phrases and sentences; Comm = communication; DLS = daily living skills; Soc = socialization; MS = motor skills; MSEL = Mullen Scales of Early Learning; VR = visual reception; FM = fine motor; RL = receptive language; EL = expressive language; FR = fluid reasoning; FV = fundamental visualization; MS = memory screen; RM = recognition memory.

Setting and Experimenters

The DA and experimental sessions were administered by the author, another SLP graduate student, and the principal investigator for the larger study (a certified SLP and the thesis student's advisor). The author and other graduate student received training prior to administration of DA and the experimental tasks by the advisor, who had over 20 years of experience working with children who require AAC and had been involved in numerous research studies designed to teach early grammar to preschool children who use AAC. All sessions were conducted at the University of New Mexico Speech-Language and Hearing Clinic in a private therapy room. The experimenter and child were either seated on the floor or at a table. Sessions were conducted approximately two times per week and lasted for approximately 60 minutes. All DA and experimental sessions were video-recorded.

Targets and Instrumentation

For both DA and the experimental task, all participants were provided with the same AAC device: an iPad (Apple, Inc.) containing the ProloquoToGo™ app. All vocabulary was programmed into this software program. Synthesized speech software from Acapela Group©, the voice output software that comes with this device, was used as voice output. The same semantic-syntactic targets were used for both DA and the experimental task. These targets included: agent-action, attribute-entity, possessor-entity, action-object, agent-action-object, and attribute-agent-action, and all targets were presented in the same order to the participants. Target vocabulary used for each semantic-syntactic structure was selected from the CDI (Fenson et al., 1993) and is presented in Table 3. Graphic symbols representing target vocabulary consisted of color photographs and line drawings from the ProloquoToGo™ app. One symbol (*falls*) was downloaded from the internet to present a more salient image than was available on the app. Separate communication pages were used for DA and experimental sessions, and each page contained all the vocabulary required for each semantic-syntactic target (see Appendices A and B). Symbols were organized using a Fitzgerald key (McDonald & Schultz, 1973), a vocabulary organization system in which graphic symbols from different semantic and syntactic classes are organized in color-coded groups from left to right with the intention of facilitating sentence construction (Beukelman & Mirenda, 2013).

Training and Familiarization

Prior to beginning DA and the experimental task, participants were required to identify the symbols on the communication pages used during the session. For example, the examiner would ask the child, *Show me monkey,* and the child would be expected to point to the corresponding symbol. A paired instructional paradigm (Schlosser & Lloyd, 1997) was used to teach any symbols in error. For this procedure, the instructor showed the symbol and referent to the child and provided a brief explanation about both. For example, to teach the symbol *JUMP* the instructor would manipulate a puppet to jump and say, *this is jump,* while simultaneously selecting *JUMP* on the SGD. Participants were required to identify symbols for each set of vocabulary with at least 90% accuracy before beginning DA or the experimental task.

Table 3

Vocabulary for Semantic-Syntactic Targets for DA

Agent-Action		**Attribute-Entity**		**Possessor-Entity**		**Action-Object**		**Agent-Action-Object**			**Attribute-Agent-Action**		
Agent	*Action*	*Attribute*	*Entity*	*Possessor*	*Entity*	*Action*	*Object*	*Agent*	*Action*	*Object*	*Attribute*	*Agent*	*Action*
Lion	cries	happy	Lion	Lion	cup	kisses	Lion	Lion	kisses	Lion	happy	Lion	cries
Monkey	jumps	sad	Monkey	Monkey	spoon	chases	Monkey	Monkey	chases	Monkey	sad	Monkey	jumps
Penguin	rides	clean	Penguin	Penguin	plate	bites	Penguin	Penguin	hits	Penguin	clean	Penguin	rides
Cow	bites	dirty	Cow	Cow	car	hits	Cow	Cow	throws	Cow	dirty	Cow	bites
Pig	hits	wet	Pig	Pig	hot dog	throws	Pig	Pig	bites	Pig	wet	Pig	hits
	climbs	dry			airplane						dry		climbs
	sleeps	big			grapes						big		sleeps
	throws	little			motorcycle						little		throws
	falls	red			bananas						red		falls
	hides	blue			bed						blue		hides

DA Session Procedures

Materials. Materials included all of the characters and objects listed in Table 3. Puppets were used to depict larger versions of the animals, and plastic figures were used for the smaller ones. In addition, materials were used to depict various conditions (e.g., water sprayer used to make the animals wet). To demonstrate actions, other simple props were used (e.g., a box for the animals to hide behind). The child was provided access to the DA communication board on the iPad.

Procedures. The DA session procedures were adapted from Olswang and Bain's (1996) procedures. DA took place within 1-hour sessions with DA for each target administered in a separate block. The total time spent completing DA for all six semantic-syntactic targets ranged from about 90 to 160 minutes across children. Ten trials were administered for each semantic-syntactic target, and the child's production at each cueing level was recorded. For each trial, the examiner used the toy animals and objects to demonstrate the target structure. For example, for the agent-action target *MONKEY JUMPS*, the examiner manipulated the monkey puppet to jump. A cueing hierarchy from least to most support was used to prompt the correct production of the target. The cueing hierarchy was as follows:

- Level A: Elicitation question/prompt
- Level B: Spoken and aided model of alternate target plus sentence completion
- Level C: Spoken model plus elicitation cue
- Level D: Direct model plus elicitation statement.

Examples of the cueing hierarchy for a given target are provided in Table 4.

Table 4

Cueing Hierarchy and Examples for Attribute-Entity Including Cueing Level, Type of Prompt and Examples

Target: *HAPPY PENGUIN* Contrast: *SAD COW*			
Level	Prompt	Example	
		Set up/Directions	Prompt
Level A:	Elicitation question/prompt	Arrange happy Penguin and sad Penguin as well as contrast puppets, happy Cow and sad Cow, in front of child. Point to the happy penguin	*Who is this?*
Level B:	Spoken and aided model of alternate target plus sentence completion	Point to sad Cow, then point to happy Penguin	*Look, this is sad Cow SAD COW and this is* ______.
Level C:	Spoken model plus elicitation cue	Point to happy Penguin	*See, this is happy Penguin. Who is this?*
Level D:	Direct model plus elicitation statement	Point to happy Penguin	*Tell me, happy Penguin HAPPY PENGUIN.*

Experimental Task Procedures

Materials. During the experimental task, the participants were provided with the same communication board as the one used during DA except for the inclusion of different characters. Instead of animals, the communication board used during the experimental task included Mickey Mouse Clubhouse characters, including Mickey, Minnie, Donald, Goofy and Pluto. In addition to the iPad containing the experimental task communication board, the participants were provided with a separate iPad containing videos depicting the target relations.

Procedures. A pool of 50 probes was developed for each semantic-syntactic target except for the action-object target, for which a pool of 25 probes was used. Only transitive verbs were used for this target, which limited the available combinations of vocabulary. Videos of Mickey Mouse Clubhouse characters illustrating the targets and foils were created and assigned to probe sets. Probe sets included 10 randomly selected probes of a given target structure and two randomly selected foils. Foils were included to ensure that the child was discriminating between the targeted structure and other depictions—in other words, to ensure that the child was not following the same pattern of message construction regardless of the target. All foils consisted of single-word naming of the characters. The foil videos involved presentation of two characters with the target character moved forward toward the camera. The examiner then pointed to the target character and provided a cloze sentence: *This is* ____. The child was expected to select the name of the character on the communication device (e.g., *MICKEY).*

To elicit the target, the examiner first showed the child the video depiction of the given semantic-syntactic target. The examiner then asked the child an elicitation question/prompt. For example, for the agent-action structure, the elicitation prompt used was, *What's happening?* and the child was expected to produce the target structure using the SGD. If necessary, the examiner also provided a spoken and gestural cue to use the device (e.g., *Tell me*, while pointing to the communication board on the iPad). The examiner did not provide feedback on the correctness of the child's production. The child's production for each trial was recorded in real time by the examiner.

Data Collection and Reduction

DA scoring. Productions at each cueing level were assigned a score of 0-4. For each trial, the child received the point value corresponding with the cueing level at which correct production of the target was achieved. Correct productions at Level A cueing (i.e., the least amount of support) were scored as 4, Level B as 3, Level C as 2, and Level D as 1. If the child failed to achieve a correct production, it was scored as 0. Additionally, cueing levels were assigned a descriptive label ranging from minimal to maximal support. Level A and B cueing corresponded with minimal support, Level C with moderate support, and Level D with maximal support.

Experimental task scoring. For the experimental tasks, the percent of correct productions for each set of 10 trials was calculated for each target.

Measures of amount of support (Aim 1). For DA, the mean level of support required for accurate productions was calculated for each target and each participant using the scoring system described above (i.e., participants' scores on the 10 trials within a session were averaged, giving a final mean score ranging from 0-4). Additionally, the amount of support that each participant required at each cueing level was calculated for each target. That is, for each participant the percent of correct productions achieved at Level A, B, C, and D were calculated as well as the percent of productions that were not produced correctly even after all levels of cueing had been implemented.

Measures of modifiability (Aim 2). For each target during DA, modifiability was calculated by comparing the child's combined performance on the first two items to their combined performance on the last two items within a task (e.g., a list of 10 trials of a semantic-syntactic target). Scoring procedures outlined above were used to determine performance at each level of cueing. For example, within a DA session for a given target, a participant's combined score of 2 on the first two trials would be compared to a combined score of 7 on the last two trials. A Wilcoxon signed-rank test, a non-parametric measure used to evaluate the difference between two treatments or conditions where the samples are correlated (Wilcoxon, 1945), was used to determine the significance of the change.

Measures of predictive validity (Aim 3). Predictive validity was addressed by comparing the children's performance during DA to their performance on the experimental task. For DA, each participant's average performance on the six targets was compared to the percent of correct productions they achieved for each target on the experimental task. In addition, the rate of change within a DA session was compared to performance on the experimental task. A growth curve model was used to provide a linear depiction of a participant's rate of change across the 10 trials within a given DA session. For each participant the rate of change, or growth curve calculation, was compared to the percent of correct productions achieved on the experimental task.

Fidelity and Reliability Measures

Fidelity measures. Following completion of DA and the experimental task, a trained research assistant determined treatment fidelity for the study by comparing the clinicians' behaviors against pre-established fidelity measures. This assistant was an upper level undergraduate student in speech and hearing sciences who was blinded to the purposes of the study and was not involved in the administration of either phase of the study. The assistant viewed 33% of the videotaped sessions for each participant. For each child, two targets were randomly selected, and fidelity measures were calculated on the corresponding DA sessions and experimental sessions for those targets. Session data were presented to the assistant in randomized order, with no indications given of which sessions occurred in which order (e.g., DA before experimental session or vice versa). In order to ensure that administration procedures were followed consistently and correctly, the clinicians' behaviors were judged on adherence to DA and experimental task administration protocols. For DA, the mean procedural reliability across participants was 88% (range = 79% - 100%). For the experimental task, the mean procedural reliability across participants was 98% (range = 92% - 100%).

Overall, results from the fidelity measures reveal that the administration protocols for DA and the experimental task were adhered to consistently, indicating that the data were reliable. Error patterns were analyzed for the one session falling below 80%, revealing that the majority of errors were due to spoken labeling of the target vocabulary during steps in which no spoken labels were indicated. For example, the Level A prompt for the agent-action-object target *Pig chases Monkey* required the clinician to demonstrate the target using the puppets and then provide the prompt, *What's happening?*. A typical error in this case constituted the clinician accidentally labeling one of the animals during this step. These errors were unlikely to have an effect on the participants' outcomes, as the complete target was not provided in these instances. The few errors observed on the experimental task were similar to those described above (i.e., providing a spoken label for one of the characters in the probes).

Data reliability. Operational definitions for coding correct and incorrect productions of semantic-syntactic targets and foils were constructed for the larger research study. To establish interrater reliability of the data, the same research assistant who completed fidelity measures used these operational definitions and re-analyzed data for 33% of randomly selected sessions from both DA and the experimental sessions. The same sessions that were used to calculate procedural fidelity were used for data reliability (e.g., for each child, two DA sessions and the corresponding experimental sessions for those targets). Interrater agreement was calculated using Cohen's kappa and was found to be 1.0 for both DA and the experimental task, indicating strong reliability in the data.

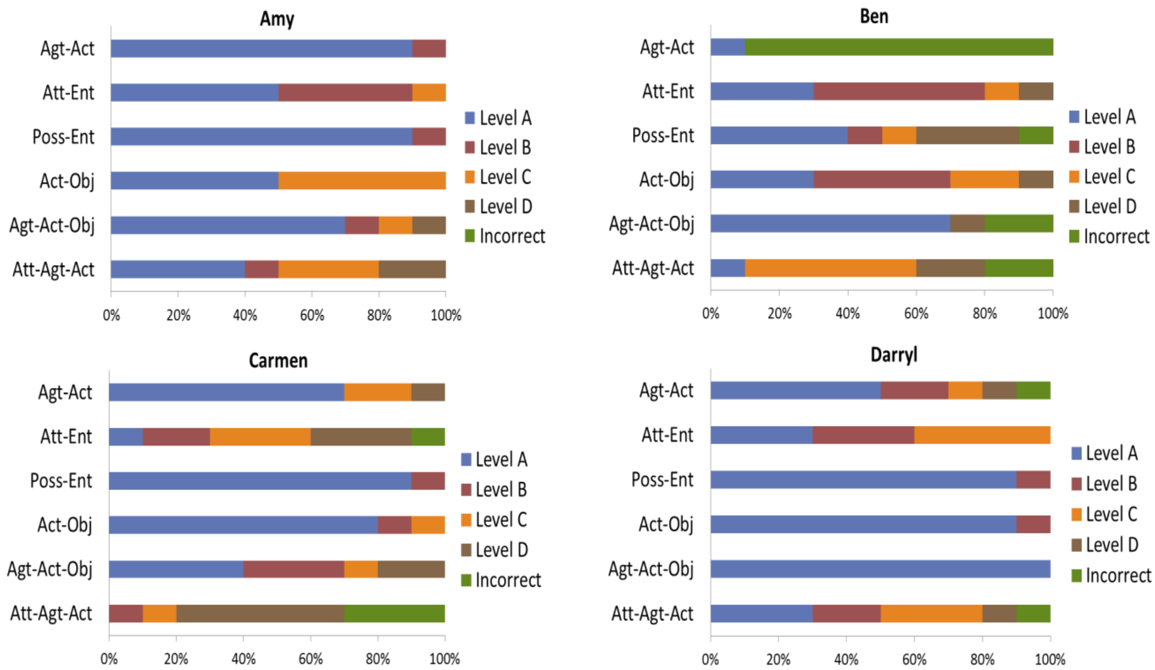
Results

Amount of Support (Aim 1)

Participant's performance at each cueing level during DA. As shown in Figure 1, the participants required varying levels of support across the six semantic-syntactic structures, although the majority of productions were correct at Levels A or B cueing. In other words, the participants frequently achieved correct productions of a given target with an elicitation question/prompt (i.e., Level A) or at the sentence completion level (i.e., Level B). Every child attained at least one correct production at Level A or B for every target with one exception: Child C for attribute-agent-action. However, across all targets, all participants required cueing from each level at some point during DA. One participant, Ben, performed more poorly than the other participants on DA and overall had more incorrect productions. It is also interesting to note that Carmen required significantly higher levels of cueing for two of the targets (attribute-entity and attribute-agent-action).

Figure 1

Participant's Performance at Each Cueing Level during DA



Across the six semantic-syntactic structures, the possessor-entity target appeared to be the least challenging. As depicted in Table 5, the mean level of correct productions across participants at Level A cueing was highest for the possessive-entity target and lowest for the attribute-agent-action target. It is worth noting that across participants, more productions were correct at Level A cueing for the agent-action-object target than for the agent-action and action-object targets. Variability in performance at Level A cueing was evident across structures, highlighting the differing degrees of difficulty across semantic-syntactic structures.

Table 5

Mean Level of Support for Correct Productions at each Cueing Level across Participants and Semantic-Syntactic Targets

	Ag-Act	Att-Ent	Poss-Ent	Act-Obj	Ag-Act-Obj	Att-Ag-Act
Level A	55%	30%	77.5%	62.5%	70%	20%
Level B	7.5%	35%	10%	15%	10%	7.5%
Level C	7.5%	22.5%	2.5%	20%	5%	27.5%
Level D	5%	10%	7.5%	2.5%	10%	17.5%

Note. Table columns do not add up to 100% because productions that were incorrect after all levels of cueing were not included.

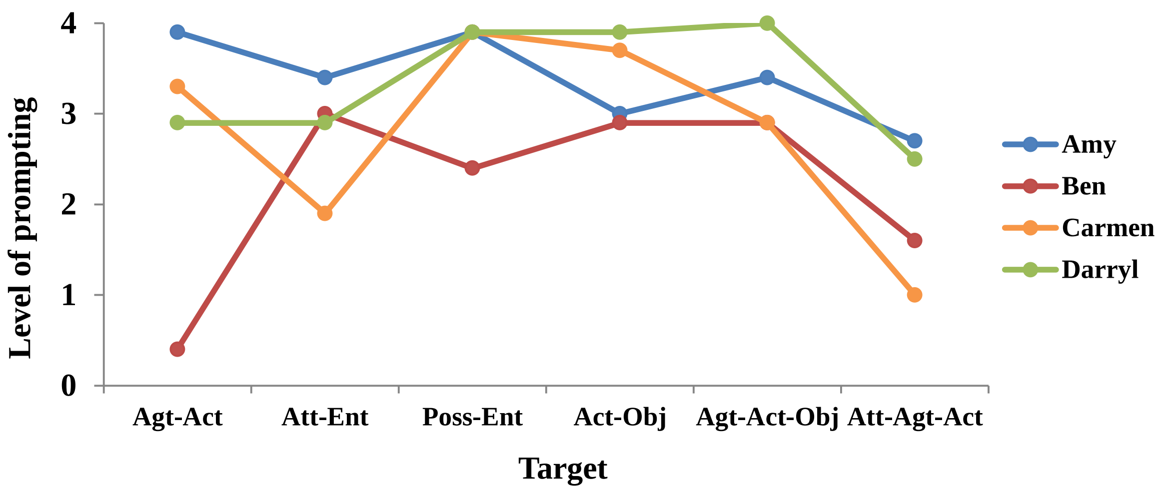
Mean Level of Support during DA. As depicted in Figure 2, the average level of support required for accurate target productions varied across semantic-syntactic structures and across participants. However, fifty percent of mean scores across participants were greater than 3.0 with the vast majority scores greater than 2.5, indicating that participants correctly produced many targets at Levels A and B. These results suggest that overall, participants produced the semantic-syntactic structures with minimal-moderate cueing. Notably, every child produced every target correctly at least once in levels A-D.

Amy's mean scores across all targets ranged from 2.7 – 3.9. With the exception of the attribute-agent-action target, her scores fell between 3 and 4, indicating that Amy generally produced the semantic-syntactic structures with minimal support. Ben demonstrated somewhat lower averages and greater variability in performance than the other participants, with mean scores ranging from 0.4 to 2.9. Carmen's mean scores ranged from 1 to 3.9, representing a wide range in performance across the targets; her poorest performance was with the attribute-agent-action target (which was the case for all four participants), and her highest performance was with the possessor-entity target. This variability highlights the differences in the amount of support that Carmen required across the targets. Finally, Darryl's mean scores ranged from 2.5 to 4, with three scores falling between 3.9 and 4 (indicating minimal support required for these targets).

Across participants, some common patterns were evident. As mentioned above, the possessor-entity target was the least challenging structure, with three of the four participants obtaining a mean score of 3.9; the exception was Ben, with a mean score of 2.4. The attribute-agent-action structure was the most challenging for the participants, with a mean score across participants of 1.95 and ranging from 1.0 to 2.7. Even though this was the last target presented to all the children, all participants demonstrated their lowest or second lowest performance on this target.

Figure 2

Mean Level of Support Required for Accurate Productions across Targets during DA



Modifiability (Aim 2)

Modifiability within DA session. As shown in Table 6, each participant's performance on the first two trials of a DA session for a given target was compared with their performance on the last two trials of that same session. A Wilcoxon signed-rank test was used to calculate change in performance with significance measured at $p \leq 0.05$. Amy and Carmen demonstrated significant modifiability; that is, they required considerably less cueing for accurate productions on the last two trials of a particular target compared with the first two trials. These results indicate that these participants learned to produce the semantic-syntactic structures within a brief learning experience. One participant, Ben, did not demonstrate significant modifiability within the DA sessions. However, his scores increased for four targets and remained the same on one and only decreased by a single point on one target. Results on this measure were not calculable for Darryl. On four out of six targets his performance on the first two trials was equal to his performance on the last two trials – and in three of these cases, his scores were at the maximum level (8). His lack of effect for DA, then, was due at least in part to a ceiling effect.

Table 6

Combined Scores on First Two Trials of DA (Max = 8) Compared with Combined Scores on Last Two Trials (Max = 8)

	Amy		Ben		Carmen		Darryl	
	First	Last	First	Last	First	Last	First	Last
Ag-Act	7	8	0	0	6	8	5	8
Att-Ent	6	8	6	8	2	4	8	8
Poss-Ent	7	8	2	4	7	8	8	8
Act-Obj	4	8	4	7	7	8	7	8
Ag-Act-Obj	4	8	4	8	4	6	8	8
Att-Ag-Act	2	6	5	4	1	3	5	5
Modifiability*	*Significant*		*Not Significant*		*Significant*		*Not Calculable*	

*****Significance measured at $p \leq 0.05$

Predictive Validity of DA (Aim 3)

Correlation between DA and experimental task. The predictive validity of DA on participants' performance on a subsequent experimental task was assessed using two different DA measures: mean level of support during DA compared with performance on the experimental task, and rate of change of performance during DA compared with performance on the experimental task. These correlations are depicted in Table 7.

Table 7

Relation between DA and Experimental Task Using Percentage of Variance (r^2)

	Amy	**Ben**	**Carmen**	**Darryl**
Mean level of support during DA and experimental task	0 trivial	.25 moderate	.30 moderate	.44 moderate
Rate of change of performance during DA and experimental task	.02 trivial	.18 small	-.10 small (neg)	.33 Moderate

Mean level of support during DA and experimental task. The first measure involved comparing the average level of support that the participants required for accurate productions during DA to the percent of correct productions on the experimental task. Using this measure, three out of four participants (i.e., Ben, Carmen, & Darryl) demonstrated a moderate correlation between mean level of support required during DA and performance on the experimental task, using ratings from Cohen (1988; see Table 7). When data were pooled across participants, the percentage of variance using r^2 was .20, indicating a moderate correlation. These results suggest that DA was predictive of performance on a similar task for some of the participants. Amy demonstrated a trivial correlation when her mean level of support during DA was compared to her performance on the experimental task. A closer analysis indicates that Amy demonstrated relatively high levels of performance during DA, but as shown in Table 8, she performed more poorly on particular targets during the experimental task. For example, on the possessor-entity target her average score during DA was a 3.9, but her percent of correct productions on the experimental task was only 10%. It should be noted, however, that her performance in subsequent identical experimental tasks (which are not the focus of this paper) improved substantially and rapidly without additional intervention. For example, on the following three experimental tasks for possessor-entity, correct productions were 10%, 30%, and 100%, respectively, indicating significant improvement by the fourth session, even though no additional instruction or cueing was provided.

Table 8

Mean Level of Support during DA and Percent of Correct Target Productions during the Experimental Task

	Amy		Ben		Carmen		Darryl	
	DA	ET	DA	ET	DA	ET	DA	ET
Ag-Act	3.9	50%	0.4	0%	3.3	10%	2.9	90%
Att-Ent	3.4	40%	3.0	10%	1.9	0%	2.9	80%
Poss-Ent	3.9	10%	2.4	30%	3.9	100%	3.9	70%
Act-Obj	3.0	80%	2.9	80%	3.7	0%	3.9	100%
Ag-Act-Obj	3.4	40%	2.9	80%	2.9	30%	4.0	100%
Att-Ag-Act	2.7	10%	1.6	60%	1.0	0%	2.5	10%

Note. DA = Dynamic Assessment, ET = Experimental Task

Rate of change of performance during DA and experimental task. As shown in Table 7, the second measure of predictive validity compared the participants' rate of change across trials within a DA session with their performance on the experimental task. Using this measure, two out of four children (Ben and Darryl) demonstrated a small to moderate correlation between rate of change during DA and performance on the experimental task. Carmen however, demonstrated a small negative correlation when her rate of change during DA was compared with her performance on the experimental task, and Amy demonstrated a trivial correlation. Interestingly, when the percentage of variance was calculated using the combined data across participants, the correlation was trivial (r^2=0), indicating that the growth curve measure may not have been a valid predictive measure for this study.

Discussion

Results of the current study provide preliminary support for the hypothesis that DA may be an effective tool for assessing 5-year-old children's readiness to create simple, rule-based messages using an AAC iPad app. In general, the participants did so with minimal-to-moderate clinical support, although the degree of support required varied across semantic-syntactic targets and across participants. Additionally, results suggest that examining a child's modifiability, or ability to improve performance within a brief, supportive experience, may be helpful in determining the amount of adult support required to achieve a task (i.e., the child's ZPD). Furthermore, findings indicate that performance during DA may be predictive of future performance on a similar task. As discussed below, these results have important theoretical implications related to the development of early syntax in children who use aided AAC.

Variability in Support Required during DA (Aim 1)

Differences were observed in the amount of support participants required to correctly produce the target structures during DA; that is, sometimes the children needed little help with producing the targets (e.g., producing the target following a question such as, *What's happening?*), and at other times, they needed more assistance (e.g., requiring a model of the target on the iPad before producing the target). Although differences were evident both within and across individuals and semantic-syntactic structures, patterns of similarity emerged as well. Three participants (Amy, Carmen and Darryl) demonstrated high levels of performance with minimal cueing (i.e., mean level of support > 3.0 on a 4-point scale) on at least three targets; that is, the participants produced the majority of the targets correctly at either Levels A or B cueing. In general, Ben required more support than the other participants and also demonstrated more variability both across targets and within sessions. His fluctuating performance may, at least in part, be attributed to frequent challenging behaviors: Ben was quite resistant to the tasks and structure of the DA sessions. For example, he often shook his head no when asked to do something or would crawl under the table and refuse to come out. These behaviors negatively impacted his performance and may help to account for the variability in his results.

It is interesting to note that although Carmen generally did not require a great amount of support to produce correct targets, she required significantly more cueing for two structures: attribute-entity and attribute-agent-action. Both of these targets include the attribute-entity relationship, and for both targets, additional analysis revealed that her errors on the attribute-entity target frequently resulted from inverting the attribute and entity elements (e.g., *PIG CLEAN* instead of *CLEAN PIG*). Specifically, 33% of Carmen's errors during DA for both attribute-entity and attribute-agent-action included an attribute-entity inversion. On the experimental task, 100% of her errors for the attribute-entity target were inversions, and 30% of errors on the attribute-agent-action target were inversions. For the latter target, other errors mainly included omission of one or more elements (e.g., *GOOFY CRY* for the target *BIG GOOFY CRIES*) and substitution of incorrect vocabulary (e.g., *BIG GOOFY JUMPS* for the target *BIG GOOFY CRIES*. In an effort to avoid the problem of attribute-entity inversions, the cloze sentence *This is*_____[*WET MICKEY*] was used as the elicitation prompt for the attribute-entity structure on the experimental task, but it is possible that Carmen may not have understood or attended to these cloze sentence prompts, thus contributing to word order errors.

Interestingly, the inverted structure (entity-attribute, such as *pig clean*) may be perceived by many listeners as more natural for some targets. An additional analysis was conducted in which 10 undergraduate students in speech and hearing sciences were asked to rate which structures sounded more natural: attribute-entity or entity-attribute. Each student was provided with a list of 10 randomly ordered pairs of sentences containing attribute-entity and entity-attribute structures (e.g., *Mickey is happy* vs. *Happy Mickey*), that used the same vocabulary as the targets used in the current study. The students were then asked to rate each sentence structure and its correlate on a scale according to how natural they thought the sentence sounded. Sentences were visually placed on either end of a scale, with ratings of *most natural* appearing on the ends followed by *somewhat natural*, and *same* appearing in the middle. The participants were provided with an example image of the target and were asked to imagine that they were receiving the prompt *tell me about this* while completing their ratings. Entity-attribute (*Mickey is happy*) was viewed as most natural by 9 out of 10 students, with participants favoring the entity-attribute construction 92% of the time. These data demonstrate that for Carmen, using the entity-attribute structure instead of attribute-entity may not have represented a true inversion; she may well have been accurately mapping her mental representations onto the iPad (Mickey is happy), without the benefit of having access to the word *is* to place in the middle of her sentences (thus, *MICKEY HAPPY*).

In addition to individual differences observed across participants, variability across semantic-syntactic targets was noted. Across the six structures, possessor-entity was the least challenging (77.5% of productions were correct at Level A; see Table 5); this is one of the earliest relations to develop (Leonard, 1976) and is typically acquired between the ages of 15 and 30 months (Brown, 1973). Additionally, it is the only one of the six targets that contains only two nouns. The visual depiction of the nouns may have been particularly salient on the communication boards—for example, color line-drawings of the Mickey Mouse characters—compared with the inherently more abstract depictions of the attributes and actions. Research suggests that young children who use AAC tend to select nouns more frequently than other parts of speech (Sutton et al. 2010; Buenviaje & Binger, 2013), and that preschoolers are more accurate selecting concrete symbols versus abstract symbols when using AAC (Light et al., 2004). Perhaps a combination of these factors helps explain this finding.

In contrast, attribute-agent-action was the most challenging target, with an average of only 20% of correct productions achieved at Level A. These findings are particularly striking, given that this was the final target presented for every child, and therefore the participants were more familiar with the task prior to beginning work with this target. Notably, however, attribute-agent-action is inherently a more complex structure: not only is this a three-term message (four of the six targets were two-term targets), it also combines two different semantic-syntactic relations: attribute-agent (*WET PIG*) + agent-action (*PIG FALLS*). Interestingly, participants had much less difficulty with the other targeted 3-term relation, agent-action-object (70% accuracy at Level A).

Several factors may help to explain the differences in performance across children and targets. As discussed above, the complexity of the target structure may have contributed to variability in performance across semantic-syntactic relations. In addition, Leonard (1976) observed that the acquisition of semantic-syntactic relations varies considerably across children, and a clear and consistent order of emergence of these relations is not readily apparent. Leonard also noted that the order of acquisition is not necessarily dependent on utterance length or type of semantic-syntactic relationship, and increasing syntactic complexity may not necessarily be reflected in utterance length. This may further help to explain the variability observed within and across participants.

Additionally, age may have contributed to differences in performance across children. Ben, who had just turned 5 when he began the study, was the youngest participant. Research assessing typically developing preschool children's ability to sequence graphic symbols suggests differences in children's ability to construct these sentences depends in part on their ages; not surprisingly, the younger the child, the more poorly they perform (Poupart et al., 2013). In a sample of 74 French-speaking children who were ages 4, 5, and 6, the authors found a significant age effect between 4-year-olds and the other two groups, and the age effect between the 5-year-olds and 6-year-olds approached significance as well. These results indicate that age may be an important factor in determining preschool-aged children's abilities to sequence graphic symbols. Although generalization of these findings to the current study is limited, the findings of Poupart and colleagues suggest that consideration of age is warranted.

In summary, it was predicted that participants would require a moderate amount of support to correctly produce the target structures. Overall, however, correct productions across participants were generally achieved with minimal support—that is, between Levels A and B for all targets except for attribute-agent-action. Although variability was evident across participants and targets, in general the findings support the argument that 5-year-old children are able to correctly sequence graphic symbols to create simple sentences with minimal-to-moderate clinical support.

Modifiability within DA (Aim 2)

Results of the study revealed mixed findings regarding participants' modifiability within a DA session. Two out of four participants (Amy and Carmen) demonstrated significant improvement within the DA sessions, and the data for a third (Darryl) suffered from ceiling effects. These outcomes indicate that rapid learning of sequencing semantic-syntactic messages can occur within a supportive learning environment for some children.

Ben did not demonstrate significant modifiability within DA, although the data indicate that on all but the attribute-agent-action target, the final two data points either increased or stayed the same. As discussed above, Ben's performance may be attributed at least in part to behavioral issues, which contributed to inconsistencies in his performance. In fact, he sometimes demonstrated an increased frequency of his challenging behaviors as DA sessions progressed—possibly due to fatigue and boredom—during the course of each session. This may explain, in part, why Ben earned zero scores in multiple cases, and why he performed higher on one of the initial trials and more poorly on the final trials (Table 6). Thus, his performance during DA may not have been a clear reflection of his ability.

Because of the mixed findings related to participants' modifiability within DA, the implications of these results are not easily generalized. The sample size (n=6) was very limited, and tied values were thrown out, further reducing the sample size. However, it is important to note that across all participants, performance on the last two trials of DA was either greater or equal to performance on the first two trials in all but one instance. Additionally, other methods may be better suited to address the notion of modifiability within a session. For example, a split half analysis (i.e., first five data points vs. last five data points) is one alternative measure that may allow for a broader analysis of modifiability by taking into account participants performance on all trials, not just the first two and last two trials. Further, a larger sample size of participants would allow for more statistically sound measures by providing a more equal distribution of performance across participants. In summary, results offer partial support for the hypothesis that participants' performance on the final two trials within a DA session would be significantly better than performance on the first two trials.

Predictive Validity of DA (Aim 3)

Mean level of support. When participants' mean level of support during DA was compared with their performance on the experimental task across targets, three out of four participants (Ben, Carmen, and Darryl) demonstrated a moderate correlation (Table 7); that is, the less support required in DA, the better the performance on the experimental task, and vice versa. These results support the hypothesis that performance during DA was predictive of performance on a subsequent, similar task for some of the children.

One participant, Amy, demonstrated a trivial correlation using this measure. During DA, Amy generally was able to produce the target with minimal cueing, however on the experimental task—where she essentially received Level A cueing—her performance was significantly lower. Although there is no obvious explanation for this finding, several factors may help to explain Amy's relatively poor performance on the experimental task compared with her performance during DA. One reason is that Amy may not have responded as well to the format of the experimental task. Unlike DA, which involved the clinician manipulating animal puppets to demonstrate the targets, the experimental task used a video format in which the clinician presented an iPad video of Mickey Mouse Clubhouse characters depicting the targets. Amy may not have understood the semantic-syntactic target as clearly in the video depiction, resulting in poorer performance on the task. More importantly, no additional prompting was provided during the experimental task, thus the lack of additional cueing likely impacted Amy's performance.

It should be noted that Amy's performance on the experimental task does not provide a complete picture of her abilities. Amy (as well as the other participants) was enrolled in a larger study in which the children participated in additional sessions using the same procedures as the experimental task. Amy's performance in the sessions following the first experimental task revealed a pattern of rapid improvement; that is, in the very first session (i.e., the experimental task), she achieved only 37% accuracy on average across targets (range: 0% - 80%), but in the subsequent three sessions, her average scores across targets were 72% (range: 10% - 100%), 72% (range: 30% - 100%), & 97% (range: 80% - 100%), respectively. This success was achieved without support from the examiner; again, only Level A cueing was used in these sessions. These findings suggest that it might take more than one session for a child's abilities to accurately be reflected in a task in which he or she is no longer receiving cueing supports or become accustomed to the video format of the experimental task.

Overall, predictive validity results using this measure indicate that for some children, average performance during DA may provide an indication about future performance on a similar task. One purpose of DA is to measure the potential for immediate change and assumes that if a child responds to adult cues and prompts to form a new behavior, then that child is ready for change (Bain & Olswang, 1995). In a review of 15 DA studies that used Pearson's correlation coefficients to measure predictive validity of DA, Caffrey, Fuchs and Fuchs (2008) found that in general, DA was predictive of subsequent performance, particularly when applied to students with disabilities rather than at-risk or typically achieving students. The results of Ben, Carmen and Darryl provide further support for these findings and contribute to the growing body of evidence that supports the predictive validity of DA.

Rate of change. In general, comparing participants' rate of change across a DA session to their performance on the experimental task offered less compelling support for the predictive validity of DA. Three participants (Amy, Ben and Darryl) demonstrated a positive correlation (trivial, small, and moderate respectively) using the rate of change measure, and one participant (Carmen) demonstrated a small negative correlation. One explanation for the minimal correlation evidenced using this measure may be found by inspecting the measure itself. It would be expected that rate of change during DA would demonstrate a child's potential to learn (i.e., modifiability) and thus would be better correlated to an intervention phase and not a static task such as the experimental task. In other words, comparing performance in a dynamic task to performance in a static task may not be an accurate measure by which to determine predictive validity. In addition, rate of change does not account for a child's level of mastery of the target; that is, rate of change could be minimal due to generally lower scores or generally higher scores. This discrepancy was observed in the results of Darryl, whose limited rate of change was not due to lower performance but to a ceiling affect.

Overall however, correlations using the rate of change measure were consistently either smaller or equal (for one participant) to the correlation using the mean level of performance. This indicates that using rate of change within a DA session may not be as useful a measure as mean level of support, although caution should be warranted in drawing conclusions regarding the usefulness of this measure, given the small number of participants. Additionally, it is important to note that although the correlation for Darryl and Ben was characterized as moderate and small, respectively, these findings should not be ignored. Given the limited data set and sample size in the current study, a small or moderate correlation should not be disregarded and can provide useful information regarding direction for future studies.

Theoretical Implications

Taken as a whole, findings of the current study provide support for the translation hypothesis. The central tenant of the translation hypothesis is that individuals begin with an internal representation of a message which they then translate onto the graphic symbol modality (Sutton et al., 2010), whereas the modality specific hypothesis proposes that aided AAC productions are influenced by inherent restrictions of the graphic symbol modality, such as limited vocabulary and lack of grammatical morphemes on devices (Smith, 1996; Soto, 1999; Sutton & Morford, 1998). In the current study, preliminary testing of receptive syntax revealed that the participants demonstrated understanding of all six semantic-syntactic structures. It therefore can be speculated that when constructing the target structures, the children did so by mapping the internal representation of the message onto the graphic symbols on the iPad app. This hypothesis is supported by the fact that all of the children correctly produced all of the targets at some point in the study with minimal cues. Although the findings do not rule out modality specific impact, the participants' success may be attributed to their ability to transpose the internal representation of the target structure onto the graphic symbols and overcome the limitations of the graphic symbol modality. The overall success of the participants and the speed with which they acquired the target structures indicates that in general the children were not greatly restricted by the graphic symbol modality. However, the modality specific hypothesis may help to explain Carmen's frequent errors on the attribute-entity target. The salience of the noun symbols on the board and the lack of the grammatical morpheme *is* may have influenced Carmen's productions of this target, thus restricting her graphic symbol productions. The impact of inherent constraints on message production—such as lack of grammatical morphemes—warrants further consideration, and more research is needed to investigate the impact of both the translation and modality specific hypothesis on young children's ability to sequence simple sentences via graphic symbols.

Clinical Implications of the Findings

The findings of this study have important clinical implications. First, results support the notion that 5-year-old children are capable of learning to sequence simple sentences using aided AAC—and do so very quickly—thus adding to an emerging body of evidence that supports this idea (e.g., Binger et al., 2008; Binger et al., 2010; Poupart et al., 2013). As was done in the current study, Poupart and colleagues specifically taught semantic-syntactic relations. This is important clinically, because syntax intervention is a key consideration from the outset of therapy (Bloom & Lahey, 1978). As Fey (2008) stated, syntactic intervention is often neglected in children who rely on AAC to communicate. Learning to correctly sequence simple sentences using aided AAC is certainly important for both language development purposes as well as increasing communicative competence in children who use AAC. The findings of the current study support the hypothesis that some 5-year-old children are able to learn this important skill even within a brief DA session.

Another significant clinical implication relates to the measure of modifiability, which shows that improved performance is possible within a brief supportive experience. These findings offer support for the idea that graduated prompting may be an effective approach in determining preschool-aged children's ability to sequence graphic symbols and that these measures have a degree of predictive validity; that is, the DA results can, at least for some children, predict future language performance on the productions of specific, aided semantic-syntactic structures. Furthermore, the measure of modifiability has important implications for determining a child's ZPD. Campione and Brown (1987) proposed the idea of using graduated prompting to measure the child's ZPD. Instead of calculating the number of right and wrong answers in a set of problems, the authors tallied the total number of cues or prompts that a child required to complete an item and subsequent trials. Similarly, in the current study, the number of prompts or level of prompting required was taken as a measure of transfer of learning and an indication of the child's ZPD. Data from the current study indicated that the level of support required by participants varied across targets, thus, the participants' ZPD varied across targets. Although more research is needed to determine how scores on this task translate to an exact measure of a child's ZPD, these findings support the notion that graduated prompting can be an effective measure of a child's ZPD which in turn can be useful in clinical decision making including readiness for intervention and appropriate target selection.

Overall, the use of DA in assessing the abilities of children who use AAC to sequence graphic symbols appears to be a promising intervention approach. Although the focus of the current study was on sequencing graphic symbols, the use of DA with children who use AAC could potentially have broader clinical utility such as informing device selection and symbol layout, informing intervention decisions, and setting appropriate expectations for children who require AAC. Emerging evidence suggests that DA is an effective clinical tool to assess the language abilities of young children and can be important for informing intervention decisions (Olswang et al., 2013).

Limitations

Several factors constrain the interpretation and generalization of this study. First, the limited number of participants makes generalization to a wide range of children difficult. Another limiting factor was that no static pre-test was given prior to administration of DA. Inclusion of a static assessment of participants' abilities to complete the tasks with no cueing would have provided a baseline measure of comparison to performance during DA (Bain & Olswang, 1995). Static assessments typically include standardized and non-standardized tests in which contextual support is minimized and habitual or actual performance is measured (Olswang & Bain, 1996). Information obtained from static measures could provide useful information about the necessity of DA. For example, if a participant is successful at Level A cueing in DA, this indicates that they may already have the skill and may be able to complete the task with little to no cueing. An initial static assessment could be used to determine a child's baseline level of functioning, thus providing a more efficient evaluation tool.

In addition, comparison of participants' performance during DA to an intervention phase would have provided added strength for generalization and for informing intervention. As discussed previously, comparing the participants' performance during DA to a single experimental task may not have provided a complete or accurate picture of the children's future language performance. For example, Amy's performance during DA was not predictive of her performance on the experimental task, yet analysis of subsequent sessions revealed that she achieved mastery of the target relatively quickly, even without additional cueing or supports. These findings indicate that the predictive validity of DA may be more accurate if a broader measure of success following DA is employed.

Directions for Future Research

The development of effective and reliable language assessments for children who use AAC is still in the early stages. Clearly, more robust research studies are needed in order to further investigate the effectiveness of DA to determine preschool children's abilities to use aided AAC to sequence sentences. Replication of the current study using the same procedures but with a larger group of participants with similar profiles would strengthen the results and allow for calculation of group statistics. Further, replication of the study with children who have different cognitive/receptive language profiles is important and would further increase the generalizability of DA. Because children typically begin combining words at around 18 months (Brown, 1973), inclusion of younger children is warranted as well. Intervention goals for children who require AAC to communicate should reflect typical language development (Fey, 2008). Thus, it may be appropriate to use DA with younger children to help determine their abilities to sequence multi-symbol messages via aided AAC. Given the potential for broader application of DA with children who use AAC, a further area of study is to include additional targets, such as children's ability to use grammatical morphemes (e.g., possessive –s, present progressive –ing) when constructing messages via graphic symbols. In addition to assessing grammatical and syntactic targets, research is needed to investigate the potential of using DA in other areas of AAC clinical decision making such as informing vocabulary selection, symbol selection, and device layout.

New research is also needed in order to further investigate the predictive validity of DA. The current study could be strengthened by inclusion of an intervention phase which could be compared with performance during DA. In their study of 30 children with specific expressive language impairments (age 31-36 months), Olswang & Bain (1996) compared children's ability to produce two-term semantic-syntactic messages during a DA session with their performance on the same task during a subsequent intervention phase. The authors found that the DA outcome measure was highly correlated with language production and success during the treatment phase for the children who required intervention. This study demonstrates support for the predictive validity of DA and provides a model for using performance during an intervention phase as a measure of predictive validity for DA.

Finally, the graduated prompting hierarchy itself merits further examination as a valid and reliable assessment tool. Further studies including larger groups of participants are needed to determine how the level of prompting required for accurate productions during DA correlates to a measure of a child's ZPD. For example, if the child is consistently producing the target correctly at Level A (i.e., minimal cueing), this may indicate that the task is below a child's ZPD and a more challenging target is warranted. On the other hand, if a child struggles to achieve correct production of a target, even with maximal support, this may indicate that the task is above their ZPD and should be simplified. Additionally, a larger study could provide a greater body of data to analyze the effectiveness of each level of cueing within the graduated prompting framework, thus supporting the reliability of the tool. Additional analyses could be included to determine which levels of prompting seemed to be most predictive of future performance and for determining how quickly a child will be successful. Furthermore, inclusion of additional or alternative prompts within the graduated prompting framework would help to create a more nuanced assessment tool. For example, additional prompts could include expectant delay, gesture toward the device, or binary choice.

In summary, findings of this study present emerging evidence that DA may be a useful tool in evaluating 5-year-old children's ability to sequence simple, rule-based messages via graphic symbols, and for some children, rapid change can be measured within a brief graduated prompting session. In addition, the results offer partial support for the predictive validity of DA on a subsequent experimental task. Because children who use AAC are a heterogeneous population who are faced with a wide range of challenges related to language acquisition, valid and reliable assessment tools such as DA are critical to improving their language outcomes. For these children, learning to use generative language is an important goal in becoming competent communicators and to improving their educational, social and occupational outcomes. Because the acquisition of syntactic and morphological skills is a critical factor in this process, learning to correctly sequence semantic-syntactic messages is an important step, and DA may be an effective and reliable tool to help clinicians evaluate children's abilities in this area.

List of Appendices

Appendix A

Communication Board used during Dynamic Assessment

Appendix B

Communication Board used during Experimental Task

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