The Effects of an Animated Exemplar/Nonexemplar Program To Teach the Relational Concept on to Children With Autism Spectrum Disorders and Developmental Delays Who Require AAC

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Abstract: Purpose: Children with autism spectrum disorders with little or no functional speech may benefit from visual symbols for communication. Although a variety of teaching paradigms are available for teaching children to associate a single word with a visual symbol (e.g., dog with a drawing of a dog), there are fewer options to teach relationships between a concept with contextually dependent meanings and a single symbol (e.g., on with a single drawing). Method: An animated instructional program using a structured approach was used to teach the relational concept on to 2 children with autism spectrum disorders and 1 child with speech-language and pragmatic impairments. A single-subject multiple-baseline design across participants was used. Results: The relational concepts computer program used was effective in teaching the targeted concept to the children. Generalization of the concept at criterion was demonstrated by 1 participant, with the other 2 showing evidence of generalization. KEY WORDS: AAC, autism spectrum disorders, computer-assisted instruction, developmental delay

More than 3.5 million individuals in the United States require some form of augmentative and alternative communication (AAC) because of communication impairments so severe that their natural speech is inadequate to meet their daily communication needs (Beukelman & Mirenda, 2005). The underlying causes for severe communication impairments include autism spectrum disorders (ASD) and developmental disabilities in addition to acquired, degenerative, and temporary disorders (American Speech-Language-Hearing Association, 2004).

AAC systems can involve signs, gestures, symbol-based communication boards, and computer-based systems with speech output. Lord, Risi, and Pickles
(2004) estimated that 14%–20% of children with ASD will require AAC in the long term. For children with ASD requiring AAC, technology serves not only a communicative purpose but also an instructional one (Light & Drager, 2007; Shane, O’Brien, & Sorce, 2009). It is important that young children with complex communication needs learn to communicate effectively as early as possible in order to facilitate language and cognitive/conceptual skills development, social development, and functional communication (Light & Drager, 2007). Therefore, it is critical to find ways to draw children with ASD in to using AAC systems as early and as often as possible.

Children with ASD spend more time playing with electronic media (particularly animated media) than any other leisure activity (Shane & Albert, 2008) and respond to the visual presentation of instructional materials (Althaus, deSonnewille, Minderaa, Hensen, & Til, 1996). This engagement with animated media represents an opportunity for intervention in AAC. Shane and Weiss-Kapp (2008) described a role for AAC with individuals with ASD as the visual instructional mode where visual displays can instruct as well as open paths to communication.

Instruction can be provided using face-to-face interaction with manipulatives, or it can be conducted in a computer environment. Computer programs can be highly effective in structured approaches such as the direct instruction model and have been proven effective in that format according to a narrative research review by Magliaro, Lockee, and Burton (2005). For individuals requiring AAC, computer-based instruction addresses several challenges in AAC systems and has potential benefits. In order to efficiently optimize AAC systems, task demands must be reduced, and instructional effectiveness should be maximized (Light & Lindsay, 1992). For children using AAC systems, the line between functional use and teaching may need to be blurred to create a usable interface. Teaching can take place within an AAC device so that there is a carryover of skills into everyday use.

For children with ASD, computer-assisted instruction has been shown to enhance motivation and decrease behavior problems compared to face-to-face instruction (Chen & Bernard-Opitz, 1993). Further, successful computer-assisted interventions for children with ASD have been demonstrated for social skills (Sansosti & Powell-Smith, 2008), reading skills (Hermann, Nelson, Tjus, & Gillberg, 1995), vocabulary (Bosseler & Massaro, 2003), and orthographic symbol representations (Hetzroni & Shalem, 2005). A particular advantage of computer-assisted instruction is the ability to control overselective responding by systematically altering and fading prompts and support (Chen & Bernard-Opitz, 1993). In teaching concepts to children with ASD, such a level of control is desirable. Animations can be used to highlight various contrasts and can then be faded when they are no longer needed (Wilkinson, Carlin, & Jagaroo, 2006).

Although children with ASD may learn to make single-item or structured sentence requests using AAC, building communicative competence requires the ability to assemble novel multisymbol utterances (Binger & Light, 2008). A level of understanding needs to take place before such combinations can happen. Integrating visual instruction within AAC systems in particular with electronic media can help to bridge the gap from single-message requests to the building blocks of syntax. Identifying important building blocks involves an understanding of early emerging concepts that are crucial in child language development as well.

There are many early emerging concepts that are necessary in order for children to develop language. In selecting a concept for instruction, it is important to consider concepts that are both powerful (i.e., usable in many contexts) and within the realm of potential learning. Relational concepts (e.g., prepositions such as in, on, over, and under) are important tools in building multisymbol utterances, but the concepts themselves can be difficult for some children to understand, and their visual representations can add to the difficulty in communicative use. Learners need to understand the symbolic meaning of a representation prior to using it in combination with other symbols (Light, Beukelman, & Reichle, 2003).

Relational concepts can be more difficult than noun concepts for a child to picture because they change across settings and with different objects (Schlosser & Sigafos, 2002). For example, the concept in involves a relationship between two objects (e.g., the ball is in the cup). Whereas ball and cup may be easily depicted, the idea of in comes out of the relationship between the objects and not the objects themselves. Further, it is important to specify which one of a concept’s meanings is to be taught (Kameenui & Simmons, 1990). For example, the meaning of on is different in “on the table” versus “turn the lights on.” In order to visualize a relational concept, a child must visualize or learn the action associated with that concept (Kameenui & Simmons, 1990). After understanding the boundaries of a concept, individuals can then associate the concept with a visual symbol.

Relational concepts generally emerge in children’s expressive language in their early semantic relations in phrases such as doll on or shirt off and are important building blocks for more complex syntax (McLaughlin, 1998). One of children’s earliest acquired relational concepts is the concept on, as
in “the book is on the table” (Clark, 1980). Children frequently encounter events or situations in their daily lives that involve the concepts in and on (Clark, 1973).

Visual representations of prepositions may be particularly difficult for individuals with autism (Schlosser et al., 2012). Representations of on can be problematic in AAC, but a solution can be found through animating the symbol itself and/or the instruction method used to teach the concept. In a study by Schlosser et al (2011), traditional representations of on were not as transparent for young children compared to representations of a set of 32 other verbs and prepositions. Mineo, Peischl, and Pennington (2008) reported better identification of action word representations with animation representation of figures displaying the actions (e.g., an animated short movie of a stick figure falling vs. a person tipped over) rather than static images.

The animation of symbols can be effective when children have an existing representation to which they are seeking an adequate match. Teaching a child to use a visual representation when the understanding of the concept is not established is more difficult than teaching a mapping of a concept to a symbol (Schlosser & Wendt, 2008). The visual instruction mode involves using an animated sequence to provide information about an underlying concept (Shane, 2006). The instruction is done through an electronic medium. Extending a visual representation to general representations of relational concepts may require explicit instruction for individuals with ASD (Kozleski, 1991). Finding good representations is very important (Light & Drager, 2007), but guidance is lacking for how to teach a concept along with a representation.

When discussing a program to teach relational concepts, Kameenui and Simmons (1990) recommended teaching concepts using examples and nonexamples. The authors explained that it is important to include nonexamples that “demonstrate to the learner what the concept isn’t” (Kameenui & Simmons, 1990, p. 149). Incorporation of nonexamples into the teaching sequence is often crucial to children’s acquisition of a concept because it requires children to attend to a single similar quality across examples and to ignore other variants that do not define the concept. In a nonexemplar approach, on would not be taught at the same time as off or in because the learner would be required to form simultaneous representations of two concepts and may fail to recognize the important qualities of each concept. Consequently, a child could potentially distinguish on from off but then later not understand how on might be different from over because the essential features of on were never explicitly made clear. This method is not incompatible with more incidental learning techniques but may be more systematic in the presentation of only example and nonexample options rather than teaching examples and potential opposite, contrasting concepts (e.g., on/off) should the opportunity arise.

For individuals with difficulty forming mental representations of concepts, systematic instructional methods are often helpful. In AAC instruction, systematic methods are particularly useful when individuals do not have a strong representation of the spoken word, let alone an associated graphic representation to match (Romski, Sevcik, & Adamson, 1997). For broader concept terms, establishing comprehension of the variety of contextually dependent meanings can be difficult. For example, it would be difficult to teach all of the potential meanings of on (on the table, turn the light on, put clothes on) at once.

In summary, children with ASD have an interest in on-screen media and require a systematic visual instruction program with animated rather than static content. Learning key language concepts like on through such a program could help expand their possibilities for multisymbol communication. In light of the significant need for concept learning and the lack of instructional programs for children who use AAC, we designed this study to evaluate a program to teach the relational concept on using an animated computer-based exemplar/nonexemplar paradigm. We hypothesized that the program would be effective in teaching comprehension of the concept on to children with ASD and pragmatic impairments who use AAC.

METHOD

Research Design

A single-subject multiple-baseline design across subjects was used with data collected across baseline, intervention, maintenance, and generalization phases. Single-subject designs are often appropriate for studies involving AAC because the population of individuals who use AAC is diverse in terms of etiology and limited in terms of finding large cohorts of similar individuals in a single area for group studies (Schlosser, 2003). These population characteristics require intervention with children who use AAC to be individualized (Horner et al., 2005). This research design has been used in studies concerning the literacy skills of children who use AAC (Fallon, Light, McNaughton, Drager, & Hammer, 2004; Millar, Light, & McNaughton, 2004) and problem solving (McCarthy, Light, & McNaughton, 2007). Schlosser (2003) also reviewed the significant contributions of single-subject research to the evidence base in AAC.
Participants

Three children were selected to complete the study. The children met the following selection criteria: (a) age between 3 and 8 years, (b) used an AAC system, (c) used single-word or telegraphic messages for communication, (d) did not know the concept on according to parent/teacher report, (e) failed to identify the concept on in more than three out of four trials using a multiple-choice pointing task, and (f) demonstrated regular use of line-drawn symbols in classroom or home contexts for requests or other communication functions. Participant ages ranged from 4;3 (years;months) to 7;3 at the start of the study. Although the age range extends beyond what would be expected in typical development for understanding of the concept on, the screening for recognition was judged adequate in consideration of the telegraphic output of the participants. All three participants were male. A summary of the participant characteristics based on record review and parent/educator report is provided in Table 1.

Alex. Alex was a 6-year-old boy who was born at 27 weeks gestation. His hearing via sound-field testing and vision according to parent report were within normal limits. He had a history of feeding problems associated with nasogastric tube placement in the first 2 years of his life. Alex attended speech therapy twice a week and a child-care center part time during the week. His speech and language goals included requesting, commenting, engaging in social language/play, and following directions. He was diagnosed with a severe speech and language delay and apraxia of speech at age 4 years at a university speech and language clinic. A current speech-language therapy report noted that Alex’s pragmatic skills were also significantly delayed for his age. Specifically, Alex generally sustained interactions for one to two turns, frequently engaged in solitary play, and would lead partners to objects as a request. He required two to three gestural prompts to complete turns and to relinquish his turn.

Alex would say hi and bye when prompted to do so. He answered who questions when selecting from an array of four choices for the answer and could answer where questions by finding an object and pointing to it (or by leading a person to an object). Alex followed basic commands (up to three steps) with gestural prompts and a classroom schedule given visual supports. The commands that Alex followed generally did not involve location words but were more of the single-action (e.g., sit, watch, jump) or action–object (e.g., throw the ball, carry the book, eat the jello) types. He demonstrated knowledge of color concepts by matching color cards to the predominant color of an object. In the past, Alex used a modified version of the Picture Exchange Communication System (PECS; Bondy & Frost, 2001) in addition to speech. At initiation of the study, Alex used speech (generally single-word utterances) with some line drawings, gestures, and facial expressions to communicate.

Andrew. Andrew was a 4-year-old boy who was diagnosed with ASD at 2 years of age at a metropolitan children’s hospital. His hearing via sound-field testing and vision according to parent report were within normal limits. He attended an integrated preschool three times per week. Andrew used a modified picture exchange system with a sentence strip

Table 1. Demographic information for the three participants in our study.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Age (years;months)</th>
<th>Current grade (age equivalent)</th>
<th>School placement</th>
<th>Communication modality</th>
<th>Diagnosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alex</td>
<td>6;3</td>
<td>Preschool (K–1st)</td>
<td>Part-time integrated day care, preschool</td>
<td>Natural speech, picture cues, gestures and facial expressions</td>
<td>Apraxia, severe speech and language delay, including pragmatic impairment</td>
</tr>
<tr>
<td>Andrew</td>
<td>4;3</td>
<td>Preschool (Preschool)</td>
<td>Part-time integrated classroom</td>
<td>Speech, adapted PECS, adapted classroom, picture cues</td>
<td>Autism spectrum disorder</td>
</tr>
<tr>
<td>Ken</td>
<td>7;3</td>
<td>K (1st–2nd)</td>
<td>Full-time multiple disabilities classroom</td>
<td>Speaking Dynamically Pro, on a Toughbook, gestures</td>
<td>Autism spectrum disorder</td>
</tr>
</tbody>
</table>

Note. PECS = Picture Exchange Communication System.
and a binder filled with pictures to make requests at school and at home. Generally, his requests were for food items or a ball. His classroom used a total communication approach with either key word signs or symbols in conjunction with speech. Andrew’s communication at home included line-drawn picture symbols and digital photographs attached to common objects or to denote different “centers” for him to complete different activities.

Andrew answered who and what questions when selecting from an array of four to six choices for the answer and answered where questions by finding an object and pointing to it (or by leading a person to an object). He followed basic commands (up to three steps) given one gestural cue and required visual or verbal prompts to transition and to follow a class schedule. The commands that Andrew followed generally did not involve location words but were more of the single-action (e.g., sit, watch, jump) or action–object (e.g., throw the ball, carry the book, eat the jello) types. Andrew used vocalizations and verbal approximations to protest. He independently requested using his sentence strip and a binder filled with pictures if it was present at the time of the request. Andrew did not independently locate the binder to request if it was not visually present.

Andrew participated in imaginative play and turn-taking activities (approximately four to five turns unless the activity was of high interest) given verbal and physical prompting. He initiated preferred play activities and requested preferred play and food items without prompting. Andrew demonstrated perseverative behaviors relating to sensory preferences (i.e., spinning a ball, drawing circle shapes). The focus of Andrew’s speech and language therapy in the school setting was requesting, using augmentative communication for extending turns taken, transitioning, making socially appropriate protests, and engaging in social/play.

Ken. Ken was a 7-year-old boy who attended an integrated kindergarten program. Ken was diagnosed with ASD at age 1;4 at a university medical center and with attention deficit hyperactivity disorder at age 5 years at a separate medical center. His hearing via sound-field testing and vision according to parent report were within normal limits. Japanese was the primary language spoken at home, but outside of the home, Ken was exposed to English only. During school, Ken used a picture schedule, and his classroom was augmented with picture symbols. He had a touch-screen laptop with Boardmaker with Speaking Dynamically Pro software (Mayer-Johnson, n.d.a) on it. He used grid-based and some contextual scene boards made with the software to request preferred items and activities and participate in class routines.

Ken used the laptop and picture symbols as his primary mode of communication and also made requests by taking someone else’s hand and leading them to desired objects or activities. His requests were generally for objects and food items using these methods. Ken required prompting to participate in play and therapy activities. He demonstrated minimal self-initiation.

Ken demonstrated increased vocal behavior (e.g., jargon, singing) during independent play and often used vocalizations to express anger or frustration and to protest. He did not reliably indicate responses to who, what, or where questions; however, for activities of high interest (involving his favorite cartoon characters), he did identify who and what related to the characters. Ken followed basic commands (up to two steps) with gestural cuing and demonstrated knowledge of number, color, and shape concepts in matching tasks. The commands that Ken followed generally did not involve location words but were more of the single-action type.

Ken’s performance on visual–spatial tasks was reported to be superior by his teachers, although he would frequently and quickly lose interest in activities, making accurate assessments difficult. Speech and language therapy goals addressed in the school environment included making socially appropriate requests, engaging in social language/play, and participating more independently in activities. Based on the report of professionals working with Ken (i.e., teachers, therapists, aides) and Ken’s family, Ken’s receptive language skills were significantly greater than his expressive language skills. Ken had extremely limited expressive language. He took people to desired objects or places and displayed a high number of challenging behaviors rather than using more conventional forms of communication. Receptively, he would follow directions beyond anything he was ever reported to produce through any expressive modality.

Materials

Animated instructional program. Macromedia Flash Professional 8 (Adobe Systems, n.d.) was used to develop the relational concept computer program, and the program was presented on a touchscreen Panasonic Toughbook. The representations selected to convey the concept on included an acting object (e.g., a cat, rabbit, and turtle) that moved around a room in relation to a stationary object (e.g., a table, couch and bookcase). After moving, the animals stopped in a position that was either on or not on the stationary object in the room. Animals were chosen as acting objects because they could be moving. Pets were
chosen specifically because they could logically be found indoors. Animals were chosen that would be perceptually different from each other. The stationary objects were likewise selected to be of contrasting shape that could also logically be found indoors.

The intervention took place on the computer and consisted of a scene of a room containing the acting and stationary objects. At the bottom of the screen were two line drawings that made up the response set for the children in the study. A line drawing of a solid black circle on top of a black open rectangle represented the concept on (taken from the Mayer-Johnson [n.d.b] Picture Communication Symbols), and the same picture with a red X through it represented a nonexample. There was no available representation for not on in existing symbol sets so a commonly used symbol to indicate no combined with the unmodified concept was used. An available representation of on with a systematic relationship to other relational concepts was chosen in order to offer an avenue to extend the program to other concepts.

Procedure

**Baseline.** The baseline phase included periodic probes of the dependent variable (i.e., illustrative example). Probes were chosen to avoid extensive negative practice or resistance to continuing for participants who were kept at baseline while others were completing the intervention (Kazdin, 1982). The participants remained at the baseline phase until a stable baseline was achieved. A stable baseline was determined by three consistent measures with no upward trend (i.e., <15% variability across measures) (Richards, Taylor, Ramasamy, & Richards, 1999).

**Intervention.** The first participant began intervention by means of the relational concept program following a stable baseline. There were three instructional sessions. Each session started with the researcher prompting the child to attend to the acting object (e.g., “We are watching the cat”). For each trial in each session, an animal moved around a piece of furniture in a room and stopped in one of three general positions (e.g., far above the stationary object, just above the stationary object, or on the object) to demonstrate a minimal difference of on and not on). The placement of the acting object also varied along the horizontal plane. Following the prompt to watch the acting object, the researcher modeled five examples (two of not on and three of on) by pressing one of two line drawings at the bottom of the computer screen for where the acting object was when it stopped and verbally indicating whether the acting object was on or not on the stationary object. There was a line drawing with a dot and a box designed to represent on (taken from the Mayer-Johnson Picture Communication Symbols or the same drawing with a red X through it to represent not on (see Figure 1).

Following the researcher models, the child was asked to respond in repeated trials of the acting object moving around the stationary object. At the moment the acting object stopped, the researcher asked the child to identify whether the animal was on or not on the furniture by saying “What’s this?” The goal was to keep the cue as short and as consistent as possible, so what was chosen in favor of “Where is the [name of animal].” The child made his selection by touching the on or not on line drawing at the bottom of the computer screen. After selection, the symbol for the correct answer enlarged sequentially to fill ¼ of the screen as feedback. The researcher reinforced the correct answer by stating the correct concept within the intervention session instructions (e.g., “The cat is not on the table,” or “The cat is on the table.”) The child’s identification of the targeted concept (on or not on) was recorded. If the child incorrectly identified the concept during the intervention, the researcher provided the correct response (e.g., “The cat is on the table”) and then repeated the trial.

If the child incorrectly identified the concept again, the same procedure was repeated. After three consecutive errors on the same trial, the researcher began the intervention session from the beginning (i.e., with the researcher models) as recommended by Kameenui and Simmons (1990). During the intervention phase, the researcher supplied information on identification of the concept verbally while pressing the correct symbol for the child only five times. An example of the teaching sequence used in the intervention can be found in Kameenui and Simmons (1990, pp. 169–171).

Achievement of 80% accuracy in identification of the concept indicated criterion for the dependent variable (see the section on the dependent variable) for each scene. A specific number (at least 10/12 trials correct) was chosen as criterion because it exceeded chance (50% accuracy). When criterion had been reached for the first participant in each scene, intervention began for the second participant while the third stayed at baseline. The same cycle was repeated until all three participants completed the intervention.

**Generalization and maintenance.** Following completion of the intervention phase, maintenance of the concept learned was assessed by presenting multiple probes in the same format as the intervention phases. Participants also completed probes to assess their ability to generalize to novel acting and stationary objects (i.e., a bird on a window, a mouse on a fireplace). The generalization probes were administered.
following intervention. The maintenance probes were completed 3 weeks and 6 weeks following conclusion of the program. Booster sessions were administered when a participant achieved less than 80% accuracy (criterion) on the 3-week maintenance probes. Booster sessions consisted of a repetition of administration of the first intervention session followed by administration of one probe to assess knowledge of the targeted concept.

**Dependent Variable**

The dependent variable employed the same scenes, animals, and objects as in the instructional program in intervention. Data were the participants’ accurate identification of the targeted concept as on or not on in a static scene. Twelve trials were available for each participant, with four variables in the scene (concept/not the concept, acting objects, stationary objects, and distance between the objects) randomized across each trial. Twelve was chosen as the number in order to ensure a representative sample of potential locations and acting and stationary object combinations. The locations were slightly away (above, to the right, or to the left), far away (above, to the right, or to the left), and on the object (on the right, left, middle). For each static scene shown, the researcher asked “What’s this?” Data were collected on the responses of the child in identifying the concept by pushing the correct symbol on the computer screen. No feedback was given. If the participant responded verbally, the researcher prompted the child by saying “Show me.” This was done to ensure that the child had acquired not only the concept but also its symbolic representation.

**Data Analysis**

The data were graphed and were visually inspected for changes in trend and slope within and between the three phases. The direction and degree of trends were analyzed. The direction of the dependent variable was inspected before and after the intervention. To help measure the effectiveness of the program, the percentage of data points in the intervention phase that did not overlap with baseline data points (non-overlapping data) was also calculated (Scruggs & Mastropieri, 1998).

**Reliability**

Twenty percent of the probes were randomly selected and an independent scorer who was blind to the condition (i.e., baseline, intervention, generalization) of

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**Figure 1.** Screen capture of session one of the computer-based relational concepts program to teach the concept on.

*Note.* Symbols used are from The Picture Communication Symbols ©1981–2011 by Mayer-Johnson LLC. All Rights Reserved Worldwide. Used with permission.
the responses checked the scores against the recorded samples. Scoring reliability was 100%. Procedural reliability was maintained through use of the automated program, which presented the same intervention steps in the same manner each time it was played. There were no technical problems noted in administration of the computer program.

RESULTS

The participants’ accurate identification of the concept on within the probes administered at baseline, during intervention, and to measure generalization and maintenance are presented in Figure 2. The average number of trials (out of 12) correct at baseline for Alex and Andrew was 0. Ken averaged 4.5 trials correct at baseline. Alex and Andrew reached criterion (80% accuracy) by the third intervention session. Ken reached criterion following the first intervention session. All three participants completed three consecutive probes at or above criterion before the generalization and maintenance tasks were administered.

For all three participants, the data from baseline through intervention were 100% nonoverlapping, supporting the effectiveness of the instructional program. Also, the data points during intervention did not equal or fall below the data points at baseline. The participants’ performance on the generalization probes suggested some generalization of the concept on to novel objects. Ken performed above criterion on the generalization probes, identifying 83% of the trials accurately; Alex identified the concept correctly in 75% of the trials; and Andrew achieved 67% accuracy.

We administered additional probes to determine each participant’s ability to identify the target concept 3 and 6 weeks following intervention. Ken demonstrated maintenance in identification of the concept at 3 weeks, but Alex and Andrew did not. To improve generalization, we administered a booster session to Alex and Andrew. The booster session included a repeat of intervention session one followed by a probe set. Following the booster session, Andrew demonstrated greater than 80% accuracy on the probe set and the maintenance probe 3 weeks following. Alex did not demonstrate greater than 80% accuracy following the initial booster session; therefore, a second booster session was given. The second booster session included a repeat of intervention session two; at which point Alex demonstrated accuracy above criterion and demonstrated maintenance at 3 and 6 weeks post. Andrew and Ken did not demonstrate maintenance at 6 weeks post. No further booster sessions were implemented due to severe resistance to participation on the part of the participants. The participants would not make any selections and continually left the computer area.

Time between sessions. The average time between sessions for each participant was 2 days during the baseline, intervention, and generalization phases. The final probe in the posttest and the generalization probe were administered during the same session for Alex and Andrew. The generalization probe was administered 2 days following the final intervention session for Ken. The longest time period between sessions was 4 days, which occurred with Alex.

Length of sessions. The average length of each session with Alex was 5 min. The average length of each session with Andrew and Ken was 8 min. The intervention sessions lasted between 7 and 12 min. The baseline, posttest, generalization, and maintenance sessions lasted between 5 and 10 min.

DISCUSSION

Acquisition of the Concept

The animated instructional program used in the study was effective in teaching the targeted concept on to children who use AAC. The structured approach was successful when administered as a computer program. The program may have been successful due to many factors. The script in the intervention sessions allowed for repetition with verbal clarification for any trial in which the participant incorrectly identified the concept. Instruction regarding identification of on and not on was verbally presented along with symbol representations. In this way, the child was provided with a verbal representation of the concept they were viewing coupled with a visual/symbolic representation of the concept. The modeling on the system may have been beneficial in the children’s acquisition of on, particularly for the participants with ASD, who have been shown to benefit from augmented input (Light, Roberts, & Dimarco, 1998; Shane, 2006).

The instructions in the intervention sessions also used a specific set of movements adapted from Kameenui and Simmons (1990). The movements included minimal differences in positions of the acting object. For example, the cat would move very close to the table but not quite on, emphasizing the specific difference between on and not on. These presentations of minimal differences along with the sequence of positions may have helped the children facilitate acquisition of the concept. Another aspect of the intervention that may have facilitated concept learning was the presentation of the stimuli. All of the children maintained initial interest in using the computer. Two of the children initiated sessions with
Figure 2. The number of trials answered correctly (out of 12) by each of the children in response to the probes administered during the baseline, intervention, and generalization and maintenance phases.
the researcher by requesting the computer. The children also expressed interest in the animated animals and enjoyed pressing the buttons on the screen. The computer program presentation of the intervention assisted in maintaining the children’s attention to the task and researcher, at least in the intervention sessions.

The study also demonstrated that the program was effective in teaching the symbols for *on* and *not on* along with the concept. All of the children used the symbols for *on* and *not on* to indicate their identification of the concept within the context of the intervention sessions and probes. The symbols for *on* and *not on* were not used in the classrooms of the children during the study. The children’s use of the symbols to express *on* was not assessed within other contexts or settings. However, all of the children had significant symbol representation skills as observed by the researcher before beginning the study. All three children demonstrated the use of picture symbols to communicate in the home or school environments and demonstrated understanding of the communicative value of picture symbols. The children used the symbols in the study to express an answer to the researcher’s question, “What’s this?” with intent and understanding that selection of the symbol indicated communication of their response based on their performance above chance levels during intervention.

**Generalization of the Concept**

The results suggest that although only Ken generalized knowledge of *on* to novel objects at a mastery level, the other two participants did demonstrate generalization to novel objects at levels above chance. This may be due to several factors. Ken’s generalization of the target skill suggests complete learning of *on* and *not on*. There are several explanations for the lack of generalization above mastery in the two other participants. The other two participants may have mastered the task in other scenes but had not acquired complete knowledge of the concept *on*. Alex and Andrew may have simply required an intervention session with the new objects to acquire *on* in those contexts. More exemplars in the initial intervention session may have facilitated generalization. Additionally, the generalization probes were administered after each child had received several weeks of sessions. Alex and Andrew both exhibited difficulty attending to the task at this point in the study until the last session. The children may have been bored with the probe tasks, as evidenced by the need for increased redirection to the computer for each trial.

**Maintenance of the Concept**

Results of the present study suggest that the participants maintained knowledge of the concept *on* 3 weeks post intervention but not at 6 weeks post intervention. Alex and Andrew may have required a booster session for several reasons. First, the researcher noted an increase in the use of speech to respond during the dependent variable results from both participants. As this occurred, Andrew also demonstrated a significant increase in his use of spontaneous sentences in the school and home environment. After responding correctly with speech, the participants were prompted with “use your finger” or “show me.” Both participants complied with the request but appeared frustrated and showed decreased attention to the task. In practice, increased speech would certainly be a desirable outcome. Any potential facilitation of natural speech through this process should be ultimately considered positive. It is unfortunate that the protocol as proposed did not allow for more flexibility with regard to response modality.

The increased need for prompting was accompanied by perseveration on aspects of the computer by Andrew. Andrew enjoyed making shapes with the pointer on the screen and tracing the button boxes, which are squares. Perseveration on shapes during administration of the probe sets increased each session after generalization. Andrew was permitted to continue drawing on the screen between prompts. The researcher removed the mouse after two sessions in order to eliminate the behavior. However, Andrew became angry, and a decrease in attention was noted throughout the remainder of the study.

The final factor that may have influenced the participants’ maintenance of knowledge of *on* relates to the intervention itself. Although all three participants mastered the concept during intervention, the researcher was unable, as dictated in the procedures, to reinforce the concept after the intervention unless a booster session was given. An increase in verbal and symbolic cuing may have helped the children solidify their knowledge of the concept *on*. After the first five trials, the errorless learning aspect of the program was used, and verbal feedback was given only in conjunction with an incorrect response. The use of verbal and symbolic feedback (provided hand-over-hand) with the child may facilitate more accurate concept knowledge and increase maintenance of the skill.

**Clinical Implications**

There are several important implications that can be taken from the present study. First, results of
the study suggest that a structured, computer-based program such as that used in the study can successfully teach the concept on to children who use AAC. Children with ASD with limited expressive language skills but with adequate symbol representation skills such as the participants in the study can benefit from a structured approach to teach on. Adequate symbol representation skills should be a prerequisite for beginning a program such as that used in the current study. The children in the current study understood line drawings and used them in their school, home, and therapy environments. The children in the study also showed some evidence of understanding symbols and their function in communication.

The current study accepted identification of the concept as correct only when the child used the symbol to respond. This was done to maintain consistency and experimental integrity. However, the use of speech to identify the concept should be determined as an accurate response when using this method in clinical practice because it is communicating an appropriate response. Knowledge of the concept can be determined in this way, whereas knowledge of the symbol can be determined with a prompt such as those used in the current study (i.e., “Show me”).

Finally, a structured approach may be effective in teaching other relational concepts to children who use AAC. The computer-based nature of the program and scripted intervention made it easy to implement. The instructional program was effective in teaching the concept on, and the results suggest that the program could be effective in teaching other relational concepts such as in, under, and between to children who use AAC. Given the relative brevity of the program (only a few minutes were required for the teaching sequence), the results suggest that it could be relatively easy to cycle through several different prepositions in the course of a few weeks.

Limitations and Future Directions

There are several limitations that should be considered when interpreting the results of this study. Only one concept was presented in the study. Interpretation of results is therefore limited to the concept on. Although other relational concepts may be taught using the methods used in the present study, some of those concepts may be difficult to present in a computer program (i.e., out, beside).

The researchers were not able to determine if the participants learned the symbols for on and not on outside the context of the study. It is possible that the children memorized the position of the symbols and knew which symbol to press based on its position, which is a threat to internal validity. To effectively determine if the symbol was learned, the researcher could have switched the symbol positions or tested symbol knowledge in a new context such as during play activities (e.g., playing kitchen). Another factor is the use of negation in the symbol. The current study used a red X over the symbol for on to represent not on. None of the three participants was consistently using that representation of negation in his everyday symbols. Therefore, the children were required to learn two symbols for one concept. A pretest for comprehension of negation and understanding of symbolic representation of negation should be included in future studies to address this limitation.

Finally, two of the three participants were unable to generalize knowledge of on to novel objects at mastery level within the parameters of this study. It is important to note that their performance did not fall to baseline levels, but an intervention with more feedback may help solidify concept knowledge. Multiple generalization probes could also be used to better assess generalization of the target skill.

The current study successfully employed both evidence-based instructional methods and new technologies. For children who communicate using a visual modality like picture symbols, it is important to provide a framework for learning symbols with more abstract referents.

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