ABSTRACT: **Purpose:** Technological advances in augmentative and alternative communication (AAC) offer the potential to enhance the communication needs of individuals with severe communication disorders. However, using AAC to express concepts that cannot be easily represented in static line drawings is a significant challenge. Animation of line-drawn action verbs represents a means to enhance the transparency of previous static representations and potentially make the representations easier for children to use.

**Method:** A mixed group design with repeated measures was used to test the effect of animation used as feedback in locating and selecting action verbs in a visual scene on a dynamic AAC display. Twenty 3-year-old children without disabilities (10 boys and 10 girls) were quasi-randomly assigned to an animation or no-animation group. Participants’ accuracy in locating and selecting representations of 15 action verbs in a play activity repeated across 3 sessions was recorded.

**Results:** Results of the study revealed that animation did not lead to significant performance differences between the 2 groups. Adequate representation of concepts allowed children to perform near mastery level after 2 sessions.

**Conclusion:** Action verb representations can be quickly learned within visual scenes. Ceiling effects may have contributed to the results. The role of animation in learning should be further explored and separated from navigational demands in future studies.

**KEY WORDS:** augmentative and alternative communication, assistive technology, children, learning, animation
Individuals who can speak use words to represent the message they are trying to convey to their partner. Communication using aided AAC systems (i.e., those requiring some kind of external equipment) often requires the user to construct a message with visual symbols, which may be transformed into spoken output. In some cases, the visual representation can match an object very well. A line drawing of a “dog,” for example, can resemble a dog. In the case of more abstract items like actions such as “running,” “jumping,” or “building,” static line drawings may not provide the necessary cues to aid in symbol recognition or learning. In fact, children may have significant difficulty locating currently available representations of abstract concepts within AAC devices (Drager, Light, Speltz, Fallon, & Jeffries, 2003; Light et al., 2004).

Light and Drager (2007) suggested that in order for AAC devices to be effective communication tools, they must “minimize the cost of learning while at the same time maximizing the power of communication” (p. 208). The cost of learning is the amount of time and effort needed to learn the basic skills to find, access, and produce desired messages on an AAC system. The power is being able to express exactly what is on the user’s mind. Consideration of how best to improve AAC systems so they can convey messages on an AAC system. The power is being able to express exactly what is on the user’s mind. Consideration of how best to improve AAC systems so they can convey more abstract concepts like action verbs requires consideration of the nature of visual symbols in terms of how, why, and under what conditions they work.

Symbolic Representation in Abstract Symbols

Often times, it is assumed that children understand symbol representation before they are actually capable of using it. Children using AAC must not only gain an understanding of the spoken word and its relation to a verb, but they must also understand an external referent to express the concept (Light, 2003).

In order to have symbolic understanding of pictures, children progress through three stages of symbolic learning (Mineo Mollica, 2003). In the first stage, representational insight occurs when children understand basic similarities between the symbol and its referent but do not fully grasp the ability of the symbol to “stand in” for the referent ( Uttal, Schreiber, & DeLoache, 1995). For example, a child at this stage might become excited at seeing a box of cereal with a photo of the cereal on the front.

In the next stage of understanding, children learn that a symbol can dually represent an actual object as well as be an object unto itself (DeLoache, 2000). To continue the previous analogy, a child at this stage could use the cereal box to request the cereal and could also put the box into a toy shopping cart. The child understands both the referential value of the object as well as its immediate physical function. For abstract concepts, children must recognize two things: the individual items within a representation and the new concept portrayed by the interaction of the individual items. For example, consider a boy riding a bicycle. In an aided AAC display, this picture would be static. Children would see a boy and a bicycle (both concrete objects); however, they may not immediately see that the picture can also represent the concept of ride.

In the final stage of symbolic understanding, symbolic sensitivity, children look for the symbolic relationship in other entities other than the ones they may have been previously taught (DeLoache, 1995). For example, a child who can point to a drawing of a milk carton can then start to make other food item requests when eating (Mineo Mollica, 2003).

Rather than trying to disambiguate the meaning of a single symbol in a box, it is possible that providing a background or context for a visual symbol could aid in identifying its intended meaning. Contextual scenes provide a potential format for displaying abstract symbols.

Contextual Scene Displays

Young children learn language through interactions with the environment. Therefore, it is appropriate for an AAC device to approximate the medium through which the typical child learns language. Contextual scene AAC displays embed symbolic representations into a cohesive scene rather than as independent “boxes.” Contextual scenes can be photographs of familiar scenes or line drawings. For example, a contextual scene could contain a drawing of a living room complete with the objects one might expect to find in a living room (e.g., couch, lamp, table). Each object would be represented according to the size and location one might expect in an AAC display. Voice output would be activated by touching an object in the scene. For example, touching the couch could retrieve the message, “couch.” Contextual scene displays have been found to be an effective layout method for representing language concepts for young children (Drager et al., 2003, 2004; Light et al., 2004).

Currently, contextual scenes are static in nature. Despite contextual support, it is difficult to represent an abstract concept like play or come within a static scene. Research done by Drager et al. (2003, 2004) and Light et al. (2004) concluded that children had significant difficulty locating abstract concepts in AAC displays whether a scene or a traditional grid of rows and columns was used. In these studies, children 2½ to 5 years old were asked to locate concrete and abstract concepts within various AAC displays by helping “Bobby the bear” find and say words to participate in a birthday party. Concrete concepts were items such as cake and present; abstract concepts included come and play. Drager et al. (2003) found that 18 out of 30 of the 2½-year-olds in their study could not locate any of the six abstract concepts in any of the AAC systems used, even after three learning sessions.

Similarly, Light et al. (2004) discovered that forty 4-year-old and forty 5-year-old children located 12 or 15 abstract concepts, respectively, with significantly less accuracy than equivalent numbers of concrete items over three learning sessions. In looking at overall trends across their studies, the authors found an advantage for organizing items in scenes for 2- and 3-year-old children in particular, but the disparity between abstract and concrete retrieval could certainly be improved. An examination of the visual cognition literature can help to determine more appropriate symbol representations for abstract concepts.
Visual Cognition and AAC Displays

Visual cognition is the study of visual, spatial functioning and neurological foundations. It has been suggested that considering what is known about visual cognition and how different visual information impacts attention and memory may aid in reducing the learning demands of AAC systems for young children (Light & Drager, 2007). One of the current problems with AAC technologies is that visual stimuli represented on the display can symbolize an object, an event, an emotion, or even a concept (Wilkinson, Carlin, & Jagaroo, 2006). The ability of young children to discriminate, identify, and/or recall information from memory may depend highly on the degree to which symbol representations conform to visual processing principles (Wilkinson et al., 2006).

Jagaroo and Wilkinson (2006) suggested that using movement may help increase the saliency of different concepts on a schematic display by drawing attention to those objects. Task learning, task performance, item discrimination, and memory improved when motion was given to the stimulus (Jagaroo & Wilkinson, 2006). Motion can highlight things like causal or functional relationships between objects to enhance the clarity of visual representations (Jagaroo & Wilkinson, 2006).

Mineo Mollica, Peischl, and Pennington (2008) found that simple animations with stick figures based on human movement were more helpful than static drawings in helping 3-year-old children to identify action verbs in a grid of four choices. The authors also noted a developmental trend of improved performance across representation types (static and animated) with 4- and 5-year-olds. The research was not extended to include larger arrays of symbols or embedding symbols within a contextual scene. Similarly, Fujisawa, Inoue, Yamana, and Hayashi (2011) found that 16 children with intellectual disabilities ages 11–18 years were more accurate in labeling symbols of 16 action words (e.g., throw, wipe, put) when the symbols were animated than when they were not animated. Further, the authors found that the participants with lower scores on a standardized Japanese developmental inventory benefited more from the animation than participants with higher scores.

Neither of the two previous studies involving animation involved animation within a contextual scene; instead, the animations could play continuously during presentation. In a contextual scene, the presence of multiple moving images is potentially distracting. To present images in a contextual display, a static representation may need to be used initially and then the animation could play on selection of an item. This role of animation would be as feedback rather than as an immediate aid to retrieval in finding an item within a display. The consequence would potentially be an aid in learning rather than in immediate recognition. Jagaroo and Wilkinson (2006) stated that only simple, localized motion was needed to represent a realistic concept, but they did not speculate about the best representation of animation within a contextual scene. Consequently, a simple animation (i.e., an animation made up of five sequential images played in a repeated loop sequence) should be sufficient for an animation task.

Although there is some empirical evidence on the potential effect of animation in small symbol arrays (Fujisawa et al., 2011; Mineo Mollica et al., 2008), there is a lack of research on how or if such animations would be helpful in children who are retrieving or learning target concepts from contextual scenes. Given the potential benefit for young children in organizing AAC displays by contextual scenes, the lack of success to date in facilitating the retrieval of more abstract concepts within those scenes, and the potential for animation to improve children’s identification of representations of verbs, a study combining contextual scenes with the decontextualized animation work to date was needed.

Research Questions

The purpose of the current study, then, was to examine the effect of simple animation as feedback on children’s ability to locate verbs within a contextual scene display. The following questions were addressed:

- What is the accuracy of typically developing (TD) 3-year-old children in locating verbs on a dynamic AAC visual scene display with only verbal feedback versus animated and verbal feedback?
- Do the children’s performances improve across learning sessions with these different forms of feedback?

METHOD

Research Design

A mixed group design with repeated measures was used to determine the accuracy of children in the two feedback conditions. The between-group factor was feedback condition (animated/verbal vs. verbal), and the within-group factor was time (Sessions 1, 2, and 3). In the one condition, children saw animated feedback of a stick figure performing the action represented by a static figure in the display and heard the label of the action. In the other condition, children heard only a label of the action.

Participants

A total of 20 TD 3-year-old children recruited from a mix of rural and urban area preschools participated in the study. All children had no significant history of language, visual, cognitive, or motor impairments, as indicated by parent report. The use of TD children has been supported by research done by Drager, Light, and colleagues (Drager et al., 2003, 2004; Light et al., 2004). Using TD children allowed the researchers to examine the effects of feedback on learning without confounds of other impairments and helped to ensure equivalency of groups.

At age 3, children are learning to take the perspective of another person (Nelson et al., 2003), but they may not yet have developed dual representation of graphic symbols (DeLoache, 2000). Children in the present study were required to take the perspective of a doll that could not use her
speech to communicate. Parents of children who met the above criteria for the present study filled out the MacArthur Communicative Development Inventory (CDI; Fenson et al., 1994) to ensure that the children had knowledge of the target concepts in the current study. Although not a formal language test, this practice was consistent with other published studies in this area (e.g., Drager et al., 2003, 2004; Light et al., 2004). The children recruited for the study had a mean age of 40.9 months and ranged in age from 37 to 45 months; 15% (3 of 20) were from diverse ethnic and cultural backgrounds (all were African American and all spoke English as their primary language at home and at school).

Stimuli

The stimulus was a house that was created using Adobe Photoshop (Adobe Systems) and BoardMaker (Dynavox Technologies) software. Verbs were chosen based on verbs from the CDI. According to the CDI, children should have all of the verbs present in the current study by 30 months of age (Fenson et al., 1994). Stimulus items for each verb were found in Microsoft ClipArt online. The house had four rooms and an outside icon as well. Children had five contexts to choose from when locating verbs: outside, bedroom, bathroom, living room, and kitchen. There was a screen shot of each room on the main page for the house. Each room in the house contained children acting on some object in the room, for a total of 15 stimulus verbs and one practice verb (see Table 1 for a list of the items). Three verbs in each room reduced the opportunity for guessing in the event that children could navigate to the correct room but were unsure of the correct verb to choose. Verbs were chosen to avoid words with overlapping meanings and to include ones that had existing picture communication symbols (PCS) animations and that could logically be performed within each room in the house. Upon selection of a verb, the label of each item was announced automatically using the DECTalk Kit the Kid voice. To ensure that the child understood the label, the experimenter repeated each label after the synthesized speech played. A copy of the home page is shown in Figure 1. The stimulus pages were presented on a Panasonic Tough Book Model CF-18 with a 10.4” viewable LCD screen swiveled to be presented as a tablet with no visible keyboard.

Table 1. Verb stimulus items.

<table>
<thead>
<tr>
<th>Hide</th>
<th>Climb</th>
<th>Kick</th>
</tr>
</thead>
<tbody>
<tr>
<td>Read</td>
<td>Jump</td>
<td>Tickle</td>
</tr>
<tr>
<td>Dry</td>
<td>Brush</td>
<td>Wash</td>
</tr>
<tr>
<td>Build</td>
<td>Sit</td>
<td>Call</td>
</tr>
<tr>
<td>Drink</td>
<td>Eat</td>
<td>Share</td>
</tr>
</tbody>
</table>

Note. The practice verb was Ride.

Procedure

After recruitment and consent, the convenience sample of participants was matched for sex and was randomly placed into two groups (Group 1, Group 2) of 10 participants with 5 girls and 5 boys in each group. The mean ages for each group were identical, with a similar range and distribution of ages between the groups. Group 1 received the animated and verbal feedback. Group 2 received only verbal feedback. Each individual in each group participated in a play activity for 20 min a session, for a total of three sessions (average session length was ~15 min for the first session and decreased with each subsequent session due to quicker response time for each item). Sessions took place at the day care center or the child’s home. All sessions were conducted by the first author.

The children were introduced to the AAC technology in the context of a play activity involving a small doll named Katie. Children were told that Katie could not talk, and they had to use the computer to talk for her. The play activity was explained to the children as follows:

Look up here. See the house? That is Katie’s house. Katie likes to sleep a lot. She will wake up soon. When she wakes up, we have to find things in and outside the house for Katie to do, so she does not go to sleep. Katie can’t talk. We have to use the computer to talk for her.

Children were given an action word to find and were expected to use the computer to “say” things for Katie to do. When children navigated to a room from the home page and then clicked on a representation of a desired verb, they received the verbal feedback of the verb name as well as a five-frame animation of a stick figure acting out the verb. Animations were used from PCS Animations (Dynavox Technologies). The animations either directly or nearly resembled the static action in the experimental house. The animations were of stick figures performing the specific actions. Although the software contained representations with nonstick figures, the items did not integrate with the background in size, shape, or orientation. Consequently, the stick figures were used to emphasize the action that the feedback was designed to provide. A copy of one of the line-drawn animations is provided as Figure 2. All rooms, verbs, and locations of verbs in the experimental condition of the house remained the same as in the control condition. The control condition contained only verbal feedback. No animation was played on selection of an item.

After each successful trial or following experimenter feedback, Katie was “woken up” by moving her around. Toys (e.g., a stuffed animal, blocks, a towel, a cup, and a ball) were provided for Katie to play with, although the experimenter never directly chose a toy for Katie to use. It was never noted that children used the toys with Katie, but rather interacted with Katie directly by moving her around to keep her awake. Play involving Katie was kept to <30 s.

In order to promote learning and avoid memorization of the task, sessions were scheduled at 3- to 5-day intervals. Two participants had 6 days between sessions. The procedures were adapted from studies by Light, Drager, and colleagues (Drager et al., 2003, 2004; Light et al., 2004). During each session, children were required to locate 15 verbs in the context of the play activity. The order of the verbs was randomly selected for each session. Each child
also received an instructional model of the task before being required to locate the 15 verbs. A scripted, instruc-
tional prompt was used for each target verb (e.g., “Katie is
hungry. Show her how to say ‘eat.’”). The last word of the
prompt served as the cue for the child to locate that verb.
Instructional prompts were only stated once. If children
were incorrect or did not respond within 20 s, they were
given an instructional response. That is, the researcher read
a prepared response explaining the rationale of where the
item is in the house (e.g., “‘Eat’ is in the kitchen because
that is where you eat food”) and the specific item (e.g.,
“This is ‘eat’ because the boy is eating a sandwich”).
Instructor responses for incorrect or no response were the
same in both conditions. The child’s first selection was
recorded, and children were prompted to continue to pre-
vent revisions within sessions. To ensure that the children
understood the synthesized speech label from the computer,
the experimenter repeated each label after the synthesized
speech played. A portion of the script used for the sessions
is contained in the Appendix.

Reliability
To ensure correct administration of the task, procedural re-
liability was calculated for each condition. The first author
practiced the scripted procedures until she could administer
them consistently with at least 90% accuracy. An indepen-
dent judge who was a graduate student in speech-language
pathology listened to audio-taped recordings of 20% of the
samples along with the same script used by the investiga-
tor to determine if the investigator followed the procedures
correctly. The judge practiced with two samples (once with
the investigator and once independently) and achieved
100% agreement with the investigator’s scores as training.
Procedural reliability was calculated to be 95% accurate
with deductions occurring for any deviation from the script
(resulting mostly from misspoken or skipped single words
that would most likely not have affected the child’s under-
standing of the trial).
To determine the reliability of scoring, at least 20% of
samples across children and sessions were chosen and were
coded by a separate trained observer. Scoring reliability
was judged by the same graduate student in speech-language pathology. The student practiced with two samples (once with the investigator and once independently) and achieved 100% agreement with the investigator’s scores as training. Scoring was based on the label as spoken by the investigator during trials (in no cases did the investigator fail to repeat the same label as produced via synthesized speech from the computer) and the synthesized speech output from the child’s selection. Interrater agreement was determined by calculating the number of agreements divided by the number of agreements, disagreements, and omissions. Scoring reliability was calculated to be 100%.

Data Analysis

The percentage of correct responses out of 15 was calculated for each child in each of the feedback conditions for each of the three data collection sessions. Means and standard deviations were calculated for each session for the control group and the feedback group. Planned comparisons using repeated measures analyses of variance (ANOVAs) were conducted to investigate each of the research questions.

RESULTS

Verbal-Only (VO) Versus Verbal+Animation (VA) Feedback

The first research question addressed whether the accuracy of TD 3-year-old children locating verbs within a dynamic AAC display would improve with the use of animation as feedback. A repeated measures ANOVA was conducted with feedback (VA vs. VO) as the between-subjects factor and time (Sessions 1, 2, and 3) as the within-subjects factor. The results of the ANOVA are displayed in Table 2.

The main effect for feedback was not significant, $F(1, 18) = .242, p > .05 (p = .629)$, indicating no significant effect for the use of animation as feedback. There was no interaction between condition and time, $p = .62$. The mean and standard deviation results for each condition across sessions are displayed in Table 3.

Performance Across Learning Sessions

The second research question asked whether 3-year-old children’s performance for locating verbs improved across
sessions with the different conditions (VO vs. VA). Results revealed that time was a significant factor in learning to locate verbs within a dynamic display, regardless of condition. The main effect for time was significant, $F(1, 18) = 52.40$, $p < .01$. There was no interaction between time and condition, $p = .62$. Post hoc testing was conducted to investigate significant differences between sessions. The Bonferroni correction was used to control for multiple comparisons ($\alpha = 0.001$). Posttesting revealed a significant difference between scores in Sessions 1 and 2, $p < .001$, with Session 2 having a significantly higher number of correct answers. There was not a significant difference between scores in Sessions 2 and 3, $p = .37$. The results for accuracy over time are displayed graphically in Figure 3.

In addition to the learning that occurred across sessions, the majority of children ($n = 14$) performed at mastery level (80%) by the second session of testing, regardless of feedback condition. By the end of Session 3, 90% of the children in the study had performed at mastery level on the task. Further analysis showed that learning was demonstrated within the first session. Figure 4 provides a descriptive representation of learning within Session 1.

Table 2. Analysis of variance for the effects of feedback by group and learning session.

<table>
<thead>
<tr>
<th>Source</th>
<th>$df$</th>
<th>$F$</th>
<th>$p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between subjects</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group</td>
<td>1</td>
<td>0.24</td>
<td>.63</td>
</tr>
<tr>
<td>Error</td>
<td>18</td>
<td>(13.52)</td>
<td></td>
</tr>
<tr>
<td>Within subjects</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Session</td>
<td>2</td>
<td>52.40**</td>
<td>.00</td>
</tr>
<tr>
<td>Session x Group</td>
<td>2</td>
<td>.48</td>
<td>.62</td>
</tr>
<tr>
<td>Error (Session)</td>
<td>36</td>
<td>(5.24)</td>
<td></td>
</tr>
</tbody>
</table>

**$p < .01$. 

Assessing the Impact of Age

The groups in the present study were matched by sex, and equivalent mean age (40.9 months) was established for each group. Children were not matched in each group by age. In order to assess the impact of age, a repeated measures ANOVA was conducted with age as the covariate. Statistical analysis with age as the covariate did not reveal significant results between groups, $F(1, 17) = 2.24$, $p > .05$ ($p = .15$), nor within groups, $F(2, 34) = .19$, $p > .05$ ($p = .83$).

DISCUSSION

The Lack of Effect of Feedback

Contrary to predictions, animated feedback did not significantly improve children’s ability to accurately locate verbs within a dynamic communication display. Children in the experimental condition performed comparably to children in the control condition. It is possible that animation in the form of feedback did not aid in rapid learning. Children were still required to understand the immediate symbol representation in order to get an item correct. Animated feedback may not have been necessary because all children had knowledge of all of the verbs. There are several other possible explanations for the lack of effect, having to do with the age of participants, the demands of the task, and the mismatch of the animated figures with the static representation.

Children who participated in the present study may have been too old developmentally to benefit from the use of animated feedback during the task. It was confirmed that the children had receptive knowledge of all of the verbs in the study, and so they should have had a firm representation of the verbs in their mental lexicon. The children may have also fully developed dual representation of the stimuli before completing the study, thereby reducing the learning demands of the task considerably.

The stimuli used in both the experimental and control conditions may have given the children too many cues, thus reducing the demands of the task. The only selectable items within each display were verb items. Children were required to find a child who was “doing ______”. The prompts for each verb did not vary across items or sessions. Therefore, the tasks may have relied more on the children’s ability to memorize the verb representations rather than learn to develop a map for a given verb representation via animated feedback. Given how quickly most of the children reached mastery, it is possible that inclusion of more items (verb or nonverb items) would have led to differences between the groups.

One concern about the animations that were used in the study is that they were not similar to the symbol representations. The animations used in the experimental condition were five-frame line drawings. The line drawings approximated the qualities of the symbol representation; they were not actual animations of the symbol. It was thought that an animated approximation of the symbol would serve as enough of a referent for the children in the experimental condition. Research has suggested that only a hint of animation (e.g., partial movement of an object) is enough for an individual to determine the action taking place (Jagaroo & Wilkinson, 2006); however, there is little guidance in the
literature to indicate how closely a static representation and an accompanying animated representation need to resemble each other. Despite difficulty with some representations, an error analysis revealed no single item as being consistently missed across sessions.

The Effect of Time

Results revealed that participants performed markedly better after the first session of the task, regardless of condition. Interestingly, learning occurred across both groups in the first session. There are two possible explanations for the learning: the instructional script and the stimulus items. The instructional script provided a clear task for the children. For each verb, children were first given a semantic cue (e.g., “Katie is hungry”) then the stimulus prompt (e.g., “Show her how to say ‘eat’”). The syntactic structure of the prompts was the same for each stimulus item. This reduced the sentence processing involved in the task while simultaneously providing a task that was simple for the children to follow. Furthermore, the task itself appeared to be motivating for young children. Children enjoyed finding activities for the doll around the house, and they also enjoyed time spent on the computer. Both features of the script could have reduced the learning demands of the task for the children.

It can be concluded that most of the symbols used in the present study provided an appropriate representation of the verbs. The stimulus symbols were a close match to the children’s mental representations of the verbs. Few of
the symbol representations did not accurately reflect the children's mental lexicon. Those that were not as accurately located between the two sessions may be considered more difficult to represent in a static picture (e.g., share). For those symbol representations, it may be that children did not understand the picture used or confused it with another, similar-looking concept (e.g., give).

Clinical Implications

There are two important interpretations to be taken from the present study. First, results of the current study suggest that animation may not be needed to access more transparent verbs provided that the scene and task promote links to storage of representations as verbs. Animation may also not be needed for children who already have a representation of the verb in their mental lexicon. Previous research studies (e.g., Drager et al., 2003, 2004; Light et al., 2004) have shown that young children with serious communication needs understand language better when it is represented in a scene. These scenes must be familiar to the child (e.g., a photograph of a living room) or must closely resemble their understanding of the world (e.g., a cartoon picture of a room). For nonphotographic scenes, it is important that the symbols that are used in the picture accurately reflect a child’s perception of the world.

A second implication is that the activity used for both conditions may be an effective teaching tool for children who are using AAC devices. Across two sessions (~25 min of interaction), children located 12 concepts within a four-room scene on a dynamic display. This could provide a child with a significant increase in AAC verb symbols for two-word utterance construction. The activity could supply children with action–object and agent–action word combinations not previously capable without the use of verb symbols. It would take little time for children to acquire this vocabulary. The overall activity for embedding language has been used effectively in other AAC studies as well (Drager et al., 2003, 2004; Light et al., 2004).

Limitations

The present study had several limitations. Participants in the current study were TD children. Results may not generalize to children who require AAC. Children with severe physical and communication impairments may not have had the same experiences with the verbs in the current study. It is possible that children requiring AAC could benefit from animation; however, the current results cannot address this idea. All children had the concepts of the verbs in their mental lexicon. It is unknown how children would perform in the experimental task if they did not have prior knowledge of the verbs. Given that children were required to navigate to a page as well as select the correct item, there were two demands in the current task. Future research could separate the two before considering the combined effects of each.

The number of verb items used in both conditions may not have been enough to necessitate the use of feedback. Fifteen verbs and one verb model were used in both displays. The low number of verbs in each room paired with the room displayed on the home page may not have been a challenge. The number of verbs deals similarly with the overall issue of scene layout. It is not yet known how many objects in a room is too many for a child to perform successfully. Therefore, it is difficult to determine whether the number of verb items had a significant impact on the results of the study.

In terms of design, review of videotapes of sessions would have helped to ensure that all animations played correctly. Further, use of multiple raters may have helped to further establish procedural integrity and scoring reliability. A larger number of participants would have given the study more power in asserting conclusions.

Directions for Future Research

The present study examined the effects of animated feedback on TD 3-year-old children. Research conducted by DeLoache (2000) has suggested that children develop dual representation for symbols between 2½ and 3 years of age. Taking into account the age at which dual representation develops, it would be important to conduct the current study with TD children between 2 and 2½ years of age. Future research could determine the effects of dual representation development on children’s ability to locate verbs within a contextual scene.

It is also important to consider the animations that were used in the current study. Animations in the present study did not resemble the static representation of the children on the page. Instead, the children were shown a stick figure performing an approximation of the action. Further research may consider the use of direct animation (e.g., animating the stimulus items more realistically in the scene) or video animation. Video animations of actions being completed could be another useful method of teaching verb concepts to children with severe motor and cognitive impairments.

Finally, it is important to consider isolating animation from other confounding factors that may be present in high-tech communication devices. Separating animation effects from those demands placed on new user navigation issues could provide interesting results. Separating the need for animation as a teaching tool from the purpose of gaining attention to a new item within a page may also be investigated.

Conclusion

Children who use AAC devices are in need of sufficient symbolic representation for a variety of concepts. Visual scenes have provided an appropriate context in which to embed language concepts; however, current visual scenes have not provided enough support for a dynamic verb. Animation as a form of feedback showed potential for decreasing the gap in symbolic representation of a verb in a child’s lexicon to that on a static photo. Animations did not help to decrease the learning demands of this particular visual scene task; however, children were still able to...
learn, and master, the task within a short period of time. Animation may still prove useful in teaching verb concepts to young children with restricted environmental exposure. For now, it is necessary to consider the representation of the symbols used for various concepts when constructing a visual scene.

REFERENCES


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**APPENDIX. SCRIPT USED IN THE STUDY**

<table>
<thead>
<tr>
<th>Look up here. See the house? That is Katie’s house. Katie likes to sleep a lot. She will wake up soon. When she wakes up, we have to find things in and outside the house for Katie to do, so she does not go to sleep. Katie can’t talk. We have to use the computer to talk for her.</th>
<th>Notes:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Say: <em>Katie is ready to play. Show Katie how to say RIDE.</em></td>
<td>Model Completed?</td>
</tr>
<tr>
<td>I look... (point to each room and outside as you look for RIDE).</td>
<td>YES ______ NO _______</td>
</tr>
<tr>
<td>I see a boy <strong>riding</strong> a bicycle. Let’s go Outside. (Push the Outside Page)</td>
<td>Notes:</td>
</tr>
<tr>
<td>This boy can ride a bike. (Push RIDE)</td>
<td></td>
</tr>
<tr>
<td>We wanted RIDE. We picked RIDE!</td>
<td></td>
</tr>
<tr>
<td>Now it’s your turn</td>
<td></td>
</tr>
<tr>
<td>Open Home Page</td>
<td></td>
</tr>
<tr>
<td>Say: <em>Katie is ready to play. Show Katie how to say RIDE.</em></td>
<td>Model Completed?</td>
</tr>
<tr>
<td>Let’s look for RIDE. RIDE is outside.</td>
<td>YES ______ NO_______</td>
</tr>
<tr>
<td>Look.....</td>
<td></td>
</tr>
<tr>
<td>You wanted RIDE. You picked RIDE!</td>
<td></td>
</tr>
<tr>
<td>Now you do it. Help Katie</td>
<td></td>
</tr>
<tr>
<td>Say: <em>Katie’s hands got wet. Show Katie how to say DRY.</em></td>
<td>Please Circle One</td>
</tr>
<tr>
<td>(If right) You wanted DRY. You picked DRY!</td>
<td>DRY</td>
</tr>
<tr>
<td>(If wrong) You wanted DRY. Uh-oh you picked <em>(actual)</em></td>
<td>Right</td>
</tr>
<tr>
<td>(If no response) You wanted DRY. Uh-oh!</td>
<td>Wrong (please write response given)</td>
</tr>
<tr>
<td>Model for wrong or NR: We need to find DRY. DRY is in the Bathroom page because the bathroom is where you clean yourself. This is the Bathroom page because children are washing themselves. This is DRY because the boy is drying his hands with a towel.</td>
<td></td>
</tr>
<tr>
<td>Open Home Page</td>
<td>No Response</td>
</tr>
<tr>
<td>Say: <em>Katie likes to play a lot. Show Katie how to say CLIMB.</em></td>
<td>Please Circle One</td>
</tr>
<tr>
<td>(If right) You wanted CLIMB. You picked CLIMB!</td>
<td>CLIMB</td>
</tr>
<tr>
<td>(If wrong) You wanted CLIMB. Uh-oh you picked <em>(actual)</em></td>
<td>Right</td>
</tr>
<tr>
<td>(If no response) You wanted CLIMB. Uh-oh!</td>
<td>Wrong (please write response given)</td>
</tr>
<tr>
<td>Model for wrong or NR: We need to find CLIMB. CLIMB is in the Outside page because it is a place where you can climb. This is the outside page because you can see people playing outside. This is CLIMB because the boy is climbing the tree.</td>
<td></td>
</tr>
<tr>
<td>Open Home Page</td>
<td>No Response</td>
</tr>
<tr>
<td>Say: <em>Katie is thirsty. Show her how to say DRINK.</em></td>
<td>Please Circle One</td>
</tr>
<tr>
<td>(If right) You wanted DRINK. You picked DRINK!</td>
<td>DRINK</td>
</tr>
<tr>
<td>(If wrong) You wanted DRINK. Uh-oh you picked <em>(actual)</em></td>
<td>Right</td>
</tr>
<tr>
<td>(If no response) You wanted DRINK. Uh-oh!</td>
<td>Wrong (please write response given)</td>
</tr>
<tr>
<td>Model for wrong or NR: We need to find DRINK. DRINK is in the Kitchen page because the kitchen is where you eat food. This is the Kitchen page because it has a refrigerator and stove. This is DRINK because the girl is drinking from a cup.</td>
<td></td>
</tr>
<tr>
<td>Open Home Page</td>
<td>No Response</td>
</tr>
</tbody>
</table>