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Brief Report

Brief Report: Vocabulary Acquisition for Children with Autism: Teacher or Computer Instruction

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This study examined the impact of computers on the vocabulary acquisition of young children with autism. Children's attention, motivation, and learning of words was compared in a behavioral program and an educational software program. The educational software program was designed to parallel the behavioral program, but it added perceptually salient qualities such as interesting sounds and object movement. Children with autism were more attentive, more motivated, and learned more vocabulary in the computer than in the behavioral program. Implications are considered for the development of computer software to teach vocabulary to children who have autism.

KEY WORDS: Vocabulary acquisition; autism; computer technology.

INTRODUCTION

Autism is a communication disorder affecting between 100,000 and 400,000 Americans (Maurice, Green, & Luce, 1996). Behavioral treatments, such as the Lovaas (1981) method, have successfully taught language skills to many children with autism (Maurice *et al.*, 1996). Through behavioral techniques, such as shaping and reinforcement, children acquire vocabulary and communication skills, thereby facilitating their cognitive development.

Although various behavioral treatments have been successful, individual teacher–pupil learning techniques are time intensive and expensive. With the entry of computers into classrooms, children with autism now have readily available tutors who are patient and respond contingently to their responses.

Computer software can be developed that creates an intrinsically interesting learning environment that appeals to children with autism. For instance, children with autism who were about age 9 learned more vocabulary and appeared to enjoy learning more when taught by a computer rather than by a teacher (Heimann, Nelson, Tjus, & Gillberg, 1995). How might computers impact younger children's vocabulary acquisition when they are in a sensitive period for language acquisition?

One important aspect of creating intrinsically interesting learning environments involves the use of perceptually salient production features, such as sound effects and action, that are likely to elicit children's attention to, and processing of, information (Calvert, 1999). These features may be especially helpful to young children or to those who have developmental delays. For example, computer software that utilizes features like action increases poor readers' memory of nouns by providing a visual, iconic mode that children can use to represent content (Calvert, Watson, Brinkley, & Penny, 1989). We hypothesized that similar beneficial effects of perceptually salient features would occur for children with autism.

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The purpose of this study was to create a computer software program that builds upon behavioral learning principles to enhance the vocabulary skills of children who have autism. To do so, we incorporated perceptually salient techniques in the program to elicit children's attention, enhance their motivation, and foster their memory of nouns.

METHOD

Participants

Participants attended a school in which children were grouped in classes according to their skill levels: (a) those who displayed some receptive verbal skills; (b) those who could generate and understand simple, but not complex, sentences; and (c) those who could generate and use complex sentences but not consistently. Children within each class ranged in age from 3 to 6. Within skill level and gender groups, 14 children (12 boys and 2 girls) with autism were randomly assigned to one of two treatment conditions: the behavioral condition and the computer condition.

Procedure

Before beginning treatment conditions, participants were taught to "sit" in a chair, and to "look at," or attend to, the teacher on command. Treatment began after children could sit for at least 10 consecutive minutes, and consistently attend in response to the commands "look," or "look at." The amount of time taken to teach children these two tasks varied according to each individual, but averaged about 10 minutes per day for 5 days.

Vocabulary acquisition in the behavioral condition began with teaching simple skills that were gradually expanded by chaining mastered skills. The first step was to teach the names of simple objects through an object labeling drill. In these drills, children were taught to respond to verbal commands such as "Give me (object)," or "Touch (object)." Rewards of verbal praise or playing with a desired object, lasting an average of 7.41 seconds, were given when children responded correctly. Verbal prompts were given after an incorrect response and continued until children made the correct response. An object name was mastered when children correctly responded three times in a row without prompting.

The computer software program paralleled this drill, but added sensory reinforcement and potentially attention-getting features such as color, animation, music, and interesting sounds. After an object was mastered, the computer delivered an 8-second reinforcement of visual stimulation and interesting sounds.

All children in the behavioral condition had previously experienced behavioral training. Five of seven children in the computer condition had previously interacted with a computer and knew how to use a mouse. All children began treatment as soon as they could sit and attend on command. The two children who were unfamiliar with using computers were also given an initial practice session to familiarize them with the click function of the mouse. Children in both groups learned three new objects a day over a 2-day period.

Dependent Measures

Learning Measures (Pretest/Posttest)

Prior to treatment, each child was given a pretest consisting of 18 nouns ranging from commonplace to obscure. The nouns were dog, cat, horse, bunny, cow, bull, fly, scorpion, butterfly, ladybug, lizard, nail, penny, thimble, dropper, safe, scale, and pin. Each noun was placed on a flashcard. The teacher then showed children two flashcards simultaneously and asked children to identify an asked for object three times in a row. Feedback about the child's responses was not provided. Known and unknown nouns were recorded for each child.

During treatment conditions, children were taught the names of six targeted nouns that they did not previously know. Approximately 1 week after completion of treatment conditions, the teacher used the same flashcard procedure to posttest children on their learning of the six targeted nouns.

Attention Measure

To examine attentional patterns, children were videotaped during treatment conditions. The total percentage of time attention was "on" or "off" was recorded for each subject. "On" looks were defined as the duration of visual attention directed at the teacher or learning materials for those in the behavioral condition, or at the computer for those in the computer condition. "Off" looks were defined as the duration of visual attention directed away from the teacher or learning materials for the training condition, or away from the computer screen for those in the computer condition.

To calculate reliability, two observers scored the duration of attention (i.e., "on looks") for six randomly chosen subjects, three from each treatment group. Interobserver agreement was 96% for duration of attention.

Motivation Measure

Following the final treatment session, children were asked if they wanted to keep working or go play. If children did not initially understand the question, it

was verbally repeated. The teacher also prompted responses by pointing at drill materials and play items. Children indicated their choices to stay with the drill activity either verbally or by pointing at the drill activity. Children indicated their choice to leave the drill activity verbally, by pointing at the play activity, or by leaving the drill chair and moving to the play activity. When participants chose to continue working on the drill, their condition was scored as being motivating to them. When participants chose to go play, their condition was scored as being less motivating to them.

RESULTS

Treatment Effects on Attention, Learning, and Motivation

The first hypothesis was that children would attend more during treatment conditions when a computer rather than a teacher presented words. As predicted, a one-way ANOVA revealed that children were more attentive in the computer than in the teacher presentation (M = 97 vs. 62%, respectively), $F(1, 13) = 13.28$, $p < .01$.

The second hypothesis was that children would remember more of the nouns in the delayed recall test when a computer rather than a teacher presented words. There were six possible words to learn. As predicted, a one-way ANOVA revealed that children recalled more nouns after exposure to the computer (M = 4.43 or 74%) than to the teacher presentation (M = 2.43 or 41%), $F(1, 13) = 10.89$, $p < .01$.

The third hypothesis was that children would be more motivated to interact in the computer than in the behavioral condition after treatment ended. As expected, a chi-square analysis revealed that significantly more children were interested in continuing treatment in the computer than in the behavioral condition, $\chi^2_{(1)} = 3.818$, $p < .05$. None of the children in the behavioral condition elected to stay in treatment whereas 57% of children in the computer condition elected to do so.

Relation Between Attention and Learning

To test the prediction that learning would improve when children attended more to the teacher or the computer, a regression analysis was run with duration of attention as a predictor of learning. As expected, the more children attended in either condition, the more they learned, $F(1, 13) = 38.45$, $p < .001$.

DISCUSSION

The purpose of this study was to examine the impact of a computer program on vocabulary acquisition for children who had autism. Children were attentive 97% of the time in the computer condition and only 62% of the time in the teacher condition; they learned 74% of the targeted nouns in the computer condition and only 41% of the nouns in the teacher condition; and 57% of the children in the computer condition wanted to continue treatment compared to none of the children in the teacher condition. Moreover, there were links between attending during treatment and later memory for the nouns that had been taught in both conditions, suggesting that eliciting children's visual attention is an important first step in improving children's subsequent retention of information.

The computer package created here combined attention-getting features, such as sound effects and actions (Calvert, 1999), with behavioral methods, such as chaining and immediate contingent reinforcements, that are effective in treating children who have autism (Heimann *et al.*, 1995; Maurice *et al.*, 1996). The results reported here suggest that the combination of these approaches yields beneficial effects for children with autism. Integrating computers in classrooms could provide a cost-effective teaching method to supplement current behavioral pedagogical practices.

This study is limited by the small sample and by the potential variance in responses by children with autism. However, random assignment of children to treatment conditions should have spread the variance in children's responses across the two treatment conditions equally. Moreover, treatment effects were highly significant, and it is more difficult to get significant effects with a small than a large sample. Nonetheless, to increase the generalizability of the findings, future research should expand the number of children examined and include a control group that receives no treatment. The durability of children's retention of material over longer periods, the potential novelty effects of computer instruction, the use of collaborative as well as individual computer activities, and the specific visual and auditory production techniques that promote interest and learning should also be examined.

In conclusion, this study demonstrates the promise of computer technologies as a supplement to traditional behavioral techniques in teaching vocabulary to children with autism. Carefully constructed computer programs gain children's attention, motivate them, and promote their learning of vocabulary. Moreover, computers are a cost-effective method to educate children who require one-on-one assistance in learning environments. The software developed here is a first step in examining how computers can be used to integrate children who have autism into the linguistic environment that characterizes human interaction.

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