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Effects of superimposition and background fading on the sight-word reading of a boy with autism

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Abstract

We used a multiple-baseline design across materials to assess the effects of stimulus superimposition and background fading on the sight-word reading skills of a 6-year-old boy with autism. Before the study began, the boy was taught to make verbal responses when shown 15 photographs of physical education activities and equipment. During baseline and teaching, probes of target words relevant to the photographs (e.g., slide, swing) were conducted in discrete-trial sessions. When teaching began, three sets of target sight words were successively superimposed on photographs of the corresponding activities and backgrounds were then faded by removing portions of the photographs until only the text was visible. After all fading steps were completed, the student correctly read 14–15 of the 15 target words and these skills maintained on a 44-day follow up probe. Further, generalization measures showed that reading skills transferred across text size and color. Superimposition and background fading quickly expanded the sight-word reading repertoire of a youngster with autism.

Keywords: Autism; Stimulus fading; Stimulus superimposition; Reading

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1. Introduction

Error-reducing procedures have been used to teach many different skills to people with developmental disabilities, including left–right discriminations (Bijou, 1968); bathing (Cameron, Ainsleigh, & Bird, 1992); up–down discriminations (Etzel, LeBlanc, Schilmoeller, & Stella, 1981); aquatic play skills (Yilmaz, Birkan, Konukman, & Erkan, 2005); unprompted social interaction (Krantz & McClannahan, 1993, 1998); stating monetary amounts that include decimals (MacDuff, Krantz, & McClannahan, 2001); shape discriminations (Sidman & Stoddard, 1966); and solving missing minuend problems (Smeets, Lancioni, & Striefel, 1987). These procedures are often more efficient than instructional strategies that generate higher error rates, because when errors occur they are likely to be repeated, and it may be increasingly difficult to prevent them (Etzel, 1997; Terrace, 1963). In addition, because incorrect performances are not followed by rewards, children who make many errors may become inattentive or disruptive (McClannahan & Krantz, 2005).

Etzel and LeBlanc (1979) identified five error-reduction procedures: fading, stimulus shaping, superimposition and fading, superimposition and stimulus shaping, and delayed cues. After reviewing the use of many such procedures, Lancioni and Smeets (1986) observed that these teaching strategies enable people with severe developmental disabilities to acquire skills that previously seemed unattainable with trial-and-error procedures.

The present study used superimposition and stimulus fading; two classes of stimuli were presented to prompt the target responses and subsequently, one class was faded out (cf. Cooper, 1987). Specifically, textual stimuli (S+) that corresponded to photographs were superimposed on photographs (S−) and the photographs were then faded. Stimulus fading involves the gradual manipulation of some physical dimension (e.g., size, color, intensity) of a stimulus to promote a shift in stimulus control ''from some dominant stimulus element to a different and criterion stimulus'' (Etzel & LeBlanc, 1979). In this case, the size of the photographs that appeared as background for the text was systematically reduced until photographs were absent.

2. Method

2.1. Participant

EJ was 6.2 years of age when he was enrolled in the Princeton Child Development Institute's school program. He arrived with an independent diagnosis of autism. When first seen, he engaged in delayed echolalia but displayed little functional expressive language. His stereotypic responses included non-contextual laughter, repetitive hand and arm movements, muscle tensing, and posturing. If stereotypy was interrupted, he often engaged in tantrum behavior or attempted to flee.

At the time of the investigation, EJ was 6.8 years old; his age-equivalent score on the Peabody Picture Vocabulary Test of receptive language was 4.2 years. In the 57 school days subsequent to his enrollment, he learned to follow a photographic activity schedule

(McClannahan & Krantz, 1999), to imitate many verbal models, to label many common objects, and to point to and say alphabet letters. He also mastered 16 sight words in Edmark Reading Program (1992). His parents gave informed consent for his participation in this study.

2.2. Pre-investigation instruction

Before the study began, EJ was taught to make 15 different verbal responses when presented with 15 photographs related to exercise activities; for example he learned to say ''slide'' when shown a photograph of a slide, and to say ''tumble'' when shown a photograph of an exercise mat. The instructor presented each photograph, said ''Tell me about this,'' and provided verbal prompts (e.g., ''Say, 'slide'''). Correct responses were rewarded with tokens placed on a token board. Instruction ended when EJ correctly responded to all 15 photographs in two consecutive sessions.

2.3. Settings

Teaching sessions occurred in a 7 m × 7 m gym used by young children. It contained typical physical education equipment, such as a Pogo stick, a balance beam, a jogging trampoline, and a plastic basketball hoop. EJ's activity schedule was located on a table on one side of the room. During sessions, only EJ, the instructor, and observers were present. Teaching sessions were conducted once or twice daily at 12:15 p.m. and 2:15 p.m.

Probes were conducted in the student's usual 4 m × 4 m classroom, which contained desks, chairs, and shelves upon which toys and learning materials were displayed. Only EJ, the instructor, and observers were present.

2.4. Materials

EJ's photographic activity schedule was presented in an 18 cm × 23 cm notebook, which contained fifteen 35-mm digital photographs of exercise equipment (e.g., inflatable plastic punching bag, jogging trampoline, balance beam). Color photographs (7 cm × 10 cm) were placed in plastic baseball card holders and mounted in the album, one picture to a page, on a black background. The textual stimuli used during teaching were white words printed in 48-point *Times font*, which were superimposed on the center of each photograph; this was accomplished using Adobe Photo Shop, Version 7.0. White text was selected because it was more visible when superimposed on the photographs.

During probes, the same white text (in 48-point *Times font*) was presented on a plain black background on cards that were inserted in baseball card holders. The materials used at follow up were identical to those used on baseline and teaching probes. During generalization assessment, black text was printed on white 5.5 cm × 8.5 cm cards, using 36-point *Times font*. Cards were encased in clear vinyl pockets available from stationery stores. The target sight words were randomly assigned to three sets. Words in Set 1 were Pogo stick, punch, slide, video, and walk; Set 2 words were wheels, basketball, jump, swing, and tumble; and Set 3 words were tunnel, beam, bat, toss, and lift.

2.5. Dependent variable

A sight-word reading response was scored correct if the participant, without prompts, said an understandable word or words that corresponded to a written word or words, said only the target words, and did so within 5 s of the presentation of textual cues that were: (a) superimposed on a photograph, (b) presented on a black background on a page of his activity schedule, or (c) presented on a card.

2.6. Experimental design and measurement

A multiple-probe design across three sets of five sight words was used to assess the effects of stimulus superimposition and background fading. Throughout all conditions, observers used a per-opportunity measure to score reading responses. During training, opportunities occurred when the learner pointed to textual stimuli on a page of his activity schedule; during probes and generalization assessment, opportunities occurred when the instructor displayed target text and said, ''Read.''

2.7. Experimental conditions

2.7.1. Baseline

During baseline probes, the instructor presented each of the 15 sight-word cards in a one-to-one session in the boy's usual classroom. The instructor said, ''Read,'' and waited 5 s. Correct reading responses were not rewarded. Tokens were delivered for attending behavior (e.g., sitting quietly, orienting toward the instructor) and were exchanged at the end of the session for a toy, snack, or activity that EJ selected.

2.7.2. Teaching

Probes were conducted in the learner's usual classroom; procedures were identical to those used during baseline. Teaching sessions occurred in the gym. The three-ring binder, placed on a table, contained 15 pages and a color photograph that corresponded to each exercise activity was attached to each page. The order of pages in the activity schedule was randomly re-sequenced each session. Three sets of five sight words were successively introduced. Initially, white text, presented in 48-point, *Times font*, was superimposed on the full-size photographs.

Teaching sessions began when EJ opened (or was prompted to open) his activity schedule to the first page and ended when he had completed all 15 physical education activities (approximately 15 min). If necessary, the instructor used graduated guidance to help EJ point to photographs or sight words, go to the relevant exercise equipment, complete the physical education activity, return to the activity schedule, turn the page, and repeat this sequence. If EJ did not label a depicted activity or read a sight word, the instructor modeled the relevant words or the reading response while manually guiding him to point to the photograph or text.

During pre-investigation instruction, EJ learned to make verbal responses that corresponded to the 15 photographs. Therefore, teaching began with superimposition of textual cues that matched his verbal responses, and fading of photographic backgrounds. In Fading Step 1, 1-cm strips were cut and removed from the top and bottom of each

photograph. In Fading Step 2, 1-cm strips were again removed from the top and bottom of each photograph, and in Fading Step 3, the photograph was cut to reveal only the text and the small portions of the color photograph that showed through the letters in each word. At Fading Step 4, only the sight-word cards remained on the pages of the activity schedule; these cards were identical to those presented during probes.

In Set 1 only, after EJ made three errors at Fading Step 4, Fading Step 5 was introduced. This step was identical to Fading Step 3, except that all background color was removed from the portions of the photograph that remained visible around letters in the text. After two consecutive teaching sessions in which all five words were correctly read, Fading Step 4 was re-introduced.

2.7.3. Follow up

Forty-four days after the experiment ended, the instructor administered a probe that was identical to those used during baseline and teaching. It was conducted in EJ's usual classroom and only EJ, the instructor, and observers were present.

2.8. Generalization assessment

Skill transfer was assessed on Sessions 1 and 41 in the student's usual classroom, in the presence of the instructor and observers. The procedures were the same as those used during probes with the exception that font size, text color, background color, and card cases differed. On probes, sight words were presented as white, 48-point *Times font* on a black background and cards were encased in 7.5 cm × 10.5 cm baseball card holders. On generalization measures, sight words were presented as black, 36-point *Times font* on a white background and cards were encased in 6.5 cm × 9.5 cm vinyl envelopes.

2.9. Interobserver agreement

Observers were experienced data collectors who did not require training. During probes in the classroom, they stood facing one another on opposite sides of EJ and the instructor, so that they had unobstructed views of EJ's face and the textual cues presented by the instructor. During teaching sessions in the gym, they were stationed one on each side of EJ's activity schedule, so that they could observe the target word(s) as well as EJ's verbal or reading responses.

Agreement was assessed on 100% of probes, 54% of teaching sessions, on follow up, and on both generalization measures. Percentage interobserver agreement was calculated by dividing number of agreements by total number of agreements plus disagreements and multiplying by 100. Mean percentage interobserver agreement was 93% on probes (range = 86–100%); 100% on teaching sessions; 100% on the follow-up measure; and 100% on both generalization measures.

3. Results

On probes during baseline, EJ correctly read one word in Set 1 (Sessions 3 and 4), and one word in Set 3 (Session 30). Teaching concluded after 30 sessions (Fig. 1). EJ completed

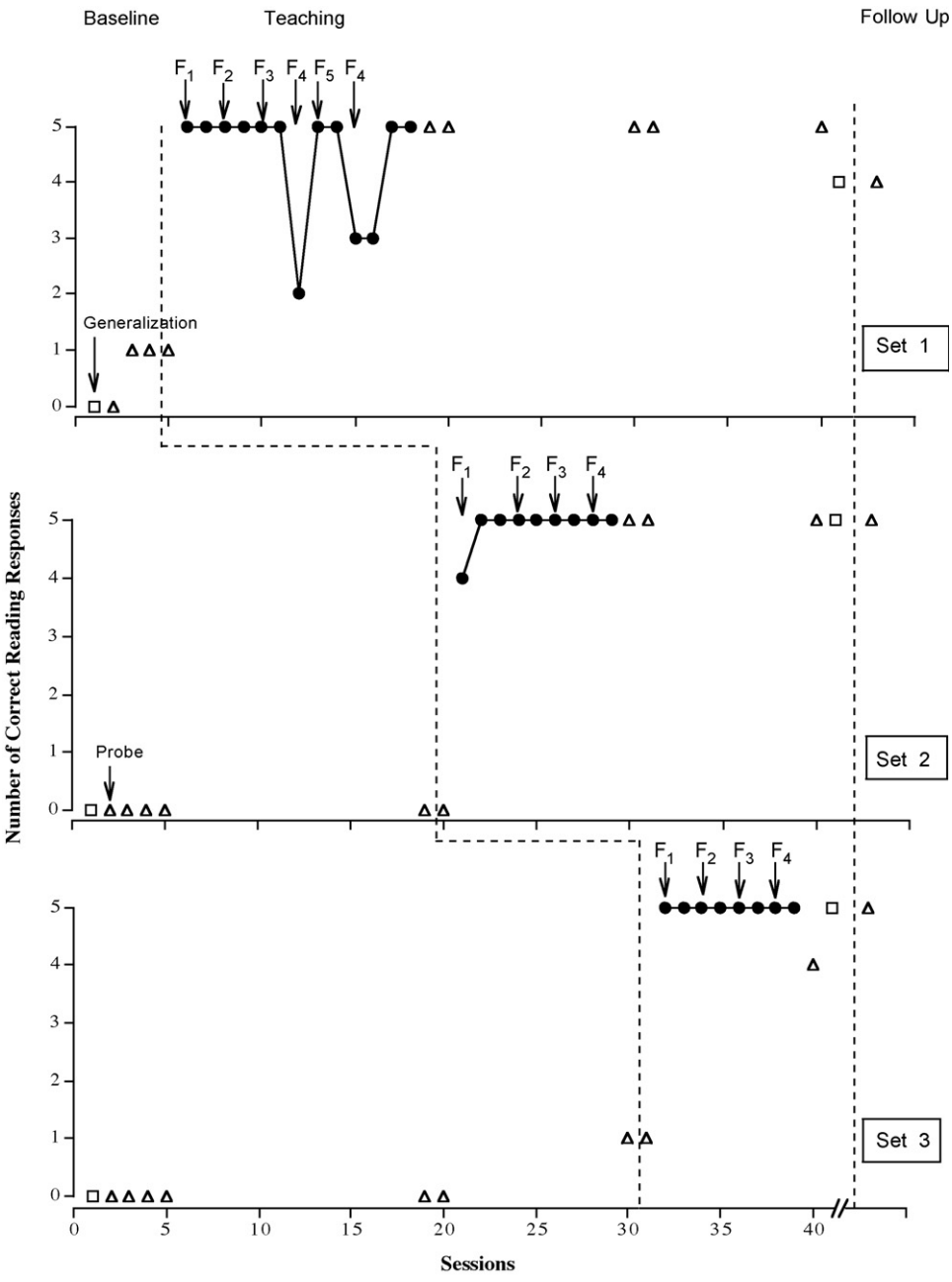

Fig. 1. Number of correct reading responses per session on Sets 1–3 during baseline, teaching, and follow-up. Triangles represent probes and closed circles indicate teaching. Arrows mark Fading Steps 1–5. Generalization assessment is noted by squares.

Set 1 after 13 teaching sessions, Set 2 after 9 sessions, and Set 3 after 8 sessions; fading steps were completed more quickly on each successive set. After teaching sessions ended, the boy correctly responded on all probes except one—in Session 40, he made one error on a word in Set 3.

Because three errors occurred on Fading Step 4 (Session 12), Fading Step 5 was introduced. On this fading step, background color was removed from the portions of the photograph that remained visible. Error-free performance resumed on Sessions 13 and 14; return to Fading Step 4 temporarily produced errors that ceased at Session 17.

Generalization to text in a different size and color and displayed on a different background was assessed in Session 1 (Baseline) and Session 41 (post Teaching). None of the target words was correctly read on the first generalization measure and 14 of 15 were correctly read on the second measure (there was one error on a word in Set 1). On a follow-up probe conducted 44 days after sessions ended, EJ correctly completed 14 of 15 reading tasks.

4. Discussion

Although much has been written about the advantages of stimulus shaping versus stimulus fading in producing fewer errors and more efficiently achieving the desired shift in stimulus control, there is also recognition that any procedure that achieves rapid behavior change with few errors should be included in educational technology (Cooper, 1987; Etzel et al., 1981). Stimulus fading often requires less-extensive preparation of teaching materials than stimulus shaping (Lali & Browder, 1993), and intervention personnel are more quickly trained to assist in the production and alteration of instructional stimuli used in stimulus fading. In this study, stimulus materials were easily created, using a digital camera, computer, and color printer—equipment that is available in many educational settings.

We found it interesting that EJ made correct responses on three baseline probes. He sometimes ‘‘guessed’’ when the instructor presented a probe stimulus and said, ‘‘Read,’’ and some of his guesses were words taught during pre-investigation instruction. Perhaps these occasional correct responses occurred because the instructor who conducted probes was the same person who provided pre-investigation training and his presence evoked some of the previously taught words.

When Fading Step 4 was introduced on Set 1, stimulus control failed to transfer from photographs to textual stimuli. Subsequently, Fading Step 5 (no background color in the remaining portion of the picture) achieved a return to errorless responding, and the return to the final fading step (Step 4) produced temporary errors that disappeared in subsequent sessions. Problems in transfer of stimulus control were confined to Set 1; in Sets 2 and 3, control transferred immediately when pictorial cues were no longer available.

A total of 8 errors were recorded during 30 teaching sessions (13 sessions for Set 1, 9 for Set 2, and 8 for Set 3), which contained 150 opportunities to respond; thus, during background fading, only 5% of responses were errors. Errors that occurred after background fading was completed were few and scattered. EJ made an error on the final probe of Set 3, although he consistently read the target text (‘‘toss’’) on 8 prior

opportunities during teaching. On follow-up assessment 44 days after the experiment concluded, there was one reading error on the Set 1 text ''punch,'' which was correctly read on five post-teaching probes. Because errors were scattered rather than repeated, they may have been a result of inattention.

Six-year-old EJ arrived in the intervention program with few skills and without a prior intervention regimen that was effective. After enrollment, his rapid acquisition of verbal-imitation skills, receptive and expressive labels, and beginning handwriting skills suggested that every effort to maximize instructional time would be critically important to his progress. In 5 months, he learned 16 sight words in the Edmark Reading Program (a carefully programmed curriculum based on behavior analysis). The superimposition and fading program helped him virtually double his reading repertoire in 6 pre-investigation instructional sessions and 30 teaching sessions that spanned 24 days.

These procedures were time-efficient because reading instruction was embedded in a gym activity, simultaneously accomplishing two educational goals. Additional sight words will be taught in a similar manner in other daily school activities, such as lunch, personal hygiene, and leisure activities.

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