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DECREASING ERRORS IN READING-RELATED MATCHING TO SAMPLE USING A DELAYED-SAMPLE PROCEDURE

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Two men with intellectual disabilities initially demonstrated intermediate accuracy in two-choice matching-to-sample (MTS) procedures. A printed-letter identity MTS procedure was used with 1 participant, and a spoken-to-printed-word MTS procedure was used with the other participant. Errors decreased substantially under a delayed-sample procedure, in which the choice stimuli were presented first and the sample was presented only after 5 s without a response to the choice stimuli.

DESCRIPTORS: conditional discrimination, delayed sample, intellectual disabilities, matching to sample

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Matching-to-sample (MTS) procedures are used widely in teaching preacademic and language skills to individuals with intellectual disabilities (e.g., Leaf & McEachin, 1999; Walpole, Roscoe, & Dube, 2007). In a typical application of the procedures, trials begin with the presentation of a spoken or visual sample stimulus. An observing response (e.g., touching the visual sample stimulus) produces two or more choice stimuli while the sample remains present. Selecting the correct choice stimulus produces a reinforcer.

The goal of our research program is to develop instructional programming for the component skills of individual-word recognition with a focus on establishing relations between spoken words and print and the discriminations required to master these relations. We recently encountered 2 participants who, despite having shown high accuracy (percentage of trials on which the correct choice stimulus was selected) under MTS procedures with other stimuli, had difficulties reaching accuracy levels of above 90% with specific stimuli. One participant performed printed-letter identity MTS with high accuracy, but showed accuracy of 72% to 80% with *p* and *q*. The second participant had learned numerous spoken-to-printed-word relations to levels of above 90% (e.g., *mut* and *mot*), but showed accuracy of 77% to 87% with *tut* and *tot*. Thus, these 2 individuals participated in this study because they exhibited intermediate accuracy on specific discriminations.

Intermediate accuracy may suggest that the sample stimuli controlled stimulus selection on some, but not all, trials (see Sidman, 1980). Had there been no control by the sample stimuli, accuracy would have been 50%. Because the

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participants already demonstrated MTS skills, we chose a streamlined procedure for promoting more consistent sample-stimulus control. McIlvane, Kledaras, Stoddard, and Dube (1990) addressed a similar teaching problem using a two-choice identity MTS procedure. New stimuli (line drawings) were presented in each session. In the sample-first procedure (as described above), the 2 participants showed mean accuracy of about 90%. As with our participants, accuracy was inconsistent across stimuli, ranging from 85% to 90% and 75% to 100% across three and nine stimulus sets, respectively.

Next, in the delayed-sample condition, choice stimuli were presented first. The sample was presented after 3 s elapsed without a response. The goal was to extinguish selections of choice stimuli that were not controlled by the sample stimulus (i.e., undesired stimulus control). Both participants initially made many responses before the sample was presented—responses that clearly were not controlled by the sample stimulus. As these presample responses decreased, the percentage of correct selections with the sample stimulus present became nearly perfect. Thus, desirable stimulus control replaced undesirable stimulus control.

The present study extends McIlvane et al. (1990) by demonstrating decreases in a specific source of stimulus control, referred to as stimulus bias or stimulus preference. Stimulus bias involves the selection of one choice stimulus more often than the other, regardless of which sample stimulus is presented. In a two-choice MTS task, for example, each choice stimulus is correct on 50% of the trials. Consistently selecting one of the stimuli (called the preferred stimulus) on more than 50% of the trials defines stimulus bias. There were several additional extensions. First, the relations taught were component skills of reading. Second, our baselines were longer, baseline accuracy was lower, and the delayed-sample procedure was implemented with the same stimuli that were presented in baseline. Finally, some of our baseline sessions assessed whether the delayed-sample procedure might increase accuracy by increasing the time between choice responses, which might diminish residual stimulus control from the previous trial (i.e., *proactive interference*; see, e.g., Williams, Johnston, & Saunders, 2006).

METHOD

Participants

Brian was an 18-year-old man with moderate intellectual disabilities. Rob was a 40-year-old man with mild intellectual disabilities. Age-equivalent scores on the Peabody Picture Vocabulary Test, Version 3, were 8 years for Brian and 7 years 5 months for Rob. Sight-word reading, assessed using the Woodcock Reading Mastery Word Identification subtest, was at the kindergarten and high first-grade levels, respectively. There was no instruction on the targeted skills outside the study.

Procedure

We replicated the delayed-sample procedure across two baselines that differed in both participant and type of MTS task. There were two dependent measures: *accuracy*, defined as the percentage of trials on which the correct choice stimulus was selected, and *stimulus bias*, defined as the percentage of trials on which the preferred stimulus was selected. The selection of one stimulus on more than 50% of the trials was an indication that, on some trials, the choice stimulus alone controlled selection. The delayed-sample procedure was initiated when there was no decreasing trend in stimulus bias and no increasing trend in accuracy for eight sessions. If the delayed-sample procedure decreased reinforcement for responses that are not under the control of the sample stimulus, one would predict decreases in stimulus bias, followed by increases in accuracy, following the introduction of the procedure.

Sessions of 60 trials occurred daily. Letters and printed words (1.5 cm, lower case) were presented on a touch-sensitive monitor, and recorded spoken words were presented by the computer. We used a two-choice task because our teaching goals required responding differentially to minimally different stimuli. Every correct response produced a series of tones, and approximately every 2.5 correct responses also produced a nickel. Incorrect responses briefly darkened the screen. An intertrial interval (ITI; 3 s unless noted otherwise), during which the screen was blank, followed the feedback. Under these contingencies, both men had learned numerous matching relations of the type each had been taught, but with different stimuli.

Sample-First Baseline

Brian was exposed to a printed-letter identity MTS procedure with the letters *p* and *q*. Each trial began with the presentation of the sample stimulus (either the letter *p* or the letter *q*) in the center of the screen. Touching the sample produced two choice stimuli (the letters *p* and *q*) in two of the four corners of the screen. The sample and choice stimuli remained on the screen until the participant touched one of the choice stimuli. Rob was exposed to a spoken-to-printed-word MTS procedure with the syllables *tut* and *tot*. Each trial began with the presentation of the spoken-word sample, accompanied by a black square in the center of the screen. Touching the square removed it from the screen and produced the choice stimuli (the printed syllables *tut* and *tot*). The choices remained on the screen, and the spoken-word sample was presented every 2 s, until the participant touched a choice stimulus. For both procedures, sample stimuli were presented in quasirandom order.

In some baseline sessions, the ITI was longer than 3 s. To explore the possibility that increasing the ITI might increase accuracy, the ITI was 5 s or 10 s for Brian and 8 s for Rob.

Delayed-Sample and Second Sample-First Conditions

The delayed-sample procedure differed from the sample-first procedure in two ways. First, the choice stimuli were presented first. The sample was added to the display only after 5 s had elapsed without a response to the choice stimuli. Second, because the choice stimuli were already on the display, there was no requirement to touch the sample. To determine whether improved accuracy was maintained in the sample-first condition (cf. McIlvane et al., 1990), the last few sessions involved a return to that condition.

RESULTS AND DISCUSSION

Figure 1 shows, for each session, overall accuracy and the percentage of trials in which the preferred stimulus was selected.

Sample-First Baseline

Overall accuracy was between 72% and 87%, with no increasing trend. Both participants exhibited a stimulus bias. Brian selected *p* on almost all *p* trials but also selected *p* on approximately 40% of the *q* trials. Rob selected *tot* more often than *tut*, although the bias was not as extreme as for Brian. Increases in the ITI had no effect.

Delayed-Sample and Second Sample-First Conditions

For Brian, marked decreases in stimulus bias and increases in accuracy began in the second and fourth sessions, respectively. For Rob, a decrease in stimulus bias began in the fifth session. Overall accuracy decreased initially, reflecting fewer selections of the preferred stimulus (i.e., bias) in the presence of both samples (Figure 1, bottom).

Not shown graphically is the proportion of trials during which responses occurred during the 5-s presentations of the choice stimuli alone. For Brian, 22% of the trials in the first delayed-sample session contained such responses, which were infrequent thereafter. Thus, the decrease in stimulus bias was associated with a decrease in presample responses. For Rob, bias decreased even though there were few presample responses across all sessions, suggesting that undesired stimulus control can decrease without presample responses. Such responses may have been low for Rob because he showed less bias and

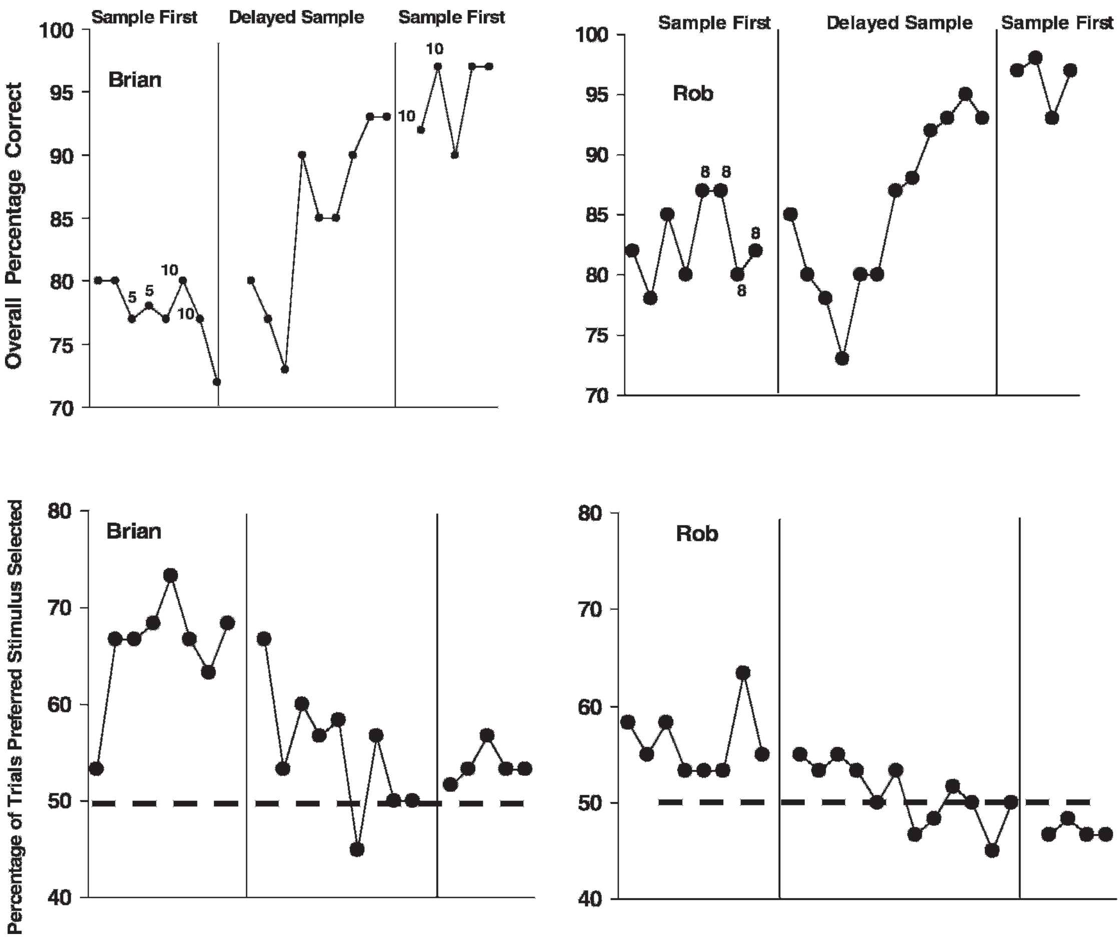

Figure 1. Overall percentage correct (top) and percentage of trials in which the preferred stimulus was selected (bottom) for Brian (left) and Rob (right) across all sessions. For Brian, *p* was the preferred stimulus, and for Rob, *tot* was the preferred stimulus. The numbers next to data points indicate the duration of the ITI, if other than 3 s.

because delaying an auditory sample may be especially salient.

Was the change in bias and accuracy due to the delayed-sample procedure? Participants were not receiving instruction in the skills outside the study, so extraexperimental influences seem unlikely. We cannot rule out the possibility, however, that stimulus bias could have decreased with the same number of additional baseline sessions. Bias was stable in baseline, however, and was largely outside the baseline range beginning in the second (Brian) and fifth (Rob) delayed-sample sessions. Accuracy began increasing in the fourth (Brian) and seventh (Rob) delayed-sample sessions, after an initial decline. The initial decline is not unexpected, if the procedures reduce selections that are controlled by the choice stimuli alone. Even though such selections are not controlled by the sample stimulus, for purposes of calculating accuracy, they would be defined as correct on approximately 50% of their occurrences. Put another way, the procedures first "broke down" undesired stimulus control, which increased the likelihood that the desired sample–comparison relations were reinforced.

The participants entered the study with a history of acquiring MTS performances. Further, their initial accuracy with the current stimuli was well above chance levels. Effectiveness might have depended on these characteristics. As with any procedure for decreasing undesired behavior (in the present study, stimulus bias), a means of establishing and maintaining the desired behavior (here, stimulus control by the sample) must be in place. As a simple manipulation to boost intermediate accuracy, however, the procedures deserve further study as a potential tool for practitioners.

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