*A NOTE ON TRANSFER OF STIMULUS CONTROL IN THE
DELAYED-CUE PROCEDURE: FACILITATION BY AN OVERT
DIFFERENTIAL RESPONSE*

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This case study describes initially unsuccessful attempts to use the delayed-cue procedure to teach conditional discriminations to an individual with moderate mental retardation. The task was matching printed-word comparison stimuli to dictated-name sample stimuli. In three experiments, the subject typically waited for the delayed cue unless differential responses to the dictated samples (repeating the sample names) were required. Hence, the study provides an example of a way to make the delayed-cue method more effective. The stimulus control bases for the results are discussed.

DESCRIPTORS: conditional discrimination, matching to sample, delayed cue, differential sample responses, mental retardation

In Touchette's (1971) original demonstration of the delayed-cue procedure, an already learned ("old") discriminative basis for responding was initially paired with a to-be-learned ("new") basis on each trial, and then presentation of the old basis was progressively delayed across trials (the delayed cue). In this simple discrimination task, transfer of discriminative control from the old basis (red vs. white light) to the new one (different orientations of two letter Es or tilted lines) was shown when

the subject responded correctly and reliably on the basis of form orientation before the onset of the red-light delayed cue. Touchette reported rapid and errorless transfer except for one discrimination problem with 1 of the 3 subjects. Oppenheimer, Saunders, and Spradlin (1993) recently reported a replication of Touchette's study with 34 subjects, using the same stimuli and virtually identical procedures. They observed varied outcomes, with many instances of unsuccessful transfer. Frequently, subjects continued to wait for the delayed-cue presentation instead of responding before its onset. To extend the Oppenheimer et al. findings, we report a case study of initially unsuccessful attempts to use the delayed-cue procedure to teach conditional discriminations. In three experiments, the subject typically waited for the delayed cue unless differential responses to the dictated sample words were required. Therefore, this study suggests a way to make the delayed-cue method more effective. Because the method is widely used in research and practice, perhaps because it is an easy-to-use teaching tool (cf. Handen & Zane, 1987; Oppenheimer et al., 1993; Wolery et al., 1992), demonstrations like this one, illustrating ways to enhance its successful application, are likely to be helpful.

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SUBJECT, GENERAL PROCEDURES, AND EXPERIMENTAL OVERVIEW

The 25-year-old male subject had a diagnosis of congenital hydrocephaly with moderate mental retardation. His history included accurate matching of colors and numerals to their dictated names and identity matching with these visual stimuli and printed words. A delayed-cue procedure was used in an attempt to teach him to match printed words to their dictated names. He had previously participated in a laboratory research project on the delayed-cue technique, but that procedure had failed to teach him the desired performances. The experimenter and subject sat at adjacent sides of a table. On each trial, the experimenter presented a display card divided into a 3×2 matrix, with comparison stimuli (colors, numerals, or words) appearing in five of the six areas (locations changing unsystematically across trials). Auditory samples were dictated by the experimenter every 2 s until the subject chose a comparison by touching it. When used, visual samples identical to the correct comparison were presented on a separate card above the comparison display. Some visual samples functioned as delayed cues (see below).

Before each experiment, pretests and pretraining verified identity matching of the printed words to be used in training, oral repetition of their dictated names, failure to match the printed words to their dictated names, and two delayed-cue baselines. These were (a) a waiting baseline, in which the subject waited for the delayed cue (the comparison stimuli were colors or numerals, and the samples were dictated Portuguese names; because the subject was unfamiliar with this language, the names did not control correct selections); and (b) an anticipation baseline, in which he responded correctly before the cue (thus "anticipating" or "preempting" the cue; the comparison displays were again colors or numerals, and the samples were the already controlling dictated English names). On the first delayed-cue trials, after the name was dictated, a visual sample identical to the correct comparison was presented simultaneously with the comparison display. After every three consecutive correct trials,

the delay before presenting the visual sample increased by 1 s until it reached approximately 6 s (except as noted below; timed by silent counting).

In experimental training, the delayed-cue procedure was used with English printed-word comparisons and dictated-name samples. After the delay reached the 6-s maximum, it stayed at that value across training sessions with the same stimuli (except in Experiment 1; see below). Transfer of stimulus control from the visual cues to the dictated-name samples was shown when the subject responded before the presentation of the visual cue on 40 consecutive trials (20 with each of the two sample names used in each training set) with at least 90% accuracy.

Correct comparison selections (before or after the visual sample presentation) produced praise and a penny. The subject exchanged the pennies after the session at a small store in his residence (a state institution) or for other coins that he saved for use in vending machines or restaurants. Incorrect selections were followed by the next trial, after a brief intertrial interval.

An independent observer assessed reliability of sample stimulus presentations, comparison selections, and whether the subject responded before or after the delayed-cue presentation. In 13 such assessments (at least one session in each condition in each experiment), agreement averaged 99%.

EXPERIMENT 1

Procedures and overview. The experiment began with delayed-cue training trials as described above. The training stimuli were the printed words "boy" and "hat" and their dictated names, and the printed words "bed," "cup," and "car" served as invariant incorrect comparisons. All five words appeared on every trial. When the subject failed to demonstrate transfer of stimulus control after a large number of trials, he was required to repeat the dictated name for each trial before the comparison display was presented. When he eventually showed such transfer, the sample-repeating requirement was eliminated to determine whether his performance would be maintained.

Results and discussion. The top row of Figure

1 shows the results. Each bar indicates the percentage of trials on which the subject selected a comparison before cue presentation (anticipations) in successive blocks of trials. In the first five blocks without sample repeating (84 trials), the subject virtually always waited for the cue, even when the delay was increased to 12 s in the last block of that condition. When the sample-repeating requirement was introduced, the progressive delay from 0 to 6 s was reinstituted, and the subject began to respond before the cue soon after the delay reached its maximum. In subsequent blocks, the percentage of anticipations gradually increased. Sometimes, however, the subject anticipated incorrectly (hatched portions of bars), making 15 errors in 108 trials. Eventually, he met the learning criterion in the 14th block. Eliminating the sample-repeating requirement produced only a slight and temporary disruption of the subject's performance.

Although the data suggest that transfer of stimulus control was facilitated by sample repeating, there were two other possibilities. Perhaps successful transfer resulted merely from protracted exposure to the pairing of the dictated samples with the delayed cues. Second, the use of the progressive delay, starting at 0 s, at the beginning of the sample-repeating condition may itself have provided additional instruction. Experiment 2 provided additional controls for these possibilities.

EXPERIMENT 2

Experiment 2 evaluated the effects of giving more than twice the number of trials as in Experiment 1 (218 vs. 84; approximately the same number that the subject required to reach the learning criterion in the first experiment) without sample repeating. Also, when the sample-repeating requirement began, the delay stayed at 6 s. The training stimuli were now the printed words "bus" and "pen" and their dictated names, and the printed words "egg," "cat," and "sun" served as invariant incorrect comparisons.

Results and discussion. The subject anticipated the delayed cue only once when not required to repeat the sample names (second row of Figure 1, Blocks 1 through 12). In the first session when

sample repeating was required, he began to anticipate frequently. Anticipations declined in the next two sessions (possibly a function of his anticipatory errors), but then steadily increased until he met the learning criterion in the 22nd block. Again, removal of the repetition requirement had only a small effect.

The rapid occurrence of anticipations in the sample-repeating condition strongly supports a conclusion that successful transfer did not result from merely giving protracted exposure to the delayed-cue procedure. Still, the data do not rule out the possibility that some prior exposure may be important. The procedures in Experiment 3 evaluated this possibility.

EXPERIMENT 3

Experiment 3 directly compared the sample-repeating and no-sample-repeating conditions. The subject was taught two tasks concurrently in alternating sessions, one with and the other without sample repeating. In Task A, the no-sample-repeating condition, the training stimuli were the printed words "bat" and "dog" and their dictated names, and the printed words "eye," "ant," and "arm" served as invariant incorrect comparisons. In Task B, the sample-repeating condition, the training stimuli were the printed words "leg" and "box" and their dictated names, and the printed words "mop," "bag," and "ear" were invariant incorrect comparisons.

Results and discussion. In the sample-repeating condition (bottom row of Figure 1), the subject began to respond before the visual cue on the first few trials, even before the delay reached 6 s. Also, his performance met the learning criterion with few errors within five blocks and was maintained when sample repeating was eliminated. In the no-sample-repeating condition (third row of Figure 1), although the subject began to anticipate the cue by the third block and did so in every block thereafter with generally increasing frequency, his performance did not meet criterion until the 18th block. The facilitative effect of the sample-repeating procedure was clearly demonstrated, given the marked

Figure 1. Percentage of anticipatory responses in successive trial blocks in the no-sample-repeating and sample-repeating conditions in each experiment. If marked with an asterisk, the number of trials in the block ranged from 10 to 30; all other blocks contained 20 trials.

contrast in the subject's rates of acquisition when he did and did not repeat the sample.

GENERAL DISCUSSION

Failure of stimulus control transfer in the delayed-cue procedure may occur because the subject ignores the new stimuli and responds only to the delayed cue. When sample repeating was not required, informal observations of the subject during the delay indicated that he looked away from the comparison display (with arms crossed) and began to scan it only after the visual sample appeared. This behavior resembled that observed during intertrial intervals. The contingencies of the progressive-delay procedure seem especially likely to establish such behavior. The appearance of the already controlling (and hence conditioned reinforcing) delayed cue will reinforce whatever behavior that occurs before it. When the delay is short (especially when it is shorter than the subject's typical response latency), that behavior is likely to be a continuation of intertrial-interval behavior. As the delay lengthens in small increments, prolongation of waiting will be gradually shaped. That is what appears to have occurred in the present study.

Oppenheimer et al. (1993) reported that a few of the subjects who waited consistently for the delayed cue (a red light) demonstrated the new form discrimination by anticipating correctly after (a) receiving a verbal prompt ("You can touch the window before the red light if you know the correct one") or (b) onset of the red light on both S+ and S- 2 s after the start of the trial (thus probing for whether the nondifferential light might function merely as a prompt to respond, serving a "go" function). This outcome suggests that these subjects had learned all the prerequisites for the new discrimination but had failed to demonstrate it because of competing and overriding control by the delayed cue. It is unlikely that such prerequisite learning and failure to demonstrate it had occurred with the subject of the present study, given his anticipatory errors during the early stages of each sample-repeating condition in Experiments 1 and 2.

Our subject's data also show competing stimulus control by the old and new discriminative bases, most clearly in Experiment 2, but they do so in a way different from what Oppenheimer et al. (1993) observed in their probe trials. In the sample-repeating condition, the combination of correct anticipations on some trials and waiting for the cue on others (in Blocks 16 through 19; Figure 1, second row) suggests that once established, control by the cue over waiting may persist for some time.

The delayed-cue procedure shares the limitations of any pairing procedure to produce new stimulus control, as seen in the extensive research on blocking effects (see Partington, Sundberg, Newhouse, & Spengler, 1994; Singh & Solman, 1990). In studies of blocking, the typical design is to present two redundant discriminative bases for responding, one of which already exerts control. The already controlling basis blocks acquisition of control by the other one. In the case of the delayed-cue procedure, this limitation is compounded by the likely conditioning of waiting behavior. A question of experimental interest, therefore, is what precursory behavior will lead to acquisition of control by the new stimulus basis, as shown by correct anticipations.

The present case study provides one example of that precursory behavior. It is likely that sample repeating functioned as a differential observing response that required the subject to discriminate the current dictated sample on each trial. The experimenter also informally observed that repeating the sample set the occasion for the subject to start scanning the comparison display before the delayed cue appeared, unlike his earlier behavior when he did not repeat the sample. Whether or not these observations are valid descriptions of what the subject had done, the data clearly indicate that the dictated names exerted no control until sample repeating required him to attend to them. When he did, transfer occurred.

Would sample-name repetition by itself, even without the delayed cue, have been sufficient to teach the subject to match the printed to dictated words? The question cannot be answered with certainty for this subject, although one can ask whether

his learning in Experiment 3 would have been nearly errorless without the delayed cue. Additional control procedures (e.g., a no-delay condition) are needed, however, to answer this question. Other findings indicate that differential sample responding may not be effective (e.g., Saunders & Spradlin, 1989) or, when it seems to be effective, may merely bring about discriminative control by the response instead of the stimulus (e.g., Urcuioli, 1984).

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