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# EFFECTS OF FIXED-RATIO SAMPLE AND CHOICE RESPONSE REQUIREMENTS UPON ODDITY MATCHING[1]

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Three pigeons were trained on oddity matching in which either 1, 4, 8, 16, or 32 sample-key observing responses were required to turn off the sample stimuli and turn on the comparison stimuli. Oddity accuracy increased when the observing-response requirement was raised and decreased when the requirement was lowered. Next, while the observing requirement was maintained at one response, the number of responses required to the comparison stimuli was either 1, 4, 8, 16, or 32. Under these conditions, choice was defined as the comparison that first accumulated the required number of responses. In general, increasing the comparison-response requirement decreased accuracy and lowering the comparison requirement increased accuracy. The fixed-ratio observing requirements appeared to facilitate control by stimuli serving an instructional function.

*Key words:* oddity matching, observing responding, choice response requirements, fixed ratio, acquisition, key peck, pigeons

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On discrete-trial conditional discrimination tasks, the number of responses to the sample stimulus may have a marked effect on matching performance. For example, Eckerman, Lanson, and Cumming (1968) found that matching-to-sample acquisition was considerably more rapid when a single sample-key "observing" response was required than when a sample response requirement was not in effect. Following acquisition, the addition of an observing-response requirement increased accuracy, and the prevention of observing responding decreased accuracy. Sacks, Kamil, and Mack (1972) extended the generality of this effect to higher observing-response requirements. They found that the larger the number of sample-key responses required (*i.e.*, fixed-ratio (FR) observing), the more rapid the acquisition and the higher the accuracy of matching-to-sample across a series of delays between sample offset and presentation of comparison stimuli.

The facilitating effect of FR response requirements on choice performance has also been found with complex discriminations other than matching-to-sample. For example, Williams (1971*a*) found that pigeons acquired accurate color alternation performances when stimulus choice was defined as the first color that accumulated 15 or 30 responses (FR 15 or FR 30). However, acquisition did not occur when the choice response requirement was FR 1 or FR 5. Subsequently, Williams (1971*b*) reported above-chance performance with FR 15 or FR 30 choice-response requirements and delays between trials of as long as 45-sec. Williams suggested that, at least with color alternation, the FR observing requirement was important primarily during the choice between stimuli.

The present study attempted to determine if FR observing requirements facilitate oddity matching in the same way as has been found with matching-to-sample. Also, a study was made of the effects of placing FR response requirements on the choice, or comparison, keys in a way analogous to Williams' (1971*a, b*) color-alternation procedure.

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## METHOD

### *Subjects*

Three experimentally naive White Carneaux pigeons were maintained at about 80% of their free-feeding weights.

### *Apparatus*

A three-key stimulus panel enclosed in a ventilated, cube-shaped chamber with 33-cm sides was used. The response keys were 2.5 cm in diameter, 6.4 cm apart, center to center, and 24.1 cm above the floor. Industrial Electronics Engineers' inline display units projected appropriate stimuli on each key. A rectangular opening centered below the response keys permitted access to mixed grain when a grain hopper was raised. The opening was illuminated with white light during hopper operation. Two 6-W houselights, 10.2 cm apart and 30.5 cm above the floor, were centered on the wall opposite the stimulus panel. A sound-attenuating enclosure and white noise masked most extraneous stimuli. A BRS/LVE DigiBit system controlled experimental events and recorded data.

### *Procedure*

Subjects were trained to peck a white center key and then received one session during which 50 center-key responses were each reinforced by 3-sec access to mixed grain. The birds were then placed on oddity-matching acquisition. Oddity trials began with presentation of either a red or a green stimulus on the center key. A response to the sample turned off the center key and transilluminated the two side keys, one with a red comparison stimulus and the other with green. A response to the comparison that did not match the color of the sample produced 3-sec access to grain, while a response to the comparison that matched the color of the sample produced a 3-sec blackout, during which the chamber was dark. The next trial followed immediately after reinforcement or blackout.

During each session, the two sample colors were presented equally often in a mixed sequence, with the restriction that one sample color could appear on no more than three consecutive trials. Similarly, the location (right or left) of the comparison colors was mixed, also with the restriction that a given color could appear on the same side key a maximum of three consecutive trials. Sessions were conducted six days per week and consisted of 96 trials.

Following 57 sessions of oddity-matching acquisition, the number of responses to the center key (*i.e.*, FR observing responses) required to produce sample offset and comparison onset was increased. The ratios studied were FR 1, FR 4, FR 8, FR 16, FR 32, FR 8, FR 4, and FR 1. Next, while the sample-response requirement was maintained at FR 1, the number of responses to the comparison keys required to produce reinforcement of a correct choice or blackout for an incorrect choice was increased. Both comparisons remained illuminated until one key accumulated the required number of responses. Subjects could, therefore, switch from one comparison to the other during a trial. The ratios studied were FR 1, FR 4, FR 8, FR 16, FR 32, FR 8, FR 4, and FR 1. Throughout the study, three sessions without systematic accuracy changes preceded changes in FR value.

## RESULTS

The acquisition of oddity matching is presented in Figure 1. Initial exposure to oddity matching produced near-chance (50%) accuracy for all birds. For two birds, oddity accuracy increased rapidly after about 15 (Bird 38) or 35 (Bird 28) sessions of chance performance. The third bird (37) started above-chance matching early, followed by a slow increase in accuracy across sessions. The mean accuracy across the last five sessions of acquisition was 75%, 64%, and 80%, respectively, for Birds 28, 37, and 38.

The effects on accuracy produced by increasing the sample and comparison response requirements are shown in Figure 2. Each data point represents the mean accuracy of the last three sessions on each of the FR response requirements. As shown, increases in the sample FR increased matching accuracy. For Birds 37 and 38, a change in the ratio from FR 1 to FR 4 markedly increased matching accuracy. Subsequent increases in the ratio resulted in further, but smaller, increases in accuracy. For Bird 28, only small increases in accuracy were obtained until the response requirement reached FR 32. Subsequent decreases in the size of the observing FR also decreased matching accuracy, thereby indicating that the facil-

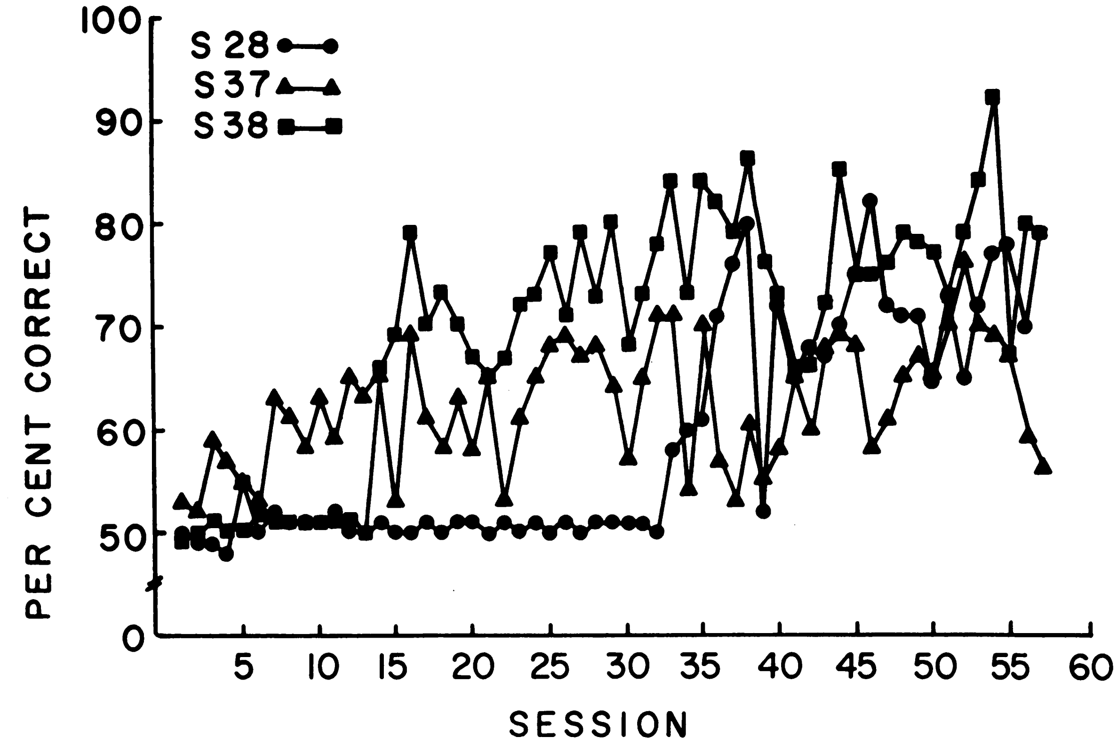


Fig. 1. Per cent correct choices during acquisition of oddity matching for each bird.

itating effects of larger FRs were not simply due to extended training on oddity matching.

When the response requirement on the comparison keys was changed, so that the first color to accumulate the required number of responses was designated as the chosen color, increases in the response requirement decreased matching accuracy for two birds: this effect was minimal for Bird 37. As shown in Figure 2, a return of the ratio requirement to FR 1 increased oddity-matching accuracy for the birds, although the effect again was minimal for Bird 37.

## DISCUSSION

When FR schedules were in effect for sample-key responding, oddity-matching accuracy was increased by raising the FR observing requirement and decreased by lowering it. Thus, observing requirements facilitate accuracy both with oddity matching and with matching-to-sample. However, when FRs were scheduled for comparison-key responding, the opposite effect was obtained. That is, raising the FR decreased accuracy and lowering the FR increased accuracy. Branch (1974) found no effect with FR 5 scheduled on the comparison keys in a conditional discrimination task. This is consistent with the present results, in that strong effects on choice accuracy did not occur with very small ratios.

The present results are not consistent with Williams' (1971*a, b*) suggestion that FRs appeared to have the primary effect during the choice between stimuli. Two possible explanations for the differences in results will be considered. It seems possible that FR responding increases the effectiveness of stimuli serving an informative or instructional function, both in oddity matching and color alternation. Although sample stimuli in oddity matching appear to possess an instructional function (Cumming and Berryman, 1965), such a function by stimuli in color alternation is less apparent, since sample stimuli, as such, are not presented. However, in terms of color alternation, it would seem that reinforcement for the correct choice of a color on one trial instructs the subject that a different color will be correct on the next trial. That is, the chosen stimulus serves as a sample for the next trial. Color

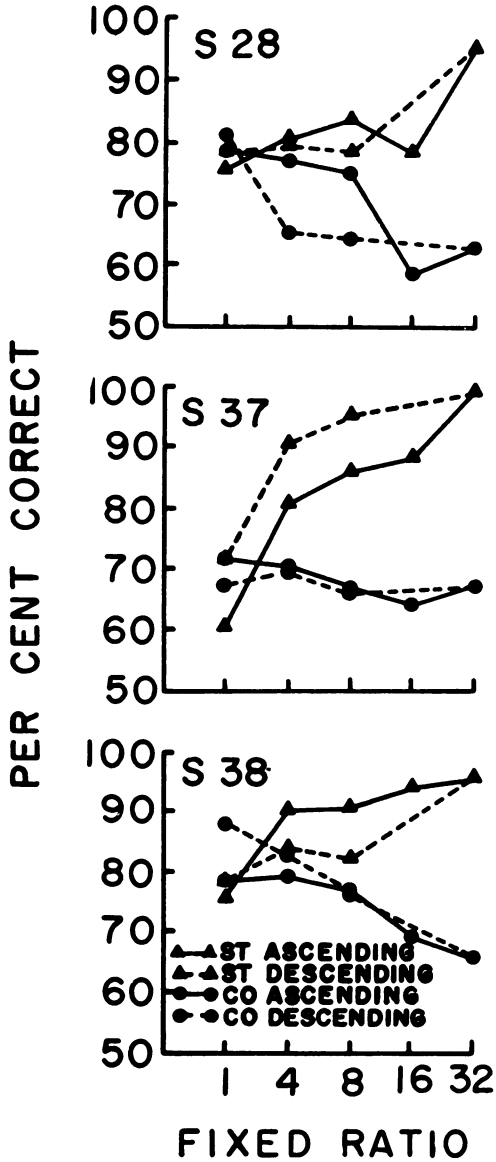


Fig. 2. Per cent correct choices as a function of sample- or standard-(ST) key FR requirements and comparison-(CO) key FR requirements for each bird. The Figure is based on the last three sessions on each condition.

alternation appears, therefore, to be related to oddity matching, a task in which a sample stimulus instructs the subject that a different comparison stimulus is correct within the same trial. It is also possible that the FRs serve different functions in color alternation and oddity matching.

It seems rather likely, however, that the FRs serve the same function with both procedures. As previously indicated, observing requirements have not only facilitated matching-to-sample (*e.g.*, Eckerman *et al.*, 1968; Roberts, 1972; Sacks *et al.*, 1972), color alternation (Williams, 1971*a*, *b*), and the present oddity-matching task, but similar effects have also been obtained on successive discrimination (Elsmore, 1971) and successive discrimination reversal (Gonzalez, Bainbridge, and Bitterman, 1966; Williams, 1971*c*) as well. Thus, the common effect produced by FR schedules suggests the existence of a common function.

The present results are also of interest in that the subjects acquired the task at all. In the matching-to-sample situation, it appears that acquisition either does not occur or is very slow unless an intertrial interval is used (Holt and Shafer, 1973). In the present oddity study, no intertrial interval was used, yet acquisition occurred. Why the intertrial interval should be vital during matching-to-sample, but not during oddity-matching acquisition is not clear. Matching-to-sample and oddity-matching performances have, however, been shown to differ in a number of ways, especially with respect to rate of acquisition and drug effects (*e.g.*, Berryman, Cumming, Nevin, and Jarvik, 1964; Nevin and Liebold, 1966). The present results suggest that sensitivity to intertrial intervals may be yet another way in which matching-to-sample and oddity-matching performances differ.

## REFERENCES

Berryman, R., Cumming, W. W., Nevin, J. A., and Jarvik, M. E. Effects of sodium pentobarbital on complex operant discriminations. *Psychopharmacologia,* 1964, **6,** 388-398.

Branch, M. N. Behavior as a stimulus: joint effects of *d*-amphetamine and pentobarbital. *Journal of Pharmacology and Experimental Therapeutics,* 1974, **189,** 33-41.

Cumming, W. W. and Berryman, R. The complex discriminated operant: studies of matching-to-sample and related problems. In D. Mostofsky (Ed.), *Stimulus generalization.* Stanford: Stanford University Press, 1965. Pp. 284-330.

Eckerman, D. A., Lanson, R. N., and Cumming, W. W. Acquisition and maintenance of matching without a required observing response. *Journal of the Experimental Analysis of Behavior,* 1968, **11,** 435-441.

Elsmore, T. F. Effects of response effort on discrimination performance. *The Psychological Record,* 1971, **21,** 17-24.

Gonzalez, R. C., Bainbridge, P., and Bitterman, M. E. Discrete-trial lever pressing in the rat as a function of pattern of reinforcement, effortfullness of response, and amount of reward. *Journal of Comparative and Physiological Psychology*, 1966, **61**, 110-122.

Holt, G. L. and Shafer, J. N. Function of intertrial interval in matching-to-sample. *Journal of the Experimental Analysis of Behavior*, 1973, **19**, 181-186.

Nevin, J. A. and Liebold, K. Stimulus control of matching and oddity in a pigeon. *Psychonomic Science*, 1966, **5**, 351-352.

Roberts, W. A. Short-term memory in the pigeon: effects of repetition and spacing. *Journal of Experimental Psychology*, 1972, **94**, 74-83.

Sacks, R. A., Kamil, A. C., and Mack, R. The effect of fixed-ratio sample requirements on matching to sample in the pigeon. *Psychonomic Science*, 1972, **26**, 291-293.

Williams, B. A. Color alternation learning in the pigeon under fixed-ratio schedules of reinforcement. *Journal of the Experimental Analysis of Behavior*, 1971, **15**, 129-140. (*a*)

William, B. A. Non-spatial delayed alternation by pigeons. *Journal of the Experimental Analysis of Behavior*, 1971, **16**, 15-21. (*b*)

Williams, B. A. Fixed ratio schedules of reinforcement as a determinant of successive discrimination reversal learning in the pigeon. *Psychonomic Science*, 1971, **25**, 143-144. (*c*)

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