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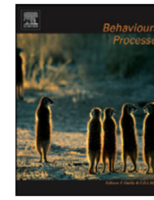

Effects of prefeeding, extinction, and distraction during sample and comparison presentation on sensitivity to reinforcer frequency in matching to sample☆

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ABSTRACT

The present experiment examined the effects of several test manipulations on discrimination, accuracy and sensitivity to reinforcer frequency in a conditional discrimination. Four pigeons responded on a multiple schedule of matching to sample procedures in which the reinforcer-frequency ratio for correct comparison choice responding was varied across components within session from 1:9 to 9:1. Following stability, the effects of prefeeding, extinction, and distraction during sample and comparison presentation were assessed. Discrimination accuracy decreased under prefeeding, extinction, and distraction during sample presentation. Sensitivity to reinforcer frequency decreased under prefeeding and extinction. Decreases in sensitivity were positively related to decreases in discrimination accuracy. The decreases in discrimination accuracy and sensitivity under prefeeding and extinction are interpreted as being due to decreases in attending to the sample and comparison stimuli, respectively, possibly mediated by motivational effects of these manipulations. This interpretation is consistent with current conceptualizations of the contingencies that govern conditional-discrimination performance.

Discrimination in non-humans is commonly studied using a conditional-discrimination procedure. In one variant of this procedure, matching to sample (MTS), subjects (generally pigeons) are presented with a sample stimulus (S_1 or S_2). Following a specified number of responses or amount of time, the sample is terminated and comparison stimuli are presented. Responses to the comparison stimuli are reinforced with some probability depending on the value of the presented sample stimulus. A large body of empirical work has been devoted to understanding the processes underlying discrimination performance within this experimental framework (see Davison and Nevin, 1999, for review).

Much research on conditional discrimination has been conducted to evaluate and quantitatively formalize the relation between reinforcement parameters and conditional-discrimination performance (see Nevin et al., 2005, for review). Borrowing from the mathematical description used to characterize the relation between reinforcer allocation and the distribution of behavior between two choice alternatives in simple concurrent schedules (i.e., the generalized matching law; Baum, 1974), current quantitative models of conditional-discrimination performance provide ways to assess the degree to which changes in the distribution of reinforcers for correct choice responses produces concomitant changes in the frequency of choosing a particular comparison stimulus (termed sensitivity). The general finding is that the relative frequency of choosing comparison stimuli in MTS procedures "matches" the relative frequency with which correct choices are reinforced.

A more recent line of work has been focused on identifying variables that are important in the persistence of MTS performance in the face of some disruptive manipulation (e.g., Nevin et al., 2003; Odum et al., 2005). Once again borrowing from research with simple schedules of reinforcement, this paradigm imposes some test manipulation, such as presession feeding (hereafter prefeeding), or extinction (discontinuing food for correct choice responses) on a stable baseline of MTS performance and assesses the degree to which MTS performance persists in the face of the test manipulation. The general finding from this line of work is that these sorts of test manipulations decrease discrimination accuracy (see Nevin et al., 2009, for discussion).

Discrimination accuracy has been shown to moderate sensitivity to reinforcer frequency in MTS. Results from multiple studies indicate that sensitivity to variation of reinforcer frequency changes with changes in discrimination accuracy (see Nevin et al., 2005, for review). These results, when considered with reports of decreased discrimination accuracy following imposition of certain test manipulations, suggest that assessing the effects of such manipulations on

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sensitivity of MTS performance to variation of reinforcer frequency is warranted.

To date, there have been no investigations of the effects of test manipulations (e.g., prefeeding, extinction) on sensitivity to reinforcer frequency. One possible reason has to do with the way that reinforcer ratios have been manipulated in previous studies. In traditional assessments of sensitivity to variations of reinforcer frequency, the reinforcer ratio for correct comparison choice responses is varied parametrically across several (at least three, but usually five) conditions (e.g., from 1:9 to 9:1). Conditions are in place for many sessions (e.g., at least twenty 90-trial sessions), and a measure of the relative distribution of responses to the two comparison stimuli is calculated under each reinforcer ratio. Once these estimates are calculated, estimates of sensitivity can be derived via quantitative analysis. This type of parametric manipulation (across conditions) does not easily lend itself to an assessment of the effects of test manipulations on sensitivity, because such an assessment would require deriving an estimate of sensitivity to reinforcer frequency in the absence of the test manipulation, and then imposing the test manipulation repeatedly across conditions in which the reinforcer ratio is varied. Aside from the potential problems introduced by variability in the distribution of comparison choice responses across multiple replications of reinforcer-ratio conditions, this strategy could be particularly problematic when assessing the effects of test manipulations that can differ in their effects with repeated implementation (such as extinction).

We have recently developed a procedure in which estimates of sensitivity to variations in reinforcer frequency can be obtained within session (Ward and Odum, 2008). Briefly, the procedure consists of a multiple schedule of MTS procedures in which the reinforcer-frequency ratio for correct comparison choices is varied across components within session. Thus, estimates of the distribution of comparison choice responses under each reinforcer ratio are obtained in each session, rather than across several conditions. Using this procedure, stable estimates of sensitivity can be obtained within session.

In addition to practical utility, this methodological paradigm lends itself well to assessing the effects of discrete test manipulations on sensitivity to reinforcer frequency. In the present study, we assessed the effects of two frequently used test manipulations, prefeeding and extinction, as well as two more recent test manipulations that specifically target behavior during presentation of the sample and comparison stimuli (see Nevin et al., 2009) on discrimination accuracy and sensitivity to reinforcer frequency. In accordance with previous results, we expected discrimination accuracy to decrease under the test manipulations. The question of interest was how the test manipulations would affect sensitivity to reinforcer frequency.

1. Method

1.1. Subjects

Four homing pigeons that had prior experience with related delayed matching to sample (DMTS) procedures (reported in Ward and Odum, 2008) served as subjects. Pigeons were maintained at 80% ± 15 g of their free-feeding weight by post session feeding as needed. Between sessions, pigeons were individually housed with free access to water in a temperature-controlled colony under a 12 h:12 h light/dark cycle. Experimental sessions were conducted 7 days per week at approximately the same time.

1.2. Apparatus

Four Lehigh Valley Electronics sound-attenuating chambers were used. Chambers were constructed of painted metal with aluminum front panels. The chambers measured 30 cm across, 35 cm deep, and 35 cm high. Each front panel had three translucent plastic keys that could be lit from behind with red, green, white, yellow, pink, and turquoise light and required a force of at least 0.10 N to record a response. Keys were 2.5 cm in diameter and 24 cm from the floor. A lamp (28 V, 1.1 W) mounted 4.5 cm above the center key served as a houselight. A rectangular opening 8.5 cm below the center key provided access to a solenoid-operated hopper filled with pelleted pigeon chow. During hopper presentations, the opening was lit with white light. White noise and chamber ventilation fans masked extraneous noise. Contingencies were programmed and data were collected by a microcomputer using Med Associates® interfacing and software.

1.3. Procedure

As all pigeons had previous experience with the final procedure, no preliminary training was necessary. The procedure was a three-component multiple schedule of MTS procedures (cf., Ward and Odum, 2008) in which S_1 and S_2 (turquoise and white, respectively) were selected randomly from trial to trial with the constraint that each sample stimulus could not be presented on more than 10 consecutive trials. At the beginning of a trial, S_1 or S_2 was presented on the center key. A peck to the center key extinguished it and lit the side keys, one turquoise and one white (comparison stimuli). The location of each key color (left or right key) was randomly determined from trial to trial. A peck to the key color that matched the presented sample color produced 2-s access to food, while a peck to the non-matching key color resulted in a 2-s blackout. A limited hold of 20 s was in place such that if a response did not occur to either sample or comparison stimuli after 20 s, these stimuli were extinguished and the next experimental event (comparison presentation or blackout) was initiated. Trials were separated by a 5-s intertrial interval (ITI).

Across components within session, the reinforcer-frequency ratio for correct S_1 and S_2 choice responses was varied from 1:9 to 9:1. Reinforcers for correct S_1 and S_2 responses were scheduled as follows. At session (or component) onset and following each reinforcer presentation, the next reinforcer was assigned to a correct S_1 or S_2 response with a fixed probability. No other reinforcers were arranged until the scheduled reinforcer was collected (or until the component ended). Thus, if a reinforcer was scheduled for a correct S_1 response, no reinforcers would be delivered for correct S_2 responses until a correct S_1 response occurred. This way of scheduling reinforcers is a controlled reinforcer ratio procedure and ensures that the programmed reinforcer ratios are similar to the obtained reinforcer ratios (e.g., McCarthy and Davison, 1991). The reinforcer ratio was varied by changing the probability that a reinforcer would be assigned to a correct S_1 or S_2 choice response. For example, in the 9:1 component, correct S_1 choice responses produced food with 0.9 probability, while correct S_2 responses produced food according to a probability of 0.1. During each component, the reinforcer ratio in effect was signaled by the lighting of the three response keys during the 5-s ITI (red, green, and yellow; different colors for each component, counterbalanced across pigeons). Components (1:9, 1:1, and 9:1) were selected randomly without replacement and ended after 30 trials (15 S_1 and 15 S_2 presentations). The houselight remained on for the duration of each component and components were separated by a 10-s blackout. Each component began with a 5-s ITI. Sessions ended after each component was presented once.

1.4. Test manipulations

Following 50 sessions of exposure to the baseline procedure, we assessed the effects of several test manipulations on