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Distinguishing Performance and Learning in Laboratory Animals

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Undergraduate students enrolled in Psychology of Learning courses often have difficulty distinguishing between learning and performance. In standard operant conditioning labs students are quick to conclude that higher response rates indicate better learning (e.g., rats rewarded with sugar typically have higher response rates than those rewarded with grain). Therefore, to demonstrate differences in performance based on motivation, rats were originally trained to lever press for food reward (grain or sugar) on a fixed ratio (FR) schedule and later switched to the other reward type. Response rates were recorded for a 15-minute period both before and after the reward type was switched. Students were then asked to graph, analyze, and interpret the response rates before and after the shift. Although no main effects were found, there was a significant interaction between the Type of Reward (Sugar or Grain) and Time of Measurement (Pre- or Post-Shift). Animals originally rewarded with sugar had a significantly lower response rate when rewarded with grain, demonstrating negative contrast. Response rates did not differ in animals switched from grain to sugar. Demonstration of contrast effects assists students in understanding the importance of motivation in operant based tasks and also helps them process various theories of learning that incorporate motivation.

Keywords: *Negative contrast, Positive contrast*

Psychology classes in Learning, which have the ability to use live animals, typically train and test rats in standard operant chambers. Laboratory sessions may involve shaping the rat to press a lever for food reward, manipulating schedules of reinforcement (i.e., fixed ratio versus fixed interval), and examining response rates as a dependent variable. In such courses, undergraduates can be quick to conclude that a higher response rate indicates better learning. Additionally, with these standard laboratory tasks, undergraduate students may not recognize the important distinction between performance and learning. While learning is often defined as a lasting change in behavior based on previous experience(s), the performance of animals (the current behavior or act) can be modified by several variables, including but not limited to illness, fatigue, maturation, and motivation. The difference between learning and performance was originally noted by Tolman and Honzik (1930) in the well known latent-learning experiment. Additionally, manipulations in the reinforcer available following instrumental behavior also demonstrate differences in learning versus performance. Both Crespi (1942) and Mellgren (1972) demonstrated immediate changes in performance of subjects when reinforcers were changed in quantity (large to small or small to large) and several researchers (Flaherty, Becker, & Checke, 1983; Pecoraro, Timberlake, & Tinsley, 1999) have also reported decreases in performance following changes in the quality of reinforcer available (e.g., 32% sucrose solution shifted to a 4% sucrose solution). Therefore, to help undergraduate students appreciate the difference between learning and performance and the importance of motivation, a laboratory activity was used in which the quality of the reinforcer was manipulated.

Method

Subjects

Twenty-seven male Sprague Dawley rats were purchased from Charles River (Wilmington, MA). The rats were approximately 50 days old when purchased and approximately 90 days old when the data was collected. The rats were double-housed in 42.5 cm (length) x 21.0 cm (width) x 21.0 cm (height) polycarbonate cages in a temperature controlled room. The animals were kept on a 12:12-

hour light/dark cycle, and all testing was completed during the light cycle. All rats were allowed a minimum 3-day adjustment period to the home facility and were extensively handled prior to being placed in an operant box. After animals adjusted to the facility, each animal was food deprived and fed approximately 20 g of food (Prolab; Brentwood, MO) a day, which maintained a 90% free-feeding weight. All animals were given unlimited access to water throughout the semester and all animals were weighed weekly as a measure of general health. All protocols were approved by the St. Mary's College of Maryland Institutional Animal Care and Use Committee.

Apparatus

All testing took place in standard operant boxes run by Med. Associates software (St. Albans, VT). Seven equivalent operant boxes (30.5 cm X 24.1 cm X 21.0 cm) were used, and each animal was randomly assigned to one of the boxes for the duration of training and testing. Animals were randomly assigned to receive either grain food reinforcers (45 mg pellets; Bio-Serve; Frenchtown, NJ) or sugar reinforcers (45 mg pellets; Bio-Serve; Frenchtown, NJ), which were delivered to a food dish (2.5 cm above the floor) centered between two retractable levers (7.6 cm above the floor) at the front of the box. A 100 mA white light was located 7.6 cm above each lever.

Procedures

General timeline. All animals underwent 4 weeks of training in which they were exposed to magazine training, shaping, extinction, and spontaneous recovery prior to the shift in reinforcers. Data presented and discussed here was collected immediately after a 5-minute measure of spontaneous recovery.

Shift in quality of reinforcer. Animals were placed in the operant box for 15 minutes and were presented with the left lever with the stimulus light above the lever illuminated. All animals were rewarded (either sugar or grain) on a Fixed Ratio (FR) schedule of reinforcement. The FR value varied by animal but did not differ between animals originally given sugar (M = 9.64, SD = 2.16) and those given grain (M = 9.67, SD = 2.66), t (15) = 0.03, $p > 0.05$. Following 15 minutes, animals were returned to their home cages and given access to water for approximately 10 minutes. Animals were then returned to the operant box for a second 15-minute period and again placed on a FR schedule. However, the reinforcers were now switched (animals originally rewarded with sugar were now rewarded with grain; animals originally rewarded with grain were now rewarded with sugar). Response rates (number of lever presses/minute) from each 15-minute period (pre-shift and post-shift) were recorded.

Student assignment. At the time of data collection, students were asked to consider the impact that the type (quality) of reinforcer would have on behavior and what they (the students) could learn from switching the reinforcers. Toward the end of the semester, corresponding to lecture material presented on motivation, students were asked to graph, analyze, and interpret the response rates collected before and after the shift (see Appendix). This assignment was completed in class with students working in groups of 2 – 3.

Results

Response rates were analyzed with a 2-way mixed Analysis of Variance (ANOVA; Type of Reward X Time of Measurement). Predictive Analytics SoftWare (PASW) output was presented to the students for their assignment. There was no effect of Time of Measurement, F (1,25) = 2.0, $p >$ 0.05. There was no effect of Type of Reward, F (1, 25) = 0.75, $p > 0.05$. There was a significant interaction, F (1, 25) = 5.16, $p = 0.03$ (see Figure 1). Animals originally rewarded with sugar (M = 20.55, SD = 14.24) had significantly lower response rates when rewarded with grain (M = 15.21, SD = 13.56), t (15) = 3.26, $p = 0.005$. Response rates were not different in animals originally rewarded with grain (M = 13.49, SD = 9.68) and then switched to sugar (M = 14.73, SD = 3.69), t (10) = 0.48, $p > 0.05$. Animals originally rewarded with sugar had a higher, although not significant, response rate than those originally rewarded with grain, t (25) = 1.43, $p >$ 0.05.

Discussion

Undergraduate students frequently assume that a higher response rate indicates better learning by an animal. As can be seen in Figure 1, animals originally given sugar have higher response rates than rats given grain. Students in the past have mistakenly concluded that the animals given sugar have learned the FR task better. This laboratory activity can be used to correct this misunderstanding and to help students distinguish learning and performance. The

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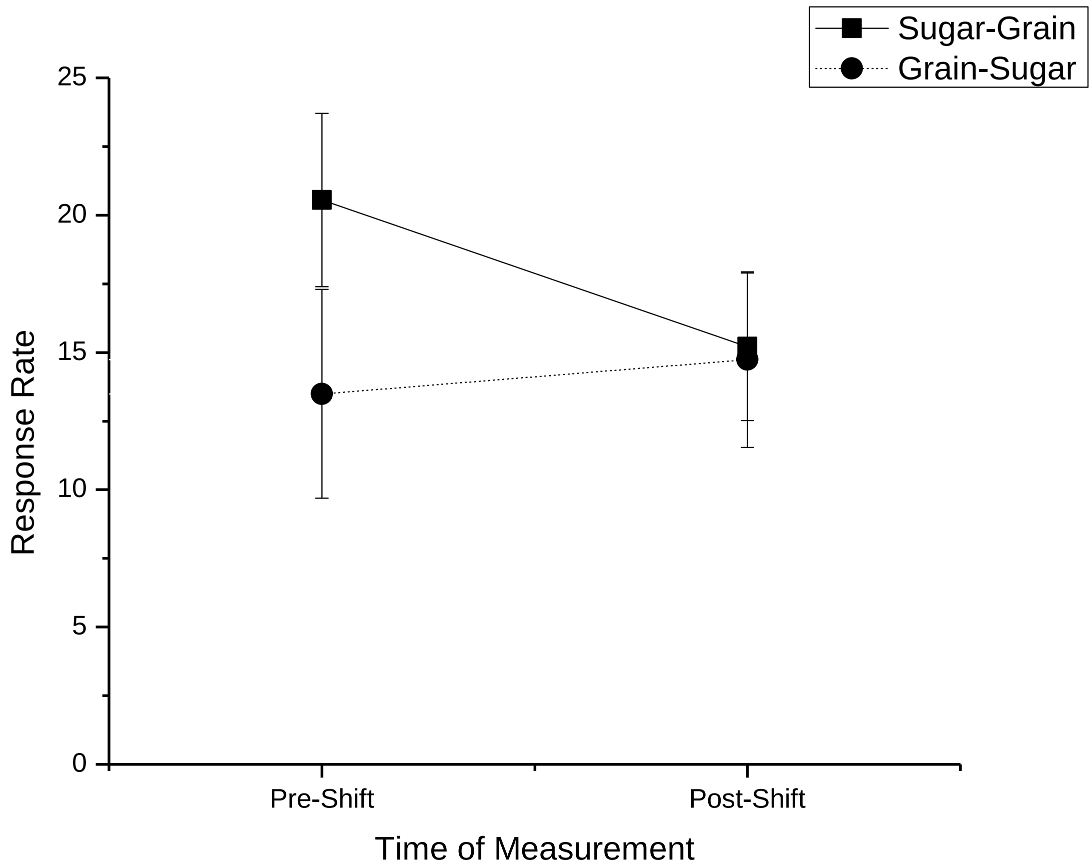

Figure 1. Mean (±SEM) response rates of animals prior to and after the shift in quality of reinforcer.

response rates of animals originally presented with sugar dropped significantly when switched to grain reward displaying negative contrast (see Figure 1). This change in behavior is immediate and is discussed along with the research by Crespi (1942), in which the reinforcer quantity was switched. The animals here did not, however, display positive contrast when shifted from grain to sugar (see Crespi). It is worth noting that it is considered difficult to attain positive contrast effects in comparison to negative contrast (Domjan, 2003). With the data presented, students learn that it is too easy, and in fact incorrect, to conclude that higher or lower response rates necessarily reflect learning. Not only do students notice that response rates may be related to the type and value of the reward available, but they begin to suggest other reasons for differences in performance (e.g., hunger, fatigue, neophobia).

The animal data was collected in the laboratory portion of the course; however, the group assignment was presented to the students in class following a lecture on motivation. In particular, this assignment was used to help students understand and appreciate the concepts of Behavior Strength (Hull, 1943) and Incentive Motivation (Hull, 1952). Concepts and theories in learning are often abstract and difficult for undergraduate students to understand. However, presenting theories along with data the students themselves collected generally helps theoretical understanding. Additionally, the assignment given (see Appendix) allows the students to interpret statistical output, write in American Psychological Association (APA) style, and graph outcomes.

This laboratory could be expanded to include a control group of animals that had the same type of reinforcement at both measurement times. This control group was not used in the data presented above but was used as matter of discussion when students were completing the assignment. In addition, while this assignment was used as an in-class activity, one could create an assignment in which a full laboratory report was required. Finally,

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students could be asked to systematically observe the animals following the reinforcer shift. The behavior of the animals switched from a higher (sugar) to a lower-valued reward (grain) may produce easily measured behavioral changes such as increases in exploratory (Pecoraro, Timberlake, Tinsley, 1999) or emotional behavior (Flaherty, Greenwood, Martin, & Leszczuk, 1998).

Author Note

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Appendix

Student Assignment

Early in the semester some of the rats were rewarded under a FR schedule with 45 mg sugar pellets and the other rats were rewarded with 45 mg grain pellets. After recording their response rates we switched the reinforcers (those that originally had sugar received grain and those that originally had grain were given sugar).

The attached SPSS/PASW printout is an analysis of the resulting data. The response rates before and after the shift were analyzed with a 2-way mixed ANOVA (Type of Reward X Time of Measurement). Your task is to interpret the SPSS/PASW analysis and to create an appropriate graph (see below). In addition, write an APA style results section followed by a brief conclusion.