# FACILITATION OF ACQUISITION OF A VISUAL DISCRIMINATION BY DIFFERENTIAL OUTCOMES

by

Madie Westbrook

Submitted in partial fulfillment of the
requirements for Departmental Honors in
the Department of Psychology
Texas Christian University
Fort Worth, Texas

May 4th, 2020

FACILITATION OF ACQUISITION OF A VISUAL

DISCRIMINATION BY DIFFERENTIAL

OUTCOMES

Project Approved:

Supervising Professor: Kenneth Leising, Ph.D

Department of Psychology

Gregory Repasky, Ph.D.

Department of Psychology

Alex Lemon, M.F.A

Department of English

Abstract

Past research has shown that receiving different rewards for separate responses results in faster acquisition compared to receiving the same reward for both responses. This is known as the differential outcomes effect. The current study investigated whether using a visual discrimination with differential outcomes improved discrimination learning in rats. This was completed by training rats to press one lever (e.g., on the left side of the chamber) when presented with a flashing light and press a different lever (e.g., on the right side of the chamber) when presented with a steady light. The experimental group received sugary water as reinforcement for pressing one lever and chocolate pellets for pressing the other while the control groups either received only sucrose or only chocolate pellets. Differential outcomes should result in faster acquisition in the experimental group. The rats that received differential outcomes performed better than the control sucrose group but the control pellet group, receiving only chocolate pellets, achieved the fastest acquisition. This suggests the quality of the reinforcer may overshadow the differential outcomes effect if only one of the two outcomes is less preferred.

# Facilitation of Acquisition of a Visual Discrimination by Differential Outcomes

When a parent wants their child to do chores (e.g., like cleaning their room), giving them some form of reinforcement (e.g., money) after the desired behavior is performed helps increase the probability of the child performing that action again. In an operant discrimination procedure, a discriminative stimulus is presented and the participant makes a behavior to receive the reinforcer or punisher as an outcome. For example, a rat may hear a tone and, in response, press a lever to receive sucrose as a reinforcer. In terms of a child doing their chores, the parent would give a verbal command that signals the appropriate behavior in the child and then give them a reinforcer once the response is made. When learning to make two separate responses (or chores), different rewards could be used to reinforce each behavior.

Previous research suggests that giving the child two separate rewards for two different responses results in learning the appropriate response to each task faster compared to receiving the same reinforcement for both responses (Estevez et al., 2001). If the child receives a piece of chocolate for cleaning their room and a juicebox for doing their homework, their expectations about the outcome of each response will grow to be discriminably different. They will learn to expect chocolate as a reinforcement when they clean their room, not a juicebox. When the child is told “clean your room”, it might activate a memory of doing the task, which was followed by chocolate. It is as if the child thinks, “if I clean my room, I will receive chocolate”. The memory of receiving chocolate for cleaning their room is distinct. Both the memory for chocolate and the verbal stimuli “clean your room” signal the correct behavior. However, if they received chocolate for both responses, the expectation of “I’ll get chocolate” would be a signal for both responses, so only the verbal “clean your room” would signal the correct behavior.

Consequently, they would take longer to learn when to do the two tasks since the responses are linked to the same reward.

If the reinforcement differs from the reward received for doing their homework, the child's experience during the cleaning process should be distinguishable from the experience of doing their homework, thus making it easier to differentiate between the two tasks. Faster acquisition when two different rewards for two separate responses result in two different rewards is referred to as the differential outcomes effect, which was best demonstrated by Trapold (1970).

In two experiments, Trapold tested whether the expectancy triggered by a stimulus for receiving one reward versus another would facilitate acquisition of a discrimination with rats. In the first experiment, an experimental group (Group E) received two different reinforcements for two separate responses and the control group (Group C) received the same reinforcement for both responses. The rats were presented with two response bars and exposed to two different auditory stimuli. Both groups learned to press the bar to the right of the location where reinforcement was given when presented with a tone and the left bar when given a clicker. However, Group E received one reinforcer (e.g., sucrose) when they gave the correct response during the tone and a different reinforcer (e.g. food pellet) when they responded correctly to the clicker. Group C received the same reinforcer for both correct responses. The results indicated that the rats in Group C learned the task slower compared to Group E. The rats in Group E received two different reinforcements, so the reinforcement acted as a cue for which response the rat should make. For example, when the rats in Group E heard a tone, an association between the tone, the right bar, and sucrose while the rats in Group C only had the tone to determine which response to make. Differential outcomes helped the rats in Group E achieve faster acquisition.

In the second experiment, Trapold (1970) tested how pre-establishing a connection between a stimulus and response then testing with either a consistent or inconsistent relationship affected the acquisition of learning. If the stimulus and response were pre-established and tested with a consistent relationship, faster learning should occur. However, if a stimulus and response is pre-established then a different stimulus is given at test, a discrimination problem should disrupt learning. For example, a child is told to do their homework when their parent comes home and leaves the house. If a child is given chocolate when their parent comes home and a soda when their parents leave the house, a connection between the stimulus and response is created. If the reinforcement is changed, so the child is given chocolate when their parents leave the house, their response would be slower, as the stimulus and reinforcement do not match what they previously learned.

Two groups of rats received pre-training in which they learned to link certain outcomes to different stimuli. The facilitation group (Group F) received a food pellet when presented with a tone (T→P), and sucrose when given a clicker (C→S). For the interference group (Group I), the rats were given sucrose when given a tone (T→S) and a food pellet when presented with a clicker (C→P). After pretraining, all rats received a food pellet for correct responses in the presence of the tone (T→P) and sucrose for the correct response in the presence of the clicker (C→S). Trapold theorized that Group F would acquire the task faster since the rats' pre-training (T→P, C→S) would pre-establish the correct differential expectancies for the two separate stimuli (T→P, C→S) during training. However, Group I would experience interference as the pre-pairings they received (T→S, C→P) would establish the incorrect expectancies for the stimuli (T→P, C→S) during training. Although both groups reach about the same level of learning, Group F acquired the task at a faster rate compared to Group I. For Group F, the reward they received that was paired with the correct response essentially acted as a second kind of discriminative stimulus and allowed them to better discriminate between the two tasks. With more cues signaling the correct response, rats that received two different rewards for two separate behaviors were more likely to perform the correct response.

In a study conducted by Flemming and Thompson (2011), rhesus monkeys completed a relational learning task in which they identified a visual stimulus as matching or not matching an original visual stimulus. The goal of this study was to use differential outcomes effect to increase rate of acquisition and accuracy in monkeys' relational learning. In discrimination learning, participants must respond differently to the separate stimuli they receive. In relational learning, participants must identify the relationship between the stimuli presented, either identical or nonidentical. Monkeys have difficulty acquiring relational matching tasks (Fagot and Parron, 2010). A naive and trained monkey were assigned to each of the three conditions used: differential reward (DR), differential punishment (DP), and differential reward and punishment (DB). In a trial, monkeys were presented with a sample pair representing either the identical or nonidentical relationship (AA or BC). Using a joystick-guided cursor, the monkeys would click on the sample to reveal a novel identical pair (DD) and a novel nonidentical pair (EF). Monkeys selected a pair using the cursor. In the DR condition, rewards differed in magnitude of pellets delivered. The correct response to one relation (e.g., match) resulted in four pellets but only one pellet for correct responses to the other relation (e.g., nonmatch). For correct responses of the higher hedonic relation, monkeys received four pellets. An incorrect match resulted in a 5-second intertrial interval (ITI) for both relations. In the DP condition, correct responses yielded one pellet regardless of relation type. If the monkeys responded incorrectly on a trial with one relation (e.g., match), a 45-second ITI followed whereas a 10-second ITI followed an incorrect response to the other relation (e.g., nonmatch). In the DB condition, monkeys received different reinforcers for correct responses to one relation while incorrect responses to the other relation received one pellet and different punishments for incorrect responses. In the DB condition, the monkeys performed significantly above chance with their accuracies at 84.1 and 86.3%. In the DR and DP conditions, the monkeys' accuracy remained at chance. Overall, differential outcomes effect improved performance when monkeys received differential reward and punishment.

Previous studies completed at Texas Christian University investigated whether differential outcomes would facilitate relational learning with rats using visual stimuli presented on an iPad and responses to the iPad. In the first experiment, rats touched a ready response which led to the presentation of a sample stimulus. A touch to the sample stimulus made it disappear and, after a 50, 100, or 500 millisecond delay, a comparison stimulus was presented. The comparison stimulus either matched or did not match the sample. A touch to the comparison stimulus made it disappear and two response squares were presented. One square was assigned as correct for one relations (e.g., same) while the other indicated a different relations (e.g., different). There were four possible trial outcomes; a match trials with a correct or incorrect response, and a different trials with a correct or incorrect response. The reinforcements given were either sucrose or pellets and the punishment was a 2-sec bursting tone or a 4-sec flashing light. As in Flemming and Thompson (2011), the rats were divided into three different groups (DB, DR, DP) plus a same both (SB) control group. There were no significant differences in acquisition between any groups. Although Trapold (1970) was able to find results that supported the differential outcomes effect, this study did not. Overall, all groups performed at the same level regardless of differential outcomes or punishments. Unlike Trapold, this study used visual stimuli instead of auditory stimuli, which may be one reason why the results differed between the two.

For the second experiment conducted, the number of groups was reduced to emphasize the two groups most likely to indicate a differential outcomes effect. There were only two groups: differential reward versus control. There was no difference between groups, and both groups of rats barely performed above chance. Again, this may be because of the stimulus used, as the DOE effect has been shown to work with auditory stimuli while this study used visual stimuli. For the third experiment, the design was simplified even further. Instead of matching (a relational learning task), one stimulus acted as a cue to go left while another stimulus signaled to go right. This was a simple discrimination task (i.e., no relationships were present), there was one stimulus and one response. Again, rats performed at chance. The most recent experiment conducted mimicked the original Trapold experiment, using levers instead of the iPad to record responses. However, this experiment used visual stimuli in the form of a steady or flashing light instead of the auditory stimuli used by Trapold (1970). If rats were presented with the flashing light, the correct response was pressing the right lever. If the rats were presented with the steady light, they were required to press the left lever. However, there was a lever bias for the lever that provided rats with chocolate pellets. This bias prevented the rats from learning the task.

The present experiment will further investigate whether differential outcomes will improve discrimination learning in rats. Although previous research has found that receiving two separate outcomes (e.g., rewards) for different responses should increase the discriminability of those responses, our lab has been unable to produce a DOE. The experiment included a ready response to start a trial and used lights instead of auditory stimuli. This is significant as the ready response will ensure the rats are ready and attentive for the session and should facilitate acquisition in both groups. Correction trials will be also be used to make rats choose the correct response. Also, the visual stimulus may provide a different way to learn compared to an auditory stimulus since rats are nocturnal. Being prey animals, a rat may be able to hear a predator and hide or flee. If they already see the predator, their chances of survival decrease tremendously. Although not highly visual animals, they can discriminate visual stimuli and differential outcomes should facilitate this acquisition.

Rats will be presented with a flashing light on some trials and the correct response will be to press a lever (e.g., on the left side of the chamber) and receive one reinforcement (e.g., sugary water). On other trials, rats will be presented with a steady light and press the left lever to receive a different reinforcement. Also, most importantly, correction trials will be used so that rats have to make the correct response to move on to the next trial. This will eliminate a chocolate pellet bias. Having two different rewards for two tasks gives the rats more cues to help them perform the correct behavior and should facilitate acquisition in that group.

# Method

## Subjects

The subjects were eight female and eight male Long-Evans hooded (*rattus norvegicus*) that were maintained at 83-85% body weight to motivate activity during trials. Water was made available at all times in their home cages, and they were on a 12:12 light/dark cycle. The rats were supplied by Envigo (Indianapolis, Indiana) and had previously participated in the experiment in which the rats showed a chocolate pellet bias and no evidence of learning the task. All research was conducted in accordance with Texas Christian University's Institutional Animal Care and Use Committee (IACUC).

## Apparatus

An operant box (30 x 25 x 30 cm) within a sound attenuating chamber was used. The box consisted of clear Plexiglas walls and ceiling while the floor was made of stainless-steel rods measuring 0.5 cm in diameter and spaced 1.5 cm center-to-center. There was also a fan for ventilation and a white-noise generator located on a shelf outside of the box that provided a steady 74-dB (A) background noise. The magazine was in the bottom-center of the right wall and capable of delivering sucrose solution (16% v/v) and chocolate-flavored pellets. The operant box housed two retractable levers on each side of the magazine. The levers were used to measure the subjects' responses. A speaker located in the center of the chamber delivered a 1-sec auditory stimulus (a high 3500 Hz or low 2500 Hz) to indicate the availability of a reinforcer. A discrete light on top of the chamber was used as the visual stimulus as a steady or flashing light.

**Procedure**

***MagTrain.*** On days 1-2, all rats were trained to drink and retrieve pellets from the feeding niche. After 3-min, sucrose and pellets were randomly delivered on a variable time (VT) 10-s schedule for the first six trials and VT 60-s for the remaining trials over the course of 50-min sessions. As a control, group one received sucrose and the high tone only and group two received pellets and the low tone only. The houselight remained on throughout the session.

***Phase 1.*** For days 3-12, all were trained to lever press. For three of the ten days, one of the two levers (alternating across trials) was inserted according to a mixed Pavlovian-Instrumental schedule. Once a lever was inserted, if no response occurred after 15-s, one of the outcomes was delivered. After retrieving the outcome, the lever was reinserted for 1-min. If no response occurred, the lever was removed for a VT 1-min period, and then the cycle restarted. If a response occurred, then the lever was reinserted immediately after the outcome was retrieved. After two sessions with 10 or more lever-presses, all rats were moved to one session with a

Fixed-Ratio (FR) 1 schedule, meaning the reinforcer was delivered after one response. The rats then advanced to two sessions on a Random-Ratio (RR) 2, where a random number of responses is required to progress, and a RR5 schedule, and two sessions of a FR10 schedule. If a rat pressed the lever the required number of times, the lever retracted and a 1-s tone (either high or low) was presented. The tone and outcome varied across trials, although the high tone was always associated with one outcome and the low tone with another. Each combination was presented with each lever an equal number of times. The houselight remained on throughout the session. A session ended after the completion of 60 trials or one hour, whichever occurred first.

***Phase 2.*** For days 13-16, rats were required to insert their head into the feeding niche to initiate the trial. The houselight remained on throughout a session. After a 60-s acclimation period, a nose-poke caused one lever to be inserted into the chamber. After a correct response, the lever retracted and an outcome was delivered (as in Phase 1). Rats were reinforced on a RR2 and FR10 schedule, each for two days. A session terminated after the completion of 60 trials or an hour, whichever occurred first. They number of trials with the left and right lever were the same in each session.

***Phase 2b.*** For days 17-18, the same design described above was used though a VI 15 separated the end of one trial and the ability to start a new trial with a nose-poke. Rats were on this phase for two days. The maximum number of trials was 60 on an FR10 schedule. Trials with the left lever and right lever were randomized without replacement to ensure an equal number of left and right lever trials throughout the session (30 trials x 10 responses per trial = 300 maximum responses per lever).

***Phase 3.*** For days 19-32, the rats were split into two separate groups: experimental and control. A flashing or steady light signaled for which of the two levers a response would be reinforced and a correction procedure was in place. After a nose-poke, the steady or flashing light was presented for 3-s prior to the insertion of the levers. The first response to any lever committed the rat to that lever (the other lever retracted immediately). The rat was required to complete 9 more responses to terminate the trial. In the experimental condition, one group of rats (Exp. RL Pel) was required to press the left lever in the presence of the steady light and were reinforced with the delivery of one reinforcer and the high tone and were required to press the right lever in the presence of the flashing light. The assignment of reinforcer to correct lever (i.e., steady light → left lever → pellets/high tone would be Exp-LL Pel) was counterbalanced so that half of the rats received each assignment (Exp-LL Pel and Exp-RL Pel). In two control groups, half the rats received sucrose and high tone for both response types (Ctl Sucrose) and the other half received pellets and low tone for both response types (Ctl Pellet). Ten correct responses in the presence of the stimulus was accompanied by a 1-sec tone (high or low) and 3-sec access to sucrose or a pellet (the next trial was delayed until the reinforcer was retrieved). If the rat made an incorrect response, a correction procedure was implemented, and the same trial type would be given and repeated until the correct lever was selected. Each trial was separated by a VI 20-s ITI. Latency of response time was measured. This phase lasted 14 days.

## Results

In Phase 2b, responses were required to be reinforced equally often on both levers and eliminated any preexisting lever bias. Table 1 indicates that rats in all groups responded nearly 300 times per session. There was an additional 30-sec period at the end of the Phase 2 sessions when additional responses were counted but not reinforced, which is why some means are slightly above 300.

In Phase 3, the percent correct for the first response on each trial was calculated by taking the number of trials in which the first response was correct and dividing it by the total number of trials. Both experimental groups increased their acquisition over time and looked very much the same (See Figures 1 and 2). An increased performance in one group would imply a bias for one lever over the other. They were expected to be the same as they differed only in the assignment of correct lever to reinforcer. This observation was supported by the statistical analyses. A two-way Analysis of Variance (ANOVA) with Group (Exp-LL Pel and Exp-RL Pel) as a between-subjects factor and Block as a repeated measure was conducted on the percent correct for each block for Groups 3 and 4 only. There was no main effect of Group, $F(1, 5) = 0.13$, $p = 0.73$. There was a main effect of Block, $F(2, 10) = 40.85$, $p > .001$. There was also no two-way interaction, $F(2, 10) = 1.58$, $p = 0.25$. Because there was no main effect of Group or Interaction, both experimental groups were collapsed for subsequent analyses

Again, both experimental groups (Exp-LL Pel and Exp-RL Pel) increased their acquisition over time in very similar manners (See Figures 1 and 2). The Ctl Sucrose group did not improve their performance between Blocks 1 and 2 before improving significantly in Block 3 (See Figures 1 and 2). A two-way ANOVA with Group (Ctl Sucrose, Ctl Pellet, and DOE) as between-subjects factor and Block as a repeated measure was conducted on the percent correct for each block. There was no main effect of Group, $F(2, 12) = 2.76$, $p = 0.10$. There was a main effect of Block, $F(2, 24) = 33.71$, $p \leq .001$ and a significant two-way interaction $F(4,24) = 4.71$, $p = 0.01$. Post-hoc tests were conducted on the main effect of Block using Tukey Honestly Significant Differences (HSD) correction indicated that percent correct scores on Block 1 were significantly lower than on Blocks 2 and 3, $p$s > .001. There was no difference in performance between Blocks 2 and 3, $p = 0.12$.

The Ctl Sucrose group did not improve performance until Block 3 (See Figures 1 and 2). Post-hoc HSD tests conducted on the interaction of Block and Group indicated that, for Ctl Sucrose, Blocks 1 and 2 did not differ, $p = 0.35$, and 2 and 3 did not differ, $p = 0.93$. Performance on Block 3 was significantly higher than Block 1, $p = 0.03$. For Ctl Pellet, there was no improvement across all Blocks. Percent correct did not differ on any of the blocks in Ctl Pellet, $ps \geq 0.42$. For Exp-LL Pel and Exp-RL Pel, performance was higher in Blocks 2 and 3 than Block 1, $ps \leq 0.001$. Performance did not differ in Blocks 2 and 3, $p = 0.85$.

The number of incorrect trials repeated in a session were recorded and averaged. Both experimental groups increased acquisition in a similar manner (See Figures 1 and 2). A two-way ANOVA with Group (Exp-LL Pell and Exp-RL Pell) as between-subjects factor and Block as a repeated measure was conducted on the number of incorrect trials for each block. Both groups decreased the number of correction trials they completed over time (See Figures 3 and 4). There was no main effect of Group, $F(1, 5) = 0.57$, $p = 0.48$. There was a main effect of Block, $F(2, 10) = 22.23$, $p > .001$. There was no significant two-way interaction, $p = 0.72$. Because there was no main effect of Group or Interaction, both experimental groups were collapsed for subsequent analyses.

Both experimental groups increased acquisition over time in a similar manner while the Ctl Sucrose group did not improve until Block 3 and the Ctl Pellet group did not improve across all Blocks (See Figures 1 and 2). A two-way ANOVA with Group (Ctl Sucrose, Ctl Pellet, and DOE) as between-subjects factor and Block as a repeated measure was conducted on the number of incorrect trials for each block (See Figures 3 and 4). There was no main effect of Group, $F(2, 12) = 2.55$, $p = 0.12$. There was a main effect of Block, $F(2, 24) = 30.42$, $p > .001$ and a two-way interaction, $F(4, 24) = 3.77$, $p$ - 0.02. Post-hoc tests conducted on the main effect of Block using

Tukey HSD correction indicated that the number of incorrect trials completed on Block 1 was significantly higher than Blocks 2 and 3, *p*s $\leq$ .001. Incorrect trials did not differ in Blocks 2 and 3, $p = 0.46$.

The Ctl Sucrose and Ctl Pellet groups maintained the same number of correction trials while Group DOE decreased the number of correction trials completed across Blocks (See Figure 3). Post-hoc analyses conducted using Tukey (HSD) correction conducted on the Block by Group interaction indicated that, for Groups Ctl Sucrose and Ctl Pellet, the number of incorrect trials did not differ across all Blocks, *p*s $\geq$ 0.05. For Group DOE, the number of incorrect trials completed on Block 1 decreased as compared to Blocks 2 and 3, *p*s > .001. Performance did not differ in Blocks 2 and 3, $p = 0.99$.

The control pellet group appeared to perform better in Block 1. To see whether the control pellet group acquired faster (i.e., in Block 1), a *t*-test was conducted to compare responding in each group against chance performance during each block of training. The control sucrose group never acquired, $t(3) = 3.1$, $p = 0.1$. The control pellet group nearly acquired in Block 1, *t*s(3) < -0.2, *p*s < 0.9. The DOE group did not acquire until Block 2, $t(6) = 5.9$, $p =$ 0.001. The control pellet group did outperform the DOE group in Block 1, $t(3) = 2.7$, $p = 0.08$. The control pellet group pressed more accurately in Block 1 while DOE pressed more accurately in Block 2. The control sucrose group never learned.

## Discussion

The differential outcomes effect occurs when the use of different rewards for separate responses leads to faster acquisition compared to receiving the same reward for both responses (Estevez et al., 2001). In the current experiment, rats were presented with a flashing light, made a response, and received sucrose if the correct response was made. On other trials, a steady light was presented, the correct response was made, and chocolate pellets were given. Having two different rewards for two responses gave the rats more cues to help them improve their performance.

In Phase 2, the rats were trained to nose poke before pressing the lever. During training, any response bias for the left or right lever was eliminated. Both groups had equal exposure to reinforcement on each lever.

The DOE group made more correct responses and required fewer correction trials in Blocks 2 and 3 than Block 1. This indicates the rats were learning the task and showed fewer errors as they learned. In contrast to Group DOE, the control sucrose group did not achieve acquisition until Block 3 while the control pellet group acquired in Block 2. The group that received two different rewards for the two responses appeared to learn faster and make fewer errors compared to the control groups. The percent correct scores on Block 1 were significantly lower than Blocks 2 and 3. There was no different in performance between Blocks 2 and 3. For the Ctl Sucrose group, performance did not differ improve between Blocks 1 and 2. Performance on Block 3 was significantly higher than Block 1. For the Ctl Pellet group, percent correct did not differ on any of the blocks as performance did not improve. For the Exp. RL Pel group, performance improved across Blocks 2 and 3. For the Exp. LL Pel group, performance did not improve across Blocks 2 and 3.

These results look like a DOE effect, but the other groups, group DOE and control sucrose, start with lower percent correct in Block 1 compared to the control pellet group. Based on these results, the improvement in accuracy and fewer correction trials in Group DOE reflects slower learning than the control pellet group. Differential outcomes didn’t facilitate acquisition but receiving chocolate pellets did.

If a follow up experiment were conducted, a preference test should be used to determine whether there is a preexisting bias for pellets or sucrose. If the rats continue to prefer pellets, the percentage of sucrose should be increased to better match the sugar content of the chocolate pellets. For this experiment, 18% v/v sucrose was used, whereas the chocolate pellets contain 50% sucrose. This may be one reason as to why rats preferred the pellets.

In the real world, an animal has to match their behavior to the conditions for success in that environment. For example, failure could be seen as going against the norms of society by breaking the law. If you continue to break the law, your behavior is labeled inappropriate and your access to resources (mates, safety) is compromised by jail or prison time. Discrimination learning allows the organism to figure out how to succeed in their environment. For example, learning the laws that people must abide by helps to prevent breaking it. Failing to learn to behave normally in society can be seen in criminal behavior, developmental disabilities, and psychological disorders. Discrimination learning occurs when teenagers first learn to drive. For example, a red light signals the driver to stop, which is reinforced by not getting in an accident and receiving their driver’s license. The DOE involves receiving two different reinforcements for two separate behaviors to facilitate faster acquisition. This would allow people in society to succeed at a quicker rate. With this experiment, having rats achieve faster acquisition using DOE with visual stimuli would prepare us to transfer that success over to human research.

This experiment did not reveal a difference between the control pellet and DOE groups. In other words, the rats that did not receive differential outcomes, but did receive the preferred reinforcer, were able to perform the same as those who did. This is similar to an animal's behavior matching the conditions for success but not requiring different outcomes to learn those correct responses. Overall, there was limited evidence of a differential outcomes effect. The differential outcomes effect is a reliable finding, but perhaps we failed to obtain it in our experiment due to the preference for one reinforcer or the use of visual stimuli.

**References**

Trapold, M. A. (1970). Are expectancies based upon different positive reinforcing events discriminably different? *Learning and Motivation, 1*(2), 129-140. Doi: 10.1016/0023-9690(70)90079-2

Fagot, J. & Parron, C. (2010). Relational matching in baboons (*Papio papio*) with reduced grouping requirements. *Journal of Experimental Psychology: Animal Behavior Processes, 36*, 184-193

Flemming, T. M., Thompson, R. K. R., Beran, M. J. & Washburn, D. A. (2011). Analogical reasoning and the differential outcome effect: Transitory bridging of the conceptual gap for rhesus monkeys (Macaca mulatta). *Journal of Experimental Psychology: Animal Behavior Processes, 37*(3). Doi: 10.1037/a0022142

Estevez, A. F., Fuentes, L. J, Mari-Beffa, P., Gonzalez, C. & Alvarez, D. (2001). The differential outcome effect as a useful tool to improve conditional discrimination learning in children. *Learning and Motivation, 32*(1), 48-64. Doi: 10.1006/lmot.2000.1060

Table 1
*Mean Number of Responses and Standard Deviations*

| Group | Left Lever | Right Lever |
|---|---|---|
| Control Sucrose | 302.25 (3.86) | 301.5 (1.73) |
| Control Pellet | 301 (1.15) | 301.75 (0.96) |
| RL Pellet | 295.33 (13.32) | 296.66 (15.28) |
| LL Pellet | 303.25 (4.72) | 300.75 (0.5) |

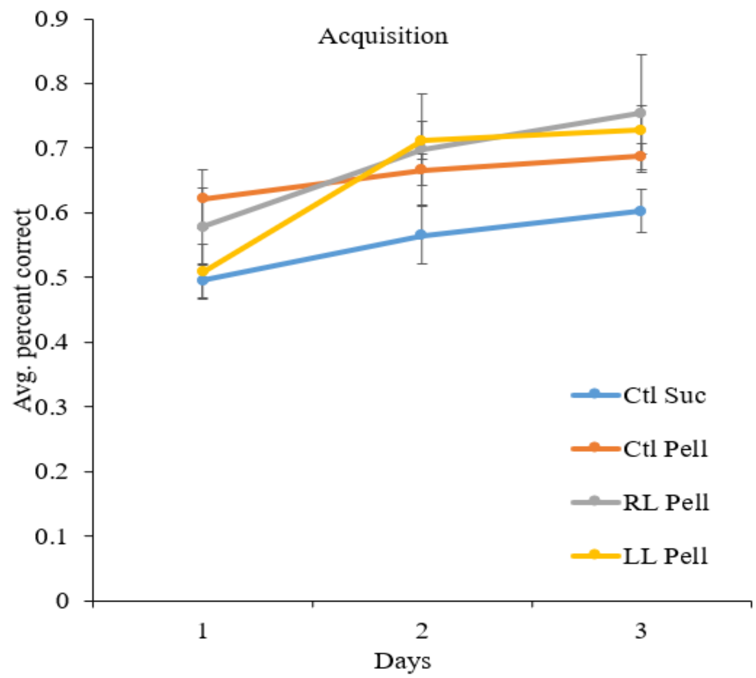


*Figure 1.* Percent of correct responses completed across Blocks in Phase 3. One block is two sessions. Error bars represent standard error of the mean.

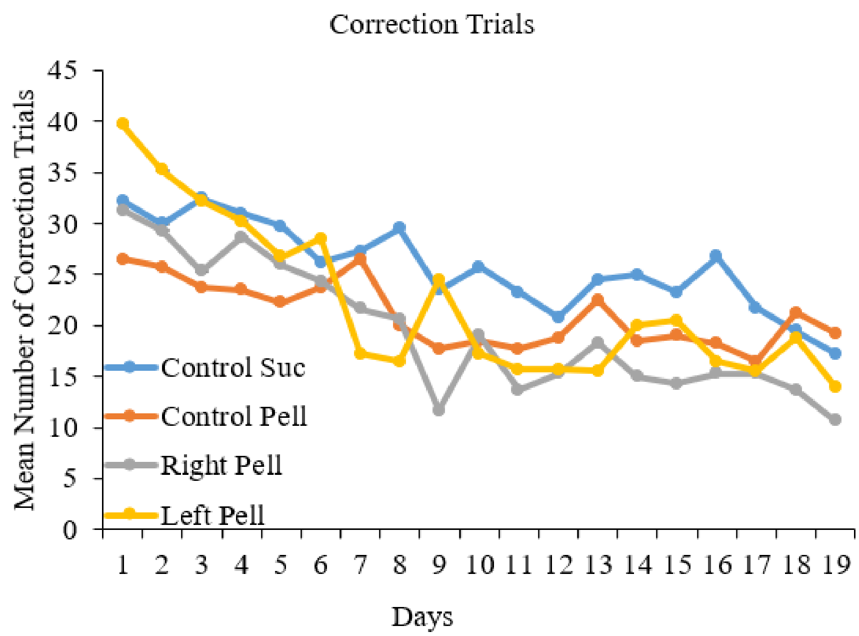


*Figure 2.* Percent of correct responses completed across days in Phase 3.

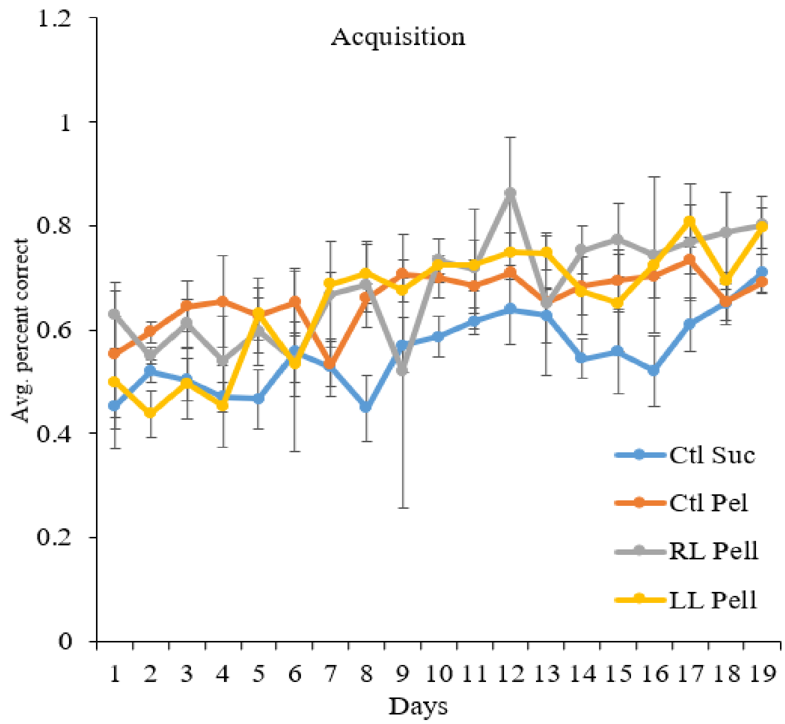


*Figure 3.* Correction trials completed across days in Phase 3.

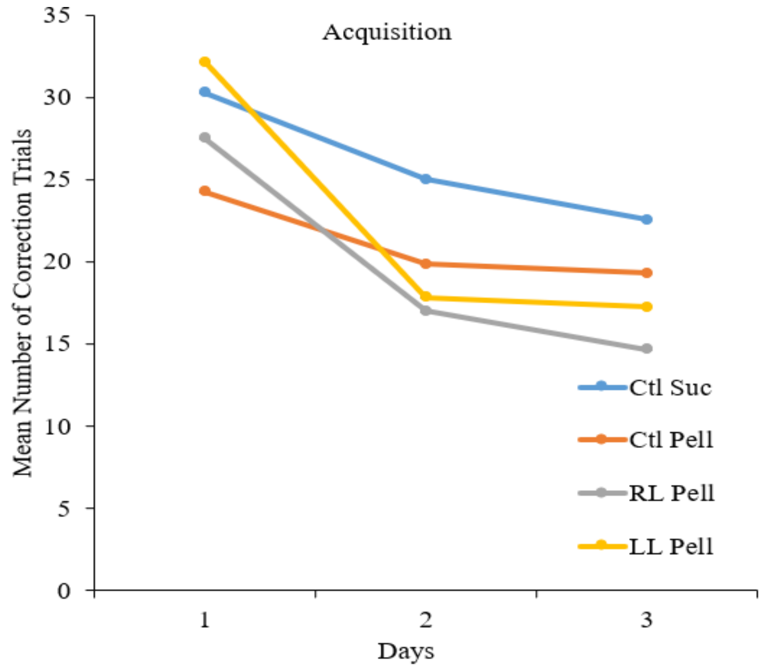


*Figure 4.* Correction trials completed across Blocks. One block is two sessions.