EXTRINSIC REWARD DOES NOT DECREASE INTRINSIC MOTIVATION TO LEVER PRESS IN RATS

by

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INTRINSIC MOTIVATION TO LEVER

PRESS IN RATS

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ABSTRACT

The overjustification effect can be described as the effect that occurs when an extrinsic reward is briefly given for a behavior that already occurs in the absence of external rewards, and once the external reward is no longer given for a certain behavior, the behavior will decrease to a level below what it was before the external reward was given. This effect applies broadly to everyday life. For example, this effect applies to the process of encouraging students to finish schoolwork. The current study investigated whether the overjustification effect can be observed in rats using lever pressing as a measure of intrinsic motivation. In this experiment, rats were split into three groups: Group No reward (NR) control, Group Unexpected (UE) reward control, and Group Extrinsic reward (ER). In the first phase, all groups pressed the lever without a reward to measure intrinsic motivation. In the second phase, Group ER was reinforced for lever pressing, Group UE was reinforced intermittently for lever pressing, and Group NR was placed in the experimental chamber without the presence of a lever. Finally, in the third phase, lever pressing was observed across the groups in the absence of reinforcement (as in Phase 1). Evidence for the overjustification effect would be a decrease in lever pressing during Phase 3 in Group ER that fell below the level of both Group UE and Group NR. In Phase 1, lever pressing decreased across Days 1-3 in all groups. In Phase 2, lever pressing by Group UE and Group ER increased across Days 6-8. In Phase 3, lever pressing by Group ER decreased rapidly, lever pressing by Group UE decreased gradually, and lever pressing by Group NR started low and remained at a low level throughout the phase. By the end of Phase 3, all rats were pressing the lever at a similarly low level. These data do not support the idea that the overjustification effect can be observed in lever pressing in rats.

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Abstract

The overjustification effect can be described as the effect that occurs when an extrinsic reward is briefly given for a behavior that already occurs in the absence of external rewards, and once the external reward is no longer given for a certain behavior, the behavior will decrease to a level below what it was before the external reward was given. This effect applies broadly to everyday life. For example, this effect applies to the process of encouraging students to finish schoolwork. The current study investigated whether the overjustification effect can be observed in rats using lever pressing as a measure of intrinsic motivation. In this experiment, rats were split into three groups: Group No reward (NR) control, Group Unexpected (UE) reward control, and Group Extrinsic reward (ER). In the first phase, all groups pressed the lever without a reward to measure intrinsic motivation. In the second phase, Group ER was reinforced for lever pressing, Group UE was reinforced intermittently for lever pressing, and Group NR was placed in the experimental chamber without the presence of a lever. Finally, in the third phase, lever pressing was observed across the groups in the absence of reinforcement (as in Phase 1). Evidence for the overjustification effect would be a decrease in lever pressing during Phase 3 in Group ER that fell below the level of both Group UE and Group NR. In Phase 1, lever pressing decreased across Days 1-3 in all groups. In Phase 2, lever pressing by Group UE and Group ER increased across Days 6-8. In Phase 3, lever pressing by Group ER decreased rapidly, lever pressing by Group UE decreased gradually, and lever pressing by Group NR started low and remained at a low level throughout the phase. By the end of Phase 3, all rats were pressing the lever at a similarly low level. These data do not support the idea that the overjustification effect can be observed in lever pressing in rats.

Extrinsic Reward does not Decrease Intrinsic Motivation to Lever Press in Rats

Organisms have biological needs and learned wants that lead them to emit certain behaviors. Meeting a want or need is often described as producing satisfaction (e.g., drinking water when very thirsty), either directly or indirectly (i.e., by relieving an aversive state). The satisfaction can then modify the value of initial wants and needs (ridding of or intensifying). The loop of needs leading to behaviors, behaviors satisfying the need, and modification of the value of needs describes motivation in three steps. Researchers have identified two main types of motivation, intrinsic and extrinsic (Deci & Ryan, 2000). The prefixes of these terms give clues about their definitions. Intrinsic and extrinsic motivation can be described as existing within and outside the organism, respectively. In other words, intrinsic motivation refers to doing a behavior for the pleasure of or due to interest in the behavior itself, whereas extrinsic motivation refers to doing a behavior for a separate, pleasurable outcome. The two types of rewards, intrinsic and extrinsic, refer to the outcomes of each type of motivation. Intrinsic reward is the end goal of an intrinsically motivated action. Examples of intrinsic rewards include reaching personal goals, gaining purpose, or gaining a sense of satisfaction of any kind. Similarly, extrinsic reward is the end goal of an extrinsically motivated action. Examples of extrinsic rewards include high grades, trophies, food, or money.

In the early theories of motivation, biological drives (e.g., hunger, thirst, reproduction) and external factors (i.e., extrinsic motivation) were considered the sole catalysts to motivate an organism. In a study done by Harlow (1950), rhesus monkeys were given many sessions over a period of time to solve a mechanical puzzle without any extrinsic rewards. Interestingly, even in the absence of external rewards, the monkeys learned and improved their ability to solve the puzzle. These results conflicted with the previous idea that motivation was initiated by biological

drives or external factors only. Harlow concluded from this study that another main form of motivation might exist, one not dependent on external rewards like extrinsic motivation. That is, Harlow hypothesized that the monkeys were intrinsically motivated, such that the opportunity to engage in the behavior was itself rewarding.

Building off of this finding by Harlow (1950), researchers began to study how different rewards affected intrinsic and extrinsic motivation. Deci (1971) was interested in how the delivery of extrinsic rewards might alter intrinsic motivation. In the first part of this experiment, college students were given three sessions to solve a puzzle using specific instructions. In the second of the three sessions, the experimental group was given a monetary reward for correctly solving a configuration of the puzzle. In the first and third sessions, no money was given to any of the participants. To measure motivation, the experimenter left in the middle of each session, and the subjects were told that they could do whatever they wanted to do while the experimenter was gone. They could read magazines that were on the table, work on the puzzles, look around the room, or do nothing. At the end of each of the sessions, the subjects were asked to rate the task on how enjoyable or engaging it was (1-9 scale). Intrinsic motivation was quantified as seconds working on the puzzle in the first and third sessions when no rewards were delivered. In the first session, both groups had around the same amount of seconds spent working on the puzzle. In the second session, the experimental group spent much more time working on the puzzles, which demonstrates the additional motivation of the extrinsic reward. In the third session, motivation dropped much lower than it was in both of the previous sessions for the experimental group. In all three sessions, both groups described the experiment as interesting and engaging. The activity of the experimental group in the last session is what Deci found the most interesting. He defined the behavior of reduced preference for the target behavior in the

experimental group as overjustification. The overjustification effect occurs when an extrinsic reward is briefly given for a behavior that already occurs in the absence of external rewards. Most importantly, once the external reward is no longer given for a certain behavior, the behavior will decrease to a level below what it was before the external reward was given. In the experiment performed by Deci (1971), the performance of the experimental group fell below the performance that was observed before money was given as a reward.

Lepper, Greene, and Nisbett (1973) explored children's intrinsic motivation following an extrinsic reward. The purpose of this study was to test the overjustification hypothesis, which states that the overjustification effect is due to a reduction in one's intrinsic interest in an activity after engaging in that activity as an explicit means to some extrinsic goal (Lepper et al., 1973). The experiment was carried out using preschool children that already showed an intrinsic interest in drawing as subjects. The children were split into three different conditions: expected-reward, unexpected-reward, and no-reward. In the expected-reward condition, the children agreed to draw pictures with the end result of a ribbon and certificate. The unexpected-reward condition was one where the children received a reward but did not know about the reward before drawing. In the no-reward condition, the children were allowed to draw but with no reward. During the experiment, a child was deemed as interested if they sat at the table with the drawing supplies or picked up a marker. They were considered uninterested or unmotivated if they left the table or put down a marker. The expected-reward children had the lowest percentage of free choice time drawing whereas the unexpected reward children had the highest percentage (not significantly higher than the no-reward group). The results of the experiment supported the theory that extrinsic rewards undermine intrinsic motivation only when the extrinsic reward is expected.

The current study had the purpose of investigating whether the overjustification effect can be observed in rats using lever pressing as a measure of intrinsic motivation. The overjustification effect is important because it may apply to many everyday activities involving motivation, such as encouraging students to finish their school work, ensuring that employees finish their tasks as work, or guaranteeing that children complete their chores at home. Boughner and Papini (2005) allowed rats to press in the absence of direct reinforcement over 24 sessions with 20 trials each. Lever pressing performance was highest in the first session and declined to a rate of one lever press per minute for the remainder of the sessions. Considering the results of this experiment, lever pressing seems to be an intrinsically motivated behavior because the rats continued to press for many sessions in the absence of reinforcement. In the current experiment, there were three groups: Group No reward (NR) control, Group Unexpected (UE) reward control, and Group Extrinsic reward (ER). In the first phase, the groups experienced intrinsic trials (no reinforcement for lever pressing). In the next phase, Group ER was reinforced for lever pressing, Group UE was reinforced intermittently for lever pressing, and Group NR was placed in the experimental chamber without the presence of a lever. Finally, in the third phase, lever pressing was observed across the groups in the absence of reinforcement once again. If we were to observe an overjustification effect in rats, then we would expect to see a decrease in behavior in the extrinsic group that falls below the level of the two intrinsic control groups.

The use of rats as the subjects of this study enabled experimenters to have a greater degree of control over the experiment. This greater control was due to the fact that experimenters knew the history of the rats, and by knowing the history of the rats, experimenters were able to ensure that the behavior and environments were novel and motivation could be controlled (i.e., unlike experiments with college students). The use of rats also allowed experimenters to control

the stimuli that the rats experienced, withhold certain stimuli, and test for a longer duration than would have been possible with human subjects. The external validity of the use of rats in this experiment should be considered as rats are a different species with different environments and a different evolutionary history.

Method

Subjects

Eight female and 12 male Long Evans Hooded rats from the TCU breeding colony were used in this experiment. They were housed in plastic bins, had water available at all times of the day, were kept at 83-85% of their free-feeding body weight, and were kept on a 12:12 light/dark cycle. The rats performed the task during the light half of the cycle. All research conducted was approved by Texas Christian University's Institutional Animal Care and Use Committee.

Apparatus

The apparatus consisted of an operant box (dimensions: 30x25x30 cm (lxwxh)) and a sound and light attenuating chamber surrounding the operant box (Med Associates) along with a ventilated fan. The walls and ceiling of the chamber were constructed of clear Plexiglas, and the floor was constructed of stainless-steel rods measuring 0.5 cm in diameter, spaced 1.5 cm center-to-center. The operant box was equipped with a house light at the top center of the chamber, a pellet dispenser that drops pellets into a magazine located in the center bottom, and two levers located to the left and right of the magazine. The levers were located equal distance from the pellet dispenser. All experimental procedures were conducted with the house light on.

Procedure

Phase 1. Intrinsic motivation was measured using the number of lever presses by each rat in a 30-minute session. During the first 10 minutes of the session, the lever was extended for 10

seconds and then retracted for 90 seconds on average (range of 60-120s). The lever was then retracted for the next 10 minutes. Finally, the lever was extended for the entire duration of the final 10 minutes. The time of each lever presses was recorded. The rats were placed in the experimental chamber for one session per day for a total of 3 days.

Phase 2. The rats were given 2 days of magazine training to show the rats where to retrieve the pellets. Over the next three days (Days 6, 7, and 8 of the experiment), rats in Group No reward (NR) control ($n = 6$) were placed in the experimental chamber with no lever for 30 minutes each day. On Day 6, Group Unexpected (UE) reward control ($n = 7$) and Group Extrinsic reward (ER, $n = 7$) each experienced a lever that was present for a period of time but experienced different consequences for each lever press. As in Phase 1, the lever was extended for 10 seconds and then retracted for 90 seconds on average (range of 60-120s) for the first 10 minutes of each session. In the next 10 minutes, the lever was retracted. In the final 10 min, the lever was extended for the entire duration period. Rats in Group UE received extrinsic reinforcement intermittently. During the first 10-minute period, the Group UE rats received reinforcement after the first lever press or after the 3rd extension of the lever. During the second 10-minute lever extension period, the rats received reinforcement after the third lever press or after 5 minutes. The rats in Group ER received extrinsic reinforcement for each lever press. The rats were able to press the lever a maximum of 12 times each day (6 times maximum per 10-minute period). If the rats completed all 6 presses, the lever was retracted, and the next period began (e.g., 10-minute retraction), or the session was terminated.

On Days 7 and 8, the Group ER rats acted as the master rats in a yoking procedure with Group UE. During the first 10 minutes of each session, the lever was extended for 10 seconds and then retracted for 90 seconds on average (range of 60-120s). In the next 10 minutes, the lever was

retracted. In the final 10 min, the lever was extended for the entire duration of the final period. Rats in Group UE received extrinsic motivation intermittently. On Day 7, During the first 10-minute period, the Group UE rats received reinforcement after the first lever press or after the 3rd extension of the lever. During the second 10-minute lever extension period, they received reinforcement after the third lever press or after 5 minutes. On Day 8, the Group UE rats received reinforcement after the third lever press or after the 3rd extension of the lever in the first period of lever extension. During the second 10-minute lever extension period, they received reinforcement after the third lever press or after 5 minutes. The Group ER rats were able to press the lever a maximum of 20 times across both periods each day. The yoking procedure was important during the second 10-minute period. If the Group ER rat completed all 20 presses in the second period, then the lever was retracted, and the session terminated for both the rat in Group ER and the yoked rat in Group UE.

Phase 3. All details are as described in Phase 1. All groups were placed in the experimental chamber for 30 minutes each day for 15 days (Days 9-23 of the experiment) without external reinforcement to measure lever pressing.

Results

Rats 5 and 15 did not lever press during Phase 2 and were removed from all analyses. In Phase 1, all groups decreased in the amount of lever pressing across each session (see Figure 1). This observation was supported by a repeated measures analysis of variance (ANOVA) conducted on lever pressing with the between-subject factor Group (NR, UE, and ER) and within-subject factor Days (1-3). The analysis revealed no effect of Group, $F(2,15) = .22$, $p = .81$, a marginally non-significant effect of Day, $F(2, 30) = 3.05$, $p = .06$, and no interaction, $F(4, 30) = .96$, $p = .44$.

In Phase 2, Group NR was placed in the box with no lever, so Group NR is not included in the data reported for this phase. Group UE and Group ER increased in the amount of lever pressing across each session (see Figure 1). This observation was supported by a repeated measures ANOVA conducted on lever pressing with the between-subject factor Group (UE and ER) and within-subject factor Days (6-8). The analysis revealed no effect of Group, $F(1,10) = .05$, $p = .82$, a main effect of Day, $F(2, 20) = 10.37$, $p < .01$, and no interaction, $F(2, 30) = 1.03$, $p = .38$.

A Tukey's Honestly Significant Differences post-hoc test (HSD) was performed to further explore the main effect of Day. There was a significant increase in lever pressing from Day 6 to Day 7, $p = .02$, and from Day 6 to Day 8, $p < .01$. However, there was no significant increase in lever pressing from Day 7 to Day 8, $p = .41$.

Due to a programming error, the data from Group NR was not recorded during the first 4 days (Days 9, 10, 11, and 12 of the experiment) of Phase 3. At the beginning of Phase 3, the rats from Group ER and Group UE pressed the lever more than they did at the end of Phase 3 (See Figure 1). Group ER pressed the lever a large number of times at the beginning of Phase 3, and this lever pressing decreased rapidly. Group UE pressed the lever less than Group ER at the beginning of Phase 3, and this pressing decreased gradually. Lever pressing for Group NR started low at the beginning of Phase 3, and this pressing remained low for the duration of the phase (See Figure 1).

To reduce between session variability and directly compare lever pressing across Phase 3, the data was blocked in groups of four days (Block 1, Block 2, Block 3). This also allowed a comparison of Group ER and Group UE during Block 1 (Days 9-12), which does not include data from Group NR.

In Block 1, Group ER pressed the lever more than Group UE (see Figure 2). This observation was supported by a repeated measures ANOVA conducted on lever pressing with the between-subject factor Group (UE and ER). The analysis revealed a main effect of Group, $F(1,10) = 6.76$, $p = .03$.

Across Blocks 2 and 3, the amount of lever pressing decreased for each group (see Figure 2). This observation was supported by a repeated measures ANOVA conducted on lever pressing with the between-subject factor Group (NR, UE, and ER) and within-subject factor Block (2-3). The analysis revealed marginally non-significant effect of Group, $F(2,15) = 3.45$, $p = .06$, a main effect of Block, $F(1, 15) = 21.68$, $p < .01$, and an interaction, $F(2, 15) = 4.12$, $p = .04$.

A Tukey HSD was performed to further explore the marginally non-significant effect of Group. The difference between Group ER and Group NR was marginally non-significant, $p = .06$. However, there was no significant difference between Group ER and Group UE, $p = .12$ or between Group UE and Group NR, $p = .88$.

Another Tukey HSD was performed to further explore the interaction between Block and Group. Group ER Block 2 significantly differed from Group UE Block 2 and 3, as well as from Group NR Block 2 and 3, $ps < .05$. No other groups or blocks differed significantly from each other, $ps > 0.45$.

Discussion

The current study had the purpose of investigating whether the overjustification effect can be observed in rats using lever pressing as a measure of intrinsic motivation. If we were to observe an overjustification effect in rats, then we would expect to see a decrease in behavior in the extrinsic group that fell below the level of the two intrinsic control groups (Group NR and Group UE). In Phase 1, lever pressing decreased across Days 1-3 in all groups. In Phase 2, lever

pressing by Group UE and Group ER increased across Days 6-8. In Phase 3, lever pressing by Group ER decreased rapidly, lever pressing by Group UE decreased gradually, and lever pressing by Group NR started low and remained at a low level throughout the phase. By the end of Phase 3, all rats were pressing the lever at a low level. These data do not support the idea that the overjustification effect can be observed in lever pressing in rats.

Lever pressing decreased across Days 1-3 in Phase 1 for all groups. The lever pressing of each group did not differ, and the way in which lever pressing in each group decreased did not differ. This phase was a measure of the intrinsic motivation the rats had to press the lever. These results were expected. The rats from Group NR, Group ER, and Group UE experienced the same conditions in Phase 1, so the amount of lever pressing by each group should have been similar. These results are similar to the results obtained by Boughner & Papini (2005) in that lever pressing in the absence of reinforcement decreased across Days 1-3 of the experiment. Boughner & Papini (2005) found that lever pressing in the absence of reinforcement started at a high level initially, decreased to a low level of pressing, and remained at this low level for the remainder of the experiment.

In Phase 2, the amount of lever pressing increased across Days 6-8 for both Group ER and Group UE. The amount of lever pressing by Group ER and Group UE did not differ, and the way that lever pressing in each group increased did not differ, but lever pressing on Day 6 differed from both Day 7 and Day 8. This increase in lever pressing reveals that the extrinsic reinforcement (i.e., food pellet) led to an increase in responding in Group ER and Group UE. Considering that the two groups received different amounts of reinforced responses, it is interesting that the groups did not differ in the amount of lever pressing or the way in which

lever pressing increased throughout Phase 2. This lack of difference may reveal that the different amounts of reinforced responses did not affect the acquisition of the task of lever pressing.

In Phase 3, lever pressing by Group ER and Group UE decreased across Days 9-23, and lever pressing by Group NR started low and remained low across Days 13-23. In Block 1, Group ER pressed the lever significantly more than Group UE. The results of Block 1 indicate that the reinforcement for each lever press by Group ER led the rats to learn to lever press to receive extrinsic reinforcement. The intermittent reinforcement of Group UE led to a lower level of lever pressing once the rats were no longer reinforced, meaning that the rats may not have learned to lever press for reinforcement to the same extent as Group ER. Also, in Block 2, lever pressing by Group ER was significantly higher than pressing in Group UE and Group NR. This high level of pressing my Group ER may reveal that extrinsic reinforcement increased motivation to lever press even after reinforcement was no longer given. The results revealed no evidence for the overjustification effect. If the level of lever pressing by Group ER had fallen below the levels of both Group UE and Group NR, then evidence for the overjustification effect would have been found.

This lack of evidence for the overjustification effect differs from the results obtained by both Deci (1971) and Lepper, Greene, and Nisbett (1973). In both of these experiments, responding by the groups given extrinsic reinforcement fell below the level of the control groups after the extrinsic reinforcement was no longer given for responding. The results obtained by the current experiment may differ from these previous results due to the use of lever pressing as a measure of intrinsic motivation in the current experiment. Due to the low responding in Phase 1, lever pressing may not be an intrinsically motivated task for rats. Additionally, no data was collected from Group NR on days 9-12 of Phase 3 because of the programming error. During

Days 9-12 of Phase 3, Group NR did not experience the lever, so it is difficult to compare the level of lever pressing by all groups across Blocks 1-3.

For several days after reinforcement was no longer given to the rats, Group ER continued to press the lever at a higher level than the other groups. This finding is the opposite of the overjustification effect, but this finding is consistent with other effects that have been reported in the literature on overjustification. According to Cameron, Banko, and Pierce (2001), activities that initially have low intrinsic motivation may benefit from extrinsic reinforcement. This may reveal that if the motivation to lever press was initially low, the extrinsic reinforcement might have led to an increase in the behavior of lever pressing. However, in our task, this increase only lasted for a few days. It is difficult to compare this result to humans. In those experiments, human participants are typically only tested during one session, whereas our rats were given seven sessions.

In the future, the experiment could be repeated with a different task that rats would be intrinsically motivated to complete. According to the experiment done by Belke and Pierce (2013), an example of an intrinsically motivated task could be wheel running. Instead of being reinforced for lever pressing, the rats in the extrinsic reinforcement group would be reinforced for wheel running in Phase 2. Experimenters could also repeat the experiment, but to make pressing the lever more intrinsically motivating, when the rats press the lever, it could turn on a light present in the box. This method is closer to the method employed by Lepper, Greene, and Nisbett (1973) because the light could act in the same way as the finished drawing acted in the experiment. In either scenario, the phases and groups would remain the same.

In terms of practical and theoretical implications, the results of the current experiment are important in that they reveal that it may not be possible to find evidence for the overjustification

effect in lever pressing in rats. Future research will need to further explore the overjustification effect on other tasks in rats. Research of the overjustification effect is important as the overjustification effect applies broadly to everyday life. From encouraging children to complete their chores at home to ensure that employees finish their tasks as work, the overjustification effect may apply, so further research is needed to better understand the best approach to guarantee a lasting, high level of motivation.

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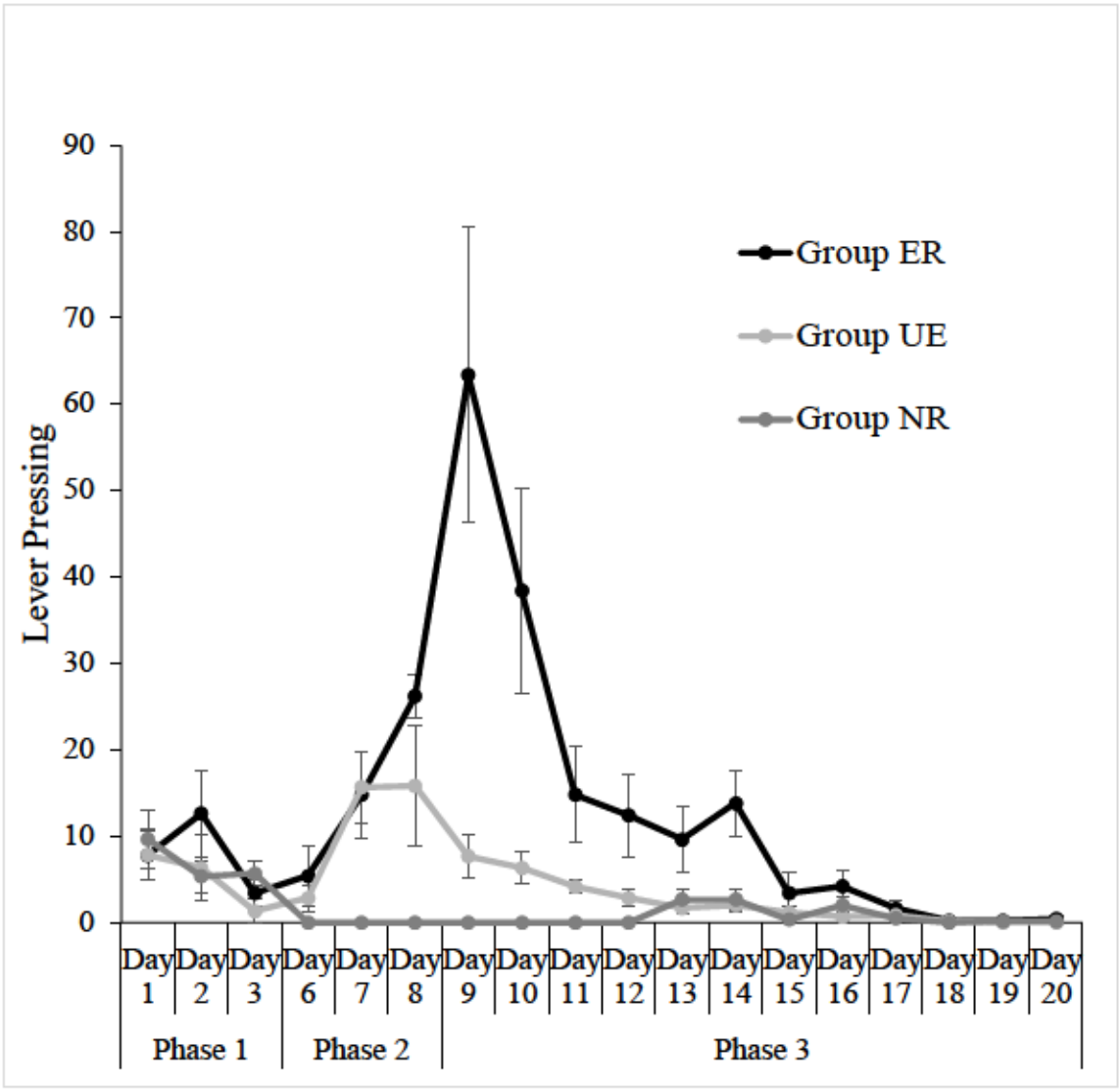

Figure 1. Average lever pressing of Group ER, Group UE, and Group NR across Days 1-23 of the experiment. Phase 1 measured intrinsic motivation, Phase 2 measured the effect of extrinsic reinforcement on Groups ER and UE, and Phase 3 measured motivation to press in the absence of reinforcement. Rats 5 and 15 did not lever press and were removed from the data collected. Error bars display the standard error of the mean.

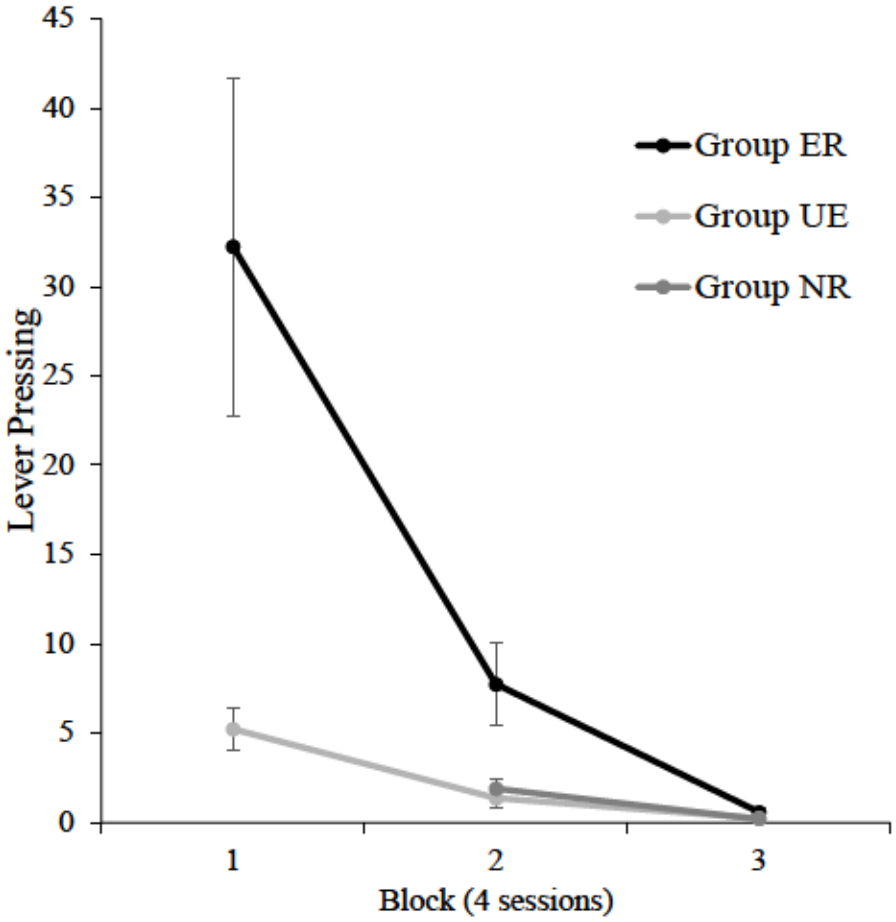

Figure 2. Average lever pressing for Group ER, Group UE, and Group NR across Blocks 1-3 of Phase 3. Block 1 consisted of Days of experimental days 9-12, Block 2 consisted of Days 13-16, and Block 3 consisted of Days 17-20. There are no data for Group NR for Block 1 due to an experimenter error. Error bars display the standard error of the mean.