Resistance to extinction and continuous punishment in humans as a function of partial reward and partial punishment training¹

JAN L. DEUR and ROSS D. PARKE, *University of Wisconsin, Madison, Wisc. 53706*

Human Ss were trained under 100% reward, 50% reward-50% nonreward, or 50% punishment-50% reward. Following acquisition, half the Ss experienced extinction while the remaining Ss experienced continuous punishment unaccompanied by reward. Both partial punishment and partial reward training led to greater resistance to extinction than continuous reward. Partial punishment training increased persistence under continuous punishment.

Martin (1963) and Banks (1966a) have extended Amsel's theory of frustrative-nonreward to punishment situations. Martin asserts that reinforcing a response while providing intermittent punishment of this same response will result in the classical conditioning of anticipatory punishment responses to the approach response, thus resulting in greater persistence during extinction. Banks (1966a) has argued that partial punishment training will result in greater resistance to continuous punishment and recently provided supporting data (Banks, 1966a, b) using rats as Ss.

Underlying these theoretical arguments is the assumption that frustrative-nonreward and punishment represent points along the same continuum (Martin, 1963). Brown & Wagner (1964) provided support for this conception by demonstrating that rats given either 50% reward or 50% punishment training persisted longer under extinction and under continuous punishment paired with reward than animals trained under 100% reward. Vogel-Sprott (1967) has recently replicated this finding with human Ss. The purpose of the present study was to compare the effects of partial punishment and partial reward training on subsequent resistance to extinction and to continuous punishment unaccompanied by reward in humans. The following hypotheses were tested: (1) irrespective of training schedule, punishment following acquisition of a response should result in fewer goal responses than does extinction; (2) intermittently punished Ss will show greater persistence during extinction and during continuous punishment than Ss continuously rewarded during acquisition; and (3) intermittently rewarded Ss will show more persistence during extinction and continuous punishment than continuously rewarded Ss.

METHOD

The Ss were 48 male introductory psychology students at the University of Wisconsin who received points toward their final grade for participating in the experiment. Eight Ss were randomly assigned to each of the six experimental conditions.

Apparatus

The apparatus consisted of a 3-button response panel similar to that described by Vogel-Sprott (1966). The panel contained a small white light in one corner. On the same circuit was another panel visible only to E, which indicated the response sequence employed by S on each trial and contained a button which activated the signal light on S's panel. S and E sat at opposite ends of a table divided by a Masonite screen to eliminate visual contact. A hole in the screen allowed an aluminum tube to extend downward to a plastic receptacle on S's side of the screen, through which pennies could be delivered as reinforcers.

The buzzer used as a punisher was an Edwards No. 115

model, operated at 18 V. The duration of the buzzer, which was automatically timed, was 3 sec. A General Radio Co. sound level meter, Type 1551-C, indicated that the loudness of the buzzer was 87 dB.

Procedure

Each S was brought from a waiting room into the experimental room by E, a graduate student in his mid-twenties, who then read the instructions to S. S was informed that his task was to learn a correct response sequence as soon as possible by pushing the buttons on the response panel in different combinations (e.g., 3-1-2, 1-3-2) using no more than three button presses per trial. A light signalled the onset of a trial and a penny was dispensed following the choice of the correct sequence. S was informed that the object of the experiment was to accumulate as many pennies as possible. To control for possible anticipation of the buzzer, all Ss, regardless of their experimental condition, were told that some Ss would receive the buzzer though it was uncertain whether they themselves would receive it since this had been determined "automatically." Finally, each S was told that he could end the experiment anytime simply by depressing the first button four times.

Following the instructions, E seated himself behind the screen and flashed S's signal light. E then recorded each response sequence attempted by S. Intertrial interval was 20 sec. As in previous studies of this type (Vogel-Sprott, 1967), the first two trials were not reinforced, and the third was arbitrarily chosen as the goal response. This first goal response was reinforced with a penny for all Ss. Acquisition continued until a criterion of 20 goal responses was met. No reinforcers were dispensed for any response other than the goal response.

There were three acquisition conditions: continuous reward (100% R), 50% reward (50% R), and 50% punishment (50% P). In the partial reinforcement groups only 50% of the goal responses were rewarded, the others being either nonreinforced or punished, depending on experimental condition. In the partial punishment condition E sounded the buzzer immediately following the last button press of each punished trial. The schedule for the partial reinforcement groups was randomly generated, with the restrictions that both the first and twentieth goal responses were rewarded and that no more than two rewards or two punishments were consecutive.

After 20 goal responses the three acquisition groups were divided into extinction (E) and continuous punishment (CP) groups, in which the goal response was ignored or continuously punished, respectively. All rewards were discontinued.

The dependent measure was the number of goal responses made by S before he terminated the experiment. For the six Ss who did not voluntarily end the experiment, E terminated the experiment after 45 min and credited S with the number of goal responses emitted up to that point.

In addition to the 48 Ss on which the data analysis is based, 10 Ss were run but dropped before the analysis of data for these reasons: six voluntarily ended the experiment before acquisition was completed; four failed to follow the instructions. The S loss was distributed approximately equally across the experimental groups.

RESULTS

Due to extreme skewness in the data a Kruskal-Wallis one-way analysis of variance was performed on the six groups.

Since significant differences were present ($\chi^2 = 11.42$, corrected for ties; $df = 5$, $p < .05$) Mann-Whitney U tests were then used for selected individual comparisons. The median number of goal responses for each of the six groups following acquisition was: 100% R-E = 5.5; 100% R-CP = 3.0; 50% R-E = 19.5; 50% R-CP = 7.5; 50% P-E = 21.0; 50% P-CP = 18.0. Contrary to the first prediction there was no overall difference between extinction and punishment ($z = 1.23$, ns). In support of Prediction 2, Ss trained on partial punishment were significantly more resistant to continuous punishment than Ss trained on continuous reward ($U = 12$, $p < .02$, one-tailed test); similarly Ss trained on partial punishment showed greater resistance to extinction than continuously-reinforced Ss ($U = 15.5$, $p < .05$, one-tailed test). In regard to the third prediction, Ss trained on partial reward persisted longer during extinction than Ss trained on 100% reinforcement ($U = 15.5$, $p < .05$, one-tailed test). However, the persistence scores of the partial reward and continuous reward groups under continuous punishment conditions did not significantly differ ($U = 29$, ns). Ss receiving partial punishment in acquisition were more persistent during continuous punishment than Ss receiving partial reward in acquisition although the difference was of borderline significance ($U = 14.5$, $p < .08$, two-tailed test); resistance to extinction scores for these two groups did not significantly differ ($U = 30.5$, ns).

DISCUSSION

The results of the experiment provide, with few exceptions, support for frustration theory as it applies to human behavior in a simple learning task. The finding that intermittent punishment increases persistence to continuous punishment in humans buttresses the results of Banks' (1966) experiment, in which he obtained similar results with rats, using shock as a punisher. However, without a noncontingent-buzzer control group, it is impossible to rule out an adaptation-to-punishment interpretation of the present findings.

Moreover, partial punishment training during acquisition led to more persistence during extinction than continuous reward training. While these data support theoretical notions stressing a similarity between frustrative nonreward and punishment, the failure to replicate the previously reported finding (Vogel-Sprott, 1967) that partially rewarded Ss show increased resistance to continuous punishment is inconsistent with this conceptualization. However, task and procedural differences can probably account for this discrepancy. One important difference involves Vogel-Sprott's pairing of reward with continuous punishment, whereas in this study continuous punishment was presented alone. The possibility that this difference may account for the discrepant findings is suggested by a recent experiment (Vogel-Sprott & Thurston, 1968) in which Ss trained on a 50% reward schedule showed less

persistence when exposed to continuous punishment unaccompanied by reward than Ss exposed to continuous punishment paired with either 50% or 100% reward.

The extent to which frustrative nonreward and punishment can be considered conceptually similar clearly requires further study. In light of the successful transfer of punishment training to resistance to extinction, and the poor transfer of nonreward training to resistance to continuous punishment, it appears that transfer from a more emotionally-arousing stimulus (punishment) to a less arousing one (nonreward) is easier than transfer from nonreward to punishment. When transferring from nonreward to punishment a factor of considerable significance is probably the intensity of punishment used in the persistence test; maximal transfer between nonreward training and punishment will probably occur at low levels of punishment intensity, but may decrease as the intensity increases. However, resistance to high intensity punishment following partial reward training could possibly be increased by pairing reward with the punishing event (Vogel-Sprott & Thurston, 1968). Comparisons involving the relative effectiveness of partial reward and partial punishment training for increasing persistence to continuous punishment should take intensity of punishment employed during testing into account as well. In fact, the borderline difference between the partial reward and partial punishment groups under continuous punishment is probably due to the relatively mild punisher used in this study; if a more intense punisher (e.g., electric shock) was employed the relative superiority of partial punishment training would perhaps have been more marked.

REFERENCES

- BANKS, R. K. Persistence to continuous punishment following intermittent punishment training. *Journal of Experimental Psychology*, 1966a, 71, 373-377.
- BANKS, R. K. Persistence to continuous punishment and nonreward following training with intermittent punishment and nonreward. *Psychonomic Science*, 1966b, 5, 105-106.
- BROWN, R. R., & WAGNER, A. R. Resistance to punishment and extinction following training with shock or nonreinforcement. *Journal of Experimental Psychology*, 1964, 68, 503-507.
- MARTIN, B. Reward and punishment associated with the same goal response: A factor in the learning of motives. *Psychological Bulletin*, 1963, 60, 441-451.
- VOGEL-SPROTT, M. D. Suppression of a rewarded response by punishment as a function of reinforcement schedules. *Psychonomic Science*, 1966, 5, 395-396.
- VOGEL-SPROTT, M. D. Partial-reward training for resistance to punishment and to subsequent extinction. *Journal of Experimental Psychology*, 1967, 75, 138-140.
- VOGEL-SPROTT, M. D., & THURSTON, E. Resistance to punishment and subsequent extinction of a response as a function of its reward history. *Psychological Reports*, 1968, 22, 631-637.

NOTE

1. The research reported in this paper was supported in part by United States Public Health Service Training Grant 144-8920 from the National Institute of Mental Health.