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Effects of magnitude of reward and intensity of intermittent punishment on resistance to extinction

NABIL F. HADDAD and ROGER L. MELLGREN
University of Oklahoma, 455 West Lindsey, Norman, Oklahoma 73069

Subjects were given a high (10 pellets) or a low (one pellet) magnitude of continuous reinforcement combined factorially with 0, .1, or .8 mA of intermittent shock. Groups that received a low magnitude of food reinforcement were more resistant to extinction than those that received a high magnitude of reinforcement. Shock intensities did not have any systematic effect on resistance to extinction, indicating that response suppression due to intense punishment during acquisition is not sufficient to cause an increase in resistance to extinction.

Numerous investigators have reported that intermittent punishment of an appetitively reinforced instrumental response during acquisition produces increased resistance to extinction (e.g., Brown & Wagner, 1964; Linden & Hallgren, 1973). Interpretations of this effect have relied for the most part on extending Amsel's (1962, 1967) frustration theory to punishment by assuming a functional similarity between nonreward and punishment. Accordingly, fractional anticipatory fear or pain and fractional anticipatory frustration are assumed to have similar effects which transfer from one event to the other. The extent to which such transfer takes place appears to be a function of the intensity of punishment (Banks & Torney, 1969) with more suppressive punishment intensities resulting in higher resistance to extinction. At very high levels, however, resistance to extinction may decrease toward an unpunished control group level (Linden, 1974).

The purpose of the present study was to investigate whether intensity of punishment and magnitude of food reinforcement may interact to determine resistance to extinction. A small magnitude of continuous food reinforcement is known to result in higher resistance to extinction relative to a large magnitude (Wagner, 1961). Under the assumption that a summation of effects occurs, combining a small magnitude of continuous food reinforcement with a strong suppressive punishment intensity should result in higher resistance to extinction relative to conditions involving either a small magnitude of food reinforcement, a weak intensity of punishment or a combination of these two.

Reprint requests should be sent to Roger L. Mellgren, Department of Psychology, University of Oklahoma, Norman, Oklahoma 73069.

METHOD

Subjects and Apparatus

The subjects were 48 naive male albino rats randomly assigned to one of six groups (n = 8). The apparatus consisted of a commercially manufactured (Hunter) Plexiglas straight runway with a grid floor. It measured 150 x 15 x 9 cm and was divided into start, run, and goal sections separated by guillotine doors. A Grayson-Stadler shock scrambler (Model 700) provided shock to the goalbox section of the runway. A teaspoon was mounted in the middle of the far end of the goalbox and served as a foodcup. Times were measured by three .01-sec Standard timers and a series of photoelectric cells yielding start, run, and goal times. Fractionated and total times were converted to reciprocals for analysis.

Procedure

After 14 days of free access to food and water, the subjects were placed on a 12-g-daily food-deprivation schedule. Seven days after that start of the deprivation schedule, all subjects received two reinforced pretraining trials per day for 2 days. A 3 (shock level) by 2(reinforcer magnitude) factorial design was employed. The magnitude of shock delivered on punished trials was either 0, .1, or .8 mA for 1 sec. The magnitude of food reinforcement was either 1 or 10 45-mg Noyes pellets. Thus the design yielded the combination of no (N), weak (W), or strong (S) punishment with large (10 pellets) or small (one pellet) magnitude of food reinforcement, thereby providing two CRF control groups.

Acquisition consisted of four trials per day for 24 days with an intertrial interval of 15 sec. Food reinforcement (1 or 10 pellets) was available on every trial with punishment occurring on Days 4 (Trials 2 and 3), 5 (Trial 3), and 16 (Trial 3) only. Extinction consisted of four trials per day for 4 days with a 15 sec intertrial interval. On each of these trials, the subject was confined to the unbaited goalbox for 30 sec. Shock was not delivered during extinction.

RESULTS AND DISCUSSION

Since differences in start, run, and goal speeds were reflected in the total speed measure, only the analyses pertaining to the total speeds will be reported here. It is clear from Figure 1 that strong shock on Days 4, 5, and 16 resulted in a dramatic suppression of

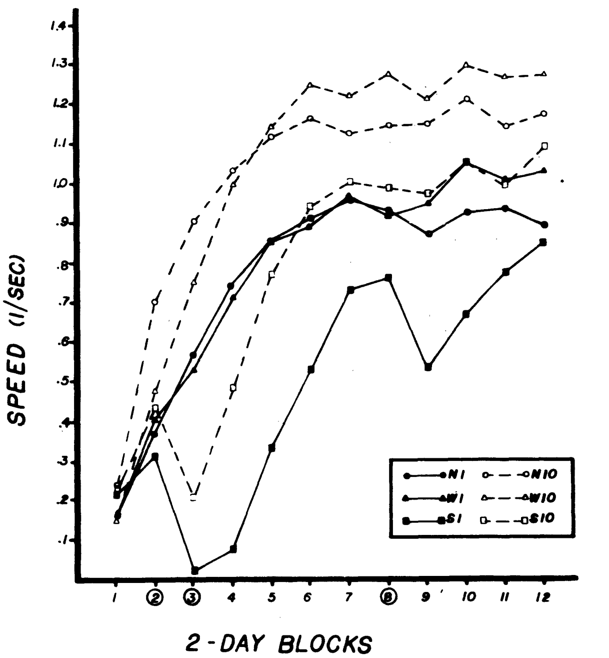

Figure 1. Mean running total speeds over the 24 days of acquisition. Circles indicate the days on which punishment was delivered.

responding but that weak shock did not result in any suppression of responding. A 2 by 3 analysis of variance was performed on the mean total speeds of the last day of acquisition to assess terminal acquisition differences. A significant intensity-of-shock main effect was found [$F(2,42) = 3.86$, $p < .05$] indicating the inferiority of Groups S1 and S10. In addition, a significant magnitude-of-reinforcement main effect was found [$F(1,42) = 16.71$, $p < .05$] indicating the inferiority of the groups reinforced with one pellet.

The mean extinction total speeds from the 4 days of extinction were analyzed via a 2 by 3 by 4 repeated measures analysis of variance. A significant main effect due to magnitude of food reinforcement was found [$F(1,42) = 4.93$, $p < .05$] indicating, as Figure 2 shows, that the three groups receiving small magnitude of continuous reinforcement (one pelet) were more resistant to extinction than those receiving large magnitude of continuous reinforcement (10 pellets). In addition, this main effect interacted significantly with days [$F(3,126) = 6.02$, $p < .05$], indicating that the rate of extinction of the small reward groups was slower than that of the large reward groups. Finally, the main effect of punishment intensity was not significant. It also did not interact significantly with any other variable, indicating that the intensity of punishment, within the range used in this study, did not have any systematic effect on resistance to extinction.

These results support the many reports showing that a small magnitude of continuous reinforcement results in higher resistance to extinction than a large magnitude of continuous reinforcement (e.g., Wagner, 1961). The absence of any effects due to punishment is somewhat troublesome, however. Linden (1974) has recently argued that punishment should increase resistance to extinction if it results in some suppression of responding. Furthermore, he argues that the lack of such an increase in resistance to extinction (e.g., Banks & Torney, 1969) is attributable to the absence of a suppressive effect by punishment. The data presented here contradict this assessment of intermittent punishment. It is clear that Groups S1 and S10 suffered a dramatic suppression of responding in the acquisition phase. Moreover, their recovery from this suppressive effect indicates that anticipatory pain or fear should have been counterconditioned. Therefore, the failure of this strong intensity of punishment to result in greater resistance to extinction than that of the unpunished groups suggests that suppression of responding and subsequent recovery do not constitute reliable indices for the prediction of intermittent punishment effects. It may be that the recovery of responding must occur while punishment is still being delivered, as Linden (1974) suggests. The rather dramatic suppressive effects of the strong shock precluded the possibility of continuing to administer punishment while the recovery of the running response was occurring. Thus, it may be necessary for the shock to be gradually increased in intensity to its final strong level in order to keep from producing such severe suppression of responding that recovery does not occur.

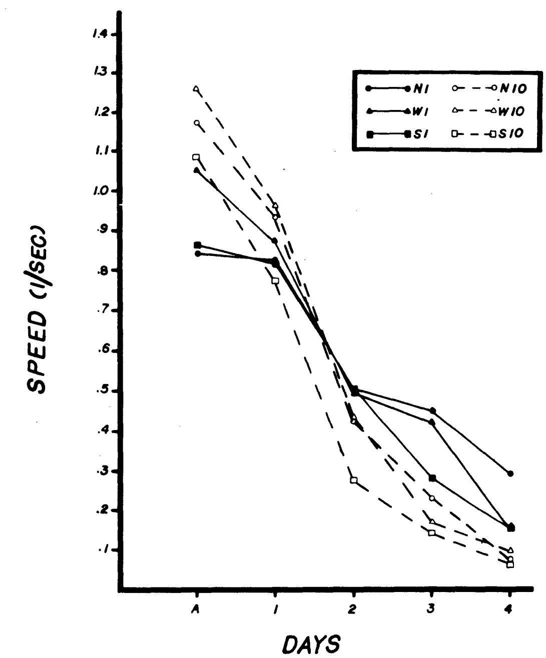

Figure 2. Mean running total speeds for the last day of acquisition and the 4 days of extinction.

REFERENCES

AMSEL, A. Frustrative nonreward in partial reinforcement and discrimination learning: Some recent history and a theoretical extension. *Psychological Review*, 1962, **69**, 306-328.

AMSEL, A. Partial reinforcement effects on vigor and persistence. In K. W. Spence & J. T. Spence (Eds.), *The psychology of learning and motivation: Advances in research and theory* (Vol. 1). New York: Academic Press, 1967.

BANKS, R. K., & TORNEY, D. Generalization of persistence: The transfer of approach behavior to differing aversive stimuli. *Canadian Journal of Psychology*, 1969, **23**, 268-273.

BROWN, R. T., & WAGNER, A. R. Resistance to punishment and extinction following training with shock and nonreinforcement. *Journal of Experimental Psychology*, 1964, **68**, 503-507.

LINDEN, D. R. The effect of intensity of intermittent punishment in acquisition on resistance to extinction of an avoidance response. *Animal Learning and Behavior*, 1974, **2**, 9-12.

LINDEN, D. R., & HALLGREN, S. O. Transfer of approach responding between punishment and frustrative nonreward sustained through continuous reinforcement. *Learning and Motivation*, 1973, **4**, 207-217.

WAGNER, A. R. Effects of amount and percentage of reinforcement and number of acquisition trials on conditioning and extinction. *Journal of Experimental Psychology*, 1961, **62**, 234-242.

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