Motivational properties of nonreward¹

ROBERT S. TACKER AND JOYCE WAY
UNIVERSITY OF SOUTH DAKOTA

The subsequent effects on general activity of nonreward for a previously rewarded response were explored using a runway and an open field. The field served as a goalbox for the runway and a device for the measurement of general activity. Both ambulation and rearing were energized by nonreward but unlike the durable effect on learned responses, the energization of general activity was temporary.

The energizing properties of nonreward for a response which has previously been rewarded have typically been observed in the second of two learned responses. The bulk of the research has been carried out by Amsel and his co-workers using a tandem runway apparatus. Animals run faster in the second runway after nonrewarded trials in the first goalbox than after rewarded trials. The energization of the second response has been labeled the frustration effect (FE) and has been used in explanations of the partial reinforcement paradox (Amsel, 1962; Goodrich, 1959) and of extinction (Amsel, 1958). Both explanations assume that nonreward is followed by an increase in motivation. Yet, most of the supporting evidence has come from a change in the vigor of a rewarded response which is quite similar to the nonrewarded response favoring an interpretation of the FE as an incentive phenomenon.

Although Amsel (1958) attributed FE to an increment in drive, it remains to be demonstrated that nonreward, like other antecedents of drive, energizes general activity as well as learned responses. In the present experiment, a runway was used for the establishment of a rewarded, instrumental response which was periodically not rewarded. The subsequent effects of nonreward on general activity were evaluated using an open field which served as both a goalbox for the runway and an apparatus for the measurement of activity.

Method

The Ss were 20 hooded Long-Evans female rats. They were approximately 90 days of age at the beginning of the experiment. All Ss were deprived of food for 36 h prior to preliminary training. Following the first day of preliminary training, Ss were maintained on a 22 h food deprivation schedule for the remainder of preliminary training and throughout testing. Eight Ss did not complete preliminary training, were discarded, and then replaced by eight others in order to obtain a total of 20 Ss.

The apparatus consisted of a 78 x 4 x 4 in. black runway which opened into a square, white open field, 24 x 24 x 18 in. The floor of the open field was divided into 16 squares with the divisions marked with black paint. The start box of the runway was 1 ft in length

and was separated from the runway by a guillotine door. A timer started when S interrupted a photoelectric beam situated 3 in. past the start box door. The timer was stopped when S interrupted a second beam, 48 in. beyond the first. A guillotine door was located 3 in. beyond the second beam and was lowered behind S to prevent retracing of the runway. This door was 12 in. from the entrance to the open field and was necessary because the rats were hesitant to enter the open field early in testing and tended to retrace the runway rather than enter the field. After S entered the open field, a final door which separated the runway from the open field was lowered in order to confine S to the field.

For two days Ss were adapted to handling and to the apparatus. On the first day, each S was placed in the open field where Purina Lab Chow pellets were scattered on the floor. If S began eating within 10 min, 3 min of eating were allowed, at the end of which S was transferred to the start box and allowed to traverse the runway and again allowed to eat for 3 min in the open field. Animals which did not eat during the first 10 min period were returned to the home cage. The following day the same procedure was followed. If S again failed to eat within 10 min, she was eliminated from the experiment. On the second day of pretraining, the procedure was the same as on the first except that eight 45 mg Noyes pellets were placed in the food dish in the center of the field and food was no longer scattered on the floor.

During testing, each S was allowed to traverse the runway to the open field and was given four 45 mg Noyes pellets except on nonrewarded trials. Measures of activity included frequency counts of the number of squares traversed and of number of rears. Number of seconds spent in grooming was also recorded. Activity on each trial was measured for 60 sec beginning with the first defined count of activity (locomotion, rearing, or grooming) after completion of eating on reward trials, and the first defined movement after reaching the food dish on nonrewarded trials. Trials were administered at a rate of four trials per day for 12 consecutive days. Beginning with the third trial of the second day of testing, the third trial on alternate days was designated as a nonreward trial. The intertrial interval varied between 5 and 10 min.

Results and Discussion

Grooming occurred so infrequently (median time spent grooming was zero sec) that the data were discarded.

Data for squares and rears were analyzed using a

Fig. 1. Ambulation after reward on the trial preceding (RP) and the trial following (RF) the nonreward test trial, and ambulation following nonreward (N).

three-factor analysis of variance for a completely within-Ss design in which main effects were Trials, Conditions (reward or nonreward), and Subjects (Walker & Lev, 1953).

Figure 1 shows the results of the ambulation measure. Activity following nonreward is contrasted with activity following reward on the trial preceding and the trial following the nonreward trial. Analysis of variance applied to these data demonstrated significant effects of Conditions (reward vs nonreward) and of interaction between Conditions and Trials ($F=3.28$, $df=2/228$, $p<.05$; $F=2.50$, $df=10/120$, $p<.01$, respectively). The main effect of Trials was not significant. Although the subjects were significantly more active following nonreward than following reward, the effect was not pronounced and disappeared by the fourth nonrewarded trial.

Average numbers of rears following the reward and nonreward conditions are shown in Fig. 2. Analysis of variance applied to these data demonstrated a significant Conditions effect ($F=6.07$, $df=2/228$, $p<.01$) while the effects of Trials and of Interaction failed to reach significance.

Considering that both responses were significantly energized by nonreward, it is concluded that non-

Fig. 2. Rearing after reward on the trial preceding (RP) and the trial following (RF) the nonreward test trial, and rearing following nonreward (N).

reward contributes to an increase in the drive level of the organism. However, unlike the continued energization of a learned response, the effect was temporary and disappeared in both measures of activity. The rather surprising adaptation to nonreward in the face of failure of the Ss to adapt in numerous studies employing rewards for the indicator response is puzzling. One may speculate that two processes are operative following nonreward, e.g., a temporary increment in drive early in training followed by a more durable incentive increment after the frustrated response is more firmly established.

References

- AMSEL, A. The role of frustrative nonreward in noncontinuous reward situations. *Psychol. Bull.*, 1958, 55, 102-119.
- AMSEL, A. Frustrative nonreward in partial reinforcement and discrimination learning: Some recent history and a theoretical extension. *Psychol. Rev.*, 1962, 69, 306-328.
- GOODRICH, K. P. Performance in different segments of an instrumental response chain as a function of reinforcement schedule. *J. exp. Psychol.*, 1959, 57, 57-63.
- WALKER, HELEN M., & LEV, J. *Statistical Inference*. New York: Holt, Rinehart and Winston, Inc., 1953.

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