Magnitude of reward and the frustration effect in a within-subjects design¹

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Abstract

The effect of reward magnitude in the first goal box (G_1) of a double runway on the size of the frustration effect (FE) was studied, using a within-subjects design. During a preliminary phase, 11 rats were run in black and in white first alleys (A_1) the reward in G_1 being (say) large when A_1 was black and small when A_1 was white. Test trials followed, in which percent reward in G_1 was reduced from 100 to 50 in both the large- and small-magnitude alleys. The results indicated a significantly larger FE after nonreward in the A_1 associated with the larger reward. More important, N-trials following nonreward in the large-reward A_1 were significantly faster than N-trials following nonreward in the small-reward A_1 .

Problem

Theory of frustrative nonreward (Amsel, 1958, 1962; Spence, 1960) assumes a positive relationship between strength of the anticipatory reward response (r_R) and frustration (R_F). An indicant of R_F is the frustration effect (FE), greater vigor of responding following nonreward than following reward, typically studied in the double-runway apparatus. Experiments (Roussel, 1952; Amsel & Hancock, 1957), showing the gradual development of the FE when there is 50% reward in G_1 from the outset of training as opposed to immediate and strong FE when there has been a previous prolonged period of continuous reward, are taken to support the hypothesized relationship between r_R and R_F . Experiments showing a positive relationship between size of the FE and the similarity of G_1 to A_1 (Amsel & Hancock, 1957; Amsel et al., 1960) have also been offered as support for this relationship, as has the finding that length of A_1 and magnitude of the FE measured in A_2 are positively related (Amsel et al., 1960). To date, there has been no direct experimental demonstration of a relationship between magnitude of reward in G_1 and the FE. The closest thing to such a demonstration is an experiment by Bower (1962), which showed that the FE can be obtained with reduced reward as well as nonreward. However, no information is provided regarding effects of size of reward in G_1 on the FE when different magnitudes of G_1 are reduced to zero. The present study was designed to test the hypothesis that magnitude of the FE is directly related to magnitude of reward in G_1 , using a within-subjects design.

Method

Six female and five male hooded rats, approximately 130 days old, served as Ss. The apparatus consisted

of two straight, parallel double runways. It contained the following sections: a pre-start box (PSB); start box (SB); two parallel first alleys, one white (A_1W), the other black (A_1B); and two corresponding parallel goal sections (G_1W and G_1B); two second alleys (A_2), each of which was painted grey, and two corresponding goal sections (G_2) also painted grey and identical in all details. Both first alleys and both second alleys were mounted as a single unit on rollers and could be moved laterally so that either the black or white side was aligned with the PSB and SB sections. Food cups were placed at the end and on the left side of each of the four goal boxes. The doors were of the guillotine type, and were raised and lowered by means of a system of pulleys suspended above the runways. A timing system consisting of photocells and timers was used to record A_1 starting, running and goal times in successive 12-in segments of A_1 . Starting and running times were similarly taken from successive 12-in segments of A_2 . All Ss were maintained at 80% of their original body weight, and given preliminary acquisition training four trials per day for 64 days. A large magnitude of reward (8 37-mg Noyes pellets) was presented in G_1 on two of the four trials each day and a small magnitude of reward (2 pellets) was presented G_1 on the other two trials. For any given S, each magnitude was presented consistently with either the black of the white A_1 , thus enabling them to learn a black-white discrimination on the basis of differential magnitude of reward. All Ss received 2 pellets in A_2 consistently throughout acquisition and test trials. To control for possible reaction to A_1 brightness, half the Ss received 8 pellets in G_1 when A_1 was black, and 2 pellets in G_1 when A_1 was white (Group 8B-2W); in the other group (8W-2B) the relationships were reversed. Order of presentation of 2- and 8-pellet trials was determined by the following four kinds of daily trial sequences: $R_8R_2R_8R_2$, $R_2R_2R_8R_8$, $R_2R_8R_2R_8$, and $R_8R_8R_2R_2$. Each S was assigned a repeating combination of these four sequences in a pseudo-random fashion.

Test trials were run for 12 days and were identical to the acquisition trials, except that percent G_1 reward on each of the two kinds of trials was changed from 100 to 50 as follows: On alternating days, the first and last trials or middle two trials, respectively, were designated nonreward (N) trials. The ordinary FE test trial procedure (Amsel & Roussel, 1952) was thereby conducted separately in relation to each of the two color cues within the same S.

Fig. 1.

Results

All of the test trial data for any measure involve only within-S comparisons. A_2 starting and running speeds (1/time) are presented graphically in Fig. 1. The general pattern of the results seems the same with both measures. Each point on the graph represents the mean of 11 individual-S medians over a 4-day block for one of the four types of test trial. A S's score for each of the four kinds of trial was determined by taking the mean of the three 4-day block medians. Data for the two color groups have been combined, since there was little difference between them in A_2 measures during test trials. The statistical analyses presented below in relation to the three kinds of comparison were performed on the data from the starting measure.

The N minus R differences (FE). Speeds are faster in A_2 after nonreward in G_1 than after reward in G_1 both in the large magnitude alley (N_8 minus R_8) and in the small magnitude alley (N_2 minus R_2). Eight of 11 Ss showed positive N_8 minus R_8 differences, and a paired observation analysis of these differences was statistically significant (t , 4.89; df , 10; p < .0005). Nine of 11 Ss showed positive N_2 minus R_2 differences, and a paired observation analysis of these differences was also significant (t , 3.00; df , 10; p < .01).

Comparison of 8-pellet and 2-pellet FEs. It is clear, graphically, that the N_8 minus R_8 difference (FE to 8 pellets) is larger than the N_2 minus R_2 differences (FE to 2 pellets). Ten of 11 Ss showed positive FE_8 minus FE_2 differences; and a paired observation

analysis of these differences was statistically significant (t , 4.95; df , 10; p < .0005).

Comparison of N_8 and N_2 trials. There is a small but consistent difference between the N_8 and N_2 trials for both the starting and running measures. Positive N_8 minus N_2 differences were observed in 9 of the 11 Ss, and a paired observations analysis of these differences was significant (t , 2.34; df , 10; p < .025). In the view of the pretest and test performance of Ss on R_8 and R_2 trials, R_2 speeds being always much faster than R_8 speeds, this significant inversion of performance levels on N_8 and N_2 test trials seems particularly noteworthy.

Discussion

Despite the fact that Ss run more slowly in A_2 during preliminary and test trials after 8 pellets in G_1 than after 2 pellets, they run faster in A_2 after nonreward to the 8-pellet cue than they do to the 2-pellet cue. This striking reversal, within-subjects, provides evidence for an hypothesis relating the FE to magnitude of reward that is entirely free of the "demotivation hypothesis" objection (Seward et al., 1957). Apart from difference in color of A_1 , the N_8 and N_2 trials are identical operationally, and yield a difference within Ss which can be understood only associatively: the N_8 trials occur in the presence of a stimulus signalling 8 pellets and the N_2 trials occur when the other stimulus signals 2 pellets. Presumably, two discriminable stimuli conditioned to two magnitudes of a goal can control, within the same organism, two different strengths of r_R , each in turn producing its own appropriate value of R_F when reward is withheld.

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.
- AMSEL, A., ERNHART, C. B., & GALBRECHT, C. R. Magnitude of frustration effect and strength of antedating goal factors. *Psychol. Rep.*, 1961, 8, 183-186.
- AMSEL, A., & HANCOCK, W. Motivational properties of frustration: III. Relation of frustration effect to antedating goal factors. *J. exp. Psychol.*, 1957, 53, 126-131.
- AMSEL, A., & ROUSSEL, J. Motivational properties of frustration: I. Effect on a running response of the addition of frustration to the motivational complex. *J. exp. Psychol.*, 1952, 43, 363-368.
- BOWER, G. H. The influence of graded reductions in reward and prior frustrating events upon the magnitude of the frustration effect. *J. comp. physiol. Psychol.*, 1962, 55, 582-587.
- ROUSSEL, J. Frustration effects as a function of repeated non-reinforcements and as a function of the consistency of reinforcement prior to introduction of non-reinforcement. Unpublished master's thesis, Tulane University, 1952.
- SEWARD, J. P., PEREBOOM, A. C., BUTLER, B., & JONES, R. B. The role of prefeeding in apparent frustration effect. *J. exp. Psychol.*, 1957, 54, 445-450.
- SPENCE, K. W. *Behavioral theory and learning*. Englewood Cliffs: Prentice-Hall, 1960.

Note

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