state, such as dryness of the mouth, etc., with the shock, and subsequent injections could then restore that stimulus complex associated with the punishment. This explanation could easily be applied to the animals of Group BE since the drug effects were well established when shock was applied but less easily to animals of Group AE which received the drug after the shocks. Perhaps one could assume that, although AE Ss received the drug on Test Day 1 after the shock, the autonomic reactions to the shock lasted long enough to be associated with the peripheral effects of the drug. Weak as this explanation is, it could be tested in the future by the administration, on Test Day 2, of methyl-scopolamine which is thought to have the same peripheral effects as scopolamine-hydrobromide but does not pass the blood-brain barrier and therefore should have fewer central effects. If memory of the shock is dependent on the peripheral cues then the two drugs should be of equal effectiveness at this point in time. This explanation, however, does not account for the effects of the drug found in other types of tasks. In active avoidance learning tasks (Suits & Isaacson, 1968) injection of the drug produces significant increments or decrements in performance even though the S is always trained in the drugged state. Tapp (1965) found increased activity in drugged Ss while Douglas & Isaacson (1966) found spontaneous alternation reduced to near chance level in rats under the influence of scopolamine. These varied results cannot be

readily attributed to dissociation effects alone and further explanations must be sought.

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NOTES

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between the magnitude of R_F and the magnitude of the fractional anticipatory goal response (r_g). Several studies have demonstrated that factors assumed to determine r_g are related to the magnitude of the FE. Peckham & Amsel (1967), for example, using a within-Ss design, have shown that the size of the FE varies with the magnitude of reward given in the first goal box in a double-alley situation.

The relationship between another variable assumed to determine the strength of r_g , number of conditioning trials (N_G) (Spence, 1956), and the magnitude of the FE has received little experimental attention. Marzocco (1951) using a modified Skinner box in which measures of force exerted to depress the bar were taken, found that the FE, defined as differences in force exerted on presses prior to nonreward and force exerted during nonreward, tended to be greater in groups given 24 or 72 rewarded presses than in an 8-reward group. No double-alley studies, however, have attempted to confirm Marzocco's results. The purpose of the present study was to investigate the effect of N_G on the magnitude of the FE in the double-alley situation.

METHOD

The Ss were 42 experimentally naive male rats, 90-100 days old at the start of the habituation period, obtained from the Holtzman Company.

The apparatus consisted of two straight alleys, 4 in. high and 3½ in. wide, placed end to end and illuminated by a moderately dim diffused light source centered above the alleys. All surfaces of the alleys visible to S were painted flat black. Alley 1 consisted of a start box, 9 in. long, separated by a metal dropping door from the 48-in. long alley. A 12-in. long goal box (GB1) served as the start box for Alley 2 and was separated from Alley 1 by a metal sliding door to prevent retracing and from Alley 2 by a metal dropping door. Alley 2 was 60 in. long with a 12-in. long goal box (GB2). GB2 was separated from Alley 2 by a metal sliding door to prevent retracing. A small metal food cup was set in flush with the floor in GB1 immediately in front of the metal dropping door. A glass food cup set into a painted wooden form was placed at the end of GB2.

When the start door to Alley 2 was dropped a microswitch was triggered starting a Standard Electric clock. Interruption of a light beam 12 in. from the start door stopped this clock and started a second. Interruption of a light beam 36 in. farther down Alley 2 stopped the second clock. Start time, then, was measured over a distance of 12 in., running time over a distance of 36 in. All times were converted to reciprocals.

Magnitude of the frustration effect and number of training trials

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Groups of 14 rats were given either 12, 36, or 60 continuously reinforced trials in a double-alley situation and then shifted to a 50% partial reinforcement schedule in the first goal box for 30 test trials to determine the effect of number of reinforced trials on the magnitude of the frustration effect (FE). Results indicated a significant FE in all three groups, with the FE in the 60-trial group larger than in the 36- or 12-trial groups, and no difference in the size of the FE for the latter two groups.

The theory of frustrative nonreward proposed by Amsel (1958, 1962) and Spence (1960) assumes that nonreinforcement of a previously reinforced response produces a primary frustration response (R_F) which contributes to the drive level of the organism. In the double-alley apparatus typically used to demonstrate the presence of R_F (e.g., Amsel & Roussel, 1952), omission of reward in the first goal box on some trials after a history of previously rewarded trials produces the frustration effect (FE), or faster running in Alley 2 following nonreward than following reward.

The theory of frustrative nonreward also assumes that there is a positive relationship

Eight days prior to the start of experimental training, individually housed Ss were placed on a restricted diet of 10 g of Purina lab chow per day until their weight had dropped to 85% of their prehabitation ad lib weight and then fed the daily amount necessary to maintain them at this level.

Fourteen Ss were randomly assigned to each of three experimental groups and received 12, 36, or 60 100% reinforced training trials, at the rate of six trials per day. All Ss received one .097-g P. J. Noyes pellet in GB1 and in GB2. After the appropriate number of training trials Ss were shifted to a 50% reinforcement schedule in GB1 for 30 trials. Half of each test day's trials were reinforced (R) and half were nonreinforced (N) according to the following schedule: RNRNRN, NNRNRN, NRNRNR, RRNRNR, NRRNRN.

Since different numbers of experimental days were required for the three experimental groups, possible confounding effects due to differential handling, age, and drive effects were controlled by placing all Ss on the deprivation schedule at the same time and equating handling. Ss in G60 began training on Experimental Day 1, Ss in G36 on Day 5, and Ss in G12 on Day 9. All Ss thus started frustration training on Day 11 at the same age and after being on schedule 18 days. To eliminate differential handling effects, all Ss were placed in the transport cages and taken to the experimental room each day. Ss not yet receiving training trials were removed in their proper order in the squad from the transport cages and placed in a pan containing sawdust for 30 sec, then returned to the transport cages.

RESULTS

Since starting and running speeds yielded essentially similar results, only the running speed data will be presented here.

Figure 1 presents mean running speed as a function of test days for each of the three experimental groups. The means of the three R trials and the means of the three N trials

on each test day are plotted separately for each group. As the figure shows, N speeds are faster than R speeds on each test day within each group, with the N-R differences apparently larger in G60 than in G36 or G12.

An analysis of variance of the running speed test days' data with N_G as a between-Ss effect and test days and type of trial (R or N) as within-Ss effects yielded a significant R-N by N_G interaction ($F = 6.632$, $df = 2/39$, $p < .01$). The R-N by N_G interaction, presented in Fig. 2, shows that N speeds were faster than R speeds for all N_G groups. For each group, t tests indicated that N speeds were significantly ($p < .05$) faster than R speeds, demonstrating the presence of the FE. Inspection of the R-N by N_G interaction shows that there is no difference in the magnitude of the FE between G12 and G36, and that the magnitude of the FE is larger in G60 than in G36 or G12.

The analysis of variance also indicated that the Days by N_G interaction and the Days by R-N interaction were significant ($F = 8.403$, $df = 8/156$, $p < .01$ and $F = 5.088$, $df = 4/156$, $p < .01$, respectively). Inspection of the Days by N_G interaction suggested that G60 and G36 showed little change in speed with test days, while G12 speeds increased over days, so that by Day 15, there were no differences in speed between the three N_G groups. Inspection of the Days by R-N interaction suggested that while both R and N speeds increased with test days, R speeds tended to increase somewhat more than N speeds.

DISCUSSION

In general, the effect of N_G on the magnitude of the FE is in line with the results expected from the theory of frustrative nonreward proposed by Amsel (1958, 1962) and Spence (1960). That is, the FE was largest in the group given the greatest number of training trials and smallest in the group given the fewest

Fig. 2. Alley 2 running speeds on R and N trials as a function of number of 100% reinforced trials.

number of training trials. The failure to find a difference in the magnitude of the FE between groups given 12 and 36 training trials, however, suggests that the relationship between size of the FE and N_G , while positive, is not a simple linear function.

The somewhat surprising result of a reliable FE in a group given only 12 training trials suggests that r_g develops much faster than is generally assumed. The occurrence of the primary frustration response, R_F , inferred from the FE obtained after 12 training trials, suggests that the learned form of R_F ($r_f - s_f$) may be conditioned to the apparatus cues at a very early stage in the acquisition of an instrumental response under partial reinforcement conditions. If this is so, then it may be possible to extend the frustration theory explanation of the partial reinforcement effect (PRE) to PREs obtained after very brief training (e.g., McCain, 1966).

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Fig. 1. Alley 2 running speeds as a function of test days on R and N trials.