

Synthesis of double alley and discrimination phenomena: Cue and magnitude specific properties of G1 reward¹

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Two groups of rats received differential-reward conditioning in the second alley (A2) of the double-alley apparatus with the first goalbox (G1) reward serving as the discriminative stimulus for A2 reward. A third group received varied G1 reward uncorrelated with A2 reward. Results showed that Ss responded to both the discriminative and magnitude properties of G1 reward.

A number of double-alley studies have shown that rats run faster in the second alley (A2) following small as compared with large reward in the first goal box (G1) (Barrett, Peyser, & McHose, 1965; Bower, 1962; McHose & Ludvigson, 1965). Similarly, Ss which always receive large reward in G1 run more slowly in A2 than do Ss which regularly receive a smaller reward magnitude in G1 (McHose & Ludvigson, 1965). The most parsimonious conclusion to be drawn from these within- and between-Ss G1 magnitude effects (MEs) is that A2 performance on any trial is an inverse function of the amount of reward received

in G1 on that trial, independent of any other reward events in the organism's history. Nevertheless, at least portions, if not all, of both the within- and between-Ss MEs might be attributed to contextual or relative reinforcement effects. With regard to the within-Ss difference, faster speeds following small as compared with large G1 reward might result from an organism's reaction to small reward in G1 where large reward has been experienced on previous trials. Thus the ME of interest may reflect the effect of G1 reward relative to other G1 reward amounts previously received. Amsel's (1958, 1962) frustration theory provides a familiar example of a theory incorporating such a variable in accounts of double-alley phenomena.

While the between-Ss ME could not be attributed to the same relative reward effect as the within-Ss effect, it may nevertheless reflect a different sort of contextual reinforcement effect. Performance in A2 may depend on the schedule of reward in G1 relative to the schedule of reward in G2. Thus the observation that Ss which receive large reward in G1 run more slowly to small reward in G2 than do Ss which receive small reward in both G1 and G2 might be interpreted as a discrimination-contrast phenomenon similar to the observation that speeds to a (small reward) S- are depressed

by large reward in S+ relative to a group which receives small reward in both "S+" and "S-" (cf. Dunham, 1968).

It should be apparent, then, that in the typical double-alley experiment at least three variables (two relative and one absolute G1 magnitude effect) may influence A2 speeds on any trial. The present study represents an initial investigation in a series of studies designed to determine which of these variables will suffice to account for the various double-alley phenomena. Specifically, the present study was concerned with the extent to which the within-Ss ME would hold across A2 reward conditions. The design involved differential-reward conditioning of A2 performance with the amount of G1 reward on any trial serving as the discriminative stimulus for the amount of reward available in the second goal box on that trial. The magnitude of G1 reward (large or small) that served as the "S+" stimulus was counterbalanced between groups. For reasons of secondary interest, a third group, which received varied reward in G1 uncorrelated with A2 reinforcement, was included.

METHOD

The Ss were 30 experimentally naive male albino rats obtained from the Holtzman Company, Madison, Wis. The Ss were approximately 100 days old at the beginning of the experiment.

The apparatus was an L-shaped double alley consisting of an 11-in.-long start box (S1), 24-in.-long alley (A1), and an 11-in.-long goal box (G1), at a right angle to a second 24-in. alley (A2) and 11-in. goal box (G2), with G1 serving as the start box for A2. Solenoid-operated dropping doors separate S1 from A1 and G1 from A2. Upward-acting retrace doors, normally open, were positioned between A1 and G1 and between A2 and G2. A translucent (clouded) Plexiglas dome formed the top and sides of the entire runway, yielding a 3½-in. base width and a 2½-in. apex width. The apex was 4½ in. above the floor. The clear Plexiglas floor was scribed the width of the alley at 1/8-in. intervals through the runway. Two neutral-density filters fitted to the second alley dome provided differential first and second alley brightness. Mirrors placed under the floors in the base of the runways allowed observation of Ss through the floors of the runway.

Photocell-clock circuitry provided traversal time measures over the first 6-in. and the next 12-in. segments of A2, yielding early run and run times, respectively.

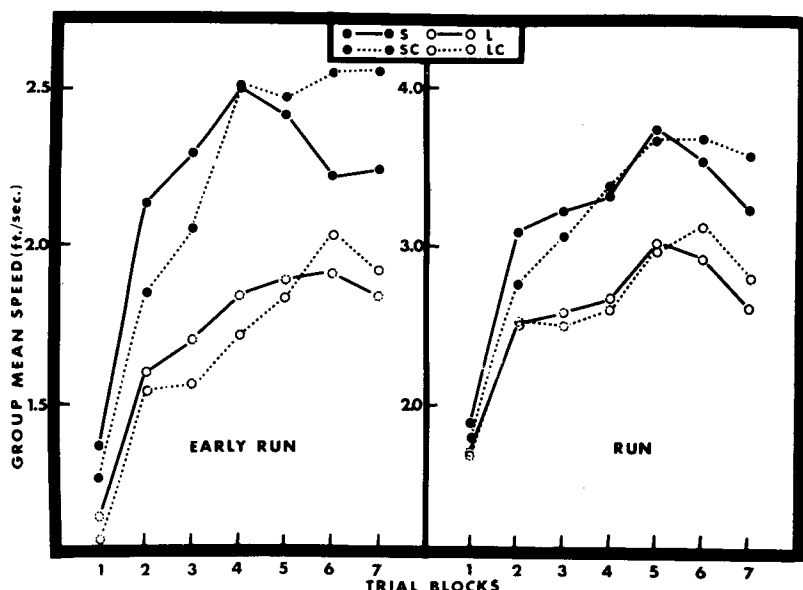


Fig. 1. A2 speeds for the various G1 reward conditions.

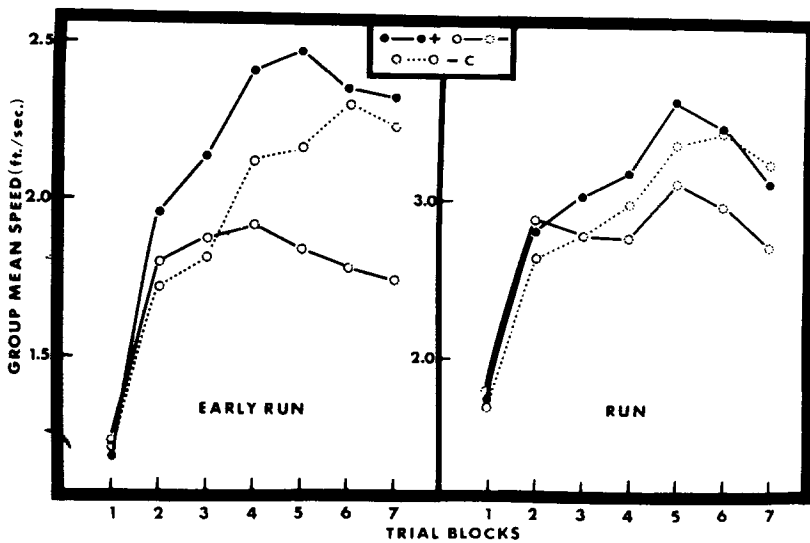


Fig. 2. A2 speeds for the various G2 reward conditions.

over Blocks 6-7 yielded a significant ($p < .01$) G1 magnitude effect in both measures ($F_s = 29.08$ and 48.69 , $df_s = 1/9$) for early run and run, respectively.

In Fig. 2, group mean A2 early run and run measures are separated according to amount of reinforcement present in G2 on the measurement trial. The data for Groups S and R were combined such that speeds on trials on which 10 pellets (S+ trials) were received in G2 are plotted separately from trials on which 2 pellets (S-) were received in G2. The S- control trend line represents the speeds of Group ND, which always received 2 pellets in G2, collapsed across both 2- and 10-pellet reinforcement conditions in G1. As may be seen in Fig. 2, speeds for the discrimination groups, Groups S and R, were faster on S+ than on S- trials over the later stages of training. Analysis of variance of the data for Groups S and R over Blocks 6-7 yielded significant G2 magnitude effects in both the early run and run measures ($F = 16.75$, $df = 1/18$, $p < .01$, and $F = 16.87$, $df = 1/18$, $p < .01$, respectively). Of further interest in Fig. 2 is the observation that S- speeds for Groups S and R combined eventually stabilized at a level below that of the S- control condition, Group ND. Orthogonal contrast comparisons of the combined S- data for Groups S and R with the speeds of Group ND yielded a significant ($p < .05$) groups difference in both early run and run measures ($F_s = 4.52, 4.72$, $df_s = 1/27$).

Finally, it should be noted that only the main effects of G1 and G2 magnitude are presented in Figs. 1 and 2, respectively. In none of the analyses, however, did G1 and G2 magnitudes interact significantly.

DISCUSSION

In the present study, A2 speeds were affected by two variables. First, the amount of reward received in G1 was inversely related to performance in A2 for both discrimination (Groups S and R) and nondiscrimination (Group ND) Ss. This effect developed early in training and persisted throughout the experiment. Secondly, Groups S and R eventually ran faster to large G2 reward, i.e., on trials on which a G1 reinforcement correlated with large G2 reward was obtained, than to small G2 reward.

The observation that Ss run faster in A2 following small (S) as compared with large (L) G1 reward, i.e., of a within-Ss ME, is consistent with previous literature (e.g., Bower, 1962; McHose & Ludvigson, 1965) and, on the basis of the present data, would appear to be independent of the amount of reward received in G2. While the within-Ss

Ten days prior to the first acquisition day, all Ss were placed on a 23-h deprivation cycle maintained throughout the experiment. On the 2 days immediately preceding the first acquisition day, Ss received approximately 1 g of 45-mg Noyes pellets, identical with the subsequent reinforcement pellet, prior to their daily ration of 1 h of free access to Purina lab chow. Ss were allowed to explore S1 and A1 for approximately 3 min on each of the 2 days preceding the first acquisition day. Ss received two trials per day on the first two acquisition days and four trials per day during the remainder of the experiment for a total of 112 trials.

All groups received either 10 (L) or 2 (S) 45-mg pellets in G1, according to the following repeating daily trial sequences: LSL, SSL, LSSL, SL, LLSS, SLLS. Three groups of 10 Ss each were randomly constituted and designated according to G1-G2 reward contingencies: Groups same (S), reverse (R), and nondiscriminable (ND). For Group S, reinforcement in G2 on a particular trial was always of the same magnitude as that received in G1 on that trial. Hence, on trials on which a 10-pellet reward was obtained in G1, 10 pellets were obtained in G2, and 2 pellets in G1 on a given trial was always followed by a 2-pellet reward in G2. For Group R, the smaller magnitude in G1 was always followed by larger magnitude in G2 on a given trial, etc. Group ND received two pellets in G2 on all trials, regardless of the magnitude received in G1.

A trial was initiated by placing S in S1. After a 3-sec orientation, the start door separating S1 from A1 was opened. The start door separating G1 from A2 was dropped after S had consumed the G1 reinforcement and had maintained a 3-sec orientation

toward the door. S was removed from G2 immediately after consuming the reinforcement. Retrace doors were used only when necessary to prevent Ss in G1 or G2 from returning to A1 or A2, respectively. Trials were administered to squads of six Ss randomly comprised of Ss from each of the three experimental groups, all Ss within a squad receiving their first trial of the day before any S received a second trial, etc. The running order of Ss within a squad was randomized from day to day. The intertrial interval was approximately 5 min within a daily session.

Early run and run times were converted to reciprocals, yielding early run and run speeds, respectively.

RESULTS

Group S speeds following 2 and 10 pellets (i.e., following presentation of S- and S+, respectively) are combined with Group R speeds following 2 (S+) and 10 (S-) pellets in Fig. 1. Speeds within Group ND on 10-pellet trials (LC) are plotted separately from those on 2-pellet (SC) trials. As may be seen in Fig. 1, both the discrimination groups (S and R) and Group ND ran faster in A2 following receipt of 2 pellets in G1 than following a 10-pellet G1 reward. Variance analysis of the data for Groups S and R at Block 1 yielded a significant ($p < .01$) G1 magnitude effect in the early run and run measures ($F_s = 10.78$ and 15.72 , $df_s = 1/18$). Similar analysis of the data for these groups over Blocks 6-7 yielded significant G1 magnitude effects ($F = 6.66$, $df = 1/18$, $p < .05$, and $F = 34.97$, $df = 1/18$, $p < .01$) for early run and run measures, respectively. Analysis of the data for Group ND at Block 1 yielded a significant G1 magnitude effect in the early run measure only ($F = 40.18$, $df = 1/9$, $p < .01$). Analysis of the data for Group ND

ME cannot be attributed to any G1-G2 relational magnitude effects, it could reflect either the effect of a relationship between G1 reward on the measurement trial and previous G1 reward amounts or a simple, nonrelational effect of G1 reward. In common theoretical terms, the faster speeds following S as compared with L could reflect the occurrence of a frustration-drive increment on S trials (the relational interpretation) or a larger demotivation (hunger reduction) on L trials as compared with S trials (the nonrelational or absolute interpretation). Certain aspects of the present data as well as related previous literature, however, invite the conclusion that this ME is an absolute-magnitude effect rather than a relational effect of the type relevant to frustration theory. Thus, the appearance of the ME in the early stages of training in the present data argues against a frustration interpretation of the effect since conventional assumptions (cf. Amsel & Ward, 1965) regarding the growth of reward expectancy and the relation of frustration to expectancy preclude the occurrence of frustration early in training. Secondly, the within-Ss FE, a specific case of the ME in which the smaller reward is zero, would appear to be independent of G1 reward history prior to experience (within-Ss) with different G1 reward events (McCain & McVean, 1967). This result, discussed elsewhere (McHose, 1969), implies that the FE is completely independent of any relational effects, i.e., that the FE depends solely on absolute-magnitude effects.

The present data, in conjunction with previous findings, strongly suggest the presence of a ubiquitous absolute G1 magnitude effect on A2 speeds in double-alley studies such that A2 performance is inversely related to the amount of reward received in G1 on the measurement trial. The importance of this tentative conclusion lies in the fact that, given this effect, a wide spectrum of double-alley phenomena, including observations previously taken as indicative of frustration phenomena, may be seen as discrimination-learning effects (McHose, 1969).

The second finding of major interest, that the A2 speeds of Groups R and S in A2 were directly related to amount of reward received in G2 is consistent with previously reported A2 magnitude effects (Hamm, 1967). In the present data, however, the occurrence of a G2 magnitude effect indicates that Ss learned a discrimination based upon G1 magnitude of reward. Thus the hypothesis that differential (nonzero) reinforcements give rise to differential stimulus aftereffects which may serve as discriminative stimuli (Capaldi, 1967) is unequivocally supported by the present

data. Finally, the observation that discrimination groups (Groups S and R) eventually ran more slowly to an S- reward of two pellets than did a nondiscrimination control condition (Group ND) demonstrates that a negative S- contrast effect occurs when reward events serve as discriminative stimuli. This finding suggests that the recent failure (Capaldi & Lynch, 1968) to obtain stable negative contrast (depression) effects with repeated shifts from large to small reward in simple instrumental conditioning is a function of the pattern of large- and small-reward trials rather than any peculiar stimulus properties of reward magnitudes as a discriminative stimulus.

REFERENCES

- AMSEL, A. The role of frustrative nonreward in noncontinuous reward situations. *Psychological Bulletin*, 1958, 55, 102-119.
- 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., & WARD, J. S. Frustration and persistence: Resistance to discrimination following prior experience with the discriminanda. *Psychological Monographs*, 1965, 79(4, Whole No. 597).
- BARRETT, R. J., PEYSER, C. S., & McHOSE, J. H. Effects of complete and incomplete reward reduction on a subsequent response. *Psychonomic Science*, 1965, 3, 277-278.
- BOWER, G. H. The influence of graded reductions in reward and prior frustration events upon the magnitude of the frustration effect. *Journal of Comparative & Physiological Psychology*, 1962, 55, 582-587.
- CAPALDI, E. J. A sequential hypothesis of instrumental learning. In K. W. Spence and J. T. Spence (Eds.), *The psychology of learning and motivation*. Vol. 1. New York: Academic Press, 1967.
- CAPALDI, E. J., & LYNCH, D. Repeated shifts in reward magnitude: Evidence in favor of an associational and absolute (noncontextual) interpretation. *Journal of Experimental Psychology*, 1967, 75, 226-235.
- DUNHAM, P. J. Contrast conditions of reinforcement: A selective critique. *Psychological Bulletin*, 1968, 69, 295-315.
- HAMM, H. D. Perseveration and summation of the frustration effect. *Journal of Experimental Psychology*, 1967, 73, 196-203.
- McCAIN, G., & McVEAN, G. Effects of prior reinforcement or nonreinforcement on later performance in a double alley. *Journal of Experimental Psychology*, 1967, 73, 620-627.
- McHOSE, J. H. Relative reinforcement effects in S1-S1 and S1-S2 paradigms. Paper presented at the Southwestern Psychological Association Convention, Austin, 1969.
- McHOSE, J. H., & LUDVIGSON, H. W. The role of reward magnitude and incomplete reduction of reward magnitude in the frustration effect. *Journal of Experimental Psychology*, 1965, 70, 490-495.

NOTES

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2. Now at the University of South Dakota, Vermillion, S.Dak. 57069.

Aphagia and adipsia following lesions of the amygdala

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Lesions of the medial nucleus of the amygdaloid complex in rats produces aphagia and adipsia.

Grossman & Grossman (1963) report that for feeding behavior, "a very diffuse inhibitory mechanism may be located throughout the ventral amygdala." Lesions of this area resulted in increased food intake, while electrical stimulation inhibited feeding behavior. Additionally, lesions in the anteroventral portion of the amygdala decreased water consumption. The time course of food and water intake change is separate, indicating possible independent control mechanisms for each. Studies by Morgane & Kosman (1959) and Wood (1958) support these observations.

Opposite results were obtained with rhinencephalic lesions in cats by Green et al (1957) who found that the animals as a rule failed to eat voluntarily and so lost weight. Koikegami (1964) reports that bilateral amygdectomy involving medial and basal nuclei in rats produced "hypophagia to some extent or perhaps a marked loss of appetite." Kling & Schwartz (1961) found profound and persistent aphagia which only a few animals will survive without forced feeding, resulting from total destruction of the amygdala. In contrast, Anand & Brobeck (1952) reported no changes in food and water intake of amygdalotomized animals.

The present study was undertaken to investigate changes in food and water intake with relatively restricted amygdala lesion sites.

METHOD

Ten male Sprague-Dawley (Holtzman) rats were bilaterally lesioned electrolytically