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GRADUATE COLLEGE

TRANSFER OF AVERSIVE CONDITIONING TO APPETITIVE EXTINCTION: EFFECTS OF PARTIAL REINFORCEMENT, N-LENGTH AND MAGNITUDE OF REINFORCEMENT

A DISSERTATION
SUBMITTED TO THE GRADUATE FACULTY
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TRANSFER OF AVERSIVE CONDITIONING TO APPETITIVE EXTINCTION: EFFECTS OF PARTIAL REINFORCEMENT, N-LENGTH AND MAGNITUDE OF REINFORCEMENT

APPROVED BY

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Abstract

Rats received escape training with either large or small magnitude of reinforcement (shock reduction), either continuous or partial reinforcement, with one nonreinforced trial followed by a reinforced one (N-length of one) or N-lengths of 1, 2, and 3. The escape training phase was followed by reward training, appetitive extinction, escape reacquisition, and escape extinction phases respectively. The extent to which effects transferred from the escape training phase to the appetitive and aversive extinction phases was used to evaluate a possible functional similarity between negative and positive reinforcement. The results indicated: (1) a possible relationship between the aversive events of shock and nonreinforcement with respect to magnitude of reinforcement (2) nontransfer of the schedule of reinforcement effects from escape training to appetitive extinction. Possible procedural difficulties and suggestions for future investigations were discussed.

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Many experimenters have been interested in exploring similarities between appetitive and aversive reinforcement procedures. Brown and Wagner (1964), German (1969) and Dyck, Mellgren, and Nation (1974) have all shown the superimposing punishment in the goal box of a straight runway during a food reinforcement training phase results in greater resistance to extinction, in a food extinction phase, relative to training with food only.

Other studies have involved negative reinforcement procedures that are analogous to appetitive procedures (Nation, Mellgren & Wrather, 1975; Nation, Wrather, & Mellgren, 1974; Seybert, Mellgren, Jobe & Eckert, 1974). Results have paralleled the findings of appetitive reinforcement procedures. For example, Nation et al. (1974) demonstrated positive and negative contrast effects, using negative reinforcement, similar to Mellgren, Wrather, and Dyck, (1972) and Shanab and Ferrell, (1970) in the appetitive situation. Additionally, the partial reinforcement effect (PRE) has been demonstrated by Seybert et al. (1974), and by Mellgren, Nation, and Wrather (1975) in paradigms employing a shock escape conditioning procedure with no shock reduction in the goal box on nonreinforced trials. In particular, Seybert et al. (1974) demonstrated not only a PRE but also sequential effects dependent on reinforcement conditions in the aversive-escape situation which were similar to the effects reported in a review article by Robbins (1971) of sequential variables in the appetitive situation. Also Mellgren et al. (1975) have demonstrated magnitude of negative reinforcement effects that parallel the magnitude of positive reinforcement effects reported by Eckert and Mellgren (1973), Hulse (1958), Leonard (1959), and Wagner (1951).

Amsel (1972) has suggested the possibility that a unitatry system governing response persistance accrued in a particular situation will transfer to another situation. Generalizing his theory would suggest that prolonged experience with the goal box event of reinforcement, whether in an appetitive or an aversive situation would result in counterconditioning of the effects of nonreinforcement to the approach response. After training under either of these reinforcement procedures persistance should be greater to either type of extinction if the approach response has occurred. Wrather (Note 1) demonstrated asymetrical transfer effects influencing response persistance. Rats were trained with either a food reward or an escape procedure under either a partial reinforcement (PRF) or continuous reinforcement (CRF) schedule. During the second phase continuous reinforcement training with the opposite paradigm was carried out. The third phase consisted of the extinction of the second phase response. (i.e., appetitive-aversive acquisition-aversive extinction or aversive training-appetitive acquisition-extinction). The results indicated a bilateral transfer effect; the PRF groups were more resistant to extinction than the CRF groups in both types of extinction. Mellgren, Haddad, Dyck and Eckert, (1976) have shown inconclusively that increasing levels of shock in escape training increase the resistance to extinction of an appetitively reinforced response. The three-phase study manipulated level of shock in escape training (0 mA, .3 mA, .6 mA and 1.0 mA) followed by a food reward training phase and then an appetitive extinction phase. Results showed greater persistance of the .6 mA and

1.0 mA groups to the .0 mA and .3 mA groups in the extinction phase. The data was interpreted as support for a functional similarity between the aversive events of shock and nonreinforcement. An alternative explanation, however, based on the functional similarity of magnitude of reinforcement between negative and positive reinforcement may be advanced. Since the level of shock increased the resultant magnitude of reinforcement was also different. Due to the confounding level of shock and magnitude of reinforcement in the escape training a clear interpretation of the transfer effects is impossible.

The present study was an attempt to investigate further possible functional similarity of positive and negative reinforcement and resultant transfer effects. The 5 phases in the study were escape training, reward training, appetitive extinction, escape reacquisition, and aversive extinction respectively. It was hypothesized that: (1) if a functional similarity does exist between positive and negative reinforcement procedures, schedule of reinforcement effects should transfer from the escape training phase to the appetitive extinction phase as was demonstrated by Wrather, (Note 1), (2) since magnitude of reinforcement effects have been demonstrated in the aversive case (Mellgren et al., 1975) they also should transfer from the escape training to appetitive extinction and affect response persistance, (3) response persistance in the appetitive extinction should also be influenced by sequential variables from the prior escape training (N-length), (4) response persistance in the aversive extinction procedure should be a function of the original aversive training procedure.

Method

Subjects

The subjects were 48 experimentally naive male albino rats, 60 days old, of the Sprague-Dawley strain, purchased from the Holtzman Company, Madison, Wisconsin. The rats were randomly assigned to one of six groups (n = 8/group).

Apparatus

The apparatus consisted of a straight-alley runway manufactured by the Hunter Company. The alley was constructed of clear Plexiglas with a grid floor and was 159 cm long, 15 cm high and 10 cm wide. It was divided into a 30 cm start section, a 91 cm run section and a 30 cm goal section, with all sections separated by guillotine doors. Raising the start door operated a microswitch which closed a shock circuit to the grid. A Grason Stadler shock scrambler was used to provide a .6 mA shock to all alley sections either simultaneously or independently as needed. Start run and goal times were measured by three .01 sec. Standard timers. Opening the start-box door operated a microswitch which activated the start timer. Interruption of the first photocell, located 5 cm inside the runway, stopped the start timer and started the run timer. The run timer was stopped and the goal timer started with the interruption of the second photocell, located 15 cm in front of the goal box. The goal timer was started when the second photocell was interrupted and was stopped when a third photocell was interrupted 5 cm inside the goal box. A teaspoon mounted 50 cm from the floor at the far end of the goal box served as the food cup. Start run, and goal speeds were obtained by converting the start, run and goal times into reciprocals.

Procedures

Immediately upon arrival in the laboratory, the rats were individually housed and placed on an ad-lib schedule of food and water for 10 days. On day 11, subjects were placed on a 10 gm daily food deprivation schedule with free access to water and remained on the schedule throughout the remainder of the experiment. On the 6th and 7th days of food deprivation subjects received 4 Startina Hog Starter pellets (approximately 10 mg each) in addition to the irregular food ration in order to familiarize them with the reward. On the last three days prior to the start of the experiment each subject was handled for 5-10 minutes daily.

One day of pretraining proceeded the actual experiment and consisted of each subject receiving two .6 mA escape training trials. (see below). The actual study consisted of 5 phases as described below.

Phase I: Escape Training. During this phase two magnitude of reinforcement (.2 mA and .4 mA shock reduction) and 3 schedules of reinforcement (CRF, N-1 and N-3) were employed. All subjects received 5 trials/day for 6 days (30 total trials). Subjects were placed in the start box and detained for 3 sec. prior to the start box door opening. Upon opening of the start-box door a .6 mA shock was applied to the grid in the start and run sections of the alley. The rats could escape by traversing the alley and entering the goal box which was electrified with a .2 mA shock on large reinforcement magnitude trials (.4 mA shock reduction) and a .4 mA shock on the small magnitude trials (.2 mA shock reduction). On nonreinforcement trials a .6 mA shock was present throughout the entire alleyway, including the goal box which resulted in a .0 mA shock reduction. The subjects were removed from the goal box to the non-electrified carrying cage after 30 sec. of goal box confinement.

The three schedules included 2 continuous reinforcement groups (CRF), one of which received a large magnitude of reinforcement on each trial (CRF-L) and the other received a small magnitude of reinforcement on each trial (CRF-S). The remaining two schedules were partial reinforcement schedules and differed in the number of successive nonreinforced trials followed by a reinforced trial (N-length). One group received N-length of 1(N-1) and the other partially reinforced group received N-lengths of 1, 2, and 3(N-3). One of the N-1 groups received a small magnitude of reinforcement (N1-S) and the other a large magnitude of reinforcement (N1-L). Similarly, one of the N-3 groups received a small (N3-S) and the other a large magnitude of reward (N3-L). Percentage of reinforcement was held constant (52%) for all PR groups. The schedule for the N-1 groups was as follows: RNRNN; NRNRN; RNRNN; NRNRN; RRRRR; RNRNN. The schedule for the N-3 groups was as follows: RNNRN; RNNNR; NRNNR; NNNRR; RRRRR; RNNRN.

The rats were run in squads of 6 with an intertrial interval of 7-8 minutes for this and all subsequent phases of the study.

Phase II: Reward Training. Following escape training a food cup was placed in the goal box. Each rat received 5 reward training trials per day for 8 consecutive days for a total of 40 trials. The reward consisted of two 100 mg pellets of Startina.

Phase III: Extinction of Reward Training. All groups received five non-rewarded trials per day for 4 days (20 trials). They were confined in the goal box for 30 sec. on these trials.

Phase IV: Reacquisition of Escape Response. To reestablish the running response each group received five continuously reinforced escape trials. The reward magnitude (shock reduction) was the same as it had been during Phase I. For the large magnitude groups the reinforcement was a .4 mA shock reduction and for the small magnitude groups a .2 mA shock reduction.

Phase V: Extinction of Escape Response. During this phase all groups received five non-reinforced escape trials per day for 4 days (20 trials). The procedure was the same as described in Phase I for a nonreinforced trial (.6 mA shock present in all sections of the alley).

Results and Discussion

Phase I: Escape Training. The data were analyzed using a 2 (schedule of reinforcement) x 2 (magnitude of reinforcement) x 6 (days) repeated measures analysis of variance.

The results indicated a significant main effect due to magnitudes of reinforcement (F (1,12) = 11.12, $p < .01$). The large magnitude groups demonstrated superior running speeds to the small magnitude groups as can be seen in the left panel of Figure 1.

Insert Figure 1 about here

The only measure that did not show this relationship was the run speed measure where magnitude of reinforcement failed to reach an acceptable level of significance (F (1,42) = 2.32, $p > .10$). None of the other effects were significant. The superior speeds demonstrated by the large magnitude of reinforcement groups relative to the small magnitude groups is consistent with the findings of Bower, Fowler, and Trapold, (1959) using a CRF escape procedure. Similar results have been reported by Bower, (1960) in reference to percentage of reinforcement using a PRF schedule in escape. Bower, (1960) found faster running speeds in acquisition as the percentage of reinforcement increased.

By the end of escape training the effect of magnitude of reinforcement seemed to dissipate and the groups converged (see Figure 1). In order to evaluate terminal differences at the end of this phase a 3(schedule of reinforcement) x 2 (magnitude of reinforcement) analysis of variance on the last day of escape training was performed. It failed to show a significant magnitude of reinforcement effect in any of the measures except start speed (F (1,42) = 6.46, $p < .05$). None of the other effects reached an acceptable level of significance in any of the measures. These data are consistent with the findings of Seybert, Mellgren, Jobe, and Eckert, (1974) and Mellgren, et al. (1975). Both studies reported no terminal acquisition effects due to magnitude of reinforcement.

Phase II: Reward Training. As can be seen by inspecting the right panel of Figure I all groups acquired the running response. A 3 x 2 analysis (schedule x magnitude) was performed for all 8 days of this phase. The results indicated a significant main effect of days in all measures: (F (7,294) = 44.23, 44.11, 62.62 for the run, goal and total speed measures respectively, p's < .01).

In addition to the days effect a significant schedule of reinforcement was indicated in the goal measure (F (2,42) = 3.88, $p < .05$). Tukey's post hoc procedure indicated the N1 group was superior in running speeds to the CRF group but did not differ from the N3 group. Neither did the N3 group significantly differ from the CRF group.

Figure 1 shows a possible effect of magnitude on performance at the beginning of acquisition. This was confirmed in the total speed measure by a significant magnitude of reinforcement x days interaction. (F (7,294) =2.15, $p < .05$). Tukey's post hoc procedure indicated an initial superiority of the large magnitude groups on day 2 but the effect was not present as training proceeded for the next 6 days. The right panel of Figure 1 shows an initial suppression of running speeds for all groups relative to the terminal level of escape training. A similar suppression effect in the acquisition of an appetitive response was reported by Babb and Leask, (1969) and Babb, Bulgatz and Matthews, (1968). Both studies showed the suppression effect to dissipate as appetitive training progresses. As can be seen in Figure 1 the asymptotic level of responding in the latter part of reward training surpasses the terminal level from escape training. Of course, controls given escape training for the food reward trials are necessary to make this finding conclusive.

Phase III: Extinction of Reward Training. Neither schedule of reinforcement nor magnitude of reinforcement had an effect on extinction performance. A 3 x 2 x 4 (schedule x magnitude x days) was performed on each speed measure. Each of the analyses revealed significant days effects in the start, run, goal, and total speed measures (*F* (3,126) = 41.55, 63.30, 77.54, 88.10 respectively, *p*'s < .01) indicating that extinction had occurred in all groups. Nondifferential extinction performance among the 6 groups was indicated by the failure of any of the other effects to reach an acceptable level of significance.

The nondifferential extinction performance of the large and small magnitude of reinforcement groups indicates that magnitude of negative reinforcement did not influence appetitive extinction performance. The results do not, however, demonstrate a lack of transfer effect in general since all groups experience aversive conditioning in phase 1. Equivalent levels of the effects may have been achieved by all groups. The appropriate control group to test transfer would have been a group that did not experience the escape training in phase 1. What these data would suggest is that the transfer effects reported by Mellgren et al. (1976) might have been caused by increased motivational levels produced by higher levels of shock and not by different magnitudes of negative reinforcement produced by shock reduction in the goal box. Since shock levels were the same in the present study, and extinction performance was not a function of magnitude of negative reinforcement the transfer effects observed by Mellgren et al. could have been a function of the similarity of the motivational components of shock and nonreinforcement rather than magnitude of negative reinforcement.

In addition to lack of transfer effects due to magnitude, the schedule of reinforcement in escape training also did not influence the appetitive extinction. These data are somewhat troubling since Wrather (Note 1) demonstrated a PRE in appetitive extinction as a function of prior escape training schedules. A possible reason for the discrepant findings could be a procedural one. Babb et al. (1968) suggest that in transfer studies the runway stimuli act as both conditioned aversive stimuli and conditioned appetitive stimuli which may result in some conflict. Also, they suggest that although running is the response in both escape and reward training they may possess different topographies (i.e., running based on shock may minimize grid-floor contact while that occurring under hunger and thirst may not). In the present study 40 reward training trials followed escape training whereas Wrather (Note 1) used only 20 reward training trials. The additional 20 reward training trials in the present study may have established a discrimination between the aversive and appetitive procedures and therefore minimized any potential effects. Further support for this idea will be discussed later in the escape extinction section.

Phase IV: Reacquisition of Escape Response. Visual comparison of the terminal asymptotic speeds obtained in this reacquisition phase (Figure 2) with those obtained in the original escape training phase (Figure 1) indicates that subjects were performing at approximately the same level as they were at the end of escape training.

Insert Figure 2 about here

Figure 2 also shows superior running speeds of the large magnitude groups relative to the small magnitude groups. A 3 x 2 analysis (schedule x magnitude) was performed on each measure. A significant magnitude effect was revealed by both the start speed measure (F (1,42) = 13.15, $p < .01$) and the total speed (F (1,42) = 17.21, $p < .01$).

Phase V: Escape Extinction. A reliable reduction in speed across days was demonstrated by all groups (see Figure 2). A 3 x 2 (schedule x magnitude) analysis was performed on the reacquisition day and the 4 days of extinction. The reacquisition day was included in the analysis to reflect the sharp reduction in speeds produced by the goal box of the extinction procedure. A significant main effect of days was obtained in all measures (F (4,168) = 7.44, 6.05, 15.44, 12.41 for the start, run, goal and total measures respectively, all p's < .01).

The start and total measures reflected a significant magnitude of reinforcement effect (F (1,42) = 8.35, 6.25 respectively, all p's < .01). Both measures showed that the large magnitude of reinforcement resulted in superior resistance to extinction relative to the small magnitude. A significant magnitude x days interaction in the total speed (F (4,168) = 2.49, $p < .05$) and subsequent analysis by Tukey's post hoc procedure revealed that the magnitude of reinforcement effect was present on the first day of extinction and diminished over the following three days.

A significant schedule of reinforcement main effect was shown by the total speed measure (F (2.42) = 3.99, $p < .05$). Tukey's post hoc procedure showed a partial reinforcement effect with the N3 groups significantly more resistant to extinction than the CRF groups. The N1 groups did not differ, however, from the CRF groups or N3 groups.

Due to the significant magnitude of reinforcement effect a separate 3 (schedule of reinforcement) x 5 (days) repeated measures analysis of variance was performed on both levels of reinforcement. Results of the small magnitude groups indicated a significant main effect of days in the goal speed (F (4,84) = 3.95, $p < .01$) and none of the other effects reached an acceptable level of significance. Analysis of the large magnitude groups, however, indicated a significant main effect of days in all measures: (F (4,48) = 6.17, 9.22, 13.80, 11.12, for the start, run, goal and total speeds, $p < .01$). Additionally, a main effect of schedule of reinforcement was obtained in the total speed measure (F (2,21) 4.66, $p < .05$). Tukey's post hoc procedure showed a partial reinforcement effect with N3 being more resistant than CRF and an N-length effect with the N3 more resistant than N1 group. The N1 group did not differ significantly from the CRF group.

Additional analyses were performed separately on the large and small magnitude groups comparing performance on a trial by trial basis on day 1. The last trial of escape reacquisition was included in each of 3 (schedule of reinforcement) x 5 (trials) repeated measures analyses of variance to again reflect the sharp reduction in speeds produced by the goal box of the extinction procedure. The significant trials effect in all but the run speed measure showed that extinction did occur in the small magnitude groups (F's (4,84) = 6.01, 2.73, 6.23 for the start goal and total speed measures respectively, p's < .05). However, none of the other effects were significant.

The significant reduction in speed across trials for the large magnitude groups can be seen in Figure 3. (F's (4,84) = 6.94, 6.89, 7.97, 14.17 for the start, run, goal and total speed measures respectively, p's < .01). A partial reinforcement effect was shown by a significant main effect of schedule of reinforcement in the total speeds measure (F (2,21) = 4.61), p < .05). Tukey's post hoc procedure revealed the N3 group was superior to the CRF group but the N1 group was not significantly different from CRF or N3 group. A significant schedule of reinforcement x trials interaction in the total speed measure (F (8,84) = 2.39, p < .01) and subsequent Tukey's post hoc analysis revealed an N-length effect (N3 > N1) on trial 4.

Insert Figure 3 about here

Since the effects of the escape training did not influence the appetitive extinction performance but did persist through the acquisition and extinction of a rewarded response to influence response persistance in the shock extinction phase, the hypothesis presented earlier that the extended training phase could have produced a discrimination between the aversive and appetitive procedures becomes more tenable. If the runway cues were differentially conditioned, as was suggested, the demonstrated lack of effects of escape training procedures on appetitive extinction would be expected. Additionally, only the habit strength associated with the reward training would be reduced in the appetitive extinction procedure and the habit strength produced by the escape training should be reflected in differential response performance in the aversive extinction phase, which was the case.

The overall findings of this study would suggest that the transfer effects demonstrated by Mellgren et al. (1976) might best be explained by the similarity between the conceptually related aversive events of shock and nonreinforcement rather than the magnitude of negative reinforcement. Caution must be taken however with the interpretations of these data since the failure to demonstrate trasfer effects of magnitude of reinforcement, and N-length in escape training to response persistance in appetitive extinction could have been the result of a discrimination between procedures produced by extended reward training.

Further investigations of transfer effects should be aware of the possible procedural pitfalls.

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TABLE 1

Analysis of Variance on Escape Acquisition Data for the Four Speed Measures

START	Source	df	MS	F
	A(Schedule of Reinforcement)	2	.128	0.13
	B(Magnitude of Reinforcement)	1	11.313	11.12**
	AB	2	2.269	2.23
	SS/AB	42	1.017	
	C(Days)	5	6.111	14.58**
	AC	10	.258	0.62
	BC	5	.321	0.76
	ABC	10	.335	0.80
	SS/ABC	210	.419	

RUN	Source	df	MS	F
	A(Schedule of Reinforcement)	2	0.159	0.32
	B(Magnitude of Reinforcement)	1	1.133	2.32
	AB	2	0.145	0.29
	SS/AB	42	0.488	
	C(Days)	5	0.136	2.08
	AC	10	0.036	0.54
	BC	5	0.031	0.47
	ABC	10	0.071	1.08
	SS/ABC	210	0.066	

GOAL	Source	df	MS	F
	A(Schedule of Reinforcement)	2	6.577	3.04
	B(Magnitude of Reinforcement)	1	5.674	2.63
	AB	2	0.654	0.30
	SS/AB	42	2.161	
	C(Days)	5	1.182	2.32*
	AC	10	0.298	0.587
	BC	5	0.377	0.742
	ABC	10	0.328	0.645
	SS/ABC	210	0.508	

TOTAL	Source	df	MS	F
	A(Schedule of Reinforcement)	2	0.088	1.25
	B(Magnitude of Reinforcement)	1	0.392	5.58*
	AB	2	0.029	0.41
	SS/AB	42	0.070	
	C(Days)	5	0.179	10.82**
	AC	10	0.016	0.98
	BC	5	0.007	0.42
	ABC	10	0.012	0.74
	SS/ABC	210	0.017	

* $p < .05$

** $p < .01$

TABLE 2

Analysis of Variance on Terminal Escape Acquisition Data for the Four Speed Measures

START	Source	df	MS	F
	A(Schedule of Reinforcement)	2	0.160	0.34
	B(Magnitude of Reinforcement)	1	2.977	6.46*
	AB	2	0.440	0.95
	SS/AB	42	0.461	

RUN	Source	df	MS	F
	A(Schedule of Reinforcement)	2	0.035	0.20
	B(Magnitude of Reinforcement)	1	0.118	0.71
	AB	2	0.031	0.18
	SS/AB	42	0.167	

GOAL	Source	df	MS	F
	A(Schedule of Reinforcement)	2	1.095	1.23
	B(Magnitude of Reinforcement)	1	0.787	0.88
	AB	2	0.139	0.15
	SS/AB	42	0.889	

TOTAL	Source	df	MS	F
	A(Schedule of Reinforcement)	2	0.006	0.23
	B(Magnitude of Reinforcement)	1	0.084	3.48
	AB	2	0.015	0.61
	SS/AB	42	0.024	

* $p < .05$

TABLE 3

Analysis of Variance on Food Acquisition Data for the Four Speed Measures

	Source	df	MS	F
START	A(Schedule of Reinforcement)	2	0.464	0.03
	B(Magnitude of Reinforcement)	1	13.289	0.90
	AB	2	6.588	0.44
	SS/AB	42	14.691	
	C(Days)	7	184.487	44.23**
	AC	14	1.487	0.44
	BC	7	3.163	0.75
	ABC	14	1.921	0.46
	SS/ABC	294	4.170	
RUN	**Source**	**df**	**MS**	**F**
	A(Schedule of Reinforcement)	2	0.015	0.09
	B(Magnitude of Reinforcement)	1	0.238	1.59
	AB	2	0.104	0.69
	SS/AB	42	0.149	
	C(Days)	7	3.539	44.57**
	AC	14	0.088	1.10
	BC	7	0.105	1.31
	ABC	14	0.028	0.35
	SS/ABC	294	0.079	
GOAL	**Source**	**df**	**MS**	**F**
	A(Schedule of Reinforcement)	2	2.146	3.87*
	B(Magnitude of Reinforcement)	1	0.029	0.05
	AB	2	0.333	0.60
	SS/AB	42	0.553	
	C(Days)	7	15.044	41.11**
	AC	14	0.384	1.05
	BC	7	0.194	0.53
	ABC	14	0.147	0.40
	SS/ABC	294	0.366	
TOTAL	**Source**	**df**	**MS**	**F**
	A(Schedule of Reinforcement)	2	0.035	0.40
	B(Magnitude of Reinforcement)	1	0.277	3.21
	AB	2	0.009	0.09
	SS/AB	42	0.086	
	C(Days)	7	1.970	62.62**
	AC	14	0.022	0.69
	BC	7	0.068	2.14*
	ABC	14	0.007	0.21
	SS/ABC	294	0.031	

* $p < .05$
** $p < .01$

TABLE 4

Analysis of Variance on Appetitive Extinction for the Four Speed Measures

START	Source	df	MS	F
	A(Schedule of Reinforcement)	2	13.553	0.93
	B(Magnitude of Reinforcement)	1	8.508	0.58
	AB	2	6.894	0.47
	SS/AB	42	14.445	
	C(Days)	3	142.785	41.55**
	AC	6	2.640	0.76
	BC	3	0.292	0.08
	ABC	6	1.621	0.47
	SS/ABC	126	3.436	

RUN	Source	df	MS	F
	A(Schedule of Reinforcement)	2	0.136	0.59
	B(Magnitude of Reinforcement)	1	0.464	2.02
	AB	2	0.160	0.69
	SS/AB	42	0.229	
	C(Days)	3	6.306	63.30**
	AC	6	0.079	0.79
	BC	3	0.030	0.30
	ABC	6	0.068	0.67
	SS/ABC	126	0.100	

GOAL	Source	df	MS	F
	A(Schedule of Reinforcement)	2	0.489	0.80
	B(Magnitude of Reinforcement)	1	0.008	0.01
	AB	2	0.683	1.12
	SS/AB	42	0.606	
	C(Days)	3	25.391	77.54**
	AC	6	0.067	0.20
	BC	3	0.078	0.23
	ABC	6	0.366	1.11
	SS/ABC	126	0.327	

TOTAL	Source	df	MS	F
	A(Schedule of Reinforcement)	2	0.055	1.26
	B(Magnitude of Reinforcement)	1	0.019	0.43
	AB	2	0.042	0.96
	SS/AB	42	0.044	
	C(Days)	3	2.514	88.10**
	AC	6	0.039	1.35
	BC	3	0.005	0.17
	ABC	6	0.023	0.80
	SS/ABC	126	0.029	

* $p < .05$

** $p < .01$

TABLE 5

Analysis of Variance on Reacquisition of Escape Data for the Four Speed Measures

	Source	df	MS	F
START				
	A(Schedule of Reinforcement)	2	0.371	0.57
	B(Magnitude of Reinforcement)	1	8.529	13.15**
	AB	2	0.228	0.35
	SS/AB	42	0.648	
RUN	Source	df	MS	F
	A(Schedule of Reinforcement)	2	0.088	0.32
	B(Magnitude of Reinforcement)	1	0.914	3.87
	AB	2	0.067	0.28
	SS/AB	42	0.236	
GOAL	Source	df	MS	F
	A(Schedule of Reinforcement)	2	0.549	0.47
	B(Magnitude of Reinforcement)	1	2.429	2.10
	AB	2	0.587	0.50
	SS/AB	42	1.153	
TOTAL	Source	df	MS	F
	A(Schedule of Reinforcement)	2	0.004	0.10
	B(Magnitude of Reinforcement)	1	0.667	17.21**
	AB	2	0.012	0.30
	SS/AB	42	0.039	

* $p < .05$

** $p < .01$

TABLE 6

Analysis of Variance on Escape Extinction Data (Adding the day of escape reacquisition) for the Four Speed Measures

START	Source	df	MS	F
	A(Schedule of Reinforceemnt)	2	2.089	1.68
	B(Magnitude of Reinforcement)	1	10.349	8.35**
	AB	2	0.514	0.41
	SS/AB	42	1.239	
	C(Days)	4	3.358	7.44**
	AC	8	0.222	0.49
	BC	4	0.805	1.78
	ABC	8	0.569	1.26
	SS/ABC	168	0.451	

RUN	Source	df	MS	F
	A(Schedule of Reinforcement)	2	0.375	0.83
	B(Magnitude of Reinforcement)	1	0.218	0.48
	AB	2	0.041	0.09
	SS/AB	42	0.450	
	C(Days)	4	0.817	6.05**
	AC	8	0.031	0.23
	BC	4	0.279	2.06
	ABC	8	0.021	0.15
	SS/ABC	168	0.135	

GOAL	Source	df	MS	F
	A(Schedule of Reinforcement)	2	7.502	2.69
	B(Magnitude of Reinforceemnt)	1	0.166	0.06
	AB	2	1.651	0.60
	SS/AB	42	2.788	
	C(Days)	4	13.885	15.45
	AC	8	0.710	0.79
	BC	4	0.997	1.10
	ABC	8	0.354	0.40
	SS/ABC	168	0.899	

TOTAL	Source	df	MS	F
	A(Schedule of Reinforcement)	2	0.341	3.99*
	B(Magnitude of Reinforcement)	1	0.535	6.25*
	AB	2	0.067	0.78
	SS/AB	42	0.086	
	C(Days)	4	0.413	12.41**
	AC	8	0.053	1.05
	BC	4	0.083	2.49*
	ABC	8	0.027	0.79
	SS/ABC	168	0.033	

* $p < .05$
** $p < .01$

TABLE 7

Analysis of Variance on the Escape Extinction Data (Adding escape reacquisition) on the Four Speed Measures: Small Magnitude of Reinforcement

START	Source	df	MS	F
	A(Schedule of Reinforcement)	2	1.826	1.19
	SS/A	21	1.534	
	B(Days)	4	0.662	1.98
	AB	8	0.431	1.28
	SS/AB	84	0.334	

RUN	Source	df	MS	F
	A(Schedule of Reinforcement)	2	0.241	0.56
	SS/A	21	0.425	
	B(Days)	4	0.113	0.69
	AB	8	0.026	0.15
	SS/AB	84	0.163	

GOAL	Source	df	MS	F
	A(Schedule of Reinforcement)	2	1.71	0.59
	SS/A	21	2.88	
	B(Days)	4	3.98	3.94**
	AB	8	0.53	0.52
	SS/AB	84	1.00	

TOTAL	Source	df	MS	F
	A(Schedule of Reinforcement)	2	0.147	1.27
	SS/A	21	0.115	
	B(Days)	4	0.064	2.31
	AB	8	0.033	1.18
	SS/AB	84	0.028	

* $p < .01$

TABLE 8

Analysis of Variance on the Escape Extinction Data (adding escape reacquisition) for the Four Speed Measures: Large Magnitude of Reinforcement

START	Source	df	MS	F
	A(Schedule of Reinforcement)	2	0.776	0.82
	SS/A	21	0.942	
	B(Days)	4	3.500	6.16**
	AB	8	0.361	0.63
	SS/AB	84	0.568	
RUN	Source	df	MS	F
	A(Schedule of Reinforcement)	2	0.175	0.37
	SS/A	21	0.473	
	B(Days)	4	0.983	9.21**
	AB	8	0.027	0.24
	SS/AB	84	0.107	
GOAL	Source	df	MS	F
	A(Schedule of Reinforcement)	2	7.440	2.77
	SS/A	21	2.683	
	B(Days)	4	10.903	13.80**
	AB	8	0.534	0.67
	SS/AB	84	0.790	
TOTAL	Source	df	MS	F
	A(Schedule of Reinforcement)	2	0.262	4.65*
	SS/A	21	0.056	
	B(Days)	4	0.431	11.11**
	AB	8	0.028	0.73
	SS/AB	84	0.039	

* $p < .05$
** $p < .01$

TABLE 9

Analysis of Variance on the Escape Extinction Data (adding the last trial of escape reacquisition) for the Four Speed Measures: Day 1-Small Magnitude of Reinforcement

START	Source	df	MS	F
	A(Schedule of Reinforcement)	2	0.144	0.06
	SS/A	21	2.200	
	B(Trials)	4	2.646	6.01**
	AB	8	0.505	1.14
	SS/AB	84	0.440	

RUN	Source	df	MS	F
	A(Schedule of Reinforcement)	2	0.333	0.74
	SS/A	21	0.449	
	B(Trials)	4	0.306	1.79
	AB	8	0.224	1.31
	SS/AB	84	0.171	

GOAL	Source	df	MS	F
	A(Schedule of Reinforcement)	2	3.531	0.90
	SS/A	21	3.912	
	B(Trials)	4	3.584	2.73*
	AB	8	1.363	1.03
	SS/AB	84	1.311	

TOTAL	Source	df	MS	F
	A(Schedule of Reinforcement)	2	0.023	0.12
	SS/A	21	0.184	
	B(Trials)	4	0.267	6.22**
	AB	8	0.032	0.74
	SS/AB	84	0.043	

* $p < .05$
** $p < .01$

TABLE 10

Analysis of Variance on the Escape Extinction Data (adding the last trial of escape reacquisition) for the Four Speed Measures: Day-1 Large Magnitude of Reinforcement

START	Source	df	MS	F
	A(Schedule of Reinforcement)	2	3.640	1.66
	SS/A	21	2.185	
	B(Trials)	4	5.728	6.94**
	AB	8	1.045	1.26
	SS/AB	84	0.825	

RUN	Source	df	MS	F
	A(Schedule of Reinforcement)	2	0.834	1.49
	SS/A	21	0.258	
	B(Trials)	4	0.814	6.89**
	AB	8	0.173	1.45
	SS/AB	84	0.118	

GOAL	Source	df	MS	F
	A(Schedule of Reinforcement)	2	6.055	2.17
	SS/A	21	2.778	
	B(Trials)	4	7.829	7.96**
	AB	8	0.603	0.61
	SS/AB	84	0.983	

TOTAL	Source	df	MS	F
	A(Schedule of Reinforcement)	2	0.498	4.61*
	SS/A	21	0.108	
	B(Trials)	4	0.513	14.16**
	AB	8	0.086	2.38*
	SS/AB	84	0.036	

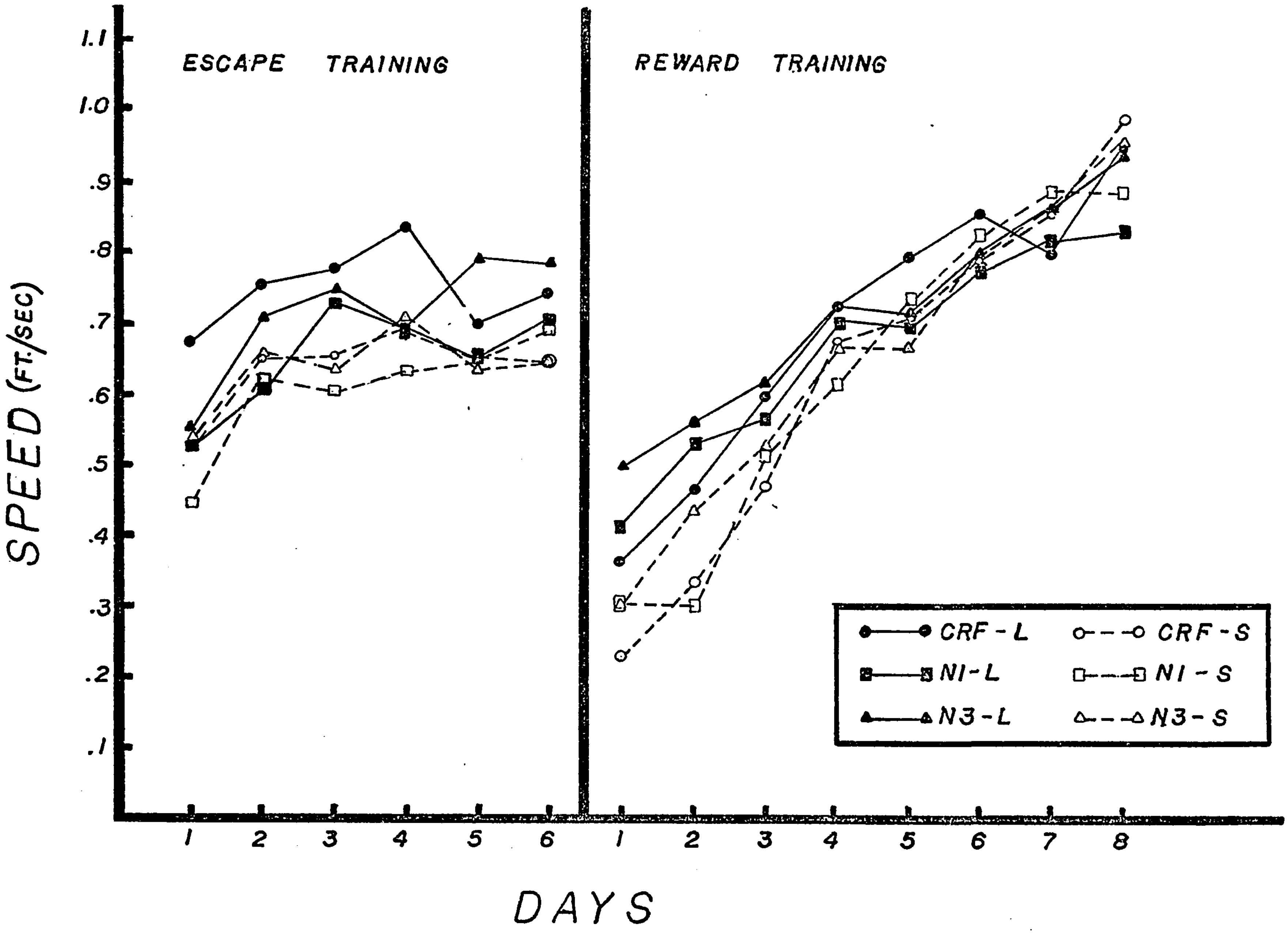
* $p < .05$
** $p < .01$

Figure Captions

Figure 1. Mean total speeds for the six days of escape acquisition and eight days of food acquisition.

Figure 2. Mean total speeds for the escape reacquisition day and four days of escape extinction.

Figure 3. Mean total speeds for the large magnitude of reinforcement groups for the last trial of escape reacquisition and the five trials of the first day of escape extinction.


ESCAPE TRAINING
REWARD TRAINING
SPEED (FT./SEC)
1.1
1.0
.9
.8
.7
.6
.5
.4
.3
.2
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1
2
3
4
5
6
1
2
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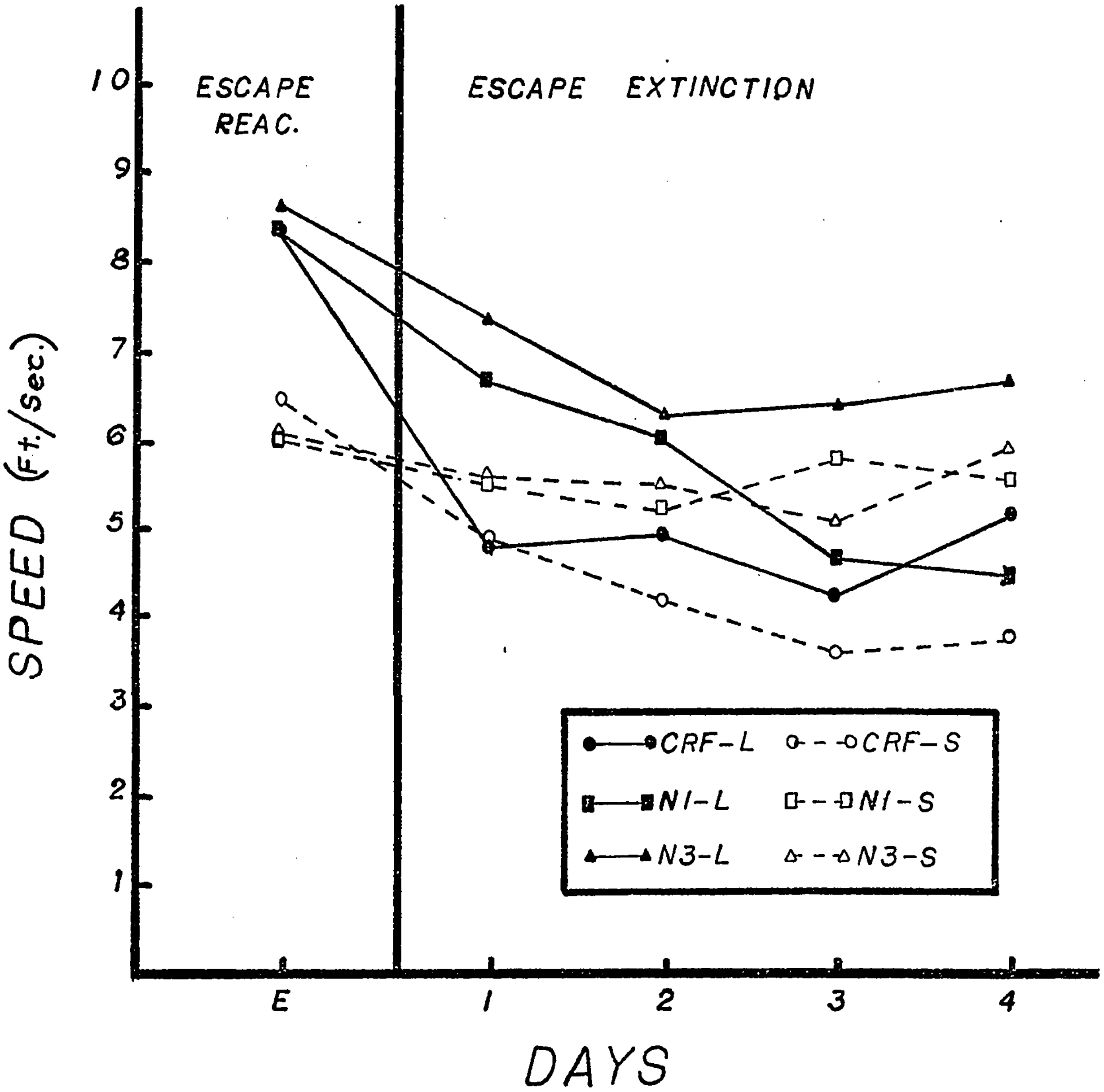
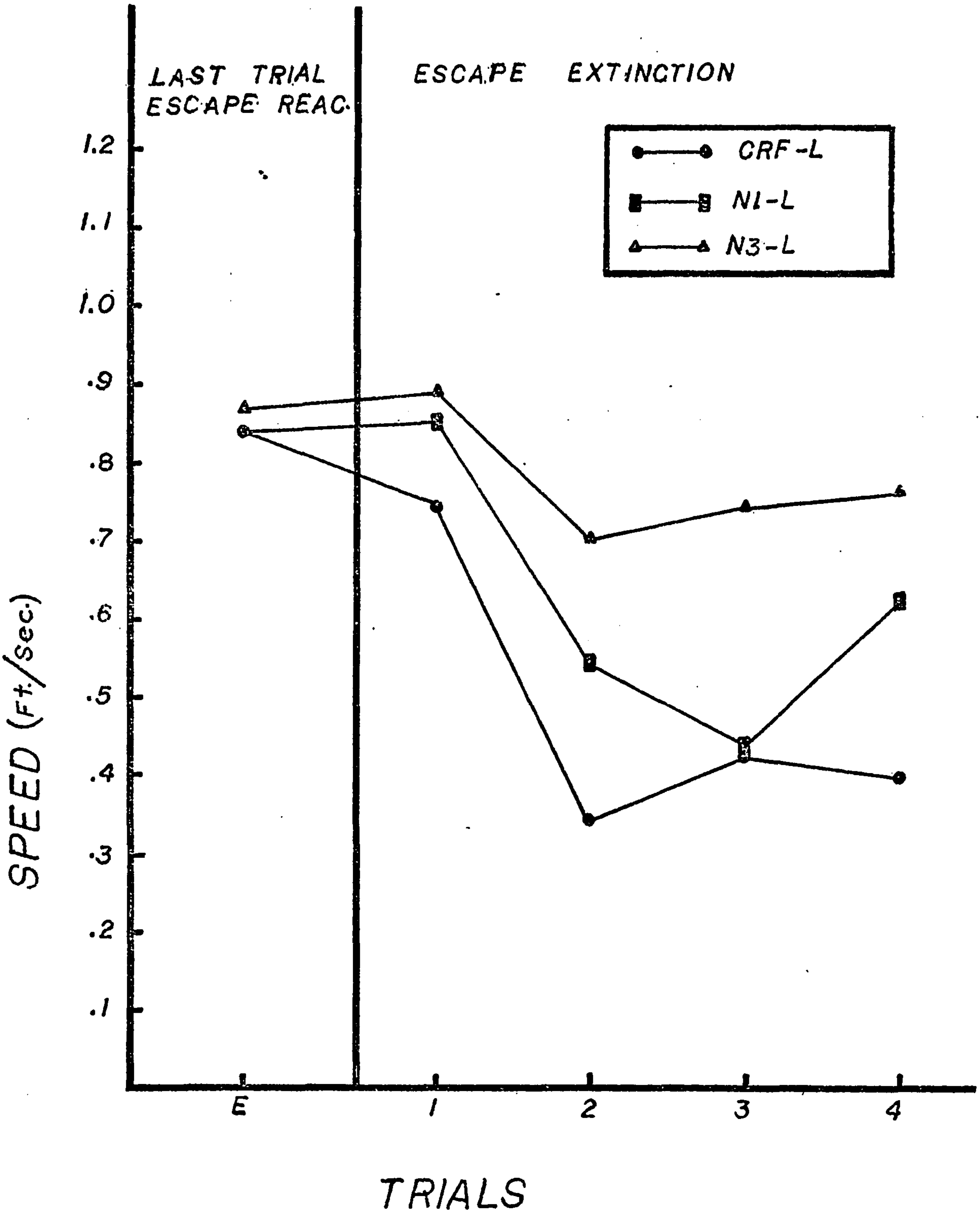
4
5
6
7
8
DAYS
CRF - L
CRF - S
N1 - L
N1 - S
N3 - L
N3 - S


ESCAPE REAC.
ESCAPE EXTINCTION
SPEED (Ft./Sec.)
DAYS
E
1
2
3
4
1
2
3
4
5
6
7
8
9
10
CRF-L
CRF-S
N1-L
N1-S
N3-L
N3-S


LAST TRIAL
ESCAPE REAC.
ESCAPE EXTINCTION
CRF-L
N1-L
N3-L
1.2
1.1
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
SPEED (Ft./sec.)
E
1
2
3
4
TRIALS

APPENDIX

Literature Review

A possible functional relationship between positive and negative reinforcement in discrete trials, has intrigued investigators for some time. Attempts to evaluate this possible relationship have generally progressed along two lines of investigation. Some researchers have employed aversive procedures that parallel appetitive procedures, in an attempt to discern whether the variables that control appetitive conditioning affect aversive conditioning in a similar manner. Other investigators have studied the relationship by using transfer procedures that evaluate the effects of one type of conditioning on response persistance of the other. The transfer procedures have commonly focused on the functional relationships of different aversive events (i.e., shock, nonreward, delay of reward).

A very reliable phenomena in instrumental learning is the partial reinforcement effect (PRE) using reward conditioning. This effect is demonstrated by greater resistance to extinction following partial reinforcement as compared to continuous reinforcement during acquisition. Numerous demonstrations of the PRE and influencing factors are presented in a review article by Robbins (1970). Due to the abundance of literature on the PRE many investigators have used the phenomenon in their attempt to uncover possible relationships between appetitive and aversive conditioning.

The present literature review will be limited to selected PRE studies that have employed either the analogous procedure or transfer of effects method in the search for functional relationships between aversive an appetitive conditioning. An attempt is made to summarize the obtained results and theoretical implications.

Analogous Procedures Method

Several investigators have shown that response persistence in aversive conditioning seems to be a function of some of the same factors as in appetitive conditioning if analogous procedures are employed. Bowers (1960) trained rats to escape with either 25, 50, 75 or 100% of the trials being reinforced. Shock reduction in the goal box was defined as a reinforced trial and no shock reduction as a nonreinforced trial. The 50% (PRF) and 100% (CRF) groups were then placed in a continuous punishment situation (0% shock reduction) which is analogous to appetitive extinction. The PRF group demonstrated superior resistance to continuous punishment relative to the CRF group. Using similar procedures, Mellgren, Nation and Wrather (1975) maipulated the amount of shock reduction on reinforced trials (magnitude of reinforcement) in escape training and found the groups ordered: large partial > small partial > small continuous > large continuous in a subsequent punished extinction (continuous punishment) phase. In a second experiment the sequence of large, small and nonreinforced trials were manipulated in escape acquisition. The four groups received trial sequences of either large magnitude of reinforcement (R) followed by nonreinforcement (N) and then small magnitude of reinforcement (S), RNS group, SNR, SNS or LNL during training. In the subsequent punished extinction phase the groups ordered: SNL > LNL > SNS > LNS. The results of Bower (1960) and Mellgren et al. (1965) parallel the findings of appetitive conditioning (Leonard, 1969; Eckert & Mellgren, (1973).

Using similar escape training and punished extinction procedures, Seybert, Mellgren, Jobe, and Eckert (1974) demonstrated response persistance in punished extinction was a function of schedule of reinforcement (PRF vs CRF), N-R transitions (nonreinforced trials followed by a reinforced trial) and N-length (number of successive nonreinforced trials preceeding a reinforced trial). The relationship of each factor to response persistance was similar to the relationship demonstrated in the appetitive situation (Robbins, 1970). Finally, a study by Nation, Mellgren, and Wrather (1973) using a shock avoidance procedure in acquisition demonstrated the PRE in continuous punishment extinction.

These data suggest a commonality between appetitive and aversive conditioning with reference to response persistance. A present theoretical approach that seems to have the most utility, with reference to the PRE in reward conditioning, is the sequential theory of Capaldi (1967, 1970). Although other theories have been proposed that can explain the PRE (Lawrence & Festinger, 1962; Amsel, 1967) they fail to account for the well established effects of sequential manipulations on response persistance. The sequential theory was proposed for the appetitive situation, however the parallel results in the aversive case suggest it possibly can be extended to aversive conditioning.

Transfer of Effects Procedures

While data using the analogous procedures method indicates common variables control response persistance in both positive and negative conditioning procedures, studies using the transfer of effects procedure indicate persistance to one type of aversive event may be a function of prior experience with a different aversive event (i.e. prior experience with shock may increase response persistance with nonreward relative to no prior experience with shock and vice versa).

A phenomenon called the intermittent punishment effect (IPE) has demonstrated that superimposing shock in the goal box on some trials during CRF reward training increases persistance to continuous punishment (shock on all trials) relative to no shock appetitive CRF prior to continuous punishment (Banks, 1966a). In another study Banks (1966b) shock was superimposed in the goal box on nonrewarded trials of a PRF schedule of food for one group (IP-N), in a separate apparatus for another group (NP-N) and no shock for the third group (PRF). In a subsequent punished extinction phase the groups ordered IPN > NP-N > PRF.

Brown and Wagner (1964) demonstrated the effects of prior shock on persistance in continuous punishment and extinction. Rats were trained on either a CRF reward schedule with shock on 50% of the trials (P), PRF no shock or CRF no shock. The groups were then divided and half of the subjects from each group experienced extinction while the other half continuous shock superimposed on reward. The groups ordered: P > PRF > CRF in the continuous punishment procedure and PRF > P > C in extinction. These data indicate transfer effects of the shock to nonreward and a possible unitary governing system. Other investigations show similar transfer effects from shock to recovery from an airblast (Terris, German & Enzie, 1969), and shock to tail pinches (Banks & Torney, 1969) showed that rats trained on a PRF shock escape schedule were more resistent to food extinction that a CRF group. Failure to find transfer effects between IP training an appetitive extinction, was reported by Banks and Torney, (1969). Wrather (Note 1) however, demonstrated asymetrical transfer effects influencing response persistance. Rats were trained with either a reward or escape procedure and either a PRF or CRF schedule. The extinction was opposite the type that occurred in training (i.e., appetitive training-aversive extinction; aversive training-appetitive extinction). The results indicated a bilateral transfer effect. The PRF groups were more resistant to extinction than the CRF groups in both types of extinction.

While the effect of sequential manipulations have been demonstrated using the analogous procedures method (Seybert et al., 1974; Capaldi & Lovas, 1972) relative few investigators have dealt with transfer of sequential variables. Dyck, Mellgren and Nation (1974) trained one group on a CRF food reward schedule and two other groups (NR and PR) received rewarded, nonrewarded and punished trials in a sequence that resulted in only NR transitions (NR group) or PR transitions (PR group). In subsequent punished extinction (continuous punishment) the PR group was more persistant than either the NR or CRF groups. However, a lack of transfer was demonstrated by nondifferential performance of the NR and CRF groups. One clear demonstration of the transfer of sequential variables was reported by Mellgren, Haddad, Williams and Conkright (1975). Rats trained with delay of reinforcement demonstrated the PRE, and N-length effects in subsequent extinction. The same effects of PRF and N-length were shown transferring from reward conditioning to continuous delay of reinforcement.

The data reported from these studies indicate a possible functional relationship between aversive events. Amsel (1972) has suggested the possibility of a unitary system governing response persistance in a particular situation will transfer to another situation. He however also says that the more probable case is that transfer is limited to the amount of overlap between the events. This would suggest according to Amsel's theory, that with prolonged experience with the goal box event of nonreinforcement, in both the appetitive and aversive situation, results in counterconditioning of the effects of the disruptive event to the approach response. Therefore, following training with either reinforcement procedure, persistance will be greater to either type of extinction if the approach response has been counterconditioned. The limitation of this explanation is in the lack of specification of the "overlapping" systems and the inability to account for the effects of sequential manipulations.

In summary, data suggest a functional relationship between different aversive events and different conditioning procedures. However, the specific factors controllong the mediation between them has yet to be clearly defined. A need for continued research in the area is indicated.

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