

**DIFFERENTIAL CONDITIONING AS A FUNCTION OF S+  
EXTINCTION AND CUE PRESENTATION**

**BY**

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DIFFERENTIAL CONDITIONING AS A FUNCTION  
OF S+ EXTINCTION AND CUE PRESENTATION

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A Research Paper  
Presented to  
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In Partial Fulfillment  
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Master of Arts

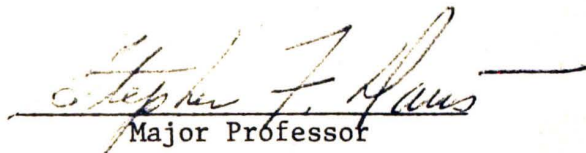
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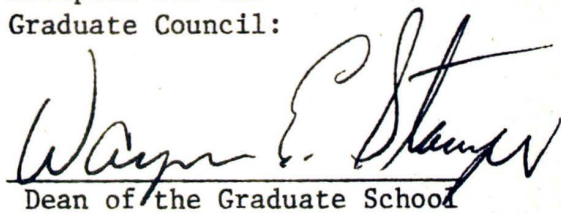
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To the Graduate Council:

I am submitting herewith a Research Paper written by Elizabeth Dawson Ivey entitled "Differential Conditioning as a Function of S+ Extinction and Cue Presentation." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Arts, with a major in Psychology.

  
Major Professor

Accepted for the  
Graduate Council:

  
Dean of the Graduate School

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### Introduction

For several years a considerable amount of research has been devoted to investigations in the area of differential conditioning. In this situation a subject is concurrently presented with two reward alternatives. For example, a large reward (S+) may be presented in a black runway and a small reward (S-) in a white runway. Both positive (overshooting a large-reward control group) and negative (undershooting a small-reward control group) contrast effects have been found in the running behavior of rats exposed to this type of conditioning.

Bower (1961) reported finding negative contrast effects but failed to observe positive contrast effects in his study. He concluded that the net incentive produced by a small reward is diminished when that reward occurs in a situation where the subject sometimes receives a larger reward. However, the converse does not appear to be true.

A study by Ludvigson and S. E. Gay (1966) emphasized the importance of cue presentation in differential conditioning. They found that contrast effects do exist, particularly in response to stimuli associated with a small and presumably less favorable alternative. Moreover, it was found that in the initial segments (i.e., start and run measures) of the response chain, the greater the S+ reward magnitude, the greater the inhibition for the S- alternative. However, by the time the goal segment was reached inhibition to the S- had dissipated and the negative contrast effect was relatively slight. Thus, negative contrast effects were observed primarily in the start and run sections.



In a study of the conditions determining contrast effects in differential reward conditioning, Ludvigson and R. A. Gay (1967) found that the response to cues signaling the lesser of the two reward alternatives (S-) is usually depressed by an amount which increases with the magnitude of the more favorable alternative (S+). The results of a second study by Ludvigson and R. A. Gay (1967) closely paralleled those of the earlier Ludvigson and S. E. Gay (1966) study in showing a strong S- contrast effect in the initial segments of the response chain, with the effect lessening as the subjects approached the goal.

The Ludvigson and R. A. Gay (1967) study also investigated the importance of where in the response chain cues are presented that signal the S+ or S- condition. Using black, white, and gray startboxes, they tested the assumption that presenting S- cues as the subject enters the startbox, as compared with presenting the cues upon entrance into the alley, will markedly influence performance in the start and run sections of the alleyway. More specifically, they tested the hypotheses that maximal inhibition will occur at the point of initial cue presentation signaling small reward and that this inhibition will dissipate quickly thereafter. The results were supportive of these hypotheses and indicated that if subjects were presented with the discriminative S- cues in the startbox, contrast effects were minimal in the start measure and virtually nonexistent in the run measure. However, they did report finding strong contrast effects in an orienting measure taken prior to raising the start door. A group receiving the discriminative cues only after the instrumental response was initiated (i.e., after the start door was raised) showed large negative contrast effects in the start and

run measures.

Davis, Gilbert, and Seaver (1971) further investigated the importance of cue presentation and its effect on S+ and S- performance in differential conditioning by starting all subjects from a nondiscriminative (gray) startbox and presenting discriminative cues during different portions of the response chain. In both the Davis, et al. (1971) and the Ludvigson and R. A. Gay (1967) studies there was a progressive increase in the S- performance (i.e., less negative contrast) as the subject approached the goal. It appears from these two studies that the longer the subject is in the presence of the discriminative S- cue, the smaller the decrement in S- performance. It also appears that performance to the S+ alternative is not affected by the different methods used to present the discriminative stimulus.

On the other hand, Logan (1968) has reported no evidence of either negative or positive contrast effects in rats trained and extinguished in a straight runway under differential reward conditions. Thus, his results are in opposition to those of Bower (1961), Ludvigson and S. E. Gay (1966), Ludvigson and R. A. Gay (1967) and Davis, et al. (1971). Logan concluded that "the rate of change in incentive motivation is a state parameter of the subject and is not affected by prior reinforcement history." If this be the case, then one would be able to predict that extinction responding, following differential conditioning, would be based upon reward magnitude alone and not related to presentation of the S+ or S- cues preceding the responses. However, a close examination of Logan's (1968) method section strongly suggests that he employed two different startboxes instead of one common startbox that could be positioned

in front of either runway. If this is true, then his subjects may have received the discriminative cues prior to making the instrumental response. This would allow inhibition to dissipate, and might possibly result in the behavior being determined more by reward magnitude than inhibition.

The present study was designed to investigate the effects of extinction in the S+ condition with and without discriminative cue presentation preceding response. If, as Logan (1968) contends, performance is solely a matter of reward magnitude, then there should be no difference in performance between subjects presented the discriminative cues prior to making the response and those receiving such cues as the start door is raised (i.e., at the onset of the response). If, on the other hand, the discriminative cues (and their associated excitatory and inhibitory properties) do have an influence on performance, then differences might well be predicted.



## Chapter II

### Method

#### Subjects

Twenty female albino rats purchased from the Holtzman Company, Madison, Wisconsin, served as subjects. The subjects were approximately 90 days old at the beginning of pretraining. One week prior to the start of the experiment, subjects were placed on food deprivation and maintained at 85% free-feeding weight. All subjects were caged individually with water continuously available.

#### Apparatus

The apparatus was essentially the same as that used by Ludvigson and R. A. Gay (1967). Basically, it consisted of two parallel runways (one black, one white), each 11.43 cm wide and 12.70 cm high. A 28.10 cm gray, movable startbox serviced both runways. Removable masonite inserts, painted the same colors as the runways, were used to provide discriminative cues in the startbox. The startbox was separated from the 91.44 cm run sections by a masonite guillotine door. A second masonite door separated each run section from a 30.48 cm goalbox. Lifting the start door activated a Standard Electric timer; interrupting a photobeam 15.24 cm beyond the start door stopped the first timer (start time) and activated a second timer. Interrupting a second photobeam 76.20 cm beyond the first photobeam stopped the second timer (run time) and started a third timer. Interrupting a third photobeam located 5.08 cm in front of a recessed goal cup stopped the third timer (goal time). The entire apparatus was covered with .64 cm hardware cloth and was floored with wood.



## Procedure

The subjects were randomly assigned to two groups of ten subjects each prior to pretraining. The subjects to start from the neutral, gray (nondiscriminative) startbox were designated as Group G. Those subjects provided the discriminative cues in the startbox (black/white) were designated as Group BW.

There was a total pretraining period of five days. During the first three days, all subjects were handled and tamed for one minute each, and pellet habituated to the 45 mg Noyes reward pellets in the home cage. In addition, each subject received a 5-min. exploration period in the unbaited runway on each of the last two days of pretraining. One exploration period was allowed in each runway. Subjects in Group G were placed directly into the gray startbox to initiate each exploration period. For subjects in Group BW the appropriately colored removable masonite insert was in position when the subject was placed in the startbox.

Phase 1, acquisition, was begun immediately after pretraining. During this phase all subjects received six trials per day (3+, 3-) for 14 days (84 trials). The administration of S+ and S- events was done according to the sequence shown in Table 1. All subjects received Trial 1 before Trial 2 was administered, Trial 2 before Trial 3, etc., with all subjects in a respective group receiving all six daily trials before the other group was run. The order for running groups alternated between days. Twelve 45 mg reward pellets were present on S+ trials, while one 45 reward pellet was present on S- trials. The designation of S+ and S- with regard to the black and white runways was balanced within each group (i.e., five subjects received S+ trials in the black runway and S- trials

in the white runway, and vice versa for the remaining five subjects). To run a trial, the appropriate subject was removed from the home cage and placed into the startbox. The gray startbox was used for Group G subjects, while the appropriate black or white removable masonite insert was in place for subjects in Group BW. Following a 5-sec. confinement period in the startbox, the start door was raised and the subject was allowed to traverse the runway. The subject was removed from the goalbox upon consumption of the reward. Start, run, and goal latencies were recorded for each trial.

Phase 2 (S+ extinction) was begun immediately after Phase 1 and lasted seven days (42 trials). The procedures used in Phase 1 were also in effect in Phase 2, the only exception being that no reward was present on any S+ trial.

### Results

The daily S+ and S- scores for each subject were averaged to yield single S+ and S- values. Figures 1-3 present the mean start, run, and goal speeds (meters/sec.) respectively, for the acquisition and S+ extinction phases. Prior to analyses these averaged scores were reciprocated and, when multiplied by the appropriate constant, yielded speed scores in meters per second. Since many and somewhat different effects were obtained in the two phases, analyses for the two phases will be presented separately.

#### Acquisition

Analyses were performed over acquisition Days 9-14. These days represented the point at which discrimination had been achieved in all measures.

Start. Analysis of variance performed over the start measure speeds indicated that the S+ vs. S- factor was significant,  $F(1, 18) = 9.78$ ,  $p < .01$ .

Run. Run measure analysis also yielded a significant,  $F(1, 18) = 12.14$ ,  $p < .01$ , S+ vs. S- effect.

Goal. Goal measure analysis yielded significance,  $F(1, 18) = 10.64$ ,  $p < .01$  for the S+ vs. S- factor, and the Startbox Conditions (G vs. BW) x S+ vs. S- interaction,  $F(1, 18) = 9.81$ ,  $p < .01$ . The significant interaction was further probed through the use of Tukey's procedure and indicated that the S- speeds for Group BW were significantly ( $p < .01$ ) depressed below the S- speeds of Group G.

### S+ Extinction

Start. Start measure analysis yielded significance for the S+ vs. S-,  $F(1, 18) = 8.53$ ,  $p < .01$ , Startbox Conditions x S+ vs. S- interaction,  $F(1, 18) = 9.07$ ,  $p < .01$ , and Days,  $F(6, 108) = 2.95$ ,  $p < .05$ , factors. Tukey's procedure was used to probe the significant interaction, and indicated that S+ speeds for Group BW were significantly slower ( $p < .01$ ) than S+ speeds for Group G. However, as will be discussed later, it is interesting to note that significant differences did not develop until Day 3.

Run. Analysis of the run speeds indicated the following significant effects: Days,  $F(6, 108) = 2.79$ ,  $p < .05$ ; S+ vs. S- x Days interaction,  $F(6, 108) = 2.35$ ,  $p < .05$ ; and Startbox Conditions (G vs. BW) x S+ vs. S- x Days interaction,  $F(6, 108) = 2.41$ ,  $p < .05$ . Further analysis (Tukey's procedure) of the significant triple interaction indicated that at Day 1 S+ speeds for Group G were significantly ( $p < .05$ ) faster than all other conditions. In turn, S+ speeds for Group BW were significantly ( $p < .05$ ) faster than either of the two S- speeds, and S- speeds for Group G were significantly ( $p < .05$ ) faster than S- speeds for Group BW. On Day 2, S+ speeds for Group G remained significantly ( $p < .05$ ) faster than all other conditions. Speeds (S+) for Group BW and S- speeds for Group G were significantly ( $p < .05$ ) faster than S- speeds for Group BW, but did not differ from each other. The only other significant difference occurred on Day 3 when S+ speeds for Group G were significantly ( $p < .05$ ) faster than S- speeds for Group BW.

Goal. Goal speed analysis indicated that the Days,  $F(6, 108) = 2.36$ ,  $p < .05$ , S+ vs. S- x Days interaction,  $F(6, 108) = 2.63$ ,  $p < .05$ , and



Startbox Conditions (G vs. BW) x S+ vs. S- x Days interaction,  $F(6, 108) = 2.89$ ,  $p < .05$ , effects were significant. Inspection of the significant triple interaction (Tukey's procedure) indicated that at Day 1 S+ speeds for Group G were significantly ( $p < .05$ ) faster than all other conditions. Also, Group BW S+ speeds and Group G S- speeds were significantly ( $p < .05$ ) faster than Group BW S+ speeds. On Day 2, Group G S+ speeds were significantly ( $p < .05$ ) faster than all other conditions. On Days 4 and 6, Group G S+ speeds were significantly ( $p < .05$ ) faster than Group BW S+ speeds. On Day 6, Group G S- speeds were significantly ( $p < .05$ ) faster than Group BW S+ speeds. On Day 7, S- speeds for both Groups BW and G were significantly ( $p < .05$ ) faster than S+ speeds for Group BW.

Discussion

Several general patterns are shown by the present data. First, in accordance with previously reported data (e.g., Bower, 1961; Ludvigson and R. A. Gay, 1967) both groups in the present experiment were able to master the discrimination during the acquisition phase. The attainment of this discrimination is reflected in all three measures by the significantly faster speeds to the S+ alternative than to the S- alternative. Second, removal of S+ reinforcement during the second phase resulted in a decrease in S+ performance for both groups. This finding is certainly in line with the multitude of instrumental-response-extinction data that have been accumulated over the past 50 years.

If the results of the present study could be viewed in isolation, then the interpretation would be relatively straightforward. However, when these data are viewed in the context of previously reported differential conditioning studies and theory interpretation, problems become all too apparent. The major discrepancy appears to center around acquisition performance, especially S- speeds. It will be recalled that the studies reported by Ludvigson and S. E. Gay (1966), Ludvigson and R. A. Gay (1967), and Davis, Gilbert, and Seaver (1971) presented relevant S+ and S- cues in the startbox prior to the initiation of the instrumental response. In those studies pre-response cue presentation resulted in a lessening of the difference between S+ and S- speeds, relative to a group receiving the discriminative cues only at the initiation of the instrumental response. This effect appeared to be due primarily to less se-

verely depressed S- speeds. Further, these studies indicated that the difference between S+ and S- speeds decreased as the subjects approached the goal. This later result was noted in all groups and did not appear to be a function of whether discriminative cues were presented prior to initiation of the instrumental response or not.

Since a group receiving pre-response exposure to discriminative S+ and S- cues (Group BW) was included in the present study, it was anticipated that similar results would be shown. More specifically, it was predicted that S+/S- differences would be smaller for Group BW than for Group G in the start measure. As can be seen from Figure 1, this was certainly not the case. Large S+/S- start-measure differences were shown by both groups.

Additionally, it was anticipated that the S+/S- differences for both Groups BW and G would dissipate as the subjects approached the goal. Figures 2 and 3 indicate that this did not happen. If anything, S+/S- differences became more pronounced for Group BW in the goal measure.

How should these discrepancies be resolved? One possible solution may lie in a consideration of the theoretical model proposed by Ludvigson and R. A. Gay (1967) and possible time-in-startbox differences. Ludvigson and R. A. Gay (1967) suggested that the initial presentation of the S- cue arouses an inhibitory (possibly frustrative) response in the subject, and that this inhibition dissipates with the passage of time. Hence, the depression of S- start speeds for subjects receiving the S- cue upon initiation of the instrumental response is predicted because there has not been time for inhibition to dissipate and the aroused inhibition presumably interferes with performance. For subjects receiving the S- cue prior to initiation of the instrumental response, inhibition, theoret-



ically, has had an opportunity to dissipate, thus reducing the depression of S- speeds.

In the Ludvigson and R. A. Gay (1967) study, all subjects were required to orient toward the start door for one second before the door was raised and the instrumental response initiated. Thus, it is quite possible that the Ludvigson and R. A. Gay (1967) subjects receiving S+/S- cues in the startbox prior to making the instrumental response were exposed to these cues considerably longer than similar subjects (Group BW) in the present study. It may be recalled that a relatively short (five-second) startbox-confinement period was imposed on all subjects in the present study. Carrying this line of reasoning one step further, it would be supposed the Group BW subjects left the startbox with inhibition aroused, but not dissipated, due to partial processing of the S- cues. It would further be assumed that as they approached the goal additional processing took place with the final result being a greater reduction in S- speeds in the goal measure itself. This interpretation would appear to be consistent with the frustration theory (Amsel, 1958) prediction that frustration (reflected in the present study via slower S- speeds) would be maximal in the goal, the point of greatest frustration. For Group G, it would appear that the inability to partially process the discriminative cues in the startbox prior to making the instrumental response resulted in less inhibition or frustration as they approached the goal. In short, the BW subjects appear to be "primed" to make an inhibitory response in the startbox, and that this inhibitory response becomes stronger as they approach the goal. In situations like the Ludvigson and R. A. Gay (1967) study where a longer startbox confinement



may have been imposed, inhibition apparently had a chance to be both aroused and dissipated.

To make the picture complete, some attention must be given to the S- performance of Group G. As mentioned, this group did not show the decrease, predicted from the Ludvigson and S. E. Gay (1966) and Ludvigson and R. A. Gay (1967) data, in S+/S- differences as they approached the goalbox. Time-in-startbox differences may, once again, provide an answer for these discrepant results. Assuming that the sight of the neutral gray startbox does arouse some (albeit, nonspecific) inhibition or frustration, then it might further be suggested that Group G subjects in the present study were not permitted sufficient time for this inhibition to dissipate. Sufficient time for the dissipation of inhibition was apparently permitted in the Ludvigson and R. A. Gay (1967) study. Thus, it is possible to observe the decrease in S+/S- differences when inhibition has ample opportunity to dissipate, but not under those circumstances of incomplete dissipation.

Turning to the question of whether extinction is solely a function of reward magnitude or is influenced by other factors, the S+ extinction phase provides some interesting insights. Unlike Logan's (1968) contention that extinction in this situation is determined strictly by the reinforcement value, the present data indicate that the context (whether or not the subject is provided the S+/S- cues prior to making the response) in which this extinction occurs is certainly a significant factor. It can be seen clearly from Figures 1-3 that presentation of the discriminative S+/S- cues in the startbox had the effect of accelerating S+ extinction for Group BW.

The partial-processing model developed above would appear well suited to account for these S+ extinction results. As already noted, there were no differences between S+ speeds in the start measure for Groups G and BW on Days 1 and 2. However, S+ goal speeds for Group BW were significantly depressed below those of Group G on Day 1 of S+ extinction. This would suggest, rather strongly, that subjects in Group BW were being primed by the discriminative cue in the startbox with the full influence of this priming or partial processing not being felt until the goal measure had been reached. Figures 1-3 indicate that as S+ extinction continued both groups displayed significant decreases in S+ speeds. However, the maximum decrease in these speeds occurred in the run and goal measures for Group G, further indicating that some partial processing had been accomplished by Group BW in the startbox.

The partial-processing model developed here appears to offer some possible reconciliation for the discrepancies between the present data and those reported by Ludvigson and S. E. Gay (1966) and Ludvigson and R. A. Gay (1967). However, much additional research will be required before all of the relevant aspects of cue processing are ferreted out.

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## APPENDIX A: TABLES

Table 1

## Sequence of Daily Trial Administration

+ = large reward (12, 45 mg pellets)

- = small reward (1, 45 mg pellet)

|           |             |           |             |
|-----------|-------------|-----------|-------------|
| Day 1, 13 | + + + - - - | Day 7, 19 | + + - - + - |
| Day 2, 14 | - - - + + + | Day 8, 20 | + + - + - - |
| Day 3, 15 | - + - + - + | Day 9, 21 | - + + + - - |
| Day 4, 16 | + - + - + - | Day 10    | - - + + + - |
| Day 5, 17 | - - + + - + | Day 11    | + - - - + + |
| Day 6, 18 | - - + - + + | Day 12    | + + - - - + |

## APPENDIX B: FIGURES



Figure 1. Mean start speeds (meters per sec.) during acquisition and S+ extinction.

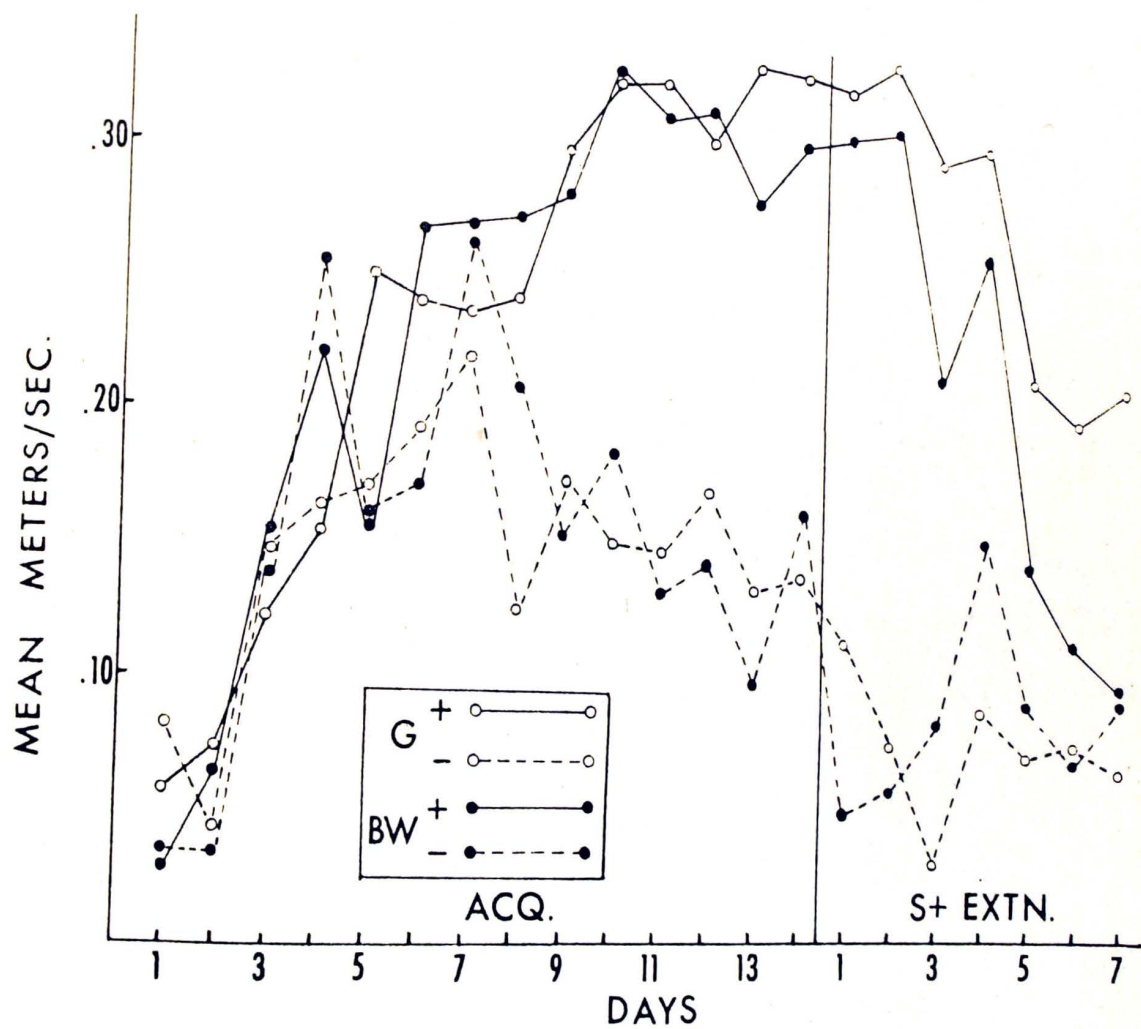


Figure 2. Mean run speeds (meters per sec.) during acquisition and S+ extinction.

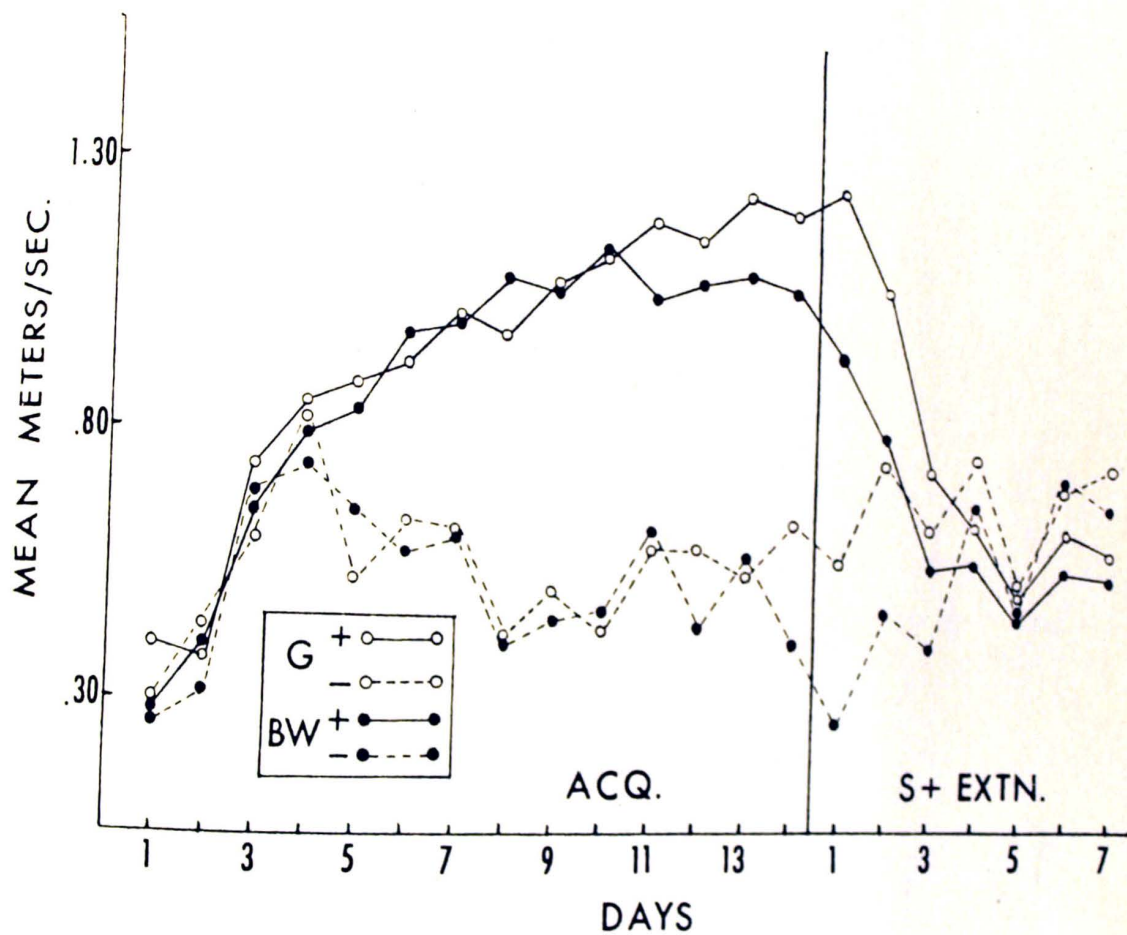




Figure 3. Mean goal speeds (meters per sec.) during acquisition and S+ extinction.

