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INCENTIVE MOTIVATION EFFECTS IN RATS

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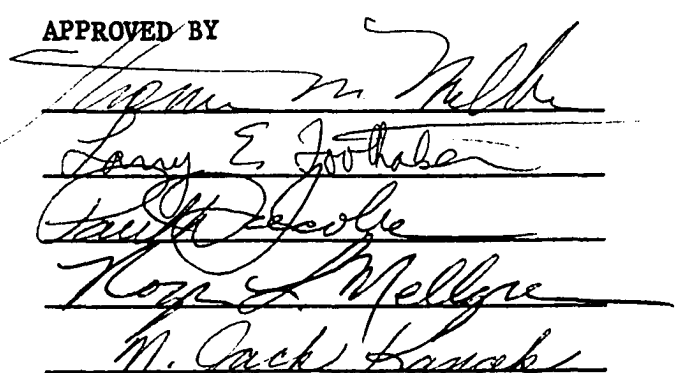

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INCENTIVE-MOTIVATION EFFECTS IN RATS

Introduction

In the Hull-Spence (Logan, 1959) motivation model, incentive motivation, K, is assumed to augment instrumental responses. Response strength is therefore a direct function of K, in which the function relating responding to reinforcement is negatively accelerated with increasing amounts of reward. It is also hypothesized that with non-reinforcement there is a decrement in response strength, (Spence, 1956). The strength of K depends directly on the hypothetical construct r_g. Attempts at direct measurement of some components of r_g, during instrumental responding have led to ambiguous results. Salivation was observed to preceed lever pressing (Shapiro, 1961, 1962) or to succeed the instrumental response (Konorski and Miller, 1930, Kintsch and Witte, 1962) depending upon the schedule of reinforcement. The manipulation of r_g through application of various drugs have failed to support the predicted relationship (Lewis, Butler, and Diamond, 1958; Soltysik, 1960; Wenzel, 1960; Lewis and Kent, 1961). Moreover, the direct determination of mediational properties of r_g is confounded by several assumptions basic to the design. Shapiro and Miller (1965) have pointed out that the order of responses may be a function of each response criterion selected, i.e., lever press force and/or size of salivatory drops, and the specification of the response origin, i.e., lever press

vs. movement leading up to the lever press. Shapiro, Miller, and Bresnahan (1966), did observe that both salivation and non-rewarded lever pressing occurred to a Pavlovian trained stimulus that was superimposed over a drl 2 min. schedule. Dogs receiving a novel stimulus also lever pressed to the superimposed signal but salivatory responses were not recorded.

Other studies reporting evidence related to the r_g mechanism without using direct measurement of the construct also have ambiguous results. A previously Pavlovian trained stimulus was able to increase response rate when presented during operant extinction (Estes, 1943, 1948, Morse and Skinner, 1958). Prefeeding in the goalbox did not produce any change in runway speed when compared to a group of rats which received an equal amount of non-fed goalbox exposures (Swift and Wike, 1958; Gonzalez and Diamond, 1960; Stein, 1957). However, Senkowski, Porter and Madison (1968) reported a positive effect on running speed in the pre-fed group when the number of prefeeding exposures was increased.

Bacon and Bindra (1967) extended Estes' (1948) design to the running response, and found that a CS classically paired in a separate chamber with water as reinforcement acted to differentially increase acquisition running behavior as compared with control groups, when this cue was presented in the startbox. No attempt was made to record asymptotic running or extinction speed. These authors obtained similar results when drives were switched from thirst to hunger, and when an aversive stimulus, shock, was used in the startbox. Two control groups showed the same facilitation in running behavior as the experimental animals which leaves the interpretation of the results ambiguous. The Ss also did not have any prior exposure to the alley before the first trial and buzzer presentation, and therefore, no r_g could have generalized backwards.

The proposed experiment is an attempt to test the retrograde generalizing function of r_g.

The present design is based on an idea suggested earlier by Estes (1948) that a cue previously associated with food should, when presented early in an instrumental chain, act to facilitate instrumental behavior. If one could assume that the 2 min. interresponse time in a drl 2 min. schedule is equivalent to the instrumental chain of a straight alley, the results of Shapiro, Miller, and Bresnahan, (1966), may be taken as support for this hypothesis, since conditioned stimuli previously paired with food increased the probability of a response when presented early or late in the 2 min. interval.

In contrast to previous discrete trial experiments (Senkowski, Porter, and Madison, 1968; Bacon and Bindra, 1967; Swift and Wike, 1958; Gonzalez and Diamond, 1960; Stein, 1957) asymptotic runway performance was compared among groups receiving a buzzer in the startbox which had been paired with either (1) the presence of food (B+), (2) the absence of food (B-), or (3) both presence and absence of food in the goalbox ($B^{\pm}$). The predictions would be that the running speeds of Group B+ should be facilitated, Group B- should be inhibited and Group $B^{\pm}$ should not change.

Method and Procedure

Subjects

Thirty-six male albino rats, 53 days old were housed two to a cage, and kept on a 23½ hr food deprivation schedule with ad-lib water.

Apparatus

The wood constructed runway measured 14 cm. wide and 17.5 cm. in height, was black, and had a 30 cm. startbox, 112.5 cm. runway, and a

37.5 cm. goalbox. Both the start and goalboxes were separated from the main runway by black Plexiglas guillotine doors which were operated manually and prevented retracing. A third guillotine door was located just in front of a teaspoon which served as the food cup. The food cup was placed on the middle of the back wall of the goalbox.

Running times in the alley were measured to the nearest 100th sec. by three Standard Timers operated by a Microswitch mounted on the startbox door, and photoelectric cells. The photoelectric cells were located 15 cm. beyond the startdoor, 5 cm. in front of and 5 cm. beyond the goalbox door. Two 1½ v.d.c. high power buzzers were used as the goalbox stimuli. Both were equated for sound level and were manually operated by push button Microswitches. Depression of the Microswitch activated the buzzer for 5 seconds. One buzzer was located on top of, and just behind, the startdoor, and the other was attached just behind the delay door. Both were mounted so that alley vibrations would be reduced.

Procedure

The deprivation schedule was established three days prior to the preacquisition phase of the experiment.

Preacquisition phase - On the fourth day of deprivation, the animals were handled 4 min. for five consecutive days and randomly divided into 3 groups of 12 each.

Acquisition phase - The Ss were placed in the startbox with their head facing the guillotine door, and after a 6 sec delay the door was opened. On the first day of acquisition, all Ss were allowed enough time to consume all the food pellets in the food cup. On subsequent days,

a period of 6 sec was allowed for the consumption of the food, after which the S was removed from the goalbox and allowed to finish his food pellet in the carrying cage. Each S received eight trials per day for which the reinforcement on four trials was 2, 97 mg. Noyes food pellets in the food cup. Ss from all three groups were given 9 days of the same acquisition training on a 50% random reinforcement schedule in the goalbox. A 5 sec delay was used on all trials. After S entered the goalbox, the door blocking access to the food cup remained down for 5 sec, after which it was manually raised. The only difference between groups was the buzzer presentations; for Group B+ the buzzer occurred on those trials in which food was present in the food cup, and for Group B-, the buzzer sounded on those trials when the food cup was empty, and for Group $B^{\pm}$ the buzzer was randomly presented, regardless of food presentation. Consequently, all three groups had the buzzer sounding only on 50% of the trials.

Testing phase - Test trials were conducted in exactly the same manner as acquisition trials except that the buzzer was sounded in the startbox on 50% of the trials for each S of each group. It was manually activated 1 sec after the S was placed in the startbox, and remained on for 5 sec after which the startbox door was opened. This could be considered a modified partial extinction procedure since the start box buzzer was sometimes followed by reinforcement, and sometimes it was not (i.e. a random 50% relation with food in the goal box).

Extinction phase - In the extinction phase, the buzzer was presented in the startbox on every trial, and all reinforcement was eliminated. As in the other phases of the experiment, the buzzer in the goalbox was presented on 50% of the trials and counterbalanced across trials.

Results

Startspeed - The mean running speed for the start, alley and total measures are presented in Tables 1, 2, and 3. Of primary concern was performance on day 10, the first test day. Inspection of Figures 1, 2, and 3 reveals that the hypothesized performance facilitation predicted from the Hull-Spence theory was not obtained. No significant main or interaction effects were obtained in a repeated measures analysis of variance (ANOVA). Day 18 was the last day of extinction trials, and, from inspection of Figure 1, the three groups appear to separate. However, statistical analysis found this graphic trend to be non-significant.

Alley Speed - As with the start measure, the alley speed also did not show the expected changes in running behavior on the first test day, day 10. The analysis of variance showed a significant groups by days interaction effect during extinction. However, what was of concern were the main effects due to groups and these data were non-significant. Therefore, there is no further elaboration on this point.

Total Speed - The analysis of variance indicated a significant effect for the groups by days interaction during the test phase. But, what was of interest was the main effect due to buzzer being on or off, and, this effect was non-significant.

Discussion

Presenting a cue in the startbox which has previously been associated with reinforcement does not facilitate asymptotic instrumental running behavior. Also, a cue which has been paired with the absence of food does not appear to inhibit asymptotic running speed when it is presented in the startbox. These findings may be explained by one or more of the following hypotheses: (a) that the generalization of R_G and the anticipation

TABLE 1

The Daily Start Speed Group Means in Seconds

Group	Day 1	2	3*	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
				Acquisition						Testing					Extinction			
B+	5.00	6.04		.56	.27	.46	.24	.33	.29	.29	.29	.22	.23	.37	.27	.39	.85	1.09
B-	7.80	7.68		1.31	.27	.49	.28	.31	.20	.29	.25	.23	.22	.22	.31	.69	1.30	2.18
B^{+}_{-}	6.65	10.57		1.64	.28	.30	.25	.27	.21	.21	.20	.31	.21	.20	.46	.80	.64	1.28

* The data for day 3 was incomplete and therefore not reported

Standard Deviations

Group							
B+	3.87	.10	.21	.32	.59	.90	
B-	5.24	.04	.32	1.06	1.33	2.69	
B^{+}_{-}	7.65	.03	.48	.68	.95	.82	

TABLE 2

The Daily Alley Speed Group Means in Seconds

Group	Day 1*	2	3*	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	Acquisition									Testing					Extinction			
B+	5.5		1.05		.85	.66	.61	.58	.60	.69	.65	.55	.66	.72	.55	.61	1.65	1.62
B-	6.33		1.25		.67	.78	.66	.62	.61	.73	.57	.57	.60	.56	.63	.93	3.00	1.72
B^{+}_{-}	6.72		.83		.66	.65	.60	.64	.58	.63	.54	.86	.58	.63	.65	.90	1.07	3.43

* The data for days 1 and 3 were incomplete and therefore not reported

Group	Standard Deviation																	
B+	3.93				.04				.06	.11	2.18	.79						
B-	5.47				.07				.20	.78	4.59	1.35						
B^{+}_{-}	5.87				.04				.17	.42	.71	2.69						

TABLE 3

The Daily Total Speed Group Means in Seconds

Group	Day 1	2	3*	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	Acquisition									Testing					Extinction			
B+	14.05	13.37		2.11	1.86	1.20	.95	.95	.93	1.12	1.10	.87	1.00	1.29	.95	1.14	4.21	5.01
B-	22.39	20.94		2.60	1.06	1.25	1.03	1.01	.92	1.11	.93	1.83	.92	.88	1.05	1.90	5.18	8.07
B^{+}_{-}	19.07	20.25		1.37	1.06	1.07	.95	1.05	.88	.95	.80	1.16	.91	.93	1.23	2.02	2.40	6.04

*The data for day 3 was incomplete and therefore not reported.

Standard Deviation

Group							
B+	6.02	.12	.31	.41	4.24	3.18	
B-	10.86	.11	.51	2.32	7.39	11.97	
B^{+}_{-}	13.69	.05	.51	1.23	2.78	3.84	

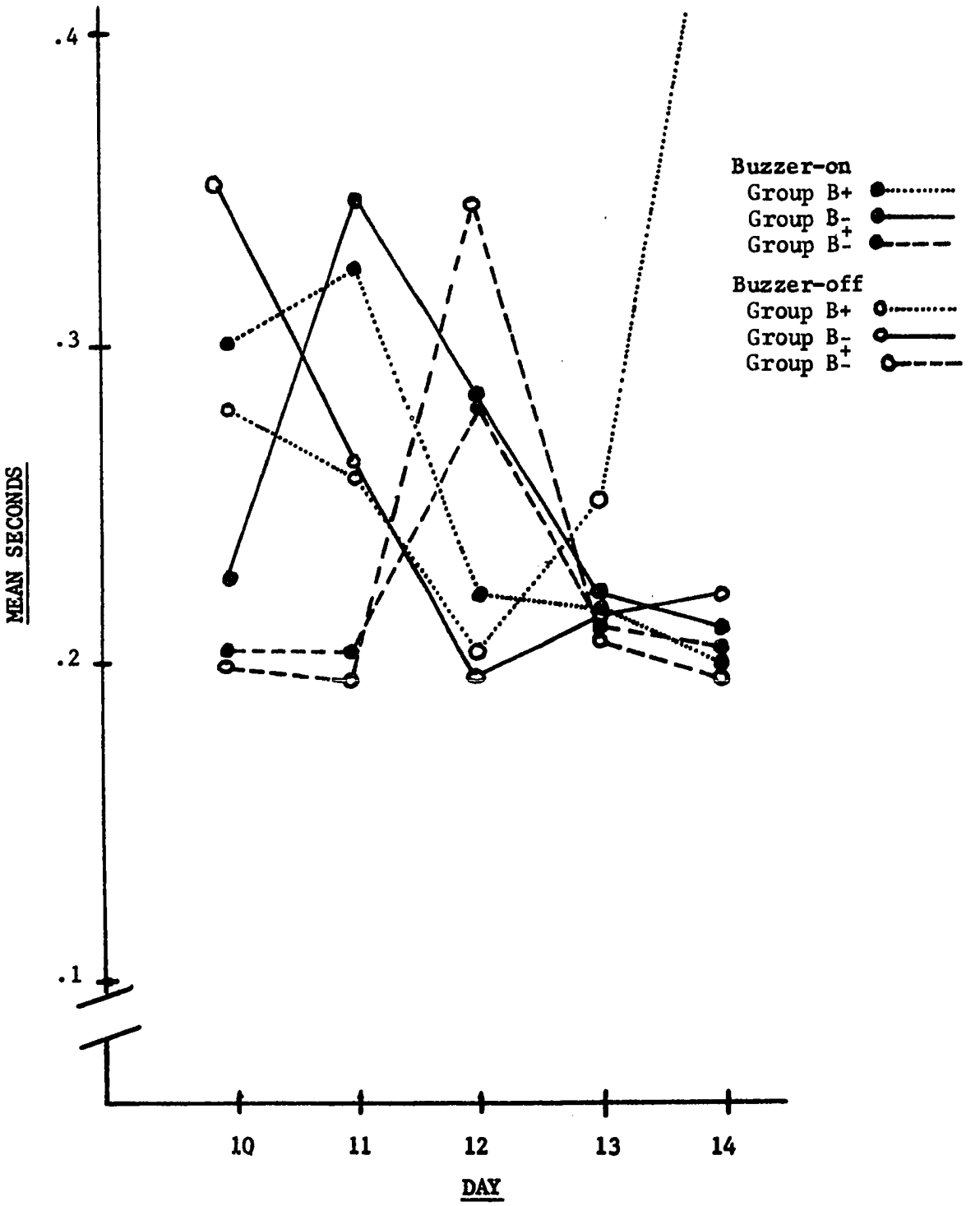

Fig. 1 . Graph of the start speed test data divided into buzzer-on and buzzer-off groups.

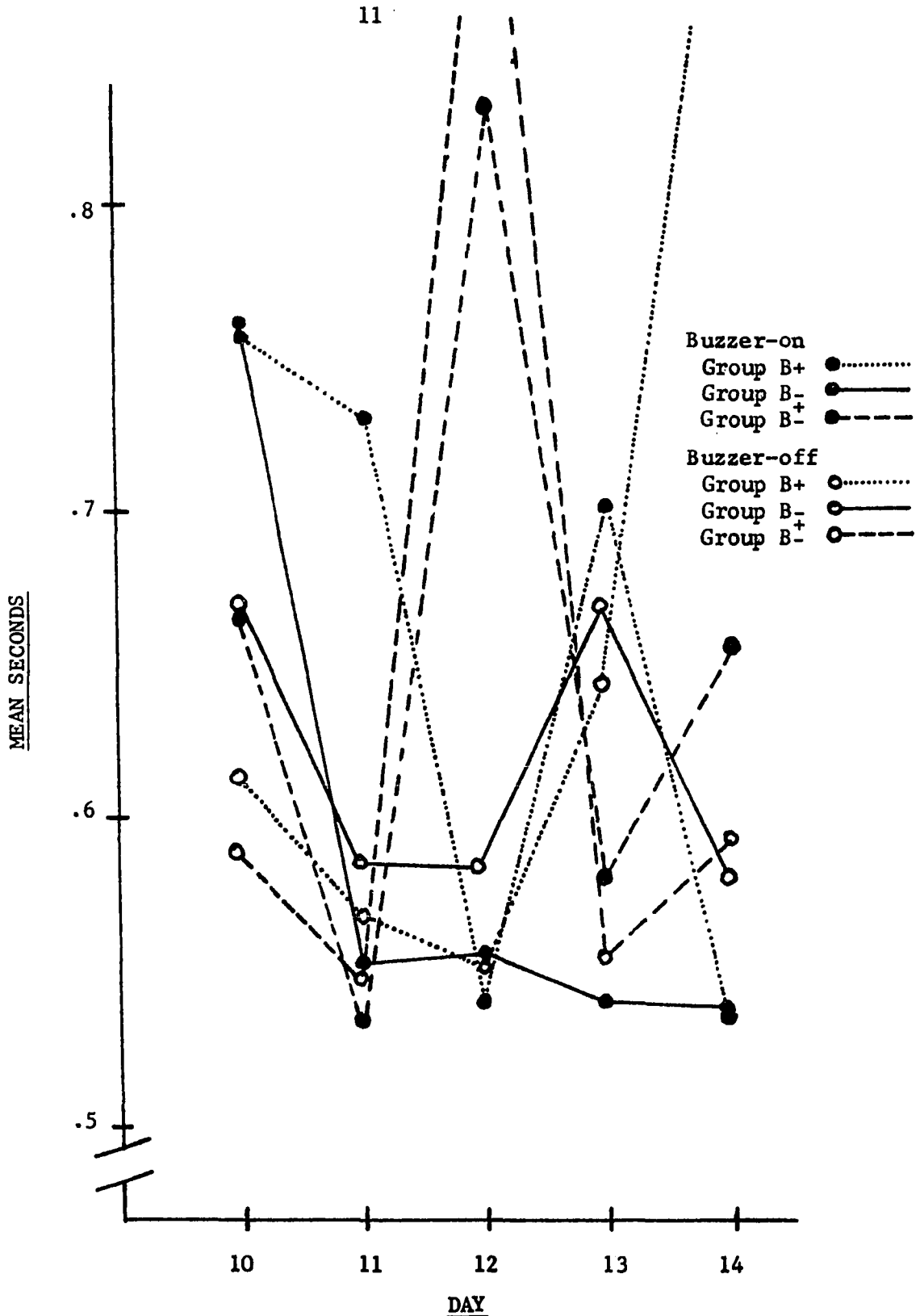

Fig. 2. Graph of the alley speed test data divided into buzzer-on and buzzer-off groups.

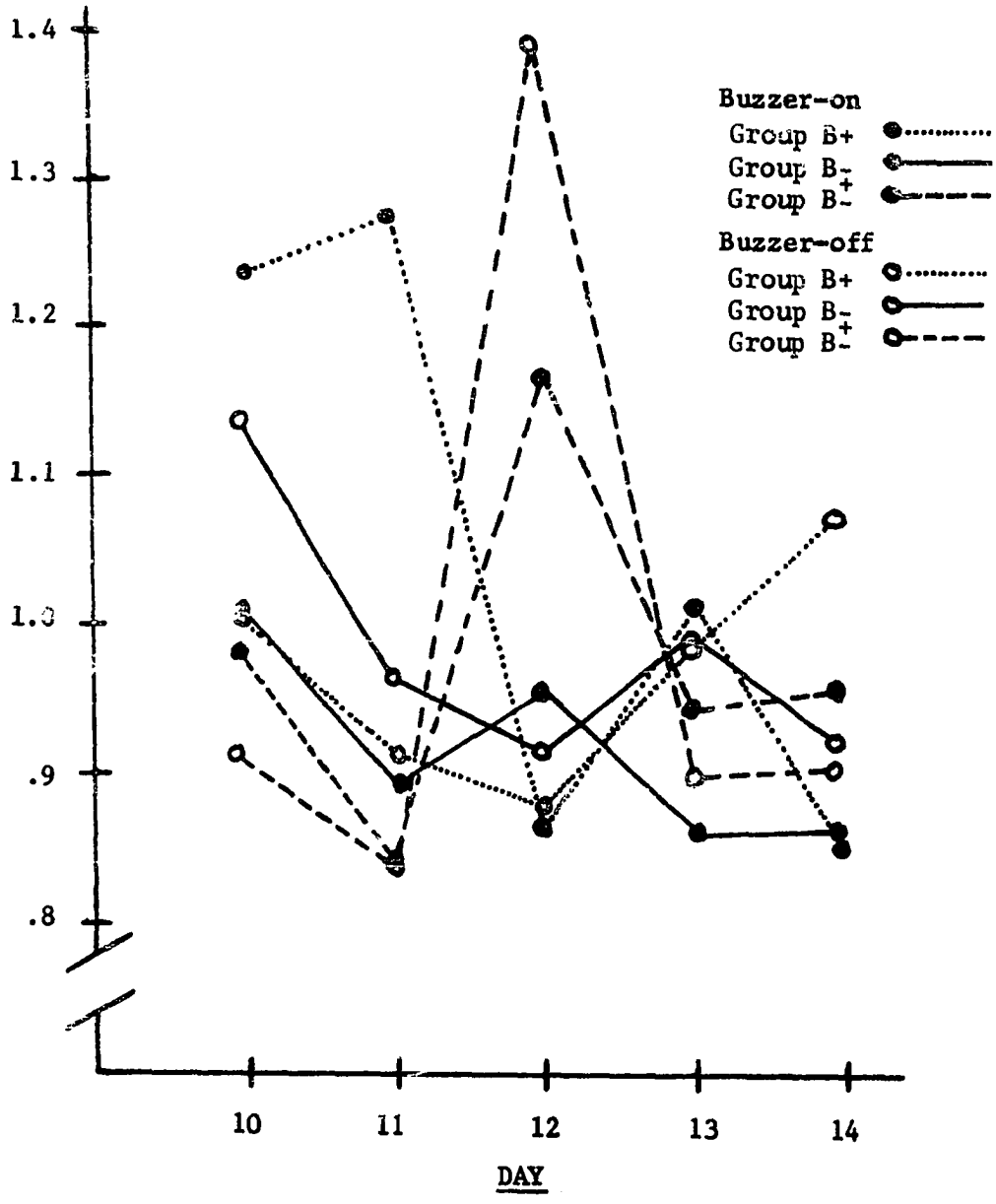

Fig. 3 . Graph of the total speed test data divided into buzzer-on and buzzer-off groups.

of R_G was not sufficient to change behavior, i.e., additional trials were needed; (b) the Ss discriminated between a buzzer signaling food in goalbox and a buzzer preceeding the start of a trial; and (c) a maximal level of running speed had been attained and the motivational effects of the buzzer in the startbox on alley speed could not be demonstrated due to the ceiling effect. Senkowski, Porter, and Madison (1968) reported positive results with 60 acquisition trials using the direct goalbox placement procedure first used by Stein (1957). The Ss in the present study received 72 acquisition trials. It is possible that with the procedure of presenting the S^D in the startbox as described here, 72 acquisition trials were not sufficient for the backward generalization of R_g to the startbox. Perhaps significance might have been obtained if more training trials were employed as with the direct goalbox placement procedure. Senkowski, Porter, and Madison (1968) did not transfer a specific stimulus cue to the startbox for testing.

A few Ss in Group B+ of the present study became so activated when the buzzer sounded in the startbox that their jumping up and down and clawing at the start-door interferred with, rather than facilitated, the instrumental response. This excitement, however, was not seen in the other two groups. There was also some indication that some of the Ss were learning that the buzzer meant food and was not a cue to run. In a number of subjects, when the buzzer sounded in the startbox and the door opened, they darted out only a couple of inches and appeared to look around as if bewildered. It seemed as if when the buzzer sounded the subjects expected to find food on the other side of the startbox door. This kind of behavior was actually conditioned in the goalbox because the Ss were required to wait in front of the delay door for 5 sec. before

it was lifted and food was available. Another possible explanation for lack of increase in running speed associated with the buzzer is that the Ss might have been running at their physiological limit, and no increase in behavior was possible on the test trials. However, Bacon and Bindra (1967) show evidence to indicate that when a cue which has been paired with reinforcement is presented in the startbox before asymptote, this cue can act to facilitate running behavior. Because this was anticipated before the start of the study, both a delay and a periodic reinforcement procedure were used. However, it is conceivable that these efforts were not sufficiently successful in slowing running speeds.

A possible explanation for no decrease in running speed of Group B- is suggested by Amsel (1967). Amsel's hypothesis is that under a partial reinforcement schedule (PRF), a frustration effect (FE) and its mediative components, frustration reaction (r_f) and its feedback stimulation (s_f), are conditioned to the running response. The FE acts to increase the vigor of responding. If, in the present study, the B- condition evoked r_f and its stimulus consequences, s_f, and s_f had been conditioned to the approach response, then running in Group B- would have been facilitated rather than showing a decrement. In this case the ceiling effect argument may actually be applicable in both the B+ and B- groups.

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APPENDICES

APPENDIX 1

Dissertation Prospectus

The Hull-Spence theoretical approach to two-process learning theory is the major concern of this paper, and an historical outline of the events leading to the inception of this theory and a discussion of some of the recent related empirical findings will follow.

In 1930, Hull introduced the notion that basic to the changes in instrumental behavior was the classical conditioning of the goal or consummatory responses to cues throughout an instrumental chain. Increases in the habit strengths of the instrumental response were associated with these fractional goal responses. Habit strength was therefore, a direct function of the classical conditioning of the consummatory response. Latent learning studies (Spence and Lippitt, 1940, 1946, Spence, Bergmann, and Lippitt, 1950, Kendler, 1947) did not fit into his model since some learning had apparently occurred without the occurrence of the goal response (US). In keeping with the flexibility of an intervening variable theory, Hull, in the early 1950's, adopted Spence's notion that the classical conditioning of the consummatory response was related to a motivational variable. This theoretical variable was given the nomothetic designation "K", and according to Hull, entered into his equation in a multiplicative fashion (Hull, 1952). However, more recently, Spence (1956) had advanced the notion that the theoretical variable incentive motivation (K) combines additively with drive (D) to produce reaction potential (E).

Spence's motivational construct, "K", was adopted by Hull and was used to explain the latent learning data. The theoretical mechanism used was that of the fractional anticipatory goal response, often abbreviated "r_g". Stimulus cues in the goal-box and from the alley just preceeding the goal-box, became conditioned to the goal or consummatory response, "R_G", and through generalization, cues at earlier points in the runway also acquired the capacity to elicit parts (r_g) of "R_G". This backwards generalization of fractional components of the goal response to anticipatory stimulus events, is often called the "r_g-s_g" mechanism (Spence, 1956) and provides the basis for increasing incentive motivation "K" in Hull's 1952 revision. Hull's motivation theory predicts that "r_g" should: (1) vary with the number of conditioning trials given in the goal-box; (2) the intensity or vigor of "r_g" should be a negatively accelerated, exponential function of the number of these conditioning trials; and (3) its strength at any point in the alley distant from the goalbox will be a function of the number of conditioning trials. The theory implies that performance as a function of incentive motivation "K" can be modified by a variety of classical conditioning manipulations, which include stimulus and reinforcement changes without regard to the response variables. Strength of the motivational factor "K", through changes in stimulus and reinforcement conditions may be manipulated independently of the learning of the instrumental response, or habit strength "$_SH_R$".

Before going into the more recent empirical evidence directly related to "K" other research will be first reviewed. These studies will be essentially treated under three implicit topics: (1) those studies which demonstrate effects of prior Pavlovian training has on subsequent operant conditioning: (2) studies which distinguish between discriminative and

the reinforcing properties of a stimulus; and (3) studies which attempt direct manipulation of behavioral and physiological events related to "r_g".

Several experiments have been directed at relating the discriminative and reinforcing properties of Pavlovian trained stimuli. In Estes' original experiment (Estes, 1943), a stimulus previously paired with food was presented during operant lever pressing extinction. The rate of bar pressing was higher in the presence of the tone than in its absence even though bar pressing had never been reinforced in the presence of the tone. Estes (1948) obtained similar results even when the tone-food pairings occurred prior to shaping the operant.

Morse and Skinner (1958) obtained comparable results in an experiment in which two conditioned stimuli were used. They trained pigeons to approach a magazine for food in the presence of one color (CS^+), but food never was presented in the presence of a contrasting color (CS^-). The Ss behavior was independent of magazine operation. Following key-peck training, the CS^+ and CS^- were alternately presented during operant extinction. The pecking rate was higher in the presence of CS^+ than it was when CS^- was present. Since no controls for extinction without superimposed conditioned stimuli were provided, excitatory or inhibitory effects of CS^+ and CS^- respectively could not be determined.

Bower and Grusec (1964) used differentially conditionable stimuli, CS^+ and CS^-, in operant discrimination training. Conditioning and discriminative training were said to be consistent when the stimuli (CS^+) paired with food served as the discriminative stimuli (S^D) for operant reward, and the stimuli (CS^-) which had not been paired with food was the stimulus (S^Δ) for operant nonreward. Conditioning and discrimination

training were inconsistent when CS^+ was an S^Δ and CS^- was an S^D. The conditioning and discrimination training were consistent for one group of rats and inconsistent for the other. Results showed that discrimination was enhanced for the consistent group but was inhibited in the inconsistent group. However, no control group was given discrimination training without prior differential training, and, as in the Morse and Skinner (1958) experiment, there was no way of ascertaining whether or not CS^- had true differential inhibitory properties.

Trapold (1966) has shown that inconsistent differential conditioning can actually facilitate reversal learning of a discriminative instrumental response. Pavlovian contingencies were powerful enough to assist the instrumental discrimination reversal.

Mellgren and Ost (1969) demonstrated similar facilitation effects of prior differential Pavlovian discriminative training on instrumental behavior. In their experiment, these authors replicated the study by Bower and Grusec's (1964) and added a third manipulation. In this manipulation, the stimuli were not present during the Pavlovian phase and thus the US could not be contingent upon them. Another control group was used in which the conditioned stimuli (CS) presentations were independent of the US presentations. In their consistent group the stimulus paired with water reinforcement in Pavlovian phase served as the S^D in operant shaping, and in the reversed group, the stimulus which had not been paired with reinforcement was used as the S^D for operant training. Their results showed that their consistent technique facilitated operant discrimination, while the reversed procedure interferred with operant discrimination.

An inevitable outcome of the former studies is that CS^+ presentations are in reality being paired not only with food presentations, but also with magazine approach responses. In order to get the food, the S must make an instrumental response. Therefore, these studies listed above fail to distinguish between the discriminative or reinforcing properties of the CS.

In a series of studies directed at determining the relationship between classical and instrumental conditioning with concurrent measurement of an operant and respondent, the temporal order of the response in different schedules of reinforcement has some bearing on the Hull-Spence model of motivation. Konorski and Miller (1930) trained a dog to lift his paw to a signal in order to obtain food. They found a close relationship between paw movements and magnitude of conditioned salivation. Their most important finding was that the operant consistently preceeded increased salivary outflow. Wolf (1963) found similar results using a fixed ratio (FR) schedule of reinforcement. Shapiro (1961) and Kintsch and Witte (1962) show supportive evidence with a fixed interval (FI) schedule during performance and extinction. Shapiro showed that the occurrences of the two conditioned responses, lever pressing and salivation, were positively correlated. Lever pressing, however, was observed to scallop slightly before the salivary response. During training, as opposed to optimal performance, concurrent measurements show salivary responses occurring after lever pressing.

Inconsistent with these findings are the results of Shapiro (1962). He trained dogs to obtain food by pressing a panel on a differential reinforcement of low rates (DRL) schedule. Using this schedule, bursts

of salivation regularly preceeded the operant, while the occurrence of the operant itself led to further increments in salivation. These results indicate inconclusive evidence for the relationship between salivery responses and instrumental behavior. It appears as if the temporal sequence of conditioned responses (CRs) and instrumental behavior is not fixed but depends upon the relations which the E arranges between instrumental response and reinforcement. Ellison and Konorski (1964) demonstrate this rather dramatically. Their dogs were trained on a FR schedule to panel press, the completion of which initiated an 8-second waiting period at the end of which food was delivered. Temporally then, panel pressing and salivation were kept almost completely separate; the operant only during the FR requirement and the respondent only following its completion. The two do not reciprocate each other and S can acquire a discrimination in this experimental manipulation. These studies show that the respondent must neither precede nor consistently follow operant behavior in order for the behavior to be maintained. Therefore, salivation consistently seems not to represent either Spence's "r_g" or Konorski's "alimentary excitation".

Mediation is perhaps the key process implied by postulating the "r_g-s_g" mechanism for the energizer of operant behavior. Spence (1956), suggested that instrumental behavior (r_g) was controlled by an internal stimulus (s_g). Mowrer (1947) discussed the concept of the CR as being a motivational mediation of instrumental behavior. Mowrer ascribed to Miller's 1941 notion that CRs can produce drive and can strongly influence operant behavior, Spence's mediational process is the appetitive counterpart of Mowrer's idea of emotional based drives. Several empirical attempts

have been made to directly manipulate "r_g" but have failed. A brief outline of these studies follows.

Lewis, Butler, and Diamond (1958) and Lewis and Kent (1961) attempted to directly manipulate "r_g" when salivation was assumed to be an index of "r_g". Direct control over the quantity of salivation during instrumental responding was achieved by injecting pilocarpine or benzocane. With this control, however, results indicated no direct relationship between quantity of pilocarpine injected and instrumental maze running performance. Soltysik (1960) found a gross temporal correspondence between cardiac acceleration and performance on a motor response reinforced by food. In this study, the cardiac acceleration preceeded the operant behavior suggesting that it may be involved in instigating that behavior. On the other hand, Wenzel (1960), found that, in cats, reserpine markedly reduced the heart-rate response with no apparent effect upon operant behavior. Cardiac changes do not appear to be necessary mediators for operant behavior. Finally, using another type of CR, licking, Miller and DeBold (1965) measured intraoral licking while their Ss were bar pressing for intraoral injections of water. The water was reinforcement for a discriminated bar-press operant. They found that licking was more probable just prior to a bar-press than at other times, but it was maximal just following an unreinforced bar-press. It would appear from these results, and those of Lewis et al. and Wenzel, that the autonomic response thought to be an indicant of "r_g" does not vary in any precise relationship with the instrumental response. This parallels the findings mentioned earlier by Shapiro (1961, 1962) that the temporal sequence of CRs and operant behavior is not fixed. In reality, this kind of evidence may not be damaging to those theorists who ascribe to "r_g" theory, for, as Spence (1956) and

Logan (1959) suggest, "r_g" is an intervening variable and does not occur anywhere within the organism. These theorist support the notion that these kinds of constructs just help in formulating what might go on between the stimulus and response in a learning situation.

Several investigators have attempted to look at "r_g" within the boundary conditions of the Hull-Spence model and how it might affect instrumental performance. Stein (1957) tested the Hull-Spence notion that instrumental reward performance involves the formation of two habits, the instrumental conditioned response leading to the reinforcer, and the consummatory response (R_G) with its fractional component (r_g) which becomes classically conditioned to the stimuli of the instrumental situation. Three matched groups of 10 animals each were used. The groups were divided as follows; one received 2 pellets per feeding in the goalbox which was closely similar to the alley in construction, another group received 10 pellets per feeding, and the last group received 2 pellets but in a dissimilar "neutral" box. The direct feedings were accomplished by gently placing the S in the loaded goalbox with its head always orientated directly over the food cup. Test periods consisted of giving all the Ss a single test run in the alley under conditions that were identical for all groups. All runs were reinforced with a 2-pellet food reward except the first test trial. The performance jump anticipated in groups one and two did not materialize. Two more recent studies (Swift and Wike, 1958, Gonzalez and Diamond, 1960) gave negative results when attempting to replicate Stein's study. These author's suggested that generalization of "K" from goalbox to runway actually may have interferred with the predicted result by causing S to seek food instead of running.

One study using this technique has reported positive results. Senkowski, Porter, and Madison (1968) tested "K" and its relationship to Hull's goal gradient hypothesis. Their two hypotheses were that (1) the effect of "K" upon first trial runway performance is dependent upon the number of prior goalbox placements, and that (2) the effects of prior goalbox placements should be most evident near the goal. Their Ss were given 10 minutes of runway exploration the first day, and 2-rewarded runway trials the second day. On the basis of the mean running speed on Day 2, the Ss were randomly assigned to four groups. These groups were as follows; a 60 and a 10 goalbox rewarded placement group respectfully, and an equal number of groups which had nonrewarded goalbox placement. The data confirmed the original hypothesis that, prior rewarded goalbox placements facilitate first trial runway performance and level support to Spence's (1956) hypothesis concerning the action of "r_g" upon running performance. The effect of prior rewarded goalbox placements was progressively less apparent as measures were taken further from the goal. This supports the notion that "r_g" generalizes backward from the goalbox. Again, the evidence for support of "r_g" theory is not, by all means, totally positive.

Marx and Murphy (1961) modified Estes' original (1948) paradigm and developed an experimental design pertinent to what is being discussed in this paper. They first gave rats discriminative training in a restraining box where buzzer (CS^+) was paired with food, and the control group had food pellets presented separately from the buzzer. Then the Ss were given 10 runway training trials on each of two days. Following this, their rats were given massed extinction trials and run to a criterion of two successful trials on which the goalbox was not reached within 90 seconds. The

critical S^D (CS^+) was introduced on trial 16 of extinction and presented every fifth trial thereafter. A five second buzzer was sounded just after the S was placed in the startbox and the startdoor was raised when the S^D stopped. The results show that when CS^+ was presented in the startbox, it had a facilitating effect on instrumental running in that it increased resistance to extinction for the experimental group. Marx and Murphy attribute these results to the energizing properties of a secondary-reinforcing stimulus and their results lend support for "r_g" theory. The role of the CS^+ was clearly seen as a motivator or energizer in that it had a clearly facilitating effect on the starting speeds of the experimental group.

A study, using an adaptation of the Marx and Murphy design, and pertinent to the present study, is that of Bacon and Bindra (1967). These authors tried to determine the effects that a CS paired with water as the reinforcement in a separate conditioning chamber might have on the acquisition of an instrumental running response. They presented the CS^+, a buzzer, in the startbox beginning with the very first acquisition trial. Using this procedure, they were able to demonstrate a facilitation in start and running time for their CS^+ group. Similar effects were shown when the drive associated with thirst was switched to another drive-reinforcement combination, namely hunger-food, and when aversive stimulation, i.e., shock was used in the startbox. However, their results are somewhat ambiguous in that two control groups, one given water only in the Pavlovian phase, and one in which the buzzer was never sounded in the startbox even though they had buzzer-water pairings in the classical conditioning chamber, showed a decrease in running behavior along with the experimental group. This leads to the assumption that the difference in running

behavior seen by Bacon and Bindra was not due solely to the incentive motivational effect of the CS per se. The investigations suggest that facilitation might be due to the whole complex of situational cues connected with the daily experimental procedure. However, these experimenters present a different test of the mediational approach to incentive-motivation hypothesized by Hull-Spence, than what will be proposed here, because their Ss did not have any alley training prior to their first exposure to the alley and buzzer. Therefore, what was observed was not the generalization of r_g-s_g backward from the goalbox, but the effect that a CS^+ can have on instrumental running behavior, before asymtote is reached.

As was mentioned earlier, and shown by Marx and Murphy, (1961), and Bacon and Bindra, (1950), one implication of the Hull-Spence theory of incentive motivation is that secondary reinforcers associated with the consummatory response may be manipulated and used as secondary motivations independently of Hull's theoretical learning variable "$_SH_R$".

The purpose of the present experiment is to study in closer detail some aspects of the Hull-Spence theory of incentive motivation. As was mentioned previously, the theory presents the notion that neutral cues associated with the consummatory response become classically conditioned. These classically conditioned stimuli can then act to energize or motivate subsequent instrumental behavior. Also, according to the theory, the "r_g-s_g" mechanism which underlies incentive motivation should cause performance variance in accord with the magnitude or vigor with which said mechanism occurs. Spence, 1956, noted that variations in the intensity of "s_g" provide an internal dynamism akin to Hull's notion of stimulus intensity dynamism (V) resulting from different intensities of both external and internal stimuli. Both Hull and Spence also call for a decreasing

gradient of performance when any shift is made from cues under which the habit was first established. Therefore, the strength of instrumental responding in a straight alley maze any distance from the goal box will be a function of the similarity of the internal and environmental cues at that point and the cues then existant in the goal box.

The subjects will be naive, male albino rats. The apparatus to be used is a simple straight alley maze with three guillotine doors: one between the startbox and the alley, the second, between the alley and the goalbox, and the last just in front of the food cup. The first two doors will be used to prevent retracing by the Ss and the last will be used in order to delay the reinforcement procedure which it is hoped will decrease asymptotic running speed (Wike, Mellgren, and Wike, 1968). The S^D will be generated by two buzzers, one just in front of the door leading out of the startbox, and one just in front of the delay door. Three days prior to the training phase, a 23-hour food deprivation schedule with ad-lib water will be established. During the pretraining phase, the animals will be shaped on a partial reinforcement schedule to run the alley to the goalbox for food reward of 2 - 97 mgm. Noyes food pellets which it is hoped will maintain a moderate running speed. It is anticipated that this moderate speed would allow for both increases in running behavior as determined by the experimental manipulation during the test phase. The Ss will be divided into three groups, two experimental and one control. The positive group, group B+, will always have the presentation of food matched with buzzer in the goalbox. Group B-, the negative group, will have buzzer presentations associated with non-reinforcement. In group B+, the S^D, buzzer, should signal food, while in group B-, the buzzer should signal no food. The control group, group $B^{\pm}$,

will have the buzzer and food presented in the goalbox in a random unpaired sequence so that no contingency will develop between them (Rescorla, 1967).

The first running trial after the discriminative cue has been presented in the start box should yield the data of the greatest interest, for it should reflect the running energized solely by the motivating effects of the discriminative stimulus. Subsequent trials might be contaminated because these would be confounded with reinforced running plus the motivational effects. Therefore, the dependent variables will be speed of running, perhaps in the first third of the alley, and/or latency of responding. As one might predict from the Hull-Spence theory of incentive motivation, running performance for the groups in which the discriminative cue was presented should be better than a control group in which no contingency between the cue presented in the start-box and reinforcement has been established.

The present design prescribes that the S^D will be presented in the startbox at a time when there will be a minimum of competing responses to interfere with the motivating effects of the cue presented in the startbox. It is hoped that with this procedure, another fruitful way of distinguishing between, and looking at secondary reinforcing and motivating stimuli is suggested.

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APPENDIX 11

TABLE 1

Summary of the Two-Way Analysis of Variance for the Start Speed Acquisition Trials

	df	MS	F
Groups (A)	2	31.47	NS
Days (B)	1	113.58	65.84*
AxB	2	32.02	NS
S/A	33	16.75	
BXSub	33	16.91	
Total	71		

*p. < .01

TABLE 2

Summary of the Three-Way Analysis of Variance for the Start Speed Test Trials

	df	MS	F
Groups (A)	2	.08	NS
Stimuli (B)	1	.04	NS
Days (C)	4	.02	NS
AXB	2	.02	NS
AXC	8	.07	NS
BXC	4	.05	NS
AXBXC	8	.07	NS
Error-B	66	.08	
C-Subj	264	.06	
Total	359		

TABLE 3

Summary of the Two-Way Analysis of Variance for the Start Speed Extinction Data

	df	MS	F
Groups (A)	2	2.75	NS
Days (B)	3	9.03	12.61*
AXB	6	1.12	NS
S/A	33	2.46	
BXSub	66	.72	
Total	143		

*p. < .01

TABLE 4

Summary of the Two-Way Analysis of Variance for the Alley Speed Acquisition Trials

	df	MS	F
Groups (A)	2	6.43	NS
Days (B)	1	513.37	38.52*
AXB	2	6.59	NS
S/A	33	13.29	
BxSub	33	13.33	
Total	71		

*p. < .01

TABLE 5

Summary of the Three-Way Analysis of Variance for the Alley Speed Test Trials

	df	MS	F
Groups (A)	2	.09	NS
Stimuli (B)	1	.00	NS
Days (C)	4	.10	NS
AXB	2	.01	NS
AXC	8	.24	NS
BXC	4	.11	NS
AXBXC	8	.11	NS
Error-B	66	.18	
C-Subj	264	.13	
Total	359		

TABLE 6

Summary of the Two-Way Analysis of Variance for the Alley Speed Extinction Data

	df	MS	F
Groups (A)	2	2.70	NS
Days (B)	3	22.67	9.01*
AXB	6	6.41	2.55**
S/A	33	4.71	
BXSub	99	2.52	
Total	143		

*p. < .01

**p. < .05

TABLE 7

Summary of the Two-Way Analysis of Variance for the Total Speed Acquisition Trials

	df	MS	F
Groups (A)	2	70.82	NS
Days (B)	1	4676.69	62.06*
AXB	2	72.96	NS
S/A	33	56.78	
BXSub	33	56.99	
Total	71		

*p. < .01

TABLE 8

Summary of the Three-Way Analysis of Variance for the Total Speed Test Trials

	df	MS	F
Groups (A)	2	.49	NS
Stimuli (B)	1	.12	NS
Days (C)	4	.19	NS
AXB	2	.02	NS
AXC	8	.63	1.98*
BXC	4	.45	NS
AXBXC	8	.54	NS
Error-B	66	.47	
C-Subj	264	.32	
Total	359		

*p. < .05

TABLE 9

Summary of the Two-Way Analysis of Variance for the Total Speed Extinction Data

	df	MS	F
Groups (A)	2	22.32	NS
Days (B)	3	208.76	15.54*
AXB	6	11.28	NS
S/A	33	45.10	
BXSub	99	13.43	
Total	143		

*p. < .01

TABLE 10

The Daily Start Speed Group Means in Seconds

Group	Day 1	2	3*	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	Acquisition									Testing					Extinction			
B+	5.00	6.04	.56	.27	.46	.24	.31	.29	.29	.29	.22	.23	.37	.27	.39	.85	1.09	
B-	7.80	7.68	1.31	.27	.49	.28	.31	.20	.29	.25	.23	.22	.22	.31	.69	1.30	2.18	
B^{+}_{-}	6.65	10.57	1.64	.28	.30	.25	.27	.21	.21	.20	.31	.21	.20	.46	.80	.64	1.28	

* The data for day 3 was incomplete and therefore not reported

Standard Deviations

Group								
B+	3.87	.10	.21	.32	.59	.90		
B-	5.24	.04	.32	1.06	1.33	2.69		
B^{+}_{-}	7.65	.03	.48	.68	.95	.82		

TABLE 11

The Daily Alley Speed Group Means in Seconds

Day / Group	1*	2	3*	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
				Acquisition						Testing					Extinction			
B+		5.5		1.05	.85	.66	.61	.58	.60	.69	.65	.55	.66	.72	.55	.61	1.65	1.62
B-		6.33		1.25	.67	.78	.66	.62	.61	.73	.57	.57	.60	.56	.63	.93	3.00	1.72
B^{+}_{-}		6.72		.83	.66	.65	.60	.64	.58	.63	.54	.86	.58	.63	.65	.90	1.07	3.43

*The data for days 1 and 3 were incomplete and therefore not reported

Group	Standard Deviation																	
B+	3.93				.04							.06	.11	2.18	.79			
B-	5.47				.07							.20	.78	4.59	1.35			
B^{+}_{-}	5.87				.04							.17	.42	.71	2.69			

TABLE 12

The Daily Total Speed Group Means in Seconds

Group	Day 1	2	3*	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
	Acquisition									Testing					Extinction			
B+	14.05	13.37		2.11	1.86	1.20	.95	.95	.93	1.12	1.10	.87	1.00	1.29	.95	1.14	4.21	5.01
B-	22.39	20.94		2.60	1.06	1.25	1.03	1.01	.92	1.11	.93	1.83	.92	.88	1.05	1.90	5.18	8.07
B^{+}_{-}	19.07	20.25		1.37	1.06	1.07	.95	1.05	.88	.95	.80	1.16	.91	.93	1.23	2.02	2.40	6.04

* The data for day 3 was incomplete and therefore not reported.

Standard Deviation

Group																		
B+	6.02						.12								.31	.41	4.24	3.18
B-	10.86						.11								.51	2.32	7.39	11.97
B^{+}_{-}	13.69						.05								.51	1.23	2.78	3.84

TABLE 13

The Start Speed Test Trials Group Means and Standard Deviations Divided into Buzzer-On and Buzzer-Off Categories

Day	10	11	12	13	14
Group					
B+					
Buzzer-On	$.31^{+}_{-}.22$	$.33^{+}_{-}.36$	$.22^{+}_{-}.07$	$.21^{+}_{-}.05$	$.20^{+}_{-}.03$
Buzzer-Off	$.28^{+}_{-}.25$	$.25^{+}_{-}.18$	$.21^{+}_{-}.08$	$.24^{+}_{-}.15$	$.53^{+}_{-}1.15$
B-					
Buzzer-On	$.22^{+}_{-}.12$	$.24^{+}_{-}.12$	$.29^{+}_{-}.27$	$.22^{+}_{-}.08$	$.21^{+}_{-}.08$
Buzzer-Off	$.35^{+}_{-}.36$	$.25^{+}_{-}.15$	$.19^{+}_{-}.04$	$.21^{+}_{-}.05$	$.22^{+}_{-}.05$
B^{+}_{-}					
Buzzer-On	$.20^{+}_{-}.07$	$.21^{+}_{-}.03$	$.28^{+}_{-}.20$	$.21^{+}_{-}.05$	$.21^{+}_{-}.03$
Buzzer-Off	$.21^{+}_{-}.06$	$.20^{+}_{-}.02$	$.34^{+}_{-}.34$	$.21^{+}_{-}.08$	$.20^{+}_{-}.04$

TABLE 14

The Alley Speed Test Trials Group Means and Standard Deviations Divided Into Buzzer-On and Buzzer-Off Categories

Day	10	11	12	13	14
Group					
B+					
Buzzer-On	.76±.52	.73±.63	.54±.05	.70±.59	.54± .06
Buzzer-Off	.62±.11	.56±.04	.55±.04	.62±.24	.91±1.16
B-					
Buzzer-On	.76±.55	.55±.04	.56±.12	.54±.05	.54± .05
Buzzer-Off	.67±.22	.58±.06	.57±.06	.64±.19	.58± .05
B±					
Buzzer-On	.66±.40	.53±.04	.83±.54	.59±.25	.66± .40
Buzzer-Off	.59±.06	.55±.04	.89±.81	.56±.05	.59± .15

TABLE 15

The Total Speed Test Trial Group Means and Standard Deviations Divided Into Buzzer-On and Buzzer-Off Categories

Day	10	11	12	13	14
Group					
B+					
Buzzer-On	$1.23^{+}_{-}.67$	$1.28^{+}_{-}1.28$	$.87^{+}_{-}.10$	$1.02^{+}_{-}.61$	$.84^{+}_{-}.09$
Buzzer-Off	$1.01^{+}_{-}.28$	$.92^{+}_{-}.21$	$.87^{+}_{-}.12$	$.97^{+}_{-}.40$	$1.73^{+}_{-}2.17$
B-					
Buzzer-On	$1.08^{+}_{-}.57$	$.90^{+}_{-}.12$	$.95^{+}_{-}.43$	$.86^{+}_{-}.14$	$.85^{+}_{-}.13$
Buzzer-Off	$1.14^{+}_{-}.52$	$.96^{+}_{-}.22$	$.90^{+}_{-}.15$	$.97^{+}_{-}.24$	$.91^{+}_{-}.10$
B^{+}_{-}					
Buzzer-On	$.97^{+}_{-}.39$	$.83^{+}_{-}.05$	$1.16^{+}_{-}.60$	$.94^{+}_{-}.45$	$.96^{+}_{-}.44$
Buzzer-Off	$.92^{+}_{-}.12$	$.83^{+}_{-}.06$	$1.37^{+}_{-}1.04$	$.88^{+}_{-}.22$	$.89^{+}_{-}.20$

APPENDIX 111

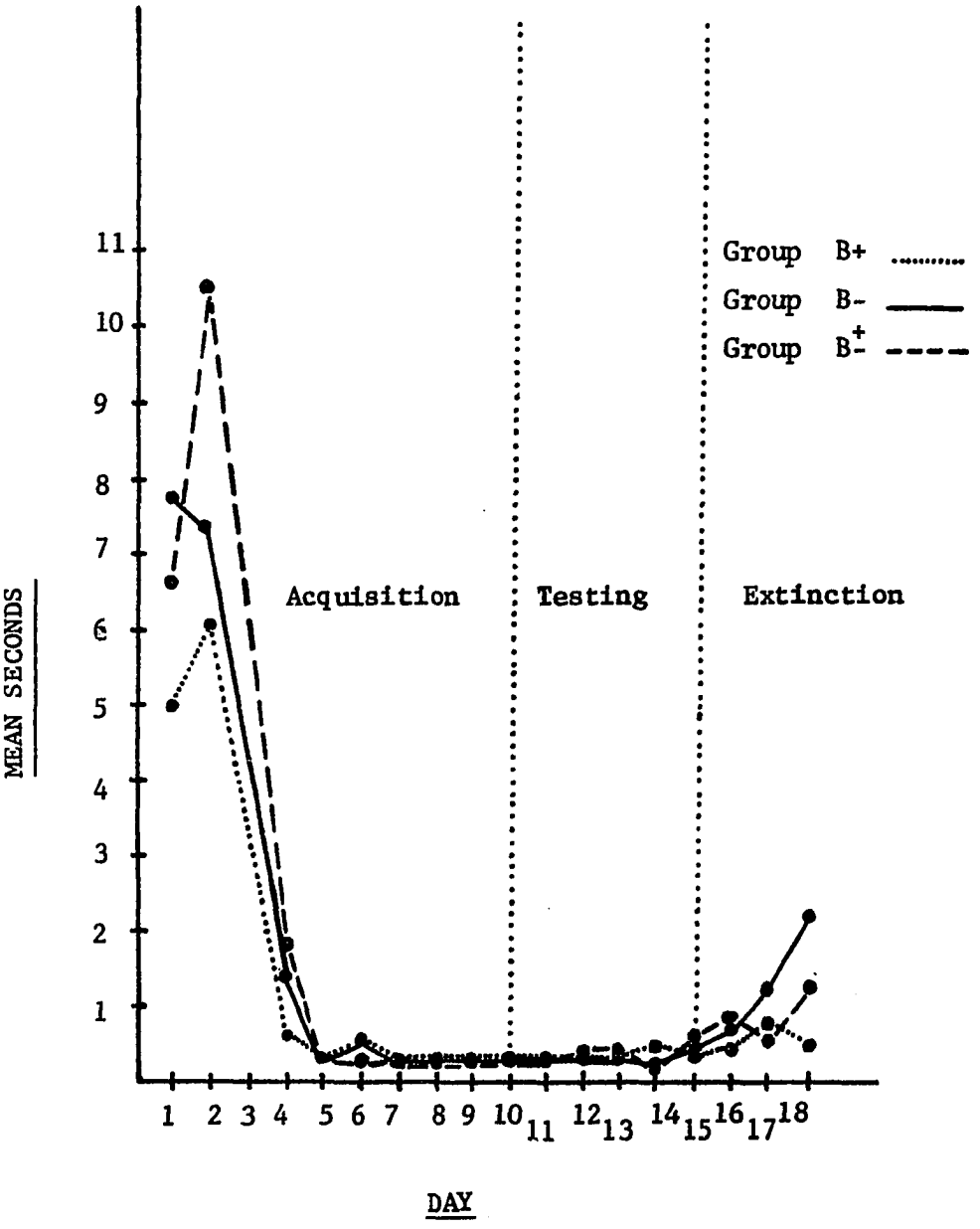

Fig. 1. Graph of the daily start speed group means for the two experimental (Group B+ and B-) and the control (Group B±) group.

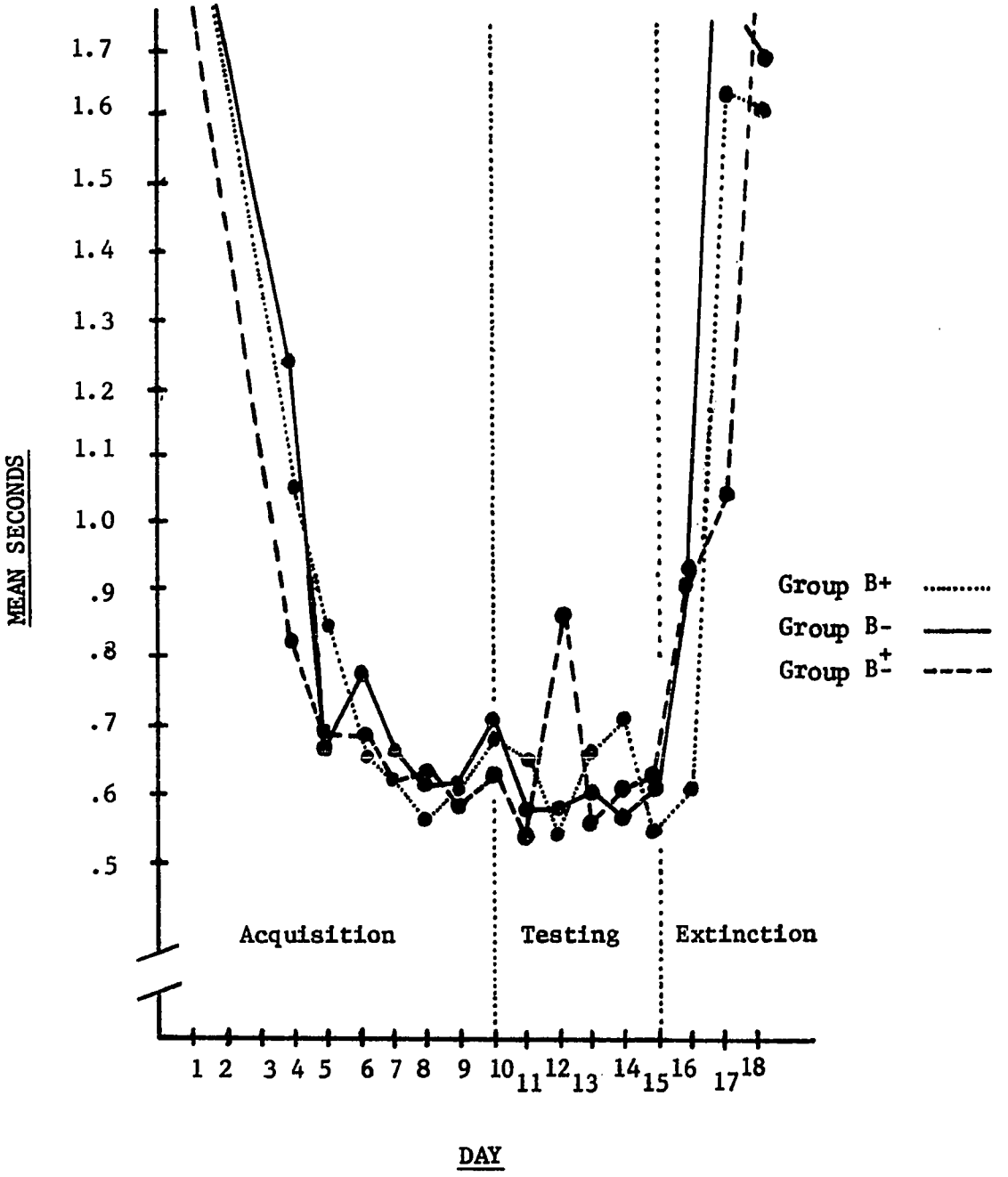

Fig. 2. Graph of the daily alley speed group means for the two experimental (Group B+ and B-) and the control (Group $B^{\pm}$) group.

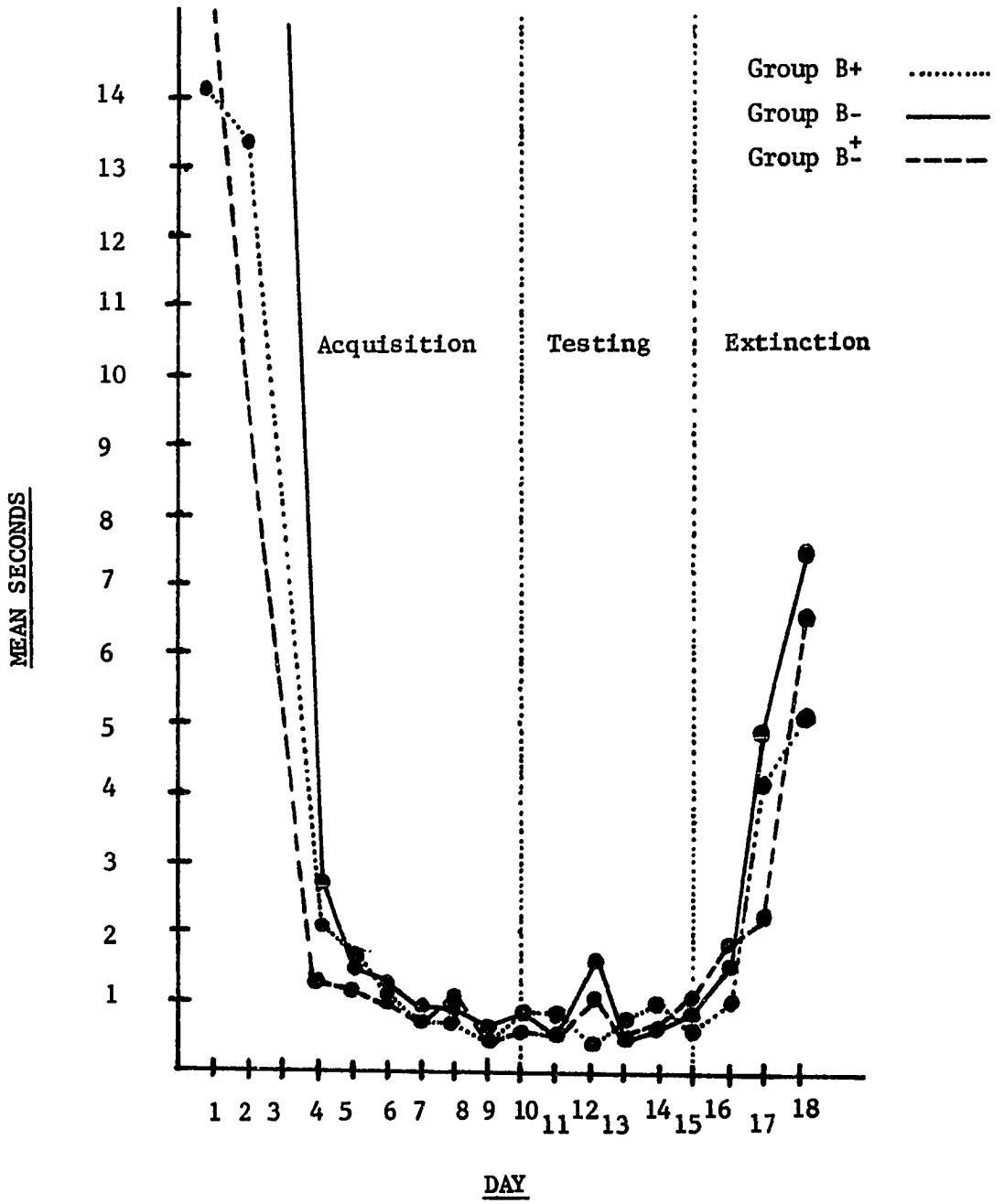

Fig. 3. Graph of the daily total speed means for the two experimental (Group B+ and B-) and the control (Group B+-) group.

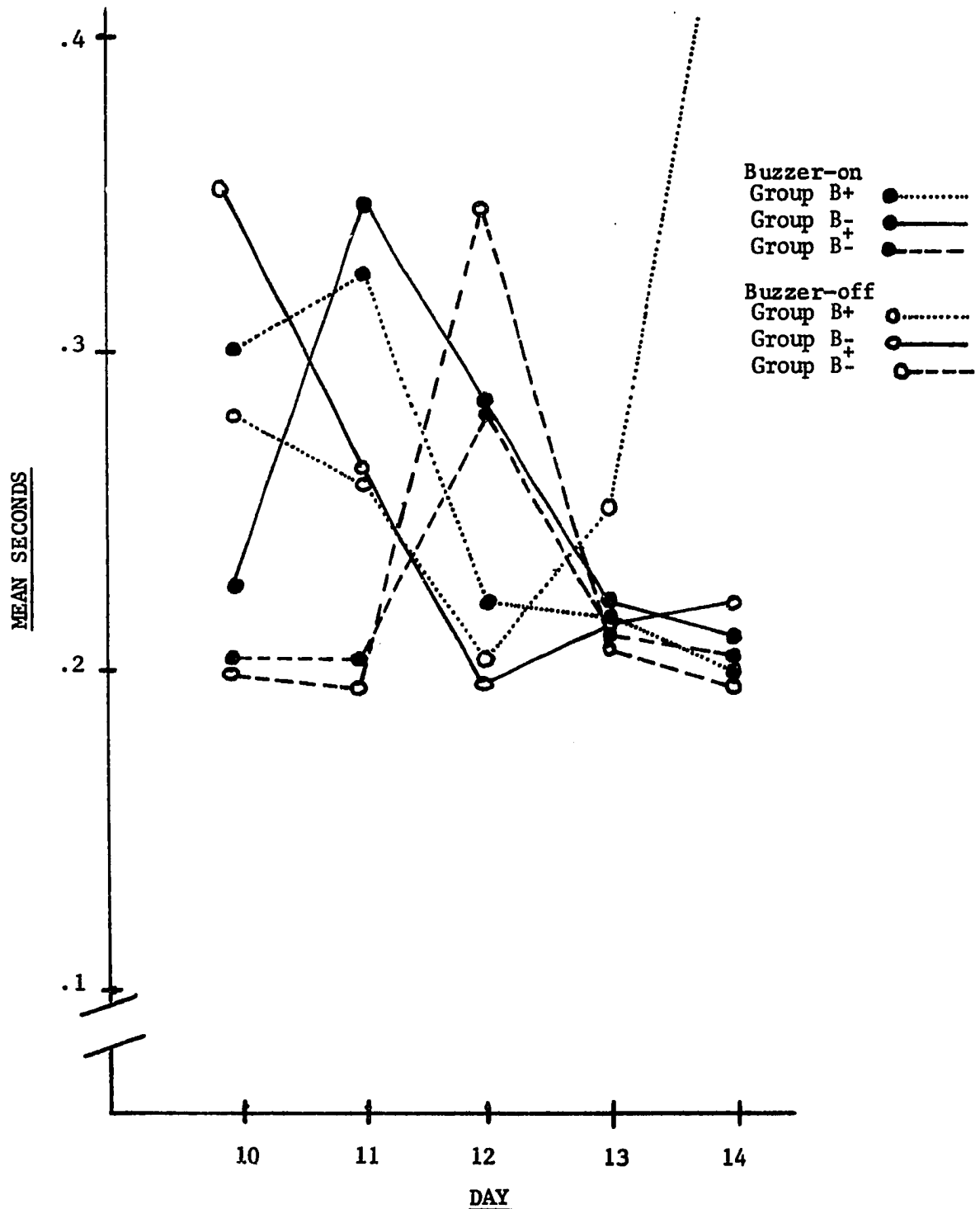

Fig. 4. Graph of the start speed test data divided into buzzer-on and buzzer-off groups.

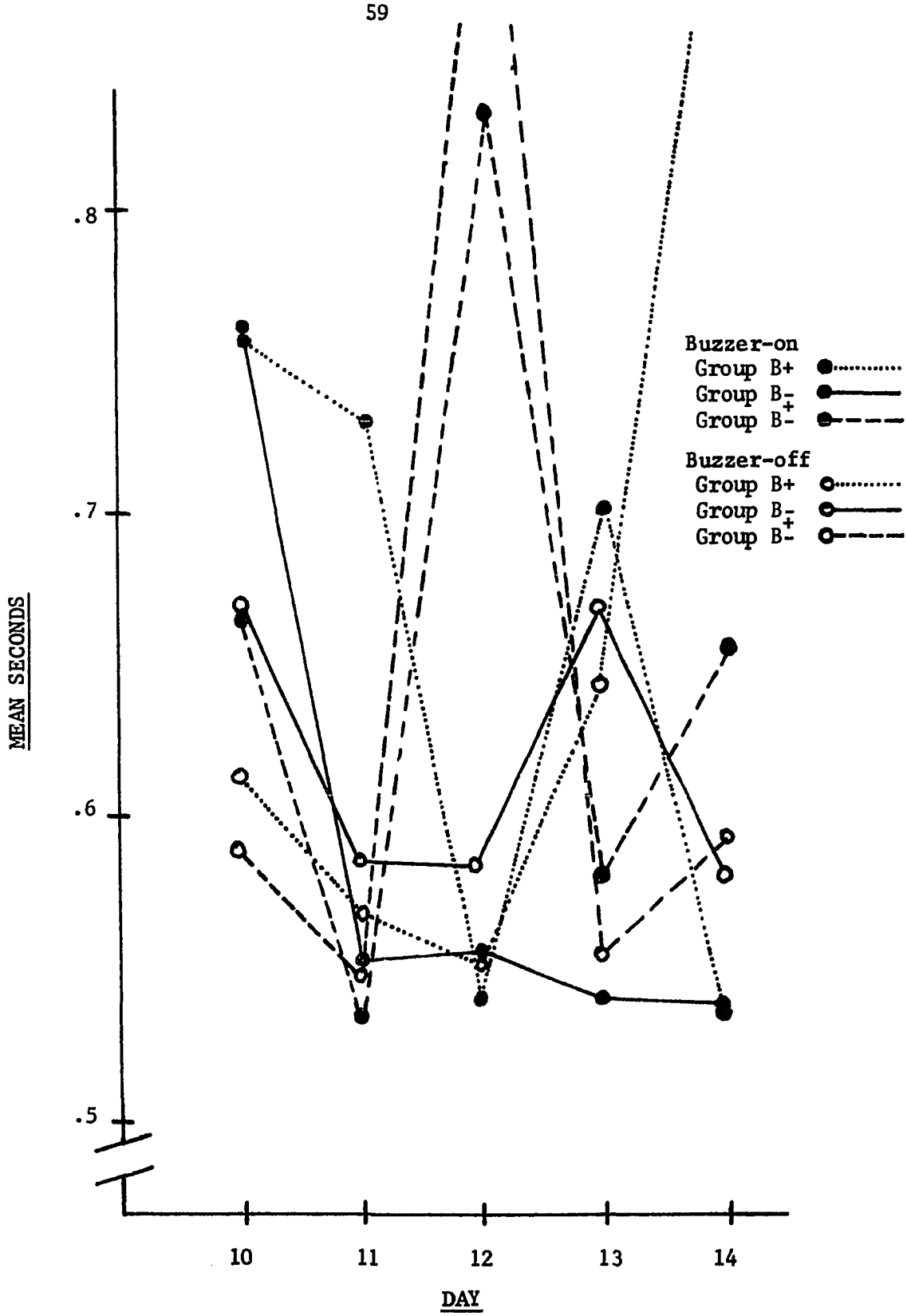

Fig. 5. Graph of the alley speed test data divided into buzzer-on and buzzer-off groups.

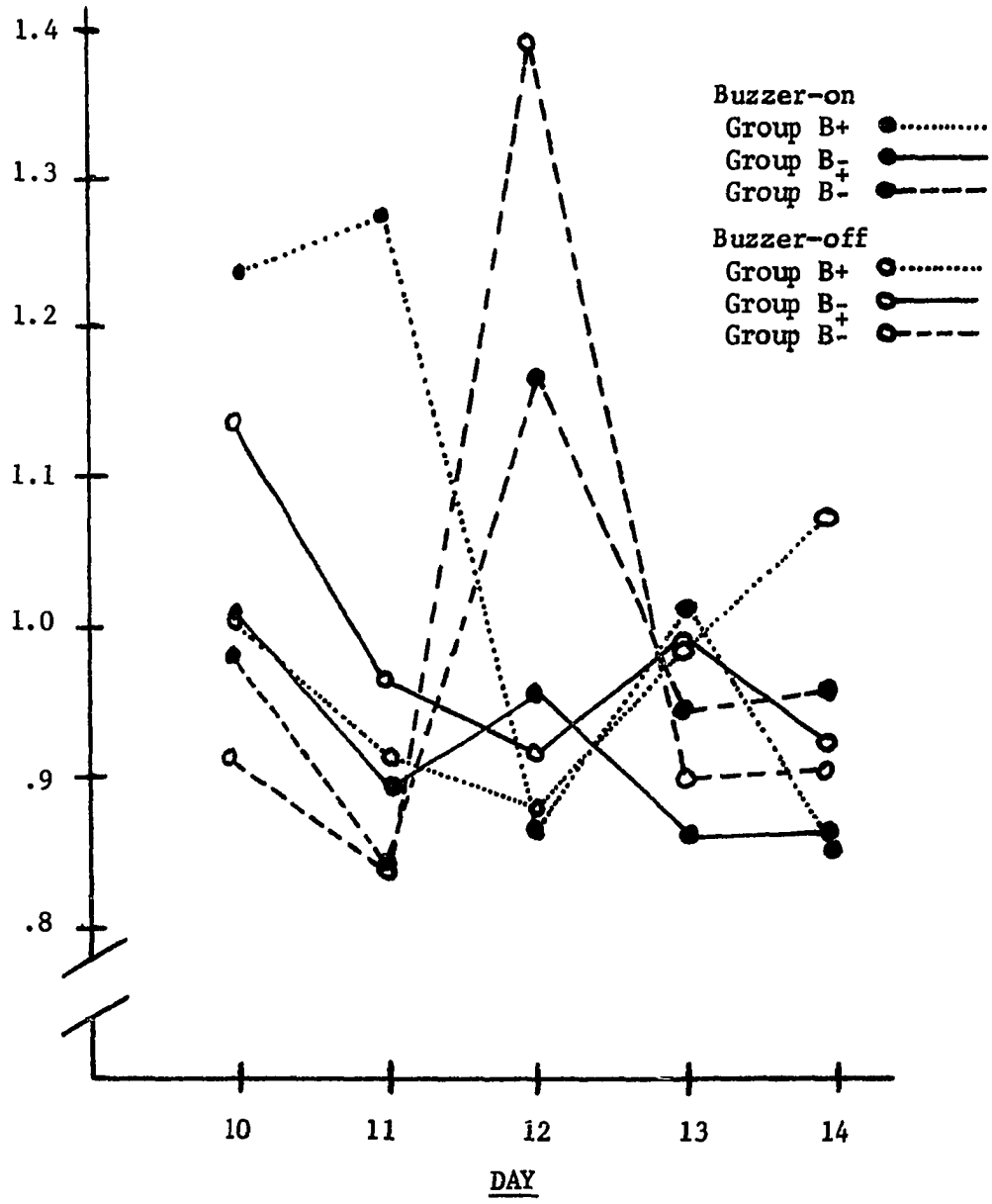

Fig. 6. Graph of the total speed test data divided into buzzer-on and buzzer-off groups.