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An Analysis of Avoidance Behavior

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AN ANALYSIS
OF AVOIDANCE BEHAVIOR

A Thesis

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The College of William and Mary in Virginia

In Partial Fulfillment

Of the Requirements for the Degree of

Master of Arts

By

Judith Ann Nichols

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APPROVAL SHEET

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the requirements of the degree of

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ABSTRACT

There are several possibilities as to what an animal may learn in the typical avoidance situation: it may learn a non-discriminatory running response; it may learn to run *away* from a fear stimulus; or it may learn to run *toward* a safety stimulus. The present study was designed to separate and compare these possibilities.

Fifty-three white rats were given avoidance training in distinctive grid and safe boxes to a criterion of 10 consecutive successful avoidances. Immediately upon reaching criterion, *Ss* were assigned to one of 9 test conditions. These consisted of starting the *Ss* in either a grid (G), neutral (N), or safe (S) box, and allowing them to run *to* either a grid, neutral, or safe box. The test procedure was identical to the training procedure, except that no shock was administered. Ten test trials were given immediately following training, and an additional ten trials were given 24 hours later.

Two predictions were made. In line with several current fear-conditioning hypotheses (Miller, 1948; Mowrer, 1960) and with "hope" and "relaxation-approach" hypotheses (Mowrer, 1960; Denny and Adelman, 1955) it was predicted that approach and avoidance cues would both contribute to the animals' test behavior, as evidenced by short latencies in Groups GN and NS. Response elements were expected to contribute minimally in the present situation. In addition, it was hypothesized that classical conditioning is fundamental to avoidance behavior (Miller, 1948; Mowrer, 1960), with the result that subjects in Groups SG and SN would be able to translate active avoidance into passive avoidance.

The present results provide evidence for an active-passive translation when external stimulus cues are radically reversed. In addition, simple running tendencies were indicated; apparently a directional cue is necessary to elicit this behavior. While there was support for the view that fear-producing avoidance cues are sufficient for avoidance behavior, there was no clear evidence for approach elements in this situation. It was suggested that a longer safe box confinement period may be necessary to demonstrate approach behavior, and that further investigations should control for directional responding.

AN ANALYSIS OF AVOIDANCE BEHAVIOR

INTRODUCTION

Woodworth and Schlosberg (1954) have suggested that there is considerable ambiguity concerning what a subject learns in the typical "avoidance" situation. More recently, Lambert and Gorfein (1958) have characterized the problem in the following manner. Consider a shuttle-box situation, where an animal is conditioned to cross a hurdle from a white shock box to a black non-shock box. The two most obvious possibilities as to what is learned in this kind of situation are: A, that the animal may learn a non-discriminatory crossing the hurdle response; and B, that it may learn a stimulus discrimination. Under possibility B, the animal may either: B1, learn to run <u>away</u> from a particular (white) stimulus or B2, learn to run <u>toward</u> a particular (black) stimulus. Possibilities A and B1 may be considered avoidance acts, but possibility B2 is an approach act. There have been few direct attempts to separate these possibilities experimentally, and few theoretical explanations of avoidance which recognize all three.

<u>Response vs. discrimination</u>. The familiar "place vs. response" controversy was an attempt to deal with possibilities A and B in general terms; most of the experimentation involved positive reinforcers. In one well-known study (Tolman, Ritchie, and Kalish, 1946) hungry rats were placed in an elevated X-maze and required to learn either a particular response or a particular location in order to obtain food reward.

The performance of the latter group was superior - results apparently embarrassing to "response" theorists (e.g. Hull, 1943). Later experiments comparing rates of response vs. place learning, or presenting subjects with a choice of cues, have produced a variety of results - place cues dominating, response cues dominating, or no difference between the two.

A more recent article by Restle (1957) suggests a compromise between "place" theorists and "response" theorists. Restle argues convincingly that there is nothing in the nature of a rat which makes it a "place" learner or a "response" learner. A rat in a learning situation will use all relevant cues. The importance of any particular class of cues depends upon the amount of relevant stimulation as well as the sensory capacities of the animal; the rate of learning depends directly on the proportion of relevant usable cues in the total set available. Restle's point, however, is better made if we say that an animal will use <u>any</u> rather than <u>all</u> relevant cues. That is, both the complexity and distinctiveness of the stimulus situation and the animal's attention may determine which and how many cues direct learning. Physiological data (cf. Morgan, 1965) has supported this notion by demonstrating that systematic removal of sensory and kinesthetic feed-back may differentially impair, but ordinarily does not destroy, an animal's learning ability.

This general argument can be applied to the avoidance situation. For example, in a one-way shuttlebox, where stimulus and response cues are both relevant, animals may rely on either or both kinds of cues, the external stimulus cues becoming more important as they are made more numerous. The two-way shuttlebox requires primarily attention to response cues; learning may be less efficient in this situation because cues are few and conflicting. Several theorists dealing specifically with avoidance, however, tend to emphasize external stimuli in avoidance; e.g. Mowrer (1960) hypothesizes that avoidance is directed by fear of place cues; Denny and Adelman (1955) hypothesize approach to place cues. Tolman (cf. Lambert and Gorfein, 1958) has suggested that either place or response learning may be obtained in avoidance, depending upon the experimental conditions.

Approach vs. avoidance. The prevailing view of avoidance (Miller, 1948; Mowrer, 1960; Solomon, 1964) has been that the behavior is mediated by classically conditioned fear to cues in the shock box; fear reduction serves as reinforcement. Hence avoidance is, for these theorists, just what the name implies - a "running away" response, mediated by emotional conditioning. Numerous experiments have been designed to illustrate classically conditioned fear as a motivator and fear reduction as reinforcement (e.g. Mowrer and Lamoreaux, 1946; Miller, 1948; Solomon and Wynne, 1954). Investigators have looked at avoidance performance as determined by such variables as number of acquisition and extinction trials (Kalish, 1954); CS-UCS interval (Low and Low, 1962); shock level (Levine, 1966); and delay of secondary reward (Kamin, 1957). The assumption underlying most of these studies is that the variables affect performance through their influence on the fear response to "danger" cues.

There are, however, concepts within general reinforcement theory which might also imply an approach element to avoidance. One of these is secondary reinforcement. The general statement is that any previously neutral stimulus consistently associated with either onset of positive reinforcement, or offset of negative reinforcement, acquires the properties of a primary reinforcer - i.e., acquires the ability to reinforce and to elicit behavior (e.g. Hull, 1943). Though the phenomenon of secondary reinforcement has been fairly well-established using positive reinforcers, the reinforcing and cue functions of a secondary reinforcer have been difficult to separate (myers, 1958). Beck (1956) reviews fourteen studies attempting to demonstrate the secondary reinforcing powers of a stimulus associated with shock termination; among these the author concludes only one or two studies were clearly supportive. However, the rest failed either because they did not provide conditions necessary for demonstrating secondary reinforcement (e.g. the secondary reinforcer had not been established as a cue in training, a procedure apparently necessary for good results) or were confounded by other variables (e.g. the secondary reinforcer was eliciting already-learned responses rather than rewarding new ones).

The eliciting function of a primary or secondary reinforcer is of particular interest here. Elicitation may be defined as the capacity of a stimulus to evoke or otherwise exert discriminative control over a response. The reinforcing property of a stimulus refers to its capacity to be effective in fixating or prolonging responding in some manner (Beck, 1956). The empirical difference between the two functions may be chiefly temporal, one operating before a response and the other after it. Some theorists have given primary importance to the eliciting function of a reinforcer, thereby emphasizing drive-induction rather than drive-reduction. For example, Spence (1958) uses degree of incentive as a motivational determiner of anticipatory responses toward a goal (the r_g-s_g mechanism), and Sheffield (cf. Seward, 1956) emphasizes the energizing function of consumatory responses which become anticipatory. Mowrer (1960) has within his theoretical framework concepts of "hope" and "relief", emotional responses classically conditioned to stimuli associated with onset of positive reinforcement or offset of negative reinforcement. These mediate approach behavior; they are not directly applied to avoidance. From such hypotheses, however, one might predict that an animal enters a non-shock box as much out of anticipatory "hope" or "relief", as it does out of "fear".

Recently, Denny and his co-workers (Denny and Adelman, 1955) have formulated an "elicitation" theory of learning. Their argument is, like Mowrer's, that all learning is fundamentally classical conditioning; however, offset of a primary reinforcer will elicit responses antagonistic to those elicited by onset of the same reinforcer. Thus food reward leads to approach; nonreward leads to extinction or avoidant-type responses. Shock presentation (and associated stimuli) elicits fear and avoidance; shock offset (and associated stimuli) elicits relaxation and approach. The authors go on to posit relaxation and approach as fundamental to "avoidance" behavior. Barlow (1956) has argued along similar lines, presenting evidence from classical conditioning experiments to support his conclusions.

There is one final aspect to both the response-discrimination and approach-avoidance questions. Most of the theorists cited above have hypothesized that classical conditioning (of either "fear" or "relaxation") is the key to avoidance. Mowrer (1960), for example, suggests that the instrumental avoidance response itself is merely an appropriate means of dealing with the classically-conditioned fear. It follows that the instrumental response should be modifiable, according to the requirements of the situation. Specifically, an animal should be able to passively avoid a shock box as well as actively avoid it, depending upon whether he is placed initially in the shock box or non-shock box. There appears to be no direct test of this hypothesis in the literature.

<u>Experimental analyses of "avoidance" behavior</u>. There is indirect evidence that something other than, or in addition to, pure avoidance discrimination might be operating in a shuttle-box or jump-out box situation. It has been demonstrated that performance of subjects required to jump toward a "danger" CS is poorer than that of subjects required to jump away from it (McAdam, 1964); and that reversal learning of an avoidance response is facilitated by either pre-reversal fear conditioning to the new start box or pre-reversal fear extinction to the new goal box (Baum, 1965). Two studies (Bolles and Popp, 1964; Bower, Starr, and Lazarovitz, 1965) have shown that the greater the change in the CS following the avoidance response, the better the performance. The latter study also demonstrated that onset of a "safety" CS after the response was as effective in facilitating performance as offset of a "danger" CS.

The striking effectiveness of the "jump-out" box first utilized in the avoidance situation by Maatsch (1958) may be due, likewise, to the discriminability of shock and safe regions. Maatsch obtained avoidance responses which were highly resistant to extinction after a single shock trial.

Four studies utilized a T-maze in order to determine secondary reward properties of stimuli associated with shock-termination. Smith and Buchanan (1954) trained one group of rats to run across an electrified grid for food in a black goal box and across a sponge runway for food in a white goal box; a second group had these colors reversed. Thus the first group experienced both shock-termination and hunger-reduction in a black box, while the second experienced only hunger-reduction in the black box, receiving no shock prior to entrance. Later in a T-maze black-white discrimination task with black positive, animals who had experienced reduction of both hunger and pain in the black box made fewer errors (presumably because of approach tendencies to "safe" cues). In a later study with the same basic design (Buchanan, 1958), it was concluded that fear-motivation was as efficient in contributing to approach tendencies in the T-maze as escape from shock, that changes in drive conditions of hunger and fear between training and testing did not appreciably affect performance, and that shock-reduction and hunger-reduction were approximately equal in their effects on the approach response. However, it is difficult to ascertain the interaction effects of hunger and fear in these studies.

In two T-maze investigations (Goodson and Brownstein, 1955; Nefzger, 1957) there were no such complications from hunger drives. Animals were first trained to escape from shock by running to a nonshock escape chamber, and then were placed in a T-maze for preference tests. Goodson and Brownstein found that the escape chamber was preferred to either the shock compartment or a neutral compartment; Nefzger, on the other hand, found no significant preferences. The conflicting results may be due to attentional factors: in the latter study animals traversed a long runway and maze arms before entering the goal box; in the former, animals were placed immediately between the two end boxes in a chamber designed so that each half duplicated the cues in the adjoining end box.

Several studies have recently been carried out to test the "relaxation-approach" hypothesis (Denny and Adelman, 1955). Denny, Koons, and Mason (1959) found that similarity of shock and escape areas facilitated extinction of an avoidance response, as predicted by the theory, but made no difference in acquisition. Later Knapp (1965), using a slightly different apparatus, demonstrated that similar boxes retard learning relative to dissimilar boxes, and that dissimilar boxes retard extinction relative to similar boxes, both results supporting the theory. Denny and Weisman (1964) report two experiments where increasing the time spent in the "safe" region of a jump-out box led to faster learning when the boxes were dissimilar and faster extinction when they were similar. In a third experiment rats were provided with a two-choice situation, and learned to select the side associated with a longer nonshock confinement period (there were controls for differences in ITI). Zerbolio (1965) trained animals in a shuttlebox situation, confining them in the "safe" box for 30 seconds ("not long enough to relax") or for 150 seconds ("long enough to relax"). A third group was confined for 30 seconds and then spent 120 seconds on a neutral open platform (controlling for ITI differences). The animals were then reversed. Provided there was no buzzer CS to mask color cues, the 150 second group learned OL faster and reversed slower than the other two groups. While these demonstrations provide indirect support, none is clearly an independent test of the "relaxation-approach" hypotheses. Of all the data cited above, only one study (Goodson and Brownstein, 1955) clearly separates approach from avoidance.

Lambert and Gorfein (1958) provided a transfer situation in order to disentangle response-learning from discrimination-learning, and approach from avoidance, in the shuttlebox situation. Animals were first conditioned to cross a hurdle from a grey shock box to, for example, a white non-shock box. After training, the animals were tested in two transfer situations: first, all animals were run from grey to black boxes; and secondly, those animals who transferred in the first situation were run from grey to grey. The experimenters assumed that animals who have learned an approach act (to white cues) would show no transfer; animals who have learned an avoidance act (from grey cues) would transfer only in the first test situation; and that animals who have learned only a running response would transfer in both situations. Of the 63 animals tested, 28 showed no transfer, 13 showed transfer in the first situation only, and 22 showed complete transfer. The presence of a buzzer in the training session and, apparently, in the transfer tests, however, may have confounded these results; that is, the experimenters may have been simply measuring the animals' responsiveness to the buzzer. Further, it is misleading to conclude that animals who transferred in both situations were pure "response" learners (they may have learned both an avoidance discrimination and a response); or to assume that animals who did not transfer in the first situation would likewise not transfer in the second situation.

In summary, there are theoretical positions which predict something operating in avoidance other than or in addition to avoidance, and data which at least indirectly supports the "approach" view. The present study was designed to answer more specifically the question of what is learned in a typical avoidance situation. An attempt was made to separate and compare possible components to the total avoidance behavior by requiring groups of subjects to depend upon particular sets of stimulus cues after all had received avoidance training in distinctive start and goal boxes. There were two underlying hypotheses. It was hypothesized that classical conditioning should be of primary importance in an avoidance situation where distinctive external cues are provided during training. If this hypothesis is true, subjects should be able to "translate" the instrumental response of active avoidance into passive avoidance when the stimulus situation requires it. A second hypothesis was that approach and avoidance elements should both contribute to the total avoidance behavior, and that response elements should be minimal. Specifically, it was predicted that subjects in the approach and avoidance groups would each produce quick latencies relative to passive groups when tested. The response group was expected to produce latencies significantly slower than those of approach and avoidance subjects.

METHOD

Subjects. The Ss were 53 experimentally naive, male albino rats of approximately the same age and weight. Ss were assigned randomly to 9 groups. Food and water were available ad lib in the home cages throughout the experiment.

Apparatus. The apparatus consisted of a start box and goal box in both training and testing sessions. Six interchangeable boxes of equal size were constructed; dimensions were approximately 8 inches long by 8 inches wide by 6 inches high. Two of these were painted black, two were painted white, and two left unpainted. The black and white boxes contained grid floors; the unpainted boxes had wood floors. The black and white boxes served as both "shock" boxes and "safe" boxes, sponge rubber covering the grids in the latter condition. The unpainted boxes served as neutral chambers.

Vertical sliding doors set in a wooden frame separated start and goal boxes. The floor of the frame measured approximately 2 inches and consisted of 3 uncharged grid bars. The doors were painted to match the boxes they separated. The entire apparatus was covered with wire mesh attached to hinged wooden frames.

Ss were retained in standard wire mesh waiting cages during intertrial intervals.

A Gra Lab microtimer measuring tenths of seconds was used to record running speeds. A fan provided masking noise.

Procedure: training. Subjects were tamed by daily handling for one week before experimentation began. On the last day of handling, each S was introduced to its respective train and test apparatus, and allowed a few minutes free exploration. No shock was administered. In order to determine initial preferences, an informal recording was made of the amount of time subjects spent in each box. There were initial preferences for grid boxes when these were paired with safe boxes; no other consistent preferences were found.

All Ss received identical training. Each was placed in a grid start box, with the door closed, for 15 seconds; at the end of this period, the door was opened. On Trial 1, a continuous shock of .6 ma was administered in the start box as the door was raised; on all succeeding trials, there was a 5-second interval between door-raising and shock onset. The animal could avoid the shock completely, therefore, by running from start to goal within 5 seconds. After entering the safe box S was retained there 15 seconds before being removed from the apparatus. As a control for possible color preferences, half the Ss ran from a black grid box to a white box with sponge rubber floor; half ran from a white grid box to black box with sponge rubber floor.

The initial opening of the door, therefore, provided a CS for the Ss to make an avoidance response. It was recognized that this procedure might cause some animals to respond merely to the opening of the door. However, the use of the door permitted E to equalize amount of time spent in start and goal boxes, facilitating later comparisons of approach and avoidance learning. It was expected that the presence of distinctive wall and floor stimuli would override the door CS; in any case, several groups were designed to assess the importance of the latter cue.

_S_s were run alternately in groups of 2 or 3 to a training criterion of 10 consecutive successful avoidances. Approximately 12 animals did not reach criterion after 35 training trials; these were discarded. This procedure reduced one group of _S_s to an _n_ of 5 rather than 6. (Group SN.) When one _S_ completed 10 avoidances ahead of other _S_s run at the same time, he was retained in the waiting cage until all were ready for testing. The interval between training and testing was not allowed to exceed 30 minutes, and usually averaged 10 minutes.

Procedure: testing. Upon reaching criterion, _S_s were placed in either a grid (G), neutral (N), or safe (S) box, and allowed to run _to_ either a grid, neutral, or safe box. These combinations produced 9 test conditions presented to 9 separate groups of animals (GG, GN, GS, NG, NN, NS, SG, SN, SS). Two groups (SG,SN) were run in a direction opposite to that required during training; the rest were run in the same direction (from _E_'s left to right). Half the animals in each group had been trained to run from black to white cues, the other half trained to run from white to black.

Ten test trials were given immediately following training and an additional 10 administered 24 hours later. The testing procedure was identical to that employed during training, except that no shock was administered. If an _S_ did not respond within 60 seconds, it was removed from the apparatus and a 60-second latency was recorded.

Of the many comparisons possible with this experimental design, the following were considered to be most important to the fundamental hypotheses. Groups of subjects started in grid boxes, as compared with _S_s started in safe boxes, were expected to reflect, respectively, active and passive avoidance behavior. The NS, GN, NN, and GS conditions were designed to permit comparisons of approach, avoidance, and response elements, respectively, with the total avoidance response.

RESULTS

General comparisons. Test trial latencies were recorded for each subject from the moment the door was raised until the animal placed all four feet in the goal box. Mean and median latencies for each of the nine groups of subjects over the entire 20 test trials are presented in Table I. The analysis (Winer, 1962) of mean latencies examined three sources of variance and their interactions: 1) start box: grid, neutral, or safe 2) goal box: grid, neutral, or safe and 3) replications: Day 1 versus Day 2 of testing, with 10 trials presented each day. The results are summarized in Table II. The start boxes proved to be the only significant source of variance, f(2,45) = 6.18, $p < .01$; eta = .45. Subjects started in grid boxes produced the shortest latencies, while Ss started in safe boxes produced long latencies and neutral start Ss had latencies between these two. None of the interactions were significant.

The Hartley test (Winer, 1962) indicated homogeneity of variances, $f_{max}(18,5) = 17.2$. However, the discrepancy between overall mean and median latencies and the "ceiling" effect produced by the 60-seconds cutoff point suggested that the data was more suitable for nonparametric analysis. A Wilson distribution-free test of analysis of variance (Wilson, 1956) was therefore performed on the overall median latencies. Both start and goal box effects reached significance ($p < .01$ and $p < .02$, respectively),

TABLE I

MEAN AND MEDIAN LATENCIES FOR 20 TEST TRIALS

			GOAL BOX		
			GRID	NEUTRAL	SAFE
START BOX	GRID	MEAN	29.6	14.9	11.4
		MEDIAN	24.2	4.2	4.3
	NEUTRAL	MEAN	27.9	24.3	22.5
		MEDIAN	20.1	9.7	9.0
	SAFE	MEAN	39.8	51.9	28.0
		MEDIAN	60.0	60.0	15.0

TABLE II

ANALYSIS OF VARIANCE OF MEAN LATENCIES

SOURCE	SS	df	MS	F	p
Between subjects	25,260.5	53			
A (Start box)	6442.3	2	3221.2	6.18	.01
B (Goal box)	2459.5	2	1229.8	2.36	
AB	1618.4	4	404.6		
Subjects w. groups (error between)	23,468.3	45	521.5		
Within subjects	81,600.4	54			
C (Blocks)	408.6	1	408.6		
AC	190.2	2	95.1		
BC	223.6	2	111.8		
ABC	76.3	4	19.1		
C x subj. w. groups (error within	81,447.3	45	1809.9		

but again no significant interaction was found between start and goal box variables.

The number of "avoidance" responses made during the 20-trial test session was considered, in addition to the latency measure, as an indicant of the strength of the tendency to respond in each of the nine groups of subjects. An "avoidance" response was defined as any latency reaching the training criterion of 5.0 seconds or less. Table III presents the median number of such responses made by each group of subjects. Analysis with the Wilson revealed the start box to be the only significant source of variance ($p < .01$) for this measure.

Overall median latencies and total number of avoidances are each plotted as a function of start and goal box in Figure I, with the start box serving as the parameter. One of the most striking features to be noted in both graphs is the spread between safe start box and grid start box subjects, the former producing much longer latencies and fewer avoidances than the latter. For purposes of statistical analysis, latency data from the three safe start box groups and from the three grid start box groups were combined respectively to form safe <u>versus</u> grid groups and compared by means of the Kruskall-Wallis analysis of variance by ranks (Siegel, 1956). The difference between the two groups so combined was found to be highly significant ($H = 15.7$; $p < .001$). Similarly combined neutral and grid start box groups did not differ significantly on either measure.

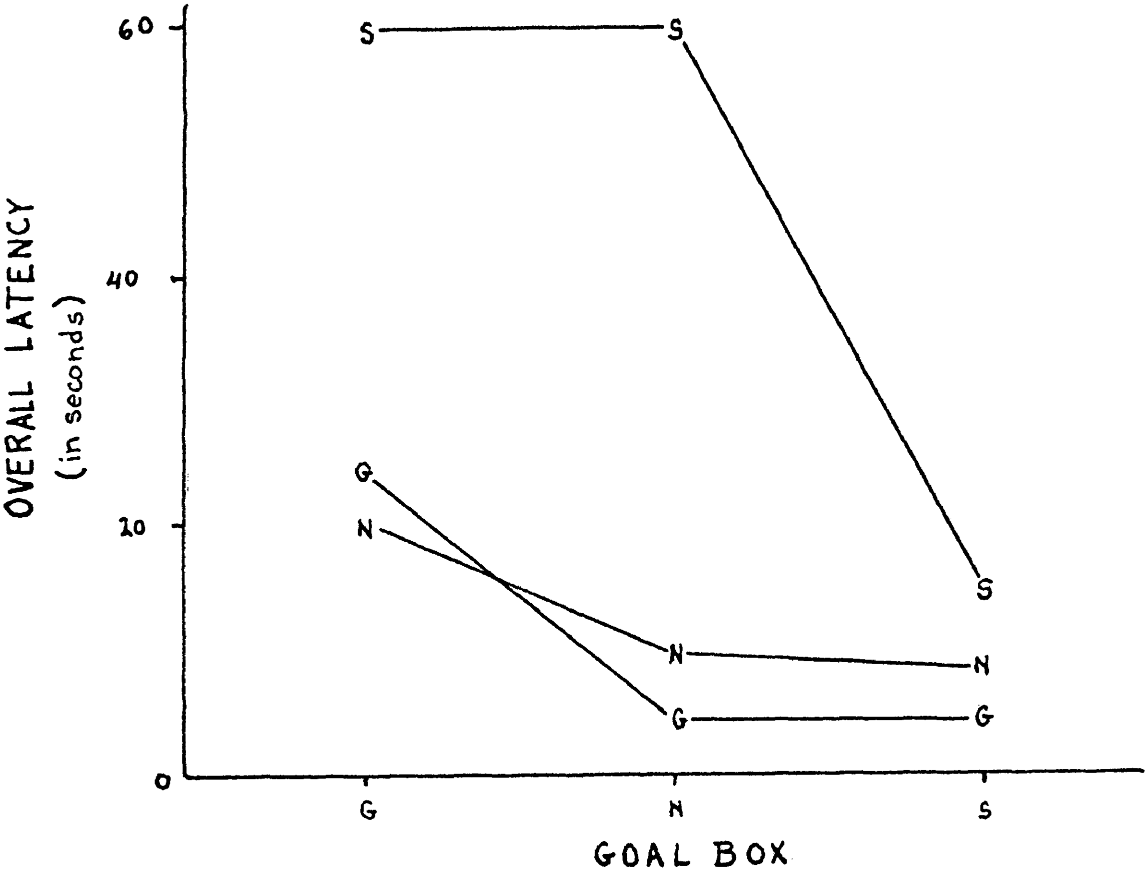
Individual row and column effects were examined further by means of several Kruskall-Wallis tests. Because Day 2 data were complicated by spontaneous recovery and differential extinction effects, and because Day I

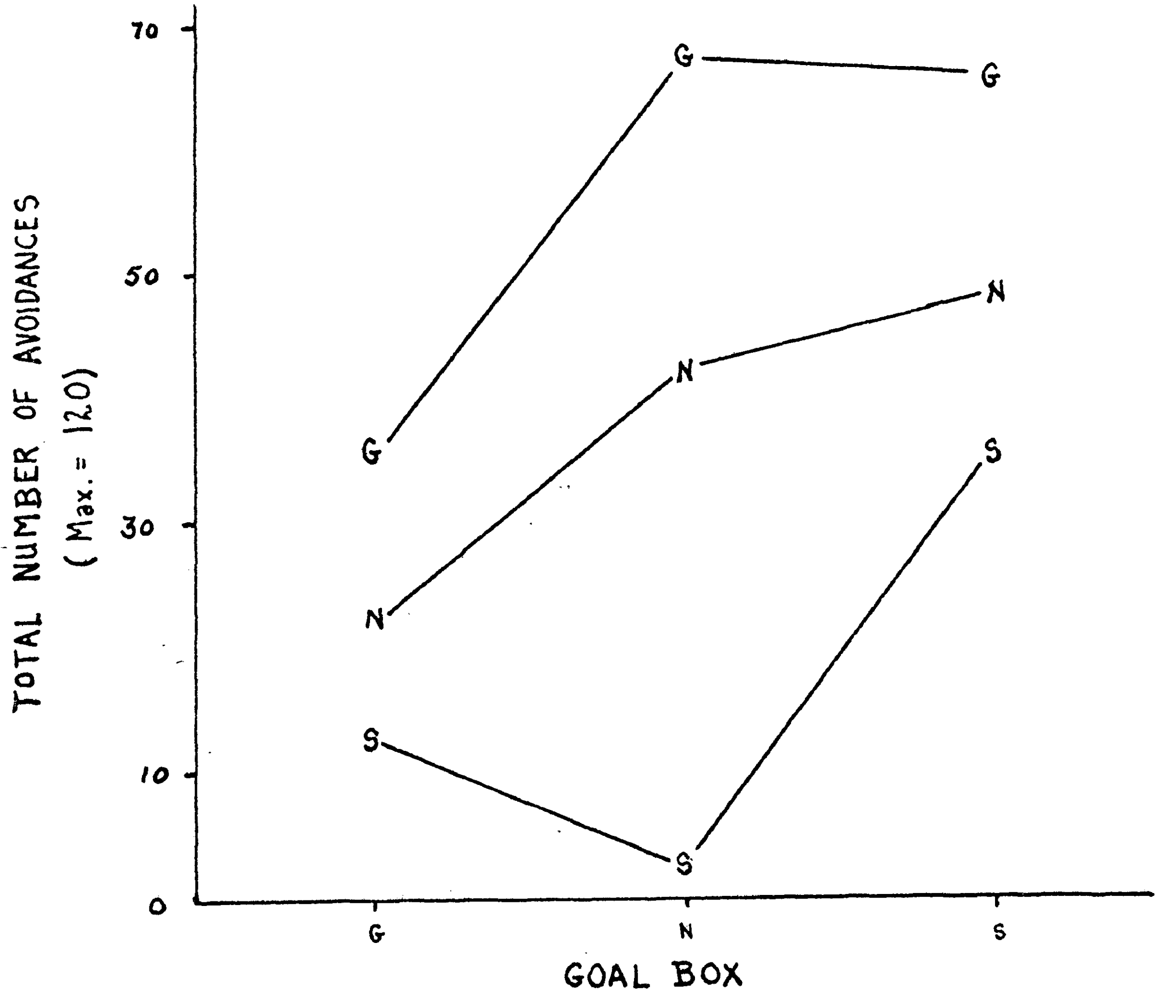
TABLE III

MEDIAN NUMBER OF AVOIDANCES OVER 20 TEST TRIALS

		GOAL BOX		
		GRID	NEUTRAL	SAFE
START BOX	GRID	3.5	13.5	10.0
	NEUTRAL	4.0	6.0	6.0
	SAFE	1.5	0.0	4.5

Figure 1. Overall median latencies and total number of avoidances each plotted as a function of start and goal box. The parameter is the start box.


OVERALL LATENCY
(in seconds)
60
40
20
0
S
S
S
G
N
N
N
G
G
G
N
S
GOAL BOX


TOTAL NUMBER OF AVOIDANCES
(Max. = 120)
70
50
30
10
0
G
G
G
N
N
N
S
S
S
G
N
S
GOAL BOX

latencies tended to cluster together, first block avoidance data were selected for these analyses. Table IV presents the median number of avoidance responses made by each group of animals during the first block of 10 trials. Significant differences existed within groups started in the safe box and within groups run to either the grid or neutral box; the remaining effects were not significant. It can be seen from Table IV that the greatest differences arise when Groups SG and SN are compared with any of the other subjects. Each of these groups produced very few avoidance responses.

Individual comparisons: latencies. Figure 2 illustrates median latencies for each groups of subjects as a function of blocks of 10 test trials. There was a tendency for all groups except SN and SG to produce relatively quick responses on Day 1; the groups spread out as extinction progressed on Day 2. Day 2 results, however, were complicated by spontaneous recovery and by differential extinction effects, the "active" groups in general extinguishing by running more slowly and the "passive" groups extinguishing by running more quickly (see Appendices F and G).

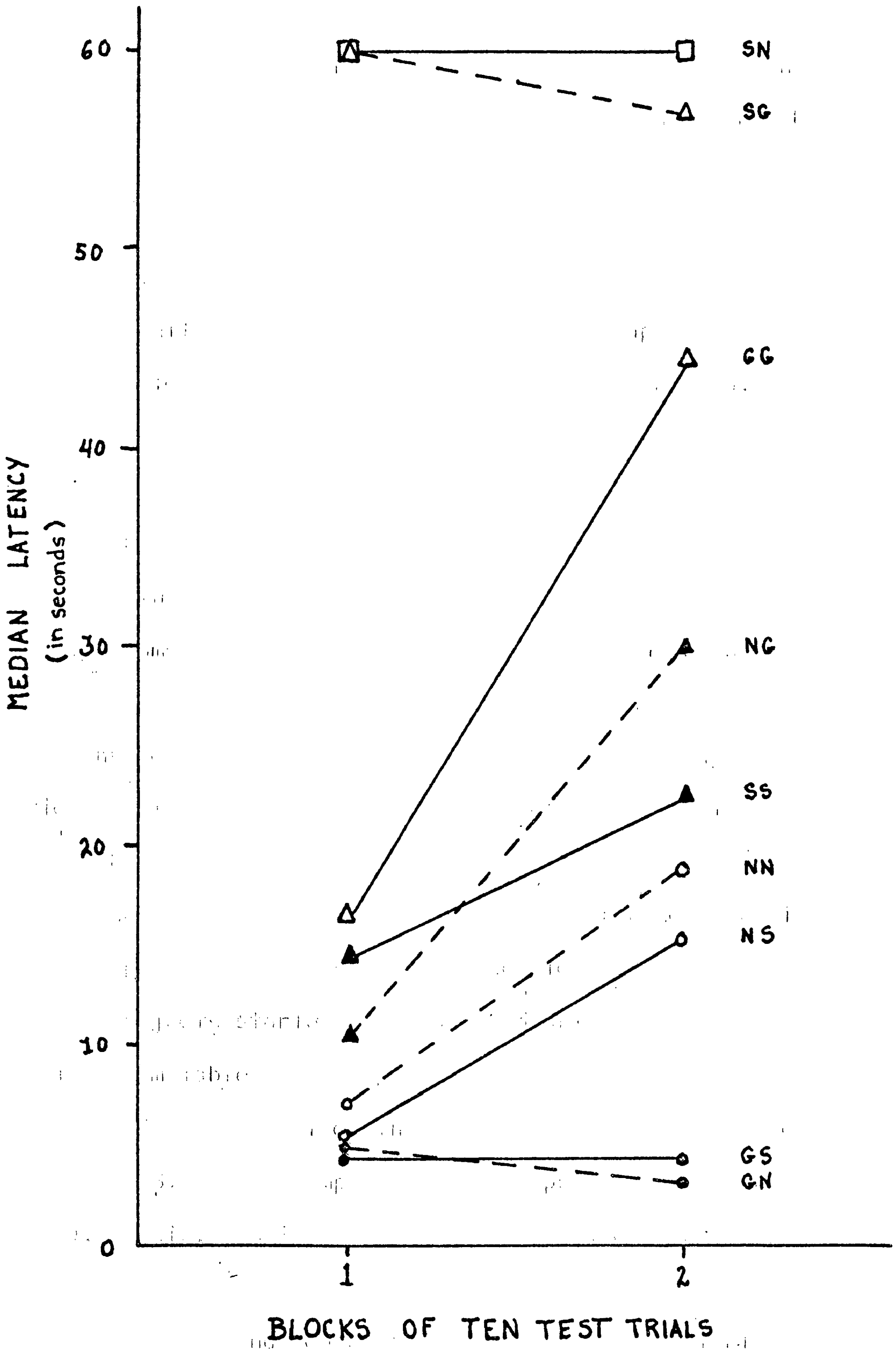
Groups GN, NS, and NN, expected to reflect respectively avoidance, approach, and response components of the total "avoidance" behavior, were each compared with Group GS (regular extinction). Mann-Whitney U values are reported in Appendix E. No significant differences existed between these groups for Block I, Block II, or overall latency data, although there was a slight tendency for NN animals to run more slowly than GS animals on Day II ($p < .09$). NN subjects differed considerably from one another, three animals having overall median latencies above 20 seconds, and three having latencies below 10 seconds.

TABLE IV

MEDIAN NUMBER OF AVOIDANCES OVER THE FIRST 10 TRIALS WITH KRUSKALL-WALLIS P-VALUES

		GOAL BOX GRID	NEUTRAL	SAFE	p
	GRID	3.5	5.0	4.5	
START BOX	NEUTRAL	2.0	5.0	4.5	.20
	SAFE	0.0	0.0	2.0	.02
	p	.02	.02	-	

Figure 2. Median latencies for each group of subjects over blocks of ten test trials.


60
50
40
30
20
10
0
MEDIAN LATENCY (in seconds)
1
2
BLOCKS OF TEN TEST TRIALS
SN
SG
GG
NG
SS
NN
NS
GS
GN

In general, subjects ran equally quickly to neutral and safe boxes except when they were started in the safe box. Individual U tests were computed comparing groups run to safe and neutral goal boxes (see Appendix E), using the median latency data from Table I. Only three comparisons reached significance, all of these involving groups started in the safe box who generally produced long latencies. Group SS occupied an intermediary position between "active" and "passive" animals, tending to differ from both GN and SN subjects, although the latter comparison does not reach significance ($p < .12$) due partially to the small n.

Particularly surprising was the rapid performance of "passive" Group NG during the first block of trials. Since these animals were run in the same direction as that required during training, this result may reflect a strong directional component to the avoidance behavior. While Group NG did not differ significantly from Group GS (regular extinction) in the first block of trials, NG subjects did run more slowly on Day 2 ($H = 4$, $p < .05$).

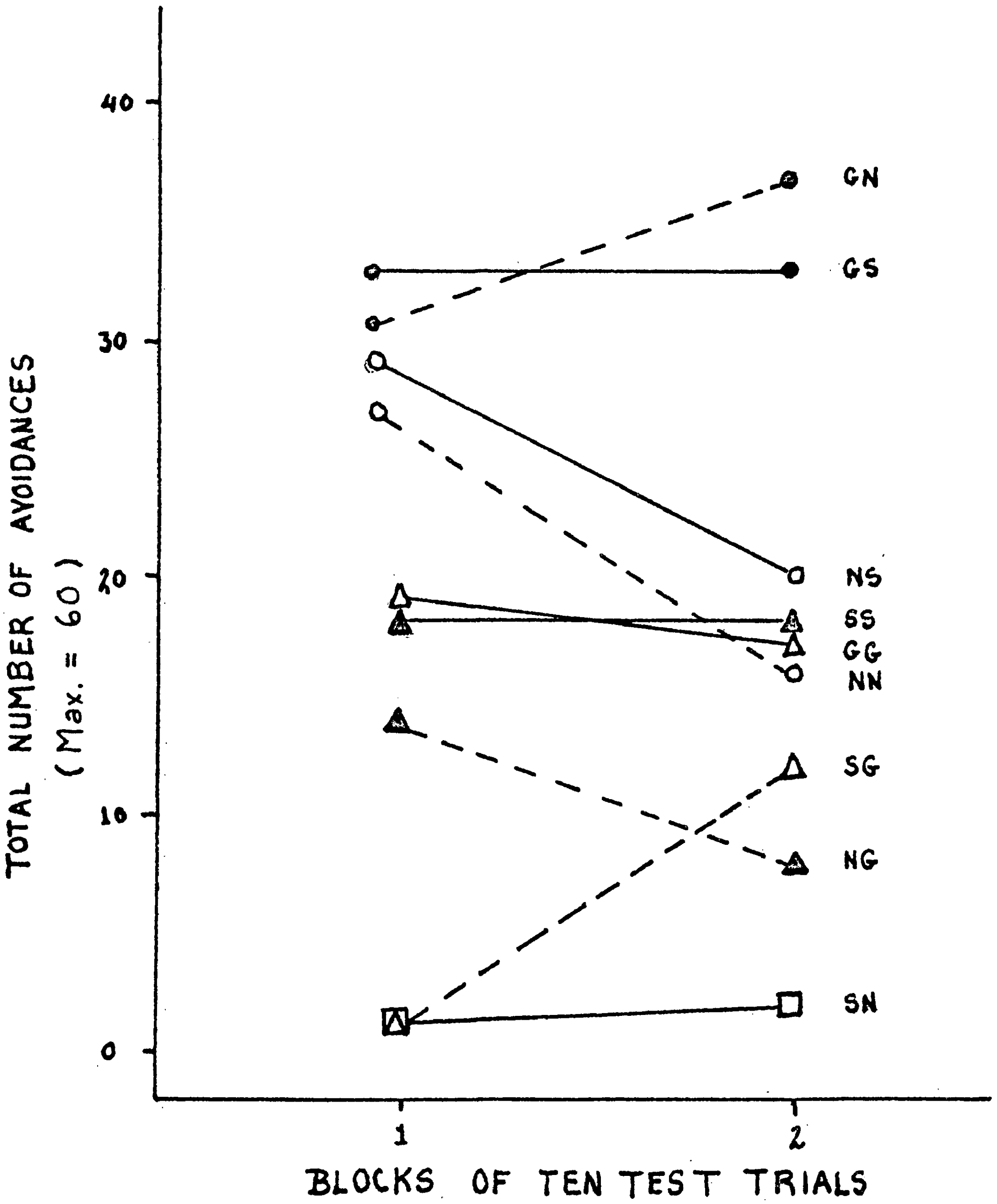
In order to examine more closely the differences obtained between active and passive test conditions, additional U tests were made between groups of subjects started from safe and grid boxes, again using median latencies from Table I (see Appendix E). Four comparisons revealed significant differences; all of these involved groups expected to respond "actively" (GS, GN) as compared with groups expected to respond "passively" (SG, SN). Again, passive subjects produced much longer latencies than active avoiders. Groups GG and SS each exhibited considerable variability in latency scores, and consequently did not differ significantly from either active or passive avoiders.

By inspection, there were no differences in any of the groups between animals trained to run from white to balck and animals trained to run from black to white.

Individual comparisons: avoidances. Data for the number of avoidances measure are plotted as a function of blocks of 10 trials in Figure 3. Comparison of latency and avoidance data reveals that on Day 1, there was somewhat more spread of scores for the avoidance measure. Mann-Whitney U tests were computed comparing Groups GN, NS, and NN with Group GS. Results were identical to those obtained with the latency measure: no significant differences were found between these groups; the NN subjects tended to run more slowly than GS subjects in the last block of trials ($H = 7.5$; $p < .12$).

Extinction rates. Both latency data and number of avoidances data were examined for the possibility of differential extinction rates (Appendix D). There was great variability among animals in difference scores obtained between Days 1 and 2, precluding any consistent conclusions. Evidence of spontaneous recovery can be noted in the first 5 trials presented on Day 2 (Appendices F and G).

Figure 3. Total number of avoidances (latencies less than or equal to 5.0 seconds) for each group of subjects over blocks of ten test trials.



40
30
20
10
0
TOTAL NUMBER OF AVOIDANCES
(Max. = 60)
1
2
BLOCKS OF TEN TEST TRIALS
GN
GS
NS
SS
GG
NN
SG
NG
SN

DISCUSSION

It was hypothesized that classical conditioning to external cues plays a fundamental role in avoidance behavior, with the consequence that an animal should be able to translate the instrumental response of active avoidance of a grid box into passive avoidance, depending upon which box it is placed in initially. Results with both the avoidance and latency measures provide definite support for this hypothesis. In general, subjects started in the safe box differed significantly from subjects started in the grid box, the former remaining in the safe box, often up to the full 60-second limit, and the latter running quickly out of the grid box. Individual comparisons, for example, between Groups GS and SG and between Groups NS and SN, clearly demonstrate an active-passive dichotomy, indicating that such translations from active avoidance to passive avoidance did occur in SG and SN subjects.

Passive avoidance was particularly consistent and long-lasting in Group SN. These subjects remained in the safe box for the full 60 seconds on 77 out of a possible 100 trials, as compared with SG subjects who remained in the safe box on about half the test trials. This difference in stability may be due to the fact that

SN subjects were afraid of a strange neutral box. Observation of the animals during testing seemed to bear out this conclusion; most of the subjects remained crouched in a corner as far as possible from the neutral box while the door was raised, and entered it only after cautiously "testing" the floor with forefeet and nose. In addition, SG subjects may have been motivated by curiosity directed towards the grid box, causing their performance to be less stable than that of SN subjects. Attempts to return to the shock box after an avoidance response had been made were often observed during training trials, necessitating quick door-lowering latencies on the part of E. During training, a kind of temporal conditioning may have contributed to this behavior, too, the animals feeling relatively freer in their explorations after an avoidance response had been made.

The performance of Group NG during the first day of testing provides an exception to the facility of an active-passive translation. It should be noted, however, that while latencies were short on Day I, there were relatively few avoidances made by these animals, indicating some hesitation before a response was made. It is likely that the conflict between a running-directional cue and the goal box cue was responsible for this behavior. These animals likewise may ahve been afraid of a strange neutral box or motivated by curiosity about the grid box. The fact that NG latencies lengthened considerably on Day II suggests that an initial response-connected fear may have extinguished through a series of non-avoidances, thus allowing a more passive response to dominate.

These results point to an underlying similarity between active avoidance and one type of passive avoidance, each of these responses motivated most probably by fear of external stimuli such as color and direction. Mowrer (1960) has noted the similarity between active and passive avoidance (the latter he also refers to as punishment), but has defined the two according to the stimuli to which fear is conditioned. With regard to passive avoidance, Mowrer emphasizes the importance of intrinsic or reponse-produced cues; while active avoidance is said to depend upon extrinsic cues. This experiment suggests another possibility -- a passive avoidance dependent upon extrinsic cues, where S learns to fear a particular place rather than a particular response.

Further predictions were made concerning the relative contributions of approach, avoidance, and response components to the total avoidance behavior. Specifically it was predicted that, in the present situation, approach and avoidance would both contribute to the total response, and that running or directional contributions would be minimal. The essential similarity of GS, NS, and NN groups on Day 1, however, indicates that running and directional responses did in fact contribute to the S's behavior. The unexpectedly short latencies of Groups NG and SS on Day 1 were probably motivated by running-directional cues. In general, it should be noted from Figure 2 that the 7 groups producing the shortest latencies were run in the same direction as that required in training, while the two producing the longest latencies were run in the opposite direction.

The fact that Group NN tended to produce longer latencies on Day 11 relative to Groups GS and GN suggests that the response component was a relatively weak one, providing some contribution to the animals' performance during the early stages of testing, but prone to more rapid extinction. Woodworth and Schlosberg (1954) have suggested that response cues operate chiefly in the early stages of avoidance, external stimulus cues gaining importance as animals are given more experience with the avoidance situation. This is an interesting possibility, and could be tested by simply varying the number of training trials given to subjects before tests are made for approach, avoidance, and response learning. In addition, the dichotomous variability within Groups NN and SS indicates that individual animals were either "runners" or "non-runners". This result is in support of Restle's (1957) suggestion that individual animals may choose any of several cues to direct their responses.

The presence of directional responding makes the task of assessing the importance of approach and avoidance contributions more difficult than anticipated. Apparently either the external stimulus cues were not distinct enough to rule out directional responding, or the animals' drive was generally too high to produce large differences between active avoiders. The former is more likely to be the case, since shock level was set at a low .6 ma. Either increasing the distinctiveness of the stimulus situation or starting the animals alternately from opposite directions might have served to reduce the importance of the directional cue.

Nevertheless, some interpretations can be made concerning approach and avoidance. That there were several groups (NG, SS, GG) tending to occupy an intermediary position between active and passive responding points to the fact that the animals were not simply running, oblivious to external cues, and particularly when these conflicted with response cues. The fact that GN subjects did not slow their responding on Day 11, as did NN and NS subjects, and that Groups GN and GS were identical on both measures, would indicate that avoidance cues are sufficient to produce avoidance behavior. The results do not, however, permit affirmation of an approach element in this situation with any certainty; approach and response elements were inseparable. The most parsimonious conclusion is that the approach element was not present.

With respect to approach, however, a distinction should probably be made between the "typical" avoidance situation, which this experiment attempted to reproduce, and the kind of situation in which approach elements have previously been indicated. Most of these demonstrations involved confining the subjects in the safe box for a longer period of time than that used in the present experiment. It may be that approach is not easily demonstrated with the typical avoidance procedure, which necessarily shortens and equalizes the time spent in both grid and safe boxes, because there is not enough time for "relaxation", as Denny et al (1955) hypothesize, or "relief", in Mowrer's (1960) terms, to become attached to safe box cues. Zerbolio (1965) defined 150 seconds as "long enough to relax", while 30 seconds were "not long enough to relax"; his study revealed differences between groups confined for these periods of time with respect to the strength of approach. Likewise, Denny and Weisman (1964) reported preferences for goal boxes associated with longer nonshock confinement periods. These results are in accordance with studies relating amount of positive incentives such as food or water to strength of response (e.g. Zeaman, 1949). It is likely, then, that either a longer training period, allowing more experience with the safe box, or a longer confinement period would have been necessary to demonstrate approach elements.

It might be argued that results with Groups SG and SN support Denny and Weisman's (1955) relaxation-approach hypothesis in the sense that these animals were "staying where it's safe". Again, however, one cannot clearly separate approach from avoidance, concluding that these subjects were either motivated by relaxation or relief in response to safe box cues, or by fear in response to grid or neutral box cues. One might guess that, since active avoiders did not demonstrate approach, passive avoiders were likewise motivated by fear rather than relief. The reversed directional cue complicates such an interpretation; eliminating directional responding as previously suggested would be a step towards disentangling the two.

In retrospect, it is tempting to turn to Restle's (1957) view that animals will use all relevant cues in a learning situation. The present results indicate use of a variety of cues, but with three qualifications. The first of these is that some cues were more important than others. Avoidance cues were more important than direction cues, and there was apparently no response to approach cues in this situation. Secondly, the number of available cues seemed to influence the speed of response.

For example, GN subjects, who could rely upon both grid and direction cues, were better avoiders than NN subjects, who were provided with a direction cue alone. Finally, individual animals differed in the extent to which they made use of specific cues, as evidenced by the intersubject variability particularly prominent in Group NN.

An overview of the present results leads to the following summary statements. The results provide evidence for an active-passive translation when external stimulus cues, including the directional cue, are radically reversed. These findings are in support of suggestions made by Mowrer (1960) and Miller (1948) concerning the centrality of classical conditioning to external cues in avoidance behavior. In addition, simple running tendencies were indicated over and above the learned response to external cues; apparently a directional cue is necessary to elicit this behavior since animals provided with a reversed directional cue did not exhibit running behavior. Finally, while the results support the view (Miller, 1948; Mowrer, 1960) that fear-producing avoidance cues are sufficient for avoidance behavior, there was no clear support for either the "relaxation-approach" hypothesis of Denny and Weisman (1955), nor for Mowrer's (1960) "relief" hypothesis.

APPENDIX A

TRIALS TO CRITERION
AND
MEDIAN LATENCIES DURING CRITERION TRIALS

Trials to criterion
and
median latencies during criterion trials

Group GG

Subjects	TC	Lat.
S1	32	0.9
S2	12	1.3
S3	13	1.1
S4	12	1.0
S5	17	1.1
S6	22	2.0
Group Median	15	1.1

Group GN

Subjects	TC	Lat.
S1	14	3.1
S2	16	1.1
S3	11	2.0
S4	12	1.1
S5	11	1.4
S6	11	1.6
Group Median	11.5	1.5

Group GS

Subjects	TC	Lat.
S1	20	1.3
S2	25	3.2
S3	11	1.4
S4	15	1.8
S5	16	0.7
S6	24	1.3
Group Median	18	1.4

Group NG

Subjects	TC	Lat.
S1	14	3.1
S2	18	1.7
S3	22	2.0
S4	23	1.0
S5	24	1.4
S6	25	0.1
Group Median	23.5	1.6

Group NN

Subjects	TC	Lat.
S1	13	1.4
S2	21	1.8
S3	14	1.2
S4	22	1.0
S5	16	2.1
S6	24	1.4
Group Median	18.5	1.4

Group NS

Subjects	TC	Lat.
S1	14	2.4
S2	13	2.1
S3	12	2.9
S4	11	1.2
S5	11	1.3
S6	19	2.3
Group Median	12.5	2.2

Group SG

Subjects	TC	Lat.
S1	14	1.7
S2	15	1.2
S3	14	1.2
S4	24	2.1
S5	27	2.1
S6	11	1.2
Group Median	14.5	1.5

Group SN

Subjects	TC	Lat.
S1	13	1.4
S2	11	2.2
S3	13	1.1
S4	13	2.5
S5	14	1.2
Group Median	13	1.4

Group SS

Subjects	TC	Lat.
S1	14	0.9
S2	15	1.5
S3	25	0.8
S4	19	3.2
S5	29	1.0
S6	16	1.3
Group Median	17.5	1.2

APPENDIX B

MEDIAN LATENCY DATA FOR INDIVIDUAL SUBJECTS

Test trials:
Block I, Block II, and overall median latency data for individual Ss

Group GG

Ss	1-10	11-20	O.A.
S1	60.0	60.0	60.0
S2	29.2	60.0	60.0
S3	4.2	33.3	19.2
S4	3.6	4.6	3.6
S5	11.9	22.9	18.7
S6	11.4	22.9	14.4

Group GN

Ss	1-10	11-20	O.A.
S1	6.9	2.6	3.8
S2	60.0	60.0	60.0
S3	12.1	5.4	9.6
S4	2.7	1.4	2.1
S5	1.1	1.8	1.2
S6	4.8	3.3	3.9

Group GS

Ss	1-10	11-20	O.A.
S1	6.4	3.3	3.8
S2	5.6	30.8	10.7
S3	1.2	0.9	1.0
S4	6.8	11.2	8.3
S5	0.8	0.9	0.8
S6	17.8	7.2	9.8

Group NG

Ss	1-10	11-20	O.A.
S1	6.7	22.9	8.2
S2	5.4	9.3	5.7
S3	25.9	43.9	23.9
S4	60.0	60.0	60.0
S5	8.2	58.1	15.4
S6	27.8	13.8	22.1

Group NN

Ss	1-10	11-20	O.A.
S1	60.0	60.0	60.0
S2	4.2	4.3	4.2
S3	60.0	60.0	60.0
S4	2.9	16.5	7.2
S5	3.9	4.0	4.0
S6	10.2	32.3	21.2

Group NS

Ss	1-10	11-20	O.A.
S1	11.8	11.2	11.8
S2	24.5	60.0	52.3
S3	1.8	4.9	3.6
S4	5.3	20.6	11.6
S5	1.5	1.3	1.3
S6	60.0	34.7	60.0

Group SG

Ss	1-10	11-20	O.A.
S1	10.6	60.0	35.2
S2	22.4	4.8	14.1
S3	60.0	60.0	60.0
S4	60.0	60.0	60.0
S5	29.1	7.2	15.0
S6	60.0	26.7	44.0

Group SN

Ss	1-10	11-20	O.A.
S1	46.0	60.0	59.7
S2	60.0	55.0	60.0
S3	60.0	60.0	60.0
S4	60.0	60.0	60.0
S5	60.0	60.0	60.0

Group SS

Ss	1-10	11-20	O.A.
S1	22.2	9.2	11.8
S2	4.1	4.3	4.1
S3	34.3	60.0	60.0
S4	13.6	42.6	18.8
S5	60.0	60.0	60.0
S6	4.3	2.3	3.0

In every group, the first three Ss were trained to run from black to white and the last three were trained to run from white to black.

APPENDIX C

NUMBER OF AVOIDANCES DATA FOR INDIVIDUAL SUBJECTS

Test trials:
Block I, Block II, and total avoidances for individual Ss

Group GG

Ss	1-10	11-20	Tot.
S1	0	1	1
S2	1	0	1
S3	5	4	9
S4	6	5	11
S5	3	5	8
S6	4	2	6

Group GN

Ss	1-10	11-20	Tot.
S1	4	8	12
S2	0	0	0
S3	3	5	8
S4	8	7	15
S5	10	9	19
S6	6	8	14

Group GS

Ss	1-10	11-20	Tot.
S1	4	8	12
S2	5	3	8
S3	10	10	20
S4	4	1	5
S5	10	8	18
S6	0	3	3

Group NG

Ss	1-10	11-20	Tot.
S1	2	0	2
S2	4	2	6
S3	2	4	6
S4	0	0	0
S5	4	1	5
S6	2	1	3

Group NN

Ss	1-10	11-20	Tot.
S1	4	0	4
S2	6	6	12
S3	2	0	2
S4	6	2	8
S5	7	7	14
S6	2	1	3

Group NS

Ss	1-10	11-20	Tot.
S1	3	3	6
S2	7	5	12
S3	5	1	6
S4	10	10	20
S5	0	1	1
S6	4	0	4

Group SG

Ss	1-10	11-20	Tot.
S1	0	6	6
S2	0	1	1
S3	0	5	5
S4	0	0	0
S5	1	1	2
S6	0	0	0

Group SN

Ss	1-10	11-20	Tot.
S1	0	1	1
S2	0	0	0
S3	0	0	0
S4	1	1	2
S5	0	0	0

Group SS

Ss	1-10	11-20	Tot.
S1	1	4	5
S2	8	5	13
S3	2	0	2
S4	2	2	4
S5	0	0	0
S6	5	7	12

In every group, the first three Ss were trained to run from black to white and the last three were trained to run from white to black.

APPENDIX D

BLOCK I - BLOCK II DIFFERENCE SCORES

Block I - Block II difference scores

Individual difference scores: latencies

		Goal box		
		G	N	S
		0.0	- 4.3	- 3.1
		+30.8	0.0	+25.2
	G	+29.1	- 6.7	- 0.3
		+ 1.0	- 1.3	+ 4.4
		- 5.4	+ 0.7	+ 0.1
		+11.5	- 1.5	-10.6
Start		+16.2	0.0	- 0.6
		+ 3.9	+ 0.1	+35.5
	N	+18.0	0.0	+ 3.1
		0.0	+13.6	+15.3
Box		+49.9	0.0	- 0.2
		-14.0	+22.1	-25.3
		+49.9	+14.0	-13.0
		-17.6	- 5.0	+ 0.2
	S	0.0	0.0	+25.7
		0.0	0.0	+29.0
		-21.9	0.0	0.0
		-33.3		- 2.0

Individual difference scores: avoidances

		Goal box		
		G	N	S
		+1	+4	+4
		-1	0	-2
	G	-1	+2	0
		-1	-1	-3
		+2	-1	-2
		-2	+2	-3
Start		-2	-4	0
		-2	0	-4
	N	+2	-2	-4
		0	-4	0
Box		-3	0	+1
		-1	-1	-2
		+6	+1	+3
		+1	0	-3
	S	+5	0	-2
		0	0	0
		0	0	0
		0		+2

Median difference scores: latencies

		Goal box		
		G	N	S
	G	+ 6.3	- 1.4	- 0.1
Start				
	N	+10.1	+ 0.1	+ 1.5
Box				
	S	- 8.8	0.0	+ 0.1

Median difference scores: avoidances

		Goal box		
		G	N	S
	G	-1	+1	-2
Start				
	N	-1.5	-1.5	-1
Box				
	S	+0.1	0.0	0.0

APPENDIX E

SUMMARY OF U TESTS

Mann-Whitney U values for GS comparisons, using latency data

		Group GS	
	Block I	Block II	Overall
Group GN	15	17.5	16.5
Group NS	13	9.5	8
Group NN	13	7	9

S <u>versus</u> G as start: Mann-Whitney U values for overall latency data

			Grid start box	
		GG	GN	GS
Safe start box	SG	13	5*	0**
	SN	6	3*	0**
	SS	17	9	7

* p .05

** p .01

N *versus* S as goal: Mann-Whitney U values for overall latency data

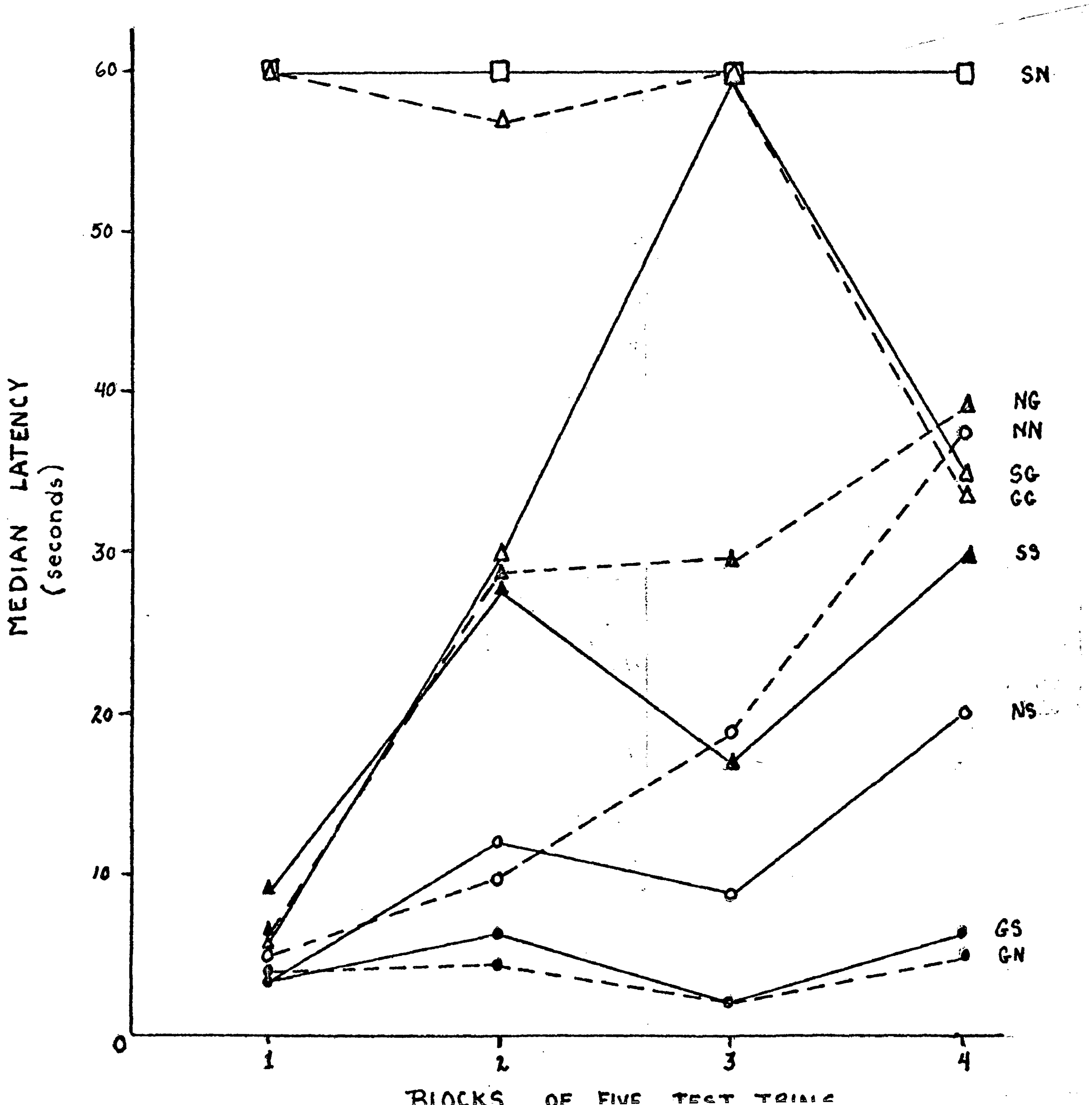
		Neutral goal		
		GN	NN	SN
Safe goal	GS	16.5	9	3**
	NS	12.5	15	3**
	SS	5*	12	6

* p .04

** p .03

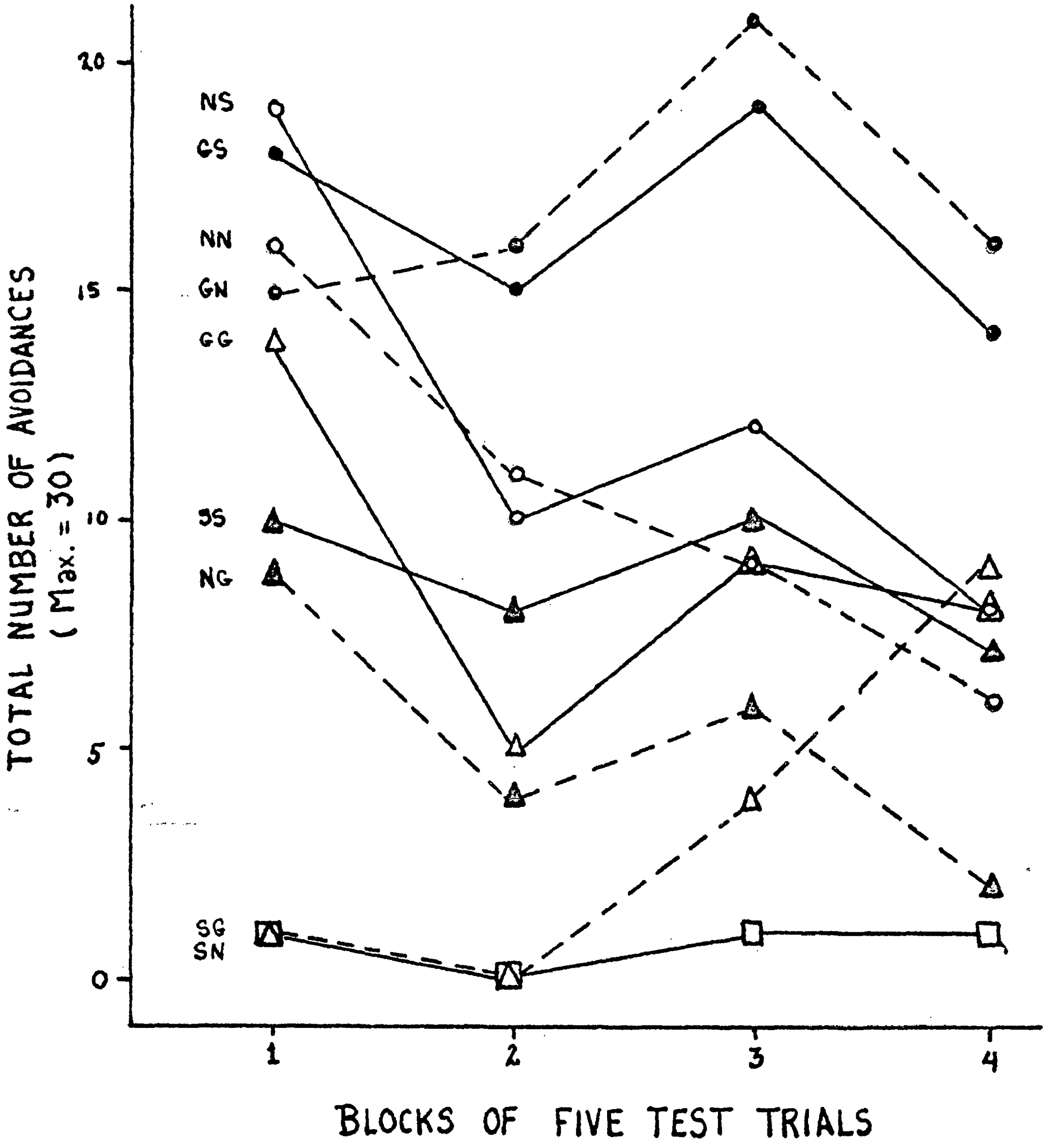
APPENDIX F

MEDIAN LATENCIES FOR EACH GROUP OF SUBJECTS OVER BLOCKS OF FIVE TEST TRIALS


MEDIAN LATENCY
(seconds)
0
10
20
30
40
50
60
1
2
3
4
BLOCKS OF FIVE TEST TRIALS
SN
NG
NN
SG
GG
SS
NS
GS
GN

APPENDIX G

TOTAL NUMBER OF AVOIDANCES FOR EACH GROUP OF SUBJECTS OVER BLOCKS OF FIVE TEST TRIALS


TOTAL NUMBER OF AVOIDANCES
(Max. = 30)
20
15
10
5
0
NS
GS
NN
GN
GG
SS
NG
SG
SN
1
2
3
4
BLOCKS OF FIVE TEST TRIALS

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