THE INFLUENCE OF EFFORT REQUIREMENT ON PERFORMANCE DURING ACQUISITION AND EXTINCTION OF A RUNNING RESPONSE

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ABSTRACT

THE INFLUENCE OF EFFORT-REQUIREMENT ON PERFORMANCE DURING ACQUISITION AND EXTINCTION OF A RUNNING RESPONSE

by Wanda R. Jagocki

Four different measures (mean reciprocal latency, mean reciprocal running time, mean number of trials to extinction, and mean number of trials to median latency of Trials 1-30 of extinction) were used to determine the influence of effort requirement on performance during the acquisition and extinction of a running response. Effort requirement was varied by having albino and grey hooded rats traverse a runway which was either in a horizontal position or tilted up at an angle of 15°. Four groups of Ss were used: 0-0. . . (low effort during acquisition and extinction)

15-15 (High effort during acquisition and extinction)

15-0 (High effort during acquisition, low effort during extinction)

15-0-0 (High effort followed by low effort during acquisition, low effort during extinction)

Each group contained 10 Ss, five albinos and 5 grey hoods. The results obtained were:

1. Significant differences between the two strains were found with regard to running time and mean number of trials to extinction. The albinos ran faster and had a greater number of trails to extinction than the grey hoods.

2. No significant difference in the decrement from the last 10 trials of acquisition to the first 10 trials of extinction with regard to latency was found between the 0-0 group and 15-15 group. However, the 15-15 group ran significantly slower during the first 10 trials of extenction than did the 0-0 group. The 0-0 group also had significantly greater resistance to extinction than the 15-15 group as evidenced by the mean number of trials to the extinction criterion, but not by the number of trials to the median latency of Trials 1-30 during extinction.

3. The 15-0 group exhibited facilitation in running time during extinction as compared to the 15-15 group. However, the reverse relationship was observed with regard to the latency measure, although the difference between the two groups was not statistically significant. No significant difference between the 15-0 and 15-15 groups was found in the two measures of resistance to extinction.

4. The 15-0 group was observed to have a greater decrement in latency and running time than the 0-0 group, although not significantly greater. The 0-0 group also exhibited a greater mean number of trials to extinction than the 15-0 group. This difference approached being statistically significant.

5. Facilitation in latency was shown by the 15-0-0 group during the final 10 trials of acquisition when the effort requirement was reduced. Although facilitation

was observed in the running time measure, the increment was not statistically significant.

6. The 15-0-0 group exhibited a significantly greater increment in latency, when the effort requirement was reduced during acquisition, than that of the 15-15 plus 15-0 group. However, the reverse relationship was observed with regard to the running time measure, although this difference was not statistically significant.

7. The 0-0 group exhibited greater resistance to extinction than the 15-0-0 group as measured by the mean number of trials to extinction.

8. The possible interaction of frustration and change in the stimulus situation in producing behavioral contrast with regard to the running response is hypothesized.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION

One independent variable which is often cited for its importance in influencing the strength of a response, usually measured in terms of resistance of the response to extinction, is that of effort. It has generally been assumed that if it takes an organism more work to make a particular response, the organism is going to stop making that response, once reinforcement is omitted, sooner than an organism that doesn't have to do quite as much work to make a similar type of response. However, attempts to demonstrate this experimentally have been inconclusive. The majority of the studies concerned with the role of effort in the resistance to extinction of a response have varied the amount of effort required to make a response by varying the weightings of the bar in a Skinner box apparatus. A general criticism which can be leveled at all these studies is that the animals must initially be trained on a light bar before any training on a heavy bar is possible. This initial training may be more of a factor in determining the greater resistance to extinction of animals trained and extinguished on light bars than the amount of effort required to make the response.

Hull

The first formal statement of the supposed relationship between effortfulness of the response and resistance to extinction was put forth by Hull. Within the framework of Hullian theory, the resistance to extinction of a response is held to be an inverse linear function of the amount of effort or work involved in making a response. As the amount of work required to make a response increases, reactive inhibition (I_r) also increases. This reactive inhibition is conceptualized as a negative-type of drive. Dissipation of I_r brought about by cessation of the response, is considered to be reinforcing, and thereby strengthens this habit of "not-responding."

> Whenever any reaction is evoked in an organism there is left a condition or state which acts as a primary negative motivation in that it has an innate capacity to produce a cessation of the activity which produced the state. (Hull, 1943, p. 278)

It is the accumulation of more I_r, when greater effort is required to make the response, which leads to faster extinction of the response.

Mowrer and Jones (1943)

As evidence for the relationship between effortfulness of the response and resistance to extinction, Hull cited a study by Mowrer and Jones in which the amount of work involved in making a bar press response was varied by changing the bar weightings. In this study, the acquisition

conditions were the same for all animals. At the end of training, each S had made 180 responses on a bar weighted with 5 gm., 20 responses on a bar weighted with 30 gm., 20 responses on a bar weighted with 55 gm., and 60 responses on a bar weighted with 80 gm. The Ss were then divided into three groups. One group was extinguished on a 5 gm. bar, one on a 42.5 gm. bar, and the last group on an 80 gm. bar. The mean number of responses made during extinction for the group extinguished on the 5 gm. bar was 350.3, for the group extinguished on the 42.5 gm. bar the mean was 248.4, and for the group extinguished on the 80 gm. bar the mean was 110.7 responses. Thus, Mowrer and Jones concluded that ". . . effortfulness of the task is inversely related to the number of extinction responses . . ." (Mowrer and Jones, 1943, p. 374).

The most obvious flaw of this study lies in the lack of control of the habit strengths of the various responses. A total of 180 reinforced responses were made on the 5 gm. bar as compared to 60 reinforced responses on the 80 gm. bar. It is more likely that differences in the number of reinforced responses, i.e., habit strength, rather than the effort variable can account for the Mowrer and Jones results.

Capehart, Viney and Hulicka (1958)

In an attempt to control for unequal training at the various bar loadings, Capehart, Viney and Hulicka gave each of their rats 30 reinforcements at each of three bar weightings. The bar loadings were scheduled by day in the order: 5 gm., 40 gm., 70 gm., 5 gm., 70 gm., 40 gm. Upon completion of acquisition, the Ss were divided into three groups and extinguished on a 5 gm., 40 gm., or 70 gm. bar. The 5 gm. group was found to be most resistant to extinction while the 70 gm. group was least resistant to extinction. The investigators concluded that "the number of responses to extinction is a function of the effort required to make the response" (Capehart, Viney and Hulicka, 1958, p. 507).

However, if one considers the point made in the Maatsch, Adelman and Denny study (1954), the Capehart, Viney and Hulicka design also failed to control for differences in habit strength. Maatsch, Adelman and Denny maintain that ". . . if trained to push a heavy bar, rats can easily push all lighter bars, but if trained upon light bars, they have difficulty in pushing heavier bars" (Maatsch, Adelman and Denny, 1954, p. 47). Therefore, in the Capehart, Viney and Hulicka study, when 30 responses on a 70 gm. bar were reinforced, 30 responses on a 40 gm., and 30 responses on a 5 gm. bar, were simultaneously being reinforced. If such an assumption is made, then each S was

actually reinforced 90 times for a 5 gm. bar press (30 on 5 gm., 30 on 40 gm., and 30 on 70 gm.), but only 60 times for a 40 gm. bar press (30 on 40 gm., and 30 on 70 gm.), and only 30 times for a 70 gm. press (30 on 70 gm.).

Maatsch, Adelman and Denny (1954)

In the Maatsch, Adelman and Denny study, after preliminary shaping on a 5 gm. and then on a 40 gm. bar, the Ss were divided into three groups. In one group, the bar was loaded at 5 gm., in the second at 40 gm., and in the last at 80 gm. The animals were given a total of 25 reinforcements, and were then extinguished on the same bar weightings as they had been trained on. The results indicated that there was "no relationship between the amount of effort required to make a response and the resistance to extinction of that response" (Maatsch, Adelman and Denny, 1954, pp. 49-50).

Weiss (1961)

In the studies previously discussed, the rate of bar-pressing was the dependent variable. Weiss gave discrete trials in a bar-pressing situation in order to measure latency rather than rate of pressing. He also varied the length of a behavior chain by having the rats make 1, 4 or 8 presses prior to delivery of reinforcement and removal of the bar. Using a complete factorial design, Weiss varied work at five levels (15 gm., 50 gm., 100 gm., 150 gm.,

and 200 gm. bar loadings) and length of behavior chain at three levels (1, 4 and 8 presses). A trial began when the bar was inserted and ended when the respective number of presses had been made, and the bar removed. After 96 reinforced acquisition trials, extinction was run and resistance to extinction determined. Although Weiss used a variety of speed measures (e.g., "starting speed" - speed of the first press in the chain), when the "total time," i.e., the time from introduction of the bar to delivery of reward, was analyzed there was no significant effect for either length of behavior chain or effort requirement. Likewise, there were no significant differences between the work groups in resistance to extinction. These results would tend to support the Maatsch, Adelman and Denny findings for even larger bar loadings.

In general, it has been noted that if rats are trained under high effort requirement and extinguished under low effort requirement, they tend to exhibit greater resistance to extinction than animals trained and extinguished under low effort requirement. Although only Stachnik, (1963) actually found statistically significant differences between groups of animals trained and extinguished light, and those trained heavy and extinguished light, it is a finding to which theorists have attempted to address themselves. The available theories have difficulty in explaining such results. According to the generalization decrement

hypothesis, greater resistance to extinction is found as the similarity between the acquisition and extinction conditions increases. Therefore, it would be expected that animals trained and extinguished under low effort, i.e. greater similarity in acquisition and extinction conditions, would exhibit greater resistance to extinction than animals trained under high effort and extinguished under low effort, i.e., little similarity between acquisition and extinction conditions. The reverse appears to be the case. It might be argued, however, that changes in the loading of the bar is not a sufficient cue to enable discrimination between the acquisition and extinction conditions. Taking a Hullian viewpoint, one might argue that greater habit strength results from making a more effortful response during training, and this would account for the greater resistance to extinction of the high effort animals when switched to low effort during extinction. However, an alternative hypothesis has been put forth by Stachnik who postulates that the facilitation observed is actually due to a contrast effect.

Among the studies which have varied effort requirement during acquisition and extinction are those by Applezweig; Stanely and Aamodt; Aiken; and Stachnik.

Applezweig (1951)

Applezweig trained five groups of rats to press bars requiring 10, 20, 30, 40 or 50 gm. of effort to obtain water. After 50 reinforced trials the Ss were divided into five sub-groups, each of which was extinguished at one of the five effort levels, e.g., (acquisition) 10-10 (extinction), 10-20, . . . 10-50, 20-10, 20-20, . . . 20-50, 30-10, etc. Applezweig concluded that "when habit strength is constant, the more effortful the performance of a task after reinforcement has been removed, the more rapidly will extinction occur" (Applezweig, 1951, p. 235). In other words, rats trained light and extinguished heavy show faster extinction. It was also asserted that "the more effortful the performance of a task, the better will it be learned (the greater will be its response potential)" (Applezweig, 1951, p. 235). A questionable assumption made in this study is that rats trained on light bars press heavier bars as easily as rats trained on heavy bars press lighter bars. Referring back to the point made by Maatsch, Adelman and Denny, i.e., rats trained on heavy bars can easily push all lighter bars while rats trained on light bars have difficulty in pushing heavier bars, this assumption does not seem tenable. In addition, Applezweig discarded 79 of an original 179 animals on the basis of a weak initial tendency to press heavy bars. Thus,

most of the 79 discarded animals were of the heavy bar loading groups and hence non-random selection of Ss in some groups resulted.

Stanley and Aamodt (1954)

Stanley and Aamodt trained half of their Ss under a 50 gm. bar loading and the other half under a 100 gm. bar loading. At the end of training, half of each acquisition group was extinguished under the 50 gm. force requirement, and half under the 100 gm. force requirement, resulting in a total of four groups: (training) 50-50 (extinction), 100-50, 50-100, and 100-100. The mean number of bar presses made during the two days of extinction was in the order: 100-50 > 50-50 > 50-100 > 100-100. However, none of these differences were statistically significant.

Aiken (1957)

Aiken employed a panel-pushing task in which the rats were reqired to swing a door forward in order to secure food. The amount of force needed to push the door forward was 32 gm. for the high effort group and 5 gm. for the low effort group. After a total of 60 acquisition trials, the Ss were fractionated into four extinction conditions resulting in a total of four groups: High-High, High-Low, Low-High and Low-Low. Although the differences in the mean number of trials to extinction were not statistically

significant, Aiken concluded that there "was increased resistance to extinction following high-effort during learning, and reduced resistance to extinction with high effort during extinction trials . . ." (Aiken, 1957, p. 51). The means were in the order : H-L > H-H > L-L > L-H.

Stachnik (1963)

Stachnik employed a bar-press situation in an attempt to determine the effect of effort requirement on resistance to extinction when habit strength was held constant. A total of seven groups were used:

Group	No. and Bar-Loading of Reinforcement	Bar-Loading During Extinction
L L 200	200 on 5 gm.	5 gm.
H H 120	80 on graduated loadings, 150 on 80 gm.	80 gm.
H H 200	80 on graduated loadings, 200 on 80 gm.	80 gm.
H L 120	80 on graduated loadings 120 on 80 gm.	5 gm.
HL L 120	50 on graduated loadings, 120 on 80 gm., 30 on 5 gm.	5 gm.
LMH L 90	30 on 5 gm., 30 on 40 gm., 30 on 70 gm.	5 gm.
LMH H 90	30 on 5 gm., 30 on 40 gm., 30 on 70 gm.	70 gm.

(Stachnik, 1963, p. 13).

Significant differences were found in the following comparisons of mean number of responses to extinction: -

LMH L 90 ($\bar{X}$ = 97.4) > LMH H 90 ($\bar{X}$ = 32.3)

H H 120 ($\bar{X}$ = 110.1) > LMH H 90 ($\bar{X}$ = 32.3)

H L 120 ($\bar{X}$ = 310.8) > L L 200 ($\bar{X}$ = 155.7)

H L 120 ($\bar{X}$ = 310.8) > HL L 120 ($\bar{X}$ = 193.0)

The significant difference between LMH L 90 and LMH H 90 supports the criticism of unequal habit strengths in the Capehart, Viney and Hulicka study. The group extinguished light made three times as many responses as the group extinguished heavy.

The assumption that rats trained on light bars depress heavier bars with equal facility is rejected on the basis of the H H 120 group making significantly more responses than the LMH H 90 group.

The fact that the mean number of responses of the H L 120 group was significantly greater than that of the LL 200 group leads to the conclusion that "animals trained on a heavy bar and extinguished on a light bar show a marked facilitation" (Stachnik, 1963, p. 30). And further "the facilitation is the result of a contrast in stimulation since the insertion of light-bar reinforcements just prior to extinction essentially eliminates it" (Stachnik, 1963, p. 30). This conclusion is made on the basis of the greater number of responses made during extinction by the H L 120 group than by the HL L 120 group.

Behavior contrast refers to "the change in the rate of responding during the presentation of one stimulus . . . in a direction away from the rate of responding generated during the presentation of the other stimulus" (Reynolds, 1961, p. 57). As applied to the situation used in Stachnik's study, the change in the cues for the high effort group when switched to low effort during extinction, elicited a greater number of responses during extinction for this group than for the group which had these cues changed prior to extinction.

Lawson and Brownstein (1957)

An attempt was made by Lawson and Brownstein to vary effort requirement in a non-bar press situation. They trained rats to "traverse a runway containing three hurdles, which for half the Ss were removed during extinction. Removal of the hurdles was presumed to reduce the effortfulness of response and simultaneously increase the discriminability of training and extinction conditions" (Lawson and Brownstein, 1957, p. 23). The three hurdles, about two inches high, were spaced about one foot apart. Following training, the Ss were divided into two groups; one which had the food and food cup removed, while the other group had the hurdles removed as well as the food and food cup. "All Ss were given massed extinction trials to a criterion of two successive failures to enter the end-box within 2 min. after the starting door was raised"

(Lawson and Brownstein, 1957, p. 124). It was found that "the Ss for which the hurdles remained in place showed significantly greater resistance to extinction, although they were presumably expending more effort per trial" (Lawson and Brownstein, 1957, p. 125). These results can best be explained in terms of the generalization decrement hypothesis. The Ss for whom the hurdles remained in place had greater similarity between the acquisition and extinction conditions than did the Ss for whom the hurdles were removed. The greater the similarity between the training and extinction conditions, the greater the resistance to extinction.

Jensen (1960)

Jensen also employed a non-bar press situation in studying the influence of the effortfulness of a response upon acquisition. It was asserted that "any variable that increases the vigor of a response also increases the effortfulness of the response (the greater the vigor, the greater the kinetic energy gained, hence the greater the effort expended)" (Jensen, 1960, p. 268). The levels of effort-requirement were obtained by varying the angle of incline of the runway of a T-maze. On the first experimental day (Day 8) each of the Ss received 30 acquisition trials. On Trials 1-5, all Ss were run with the maze in a horizontal position; on the remaining 25 trials "the maze was tilted or not tilted depending upon which condition

S was in" (Jensen, 1960, p. 263). During the second experimental day (Day 9), all Ss were given 15 acquistion trials, under the same effort requirement as they had been run under on the first experimental day, followed by 15 acquisition trials with the maze in a horizontal position. This procedure was based upon the consideration that "if the effort variable had caused depressed acquisition curves for the high-effort groups, then the acquisition curves of these groups should have approached the curve of the low-effort (horizontal) group during the last 15 trials of Day 9" (Jensen, 1960, p. 263). Jensen concluded that "the effort-requirement variable gave no suggestion of a main effect" (Jensen, 1960, p. 268).

In light of the findings of the experiments in which the bar-press situation was used, Stachnik's in particular, it was the purpose of the present study to ascertain whether similar phenomena would occur in a situation similar to that used by Jensen. An additional purpose was to see whether the results could best be predicted by a Hullian inhibition theory approach or by the generalization decrement hypothesis.

Resistance to Extinction

The major comparisons, with regard to resistance to extinction, which the present study intended to investigate were:

1. Will a group trained and extinguished on a horizontal runway (0-0 group, i.e., low effort requirement) show greater resistance to extinction than a group trained and extinguished on a runway which is inclined at a 15° angle (15-15 group, i.e., high effort requirement)? According to Hullian inhibition theory, the 15-15 group should extinguish significantly faster than the 0-0 group. The 15-15 group presumably builds up more I_r than the 0-0 group leading to a depression of performance. However, according to the generalization decrement hypothesis, there should be no significant difference between the groups, since the acquisition and extinction conditions are equally similar to each group.

2. Will a group trained on a runway which is inclined at a 15° angle and extinguished on a horizontal runway (15-0 group, i.e., high effort requirement during training - low effort requirement during extinction) show facilitation, i.e., increased resistance to extinction, as compared to the 15-15 group? Using a Hullian orientation, one might argue that the response potential of a high effort habit is greater than that of a low effort habit, thus accounting for the observed facilitation when the high effort group is switched to low effort in extinction. However, according to the generalization decrement hypothesis, the 15-0 group should show more rapid extinction of the response

since there is very little similarity between the training and extinction conditions.

3. If facilitation is exhibited by the 15-0 group, could such a result be caused by a behavioral contrast effect? If this facilitation is due to a contrast effect, could it be eliminated if the final 10 training trials were run on a horizontal runway rather than on a runway inclined at 15°, and extinction was on the horizontal runway (15-0-0 group)? According to inhibition theory, this group should still exhibit the facilitation since it is still required to make a less effortful response during extinction, and in addition any depression of performance should be dissipated more quickly due to the insertion of the low effort trials prior to extinction The generalization decrement hypothesis would predict greater resistance to extinction for this group than for the 15-0 group since the similarity between the final 10 trials of acquisition and extinction would be greater for the 15-0-0 group than for the 15-0 group.

Latency

With regard to latency, i.e., time taken by S to leave the start-box once the start-box door has been raised, the questions are:

1. Will the 15-15 group show a significantly greater decrement in latency than the 0-0 group as hypothesized by

inhibition theory, or will the difference between the decrements of the two groups be non-significant as hypothesized by the generalization decrement position?

2. Will the 15-0 group exhibit facilitation as compared to the 0-0 and 15-15 groups? If it does exhibit facilitation, this would be indicated by its having less of a decrement in latency than either the 0-0 or 15-15 group. If the generalization decrement hypothesis is supported, the 15-0 group should exhibit a greater decrement than either the 0-0 or 15-15 group.

3. Will the 15-0-0 group exhibit a greater increment in latency on the final 10 trials of acquisition than that of the 15-15 and 15-0 groups? If a contrast effect is operating, this would be exhibited by a significantly greater increment in latency for the 15-0-0 group from Trials 41-50 to Trials 51-60 of acquisition.

Running Time

With regard to running time, i.e., the time it takes the animal to run a distance of 36 in., the questions are:

1. Will the 15-15 group show a significantly greater decrement in running time than the 0-0 group as hypothesized by inhibition theory, or will there be no difference between the decrements of the two groups as hypothesized by the generalization decrement position?

2. Will there be any facilitation exhibited by the 15-0 group as indicated by less of a decrement in running time as compared to the 0-0 and 15-15 groups, or will this group exhibit a greater decrement as the generalization decrement hypothesis predicts?

3. If facilitation is exhibited by the 15-0 group, will it also be exhibited by the 15-0-0 group during the final 10 trials of acquisition?

CHAPTER II

METHOD

Subjects

A total of 40 male rats, 20 albino (Holtzman) and 20 grey-hooded, were used as Ss. The Ss were approximately 150 days old at the start of the experiment, and were obtained from the colony maintained by the Psychology Department of Michigan State University. The animals were housed in individual cages. The Ss were assigned by a table of random numbers to one of the four experimental groups. Each group contained 10 Ss, five albinos and five grey hoods. The order of running strains within a group was not randomized, rather the first five animals run in each group were albinos, and second five were grey-hoods.

Apparatus

A floor-plan of the apparatus used is shown in Fig. 1. The apparatus was a 48 in. long runway, 8 in. wide, and 5 in. deep. The runway was made of 3/4 in. thick unpainted pine, and was covered with wire mesh. The start box and goal box were 12 in. long, 6 in. wide, and 4 in. deep, and were made of clear plexiglass with a hinged top. A photoelectric cell was located at a distance of 6 in. from the start box (PEC_1), and another

cell was at a distance of 6 in. from the goal box (PEC_2). A Standard Electirc Timer was started when S passed PEC_1 and was stopped when S passed PEC_2, giving the time it took S to run a distance of 36 in. Guillotine doors were located outside of the start and goal boxes. A stopwatch was used to measure latency, i.e., the time it took S to leave the start box once the door had been raised. A shaded 75 watt bulb was suspended above the center of the apparatus yielding relatively homogeneous lighting.

The runway was attached to the start and goal boxes with hinges which enabled the inclination of the runway to an angle of 15°. The start and goal boxes remained horizontal when the runway was tilted up (Fig. 2).

Procedure

Table 1 summarizes the procedure used for the four groups. The effort requirement is defined in terms of the angle of incline of the runway, i.e., high effort refers to running up an incline of 15° and low effort refers to running an incline of 0° (horizontal).

Fourteen days prior to the start of the experimental procedure, the Ss were placed upon a deprivation schedule in which they were allowed to eat ad lib for one hour per day. Water was supplied in the home cages at all times. All Ss were handled for approximately 5 minutes per day during these 14 pre-experimental days. Two days before the start of the experiment, the Ss were allowed to explore

the runway (which was in a horizontal position) for 5 min. The animals were also given training in eating two 45 mg. pellets of food from the glass food cup while being enclosed in the goal box. The same procedure was followed on the day before the start of the experimental procedure. The Ss were under approximately 22 hr. deprivation during the experiment.

Table 1.--Summary of procedure used for the four experimental groups.

	Angle of Incline of Runway			
Trials	0-0	15-15	15-0	15-0-0
Acquisition				
1-10	0	0	0	0
11-50	0	15	15	15
51-60	0	15	15	0
Extinction	0	15	0	0

The procedure employed in running the Ss during the experiment was as follows: After being brought into the experimental room, all Ss were given a 5 min. period in which to adapt to the surroundings before the actual running was begun. At the end of the 5 min. adaptation period, E picked the first animal up and placed it in the start box. After traversing the runway and entering the goal box, the goal box door was closed, and S remained in the goal box for approximately 10 sec. During this time E noted the

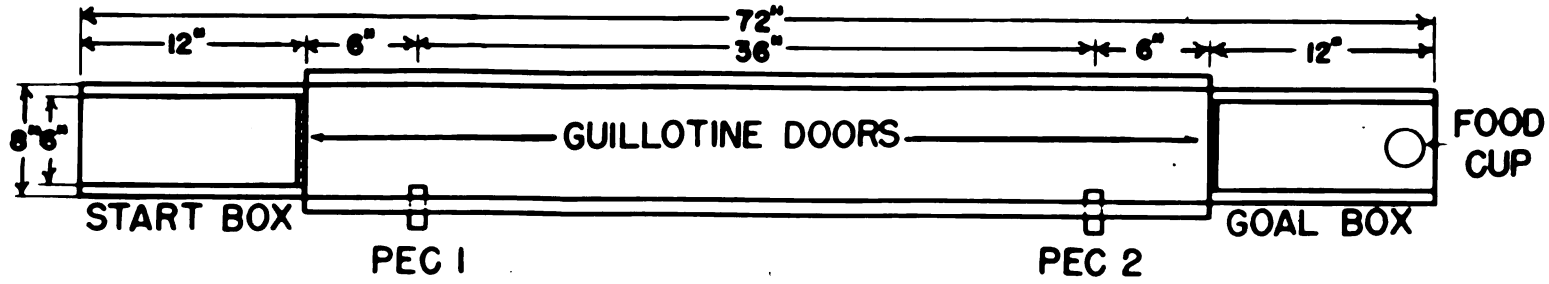

FIG. 1. Floor plan of apparatus.

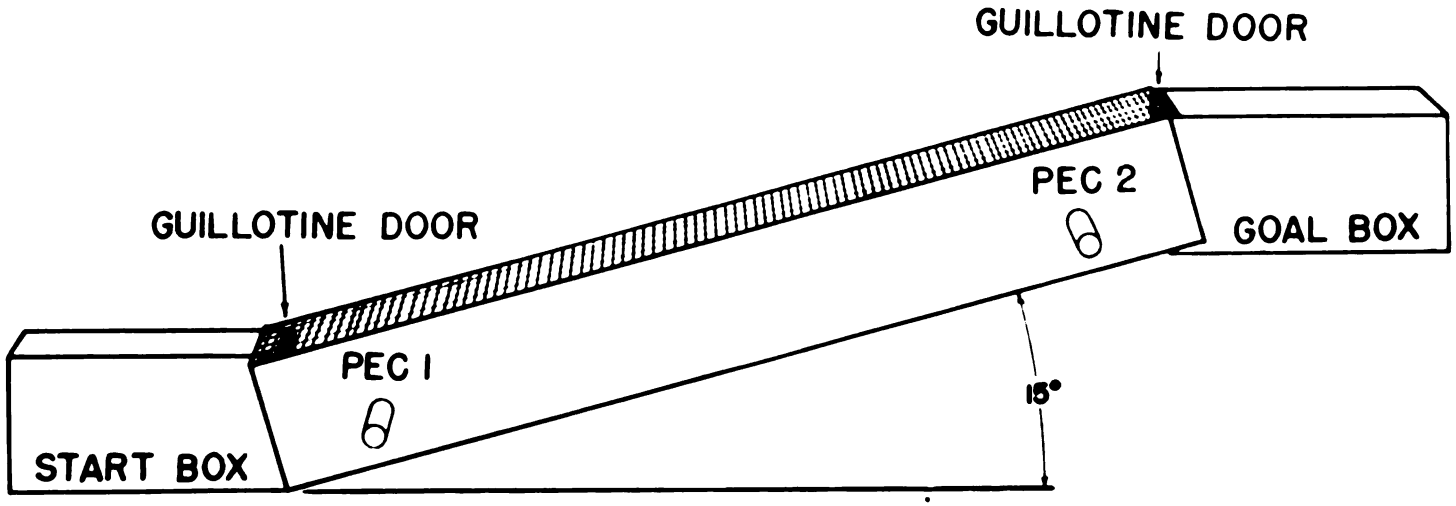

FIG. 2. Apparatus tilted up at an angle of 15°.

latency and running time measures. The S was removed from the goal box and replaced in its home cage. The second animal in the block being run was then taken from its cage and placed in the start box, and the entire procedure repeated until all Ss in the block had run a total of 10 trials (or 20 during extinction) in rotation. After the animals had been run, they were returned to the room in which they were housed and were fed.

Throughout acquisition and extinction the ITI for an individual S was the time it took the other Ss in the block to run a particular trial. Thus the ITI varied during the course of the experiment, generally becoming shorter during the latter trials of acquisition and lengthening during extinction. It should also be noted that the first 12 animals run were run in two blocks of six each, one block being started a day earlier than the other. However, due to the limitations of time, it was found to be more practical to run the animals in blocks of four, with one block starting four days prior to the second block, and the difference in procedure did not appear to affect the data. The order in which the Ss within a block were run on each day was determined by a random number table. All Ss ran a total of 10 trials per day during training, and received reinforcement (two 45 mg. pellets of food) on every trial. On Day 1, all Ss ran the initial 10 acquisition trials with the runway in a horizontal position (0° angle of

incline). On Days 2-6 the Ss were run according to their assigned groups. Extinction began on Day 7, and consisted of 20 trials per day. The Ss were run until they reached a criterion of two consecutive trials in which latency plus running time was at least 120 sec., or for 80 trials if they failed to reach criterion.

The groups employed were as follows:

0-0 (Low effort during acquisition and extinction)
This group received a total of 60 training trials with the runway in a horizontal position (0° angle of incline), and was extinguished with the alley in the horizontal position.

15-15 (High effort during acquisition and extinction)
This group received 10 training trials with the runway in the horizontal position, 50 training trials with the runway inclined at an angle of 15°, and was extinguished with the runway inclined at an angle of 15°.

15-0 (High effort during acquisition and low effort during extinction)
This group received 10 training trials with the runway in the horizontal position, 50 training trials with the runway inclined at an angle of 15°, and was extinguished with the runway in the horizontal position.

15-0-0 (High effort followed by low effort during acquisition and low effort during extinction)

This group received 10 training trials with the runway in the horizontal position, 40 training trials with the runway inclined at an angle of 15°, 10 training trials with the runway in the horizontal position, and was extinguished with runway in the horizontal position.

CHAPTER III

RESULTS

All latency and running time measures were converted to reciprocals to meet the assumptions of the analysis of variance (Edwards, 1962). The mean of the reciprocals of every 10 trials was computed for each S, and was used as a raw score in analyzing the results. For example, if a reference is made to the mean reciprocal latency of Trials 1-10 of acquisition this refers to the mean of the reciprocals of the latencies recorded on Trials 1-10 of acquisition for a particular S.

Mean Reciprocal Latencies

Latency was defined as the time it took S to leave the start box once the start box door had been raised. Table I in the Appendix shows the mean reciprocal latencies of the four groups during acquisition and extinction (each entry is the grand mean of the mean reciprocal latencies of the 10 Ss in each group).

A 4 x 2 analysis of variance was made on the mean reciprocal latencies of Trials 1-10 of acquisition to determine if any differences existed between the four groups and/or two strains (Table II--Appendix). Neither the main effects nor the interaction were found to be

significant. Since there was no difference between albinos and grey hoods, all subsequent comparisons were made without analyzing any possible strain differences.

A simple analysis of variance was run on the mean reciprocal latencies of Trials 51-60 of acquisition for the four groups (Table III--Appendix). The analysis yielded no significant differences among the groups in mean reciprocal latencies of the final 10 trials of acquisition.

In order to make the various comparisons outlined in the Introduction, difference scores were used in the remaining analyses of the latency measures. It was reasoned that a difference score, which was computed by subtracting the mean reciprocal latency of Trials 1-10 of extinction from the mean reciprocal latency of Trials 51-60 of acquisition for each S, would best represent the amount of decrement in latency from the final 10 trials of acquisition to the first 10 trials of extinction. These decrements appear in Table 2.

Table 2.--Mean decrements in mean reciprocal latencies from trials 51-60 of acquisition to trials 1-10 of extinction of the four groups

0-0	15-15	15-0	15-0-0
.488	.496	.498	.698

An analysis of variance made on these decrements indicated that the differences among the four groups were not statistically significant (Table IV--Appendix).

The measure used to indicate the amount of increment in latency was computed by subtracting the mean reciprocal latency of Trials 41-50 of acquisition from the mean reciprocal latency of Trials 51-60 of acquisition. The comparisons made on the increments in mean reciprocal latencies on the final trials of acquisition are presented in Table 3.

Table 3.--Summary of t-tests made on increments in mean reciprocal latencies from trials 41-50 to trials 51-60 of acquisition

Comparison		Mean	p
15-0-0	(Trials 51-60)	1.806	$\angle .01$(2-tailed)
	(Trials 41-50)	1.566	
15-0-0 > 15-15+15-0		.240 .158	$\angle .01$(1-tailed)

A t-test made on the difference in mean reciprocal latencies from Trials 41-50 to Trials 51-60 of acquisition for the 10 Ss of the 15-0-0 group yielded a statistically significant increment. On Trials 1-50 of acquisition, the 15-15, 15-0, and 15-0-0 groups were under the same experimental procedure. The difference in training occurred on Trials 51-60 when the 15-0-0 group ran these 10 trials on the horizontal runway while the other two groups continued

to run on the runway inclined at an angle of 15°. If the 15-0-0 group exhibited facilitation due to the hypothesized contrast in stimulation it was held that this would be manifested in a greater increment for this group as compared to the pooled increment of the other two groups (15-15 and 15-0). It was found that the 15-0-0 group did show a significantly greater increment than that of of the 15-15 plus 15-0 group. In other words, when the runway was lowered to the horizontal position during the final 10 trials of acquisition the animals left the start box significantly faster than those animals which continued to run the inclined runway.

The following is a summary of the results obtained with regard to mean reciprocal latencies:

1. No significant difference was found between the albino and grey hooded animals in mean reciprocal latencies on Trials 1-10 of acquisition.

2. No significant difference was found in the mean reciprocal latencies of Trials 51-60 of acquisition among the four groups.

3. No significant difference was found among the four groups in the decrement in mean reciprocal latencies from the last 10 trials of acquisition to the first 10 trials of extinction, although the 15-0-0 group did exhibit the greatest decrement.

4. A significant increment was found in mean reciprocal latency from Trials 41-50 to Trials 51-60 of acquisition for the 15-0-0 group.

5. The increment in mean reciprocal latency from Trials 41-50 to Trials 51-60 of acquisition of the 15-0-0 group was significantly greater than the increment of the 15-15 plus 15-0 group.

Mean Reciprocal Running Times

Running time refers to the time it took S to traverse a distance of 36 in. (the distance from PEC_1 to PEC_2). Table V in the Appendix shows the mean reciprocal running times of the two strains (i.e., albino and grey hooded) within each of the four groups during acquisition and extinction (each entry is the grand mean of the mean reciprocal running times of the 5 Ss of each strain in each group).

A 4 x 2 analysis of variance was made on the mean reciprocal running times of Trials 1-10 of acquisition to determine if any differences existed between the four groups and/or two strains. A significant difference between the two strains ($p < .005$), but not between groups, was found (Table VI--Appendix). Because of the significant difference found between strains all subsequent comparisons included this organismic variable.

A similar analysis of variance made on the mean reciprocal running times of Trials 51-60 of acquisition

for the four groups and two strains again yielded a significant difference between strains but not among the groups (Table VII--Appendix).

In order to make the various comparisons outlined in the Introduction, difference scores, which were described with regard to mean reciprocal latencies, were used to examine the decrements in mean reciprocal running times from Trials 51-60 of acquisition to Trials 1-10 of extinction. The mean decrements for each group appear in Table 4.

Table 4.--Mean decrements in mean reciprocal running times from trials 51-60 of acquisition to trials 1-10 of extinction for the four groups and two strains

	0-0	15-15	15-0	15-0-0
Albino	.177	.471	.250	.270
Grey Hooded	.122	.347	.150	.291
Mean of Strains	.149	.409	.200	.280

An analysis of variance of the decrements yielded a significant main effect of Groups ($p < .01$), but neither the main effect of Strains nor the interaction of S x G were significant. This analysis appears in Table VIII in the Appendix.

Because a significant difference among groups was found, a series of t-tests were run in accordance with the questions raised in the Introduction. The two strains

were not analyzed independently because of the non-significant difference found in the analysis of variance. The various comparisons made are summarized in Table 5.

Table 5.-- Summary of t-tests made on decrements in mean reciprocal running times from trials 51-60 of acquisition to trials 1-10 of extinction

Comparison	Mean	p
15-15 > 0-0	.409 .149	< .005 (1-tailed)
15-15 > 15-0	.409 .200	< .01 (1-tailed)
0-0 = 15-0	.149 .200	< .50 (2-tailed)
15-0-0 > 15-0	.280 .200	< .150 (1-tailed)

As can be seen from Table 5, the 15-15 group exhibited a significantly greater decrement in running time than both the 0-0 group and the 15-0 group. However, there was no difference in the decrements of the 0-0 and 15-0 groups. There was also no significant difference in the decrements of the 15-0-0 and 15-0 groups.

A t-test was made on the difference in mean reciprocal running times from Trials 41-50 to Trials 51-60 of acquisition for the 15-0-0 group. No significant increment in mean reciprocal running time was found for the 15-0-0 group. In comparing the increment of the 15-0-0 group to that of the 15-15 plus 15-0 group it was noted

that the increment of the 15-15 plus 15-0 group was actually greater than that of the 15-0-0 group. However, this difference was not statistically significant. The results of these two t-tests appear in Table IX in the Appendix.

The following is a summary of the results obtained with regard to mean reciprocal running times:

1. A significant difference was found between the albino and grey hooded animals on Trials 1-10 of acquisition as well as on Trials 51-60 of acquisition.

2. No significant difference was found in the mean reciprocal running times of Trials 51-60 of acquisition among the four groups.

3. The 15-15 group had a significantly greater decrement in mean reciprocal running time from the last 10 trials of acquisition to the first 10 trials of extinction than the 0-0 group.

4. The 15-15 group also had a significantly greater decrement than the 15-0 group.

5. No significant difference in decrements was foudn between the 0-0 group and the 15-0 group.

6. No significant increment in mean reciprocal running time from Trials 41-50 to Trials 51-60 of acquisition was found for the 15-0-0 group.

7. This increment was less than the increment of the 15-15 plus 15-0 group although not significantly less.

Mean Number of Trials to Extinction

The criterion for extinction was two consecutive trials in which latency plus running time was at least 120 sec. If this criterion was not met, extinction was carried out for a total of 80 trials.

The mean number of trials to extinction for the four groups and two strains appears in Table 6.

Table 6.--Mean number of trials to extinction for the four groups and two strains

	0-0	15-15	15-0	15-0-0
Albino	70.4	63.2	62.0	48.4
Grey Hooded	27.8	12.6	19.8	17.4

A 4 x 2 analysis of variance of the number of trials to extinction for the four groups and two strains appears in Table X in the Appendix. Only the main effect of Strains was significant ($p < .005$).

Because of the tremendous difference between strains in the number of trials to extinction, comparisons were made between the groups within each strain. Since the levels of significance thus obtained were independent, they were then combined according to the formula: $p = \frac{(P1 + P2)^2}{2}$ to yield the significance level of any particular group comparison. The various comparisons made appear in Table 7.

Table 7.--Summary of t-tests made between mean number of trials to extinction of groups within each strain and the combined probabilities of these comparisons

Comparison		Mean	p
Albino:	0-0 >	70.4	< .250 (1-tailed)
	15-15	63.2	
G. Hood:	0-0 >	27.8	< .025 (1-tailed)
	15-15	12.6	
Combined prob. 0-0 > 15-15			< .04 (1-tailed)
Albino:	0-0 >	70.4	< .30 (1-tailed)
	15-0	62.0	
G. Hood:	0-0 >	27.8	< .10 (1-tailed)
	15-0	19.8	
Combined prob. 0-0 > 15-0			< .08 (1-tailed)
Albino:	15-15 =	63.2	> .90 (2-tailed)
	15-0	62.0	
G. Hood:	15-15 =	12.6	< .20 (2-tailed)
	15-0	19.8	
Albino:	15-0 >	62.0	< .25 (1-tailed)
	15-0-0	48.4	
G. Hood:	15-0 >	19.8	< .30 (1-tailed)
	15-0-0	17.4	
Combined prob. 15-0 > 15-0-0			< .15 (1-tailed)
Albino:	0-0 >	70.4	< .10 (1-tailed)
	15-0-0	48.4	
G. Hood:	0-0 >	27.8	< .05 (1-tailed)
	15-0-0	17.4	
Combined prob. 0-0 > 15-0-0			< .01 (1-tailed)

With regard to the albinos there were no significant differences in any of the comparisons made. Considering the

grey hooded rats, the 0-0 group exhibited a significantly greater number of trials to extinction than both the 15-15 group, and the 15-0-0 group. After combining independent significance levels, the significant findings were in the comparisons of the 0-0 group having more trials to extinction than both the 15-15 group, and the 15-0-0 group.

The following is a summary of the results obtained with regard to mean number of trials to extinction:

1. A large significant difference was found between the albino and grey hooded animals. The albinos had a significantly greater number of trials to extinction than the grey hoods.

2. The 0-0 group was found to have a significantly greater number of trials to extinction than the 15-15 group.

3. The 0-0 group was found to have a significantly greater number of trials to extinction than the 15-0-0 group.

4. No significant difference was found between the mean number of trials to extinction of the 15-0 and 15-0-0 groups.

5. No significant difference was found between the mean number of trials to extinction of the 0-0 and 15-0 groups.

6. No significant difference was found between the mean number of trials to extinction of the 15-15 and 15-0 groups.

Mean Number of Trials to Reach the Median Latency of Trials 1-30 of Extinction (7.5 sec.)

Because of the huge strain differences found in the number of trials to extinction an additional measure was computed in an attempt to reduce the strain differences. The grand median latency of the first 30 trials of extinction of all 40 Ss was found to be 7.5 sec. The number of trials it took each S to reach this median was found and the mean for the two strains within the four groups appears in Table 8.

Table 8.--Mean number of trials to reach latency of 7.5 sec. during trials 1-30 of extinction for the two strains and four groups.

	0-0	15-15	15-0	15-0-0
Albino	11.4	7.8	10.0	8.8
Grey Hooded	9.0	9.0	7.6	10.0
Mean of Strains	10.2	8.4	8.8	9.4

A 4 x 2 analysis of variance of the number of trials to reach the latency of 7.5 sec. for the four groups and two strains yielded no significant main effects or interaction (Table XI--Appendix). Therefore, according to this measure there were no significant differences among the groups in resistance to extinction.

CHAPTER IV

DISCUSSION AND CONCLUSION

Mean Reciprocal Latencies

The results tend to indicate the following conclusions with regard to the latency measure:

1. No statistically significant difference was found in the mean reciprocal latencies of Trials 51-60 of acquisition among the four groups. This finding tends to suggest that the animals may have reached an asymptote of responding at the end of acquisition which could have resulted in the suppression of the possible measurable affects of the effort variable upon the latency response.

2. There was no significant difference found among the four groups in the decrements in mean reciprocal latencies from the last 10 trials of acquisition to the first 10 trials of extinction. The 15-15 group exhibited a slightly greater decrement than the 0-0 group. Although the difference is in the direction predicted by Hullian theory, the difference was non-significant as predicted by the generalization decrement hypothesis. The 15-0 group exhibited a slightly greater decrement than both the 0-0 and 15-15 groups. This difference is in the direction predicted by the generalization decrement

hypothesis. However, this difference was rather small and not statistically significant.

The Hullian position would have predicted that the 15-15 group exhibit the greatest decrement. The generalization decrement hypothesis would have predicted that the 15-0 group exhibit the greatest decrement. The data did not seem to support either hypothesis. The 15-0-0 group was observed to have the greatest decrement while the other three groups (i.e., 0-0, 15-15, and 15-0) exhibited decrements which were approximately equal in magnitude.

3. The 15-0-0 group had a significantly greater increment in mean reciprocal latency from Trials 41-50 to Trials 51-60 of acquisition than the 15-15 plus 15-0 group. It appears that reduction of the effort requirement during the final 10 trials of acquisition resulted in facilitation.

The major questions which the results pose seem to be: Why did the 15-0-0 group exhibit facilitation during the final 10 trials of acquisition while the 15-0 group did not seemingly exhibit facilitation during the first 10 trials of extinction? In other words, why did a change in stimulus conditions produce facilitation in the case of the 15-0-0 group and not in the case of the 15-0 group? The change in stimulus conditions for the 15-0 group was also accompanied by omission of reinforcement, while the 15-0-0 group continued to receive reinforcement with the

change in stimulus conditions. The correlation of reward or nonreward with the stimulus change may have interacted in such a way as to produce the results obtained. If the decrements of the 15-0 and 15-0-0 groups are compared, it might be argued that the 15-0 group does exhibit facilitation as compared to the 15-0-0 group. It is possible that the time taken to leave the start box may not have been a particularly sensitive index of the influence of the effort variable upon behavior.

Mean Reciprocal Running Times

The results seem to indicate the following conclusions with regard to mean reciprocal running times:

1. The findings obtained during the final 10 trials of acquisition are in agreement with Jensen's results of no suggestion of a main effect with regard to the effort variable. If effortfulness of the response had caused a depression in the performance of the high effort groups this would have yielded a greater increment for the 15-0-0 group, when effortfulness was reduced, as compared to the 15-15 plus 15-0 group. The 15-0-0 group was observed to have less of an increment in mean reciprocal running time from Trials 41-50 to Trials 51-60 of acquisition than the 15-15 plus 15-0 group. However, this difference between the increments of the two groups was not statistically significant. Therefore, it is concluded

that the 15-0-0 group did not exhibit the hypothesized facilitation during the final 10 trials of acquisition when the effort requirement was reduced.

2. The 0-0 group exhibited a significantly smaller decrement from Trials 51-60 of acquisition to Trials 1-10 of extinction than the 15-15 group. This finding tends to support the prediction of Hullian theory that high effort causes a greater decrement in response strength from acquisition to extinction than low effort does. It could conceivably be argued that this effect may have been caused by differences in habit strength, since the 0-0 group received 60 reinforcements while the 15-15 group received only 50 reinforcements, with regard to the response which was extinguished. According to Hullian theory, habit strength increases as a function of the number of reinforcements. Therefore, the 0-0 group, which received 60 reinforcements for the response of running the horizontal runway and then no longer received reinforcement for this response, might have been expected to exhibit less of a decrement than the 15-15 group, which received 50 reinforcements for the response of running the inclined runway and then no longer received reinforcement for this response. However, the 15-0 group received only 10 reinforcements for the response of running the horizontal runway. It was this response which was not reinforced during the extinction procedure.

Thus the habit strength of the response which was subjected to the extinction procedure should presumably have been weaker in the 15-0 group than in any of the other groups. This group would have been expected to show the greatest decrement in mean reciprocal running time. This was not indicated by the data. Therefore, the greater decrement of the high effort group as compared to the low effort group does not seem to be related to differences in habit strength.

3. The 15-0 group exhibited facilitation during extinction as compared to the 15-15 group, but not as compared to the 0-0 group. In fact, the 15-0 group was observed to have a greater decrement than the 0-0 group although this difference was not statistically significant.

The major questions which the results pose seem to be: Why did the 15-0 group presumably exhibit facilitation during extinction as compared to the 15-15 group, but not as compared to the 0-0 group? Also, why did the 15-0-0 group exhibit less of an increment during the final 10 trials of acquisition than the 15-15 plus 15-0 group?

At the start of the extinction procedure the 15-0 group was simultaneously subjected to a change in stimulus conditions and to withdrawal of reinforcement. It has been observed that nonreward of a previously rewarded response often results in an "increase in response vigor"

(Amsel & Hancock, 1957, p. 126). This observable increase has been termed "frustration effect." In other words, frustration is viewed as functioning as an energizer of behavior at the start of extinction. It is conceivable that behavioral contrast may be dependent upon the state of frustration of the organism. This might explain why, in the present study, the 15-0-0 group did not exhibit facilitation during the final 10 trials of acquisition as compared to the 15-15 plus 15-0 group. Presumably, no frustration was present during these last 10 trials since reinforcement was given after each response. Therefore, although the stimulus situation was altered, the frustration component was not present. When both the stimulus situation was changed and frustration generated, as in the case of the 15-0 group during the first 10 trials of extinction, facilitation was exhibited by the 15-0 group as compared to the 15-15 group. Further, facilitation due to behavioral contrast may be a function of the inter-trial interval. It will be recalled that behavioral contrast was observed by Stachnik in a Skinnerian situation in which the ITI was minimal. Perhaps the effects of frustration and change in stimulus conditions dissipate as a function of time. This might possibly explain why, in the present study, the 15-0 group did not exhibit any measurable facilitation as compared to the 0-0 group.

If any measure, of those used in the present study, was to indicate the influence of the effort variable the running time measure would be expected to be most likely to do so. As mentioned by Jensen, an increase in the vigor of the response also increases the effortfulness of the response, and the response presumably involved is that of running. This may partially explain why the effect of effort was reflected at all in this measure and not in the latency measure. Actually, there may have been no difference in the amount of effort required to leave the start-box, while that required to traverse the runway did vary according to the groups. It may be concluded that the running time measure reflected changes in performance more than did the latency measure.

Mean Number of Trials to Extinction

Perhaps the most striking finding with regard to the mean number of trials to extinction is that of the huge difference between strains. The albinos exhibited greater resistance to extinction than the grey hoods. Of the 20 albinos run, nine were run for the maximum of 80 trials, whereas all the grey hoods extinguished within 40 trials. Strain differences have also been found in amount of exploratory behavior (Carr & Williams, 1957; Williams, Zerof, & Carr, 1962), degree of emotionality (Broadhurst, 1958; Sines, 1962), amount of hoarding (Stamm, 1954), and even in rate of bar-pressing (Pieper,

Garwood, Lewis, & Marx, 1962). In the latter study, in which albino and hooded rats were used, it was found that "the albino strain demonstrated the higher over all BP (bar-press) rate irrespective of reinforcement concentration" (Pieper, et al., 1962, p. 425). Rate of bar-pressing is defined in terms of the number of responses made during a period of time. In most of the studies in which the effect of effort upon bar pressing was investigated, resistance to extinction was measured in terms of number of responses made until some criterion was reached. The present study also employed a measure of resistance to extinction defined in terms of number of responses (trials) made until a specified criterion was reached. Therefore, if number of bar presses is viewed as analogous to number of responses made in traversing a runway, the findings of the present study agree with those of Pieper, et al. The overall number of responses made to a criterion of extinction was higher for albinos than for grey hoods. In addition, if bar press rate is viewed as a measure of speed of responding, the findings of the present study with regard to albinos running faster than grey hoods are also in accordance with Pieper, et al. findings.

When the strains were analyzed separately and the independent significance levels of the various comparisons combined the following conclusions were made:

1. As predicted by Hullian theory, the 0-0 group (low-effort) exhibited greater resistance to extinction than the 15-15 group (high effort). This effect was more marked for the grey hooded animals than for the albinos.

2. No facilitation was exhibited by the 15-0 group as compared to the 15-15 and 0-0 groups. However, the resistance to extinction of the 0-0 group approached being significantly greater than that of the 15-0 group, a result which is in accordance with the prediction of the generalization decrement hypothesis.

3. No difference in resistance to extinction was found between the 15-15 and the 15-0 groups. This result is not in aggrement with that of Lawson and Brownstein who found that the group trained and extinguished under high effort exhibited greater resistance to extinction than the group trained under high effort and extinguished under low effort. It is possible that in the present study the difference in the training and extinction situations was not as highly discriminable to the animals as it may have been in the Lawson and Brownstein study.

Mean Number of Trials to Reach the Median Latency of Trials 1-30 of Extinction

The data for the number of trials to extinction were collected using two consecutive trials in which latency plus running time was at least 120 sec. as the criterion of extinction. This had been the criterion used by Lawson and

Brownstein. However, it was found that this measure resulted in tremendous strain differences, which were not controlled for in the original design (i.e., by randomizing order of running strains within each group). This led to the consideration that an alternative measure of resistance to extinction might make the data more easily interpretable. Therefore, the present measure of the mean number of trials to the median latency of Trials 1-30 of extinction was employed as an indicator of resistance to extinction. Using this measure strain differences were eliminated. This measure also gave no indication of any significant difference among the groups in resistance to extinction. On the basis of this measure it is concluded that either the effort variable had no influence upon resistance to extinction, or that this measure was not sensitive enough to indicate any difference that may have existed.

Conclusions

The following is a summary of the results obtained:

1. Significant differences between the two strains were found with regard to running time and mean number of trials to extinction. The albinos ran faster and had a greater number of trials to extinction than the grey hoods.

2. No significant difference in the decrement from the last 10 trials of acquisition to the first 10 trials of extinction with regard to latency was found between

the 0-0 group and 15-15 group. However, the 15-15 group ran significantly slower during the first 10 trials of extinction than did the 0-0 group. The 0-0 group also had significantly greater resistance to extinction than the 15-15 group as evidenced by the mean number of trials to the extinction criterion, but not by the number of trials to the median latency of Trials 1-30 during extinction.

3. The 15-0 group exhibited facilitation in running time during extinction as compared to the 15-15 group. However, the reverse relationship was observed with regard to the latency measure, although the difference between the two groups was not statistically significant. No significant difference between the 15-0 and 15-15 groups was found in the two measure of resistance to extinction.

4. The 15-0 group was observed to have a greater decrement in latency and running time than the 0-0 group, although not significantly greater. The 0-0 group also exhibited a greater mean number of trials to extinction than the 15-0 group. This difference approached being statistically significant.

5. Facilitation in latency was shown by the 15-0-0 group during the final 10 trials of acquisition when the effort requirement was reduced. Although facilitation was observed in the running time measure, the increment was not statistically significant.

6. The 15-0-0 group exhibited a significantly greater increment in latency, when the effort requirement was reduced during acquisition, than that of the 15-15 plus 15-0 group. However, the reverse relationship was observed with regard to the running time measure, although this difference was not statistically significant.

7. The 0-0 group exhibited greater resistance to extinction than the 15-0-0 group as measured by the mean number of trials to extinction.

8. The possible interaction of frustration and change in the stimulus situation in producing behavioral contrast with regard to the running response is hypothesized.

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APPENDICES

Table I.--Mean reciprocal latencies of the four groups during acquisition and extinction

Trials	0 - 0	15-15	15-0	15-0-0
Acquisition				
1-10	.387	.399	.400	.428
11-20	.764	.481	.545	.510
21-30	1.017	.883	.704	.771
31-40	1.555	1.124	1.188	1.236
41-50	1.626	1.375	1.376	1.566
51-60	1.750	1.596	1.471	1.806
Extinction				
1-10	1.262	1.100	.973	1.107
11-20	.311	.212	.178	.226
21-40	.192	.098	.098	.111

Table II.--Analysis of variance of mean reciprocal latencies of trials 1-10 of acquisition for the four groups and two strains

Source	SS	df	MS
Strains (S)	.021	1	.021
Groups (G)	.009	3	.003
S x G	.062	3	.021
Error	1.745	32	.058
Total	1.837	39	

Table III.--Analysis of variance of mean reciprocal latencies of trials 51-60 of acquisition for the four groups

Source	SS	df	MS	F	p
Between	.693	3	.231	1.116	$\angle .250$
Within	7.450	36	.207		
Total	8.143	39			

Table IV.--Analysis of variance of decrements in mean reciprocal latencies from trials 51-60 of acquisition to trials 1-10 of extinction for the four groups

Source	SS	df	MS
Between	.315	3	.103
Within	4.617	36	.128
Total	4.932	39	

Table V.--Mean reciprocal running times of the two strains (Albino-A and grey hooded-GH) within the four groups during acquisition and extinction

	0-0		15-15		15-0		15-0-0	
	A	GH	A	GH	A	GH	A	GH
Acq.								
1-10	.684	.440	.599	.369	.614	.433	.487	.522
11-20	.894	.545	.614	.378	.527	.430	.581	.527
21-30	.961	.614	.837	.539	.704	.528	.746	.734
31-40	1.183	.696	1.007	.598	.896	.692	.845	.810
41-50	1.113	.722	1.095	.677	.832	.710	.955	.874
51-60	1.137	.770	1.197	.765	.965	.678	1.010	.906
Ext.								
1-10	.960	.648	.726	.418	.715	.528	.740	.615
11-20	.426	.311	.416	.135	.306	.229	.397	.211
21-40	.394	.109	.382	*	.291	.051	.312	.015

*All Ss reached criterion

Table VI.--Analysis of variance of mean reciprocal running times of trials 1-10 of acquisition for the four groups and two strains

Source	SS	df	MS	F	p
Strains (S)	.240	1	.240	14.118	$<.005$
Groups (G)	.033	3	.011		
S x G	.126	3	.042	2.470	$<.100$
Error	.557	32	.017		
Total	.956	39			

Table VII.--Analysis of variance of mean reciprocal running times of trials 51-60 of acquisition for the four groups and two strains

Source	SS	df	MS	F	p
Strains (S)	.884	1	.884	19.217	$<.005$
Groups (G)	.157	3	.052	1.130	NS
S x G	.151	3	.050	1.087	NS
Error	1.465	32	.046		
Total	2.657	39			

Table VIII.--Analysis of variance of decrements in mean reciprocal running times from trials 51-60 of acquisition to trials 1-10 of extinction for the four groups and two strains

Source	SS	df	MS	F	p
Strains (S)	.042	1	.042	1.50	NS
Groups (G)	.386	3	.129	4.61	$<.01$
S x G	.029	3	.010		
Error	.904	32	.028		
Total	1.361	39			

Table IX.--Summary of t-tests made on increments in mean reciprocal running times from trials 41-50 to trials 51-60 of acquisition

Comparison		Mean	p
15-0-0	(Trials 51-60)	.958	<.20 (2-tailed)
	(Trials 41-50)	.914	
15-0-0 = 15-15 ≠ 15-0		.044 .070	<.60 (2-tailed)

Table X.--Analysis of variance of the number of trials to extinction for the four groups and two strains

Source	SS	df	MS	F	p
Strains (S)	17305	1	17305	71.21	<.005
Groups (G)	1382	3	461	1.90	<.250
S x G	488	3	163		
Error	7779	32	243		
Total	26954	39			

Table XI.--Analysis of variance of number of trials to reach latency of 7.5 sec. during trials 1-30 of extinction for the four groups and two strains

Source	SS	df	MS
Strains (S)	3	1	3.0
Groups (G)	7	3	2.3
S x G	40	3	13.3
Error	518	32	162.0
Total	568	39