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The Immediate Effects of Emotionality Upon Behavior Strength.

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THE IMMEDIATE EFFECTS OF EMOTIONALITY UPON
BEHAVIOR STRENGTH

A Dissertation

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

in

The Department of Psychology

by

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ABSTRACT

Contemporary behavior theory employs three main classes of variables in an attempt to predict behavior. These are motivation, learning, and inhibitory factors. Hull alone has attempted to quantify the interrelation of these variables. He postulates that behavior strength is a multiplicative function of a learning factor, habit, and a motivational factor, drive. The total effective drive operative at a given time is presumed to consist of the relevant drive plus any coexisting irrelevant drives.

In order to test this drive summation hypothesis, 126 rats were trained to run a linear, alley maze while under a 23-hr. hunger need. Following 21 daily training trials the animals were assigned to nine treatment groups consisting of the possible combinations of 0, 12, and 23 hrs. food privation, as a relevant need, with zero, weak and strong faradic stimulation, as an irrelevant need. The "test consisted of a trial similar to a training trial." The state induced by the faradic stimulation was called emotionality and viewed as possessing motivational properties. Both start box latency and maze running time were utilized as criterion behavior.

The findings were mainly negative. The criterion behavior was not significantly influenced by the introduction of an irrelevant need into the motivational complex. As expected, changes in the relevant need state did significantly affect latency and running time. A near significant relevant need-irrelevant need interaction was observed. Several possible ways of modifying the theory to account for more of the present experimental data were discussed. It was concluded that the present data provided no definitive evidence either for or against the theory.

INTRODUCTION

Contemporary behavior theory employs three main classes of variables in an attempt to predict behavior. These are energization or motivation, learning or cognition, and decremental or inhibitory factors (e.g., fatigue, reactive inhibition). Of these, the former two probably have received most attention. Of course, the study of learning has an extensive history, dating from the time of Ebbinghaus. Though the formal study of motivation is not as old, renewed interest in this variable is attested to by several recent publications (13, 14, 15, 18). Of the modern theorists, Hull alone has attempted to formulate in a quantitative fashion the interrelation of learning, inhibitory, and motivational factors.

Hull (11) postulated that behavior strength is a multiplicative function of a learning factor, habit strength (s^H_r), and a motivational factor, generalized drive (D). The term "behavior strength" as used throughout this paper is, in general, equivalent to Hull's concept of $s^{\dot{E}}_r$, momentary effective reaction potential. In stating the determinants of $s^{\dot{E}}_r$, constructs other than s^H_r and D have been omitted. s^H_r is defined by changes

in behavior due to practice. D is defined jointly by greater energization of behavior following such antecedent conditions as deprivation of food and noxious stimulation. Hull then hypothesized that the total effective drive strength (D) operative at a given amount consists of the relevant drive strength ($\bar{D}$) plus the irrelevant drive strength ($\dot{D}$) derived from all needs co-existing in the organism. $\bar{D}$ is contributed by the need which is reduced by the criterion behavior, whereas $\dot{D}$ is contributed by needs which are historically unrelated to the criterion behavior and whose existence is defined by independent operations.

Apparently, Hull arrived at the notion of drive summation by fitting a curve to data collected by Perin (21) and Williams (22). In independent studies these investigators trained rats to press a lever to obtain pellets of food in a Skinner box. After training, the animals' behavior was extinguished under food privation intervals ranging from 3 to 22 hrs. By fitting a curve to the results and extrapolating back to a point of zero D , Hull noted that the number of responses to extinction was 28 per cent as great as occurred under a drive resulting from 22 hrs. food privation. Unfortunately, no animals were actually tested under zero D . This finding, Hull

presumed, is due to the presence of residual $\dot{D}$ present at the time of extinction. He adduced further evidence to support this belief from studies by Zener and McCurdy (30), Finch (10), and Skinner (28).

Koch and Daniel (17) designed an experiment to test the validity of Hull's extrapolation from the Perin-Williams data. Rats were trained to press a lever in a Skinner box similar to the one used by Perin and Williams. The animals were trained under strong hunger and extinguished under conditions designed to provide maximal satiation. The median number of responses to extinction was one, and it was concluded that this small value suggests the true behavior potential is zero. The authors believe the assumption that $\dot{D}$ combines with habit structures to produce behavior is highly tenuous. However, it should be pointed out that this study does not provide a definitive test of this assumption, since no attempt was made to manipulate $\dot{D}$ per se.

Following these early studies, which dealt only indirectly with the problem of drive summation, experiments were specifically designed to test this hypothesis. These studies divide themselves into those concerned with consummatory behavior and those dealing with preparatory behavior.

Siegel and Siegel (23) observed that mildly thirsty rats receiving faradic stimulation immediately prior to drinking, drank more water than non-stimulated control animals. Their finding was interpreted within the framework of a molecular theory of thirst. In a similar, independent study, Ansel and Maltzman (3) confirmed the empirical finding of Siegel and Siegel. However, these investigators offered their results as support for Hull's generalized drive notion. Furthermore, they contended that in accordance with Hull's theory any ongoing response would have been augmented by the addition of D. In order to test this prediction, Siegel and Brantly (24) compared the dry food intake of 22-hr. hungry animals receiving faradic stimulation immediately prior to eating with non-stimulated controls. The experimental animals were shocked by an E who had no other contact with them and in a room other than the familiar test room. This procedure was designed to prevent responses which might compete with the criterion behavior from carrying over to the test situation. It was found, in keeping with Hull's theory, that the emotional animals did eat more dry food than the non-emotional control animals.

In a later study, Ellis, Siegel, and Wohl (8) tested animals under conditions which should have proven even

more favorable to Hull's theory. In all aspects this experiment was identical to the one by Siegel and Brantley except that $\bar{D}$ was generated by 4 hrs. food deprivation. Under these conditions a statistically significant decrement in dry food intake was produced by the induced emotionality. A subsequent study (29) in the same laboratory replicated the Siegel and Brantley study. Their finding was corroborated. Thus it was concluded, on the basis of these two studies, that the effects of the addition of $\dot{D}$ to a motivational complex is highly contingent upon the level of $\bar{D}$.

Several studies have been concerned with the effects of $\dot{D}$ upon preparatory behavior. Kendler (16) trained five groups of rats in a Skinner box under 22 hrs. food deprivation plus 0, 3, 6, 12, and 22 hrs. thirst. Thirty reinforcements were given under these drive conditions, and then the behavior was extinguished the following day under identical motivational conditions. Viewing responses to extinction as the criterion behavior, it was found that $\dot{D}$ induced by 3, 6, and 12 hrs. thirst significantly increased the number of responses to extinction when compared to a 0 group. The 22-hr. group showed a significant decrement when compared to any other group. Later, as Siegel (22) pointed out, Kendler recognized that his results are confounded by the differential drive conditions

during learning.

Siegel (22) trained 80 rats in a Skinner box to press a lever for food pellets. One group of (40) animals received 40 reinforcements and the remaining group of (40) received 5 reinforcements. These two groups were further subdivided into four groups of 20 animals each and extinguished under 22 hrs. food privation or 22 hrs. food privation plus 22 hrs. water privation. The addition of $\dot{E}$ did not significantly influence the number of responses to extinction. However, the slight difference was in the expected direction.

Webb (27), utilizing hunger as the dominant need state, taught rats to open a door at the end of a compartment to obtain food. Following training, the animals were divided into subgroups and the door-opening behavior extinguished under 0, 3, 12, and 22 hrs. water privation while satiated for food. In terms of trials to extinction, $s_{\dot{E}}^2 r$ was directly and linearly related to the strength of the irrelevant thirst need. This has been confirmed by Brandauer (5).

In each of the foregoing studies which were concerned with preparatory behavior the investigator has attempted to combine needs determined by food and water privation. This choice of needs meets with difficulties, as has been observed by Ansel (1). Simply stated, a

hungry animal may also be a thirsty animal, and the converse may also be true. In view of this possible confounding, other studies have employed needs which appear to be more independent.

Strange (26) conditioned rats to press a lever in a modified Skinner box to avoid light. The situation was arranged so that an animal could turn off a light for 58 sec. by depressing a lever. Each animal was placed in the box for 15 min. per day until 50 reinforcements had occurred. Subsequently, the 44 animals were subdivided into four equal groups and extinguished under the light avoidance need plus 22 hrs. hunger, 22 hrs. thirst, and 22 hrs. hunger plus 22 hrs. thirst. The extinction procedure consisted of placing the animal in the situation for a 15-min. period each day for 10 days. In terms of total number of extinction responses occurring during this period, no significant differences were observed.

An experiment by Amsel (1) constitutes a rigorous test of the generalized drive hypothesis. One hundred and forty four rats were adapted to a 4 ft. runway which had a grid floor through which the animal could receive an electric shock. On the first two days following adaptation, the animals were assigned equally to four subgroups and given 10 trials each day in which they received weak or strong shock designed to induce $\bar{D}$. They could escape the

shock by negotiating the runway and entering the goal box. Two "weak" shock subgroups and two "strong" shock subgroups performed under an irrelevant hunger need of 0 and 22 hrs. On the third test day, the four subgroups of the previous day were further divided into two each, making a total of eight subgroups. One subgroup deriving from each of these latter divisions performed under a 0 irrelevant hunger need. On this third test day shock was given on the first trial only; then the animals were given 15 additional trials without shock. Amsel proposed that the relevant motivation on these trials was anxiety, an emotionally derived need, conditioned by the previous shock experience. An analysis of scores for the first two test days showed that running time was not influenced by $\dot{D}$. Shock level was a significant source of variance. Conversely, the results of the third day yielded a significant relationship between $\dot{D}$ and running time. Indeed, the data of all four subgroups are clearly in accord with Hull's theory. In summary, the addition of a primary need to a relevant primary need failed to increase $\dot{D}$ as inferred from maze performance. On the other hand, the addition of an irrelevant primary need to an emotionally derived relevant need did increase $\dot{D}$. On the basis of these data, Amsel concludes that more research must precede

an attempt to formulate laws describing the combination of need states.

Miller (19) has reported two studies which suggest that needs may combine to affect behavior. Rats trained to negotiate a maze under 45 hrs. water privation when satiated for water and made hungry ran the maze faster than similarly trained control animals satiated for both water and food. In the same article Miller stated that rats trained under hunger in a T-maze continued to run and make correct turns when satiated. Half of this group of animals shocked immediately before testing ran faster than non-shocked controls. Unfortunately, no quantitative data were published.

Of the studies summarized dealing with consummatory behavior, only one (2) has failed to support the drive summation hypothesis. This study when viewed along with similar ones suggests that the intensity of $\bar{D}$ is critical. The relationship between $\dot{D}$ and preparatory behavior is even more obscure. Kendler's study indicates that the intensity of $\dot{D}$ is central to the problem. Webb reports findings which are entirely in agreement with Hull's hypothesis, though a possible confounding exists in his experiment. The Miller report is favorable; however, no quantitative data were published. Amsel finds positive

evidence for the summation of an emotionally derived need and a primary need only. The need for further research on this problem is clearly indicated by the preceding summary. The present experiment is designed with this need in view. Its point of departure is the Amsel and the Miller studies. Specifically, the $\bar{D}$ induced is called emotionality, viewed as a perseverative response following pain and possessing motivational properties. $\bar{D}$ is generated by food privation. The criterion behavior selected is start box latency and running time in a linear, alley maze. Each drive condition has been tested at zero, weak, and strong levels yielding unique drive conditions for nine independent groups. The occasion for drive summation has been provided under conditions which appear to constitute a fair test of the hypothesis. The conditions have been outlined by Siegel and Brantley as follows: "(a) the drive level is not already maximal, (b) the appropriate stimulus occasion for the elicitation of the response is presented, and (c) stimuli eliciting competing responses are absent." (24, p. 304).

Perhaps a symbolic statement of Hull's formulation will further clarify the present problem. The summation rule, considerably simplified, is as follows:

$$s_{\bar{E}}^{\dot{E}} r = (f) s_{\bar{E}}^H r - (f) D$$

$$\text{where } D = \frac{\bar{D} + \dot{D}}{\dot{D} + 100} \times 100$$

We are, of course, varying both $\dot{D}$ and $\bar{D}$ in a systematic fashion in an attempt to manipulate D , as inferred from $s_{\bar{E}}^{\dot{E}} r$.

METHOD

Subjects. One hundred twenty six male and female albino rats of the Harlan strain were utilized as Ss. Their ages ranged from 80 to 90 days at the beginning of the experiment, and their weights from 120 to 150 gm., with a mean of 187.3 gm. The Ss were housed in groups of four in cages of approximately 20 x 10 x 10 in. and maintained on Purina Dog Chow Checkers and water ad lib.

Apparatus. Two linear mazes and a shock box constituted the apparatus. The maze utilized for pretraining had a start box and a goal box of 12 x 11 x 10 in. inside and a 30 in. straight alley, the inside dimensions of which were 4 x 4 in. The start box was painted flat white; the alley and the goal box, flat black. Both the start box and the goal box had guillotine type doors which when opened activated microswitches controlling two electric clocks. These clocks measured start box latency and running time to the nearest .001 sec. The training-test maze was identical to the pretraining maze except that the alley was 17 ft. 6 in.

The shock apparatus consisted of a 20 x 15 x 14 in. compartment, the walls of which were painted with black

and white diagonal stripes. The top was plate glass. The grid floor was made of brass rods $3/16$ in. in diameter and spaced approximately $1/2$ in. apart. A shock current was provided by a constant D.C. source with a rated output of 805 v. A one meg. resistor was placed in series in the circuit in the instance of "strong" shock to control current intensity and to minimize changes in the S's resistance. For the "weak" shock a two meg. resistor was used. Assuming that an S's resistance is 300,000 ohms, as estimated by Muenzinger and Mize (20), the current flow in the circuit would be .62 milliamperes with the one meg. resistor and .35 milliamperes with the two meg. resistor. A Hunter-Brown electronic timer set at .5 sec. controlled the shock duration.

Procedure. The experiment was conducted in two sessions, each lasting 44 days and consisting of pretraining, training, and a test. The pretraining regimen was designed to establish specific eating habits, adapt Ss to handling, and familiarize them with the maze environment. For the first 14 days the Ss were fed wet Purina mash and handled for 1 hr. each day. Water was available on the handling table as well as in the home cage. Following this phase of pretraining, they were given one trial daily for

eight days in the short maze with wet mash available for 45 sec. in the goal box. During this phase the 23-hr. food privation regimen was maintained.

At the termination of this 22-day period the training proper was begun. Training was identical to the latter phase of pretraining except that the long maze was used and the training was continued for 21 days. Two measures were recorded for each training trial: latency and running time. Latency was defined as the time interval commencing 10 sec. after an S was placed in the start box and ending when the start box closed, i.e., when the animal was in the alley and just clear of the door. The animals were placed in the start box facing opposite the door. Running time was defined as the interval between the closing of the start box door and the closing of the goal box door after the animal had entered.

The criterion test was conducted on the day immediately following the last training day. At this time the 126 animals were equally and randomly assigned to the nine cells of a 3 x 3 factorial design. No sex bias resulted from this procedure. One dimension of this design consisted of 0, 12, and 23 hrs. food privation, $\bar{D}$. The other represented zero, weak, and strong shock, $\dot{D}$. Thus the nine groups will henceforth be designated O-n (non),

O-w (weak), O-s (strong), 12-n, 12-w, 12-s, 23-n, 23-w, and 23-s where the numerals refer to the intensity of $\bar{D}$ and the letters to $\dot{D}$.

Groups 23-n, 23-w, and 23-s were tested under the hunger need that prevailed during training. Groups 12-n, 12-w, and 12-s were allowed to eat for 1 hr. exactly 12 hrs. prior to testing. An intensive effort was made to insure that groups O-n, O-w, and O-s were satiated at the time of testing. This entailed allowing the animals access to wet mash for 2½ hrs. or until they had stopped eating for 5 min., whichever time was longer, immediately before testing. Qualitatively, all animals in these groups appeared lethargic and fairly quiescent.

The treatments designed to induce emotionality were intermittent faradic stimulation delivered immediately prior to the criterion maze run. Groups receiving no shock were simply exposed to the shock box for 20 sec. Those receiving weak shock were given 10 shocks of .35 milliampere during a 20 sec. interval and the animals getting strong shock, 10 shocks at .67 milliampere during the 20 sec. In a preliminary study some evidence for assuming that the stronger shock produces "more" emotionality was obtained. Thirty animals had been assigned equally and without bias to the n, w, and s shock conditions (identical to those employed in the main experiment). Immediately after the treatments were administered, the animals

were placed individually in an arena and the number of fecal droppings counted over a 10 min. interval. The mean for the n treatment was 0.5, for w, 1.7, and for s, 2.1. A simple analysis of variance of these differences yielded an F of 3.37 which for 2 and 17 df. is significant at the .05 level of confidence.

Several precautions were taken to prevent generalization from stimuli associated with the shock situation to stimuli in the test environment. Some of these were: (a) the shock procedure was carried out by an E who had no other contact with the Ss, (b) the E who administered the shock wore black rubber gloves, and (c) Ss were shocked in an environment other than the test situation. The exact procedure consisted of the shock-E taking the animal from his cage and placing it in the shock box. Then it was handed to the test-E and immediately placed in the start box. Approximately 6 sec. elapsed between the end of the last shock impulse and the placing of the animal in the start box. The estimate of error for this interval is 2 sec.

RESULTS

Figure 1 depicts median latency as a function of training days and treatments. Table I presents median and mean latency for each of the nine groups on the test trial. The latency raw scores meet the assumptions required for an application of the analysis of variance. Consequently, this statistic was used. The results of this analysis are presented in Table II. It is clearly apparent that the intensity of hunger is directly related to latency. The F of 3.49 is significant at the .05 level of confidence. Emotionality failed to influence latency significantly. There was also no interaction. A further test of the effects of emotionality, which is perhaps even more critical, compared the test performance of the 23-n, 23-w, and 23-s groups with their performance on the last training day. Groups 23-n and 23-w showed mean increases in latency on the test day of .68 sec. and .40 sec. respectively, whereas group 23-s showed a mean decrease of 1.06 sec., but t -tests indicated that these differences could be attributed to chance. A statistical comparison of the test scores of groups 23-n, 23-w, and 23-s apart from the other groups is logically contradicted by the results of the previous analysis of

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TABLE I
AVERAGE LATENCY AS A FUNCTION
OF TREATMENTS ON TEST TRIAL

		0	12	23
n	M	3.7	1.5	1.8
	Mdn	2.0	0.7	1.0
w	M	2.4	1.5	1.5
	Mdn	1.3	1.1	1.3
s	M	1.7	1.8	1.0
	Mdn	1.3	1.2	0.6

TABLE II
SUMMARY ANALYSIS OF VARIANCE
OF LATENCY SCORES

Source	df	SS	MS	F
$\bar{D}$	2	35.5	17.75	3.40*
$\dot{D}$	2	15.0	7.50	1.47
$\bar{D} \times \dot{D}$	4	20.4	5.10	1.00
Within gpa.	117	596.1	5.09	
Total	125	667.0		

*Significant at the .05 level of confidence

variance.

Figure 2 depicts median running time as a function of training days and treatments. Table III gives mean and median running time for each of the treatment groups on the test trial. The raw test scores were nonsymmetrically distributed within cells and the between cells variance was heterogeneous. In order to use the analysis of variance these data were converted to zien scores (4), which yielded normal distributions and homogeneity of variance between cells. Table IV summarizes the analysis of variance. The F of 38.46 with 2 and 117 df. for $\bar{D}$ is significant at beyond the .01 level of confidence. The F for $\bar{D}$ is less than one. The interaction variance yields an F of 2.30 with 4 and 117 df. which is just short of the 2.45 needed for the .05 level of confidence. Reference to Table III shows this interaction derives mainly from the differential effects of emotionality upon the 23-hr. groups when compared to the other groups. It may be seen that running time is directly related to the intensity of emotionality for the 23-hr. animals, but tends to be inversely related for the 0- and 12-hr. animals. In this instance, the near significant interaction variance offers some justification for an independent analysis of the differences between the 23-hr. animals alone. Such an

TABLE III

AVERAGE RUNNING TIME AS A FUNCTION
OF TREATMENTS ON TEST TRIAL

		0	10	20
n	M	122.9	17.7	13.9
	Mdn	58.8	12.2	10.7
w	M	102.5	39.9	13.7
	Mdn	32.6	31.5	9.4
s	M	202.9	39.2	8.9
	Mdn	81.1	36.3	8.4

TABLE IV
SUMMARY ANALYSIS OF VARIANCE
OF RUNNING TIME SCORES

Source	df	SS	MS	F
$\bar{D}$	2	200	100.0	38.46**
$\dot{D}$	2	1	0.5	-
$\bar{D} \times \dot{D}$	4	24	6.0	2.30
Within gps.	117	305	2.6	
Total	125	530		

**Significant at beyond the .01 level of confidence

analysis appears even more appropriate if it is remembered that these animals were tested under conditions which most nearly simulated training. Therefore a simple analysis of variance was performed on the transformed data (aten scores) of groups 23-n, 23-x, and 23-s. The F of 2.34 with 2 and 39 df. for between groups falls far short of significance. Figure 2 shows that the test performance of these groups is slightly poorer than that on the last training day. The median (raw score) increased from 6.4 to 9.9 sec. A simple sign test indicated this difference was statistically significant.

DISCUSSION

Perhaps our most striking result is the effect $\bar{D}$ reduction had upon running time. This effect can be clearly observed in Fig. 2. The reduction of $\bar{D}$ to zero roughly doubles running time, and, significantly, four animals in these groups did not reach the goal box during the allotted six min. (A score of six min. was assigned to these animals for statistical purposes.) The effect produced by the reduction of $\bar{D}$ to 12 hrs. is less pronounced. However, the mean running time for these groups combined is approximately equal to that at the beginning of training. Though there is a significant increase for the 23-hr. animals, this change is not appreciable in view of day to day variability. Whether the large decrement for the 0- and 12-hr. groups is due to a loss of the cue function or the energy function of $\bar{D}$ cannot be determined at this time. The best guess is that it is due to both factors.

To anticipate an argument which may be advanced, the change in procedure on the test day could have had a general disruptive effect upon performance. Such a general hypothesis could account for the overall decrement in both running time and latency. Nevertheless, it would

seem that some state of affairs must carry over to the maze situation in order to affect performance. Our only answer to this criticism would be that our test was specifically designed to minimize transfer of directive factors and to maximize energy transfer. Furthermore, a technique similar to ours has been used successfully in several past studies (7, 10, 11, 14).

In general, the trend in the latency scores on the test is similar to that of running time. However, the observed increase depicted in Fig. 2 is not statistically significant. The behavior of group O-n proves interesting in view of Hull's original formulation of the generalized drive notion and the related Koch and Daniel study. It may be recalled that Hull extrapolated a curve depicting Skinner box behavior to a point at which the animals would be performing under zero relevant drive, and found that behavior strength was appreciably above zero. He attributed this residual behavior strength to the operation of $\dot{D}$. Later, Koch and Daniel tested the validity of the extrapolation by placing satiated animals in a similar situation. They found that when $\bar{D}$ is reduced to zero, $s \frac{\dot{E}}{r}$ is likewise reduced almost to zero. This finding is not clearly supported by the present data. Though our O-n animals were very slow, 13 out of the 14 in this

group reached the goal box within 6 min. Five of these animals were observed to nibble food. Qualitatively, however, the typical behavior of an animal in the maze following exposure to the shock apparatus did not appear to be goal directed. Specifically, they had a mincing gait in the alley, were inclined to urinate, and appeared acutely disturbed. For these reasons we tend to believe simple exposure to the shock apparatus induced mild emotionality, which, according to the drive summation hypothesis, should have energized goal directed behavior in this situation. It is felt that this particular result offers no clear evidence for or against the hypothesis.

Our data, viewed in their entirety, cannot be offered in support of Hull's generalized drive hypothesis. In those instances where $\bar{D}$ is low, $\dot{D}$ should facilitate behavior more than when $\bar{D}$ is high. The near significant interaction obtained from the analysis of the running time data suggests a converse effect. It may be noted, by referring to Table I, that median running time for the 23-hr. animals is directly related to the intensity of $\dot{D}$ whereas the relationship for the 0- and 12-hr. animals tends to be inverse. No appreciable interaction is evident in the latency data. Several ad hoc explanations

can be offered for our negative findings. The tenability of some of these will now be considered.

Perhaps the utilization of emotionality will bear careful scrutiny in view of the fact that many theorists have considered it a disruptive influence rather than a motivational state. The best support for using it in the present context is offered by previous experiments in which it has been shown to energize habits set up on the basis of other drives. Significantly, the operations of inducing emotionality in those studies were similar to ours. Farber (9), in a discussion of the relations between motivation and verbal learning, cites several experiments which demonstrate the motivational characteristics of electric shock, though he does not employ the concept of emotionality. Therefore, since the generalized drive hypothesis gains substantial support from experiments which used this as a need state, it hardly seems reasonable to discount its motivational properties in order to rationalize our negative results.

A second ad hoc explanation for our negative findings appears more tenable, and, if valid, requires no modification of the generalized drive hypothesis in its present form. For drive summation to occur, $\dot{D}$ must not provide cues which elicit competing responses. The habit

structure underlying the response and associated with the cue accompanying $\dot{D}$ could be innately determined or conditioned. Amsel (2) and Amsel and Cole (4) have clearly shown that, if competing responses are conditioned to cues associated with $\dot{D}$, the criterion behavior will undergo a decrement. Farber has said, "Even in those instances in which shock is noninformative, i.e., not related in any systematic way to correct or incorrect response, it is necessary to consider its response-producing properties. The fact that shock tends to elicit withdrawal or vocalization, or muscular contraction in rats or human beings, may be a consequence, not of its drive characteristics, but rather, of its association with either learned or innate response tendencies. Since shock is an intense stimulus, capable of eliciting a variety of responses, it is not surprising that in certain situations it may elicit responses that are incompatible with those elicited by other stimulus components of the situation" (9, p. 313). Though this theorizing provides a "way out," it questions the testability of Hull's hypothesis as originally formulated. It might be inferred from Farber's discussion that an intense state of affairs, such as electric shock, may invariably be accompanied by cues which are associated with habit structures. If this is the case, and it seems

highly probable to this writer, then some qualifying conditions must be introduced which would allow drive summation, and consequently, the facilitation of behavior to occur. One such condition could be the intensity of $\dot{D}$. Perhaps mild $\dot{D}$ is accompanied by cues which are too weak to elicit associated habits, yet which have energizing effects when added to a motivational state. This possibility is suggested by a previous study (8). Another study (16) offers a converse suggestion, however. A second possibility is that the energy contribution of an introduced $\dot{D}$ is relatively greater than the decremental effect of its directive tendencies. This could or could not depend on the drive intensity. Of course, there are possibly other equally likely qualifications which could be introduced. At our present stage of knowledge, however, there is scant experimental evidence to support these speculations. Certainly our present data are not suggestive. If one's theoretical inclinations lead to some alternative other than an essential modification of the hypothesis, then the generality of the hypothesis may be curtailed by limiting the types of motivational states to which it is applied. Hull, in a later paper, has adopted this position. He said, "At least some drive conditions tend partially to

motivate into action habits set up on the basis of different drive conditions" (12, p. 7).

Brown, Meryman, and Marzocco, in a paper which appeared after this experiment was completed, reported findings which do suggest a modification of the generalized drive concept. These investigators devised two experiments to test the perseverative effects of electric shock upon the startle response to an auditory stimulus. In conclusion they stated, "The results of both experiments agree in indicating that immediately after the cessation of shock, startle-response amplitude is depressed, not enhanced. With further passage of time, the reaction shows a smooth, negatively accelerated recovery curve. In both experiments, the reaction seems to pass over into a supernormal phase after about 5 sec., but the effect is not significant by usual statistical criteria" (6, pp. 193-194).

These results provide a possible explanation of our finding. It may be recalled that our animals were traumatized and immediately placed in the maze start box. We have estimated the time elapsing between the final shock impulse and/or box exposure and the placing of the animal in the start box to be 6 sec. $\pm$ 2 sec. Reference to the "recovery" curves published by Brown et al indicates that

behavior should at this time be near the level they observed in their nonshocked animals. The net result would be no effect. For our 23-hr. animals, the effects of traumatization are, indeed, negligible.

Finally, the criterion behavior may prove central to the problem. Those studies concerned with consummatory behavior have generally reported positive findings. On the other hand, positive evidence for a facilitative effect of $\dot{D}$ upon preparatory behavior is rare. Kendler alone found positive evidence for drive summation in a Skinner box situation, and this finding was contingent upon the intensity of $\dot{D}$. Webb reported positive results when the criterion behavior is door-opening behavior, though he used two need states which may be physiologically confounded. Amsel failed to observe an increase in maze performance when a hunger need was added to a motivational complex in which the need state was emotionality. Behavior was facilitated when the dominant need state was changed to anxiety. Only Miller reported positive results from a test which resembles the present one.

In conclusion, our data cannot be offered in support of Hull's concept of drive summation. On the other hand, to propose that they constitute evidence against the hypothesis implies confidence in the fairness of our test

which we do not feel is entirely justified. At best, we can only offer these empirical data as evidence upon which to base theorizing at some later time, after more facts have been established.

SUMMARY

In order to test Hull's drive summation hypothesis, 126 rats were trained to run a linear, alley maze while under a 23-hr. hunger need. Following 21 daily training trials the animals were assigned to nine treatment groups consisting of the possible combinations of 0, 12, and 23 hrs. food privation, as a relevant need, with zero, weak and strong faradic stimulation as an irrelevant need. The "test" consisted of a trial similar to a training trial. The state induced by the faradic stimulation was called emotionality and viewed as possessing motivational properties. Both start box latency and maze running time were utilized as criterion behaviors.

The findings were mainly negative. The criterion behavior was not significantly influenced by the introduction of an irrelevant need into the motivational complex. As expected, changes in the relevant need state did significantly affect latency and running time. A near significant relevant need times irrelevant need interaction was observed. Several possible ways of modifying the theory to account for more of the present experimental data were discussed. It was concluded that the present data provided no definitive evidence either for or against the theory.

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VITA

Norman R. Ellis was born September 24, 1924, in Springville, Alabama. He attended Ragland Elementary School, Ragland, Alabama, from 1930 to 1936, graduating with a diploma. He attended Douglas High School, Douglas, Alabama, from 1936 to 1942, graduating with a diploma. In 1948 he entered Howard College, Birmingham, Alabama, and in 1951 graduated with an A.B. degree. At Howard College he majored in Psychology and minored in English. In June, 1951, he entered Graduate School at the University of Alabama, and in 1953 received an M.A. degree with a major in general experimental Psychology. In September 1952, he entered Louisiana State University to pursue work leading to the Ph.D. degree in general experimental Psychology. For the first few months upon entering L.S.U. he held a research assistantship in the Department of Psychology. Subsequently, he was promoted to the position of research associate and held this position until August, 1954. These two positions were related to research for the U.S. Air Force contracted by the Department of Psychology. In September, 1954, he returned to the University of Alabama and held the position of Acting Assistant Professor of Psychology for the academic year 1954-55. He returned to L.S.U. in June, 1955,

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EXAMINATION AND THESIS REPORT

Candidate: Norman R. Ellis

Major Field: Psychology

Title of Thesis: "The Immediate Effects of Emotionality Upon Behavior Strength"

Approved:

Major Professor and Chairman

Dean of the Graduate School

EXAMINING COMMITTEE:

Date of Examination: 21 September 1956