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STIMULUS CUES AND DRIVE LEVEL AS PARAMETERS OF AVOIDANCE GRADIENTS

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STIMULUS CUES AND DRIVE LEVEL AS

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TABLE OF CONTENTS

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INTRODUCTION

Conflict behavior theories which utilize the concepts of approach and avoidance gradients rely heavily upon assumptions concerning the determinants of avoidance gradients in deriving the implications of these theories (Miller, 1959, Hull, 1952). At the present time there exists some degree of ambiguity about several of the parameters of avoidance gradients. Moreover, there is a lack of empirical evidence, especially with human Ss, necessary to confirm a number of predictions made by these theories. Accordingly, this experiment was conducted in order to clarify the functions of two of these parameters, specifically the roles of external cues and of drive level as determinants of avoidance gradients for human Ss. (See Appendix A. for a review of relevant conflict theory.)

The manner in which changes in the external stimuli affect avoidance gradients is a crucial aspect of conflict theory. Prior to any experimentation it is necessary to decide upon a theoretical conceptualization of the relationship between external stimuli and avoidance gradients. For this study, the conceptualization accepted is that the avoidance gradient represents a stimulus generalization phenomenon. Such a conceptualization is in line with many of the theoretical formulations of Hull (1952) and of Miller (1959). Moreover, the principle of generalization has been used in collecting empirical evidence about avoidance gradients

(e.g., Brown, 1942; Miller and Kraeling, 1952; Murray and Miller, 1952).

Since this study is conceptualized within the framework of generalization, Hull's (1952, p. 220) statement of the following relationship for generalization is assumed to apply.

$$_S\bar{E}_R = {}_SE_R \times 10^{-jd}$$

where $_SE_R$ is the excitatory potential as conditioned, $_S\bar{E}_R$ is the effective or generalized reaction potential, d is the difference between the original external stimulus and the evoking stimulus in j.n.d. units, and the exponent, j, is an empirical constant. In turn, $_SE_R$ is stated in Hull's Postulate VIII (1952) to be a multiplicative function of drive (D) and habit strength ($_SH_R$), other factors remaining constant. Further, Postulate X (1952) shows the equation above to be based upon the following relationship for generalized habit strength, $_S\bar{H}_R$:

$$_S\bar{H}_R = {}_SH_R \times 10^{-.0135d}$$

(See Appendix B. for a more detailed presentation of Hull's theory.)

From these formulations it is clear that external stimulus changes would affect $_SH_R$, but an ambiguity arises when conflict theory states that stimuli play a dual role in determining the steepness of the avoidance gradient based on learned aversive drives (Miller, 1944). External stimuli similar to those of the goal site are said to evoke internal aversive drive producing responses so that the less similar the stimuli, the weaker the drive producing responses and the weaker the drive. (Such external stimuli will subsequently be referred to as motivating stimuli.) In

addition external stimuli are said to serve also as cues for overt, instrumental responses, made in the presence of the drive and these responses obey the laws of ${}_{S}H_{R}$. (These external stimuli will be referred to as task stimuli.)

Statements in conflict theory are not explicit about the exact manner in which drive is weakened when internal drive producing responses (*R*) are weakened. As *R* is presumed to be a learned response to an external cue and as it is weakened with decreases in similarity of the external stimuli to those in the original learning, *R* shows the typical generalization phenomenon (Dollard and Miller,1950). It seems reasonable to assume then that the weakening of *R* is according to the same function relating any learned response tendency, ${}_{S}H_{R}$, to a weaker generalized tendency. If it is also assumed that the strength of the drive is proportional to the strength of *R*, then if stimulus similarity is varied, the resultant weakening of drive could be expressed as follows:

$$\bar{D} = D \times 10^{-cd}$$

where $\bar{D}$ refers to drive by generalization, *D* is the drive induced by the original cue, *c* is an empirical constant, and *d* is stimulus difference in j.n.d. units. This relationship together with the one for ${}_{S}\bar{H}_{R}$, referring to instrumental responses, permits an expression of ${}_{S}E_{R}$ showing that ${}_{S}E_{R}$ depends upon the effects of a change to ${}_{S}\bar{H}_{R}$, or the effects of a weakening of *D* by generalization or both. The steepness of the avoidance gradient is thus seen to be a joint function of these two parameters.

In most previous investigations of the steepness of the avoidance

gradient, one and the same external stimulus has served simultaneously as both the motivating and the task stimulus with a resultant confounding of its dual roles. One exception is a study done by Miller and Brown (Hunt, 1944) in which task stimuli from a runway varied but where drive level was held constant through electrifying the entire runway, thus producing, as expected, a flattening of the avoidance gradient. Since other empirical evidence is lacking, it appears to be important to investigate in more detail the functions of the motivating and the task stimuli in an avoidance situation. This can be accomplished experimentally by using two separate sets of stimuli, each of which can be varied along some dimension of similarity, one as task cues and the other as motivation cues, and then by altering these stimuli independently and concomitantly in an avoidance situation involving a learned drive of fear. In accordance with the theories of both Miller and Hull, the following hypothesis may be stated:

> Hypothesis I. If task cues are varied along a similarity continuum while motivation cues are held constant or if task cues are held constant and motivation cues are varied along a similarity continuum, generalization gradients of avoidance will be obtained for each type of stimulus change.

Miller has recognized the need to explain the greater steepness of the avoidance gradient in contrast to the approach gradient. Stated in the terminology used in this experiment, his explanation is that external

stimuli are serving both as task and motivation cues in the avoidance situation but only as task cues in the approach situation. Thus, ${}_S E_R$ for avoidance should reflect the weaker ${}_S\bar{H}_R$ in addition to the weaker D by generalization. Hull's Theorem 58 (1952), dealing with the steepness of the abient gradient, is compatible with Miller's view. In accordance with these theoretical formulations, it would follow that:

> Hypothesis II. Concomitant variations of both motivation and task cues along similarity continua will result in a steeper avoidance gradient than that produced by either stimulus change alone.

A third hypothesis of this study stems from a confusion about Miller's stand on the issue of the effect of drive level change upon the avoidance gradient. Miller (1944) states merely that increased drive intensity will raise the height of the entire gradient, but he appears to be more explicit in his illustrations in Dollard and Miller (1950) and in other sources where he depicts increased drive intensity as producing a gradient higher than and also parallel to the original one. Thus, the rate at which ${}_S E_R$ decreases per unit of stimulus change remains the same in his plotted gradients. Miller cites as support some empirical evidence of parallel gradients produced by Brown (1948). However, as Champion (1961) points out, the adequacy of Brown's data to establish that gradients are, in fact, parallel is questionable and, further, a number of deductions Miller has made would not be true if the gradients were not parallel.

It is pertinent to examine Hull's predictions with regard to the

parameter of drive level since Miller purports to base his theory on Hullian principles. In other words, the question is how does change in drive level affect the values of ${}_{S}E_{R}$ in the first equation cited. Hull asserts that *j* does not change for different degrees of drive (*D*) (Theorem 59, 1952). When *j* is constant in an equation of this nature, the value of ${}_{S}E_{R}$ depends upon the magnitude of a constant, ${}_{S}E_{R}$, and the value of the variable, *d*. It is the term ${}_{S}E_{R}$ that reflects the magnitude of *D* because, according to Postulate VIII, at any given ${}_{S}H_{R}$, increases in *D* produces increases in ${}_{S}E_{R}$. The form of the equation dictates that each unit of change in *d* will produce an equal proportionate reduction in ${}_{S}E_{R}$. However, the absolute size of the proportionate reduction will be larger when ${}_{S}E_{R}$ is larger, which is the case when *D* is larger.

Thus, Hull's formulations would predict that with comparable changes in stimulus similarity, increases in drive level would produce a family of curves which increase in steepness, whereas Miller implies that the steepness would be unchanged. It seems important that more information be obtained about drive level as an avoidance gradient parameter, especially if predictions concerning this parameter are to be applied in other areas (Dollard and Miller, 1950). As the matter stands, because there is some question about the evidence supporting Miller's viewpoint and because there appears to be no reason why Hull's more explicitly stated theory should not apply, the hypothesized effect of drive level changes is in terms of Hull's theory as follows:

Hypothesis III. Other conditions being the same, if

> avoidance gradients are determined using different levels of the same drive, then the higher the drive, the steeper will be the resulting gradient.

This hypothesis does not dispute Miller's statement that the heights of gradients would be raised under these conditions but rather his implication that the gradients would be parallel.

METHOD

Subjects. -- The Ss were 248 college undergraduates, 130 males and 118 females, randomly assigned to 38 subgroups of 6 Ss and 2 subgroups of 10 Ss each, as indicated in the design below. (See Appendix C. for a Summary of the Rejected Data from other Ss.)

Apparatus. -- The apparatus provided a discrimination task in which the task stimulus was either a rectangle or an ellipse which was removed by either a left or a right set of response switches. A motivating stimulus, consisting of an illuminated arrow, signified whether or not a shock would be given if the response were not quick enough. Task or motivating stimuli could be varied independently or concomitantly along similarity continua for tests of generalization.

From S's view, the apparatus appeared as a 2 by 3 ft. horizontal response panel with a small lever located 1 in. back from the center of the near edge and with two sets of four, spring return, toggle switches arranged in rows on the right and left sides. Rows were parallel and slanted 45° toward the back edge with the switches placed 3 in. apart and numbered 1 to 4 from left to right so that each #1 switch was 12 in. from the centered lever. (See Appendix D. for a diagram of the apparatus.) Perpendicular to the back of the response panel was a 36 by 39 in. vertical frame holding a 31 by 21 in. milk glass screen covered on the back side by black cardboard containing a centered, irregularly shaped, 11 by 14 in. aperture where slides were projected. Cut into the cardboard an inch

below this aperture was a 2 1/2 in. long and a 1/2 in. wide vertical arrow pointing upward. Directly below the arrow on the wooden frame was a buzzer. Shields built on either side of the apparatus prevented S from seeing anything but the screen, response panel, and two electrodes immediately below the panel.

Behind the screen, a Kodak Carousel Projector, Model 589, was mounted at the height of the irregular aperture so that its lens was 60 in. from the screen and its angle of projection perpendicular to the screen. A single leaf, guillotine-type shutter device, activated by a solenoid and placed directly in front of the projector lens, permitted a continously illuminated 2 by 2 in. slide to be presented for controlled exposure times. The slide so projected presented either a 101.6 by 78.5 mm. black rectangle on a clear background or one of four black ellipses. The ellipses all had a horizontal axis of 190.8 mm. but the four vertical axes differed giving vertical to horizontal ratios of 0.799, 0.539, 0.407, and 0.207, respectively. A preliminary study showed the last 3 ellipses to be 10, 15, and 20 j.n.d.'s more elliptical than the least elliptical standard ellipse. If 5 j.n.d.'s are taken as the psychological unit of ellipticality, the standard and the three other ellipses represent 0, 2, 3, and 4 units of change in degree of ellipticality. (See Appendix E for details of selection of ellipses.)

Also behind the screen was a Delineascope Model D, 5000 watt projector used to illuminate the arrow 6 in. in front of the lens. Color of the arrow was determined by interposed filters; one permanently mounted

daylight filter plus one interchangeable filter. A second daylight filter gave the colorless arrow and four combinations of color filters were selected to approximate the Munsell hues of 5 red, 10 yellow red, 7.5 yellow and 5 green yellow, with value and chroma held constant. Since Munsell hues are approximately equally spaced on a psychological scale, a Munsell hue change of 2.5 may be taken as a unit of similarity (Burnham, Hanes and Bartleson, 1963). With 5 red as the standard, the four colors were assumed to represent 0, 2, 3, and 4 psychological units of difference from the standard hue. (See Appendix F. for details of the filter selection.)

Also out of S's view was E's control panel on which the following were mounted: a switch for the buzzer; a switch to select the left or right switch circuit on S's response panel; six lights, each wired in series with one of the first three switches in the left and right sets on the response panel; and a start button which, providing S's lever was depressed, activated simultaneously the shutter controlling the projection of the slides, the projector illuminating the arrow, and two Standard Electric clocks reading in hundredths of seconds. One clock was wired to stop when S's lever was released, indicating latency time and the other to stop when the correct #4 response panel switch was closed, indicating total time. Total time less latency gave execution time. Mounted above E's panel was a Beede Instrument Co., Model #228, Applegate shock apparatus connected to S's electrodes. (See Appendix G. for a wiring diagram.)

Procedure. -- Prior to experimental sessions Ss were randomly

assigned to four major groups as shown in the design in Table 1. Groups L, M, and H performed under low, medium, and high drive, respectively, while group R was under medium drive with stimulus conditions reversed. Each major group was divided into 10 subgroups for a total of 40 subgroups, each representing a combination of types and extents of stimulus change. Subgroups L BO, M BO, R BO, and H BO were control groups tested with exactly the same motivating and task stimuli used in the training trials. The 12 subgroups designated with a B were tested for generalization when both task and motivating stimuli varied concomitantly over 2, 3, or 4 psychological units. For the 12 subgroups with the symbol Mo, the task stimulus remained constant and only the motivating stimulus was changed by 2, 3, or 4 units (of hue for L, M, and H; of ellipticality for R). For the remaining 12 subgroups, identified by T, the motivating stimulus remained the same but the task stimulus varied 2, 3, or 4 units (of ellipticality for L, M, and H; hue for R).

S, seated before the response panel, was told that he was in a learning experiment and that geometric images would be projected in the window before him while simultaneously the arrow would light up, sometimes with colored and sometimes with colorless light. (See Appendix H. for verbatim instructions.) S was instructed to press down the lever when the buzzer sounded and to hold it down until he had decided which set of switches to push for the geometric shape presented; then he was to release the lever and to push the selected set of switches in 1-4 sequence as quickly as possible. If the image did not turn off, he was to push the

TABLE 1

Experimental Design and Group Designations

Type of Stimulus Change	Units of Stimulus Change (Stimulus Number)	Groups			
		L	M	R	H
Both	0	L BO	M BO	R BO	H BO
	2	L B2	M B2	R B2	H B2
	3	L B3	M B3	R B3	H B3
	4	L B4	M B4	R B4	H B4
Motivation only	2	L Mo2	M Mo2	R Mo2	H Mo2
	3	L Mo3	M Mo3	R Mo3	H Mo3
	4	L Mo4	M Mo4	R Mo4	H Mo4
Task only	2	L T2	M T2	R T2	H T2
	3	L T3	M T3	R T3	H T3
	4	L T4	M T4	R T4	H T4

other set as quickly as possible because either the left or the right set of switches would always turn out each image. S was told to learn which switch set turned out each image and to respond as quickly as possible. Also he was lead to believe that an electronic device was evaluating his performance and upon completion of his response, if it were too slow, the device would administer a shock when the arrow was colored but it would merely charge an error against him when the arrow was colorless. He was cautioned to be accurate as errors necessitated pushing two sets of switches and decreased speed.

At this point, electrodes were attached to the first and third fingers of the non-preferred hand and shock intensities were rated for unpleasantness in order to obtain information to determine drive levels. Each S rated a series of 20 electric shocks ranging from 0.1 to 4.5 ma. using the categories of "pleasant," "slightly unpleasant," "moderately unpleasant," "very unpleasant," and "painful" in accordance with the procedure of Schneider and Baker (1958). S's own ratings were used to select a shock intensity appropriate to the drive group to which he had been assigned; "slightly unpleasant" for L, "unpleasant" for M and R, and "very unpleasant" for H. The actual mean intensities found corresponding to these ratings were: L, 1.15 ma., SD = 0.35; M, 1.39 ma., SD = 0.64; R, 1.64 ma., SD = 0.65; H, 2.90, SD = 0.77. Each S was informed of the intensity of the shock he would receive if his performance should not be fast enough to avoid shock.

In training, the buzzer alerted S to press the lever, and after

varying intervals, E simultaneously presented the stimuli and started the clocks. S made his decision, released the lever, and pushed the appropriate set of switches to turn off the stimuli. The next trial was given as soon as the latency and total times could be recorded. Each S received a minimum of 16 trials and additional trials, if necessary, to meet a criterion assumed to show that the red arrow induced a fear drive. The criterion made it necessary that the last series of 3 training trials consist of the sequence: a) ellipse-colorless arrow-no shock; b) ellipse-red arrow-shock; c) ellipse-red arrow-no shock. Total time for (c) had to be less than for (a) to meet the criterion or S's data were discarded. The training always included 8 presentations of the rectangle, 4 with the standard red arrow and 4 with a colorless arrow as well as 8 presentations of the standard ellipse, 4 with the red arrow and 4 with the colorless one. Regardless of response speeds, shocks of 1 to 2 seconds duration and of the appropriate intensity were administered following two red arrow-ellipse combinations and two red arrow-rectangle combinations of stimuli. The number of training trials for this simple task was large enough to assume that learning had reached an asymptotic level.

Immediately following training, S was given a single test trial with the stimulus combinations appropriate to his subgroup. A pilot study showed a second test trial could not be used because responses were altered by the first test. Upon completion of the test trial, S was required to be able to describe the stimuli on the test trial and to state the relationship between the stimuli and the responses he made.

RESULTS

The basic data obtained were latency and execution time measurements for each individual for the last training trial (Tr.) and the single test trial that followed. (See Appendix I for individual data.) Unexpectedly, 100 Ss either failed to meet the training criterion or made errors on the test trial or did not perform as instructed. Data from these Ss were not used. Measurements were then put in the form of reciprocals as excitatory potential is assumed to be linearly related to the speed of evocation of a response (Spence, 1956). Since individual differences in reaction time also affect such time measures, difference scores (1/Tr. - 1/Te.) x 1000 were computed for each S to obtain a measure of loss in response strength from S's own training level. Since grossly deviant scores occurred in some groups, the most deviant score obtained in each subgroup of 6 Ss was discarded and the remaining five scores were subjected to statistical treatment by analysis of variance.

Execution time scores analyzed by Bartlett's test for homogeneity of variance gave a chi square value of 46.9, $p < .01$ indicating that the variances of these measures were too heterogeneous for statistical treatment. In addition examination of the plots of these data show that in a number of instances with this measure, the response was not weakened but instead slightly strengthened and relationships among the conditions were not consistent. Other workers such as Wipf (1964) also have found movement time scores obtained in similar situations to be too variable for