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THE EFFECT OF ACTIVITY AND NOVELTY  
ON RESPONSE FREQUENCY IN A  
TWO-CHOICE LEARNING SITUATION

by

PAUL O'GRADY  
B.A., Assumption University of Windsor, 1962

A Thesis  
Submitted to the Faculty of Graduate Studies through the  
Department of Psychology in Partial Fulfillment  
of the Requirements for the Degree of  
Master of Arts at Assumption  
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Windsor, Ontario, Canada  
1963

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## A B S T R A C T

This study was an attempt to separate the effect of novelty, represented here as a compound of drive and reinforcing stimuli, from the reinforcing effect of operant response activity. The dependent measure was response probability in a two choice learning situation. Two levels of novelty and two levels of activity were employed with thirty-two human subjects assigned at random to four experimental groups. Novelty was measured by the degree of uncertainty about the nature of the reinforcing stimulus and activity was measured by the number of times the subject had to press a button. All groups changed their behavior over a period of ninety training trials. The rate of change, however, was not statistically different for the four groups. The results were explained in terms of Spencian theory.

## PREFACE

The author wishes to express his personal gratitude to the mentor of the thesis, Dr. A. A. Smith, for defining and guiding the research. For theoretical and structural criticism, he thanks Dr. V. B. Cervin and Mr. M. Vukovic. He also thanks the subjects who gave so generously of their time. Finally, he gratefully appreciates the time and effort put forward by his typist, Miss Dianne Bowen.

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## CHAPTER I

### The Historical Development of Reinforcement Theory

Learning theory concerns itself with behavior by examining the conditions under which present behavior develops out of past experiences. Various theories have been advanced to account for systematic changes in behavior. The formation and testing of theories is determined by experiments conducted under controlled conditions.

Experimental analysis of learning began in Russia with Pavlov and Bechterev and in America with Thorndike. The latter proposed what is known as the Law of Effect:

Of several responses made to the same situation, those which are accompanied or closely followed by satisfaction to the animal will, other things being equal, be more firmly connected with the situation; so that, when it recurs, they will be more likely to recur; those which are accompanied or closely followed by discomfort to the animal will, other things being equal, have their connections with that situation weakened. The greater the satisfaction or discomfort, the greater the strengthening or weakening of the bond, (Thorndike, as cited by Hilgard and Marquis, 1961, P. 10).

This law says that a response that leads to satisfaction will more likely recur when the same stimulus conditions are present. A response that leads to discomfort will tend not to recur under those conditions.

Pavlov became interested in the phenomenon which he at first called psychic reflexes and later named conditioning of neutral stimuli. Food elicits a certain amount of salivation in the dog. If a neutral stimulus, e.g., a light, is presented together with food, then Pavlov found that the light, when presented alone, after a short period of time, could elicit the salivation. The light was called the conditioned stimulus and the salivation to light, the conditioned response. If the presentation of the light is not followed by food some of the time then the conditioned response disappears. This is known as extinction.

Similarly, the reflexive response to shock can come to be elicited by a neutral stimulus. The dog withdraws his leg when light is presented in close temporal contiguity with the shock. Thus, the dog learns to withdraw his leg when the light is presented alone.

For these two phenomena to occur, it is generally felt that the organism has to be in a certain state. In the first experiment, it must be hungry (appetite). In the second, the shock must be experienced as painful (aversion). This state is called a state of need or drive. Action is

required to reduce this state. That is, the organism must eat or withdraw its leg. Hull (1951, P. 15) has defined the reinforcer as the stimulus event that reduces the drive state and returns the organism to a homeostatic balance. The drive can be induced by depriving the organism of food, water, sex or by employing noxious stimuli. This is the drive reduction hypothesis. A stimulus is a reinforcer if it reduces the drive.

Some difficulties arise, however, with appetites; e.g., if hunger has to be experimentally defined. Is it the contraction of muscles in the stomach wall? Is it a chemical imbalance in the bloodstream? Learning can occur when the experimenter manipulates any one of these two variables. Which variable is necessary for the presence of the drive state called hunger?

Skinner (1953, P. 64) and various other learning theorists have sidestepped this issue by defining a reinforcer as any event, the presentation of which immediately after a response increases its probability of occurrence. The emphasis shifted from the investigation of events that contribute to drive reduction to those events that contribute to learning, i.e., to raising the probability of a response. Olds and Milner (1954) gave further impetus to this investigation when they reported that electrical stimulation of certain areas in the brain produced reinforcing effects on the behavior of rats. These effects

either favor or inhibit learning.

A similar development has taken place in another area. In the last ten years, what various authors have called exploratory behavior, activity, novel stimulation and manipulation, all have been shown to raise the probability of the response they follow. For a good reason then, reinforcement theory was extended far beyond the bounds of the original drive reduction theory postulated by Hull.

#### Novel Stimulation and Reinforcement

The concept of drive itself has been extended in recent years following the discovery of general activation effects due to stimulation of thalamic and brain stem reticular formations (Malmo, 1959). Others, too have used the idea of a general level of arousal (Fiske and Maddi, 1961, P. 30) and have attempted to relate level of arousal or activation to the concept of novelty: "Total impact and hence activation level is determined by the variation, intensity and meaningfulness of stimulation from exteroceptive, interoceptive and cerebral sources". Berlyne's theory of novelty is more explicit (Berlyne, 1960). His theory combines the effects of learning (discrimination) and drive. The organism upon encountering a novel event attempts to classify it by the learning processes of

generalization and discrimination. A stimulus is classified according to its similarity to other stimuli. A novel stimulus has many classifications. Each classification in turn will arouse a response tendency in the organism. Berlyne (1960, P. 21) assumes that some of these tendencies are incompatible and thus generate conflict. The conflict in turn contributes to the arousal level of the organism. Exploratory behavior which ensues reduces the arousal level by allowing new associations to be formed.

A novel stimulus is defined by Berlyne (1960, P. 21) to be an event that induces conflict through generalization. He then says that such an event has three supplementary variables, change, surprisingness and incongruity. Surprise is the difference between the expected and the observed stimulus. Exploratory behavior reduces the amount of uncertainty contained in the environment. An organism will explore something it can see. It has some prior knowledge either from a distance or from its imagination. Indeed, this is the motivating aspect of such behavior. The internal motivation is the driving force behind responding. Humans, knowing little of the moon, still create songs and fables of it and seek to explore it. Knowing less of Mars accounts for less concern. The uncertainty about the stimulus object must operate through some knowledge of the same object. The point of relevance here is the establishment of an upper and lower limit of uncertainty.

Dember and Earl (1957) proposed the first formalization of exploratory behavior. They subsumed all such behavior under the category of attention. Attention for them "is any behavior, motor or perceptual that has as its end-state contact between the organism and selected portions of its environment" (Dember and Earl, 1957, P. 91). Both spatial and temporal change produces attention as defined above. For Dember and Earl, spatial change is a special case of temporal change. If a stimulus is complex, then, the organism can attend to only one portion of that stimulus in any one instant of time. The variation thus will occur over time.

The central core of their theory is given by the following statement: "It should be noted that a temporal change in stimulation arouses attention only if the change produces a discrepancy between what is observed and what is expected" (Dember & Earl, 1957, P. 92). This is analogous to change in the amount of uncertainty that exists in the organism prior to receiving information about the stimulus. They continue to develop the above discrepancy concept as a measured variable scaled according to a Coomb's method. This technique permits the subjects to give a subjective appraisal of how alike stimuli are. It does not specify the attribute on which these stimuli are to be scaled. Rather it measures the perceived distance between stimuli.

Some experimenters (Berlyne, 1961; Montgomery, 1954) do not distinguish between the cue value and drive value of a stimulus. They attribute all exploratory behavior to drive motivation. This confounding of cue and drive effects of stimulation is apparent in their studies. Lack of exteroceptive stimulation (environmental detachment) leads to an increase of interoceptive stimulation. Monotony may lead to play or sleep. A child, for example, derives pleasure from the simplest stimuli investing them with his own fantasies. An adult seeks a variety of stimulation in travel, books, nightclubs, etc. However, children are not purely fanciful in their approaches to play. Daily life and experiments indicate that children also engage in investigatory behavior (Fiske and Maddi, 1961).

At present the effects of monotony or stimulus deprivation are receiving increased attention from experimenters. This interest ranges from the developmental field, (Ribble, 1951; Harlow, and Zimmermant, 1959) to controlled perceptual studies (Bexton, Heron and Scott, 1954). Solitary confinement is reported to be experienced as unpleasant. Bizarre perceptions appeared in a number of subjects who underwent restricted sensory stimulation and restricted mobility for a number of hours (Shurley, 1960). These two experimental approaches illustrate the dependence on the amount of exteroceptive stimulation at the lower end of the continuum.



The response of the organism to increased sensory input has also been extensively investigated by Berlyne (1950, 1951, 1954, 1955) Montgomery (1951, 1952, 1953a, 1953b, 1953c, 1955) and others.

Montgomery, using a maze situation, found that albino rats preferred to enter that arm of the maze which contained the greatest degree of novel stimulation. The response measure for this behavior was length of time spent in the maze and orderliness of the activity. He surmises "that a novel stimulus situation evokes in an organism an exploratory behavior" (Montgomery, 1953, P. 129). Montgomery (1953) found that food and water deprivation reduced the amount of exploratory behavior.

Berlyne (1950) has found that the attention of the subjects was related to the intensity of the stimulus. Berlyne (1951) also found that attention (key pressing) was related to change in stimuli. Subjects would change their attention (signified by the percentage of responses) to the novel stimulus. A pretest phase was used to establish monotony. The attention responses followed the stimulus in this case.

In another experiment carried out by Berlyne (1958a), the dependent variable was measured by the amount of time a subject spent in attending to an object. Berlyne projected two pictures on two screens for a period of ten seconds. On one of the screens the pictures were

changing; on the other the picture remained the same. He found that subjects spent an increasing proportion of time fixating the changing pictures and a decreasing proportion of time fixating the same picture. This experiment dealt with short term novelty.

Berlyne (1958b, 1958c) has also investigated the effect of complexity, uncertainty and incongruity of the stimulus on the orienting response. The three independent variables, bear a significant relationship to the orienting response in terms of the amount of time spent fixating the stimulus.

The same experimenter has also systematically studied the investigatory response (Berlyne, 1957c). Human subjects were seated in a darkened room and pictures were presented through a tachistoscope at an exposure time of 0.14 seconds. The subject was allowed to see each picture as often as he wished, signifying that he was ready for the next one by saying "yes" but he was not allowed to inquire about the pictures themselves.

The response measured was the number of lever presses per card. He found that incongruous pictures of birds and animals elicited significantly more responses than pictures of normal animals and birds. The degree of stimulus complexity increased the mean number of responses. Surprise also contributed to the increased response rate of subjects. Figures with more relative uncertainty or complexity attracted

more investigatory responses.

In an unpublished study, (cited by Fiske and Maddi, 1961) Mendel and Maddi tried to get more directly at the investigatory response. They used as subjects children between the ages of three and five. Every child in the experimental group was permitted to play with a set of eight toys. After eight minutes of such play they were required to select another group of toys from five such groups.

The groups had 0, 25, 50, 75 and 100 per cent novel toys in them. The control group had to choose without a prior period of habituation. The results are described by the investigator as follows:

Taken together, the arrays of from 25 per cent to 75 per cent novelty were chosen more frequently by the experimental than by the control group. In contrast, the arrays with 0 per cent and 100 per cent, taken together were chosen with less frequency by the experimental than by the control group. It would appear that the intermediate degrees of novelty were most effective, in eliciting choice or investigatory responses (Fiske & Maddi, 1961, P. 262).

The third and most often claimed functions of novel stimuli connects them with an "exploratory" drive. Novel stimuli are said to induce a drive. The organism in turn tries to reduce this state of tension to a homeostatic balance. The drive stimulus tends to activate the organism to behavior which will reduce the imbalance. Activities that lead to such a balance will recur in an organism's response repertoire. Thus an activity may elicit a

proprioceptive stimulus which in turn may act as the reinforcer when it reduces the drive stimulation. In summary then the organism engages in activity to restore proprioceptive balance which was upset by stimulation. The reinforcer is that response-produced stimulus which reduces this state of tension. The above statement is based on Hullian theory of the relationship between drive and novel reinforcers.

If an organism's level of arousal is below its appropriate level or if it is not equal to the task at hand then the organism may seek out novel situations. This behavior is accounted for adequately by Fiske and Maddi (1961). The variable which is basic in their formulation of exploratory behavior is variation in the environment. A stimulus is considered to vary if the event is different from the preceding one, or if it is temporally or spatially unexpected. This increase in variation produces a concomitant increase in the level of activation in an organism. They also postulate a normal level of activation that the organism tries to maintain. Any large deviations are typically associated with negative affect. For this reason the organism tries to maintain its normal level of activation either by increasing the stimulation from the environmental situation or by decreasing it.

Marx, Henderson and Roberts (1955) using albino rats, found that they showed striking increments in response

frequency when mild light stimulation was introduced as the aftereffect of bar pressing. Kish (1954) found that rats doubled their rate of responding when onset of illumination was used as the reinforcing stimulus. Both of the above experiments were conducted under conditions of sensory deprivation in the pre-test period. Here as in previous studies the properties of stimulation have not been investigated.

Novelty then has a cue value as is shown in the experiments on attention. The Dember and Earl theory explains exploratory behavior in terms of attention. Berlyne's theory also uses cue as an explanation for exploratory behavior, but, this is combined with the motivating properties of these stimuli. There are an assortment of experiments which illustrate this approach. Experiments also have tested the reinforcing properties of novel stimuli (i.e., stimulus follows the response). The fact that there is an effect can be explained by the drive homeostatic theory of Fiske and Maddi.

#### Activity and Reinforcement

That activity is a variable that interacts with stimulus deprivation is shown by recent studies (Shurley, 1960). Subjects in monotonous situations tend to increase their motor responses. Monotony then seems to be a drive condition which is partially relieved by activity which may be acting as reinforcement but the exact relationship is

not known. Whether overactive organisms choose monotonous situations is not known either. Here the relationship of monotony to activity is not separated.

Experimenters have found that activity is reinforcing even when the stimuli encountered do not change. An experiment by Kagan and Berkun (1954) illustrates the reinforcing effect of general activity. They found that the response probability of lever pressing by the rat could be increased when the reinforcement consisted in allowing the animal to run in an activity wheel following each lever pressing.

Response alternation is partially dependent on the discriminability of the response. That is, rats choose that response which is most different from the preceding response. This is evidence cited by Walker et. al. for the existence of the response reinforcement (Walker et. al., 1955).

Work in another area supports the hypothesis that manipulation is intrinsically rewarding. Harlow, Harlow and Meyer (1950) found that an externally elicited drive operates to channel behavior and that the task itself is rewarding. In other studies (Harlow, 1950) found that reward for successful performance in a puzzle solution interfered with exploratory behavior. The number of complete solutions for food rewarded rhesus monkeys was higher than the number of complete solutions for non-rewarded monkeys.

## The Problem

The preceding discussion suggests that, while both novelty and activity appear to be important determinants of behavior, their relative roles have not yet been clearly differentiated. Many of the investigations cited above have been studies of exploratory behavior in which the two variables have necessarily been confounded, since exploration implies activity in search of novelty.

It was decided, therefore, to set up a situation in which the influence of these factors could be varied independently of each other. To simplify the problem further, a relatively standard operant learning procedure was adopted. The problem, then, became that of investigating, both separately and jointly, the effect of novelty and activity on response probability in a two-choice learning situation.

## CHAPTER II

### METHODOLOGY AND PROCEDURE

#### Experimental Design

The two experimental variables were (a) degree of novelty in the reinforcing stimulus and (b) amount of activity in the operant response. As this was an exploratory study, it was decided to investigate only two levels of each variable in a 2 x 2 factorial design with different groups of subjects learning under the four combinations of the experimental conditions.

The two levels of novelty were chosen on the assumptions that novelty involves at least unpredictability as one of its aspects, and that the relative degrees of unpredictability can be measured by using the mathematical formulations of information theory. The concepts of novelty is not limited to the reinforcing or drive properties of the stimuli. Those groups (B & D) with maximum novelty were uncertain as to which one of a possible eight stimuli would occur after a correct response. For these each stimulus then conveys 4 bits of information. The



stimulus would indicate a correct response and which one of a possible eight stimuli did occur. The minimum novelty groups (A & C) on the other hand always knew which stimulus would occur. The only information conveyed was whether the response was correct or not (one bit).

The operant response was a light pressure on one of a pair of choice buttons. For the two minimum activity groups (A & B) only this simple pressure was required. The maximum activity groups (C & D) were required, before pressing the choice button, to press twice on a third "activity" button.

In summary, then the distinction between the two levels of the two experimental conditions were (a) between 1 and 4 bits of information in the reinforcing stimuli and (b) between 1 and 3 button pushes in the operant response. Apart from these experimental variations, the fundamental paradigm was that of a two choice learning situation with greater probability of reinforcement to the left response on an 'eighty per cent left' and 'twenty per cent right' reinforcement schedule.

### Subjects

The volunteer subjects were thirty-two freshman students from the University's men's residence. Each subject was assigned randomly to one of the four experimental groups. Male students were used because of their reported greater response stability in motor tasks.

Group A has as its conditions one unit of activity and zero "bit" of information. Group B had one unit of activity and three bits of information. Group C had three units of activity and zero bit of information. Group D had three units of activity and three bits of information as novel stimulation.

### Apparatus

The reinforcement stimuli were presented to each subject through a standard Gerbrand's mirror tachistoscope. This instrument controlled for intensity and duration of stimulation besides presenting a homogeneous non-changing stimulus field. All visual stimuli were drawn on white bristolboard,  $12 \frac{7}{8}$ " x  $8 \frac{5}{8}$ ". The stimuli were of three classes; the fixation stimulus, which was a small black cross  $\frac{1}{2}$ " x  $\frac{1}{2}$ ", the training stimulus, which was solid red parallelogram 1" x 1", and the reinforcement stimuli. The latter consisted of eight figures arbitrarily selected and drawn in India Ink. The figures and their dimensions were as follows:

- a rectangle, 4" x 3"
- dots  $\frac{1}{2}$ " apart in a 3" x 3" matrix
- a sine curve,  $y \sin x$
- a parabola,  $y^2 \frac{1}{2}x$
- an isoscles triangle,  $5 \frac{1}{4}$ " x  $5 \frac{1}{4}$ " x  $4 \frac{1}{4}$ "
- a cube,  $3 \frac{1}{4}$ " x  $2 \frac{1}{2}$ " x  $1 \frac{7}{8}$ "

- a circle, 4" in diameter
- a straight line, 4" in length

The subject was provided with three response buttons mounted on a wooden platform which in turn was clamped to a table directly beneath the eyepiece of the tachistoscope. The two black "choice" buttons were situated side by side, 2" apart. A red "activity" button was situated midway between the two black buttons and approximately one inch closer to the subject.

The experimenter's control panel provided means for vividly controlling the reinforcement schedule; and the level of response activity. Both circuits are illustrated in Appendix A. The apparatus was permanently installed in a small testing room.

#### Procedure

The subject was conducted to the test room. He was told to place both his right and left hands over the right and left black buttons, respectively. The experimenter then read out the instructions as presented in Appendix B and the experiment proceeded.

The experimental session was divided into two parts; a pre-training period and a learning period. The pre-training period was designed to equate groups on their initial level of response to the left button. The red

parallelogram was used as the reinforcing stimulus and was presented following a choice of the left button fifty per cent of the time; i.e. in every ten trials (one block), the left button if pressed would elicit the reinforcing stimulus five times. The order of reinforcement was random within blocks. There were thirty trials (3 blocks of ten) in the pre-training period.

For the next ninety trials (nine blocks) the reinforcement schedule was changed so that in every ten trials (one block), the left button if pressed would elicit the reinforcing stimulus eight times.

For groups A and C a figure was inserted into the tachistoscope. This picture remained in the machine throughout the ninety trials for each subject. However, each subject within group A had a different geometrical figure from every other subject. The same condition held for group C.

For groups B and D a total of ninety-six cards were used. That is, the eight cards were replicated twelve times. The cards were put in random order according to a table of random numbers and this order was kept for all subjects. When a subject was about to be run in groups B and D the cards were inserted into the tachistoscope. After a response was made one card was removed by the experimenter prior to the next response.

The level of activity was set at its appropriate

value according to the circuitry so that it would require one or the other level of activity before a subject could get reinforcement. The experimenter also determined whether a right or left response was to be reinforced by throwing a switch. The order of reinforcement was set up prior to each run through according to a table of random numbers. In a set of ten numbers, the numbers three and five were arbitrarily selected to stand for the left button. Thus these numbers would indicate at what time the left button was to be reinforced. Thirdly, the experimenter recorded throughout the experiment whether the subject responded to the right or left black button on each trial.

## CHAPTER III

### RESULTS

Each subject made a total of one hundred and twenty responses. These responses were divided into twelve blocks of ten for purposes of analysis. The proportion of left responses for each block of trials for the different groups is given in Table 1. The same data is presented graphically in Figure 1.

Table 1

Frequency of Responses to the  
Left Button on Successive Blocks  
of Trials for Buffer Session  
and Experimental Session

Group	Nov.	Act.	Response Frequencies											
			Buffer			Experimental								
			1	2	3	4	5	6	7	8	9	10	11	12
A	1	1	56	53	48	40	58	64	64	70	78	70	66	74
B	4	1	41	48	40	43	54	59	64	73	78	55	68	69
C	1	3	45	58	46	45	43	63	68	70	79	80	84	66
D	4	3	43	48	45	40	66	60	65	69	76	68	73	75

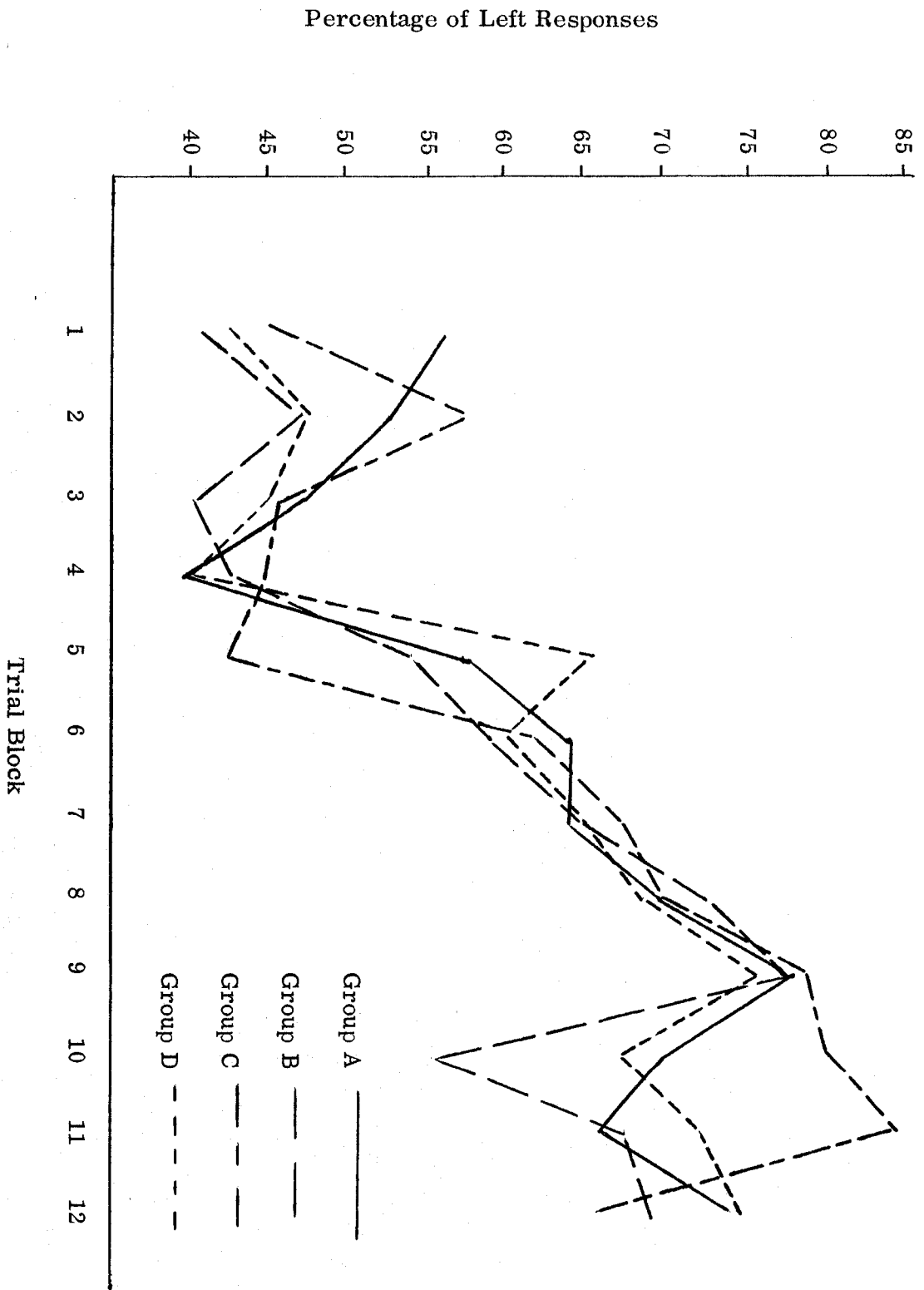


Fig. 1. Percentage of Responses to the Left Button

The first three blocks formed a buffer session designed to equalize response frequencies across groups. As can be seen, this was only partially successful. The remaining differences were adjusted by subtracting, for each subject, his score on Block three (last buffer block) from his score on each experimental block. Negative values were eliminated by adding to each difference score a constant equal to the greatest negative difference. The general form of the transformation is given by  $T_n = (B_n - B_3) \div 8$  where  $T_n$  is the transformed difference score,  $B_n$  is the response frequency for the  $n$ th block, and  $B_3$  is the response frequency for the last buffer block. The results of the transformation are shown in Table 2.

Table 2

## Transformed Response Frequencies

Group	Learning Block								
	4	5	6	7	8	9	10	11	12
A	58	72	77	77	82	88	82	79	85
B	66	75	79	83	90	94	76	86	87
C	63	61	77	81	83	90	91	94	80
D	60	81	76	80	83	89	82	86	88



An analysis of variance was performed on the transformed data. The results of this analysis are shown in Table 3.

Table 3  
Analysis of Variance of  
Transformed Response Scores

Source	Sums of Squares	df	Variance Estimate	F
Between Subjects	781	31	25.19	
Activity	.28	1	.28	
Novelty	5.87	1	5.87	
Activity x Novelty	3.31	1	3.31	
Error	711.54	28	27.55	
Within Subjects	890	256	3.48	
Trials	298.94	8	37.37	15.90 <sup>x</sup>
Trials	25.23	8	3.15	1.34
Trials x Activity	16.82	8	2.10	.89
Tr. x Act. x Nov.	23.28	8	2.91	1.24
Error	525.83	224	2.35	
-----				
X P = .001				

The only significant effect here is that due to trials; taken in conjunction with Figure 1, this demonstrates that there was a systematic non-chance increase in response

with successive blocks of trials. That is, the subjects did learn.

Differential effects of degree of novelty and level of activity would be expected in the interaction of these factors with trials. None of the interactions was statistically significant. There is, therefore, no evidence that the present attempts to manipulate either novelty or activity had any noticeable effect on rate of learning.

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## CHAPTER IV

### DISCUSSION

The one statistically significant finding from this study was that learning occurred under all four experimental conditions. This statement is not entirely trivial. In a pilot study, where all the experimental conditions were the same except that the instructions had been deliberately worded to avoid any implication that one response was more "right" than the other, or that the subject was to try to find out which button would cause the picture to appear, there appeared to be no changes in behavior which could justifiably be called systematic learning.

This suggests an explanation for the fact that the novelty factor produced no detectable differences in probability of response. If we consider first the dimension of novelty, and the amount of information supposedly carried by the reinforcing stimulus under both levels of novelty, it is clear that part of this information arises from the fact that the stimulus is a signal of success rather than failure. This source of information is independent of any additional uncertainty as to the nature of the stimulus, and consequently would be the same for

both levels of novelty. If, then, the instructions caused the subjects to classify the reinforcing stimuli in the high novelty situation only as indicators of success, ignoring the additional classification which the experimenter tried to set up, no difference in learning under the two conditions would be expected.

The above considerations reasonably account for the failure to obtain differences due to novelty. They do not, however, account for the lack of differences with respect to the level of activity. It is possible to assert, on purely theoretical grounds, that no differences should be observed in situations of this kind with respect to either variable.

The argument is necessarily abstract and depends essentially on a definition due to Cervin and Henderson<sup>1</sup> that response probability measures learning (habit strength) rather than performance. Two additional assumptions are that (a) the greater the uncertainty about the outcome, the higher the drive level; and (b) the more active the operant response, the greater the drive reduction.

That is, the two levels of novelty in the present experiment were equivalent to the two levels of drive; and the two levels of activity corresponded to different

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1 V. B. Cervin, Personal Communication, April 1963.

magnitudes of reinforcement. Now, Spence's theory (and Hull's later position) consider habit strength to be independent of both drive and magnitude of reinforcement; if, then, response probability is directly related to habit strength, no differences in this variable should occur because of changes either in novelty or in activity.

Hull's earlier theory, on the other hand, considered habit strength to be dependent upon magnitude of reinforcement, but independent of drive: this version of learning theory would call for differences due to activity but no difference due to novelty.

Since neither novelty (as defined) nor activity made any real difference in response probability then it follows that the most complete explanation is in terms of Spence's theory. To this statement must be added the additional qualification that response probability in a two choice learning situation is a measure of habit strength rather than performance.

## CHAPTER V

### SUMMARY AND CONCLUSIONS

Recent research on exploratory behavior, when studied revealed a confounding of a number of variables. One, for example, was a lack of separation of the cue, reinforcer and drive properties of novel stimulation. Another problem in exploratory behavior rests in the fact that both activity and novelty have been found to be reinforcing. Yet both of these factors are present in exploratory or investigatory behavior. The present experiment was an attempt to separate the latter two factors.

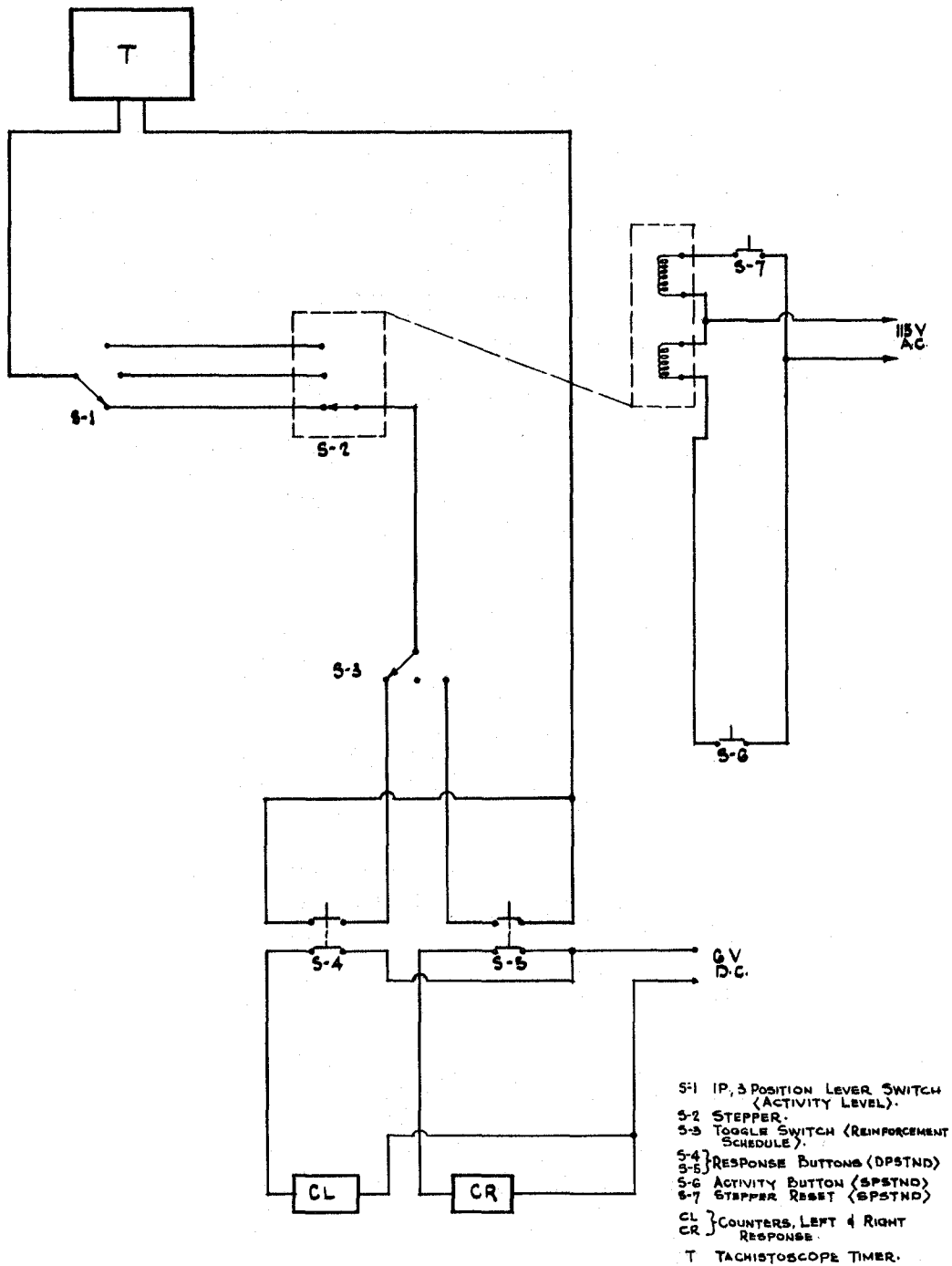
A two choice learning experiment was employed. Novelty was defined as the degree of uncertainty about the nature of the reinforcing stimulus. The measure for this was bits of information. Activity was measured by the number of button pressures called for in the operant response. Thirty-two freshmen subjects were assigned randomly to each of four groups separated into a two by two factorial design with two levels of activity and two levels of novelty.

The subjects were instructed to guess which of

two buttons would elicit a picture in a Gerbrand's tachistoscope. Under all experimental conditions, reinforcement followed the pressing of the left button with a probability of .8. In addition the subjects were told what to expect as the reinforcing stimulus.

The four groups showed no differences in response probability over ninety training trials under this reinforcement schedule. The results seemed to be most satisfactorily explained in terms of Spence's theory of learning with the additional qualification that response probability measures habit strength.

APPENDIX A  
APPARATUS SCHEMA





## APPENDIX B

### INSTRUCTIONS

Group A. In this experiment one of these two black buttons will cause a picture to appear in the eye-piece. For the first thirty times the picture will be a red parallelogram. After that the picture will be this one. (S shown one of the eight stimuli). On each trial a different black button will cause the picture to appear but the picture will be the same. When I say 'ready', look into the eye-piece and then press button which you think will cause the picture to appear. Remember I am not trying to fool you or outguess you. Any questions? (E. clarifies any questions, then says, 'ready')

Group B. In this experiment one of these two black buttons will cause a picture to appear in the eyepiece. For the first thirty times the picture will be a red parallelogram. After that, the picture will be any one of these eight. (S. shown all eight stimuli). Then, on each trial a different black button will cause the picture to appear and the picture will be different.

When I say 'ready' look into the eyepiece and then press that button which you think will cause the picture to appear. Remember I am not trying to fool you or outguess you. Any questions? (E. clarifies any questions, then says 'ready').

Group C. In this experiment one of these two black buttons will cause a picture to appear in the eyepiece but first you have to press the red button twice. For the first thirty times the picture will be a red parallelogram. After that, the picture will be this one. (S. shown one of the eight stimuli). On each trial a different black button will cause the picture to appear but the picture will be the same.

When I say 'ready' look into the eyepiece. Press the red button twice and then press that black button which you think will cause the picture to appear. Remember I am not trying to fool you or outguess you. Any questions? (E. clarifies any questions, then says 'ready').

Group D. In this experiment one of these two black buttons will cause a picture to appear in the eyepiece but first you have to press the red button twice. For the first thirty times the picture will be a red parallelogram. After that the picture will be any one of these eight. Then, on each trial, a different black button will cause the picture to appear and the picture will be different.

When I say 'ready' look into the eyepiece. Press the red button twice and then press that black button which you think will cause the picture to appear. Remember I am not trying to fool you or outguess you. Any questions? (E. clarifies any questions, then says 'ready').

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