9-1962

An experimental investigation on the theoretical development of conditioned inhibition

Daniel B. Felker
University of Nebraska at Omaha

AN EXPERIMENTAL INVESTIGATION ON THE THEORETICAL DEVELOPMENT OF CONDITIONED INHIBITION

A Thesis
Presented to
the Faculty of the Department of Psychology
University of Omaha

In Partial Fulfillment
of the Requirements for the Degree
Master of Arts

---

by
Daniel B. Felker
September 1962

ACKNOWLEDGMENTS

The writer wishes to extend grateful appreciation for guidance and assistance from the following:

William E. Jaynes, Ph.D., Associate Professor and Head of the Department of Psychology and Director of Industrial Testing and Institutional Research, University of Omaha;

John M. Newton, Ph.D., Assistant Professor in the Department of Psychology, University of Omaha;

Katherine E. Baker, Ph.D., Professor of Psychology in the Department of Psychology, University of Nebraska.

D. B. F.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER I

INTRODUCTION AND SURVEY OF THE LITERATURE

The Hullian intervening variables, reactive inhibition (IR) and conditioned inhibition (SIR) have, like many other Hullian intervening variables, generated large amounts of research as reported in the psychological literature. These views of Hull are presented systematically in two of a proposed three-book system. Hull's original formulation of his behavior theory was presented in the Principles of Behavior. This book attempted to state the primary behavior principles deemed necessary for the deductions needed by a natural-science theory of behavior. In 1951 a supplementary volume, Essentials of Behavior, presented these principles in revised form. The book A Behavior System was intended to show the application of the principles to the deduction of the simpler phenomena characterizing the behavior of simple organisms. The third volume of Hull's proposed three-book system, which was never written due to Hull's death, was to apply the same principles to the deduction of the elementary phenomena of social behavior. In the volumes mentioned above Hull presented a complex theory of behavior utilizing numerous intervening variables two of which were reactive inhibition (IR) and conditioned inhibition (SIR).

The present study will be primarily concerned with the discussion relevant to Hull's conditioned inhibition. Necessarily involved, however, will be considerations pertaining to reactive inhibition. This is because SIR, according to the Hullian view point, is generated as a secondary effect from the accumulation of IR. The eighth and ninth postulates of Hull deal directly with these intervening variables. As presented in the Principles of Behavior these postulates read as follows:

POSTULATE 8

> Whenever a reaction (R) is evoked in an organism there is created as a result a primary negative drive (D); (a) this has an innate capacity (IR) to inhibit the reaction potentiality (SER) to that response; (b) the amount of net inhibition (IR) generated by a sequence of reaction evocations is a simple linear increasing function of the number of evocations (n); and (c) it is a positively accelerated increasing function of the work (W) involved in the execution of the response; (d) reactive inhibition (IR) spontaneously dissipates as a simple negative growth function of time (t''').

POSTULATE 9

> Stimuli (S) closely associated with the cessation of a response (R) (a) become conditioned to the inhibition (IR) associated with the evocation of the response, thereby generating conditioned inhibition; (b) conditioned inhibitions (SIR) summate physiologically with reactive inhibition (IR) against the reaction potentiality to a given response as positive habit tendencies summate with each other.[1]

According to Hull then, "the effective reaction potential $S\bar{E}R$), i.e., that reaction potential which is actually available for the evocation of action (R), is the reaction

---

[1]Clark L. Hull, Principles of Behavior (New York: Appleton-Century-Crofts, Inc., 1943), p. 300.

potential (SER) less the total inhibitory potential ($\dot{I}R$)."[2] In equation form this would read:

$$S\bar{\bar{E}}R = SER - \dot{I}R$$

where

$$\dot{I}R = IR \dotplus SIR.$$

These same equations were elaborated upon and manipulated differently in a later publication to arrive at the same conclusion. These equations may be presented as follows:

$$\dot{I}R = IR \dotplus SIR$$

Now by definition

$$S\bar{\bar{E}}R = SER - \dot{I}R$$

Substituting for $\dot{I}R$ the corresponding value in the preceding equation one has

$$S\bar{\bar{E}}R = SER - (SIR \dotplus IR)$$

Since the IR spontaneously dissipates and SIR, being a habit does not, the rest period permits a partial spontaneous dissipation of $\dot{I}R$. If the rest period were long enough to permit all the IR to dissipate, the residue would be SER and pure SIR, leaving

$$S\bar{\bar{E}}R = SER - SIR.$$ [3]

The two postulates presented in the Principles of Behavior (postulates 8 and 9) have been rewritten and reworded in Hull's latest book. They are presented as one

---

[2] *Ibid.*, p. 184.

[3] Clark L. Hull, *Essentials of Behavior* (New Haven: Yale University Press, 1951), p. 76.

postulate broken into several parts and three corollaries. They are expressed by Hull in the following manner:

POSTULATE IX. INHIBITORY POTENTIAL

A. Whenever a reaction (R) is evoked from an organism there is left an increment of primary negative drive (IR) which inhibits to a degree according to its magnitude the reaction potential (SER) to that response.

B. With the passage of time since its formation, IR spontaneously dissipates approximately as a simple decay function of the time (t) elapsed.

C. If responses (R) occur in close succession without further reinforcement, the successive increments of inhibition (ΔIR) to these responses summate to attain appreciable amounts of IR. These also summate with SIR to make up an inhibitory aggregate (İR), i.e., İR = IR + SIR.

D. When experimental extinction occurs by massed practice, the IR present at once after the successive reaction evocations is a positive growth function of the order of those responses (ṅ).

E. For constant values of superthreshold reaction potential (SER) set up by massed practice, the number of unreinforced responses (n) producible by massed extinction procedure is a linear decreasing function of the magnitude of the work (W) involved in operating the manipulanda.

Corollary ix. Conditioned Inhibition

Stimuli and stimulus traces closely associated with the cessation of a given activity, and in the presence of appreciable IR from that response, become conditioned to this particular non-activity, yielding conditioned inhibition (SIR) which will oppose SER's involving that response, the amount of ΔSIR generated being an increasing function of the IR present.

Corollary x. Inhibitory Potential (İR) as a Function of Work

For a constant value of n, the inhibitory potential ($\dot{I}R$) generated by the total massed extinction of reaction potential set up by massed practice begins as a positively accelerated increasing function of the work (W) involved in operating the manipulandum, which gradually changes to a negative acceleration at around 80 grams, finally becoming symptotic at around 110 grams.

Corollary xi. Inhibitory Potential ($\dot{I}R$) as a Function of the Number of Responses

For a constant value of work (W) involved in operating the manipulandum, the inhibitory potential ($\dot{I}R$) generated by the total massed extinction of reaction potential set up by massed practice is a negatively accelerated increasing function of the total number of reactions (n) required.[4]

It should be noted that parts D and E of Postulate IX and that corollaries x and xi have no particular significance for the problem primarily involved in this study nor for the understanding of this problem. The author has presented them merely for the sake of presenting in complete form the theoretical basis on which this thesis research was based.

It is to be noted that Hull's discussion of the two intervening variable, IR and SIR, in his first and later volumes are essentially the same. They are presented in different form but the underlying meanings and explanations remain the same. Recent investigators in the field have mentioned this fact. They feel that even though Hull's systematic formulations have been revised and elaborated in Essentials of Behavior and in A Behavior System, these more recent publications have left the theory of extinction

---

[4]Clark L. Hull, A Behavior System (New Haven: Yale University Press, 1952), pp. 9-10.

essentially unaltered.[5] Consequently, since it is the theory of extinction that is relevant to IR and SIR and since this theory is essentially unaltered from the first formulation, all later discussion of these intervening variables shall be based upon the more familiar <u>Principles of Behavior</u>.

The preceding discussion has presented the definition of reactive inhibition and conditioned inhibition as was originally conceived by the author and originator of these intervening variables and in the theoretical framework in which they were expressed. As so frequently happens in psychological science, however, it is not with the originator that most of the experimental work has been undertaken in the effort to confirm or disprove a concept or theory. The present work is a case in point. Though Hull formulated his theory in such a manner that it is possible to arrive by deduction at hypotheses capable of being experimentally investigated, he actually did little experimental work himself pertaining to his inhibitory constructs. Consequently, it is to his students and other investigators that one must turn in order to see how the Hullian concepts have withstood the experimental onslaught. This is particularly true with IR and SIR. Hull gave the theoretical formulation but it was others who tested and explored the ramifications involved in these variables.

---

[5] H. Glietman, J. Nachmias, and U. Neisser, "The S-R Reinforcement Theory of Extinction," <u>Psychol</u>. <u>Rev</u>. 61:24, January, 1954.

Although Hull has defined IR and SIR fully and clearly, his discussion is not adequate enough to arrive at the problem that this study has attempted to answer. It is necessary to define and explain more completely both IR and SIR in order to develop the problems that are inherent in these concepts in their original formulation. Consequently, one has to delve into the experimental and theoretical works of other psychological investigators to obtain a balanced perspective of the experimental state of these intervening variables. Both IR and SIR then, will be discussed separately and in detail.

Of the two intervening variables being considered in this study, IR is the less troublesome and its functions are more clearly defined and understood. Two experimenters think that IR can be likened to a negative drive state. It accumulates during work, depresses performance, and dissipates spontaneously during rest. Reactive inhibition is thus regarded as a response-produced drive state for which the goal response is resting.[6] One can say in general, furthermore, that the more effortful the behavior in which an organism has been engaged, the greater will be the amount of IR present, and consequently, the greater the need to cease activity. This effortfulness is dependent upon the physical energy required to perform the task, and the length of time the organism

---

[6] J. A. Starkweather, and C. P. Duncan, "A Test for Conditioned Inhibition in Motor Learning," J. Exp. Psychol. 47:351, May, 1954.

has been forced to work without rest. Though possibly other factors may be involved, the energy expended and the length of time required have received the most experimental attention and are considered primary in importance.

Reactive inhibition has also been thought of as analogous to fatigue. It is this fatigue that accumulates during work and depresses performance. During rest, this fatigue will dissipate or decay and will result in a recovery from the effects of practice which are detrimental to performance. This I_R or fatigue-like state composes part of the total inhibitory potential ($\dot{I}_R$) which, when subtracted from the reaction potential ($_SE_R$), determines the effective reaction potential ($_S\bar{E}_R$) or the reaction potential available for the evocation of action.

In summary, I_R is determined, in part at least, by several things. Reactive inhibition is hypothesized to be a function of the number of response evocations and the amount of effort involved in the response. The amount developed accumulates and the greater the amount present, the greater will be the tendency not to make that response in the future. After a passage of time since the last response was made I_R dissipates and is consequently reduced.

The hypothesis that I_R is a function of the number of response evocations has been experimentally tested and verified by several independent investigations. Siegel designed an experiment in which subjects (Ss) could use either of two switches to turn off a light bulb which was controlled by the experimenter (E). In order to test that IR is a function of number of response evocations and that greater amounts of IR present will result in a tendency to not make the response generating the IR, Siegel had Ss turn the light off with only the switch controlled by the S's right hand. The Ss were placed in groups so that the practice of using the right hand to turn off the light varied from 0 to 160 trials. After a period of practice the Ss were told that they could turn off the light with either switch. The results demonstrated that as prior exercise in the right hand reaction increased, the frequency of occurrance of the left hand response increased.[7] The results were interpreted in a manner that verified Hull's formulation of IR as expressed in postulate 8, parts a and b. That is, the Ss who practiced with their right hand were building up IR to the right hand response. The more practiced the Ss were with their right hand, the more was the inhibition accumulated and consequently the greater the tendency not to repeat the same response. Zeaman and House found essentially the same results using rats and a T-maze. Their conclusion was that when a response is given there is built up an inhibition to that response and thus a tendency not to give the same response.[8]

[7] Paul S. Siegel, "Reactive Inhibition as a Function of Number of Response Evocations," J. Exp. Psychol. 41:604-608, October, 1950.

[8] D. Zeaman, and Betty J. House, "The Growth and Decay of Reactive Inhibition as Measured by Alternation Behavior," J. Exp. Psychol. 41:186, March, 1951.

Another study utilized an additional motor task (Minnesota Rate of Manipulation Test) to determine the effect of work and rest of IR and subsequently on the rate of learning. The Es of this investigation varied the work and rest lengths in which the Ss were required to operate. It was found that those Ss who had to work the longest length of time were significantly poorer in learning the motor task. The authors concluded that the "performance difference is a function of the length of the work period."[9] The inference was made that the longer a S worked, the more effort was required to perform, and consequently, the greater amount of IR generated. These results were further confirmed by Kimble using the alphabet printing task as described by Kientzle.[10] Generally the conclusion Kimble reached was "a longer practice period or a shorter inter-trial rest period, or both, reduced the level of performance."[11] Either condition was seen as conducive to generating and/or not dissipating the amount of IR accumulated. The conclusion suggested by these studies is that amount of IR generated is a function of effort involved in making a response.

---

[9] G. A. Kimble, and E. A. Bilodeau, "Work and Rest as Variables in Cyclical Motor Learning," J. Exp. Psychol. 39:157, April, 1949.

[10] Mary J. Kientzle, "Properties of Learning Curves Under Varied Distributions of Practice," J. Exp. Psychol. 36:189, April, 1946.

[11] G. A. Kimble, "A Further Analysis of the Variables in Cyclical Motor Learning," J. Exp. Psychol. 39:335, June, 1949.

Another characteristic of IR is that it dissipates as a decay function of time. As a result, the rate of accumulation of IR is greater not only for larger amounts of work (W) but also for smaller values of time or inter-trial rest intervals. This hypothesis was experimentally investigated in a study attempting to test the validity of some theorems deduced from Hull's postulates 8 and 9. In this study Montgomery used forty-five albino rats that were assigned randomly to three different levels of work and lengths of inter-trial rest intervals. Using response latency as the dependent variable, it was found that response latency was an increasing function of work and a decreasing function of inter-trial interval.[12] That is, the longer the inter-trial interval, the less the response latency, and, therefore, the better the performance. During the longer inter-trial intervals, greater amounts of IR were dissipated and thereby confirms the prediction that IR is greater for smaller values of time or inter-trial rest intervals. The results of all the preceding studies seem to warrant the suggestion that IR does develop and function in the manner hypothesized by Hull.[13] These studies give empirical reinforcement to the theory that IR accumulates as a function of work, depresses performance, inhibits the

---

[12] Kay C. Montgomery, "An Experimental Investigation of Reactive Inhibition and Conditioned Inhibition," J. Exp. Psychol. 41:50, January, 1951.

[13] cf. Hull, 1943, loc. cit.

response tendency that gives rise to IR, and dissipates with the passage of time.

Conditioned inhibition (SIR) is the second intervening variable that contributes to the total inhibitory aggregate ($\dot{I}R$) formulated by Hull and described by the equation $\dot{I}R = IR + SIR$. Since this investigation is primarily interested in the manner in which SIR developes it will be both desirable and necessary to elaborate upon the concept in order to obtain an understanding of its functions, determiners, and properties.

As viewed by Hull, IR may be regarded as essentially a need to cease action; if this is so, it follows that anything which reduces this need should serve as a reinforcing state of affairs. "Since the cessation of action," writes Hull, "reduces the afferent proprioceptive impulses generated by it in the presence of the inhibitory condition, particularly when many responses have generated a considerable amount of inhibition, it comes about that the cessation of action, rather than action, becomes conditioned to whatever stimuli may be present. In this way we find a plausible explanation of conditioned inhibition (SIR) and of the stimulus generalization of extinction effects."[14] As specified by Hull then, SIR is defined as a habit of resting for which the drive is IR and the reinforcement is rest.

Conditioned inhibition, like IR, depresses performance,

---

[14] _Ibid_. p. 298.

but as a habit it does not dissipate spontaneously over rest. It is a resting habit which is acquired because resting behavior is reinforced by the reduction of IR. The drive, IR, either produces, is accompanied by or is identifiable with drive stimuli which are unconditioned stimuli. When these acquire a certain strength, as a result of prolonged effortful behavior, and unconditioned resting response is elicited. This unconditioned resting in a sense provides its own reinforcement since the decay of IR occurs as a result of it. Kimble suggests then, "from the principles of conditioning, it follows that stimuli surrounding the subject will come to evoke the resting response independently."[15] This conditioned resting tendency is SIR.

Conditioned inhibition has two properties that have been investigated experimentally. Being a habit, SIR should increase as a negatively accelerated function of practice. As a condition response, it will not be acquired in the absence of an unconditioned stimulus strong enough to elicit the unconditioned response. That is, IR has to attain a minimal value great enough to force the resting response for SIR to develop. Kimble undertook an experiment using 474 Ss in an attempt to verify the two properties of SIR stated above. The results of the experiment supported the conjectures that IR does have to attain a minimal value for

---

[15] G. A. Kimble, "Performance and Reminiscence in Motor Learning as a Function of the Degree of Distribution of Practice," J. Exp. Psychol. 39:501, August, 1949.

SIR to develop and that SIR does increase as a negatively accelerated function of practice.[16] An independent and additional investigation by Kimble and Shatel confirmed further Hull's idea that SIR is a habit and should develop in the same manner as other habits, that is, in a negatively accelerated fashion.[17] Additionally, SIR being a habit will increase like any learned tendency with the number of reinforcements which is, in this case, rest. This was confirmed in an experimental study by Berlyne.[18]

With a relatively complete background and explanation of the two intervening variables IR and SIR, it is now possible to discuss the problem that this study is directly interested. Previous discussion of IR and SIR has tended to be relatively broad in scope. To narrow this scope and to limit the problems that these intervening variables evoke is a necessity to enable the present writer to present the main problem of this study--the manner in which SIR develops.

The exact manner in which SIR develops is a subject of experimental and theoretical controversy. The principal investigatory work has centered on Hull's theory as he originally stated it and on Kimble's revision and extension of

---

[16] G. A. Kimble, "An Experimental Test of a Two-Factor Theory of Inhibition," J. Exp. Psychol. 39:23, February, 1949.

[17] G. A. Kimble, and R. B. Shatel, "The Relationship Between Two Kinds of Inhibition and the Amount of Practice." J. Exp. Psychol. 44:358, November, 1952.

[18] D. E. Berlyne, "Attention to Change," Brit. J. Psychol. 42:275, August, 1951.

the original formulation. Discussion of these two viewpoints will enable this author to state the problem of this thesis in a formal manner.

Hull's theory on the manner in which SIR developed may be stated somewhat as follows: Since SIR is a habit, it can show only one type of development. It must be a positive growth function of the number of reinforcements, which is rest. Reactive inhibition, by contrast, is a drive. This would suggest that, as the organism goes on working without rest, the amount of IR might be expected to accumulate as some increasing function of the amount of effort previously expended. According to this formulation then, in a sufficiently difficult task IR accumulates to a level that "forces" rest, a state not unlike exhaustion.

Kimble suggests that the above formulation of Hull's is tenable if an organism can be induced to work a long period with no rest whatever. To Kimble this is unlikely. Kimble theorizes since IR is a drive it is reasonable to suppose that the accumulation of a certain critical amount will automatically produce resting. This automatic resting to which Kimble refers is interpreted by Archer and Bourne as indicating that it is conceivable that the organism might emit a resting response while in the act of performing, that is, would perform very slowly.[19] What this means is when IR

---

[19] E. J. Archer, and L. E. Bourne, Jr., "Inverted-Alphabet Printing as a Function of Intertrial Rest and Sex," J. Exp. Psychol. 52:322, November, 1956.

reaches a certain critical level it induces an automatic resting response though not necessarily complete cessation of activity. When this happens, the amount of IR will decrease as a function of the length of the period of inactivity and of the amount of IR present prior to the rest. Kimble writes "presumably, once IR is reduced to below the critical level, the organism driven by motivation to perform the task at hand will resume work and continue working until the critical level of IR is reached again. Then it will rest, reducing IR; start work again, increasing IR and so on."[20] It is to be remembered this may all take place while the organism is responding; it does not require complete cessation of activity.

This formulation of Kimble's theory has been graphically portrayed by Ellis and is reproduced below.

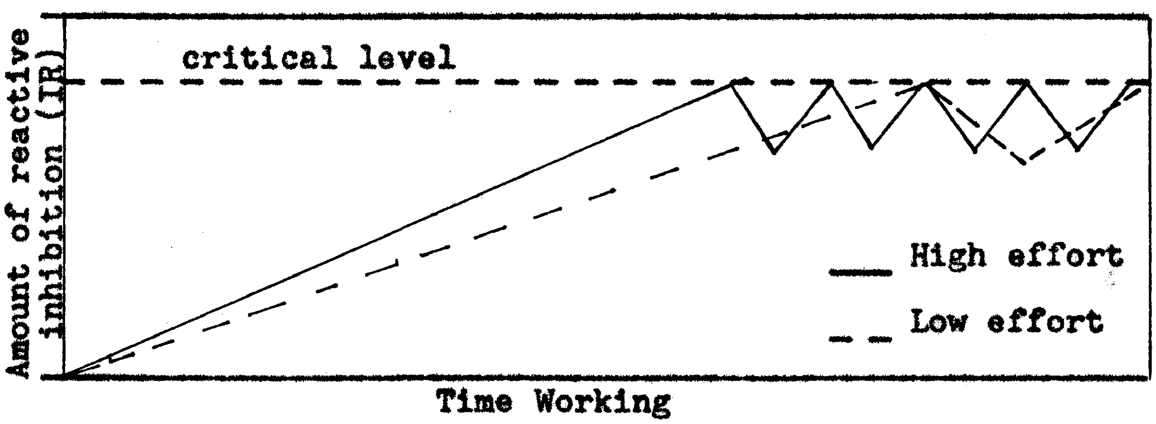

Fig. 1. Theoretical generation of IR at two conditions of task effort as theorized by Kimble.[21]

---

[20] Kimble, op. cit., p. 16.

[21] D. S. Ellis, "Inhibition Theory and the Effort Variable," Psychol. Rev. 60:388, November, 1953.

What this figure shows is that Kimble assumes Ss in the various effort conditions (i.e., high and low effort) allot the same amount of energy to the task at hand. Further, figure 1 sketches the development of IR at two conditions of effort under his modified theory. If one considers the curve for the low effort condition one can see that as responses are evoked, IR cumulates until the critical level is reached. When the amount cumulated reaches this level, the organism stops work, and IR dissipates. After sufficient IR has dissipated, the organism starts work again and the cycle is repeated. The curve for the high effort condition portrays the same sequence of events.

Figure 1 also permits some comment concerning the effects of effort on SIR. Ellis interprets Kimble by saying in Kimble's theory it is the resting responses pictured which develop SIR. Figure 1 shows that both effort conditions have identical amounts of IR present when rest is taken. This would not produce differential amounts of SIR at the two conditions. However, figure 1 does point up the possibility that the conditions might differ in the number of resting responses made. "This could produce a difference in SIR: the condition which the greater number of resting responses should develop the most SIR."[22] What this means is that according to the theory advanced by Kimble, IR under the high effort condition will reach the critical level more

---

[22] Ibid., p. 389.

often than in the low effort condition. This results in some kind of a resting response, but, as pointed out previously, not necessarily complete cessation of activity. Consequently, Ss operating under a high effort condition will be making more resting responses allowing the dissipation of IR and providing the reinforcing state of affairs necessary to condition the cease-work response to stimuli present, i.e., SIR.

In summary then, both Hull and Kimble say that the development of SIR is contingent upon the number or amount of reinforcement present in a learning situation. Hull thinks that it is only the reinforcement or rest that is necessary for the development of SIR in this learning situation. Kimble, however, believes that it is first necessary for IR to reach a certain critical level that in turn brings about a resting response of some type and it is these rests that serve as reinforcements for the development of SIR. From the previous discussion it may be suggested that, on the one hand the two theorists are agreeing on what is essential for the development of SIR, but on the other hand, they disagree with each other on the way and method in which SIR is developed.

THE PROBLEM

The basic problem that this study attempts to answer revolves around the question of whether or not IR must reach a critical level to bring about a resting response that serves as reinforcement for the development of SIR. This in turn brings about the problem of what kind of reinforcement actually generates SIR. Does SIR develop in the manner hypothesized by Kimble where IR reaches some critical level that produces a resting response, where the IR accumulated will dissipate, and where the motivation present will eventually result in the organism resuming the performance involved in the particular task at hand? Or does SIR develop in the traditional Hullian theoretical manner in which the only state necessary for the generation of SIR is a reinforcing state of affairs, or rest, and this generation of SIR is quite independent of IR reaching any critical level?

Kimble undertook an experimental investigation to test his modified Hullian theory of inhibition. He utilized five experimental groups using the alphabet printing task. All groups were given twenty-one 30 second trials with rest pauses between trials being 0, 5, 10, 15, and 30 seconds. All groups except the 30 second group (the control group) were given a ten minute rest between the 20th and 21st trials. The conclusion from this experiment was that only the massed practice group (0 second) indicated development of SIR. His explanation was somewhat as follows: the distributed practice groups prevented IR from reaching the critical level for the development of SIR because of the dissipation of IR during the intermittent rest periods. The massed practice group, however, demanded continuous performance, allowed IR to reach the critical level, and induced automatic resting. Therefore, it was these rests that served as reinforcement for the development of SIR.[23] In a word, Kimble's modification of Hull's theory was substantiated by the results of his experiment.

The conclusions reached by Kimble in his experiment suggest to the present investigator, however, that Kimble overlooked or misinterpreted one important point. Before the performance on the last trial was measured (trial 21), the massed practice group received a ten minute rest period. Kimble thereby failed to control for the dissipation of IR during this rest and the consequent reinforcement provided for the generation of SIR. He has no way of knowing for certain how the SIR he discovered developed. That is, did this SIR develop because of the critical level reached by IR and the consequent reinforcement received from automatic rest responses or did SIR result as a function of the reinforcement received from the ten minute rest interval? It is felt by the present author that the results from Kimble's study tend to suggest that he is unable to make any definite conclusions regarding the development of SIR and its place in Hullian theory. Consequently, it is this investigator's reasoning that an experiment is needed to control for the possibility of automatic resting responses to determine the importance of rest periods (controlled) for conditioned inhibition.

---

[23] Kimble, _op_. _cit_., p. 509.

Keeping in mind the preceding discussion pertaining to Hull's and Kimble's theorizing concerning the development of SIR the following hypothesis is advanced. If in a motor situation performance is held constant so as to prevent automatic resting responses from taking place and the only reinforcements allowed are well defined and controlled resting periods, then performance measures corresponding to SIR development will be found to decrease lending support to Hull's theory.

A secondary hypothesis can be derived and deduced from the above primary hypothesis. If there are two different conditions in which automatic resting is controlled but where performance under one condition requires more effort in performing the task, then that performance requiring the more effort will demonstrate greater amounts of SIR because of the greater amount of IR that is developed as a function of the more effortful behavior involved in evoking the response.

CHAPTER II

METHOD

The main function of this chapter of the thesis is to report how the experiment was conducted. This chapter serves to specify the method of gathering data that was relevant to the hypotheses and the procedure was used to test the hypotheses.

I. SUBJECTS

The subjects were forty volunteer students from the Municipal University of Omaha. The only criterion utilized in the selection of Ss was that they had to be students of the university. No effort was made to control for the grade, age, or sex since it was assumed these variable would have no effect on the magnitude of the dependent variable.

II. APPARATUS

The apparatus employed was a tapping board, a stylus with a metal point, a counter that recorded responses made on the tapping board with the metal point of the stylus, a metronome, and a stop watch. The tapping board, stylus, and counter were electrically connected to provide a count of the number of tapping responses made by the Ss. These tapping responses served as measures of the dependent variable.

III. DESIGN

To test the importance of controlled rest periods or level of IR needed for the development of SIR, this experiment involved three primary components; 1) performance measurements obtained pertaining to S's effective reaction potential ($_S\bar{E}_R$), 2) a means to force behavior at a specified rate to eliminate automatic resting responses, and 3) rest periods to serve as reinforcements for generating SIR.

The experiment employed two groups. Each group contained twenty Ss. The first volunteer S was randomly assigned to one of the groups and each following S was alternately placed in one of the two groups. One-half of the Ss were enrolled during the second semester of the 1961-1962 school year and one-half were obtained from students enrolled in the 1962 summer session.

The experiment was performed in three different assigned classrooms varying in size, color, and lighting. The circumstances involved in room availability made this arrangement necessary. Since these rooms were available at different hours and times for different days it was not possible to test an equal number of Ss in each room. Two variables that may have confounded with the independent variable (rate of forced tapping) making the dependent variable not free from irrelevant influences were, however, controlled. These controlled variables were table height upon which the apparatus was placed and chair height. At the beginning of each experimental trial the apparatus was placed at the same location of the table.

Each S's test trials consisted of four six-minute test periods separated from each other by five minute rest intervals. An additional thirty second test trial was administered after the rest interval following the fourth six-minute test trial. Each six minute test trial was composed as follows: a thirty second period that required the S to make as many tapping responses as possible on the tapping board with the stylus; that is, the S was to respond at his own pace (OP); a five minute interval of forced-pace (FP) tapping response where the S was required to respond at a certain pace by tapping in time with the clicks of the metronome; a second thirty-second test trial where the S responded at his own pace(OP). After the fourth rest interval an additional thirty second test trial of own pace (OP) response was presented.

IV. PROCEDURE

The procedure used to gather data was as follows. A tapping board, stylus, and counter were employed to obtain performance measures pertaining to number of tapping responses made. These performance measures were recorded on the E's data collection sheet. A metronome was utilized to force the rate of response and prevent automatic resting. A stop watch was used as an aid for the giving of instructions at different stages during the test trials.

The procedure was undertaken by the two groups, one whose forced pace interval was considerably faster than the other group. The two groups were labeled the forced-pace slow group and the forced-pace fast group. The forced-pace slow group was required to respond on the tapping board 144 times a minute during the five minute forced pace interval of their test trials. This was achieved by setting the metronome at 144 and requiring Ss to tap in time with each click made by the metronome. The forced-pace fast group responded to the metronome setting of 184 beats per minute. The forced pace and metronome controlled for an automatic resting and checked the hypothesis that more effortful behavior results in more IR and thus, SIR. The design and the procedure of the experiment is shown schematically in figure 2. The first six-minute trial was presented as a practice trial and was not included in any of the statistical analyses.

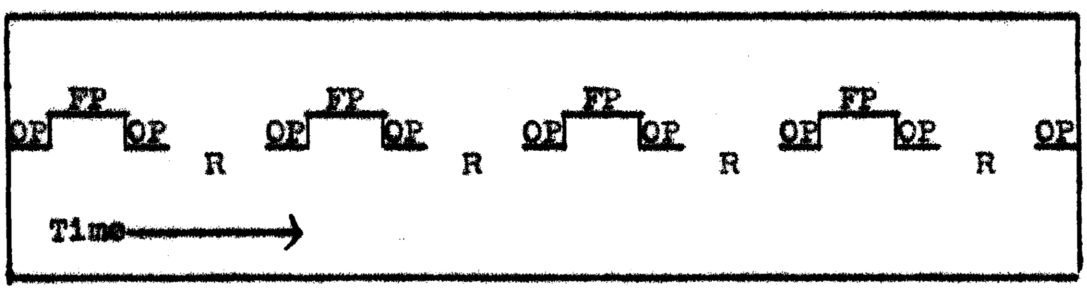

Fig. 2. The design and procedure used in the experiment in this study. The design was the same for both the forced-pace slow (FPS) and the forced-pace fast (FPF) groups. The only difference between the groups consisted of different rates of response required during the 5 min. forced pace (FP) intervals--the forced pace (FP) rate for the forced-pace slow (FPS) group was 144 beats per min. and 184 for the forced-pace fast (FPF) group. The own pace (OP) trials were 30 sec. long. Rest intervals (R) between trials were 5 min. long.

The Ss came individually to the testing room and were seated in front of the table that held the apparatus. Their instructions were as follows:

> This is an experiment designed to examine some aspects of motor behavior. Before you, you see a tapping board, a stylus (the pencil-like object), a metronome, and over here by me a counter that records the number of contacts you make on the tapping board with the stylus.
>
> Notice that when you tap the brass plates on the tapping board with the metal point of the stylus an electrical contact is made and is recorded on the counter. Basically then, this experiment deals with the number of tapping responses you make.
>
> Hold the stylus in your writing hand as you would hold a pencil. Your task when I say "start" is to first tap the left brass plate once, then the right plate once, the left once, and so on, alternating as rapidly as you can. You are to continue this alternating tapping until I say "tap in time." At this time the metronome will be going and you are to tap, still alternating left, right, left, right, and so on, in time with it. This period will be five minutes long. You are to continue this "in time" behavior with the metronome until I say "fast as can," at which time you are to tap again as rapidly as you can, still alternating left, right, left, right. When I say "stop" cease activity. Be careful always to tap the plates and not slide from one to the other. After I say "stop" you will be given a five minute rest period. Are there any questions so far?
>
> Remember now, your task is to tap in an alternate fashion going left, right, left, right. You will first do this tapping as rapidly as you can, then you will tap in time with the metronome and finally you will tap as rapidly as you can again. You will then be given a five minute rest. This procedure will be repeated several times. Do you have any questions? Any other questions you may have will be answered at the conclusion of the experiment.

During the rest intervals E engaged in casual conversation with the Ss to prevent possible rehearsal and practice of the task. No reference pertaining to the nature of the experiment was permitted during this conversation.

After all the data were collected, mean performance was determined for each of the thirty second trials and plotted on a graph. Analysis of variance technique and orthogonal polynomials were utilized in the statistical analysis to test the hypotheses under consideration. The conclusions were based on the findings of this statistical analysis.

CHAPTER III

RESULTS

The purpose of this chapter is to present as concisely as possible the data relevant to the hypotheses under test. Discussion of the interpretation and the significance of these results will be postponed until the next chapter.

The mean number of responses for the forced-pace slow and fast groups is presented in Table I, that is, the mean level of performance of each group's Ss tapping as rapidly as possible. The numbers in this table are the mean performance measurements attained in the thirty second periods that were separated from each other by the five minute interval of forced pacing--the rested and unrested periods respectively.

TABLE I

MEAN NUMBER OF RESPONSES, BY GROUPS, PERTAINING TO TRIALS INVOLVING RAPID-AS-POSSIBLE PERFORMANCE

	TRIAL 1		TRIAL 2		TRIAL 3		TRIAL 4
	rested	not rested	rested	not rested	rested	not rested	rested
Forced-pace slow group	140.00	132.90	146.15	136.25	146.15	140.23	150.90
Forced-pace fast group	133.15	120.85	137.50	129.40	137.75	125.45	141.25

It should be recalled that each trial was separated by a five minute rest interval. Trial four consisted only of a thirty second rested period in which the Ss performed as rapidly as they could. Omitted from the table are the results obtained from the six minute practice session. These practice results were excluded because they were not used in any of the statistical analyses and because it was assumed that they did not represent reliable performance measures. This six minute practice trial was exactly like the others and was separated from the first trial in Table I by a regular five minute rest interval. The Ss were unaware that their performance during the rested and unrested periods in the practice trial was not considered a regular test trial.

Table I contains the figures that are relevant to this investigation's primary hypothesis dealing with the development of SIR corresponding to the theory advanced by Hull. By way of summary, the primary hypothesis predicts that the performance measures for the rested periods will display a decline in performance due to the reinforcement obtained as a result of the dissipation of IR during the rest interval. This reinforcement is hypothesized to generate SIR and the SIR in turn creates the decrement in performance.

The means in question are portrayed graphically in Figure 3 on the next page.

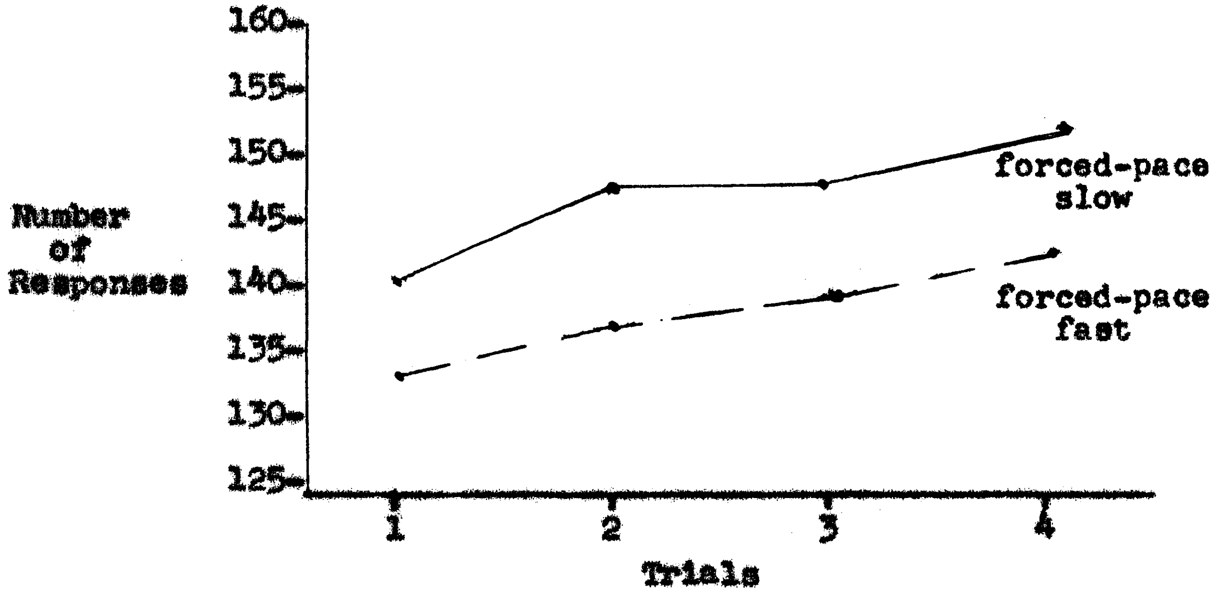

Fig. 3. Mean number of responses performed as rapidly as possible by the Ss in each group. These performance measures for each trial took place immediately after a 5 minute rest interval and represented rested performance.

The hypothesis predicted a decreasing number of responses after each rest interval. Inspection of Figure 3, however, clearly demonstrates that the general tendency is exactly opposite to that hypothesized. Instead of a generally declining performance curve indicative of the presence of SIR, the performance curve illustrates a tendency to rise. From the information present in both Table I and Figure 3, the conclusion must be drawn that the primary hypothesis has failed to be confirmed.

A phenomenon that Table I and Figure 3 also demonstrate is the consistent superiority of the forced-pace slow group over the forced-pace fast group. This, in part, may be relevant to the second hypothesis advanced in this study. This secondary hypothesis is that one can expect a greater degree of SIR development in the forced-pace fast group because of the larger amount of IR generated by more effortful behavior. However, since no evidence of SIR was found this secondary hypothesis is partially disproven. There remains though, the possibility that the forced-pace slow group is superior to the forced-pace fast group because the latter has developed more SIR but not in the manner originally hypothesized. Since Table I and Figure 3 represent rested performance, IR should be dissipated during the preceding rest intervals and any difference between the two groups may be due to the depressing effect of SIRpresent but not evident.

Two questions remain to be answered. The first revolves around the primary hypothesis. Although it has been shown that no SIR development as hypothesized was indicated, it must be determined if there is a significant difference between the performance measures found. If a significant difference is found it must be interpreted. The second question pertains to the secondary hypothesis. Since it was demonstrated that the forced-pace slow group was consistently superior in performance to the forced-pace fast group, it is desirable to test the significance the different pacing had on performance. If a significant difference is obtained a conjecture could legitimately be advanced that some type of inhibition has developed to a greater extent in the forced-pace fast group resulting in poorer performance.

To adequately answer the two questions raised in the preceding paragraph will require a statistical technique that determines over-all significance of the performance measures that comprise the raw data of the experiment. A statistical procedure that readily lends itself to such a task exists in the analysis of variance technique. Table II summarizes the results obtained by applying the analysis of variance procedure. This table is on the next page.

The between-trials row in Table II is directly concerned with the primary hypothesis. A significant difference is demonstrated as one compares trials with performance. The significant difference, however, is inverse to the predicted expectation. This test only indicates that there is a significant difference involved in the seven performance means presented in Table I. It is necessary then to discover exactly where the differences found are located. This can be accomplished by breaking down the between-trials source into various components and comparing the individual segments. This procedure discovered that the four rested performance measures differed significantly from the three unrested measures. In addition to this, within each the rested and unrested periods, it was found that only the linear component contributed anything to the significance of the difference found. Since rested and unrested performance measures both indicate a rise in performance, it may

TABLE II

ANALYSIS OF VARIANCE TABLE

Source	Sum of Squares	Degrees of Freedom	Mean Squares	F
Between trials	10,611.24	6	1776.87	11.73**
Unrested vs rested periods	7,896.67	1	7896.67	28.23**
Linear within rested	1,650.25	1	1650.25	5.79*
Quadratic within rested	10.51	1	10.51	--
Cubic within rested	155.76	1	155.76	2.34
Linear within unrested	714.01	1	714.01	6.01*
Quadratic within unrested	234.04	1	234.04	2.12
Between paces	6,499.30	1	6,499.30	2.55
Paces X Trials	501.64	6	83.61	--
Between individuals within pace groups	98,295.62	38	2,586.73	17.09**
Residual	34,513.12	228	151.37	
Unrested vs rested periods	10,407.18	38	273.87	
Linear within rested	10,872.15	38	284.93	
Quadratic within rested	2,042.30	38	53.74	
Cubic within rested	2,533.34	38	66.67	
Linear within unrested	4,517.97	38	118.89	
Quadratic within unrested	4,185.18	38	110.14	
Total	151,104.91			

**Significant at 1% level
*Significant at 5% level

be concluded that it is this rise in performance that contributes significantly to the differences discovered.

To obtain information that is pertinent to the second hypothesis, one needs to inspect both the between-paces and the interaction-between-paces-and-trials rows in Table II. The between-paces row demonstrates that the overall mean performance between the two groups does not differ significantly.

The interaction-between-paces-and-trials row tests the null hypothesis that the difference in mean performance through test periods between the two groups is equal. That is, the performance curves in Figure 3 will remain the same distance from and parallel to each other and will not converge or diverge. This null hypothesis was not rejected suggesting the different paces did not, to any significant degree, result in differential performance. Since it was predicted that the forced-pace fast group would build up more IR and consequently show inferior performance as compared to the forced-pace slow group, the failure to find significant differences eliminates the second hypothesis. The difference in performance between the two groups that is demonstrated in Table I and Figure 3, even though insignificant, will demand an explanation and will be attempted in the next chapter. The last significant difference that commands attention is the between-individuals-within-pace-groups row of Table II. This demonstrates merely that the various Ss within each pace group displayed individual differences in their ability to make tapping responses. This was not unexpected as individual differences in motor ability is a relatively universal phenomenon. This finding had no primary importance to the hypotheses under test.

The remaining task is to attempt an explanation of the results obtained in this experiment. More specifically, the significant linear rise in performance that exists between the rested and unrested periods needs to be accounted for as does the consistent superiority of the forced-pace slow group over the forced-pace fast group.

CHAPTER IV

DISCUSSION AND SUMMARY

To reiterate, the primary hypothesis of this study predicted that performance, after rest, would decrease due to the development of SIR. This SIR would develop as a function of the dissipation of IR, and performance, after rest, would reflect reaction potential minus pure SIR because all the IR would be dissipated. In Hullian symbols what was predicted to obtain was $S\bar{E}R = SER - SIR$.[24] That is, the effective reaction potential after rest would equal reaction potential minus SIR with no decremental influences from IR present due to its dissipation over the rest interval. This experiment, however, found performance increasing after rest and no indication of SIR development. Moreover, it was discovered that this performance increase of the rested periods was further accompanied by a significant increase in the unrested periods and as such, demands an explanation why.

A plausible explanation of the experimental results is the possibility that the experiment represented a learning situation and was not a means of obtaining performance level. Inspection of Figure 3 demonstrates that a perfor-

---

[24] Hull, 1951, *loc. cit.*

mance asymptote was not reached and the performance curves thus represented learning. If this were the case, habit (SHR) was increasing over the trials and masked the depressing effects of IR and SIR. Therefore, no direct conclusions are possible concerning inhibition when learning is still taking place.

Referring to Table I, it can be seen that a linear rise of performance is indicated for the unrested periods. It is also evident that the performance levels corresponding to the unrested periods display differences between the two groups. The speculation can be advanced that these differences between unrested performance in the fast and slow groups, though insignificant statistically, may indicate the differential development of inhibition--either IR, SIR, or both. This could be so because performance during the unrested period in any trial would mean that the organism had already performed through the rested period and the five minute forced-pace interval. It would be expected that this performance would be accompanied by IR development. At the time of the unrested period, the forced-pace fast group would have made more responses, developed more IR and demonstrated inferior performance.

The differential development of SIR in the unrested periods may be accounted for if the forced-pace interval is seen as a period in which rest is possible. The rested period demanded the organism to respond at an optimal level of performance while the forced-pace interval wasconsiderably slower. This change of tapping pace may have been restful for the Ss allowing for some dissipation of IR and the generation of SIR. Since each tapping response during the forced-pace interval may be regarded as reinforcing, the forced-pace fast group would be receiving the greater amount of reinforcement allowing for larger development of SIR. This too, would result in inferior performance for the forced-pace fast group and could account for the differences between the group's unrested performance.

Differences between rested performance in the fast and slow groups, again insignificant statistically, may indicate differential development of SIR if it is assumed all the IR was dissipated during the five minute rest interval. Hull could say that this SIR developed in a manner similar to that of the unrested periods. That is, the forced-pace interval was actually a reinforcing state of affairs and induced SIR development. Since the forced-pace fast group would be receiving more reinforcement, more SIR would be generated, again resulting in poorer performance. Kimble could handle this development of SIR by his critical threshold of IR. During the test trial, IR can be seen to accumulate, though at a slower rate during any forced-pace interval. If ever the critical threshold is reached automatic resting takes place generating SIR. The more times the critical threshold is reached the more SIR is developed.

The forced-pace fast group would attain this critical threshold more frequently and would display inferior performance on any rested period because of the SIR developed.

A further speculation is injected here to account why the differences found between the group's rested and unrested periods did not reach statistical significance. Inspection of Table I and Figure 3 indicates that a difference between the groups clearly exists. The failure for this difference to reach statistical significance is due to an artifact of the experiment. The analysis of variance used demanded the error term from the between-individuals-within-pace-groups row of Table II. This error term was so large that it made any comparison between paces insensitive. This could be controlled in future research by utilizing the same Ss in the two forced-pace conditions.

Because the hypotheses of this investigation were not confirmed, it may be beneficial to look at the experimental design and procedure used in order to see if there were inherent weaknesses built into the design. The design and procedure used was based on other experiments of like nature and was assumed to have strong empirical support.

The obvious place to look for possible design faults is the work and rest intervals used. The decision to use six minute work periods and five minute rest intervals was based on a study involving motor learning that used the same work-rest intervals.[25] A similar investigation by Jahnke and Duncan also utilized six minute work periods.[26] Kimble used work-rest intervals of equal length.[27] In view of these studies, the six minute work and five minute rest intervals used in the present experiment seems to have an adequate empirical foundation. Furthermore, the five minute rest intervals were chosen on the assumption that that period of time would be sufficient for the complete dissipation of IR to occur. Ammons found that dissipation of temporary work decrement reaches an approximate maximum after twenty minutes rest, with about 60 per cent of this recovery taking place during the first two minutes of rest.[28] One experimenter concluded that the dissipation of temporary inhibition is complete within five minutes,[29] while others found no evidence of IR remaining after ten minutes rest.[30] As a result

---

[25] M. R. Denny, N. Frisbey, and J. Weaver, Jr., "Rotary Pursuit Performance Under Alternate Conditions of Distributed and Massed Practice," J. Exp. Psychol. 49:51, January, 1955.

[26] J. C. Jahnke, and C. P. Duncan, "Reminiscence and Forgetting in Motor Learning After Extended Rest Intervals," J. Exp. Psychol. 52:274, November, 1956.

[27] Kimble, 1949, op. cit. p. 18.

[28] R. B. Ammons, "Acquisition of Motor Skill: II. Rotary Pursuit Performance with Continuous Practice Before and After a Single Rest." J. Exp. Psychol. 37:410, October, 1947

[29] M. R. Denny, et. al., loc. cit.

[30] G. R. Grice, and B. Reynolds, "Effect of Varying Amounts of Rest on Conventional and Bilateral Transfer 'Reminiscence'," J. Exp. Psychol. 44:251, October, 1952.

of these investigations, the choice to use a five minute rest interval in the experiment of this study seems not an unreasonable decision. The casual conversation during the five minute interval was permitted on the basis of the finding that rehearsal takes place during rest intervals and could inflate performance measures.[31] An early study previously undertaken to this investigation and using the same work-rest intervals, reinforced the choice of design used. The results of this early study indicated a tendency for performance to decrease in the manner hypothesized. It was also because of this early study that a practice session was allowed to control for gross performance variability. It was assumed that one practice session would suffice because of the simplicity of the task involved. Inspection of Figure 3, however, suggests that this was an erroneous assumption as the performance curves illustrate a continuous rise with no indication that an asymptote has been attained.

The preceding discussion has implied that the results found in this study could be due to variables involved in the experimental design. There are some relatively minor issues additionally involved that may have contributed to the findings of this study. These are pointed out to illustrate the weaknesses involved in this experiment and to serve

---

[31]R. E. Schucker, L. B. Stevens, and D. S. Ellis, "A Retest for Conditioned Inhibition in the Alphabet-Printing Task," J. Exp. Psychol. 46:97, August, 1953.

as a guide for improvement in future research.

The most conspicious variable not controlled in this experiment was the lack of environmental uniformity where the Ss were tested. The actual influence this had on the final results is indeterminate. It would be well to insure an equal distribution of the sexes. This was not deemed particularly necessary for this experiment because Siegel reported no significant performance differences between males and females on a similar type of motor task.[32] For a motor skill situation, it is probable that Ss should be assigned to their respective experimental groups on a matched basis or, as previously pointed out, use the same Ss in each group. This would insure groups of equal performance ability. Finally, it appears that more practice trials are needed to make certain measures of performance obtained are not contaminated with warm up or practice effects.

An interesting similarity involving the results of this study that merits comment was discovered between the results of the present study as illustrated in Figure 3 and the results obtained in an investigation undertaken by Kimble. Kimble presented performance curves comparing spaced practice and massed practice that strongly resembles the curves shown in Figure 3.[33] This suggests that the findings in the

---

[32] P. S. Siegel, and A. DeYampert, "Conditions of Human Variability." (Unpublished research).

[33] Kimble, op. cit., p. 19.

present study may be due to the degree of massing involved even though this was not of primary concern in the original formulations. If one considers the forced-pace fast group as representing massed practice and the forced-pace slow group as distributed practice, the performance curves are compatible with Kimble's results. This implies that perhaps an important variable was not taken into consideration in the present study.

Before concluding this paper a brief review of the state of Hullian inhibition theory as it presently exists should be attempted. This theory has been valuable in inducing research activity and interest in this area. The result of this empirical work has resulted in theoretical and experimental ferment and has created both opponents and proponents for Hullian inhibition theory.

One critic of Hull's formulation of inhibition is E. R. Hilgard. Hilgard's criticism is directed at the fact that Hull did not carry out the logical implications of his statement that IR is a negative drive state. As such, Hilgard argues that IR logically should subtract from drive (D) and, like drive, should interact multiplicatively with habit strength (SHR). Hilgard further suggests that, since SIR is a negative habit, it too should interact multiplicatively with IR.[34] Hilgard's reformulation of the equation for net

---

[34]E. R. Hilgard, <u>Theories of Learning</u> (New York: Appleton-Century-Crofts, 1956), p. 138.

reaction potential ($S\bar{E}R$) results in the following:

$$S\bar{E}R = \left[(D-IR) \times SHR\right] - (IR \times SIR)$$

to be contrasted with Hull's

$$S\bar{E}R = (D \times SHR) - (IR + SIR).$$

Osgood, another critic, thinks that if SIR is nothing other than negative habit strength, it would seem sound to subtract SIR directly from habit strength (SHR).[35] Osgood's reformulation would appear symbolically as:

$$S\bar{E}R = (D-IR) \times (SHR-SIR).$$

A revision suggested by Woodworth and Schlosberg[36] is that inhibition should subtract from incentive motivation or what Hull calls K. This incentive motivation (K) is a function of the amount of reinforcement. This is expressed thus:

$$S\bar{E}R = (K-IR-SIR) \times D \times SHR.$$

These revised editions of Hull's inhibition theory have not, however, escaped criticism. One reviewer states that most of the attempts to reformulate Hull's theory have been the result of logical, or at times merely verbal, rather than empirical considerations and have avoided trouble by not attempting to relate the reformulations to empirical findings.[37] This same author continues by stating that, Hull's revisers

---

[35] C. E. Osgood, Method and Theory in Experimental Psychology (New York: Oxford University Press, 1953), p. 349.

[36] R. S. Woodworth, and H. Schlosberg, Experimental Psychology (New York: Henry Holt Co., 1954), p. 668.

[37] A. R. Jensen, "On the Reformulation of Inhibition in Hull's System," Psychol. Bull. 58:274, July, 1961.

have followed him in treating his intervening variables as if they were real, independent quantities whose laws of interaction are isomorphic with the rules of arithmetic and algebra.[38] The same writer then summarizes the whole problem with:

> From the foregoing considerations,... the conclusion to which we are forced regarding the attempted revisions of Hull's theory is not so much that these revisions are no improvement over Hull, but that it is futile to attempt to improve upon Hull by mere juggling of his intervening variables. Hullian theory will not be improved by continuing to work with the concepts of drive, habit, inhibition, etc. in exactly the same form they were given by Hull. The very building blocks of the theory, so to speak, are inadequate and no amount of recombining them in new ways is likely to result in any substantial advance in learning theory.[39]

There is one revision of Hull's inhibition theory that is of a fundamentally different nature than the other revisions. This revision is the product of K. W. Spence and he has redefined inhibition and the independent variables of which it is a function. Spence's extinctive inhibition (I_n) is a function only of the number of nonreinforced responses and is not a function of amount of effort or rate of responding as is Hull's IR. The inhibition due to delay of reinforcement, (I_t), is assumed to be based on the competing responses that are established during the delay of reinforce-

---

[38] *Ibid.*, p. 276.

[39] *Ibid.*, p. 278.

ment period or during extinction.[40] Spence's inhibition does not interact with other intervening variables but only subtracts from reaction potential. Spence then, assigns to his inhibition construct a more generic function than does Hull. Spence's inhibition factor operates in any number of situations, in extinction and reinforcement, for example, and its meaning can be changed to meet these various situations by assigning different subscripts. Hull and Spence are theoretically similar, however, in equating effective reaction potential to inhibition subtracted from reaction potential.

This review of the state of Hullian inhibition theory as it stands today leaves no definite clue to predict what the status of this theory will be in the future. Since this investigation applied inhibition theory to motor learning, it seems apropos to present two different psychologist's views concerning the usefulness of inhibition theory to motor learning. One writer feels that the Hullian inhibition postulates as they are used in motor learning do not even represent the same processes as found in extinction phenomena upon which inhibition theory is based.[41] The other point of view, however, suggests that the divergent results found in motor studies can best be explained in

---

[40]K. W. Spence, Behavior Theory and Conditioning (New Haven: Yale University Press, 1956), pp. 120-122 and 163-164.

[41]Jensen, op. cit., p. 285.

terms of Hullian theory and that it is most promising to lead to consistency and unity in theory.[42] This is a representative sample of the degree of agreement found existing, not only regarding Hullian inhibition theory, but in almost any area of psychology.

SUMMARY

An experimental investigation utilising a simple motor task and involving forty Ss was undertaken to test Hull's theory of SIR development. The first hypothesis predicted that there would be a decrement in performance after each rest interval indicating development of SIR in the Hullian manner. The second hypothesis predicted that those Ss who were operating under more effortful behavior would demonstrate greater degrees of SIR because of more IR present. Analysis of variance technique and orthogonal polynomials were used to test these hypotheses. The statistical analyses failed to confirm either of the hypotheses. An attempt was made to interpret the results of the experiment. Weak points of the experimental design were noted and suggestions for improvement were advanced. A brief review of the present status of Hullian inhibition theory was presented.

---

[42] H. N. Wasserman, "A Unifying Theoretical Approach to Motor Learning," Psychol. Rev. 59:283, July, 1952.

B I B L I O G R A P H Y

BIBLIOGRAPHY

A. BOOKS

Hilgard, E. R. *Theories of Learning.* New York: Appleton-Century-Crofts, 1956.

Hull, C. L. *Principles of Behavior.* New York: Appleton-Century-Crofts, 1943.

Hull, C. L. *Essentials of Behavior*. New Haven: Yale University Press, 1951.

Hull, C. L. *A Behavior System*. New Haven: Yale University Press, 1952.

Osgood, C. E. *Method and Theory in Experimental Psychology*. New York: Oxford University Press, 1953.

Spence, K. W. *Behavior Theory and Conditioning*. New Haven: Yale University Press, 1956.

Woodworth, R. S., and Schlosberg, H. *Experimental Psychology*. New York: Henry Holt Company, 1954.

B. PERIODICALS

Ammons, R. B., "Acquisition of Motor Skill: II. Rotary Pursuit Performance With Continuous Practice Before and After a Single Rest," *Journal of Experimental Psychology*, 37:393-411, October, 1947.

Archer, E. D., and Bourne, L. E., "Inverted-Alphabet Printing as a Function of Intertrial Rest and Sex," *Journal of Experimental Psychology*, 52:322-28, November, 1956.

Berlyne, D. F., "Attention to Change," *British Journal of Psychology*, 42:269-78, August, 1951.

Denny, M. R., Frisbey, N., and Weaver, J., Jr., "Rotary Pursuit Performance Under Alternate Conditions of Distributed and Massed Practice," *Journal of Experimental Psychology*, 49:48-54, January, 1955.

Ellis, D. S., "Inhibition Theory and the Effort Variable," Psychological Review, 60:383-92, November, 1953.

Glietman, H., Nachmias, J., and Neisser, U., "The S-R Reinforcement Theory of Extinction," Psychological Review, 61:23-33, January, 1954.

Grice, G. R., and Reynolds, B., "Effect of Varying Amounts of Rest on Conventional and Bilaternal Transfer 'Reminiscence'," Journal of Experimental Psychology, 44:247-52, October, 1952.

Jahnke, J. C., and Duncan, C. P., "Reminiscence and Forgetting in Motor Learning After Extended Rest Intervals," Journal of Experimental Psychology, 52:273-82, November, 1956.

Jensen, A. R., "On the Reformulation of Inhibition in Hull's System," Psychological Bulletin, 58:274-98, July, 1961.

Kientzle, M. J., "Properties of Learning Curves Under Varied Distributions of Practice," Journal of Experimental Psychology, 36:187-211, April, 1946.

Kimble, G. A. "An Experimental Test of a Two-Factor Theory Of Inhibition," Journal of Experimental Psychology, 39:15-23, February, 1949.

Kimble, G. A., and Bilodeau, E. A., "Work and Rest as Variables in Cyclical Motor Learning," Journal of Experimental Psychology, 39:150-57, April, 1949.

Kimble, G. A., "A Further Analysis of the Variables in Cyclical Motor Learning," Journal of Experimental Psychology, 39:332-37, June, 1949.

Kimble, G. A., "Performance and Reminiscence in Motor Learning as a Function of the Degree of Distribution of Practice," Journal of Experimental Psychology, 39:500-10, August, 1949.

Kimble, G. A., and Shatel, R. B., "The Relationship Between Two Kihds of Inhibition and the Amount of Practice," Journal of Experimental Psychology, 44:355-59, November, 1952.

Montgomery, K. C., "An Experimental Investigation of Reactive Inhibition and Conditioned Inhibition," Journal of Experimental Psychology, 41:39-51, January, 1951.

Schucker, R. E., Stevens, L. B., and Ellis, D. S., "A Retest for Conditioned Inhibition in the Alphabet-Printing Task," Journal of Experimental Psychology, 46:97-102, August, 1953.

Siegel, P. S., "Reactive Inhibition as a Function of Number of Response Evocations," Journal of Experimental Psychology, 41:604-08, October, 1950.

Siegel, P. S., and DeYampert, A., "Conditions of Human Variability," (Unpublished research).

Starkweather, J. A., and Duncan, C. P., "A Test for Conditioned Inhibition in Motor Learning," Journal of Experimental Psychology, 47:351-56, May, 1954.

Wasserman, H. N., "A Unifying Theoretical Approach to Motor Learning," Psychological Review, 59:278-84, July, 1952.

Zeaman, D., and House, B, "The Growth and Decay of Reactive Inhibition as Measured by Alternation Behavior," Journal of Experimental Psychology, 41:177-86, March, 1951.

APPENDIX

RAW DATA FOR

FORCED PACE FAST GROUP

SUBJECT	TRIAL								
	P*		1		2		3		4
1	117	55	145	73	144	78	118	82	89
2	132	85	100	99	135	110	140	87	160
3	160	101	141	118	147	147	117	127	123
4	93	41	68	68	58	68	86	85	85
5	133	135	188	143	177	173	168	181	158
6	110	110	139	124	160	142	151	95	161
7	100	108	95	121	91	134	117	120	117
8	147	135	125	135	142	129	152	147	165
9	130	111	131	141	128	147	114	132	131
10	133	129	140	134	137	133	137	132	136
11	118	99	118	112	114	117	129	122	140
12	139	131	158	135	151	129	153	127	164
13	167	138	140	159	158	159	133	163	157
14	149	133	150	175	115	144	113	120	112
15	129	125	142	132	153	127	143	102	137
16	128	99	148	116	147	126	148	132	147
17	120	114	121	130	152	137	148	150	176
18	127	122	144	142	158	149	160	141	158
19	146	140	140	144	160	147	162	149	170
20	111	99	130	116	119	110	134	114	139

*Denotes practice trial which was not included in the statistical analyses

Median age = 22

Age range = 42 - 18

RAW DATA FOR

FORCED PACE SLOW GROUP

SUBJECT	TRIAL								
	P*		1		2		3		4
1	115	130	140	134	135	110	141	131	147
2	103	107	123	112	126	121	129	117	134
3	73	84	121	130	148	140	156	139	158
4	125	112	131	121	137	130	145	124	150
5	164	145	175	141	172	143	148	142	151
6	159	148	158	156	170	158	166	158	157
7	145	129	130	136	136	142	146	139	141
8	110	93	106	113	126	114	125	117	126
9	131	140	159	113	156	144	161	161	174
10	150	140	151	145	151	143	159	147	157
11	140	137	149	152	160	152	132	152	152
12	167	126	164	131	147	135	149	130	153
13	131	120	101	127	138	116	107	137	132
14	130	125	149	133	150	136	155	137	151
15	156	147	144	138	152	153	168	157	169
16	124	132	122	129	133	138	144	133	141
17	162	154	175	148	168	152	169	176	181
18	90	91	92	101	101	95	110	104	122
19	154	144	162	151	167	153	166	156	170
20	146	138	148	137	150	150	147	148	152

*Denotes practice trial which was not included in the statistical analyses

Median age = 22
Age range = 36 - 18