

February 28, 1955

To the Graduate Council:

I am submitting herewith a thesis written by Junius M. Rowe entitled "The Contiguity Principle and the Skaggs-Robinson Hypothesis." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Psychology.

E. Oliver Milton
Major Professor

We have read this thesis and
recommend its acceptance;

Wm B. Shag
J. M. Porter, Jr.
Carl M. Ranner
Joseph H. Dyer
W. O. Jenkins

Accepted for the Council:

E. H. Waters
Dean of the Graduate School

THE CONTIGUITY PRINCIPLE AND THE SKAGGS-ROBINSON HYPOTHESIS

A THESIS

Submitted to
The Graduate Council
of
The University of Tennessee
in
Partial Fulfillment of the Requirements
for the degree of
Doctor of Philosophy

by

Junius M. Rowe

March 1955

ACKNOWLEDGEMENT

To my Committee, Drs. E. O. Milton, W. O. Jenkins, J. M. Porter, J. T. Drake, and O. B. Graff, I wish to extend my thanks. Especially to Dr. W. O. Jenkins, for directing this research and for his interest, suggestions, and assistance, I want to express my sincere appreciation. To Dr. Evelyn T. Rule, I extend my thanks for her help and criticisms. I am also deeply grateful to Martha Thorne for her patience, endurance, and suggestions in getting this paper typed and ready for meeting all the deadlines.

Junius M. Rowe

TABLE OF CONTENTS

CHAPTER	PAGE
I. GENERAL INFORMATION AND STATEMENT OF THE PROBLEM	1
Background	3
Learning and reinforcement	3
Similarity and the Skaggs-Robinson hypothesis	15
Organization of study	20
II. HAND REMOVAL AS A REINFORCING AGENT	22
Method	22
Experiment I	24
Experiment II	24
Experiment III	25
Experiment IV	25
Results	26
Discussion	34
III. COMPARISON OF THREE SITUATIONS DESIGNED TO TEST THE SKAGGS-ROBINSON HYPOTHESIS AND A TEST OF GENERALIZATION DECREMENT	37
Experiment I	39
Method	39
Results	41
Discussion	42
Experiment II - Generalization Decrement I	44
Method	44
Results	46

CHAPTER

PAGE

III. (continued)

Discussion	46
Experiment III - Generalization Decrement II	48
Method	49
Results	51
Discussion	51
Experiment IV - Generalization Decrement III	54
Method	54
Results	56
Discussion	59
IV. TESTS OF THE SKAGGS-ROBINSON HYPOTHESIS	61
Experiment I - A test of the Skaggs-Robinson	
hypothesis	61
Method	61
Results	64
Discussion	66
Experiment II - A second test of the Skaggs-Robinson	
hypothesis	68
Method	68
Results	70
Discussion	75
V. SUMMARY AND CONCLUSIONS	78
Summary and conclusions	78
Implications and suggestions for further research	81

CHAPTER	PAGE
BIBLIOGRAPHY	82
APPENDIX	87

LIST OF TABLES

TABLE	PAGE
I. The Effect of Hand-Removal Reinforcement on a Single Trial, Upon Second Trial Rearing Latency (Sec.), in the Same Situation, in a Different Situation, and for a Control Group Removed for Not Rearing (Hayward 1953) . . .	13
II. Number of Rears in Ten Minute Test Period for Each Experiment Separately for Hand Removal (<u>E</u>) and Control (<u>C</u>) Rats and Latency (Sec.) to First Rear in the Test Period	28
III. Number of Rears in Seventh and Eighth Minutes of Test Period for Each Experiment Separately for Hand Removal (<u>E</u>) and Control (<u>C</u>) Rats	30
IV. Total Number of Rears in Ten Minute Test Period and the Latencies of the First Rear in the Test Period of Three Groups Given Twenty Training Trials and Tested in the Same Situation	43
V. Total Number of Rears in Ten Minute Test Period and Latencies to First Rear of Animals Given Ten Training Trials in B and Tested in A, B, and C	47
VI. Total Number of Rears in Ten Minute Test Period and Latencies to First Rear of <u>Ss</u> Given Twenty Training Trials With Hand Removal in A and Tested in A, B, and C . .	52

TABLE

VII.	Total Number of Rears in the Ten Minute Test Period for <u>Ss</u> Given Five Training Trials at Twenty Minute Inter-Training Intervals in Situation A and Tested in A, B, and C	57
VIII.	Total Number of Rears in the First Five Minutes of the Test Period of <u>Ss</u> Given Five Training Trials at Twenty Minute Inter-Training Trial Intervals in Situation A and Tested in A, B, and C	58
IX.	Total Number Rears in Ten Minute Test Period for Groups in the Sk-R I Experiment (Original Training in A, Interpolated Training in A, B, and C and Test in A) and the Latencies to First Rear in Test Period	65
X.	Total Number of Rears in the Ten Minute Test Period for Groups in the Sk-R II Experiment (Original Training in A, Interpolated Training in A, B, and C, and Testing in A) and the Latencies of the First Rear in the Test Period	71
XI.	Means for Total Number of Rears in the Ten Minute Test Period for GD II and GD III (AA, AB, AC) and for Sk-R I and Sk-R II (AAA, ABA, ACA)	73
XII.	Total Number of Rearing Responses Minute-By-Minute and ~~Animal-By-Animal~~ in the Ten-Fifteen Minute Test Period for Subjects in the Experimental Groups in Experiments I, II, and III of Chapter II	88

TABLE

PAGE

XIII.	Total Number of Rearing Responses Minute-by-Minute and Animal-by-Animal in the Ten-Fifteen Minute Test Period for Subjects in the Control Groups in Experiments I, II, and III of Chapter II	89
XIV.	Latency to Rear in Training Trials in Experiments I, II, and III in Chapter II	90
XV.	Stage of the Rearing Response in Terms of Whether the Animal was in Full Rear (FR), Coming Down from a Full Rear (CD), or After Front Feet Were on the Floor Following a Full Rear (AD) in Experiments II and III of Chapter II	91
XVI.	Correlation of the Number of Rears in Various Test Intervals with Stage of Rear During Reinforcement	92
XVII.	Latency to Rear in Training Trials and Number of Rears for Group Conditioned "Not to Rear" (A) and the Training Trial Latencies for the Group Conditioned to Rear (B) Experiment IV, Chapter II	93
XVIII.	Total Number of Rears in Thirty Second Intervals for the Total Ten Minute Test Period of Animals Conditioned "Not to Rear" (A) and Animals Conditioned to Rear (B) Experiment IV, Chapter II	94
XIX.	Number of Rears Minute-by-Minute and Animal-by-Animal for <u>Ss</u> Trained in A and Tested in A (<u>Ss</u> 11-15), Trained in B and Tested in B (<u>Ss</u> 6-10), and Trained in C and Tested in C (<u>Ss</u> 1-5), Experiment I, Chapter III	95

TABLE

PAGE

XX.	Training Trial Latencies (Sec.) of <u>Ss</u> Trained and Tested in A (<u>Ss</u> 11-15), Trained and Tested in B (<u>Ss</u> 6-10), and Trained and Tested in C (<u>Ss</u> 1-5), Experiment I, Chapter III	96
XXI.	Total Number of Rears for Each Animal in Thirty Second Intervals for the Total Test Period for Animals Trained in B and One-Third Tested in A (<u>Ss</u> 1-5), One-Third Tested in B (<u>Ss</u> 6-10), and One-Third Tested in C (<u>Ss</u> 11-15), Chapter III, GD I	97
XXII.	Training Trial Latencies (Sec.) for Animals Trained in B, Chapter III, GD I	98
XXIII.	Rearing Responses in Successive Thirty Second Intervals in Which Animals Were Given Twenty Training Trials in A and Tested in A (<u>Ss</u> 1-3), Training in A and Test in B (<u>Ss</u> 4-6), Training in A, Test in C (<u>Ss</u> 7-9), Chapter III, GD II	99
XXIV.	Training Trial Latencies (Sec.) for GD II Experiment in Which All Animals Were Given Twenty Training Trials in A	100
XXV.	Rearing Responses in Successive Thirty Second Intervals in Which All <u>Ss</u> Were Given Five Training Trials in A at Twenty Minute Intervals and Were Tested in A (<u>Ss</u> 1-5), B (<u>Ss</u> 6-10), and C (<u>Ss</u> 11-15), Chapter III, GD III	101

TABLE

PAGE

XXVI. Training Trial Latencies (Sec.) for <u>Ss</u> Given Five Training Trials in A at Twenty Minute Intervals, Chapter III, GD III	102
XXVII. Training Trial Latencies (Sec.): The First Ten Training Trials for <u>All Ss</u> Were in Situation A; The Second Ten Training Trials (11-20) of <u>Ss</u> 1-5 Were in A; The Second Ten Training Trials (11-20) for <u>Ss</u> 6-10 Were in B; and the Second Ten Training Trials (11-20) for <u>Ss</u> 12-15 Were in C, Chapter IV, Sk-R I	103
XXVIII. Total Number of Rears in Successive Thirty Second Intervals of <u>Ss</u> Receiving Ten Original Training Trials in A; One-Third Received Ten Interpolated Training Trials in A and Was Tested in A (AAA); One-Third Received Ten Interpolated Training Trials in B and Was Tested in A (ABA); and One-Third Received Ten Interpolated Training Trials in C and Were Tested in A (ACA), Chapter IV, Sk-R I	104
XXIX. Training Trial Latencies (Sec.): The First Five Training Trials (<u>All</u> at Twenty Minute Intervals) for <u>all Ss</u> Were in A; the Second Five Training Trials (6-10) of <u>Ss</u> 1-5 Were in A; the Second Five Training Trials (<u>Ss</u> 6-10) Were in B; and the Second Five Training Trials for <u>Ss</u> 11-15 Were in C, Chapter IV, Sk-R II	105

TABLE

PAGE

XXX. Total Number of Rearing Responses in Successive Thirty Second Intervals Where all <u>Ss</u> Had Five Original Training Trials in A at Twenty Minute Intervals; One-Third Received Five Interpolated Training Trials in A and Was Tested in A (AAA); One-Third Received Five Interpolated Training Trials in B and Was Tested in A (ABA); and One-Third Received Five Interpolated Training Trials in C and Was Tested in A (ACA), Chapter IV, Sk-R II	106
--	-----

LIST OF FIGURES

FIGURE	PAGE
1. Skaggs-Robinson Hypothesis Concerning Relation Between Similarity and Efficiency of Recall	16
2. Mean Number of Rears per Minute in the Test Period of <u>Es</u> Given Hand Removal Reinforcement and <u>Cs</u> not Given Reinforcement	27
3. A Comparison of the Skaggs-Robinson (AAA, ABA, and ACA) and Generalization Decrement (AA, AB, and AC) Functions Generated from the Sk-R II and the GD III Experiments	72

CHAPTER I

GENERAL INTRODUCTION AND STATEMENT OF THE PROBLEM

The laws governing acquisition and maintenance of behavior have occupied learning theorists in psychology for many years with the result that a great deal of data are available which demonstrate various factors influencing the acquisition of both simple and complex habits. Among the hundreds of factors now known to influence learning, similarity between original and interpolated material has received much attention in retroactive and proactive inhibition settings. The interference effects of these processes with varying degrees of similarity were first stated in 1920 by Woodworth and Poffenberger (23) and separately by Foucault (23) in 1928.

From the many studies, some of which are cited below, relating to the facilitating or inhibiting effects on learning of varying degrees of similarity between original and interpolated materials, it has been shown that there are many dimensions along which the continuum of similarity can vary. Several hypotheses concerning the relationships of these factors have been stated. Among these hypotheses is found the Skaggs-Robinson hypothesis (36, 23) which states that: "As similarity between interpolation and original memorization is reduced from near identity, retention falls away to a minimum and then rises again, but with decreasing similarity it never reaches the level obtaining with maximum similarity."

This hypothesis, while an interesting and important one to learning theory, has not been demonstrated in a single experiment, although parts of it have been suggested by several studies. The

purpose of the present study is to demonstrate the Skaggs-Robinson hypothesis in a retroactive inhibition setting within the theoretical framework of Guthrie's theory of learning.

Attempting to demonstrate the Skaggs-Robinson hypothesis within the Guthrie framework introduced the problem of selecting a response already in the repertoire of white rats which was amenable to conditioning by reinforcement as defined by Guthrie and of demonstrating that it could be reinforced and conditioned using his concept of reinforcement. The response chosen was that of full rearing which was to be conditioned by using simple hand removal from a situation as the reinforcing agent. A full rear was defined as the animal's rearing up on his hind feet to a 45° angle or more.

Another problem encountered in this study was found in setting up three situations which differed by enough cues in the two extremes and one which had cues which fell somewhere, preferably near the middle, between the two extremes. This was done largely by using what were known as factors which influence the behavior of white rats and varying the cues in three situations which would meet the above criteria. It was then necessary to demonstrate that learning was essentially equal in the three situations and that from the extremes to the middle situation the inhibitory effects were approximately equal.

In summary, the three problems were: 1) to select a response already in the repertoire of white rats and demonstrate that it could be conditioned using Guthrie's principle of reinforcement, 2) to set up three situations which varied widely in the number of cues in the

two extreme situations with a middle situation which was approximately equidistant along a sensory continuum between the two extremes, or as near to it as possible, with a behavioral demonstration of this, and 3) to demonstrate the Skaggs-Robinson hypothesis using the response and techniques worked out in the first two experiments.

Background

Learning and Reinforcement

Learning theorists, in the formulation of learning theories, have had the very difficult task of discovering the various factors and processes in learning and explaining how learning takes place or how stimulus-response (S-R) bonds are formed. Hull (11, 12) in his theory found it necessary to explain learning in a very elaborate system of postulates and hypotheses which attempt to delineate each phase of learning essentially in terms of rewards or drive reducing agents. He says that no learning can occur unless there is an accompanying drive reduction. This is his concept of reinforcement--i.e., a set of conditions which involve drive reduction. Hull (12) goes further to say that the strength of the stimulus-response bond (SHR) is dependent upon the number of reinforcements.

Guthrie (7), on the other hand, denies that need reduction is a condition necessary for learning. Learning for him is a sudden all-or-none process in which temporal contiguity of the stimulus and response is the only essential to learning--i.e., when two events (S-R) occur together in strict temporal contiguity the connection is made immediately

and when the same stimulus (cue) conditions occur again then the same response that was made in the original situation will tend to re-occur. The association, once made, is permanent and the only function of frequency is that the response becomes associated with more and more cues and hence is more likely to be elicited on a given trial where the stimulus falls within the range of $S_1, S_2, S_3, \dots S_n$, each stimulus-response connection becoming in essence a new stimulus-response bond or habit. His concept of reinforcement as stated by Jenkins (14) is as follows: "Any cue following a response that changes the organism's behavior--so that it cannot unlearn what it has just learned--will provide a basis for learning and maintenance." Reinforcement from the point of view of the contiguity principle becomes in essence a removal from the situation so that unlearning cannot occur. If this occurs many times, conditioning will take place which, as trials increase, will become more and more resistant to extinction because more members of the stimulus class are associated with members of the response class. An experiment by Jenkins and Rigby (16) demonstrates this point concerning which Jenkins (14) states:

. . .one-trial conditioning will occur whenever the same cues are represented on a second occasion. This is clearly a difficult task. The complex sensory feedback from the external and internal environment need only differ slightly on a second trial and generalization decrement will play a prominent role. On each given occasion some sub-set of the totality of cues becomes associated with the class of behavior. Since these subsets are almost infinite in number--even in the simple situation represented by the Skinner box--several thousand removals of the organism (reinforcements) should add increments to response strength so that resistance to extinction will be increased over several hundred occurrences. The data show this to be the case.

Guthrie explains the usual drive reduction definition of reinforcement

as only an introduction of an additional and novel stimulus which effectively removes the organism from the situation as it existed at the time the last response was given. Thus, the last response given before removal is the one which is conditioned or learned.

Concerning this point Guthrie (8, p. 98) states:

The next time that the disturbers are present they will tend to call out, by virtue of their last association, the act that removed them. Other acts associated with them have been dissociated or unconditioned each by the next act. But after successful removal of the disturber, it is no longer there to be associated with a new act. The drive remains faithful to the act that removed it because that was its last association.

He (9, p. 3) states that "all that escape or reward does is to protect the learning from being unlearned."

One of the questions that the contiguity principle must explain is the effectiveness of need reduction in producing conditioning which is strongly resistant to extinction. Jenkins (14), within the framework of the contiguity principle, explains it as follows:

One basic question that comes up is how, by the contiguity principle, can we decide a priori the rank order of effectiveness of cue changes? Which cues presented after the response should have the greatest effect in "stamping in" the behavior? Another way of putting the question is: Why is food so universally used for deprived organisms and why is it so effective in producing an alteration in behavior? And why are other removal methods less effective than food? A basic way of looking at this latter point is to consider whether there are ways of removing organisms from situations that are more effective—lead to faster learning and greater resistance to extinction—than food for a hungry organism. The answer from the present standpoint is that the more the behavior of the organism is changed by the post-response cue, the greater the increment in response strength. The more effective cue for removing the organism from the situation is the one that produces more of a change in the behavior of that organism. The change in behavior may be a gross increase or decrease in activity. (The rat in the Skinner box appears to expend more energy and give out with more behavior in approaching and manipulating the food than it does in pressing the bar.) In

any case, the rat is effectively removed from the situation by presentation of food so that when it finishes eating and reorients to the lever, it is put back in a very similar stimulus setting to that previously encountered. Learning to associate other reactions with this cue situation has been prevented by occupying the rat with an entirely different class of behavior.

There are numerous experiments in the literature which demonstrate various aspects of the Guthrie point of view but only the ones which seemed pertinent to this study were reviewed here.

Sheffield and his associates have demonstrated that the process of reinforcement is much more general than is explainable in terms of need reduction. In one experiment Sheffield and Roby (41) used six hungry albino rats as an experimental group and six satiated albino rats as a control group. They showed that using a non-nutritive substance (saccharin) as a reward was a very effective reinforcing agent in the acquisition of the correct response in a T-maze. Apparently there was no need reduction in this situation.

In another experiment Sheffield and his associates (42) demonstrated that copulation without ejaculation, and without any past history of ejaculation, served as an effective reward or reinforcing agent in learning running and hurdle-climbing. Again there was apparently no need reduction but rather what would seem to be a drive increasing situation. Concerning the results of this experiment they state: "The results suggest that elicitation of a dependable and prepotent consummatory response is the critical factor in the reinforcement of instrumental responses rather than drive-reduction or beneception." These experiments seem to refute Miller's (28) definition of drive reduction as a decrease in stimulation.

In an experiment designed to compare the reinforcing value of a nutritive and a non-nutritive substance under different conditions of hunger with reference to general as well as specific hungers, Carper (2) demonstrated that the mean rate of response is not significantly different for glucose and saccharin in satiated albino rats as well as for animals conditioned under a twelve-hour food deprivation period. It was shown that under conditions of general hunger glucose reinforcement was more effective than saccharin; however, learning occurred under both conditions. He says that "the results of this experiment show that saccharin reinforces the bar-pressing response for both satiated and deprived animals."

Jenkins (14) demonstrated that learning does take place without reinforcement. Two groups of pigeons under different drive levels were exposed for an hour a day for ten days to a situation without reinforcement. After this initial period they were then given food reinforcement until they had learned to a criterion. The control groups were under the same drive level and were given reinforced trials to the same criterion. The hypothesis that the experimental birds would take longer to learn to the criterion than the control birds because of habit interference (negative transfer) was supported at a high level of confidence. This is an indication that learning did occur to cues in the situation when no "reinforcement" was present.

Seward (40) designed an experiment to test Guthrie's theory that the function of reward is to remove the subject and prevent unlearning of the final response. One group of albino rats was given food as a

reward for pressing a bar while a similar group was simply removed from the situation. He found that both groups learned to press the bar but the reward group was superior to the removal group in both latency and frequency of response to extinction.

Voeks (48) points out the effectiveness of removal from a situation as a reinforcing agent in her interpretation of Perin's (34) results. Perin trained 150 albino rats to press a bar either right or left to receive a pellet of food. During this preliminary training the bar remained in the Skinner-type box when the bar was pressed in either the right or left direction. After this preliminary training the animals were divided into six groups and were then given "differential" response training. During this training the only difference in the groups was that varied intervals of delay (0, 2, 5, 10, and 30 seconds) were used in a delayed reinforcement setting. They were given 120 training trials. During this differential response training, Perin reports that the bar was automatically removed when the animal gave the "correct" response but remained in the box when the animal gave the "incorrect" response (the correct response was the direction the bar was pressed least in the preliminary training trials). He reports, however, that this procedure of removing the bar only for a correct response was a change in the original plan of the experiment. The original design was to have the bar withdraw automatically after either a correct or an incorrect response. He reports that under these conditions it was very difficult to get several of the animals to learn the correct response and it was not until he decided to leave the bar

in place for an incorrect response that learning occurred. Voeks points out here that this is exactly what would have been predicted by Guthrie's theory since removing the bar after an incorrect response constitutes a removal, in the Guthrieian sense, from the situation which would prevent new associations so that the last response given before removing the bar would be learned.

Perin found that learning was excellent after the 0 second delay, not quite as good for the 2 and 5 second delays, very poor for the 10 and 20 second delays, and almost non-existent after the 30 second delay. He concluded that the rate of habit acquisition is an inverse function of the delay of the reinforcement interval. Voeks points out that both the bar removal and food presentation constitute a partial removal from the situation. The near perfect learning which occurred for the animals under 0, 2, and 5 seconds delay was due to the fact that no unlearning could occur because the animal was sufficiently removed from the situation and no differentiation of the responses could be expected after these short intervals. Longer delay periods showed inferior learning because the animal had sufficient time to make associations to new behavior with the situation. Eventually one of these new responses comes to be associated with food presentation and is learned instead of the bar pressing response.

Voeks (48, p. 51) feels that Perin was not justified in his conclusions. She states that:

Learning is not an inverse function of the length of the delayed food interval as such. Learning is, rather, a function of the removal of the animal from the situation following some response. That response consequently is preserved and repeated through prevention of its being unlearned.

Other studies have been designed to test the hypothesis that the more an organism is removed from a situation or the greater the behavioral change, the greater the learning. Horowitz (14) subjected one group of satiated pigeons to only the sound of the food magazine's turning and another to the visual stimulus of food (they were not allowed to eat) plus the magazine noise. Both groups were compared to a control group given no change in the situation. He found a high number of pecking responses with an increase in time for both groups subjected to the cue-removal (sound alone and sight plus sound) while the control group showed a low number of responses with a decrease in time. Shrader (43), using a similar design gave one group an appreciable increase in illumination, another group was given the same increase in illumination plus the noise of the food magazine's turning (without visual stimulation of the food), and a third group which was given neither, found that all his pigeons showed an increase in pecking responses but the two groups with increased stimulation showed considerably more responses in the same direction as found by Horowitz. These studies also serve as further evidence of learning occurring in the absence of experimentally induced drive and apparently without need reduction.

Miller's (28) definition of drive-reduction reinforcement as a reduction in intense stimulation was tested by Brush and his associates (14). They demonstrated that when illumination was increased during test trials, there was increased resistance to extinction of a previously conditioned response as was expected from a Guthrie point of view.

Anderson's (1) experiment showed clearly that learning occurs when the "reward" was simply physical removal from a maze situation.

He used four groups of rats at 95 per cent of normal body weight. One group was a hungry-rewarded group, another a hungry-non-rewarded group, and two corresponding groups were satiated. His procedure included hand removal from the situation after the conditioning trial. His hungry-rewarded group showed the most efficient learning but the important point here is that the other three groups also showed an appreciable amount of learning.

An experiment by Hayward (14) indicates that hand removal from an open field situation was effective in producing one-trial learning when cues were held constant. Again his experiment pointed out the effectiveness of hand removal in facilitating learning of the terminal response. He used two kinds of fields or situations for his conditioning. One of them had a small number of distinctive cues while the other had a large number. The response used was the rearing one commonly found in albino rats. He reinforced this response by using one trial in which the animal was allowed to remain in the situation until he gave one full rear. He was lifted by hand, while still in the full rear, out of the situation and returned to a restraining cage. Two groups of fourteen rats were used and one of them was conditioned in the small-cue situation and the other was conditioned in the large-cue situation. The two groups were then split into two equal groups each. One of these sub-groups was tested in the situation in which it had received one conditioning trial and the other one was tested in the other situation. This study indicates that the rearing response can be conditioned by one-trial reinforcement with a constant cue situation. Changing cues produced the typical

decrement in behavior. His results on these points are shown in Table I. Hand reinforcement for not rearing yielded the greatest decrement even though the cue situation was held constant. It seems to follow from the literature that if the rearing response is reinforced several times the response strength should be increased.

A study by Ligon (20) was concerned with a comparison of various incentives in the learning of white rats. He measured the time animals would take to run a maze in which both locomotion and climbing were involved. The "incentives" used were: an empty cage, another rat, a buzzer, food, and food and buzzer together. The animals were under four drive levels resulting from 0, 6, 12, and 21 hours of food deprivation. He presents data to show that under 0 hours food deprivation the rats ran faster to the buzzer than to the empty cage but presents no other data for this drive level. He shows, however, that under the other drive levels running was fastest to the food-buzzer combination followed by food alone under the six and twenty-one hour drives, roughly equivalent for the buzzer and another rat, and slowest to the empty cage. Learning occurred in all groups under all conditions.

Olds and Milner (30) point out that many experiments have been done in which electrode implantation in the brain of organisms was used in an attempt to condition behavior. These experiments were concerned with the eliciting function of the stimulus which means that they dealt chiefly with the response which comes after the stimulus has been applied. They designed an experiment using electrode implantation which was concerned with the reinforcing function of electrical stimulation to the

TABLE I

THE EFFECT OF HAND-REMOVAL REINFORCEMENT ON A SINGLE TRIAL, UPON
SECOND TRIAL REARING LATENCY (SEC.), IN THE SAME SITUATION,
IN A DIFFERENT SITUATION, AND FOR A CONTROL GROUP
REMOVED FOR NOT REARING (HAYWARD 1953)

	Same Situation	Different Situation	Control Group
N	14	14	8
$\bar{X}$ - 1st rear	38.7	35.7	19.2
$\bar{X}$ - 2nd rear	17.6	51.7	45.9
Per cent change in $\bar{X}$ s	54.5	-44.8	-139.1
Median per cent change	68.5	-90.5	-241.0
Number consistent with $\bar{X}$ s	11/14	10/14	8/8

brain--i.e., the response which precedes the stimulus. In this study bipolar needle electrodes were permanently implanted in various locations in the brains of albino rats. After a three day recovery period they were tested in a Skinner box which had the usual lever. The lever was connected to a microswitch which was in turn connected to the electrode in such a way that each time the animal pressed the lever, electrical stimulation was self-administered directly to the brain area where the electrode was inserted. The animals were placed on the lever the first time they were introduced into the box. They received no reward other than the electrical stimulation. The experimenters found that the response was maintained by stimulating several areas of the brain but particularly by stimulating the septal area. In other words, learning was conditioned and reinforced in this manner. Concerning this the authors (30, p. 425) state: "It is clear that electrical stimulation in certain parts of the brain, particularly the septal area, produces acquisition and extinction curves which compare favorably with those produced by a conventional primary reward."

Several things are apparent in the experiments presented here. It is indicated that: 1) an appreciable amount of learning takes place in the absence of motivation or need reduction although drive reduction seems usually to lead to more learning; 2) an organism tends to learn the final or last response given before "removal" from a situation whether this removal consists of a change in stimuli or of an actual physical removal from the situation (these are the same thing in terms of the principle of contiguity); 3) cue constancy is important in learning; 4) increased stimulation as well as decreased stimulation is effective

in producing learning; 5) hand removal from a situation is a reinforcing state of affairs; and 6) the rearing response can be conditioned and reinforced simply by catching the animal while it is still in the full rear and removing it by hand to a restraining cage.

Similarity and the Skaggs-Robinson Hypothesis

The major problem to be considered here was the Skaggs-Robinson hypothesis, which, as stated above, had to do with the inhibitory effects of varying similarity from complete identity between the original and the interpolated material through gradual stages to maximum dissimilarity. It states that the least inhibition occurs when there is near identity, increases to its highest point when similarity between original and interpolated material is about midway on a similarity-dissimilarity continuum, and decreases again when there is complete dissimilarity to a level not quite equal to the retention level reached when there is complete similarity (35, 36, 45, 23). This hypothesis was formulated by Robinson (36) from one of his studies and from a study by Skaggs (45). A generalization of the formulation is shown in Figure 1. Concerning this figure McGeoch and Irion (23, p. 408) state:

At A, where similarity between interpolated activity and original memorization is at a maximum (where they are as nearly as possible identical), recall is at its highest level of efficiency. As this similarity approaches its minimum at C it passes through an intermediate degree, B, where recall is exceedingly inefficient. After this point is passed, there is an increased efficiency of recall, but this increase does not return to the level obtaining at A.

Attempts have been made to demonstrate this hypothesis but they have been only partially successful in that the section of the curve from A to B has been substantiated by Robinson (36) with no suggestion

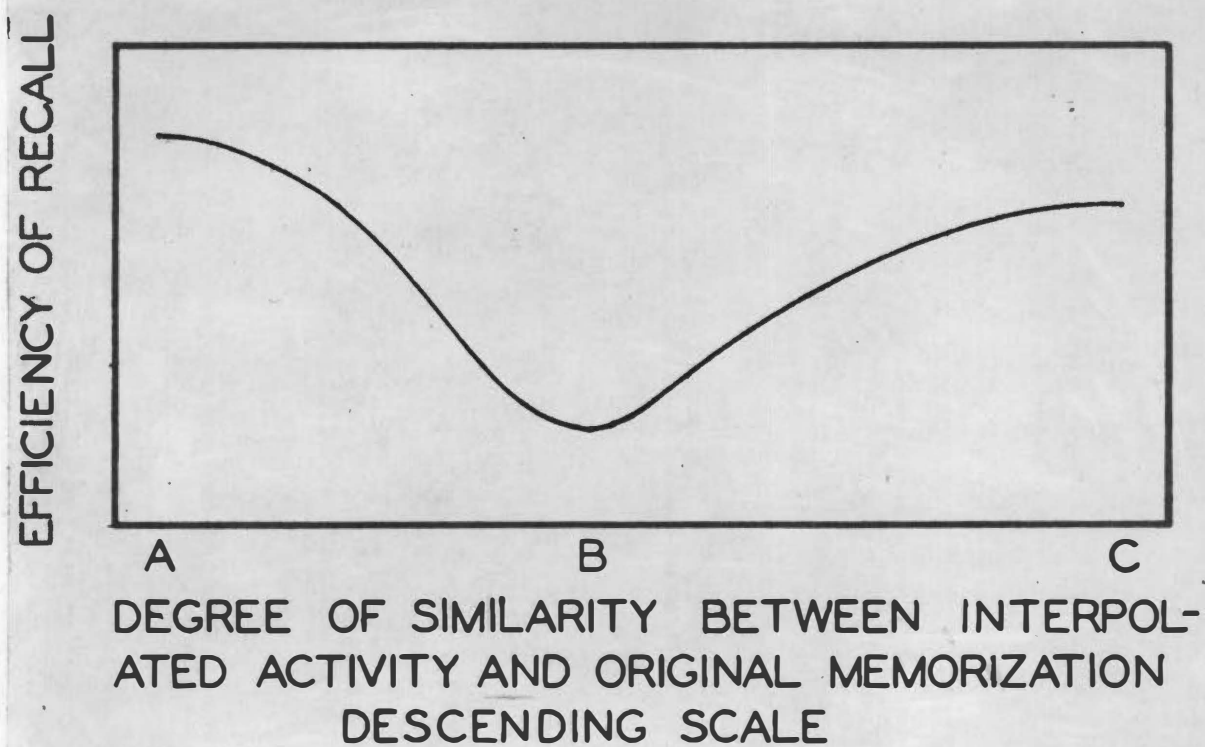


Figure 1

Skaggs-Robinson Hypothesis Concerning Relation Between
Similarity and Efficiency of Recall

as to the B to C section. Another experiment by Harden (10) supports the B to C section but does not support the A to B section. Kennelly (18), using the methods of Robinson and Harden, attempted to substantiate the hypothesis but again the results supported the A to B function with no hint of the B to C section. Robinson used the memory span method with lists of eight consonants. The two halves of the list were considered as original and interpolated material. He varied the percentage of identity between the halves as well as controlled the positions of the consonants. Identical elements ranged from complete similarity to complete dissimilarity.

Harden (10) repeated Robinson's experiment, but defined similarity in terms of the relative numbers of consonants and digits in the second half of the list. Identity was the ratio of items of the same class in the two halves of the memory span list. She was able to substantiate only the B to C section of the hypothesized curve.

A recent experiment was performed by Newton (29) in which he used four lists of five-letter meaningful words where the second list had only one letter changed from the original, the third list had two letters changed, and the fourth list had three or four letters changed. He found that when the stimulus words were most similar to the original list, fewest errors of recognition occurred. Stimulus words of intermediate similarity contained the most errors and when the stimulus words were most dissimilar to the original list, recognition errors decreased but never reached the level of the identical words. These results would have been predicted by the Skaggs-Robinson hypothesis. Newton was investigating the effects of reward, punishment, and neither of these on perception and

learning so his experiment was not strictly in the Skaggs-Robinson setting.

Other experiments, such as the one by McGeoch and McDonald (24) and one by Johnson (17), have not shown evidence substantiating the complete Skaggs-Robinson function. Osgood (33) feels that the reason for this is that the experimenters have varied both the response and the stimulus variables at the same time from zero to a very high degree of similarity. Several of the experiments, however, show that retroactive inhibition increases as the percentage of similarity decreases. In any case, a great deal of work has shown that the factor of similarity can be varied along many dimensions in both the stimulus and response variables.

Other experimenters (3, 50, 4) have shown the same thing but point out that the amount of decrement in learning is a function of kind as well as of degree of identity. McGeoch and McDonald (24), Osgood (31, 32), and Sisson (44) have shown how various aspects of similarity of meaning affect the degree of retention. McGeoch and McDonald find that retention is inversely related to the degree of closeness of meaning or that inhibition varies directly with similarity of meaning. Osgood points out that as response similarity increased to identical stimuli, the amount of retroaction decreased. Sisson, using nonsense syllables calibrated for 0 per cent and 100 per cent associative value, found that when a list of nonsense syllables with the same association value as the original list was interpolated, inhibition increases more than for lists with different associative values.

Gibson and Gibson (6), Waters and Peel (49), and Jenkins and Postman (15), have shown that the amount of inhibition is related also to the similarity of the task or operation involved as well as to similarity of content. For example, Jenkins and Postman, employing the methods of anticipation and recognition, showed that there was more retroaction when original practice was by one of these methods and interpolated learning was by the other.

Another dimension, similarity of serial position, was investigated and substantiated by McGeoch and McGeoch (25) and Irion (13). From these experiments it was found that when interpolated materials were synonyms of the original material, the amount of retroactive inhibition was large. It was also found that when interpolated material was the same as the original material, serial position was an important factor.

In addition to these variations in similarity, it has been shown by experimental evidence that there are other variables which lead to retroactive inhibition. No attempt was made here to review the literature on this point since it has been done thoroughly elsewhere (23). However, some examples of these experiments are given with the variables investigated. McGeoch (21) found an inverse relationship between the degree of original learning and retroactive inhibition. Melton and Irwin (27) show that when the degree of original learning is held constant and the degree of interpolated learning is increased, there is at first an increase in inhibition which decreases as the degree of interpolated learning increases. The greatest amount of inhibition appears when the degree of learning for both conditions is approximately equal. Robinson and

Heron (38), Robinson and Darrow (37), and Sand (39) have shown that the amount of original material influences the amount of inhibition. McGeoch (22), Twining (46), and Underwood (47) have demonstrated that the amount of interpolated material (lists of adjectives or nonsense syllables) whether in terms of the length of the interpolated list, the number of interpolated lists, or the frequency of repetition of the interpolated list, influences the amount of retroactive inhibition. The greater inhibitory effects resulted from longer lists and from the greater number of interpolated lists.

Organization of Study

Several separate studies were done in preparation for the final test of the Skaggs-Robinson hypothesis. These studies were grouped into chapters in terms of their relationship to each other and to the final problem. It was felt that at this point a general overall view of the problem in outline form might facilitate reading the series of experiments which follow in Chapters II, III, and IV. The outline is as follows:

- A. Selection of a response already in the repertoire of the animals' behavior and demonstration that it can be conditioned using Guthrie's principle of reinforcement (Chapter II).
 - 1. Conditioning the rearing response by simple hand removal from a situation. There were three replications of this investigation which are called Experiments I, II, and III in Chapter II.

2. Demonstration that the animals were conditioned by simple hand removal and not simply by introduction into the situation and handling (Experiment IV, Chapter II).
- B. Generalization decrement on a cue similarity-dissimilarity continuum in three situations (A, B, and C) which were constructed such that there was one at each extreme of the continuum and one which was between (near the middle of) the extremes (Chapter III).
1. Demonstration that the three situations were equal within sampling limits in the number of responses which would be elicited when animals are trained and tested in the same situation.
 2. The effect of training in B on responses in A, B, and C (Generalization Decrement I).
 3. Generalization decrement arising from training in A and test in A, B, and C (Generalization Decrement II and III).
- C. The test of the Skaggs-Robinson hypothesis (Chapter IV).
1. The effect of giving ten original massed training trials in situation A with ten interpolated massed training trials in A, B, and C followed by a test period in A for all groups (Experiment I, Chapter IV).
 2. The effect of giving five distributed original training trials in situation A followed by five distributed interpolated training trials in situations A, B, and C and a test period in A for all groups (Experiment II, Chapter IV).

CHAPTER II

HAND REMOVAL AS A REINFORCING AGENT

The purpose of this experiment was to demonstrate that rearing responses could be reinforced and maintained by simple hand removal from the situation in which rearing occurred. A full rear was defined as the animal's rising up on his hind legs to an angle of approximately 45° or more. According to Guthrie (7), the last act performed in the presence of a hierarchy of cues before "removal" will be the response which will be learned. He further states that need reduction or reinforcement as defined by Hull (11) is not necessary for learning to occur. For Guthrie, then, the only conditions necessary for learning are that a response and "removal" occur contiguously or close together in time.

This experiment was designed to test the hypothesis that hand removal while the animal was still in the rearing stage would reinforce and maintain rearing behavior at a significantly higher level than that of a control group which had not had this treatment.

Method

Subjects. The subjects (Ss) were thirty-four satiated male albino rats from 70-150 days old at the beginning of the experiment. They were housed in groups of three in drawers of a portable bank of cages. Not all animals were experimentally naive since some of them had been used in a "maze learning" experiment.

Apparatus. The Ss were trained and tested in an open-topped, circular field which had smooth cardboard walls. The floor was

approximately 415 square inches in area surrounded by a cardboard wall which was twelve inches high. The floor was painted a flat black while the walls were of unpainted corrugated cardboard with the smooth side facing inward. The whole interior was lighted by a 7.5 watt white frosted bulb in an ordinary goose-necked desk lamp which was mounted at one side of the field approximately two inches above the top edge of the wall. The field was placed in a black painted experimental room in which temperature did not vary by more than ten degrees. The only light in the room other than the 7.5 watt bulb was a dim desk lamp on an adjoining table which was used for recording purposes. In addition there were three small restraining cages which were unlike the home cage or the field. They were constructed of wood with a hinged frame top covered with wire mesh.

Procedure. In general, the procedure was to take the Ss from their home cages in groups of three and place them in individual restraining cages to take them to the experimental room. After a delay of fifteen minutes each experimental animal was placed in the experimental field where he was allowed to remain until he had given a full rear approximately equal to or exceeding a 45° angle. He was caught by the experimenter's right hand while still in the rear and removed to the restraining cage. To keep the cues as constant as possible a record was kept of the position and location the animal was in when he reared in order to reintroduce him in the same place and position for the next training trial. Each experimental subject (E) was given twenty training trials at approximately three minute intervals. If an animal had not made a rearing response in a five minute period after being placed in the field during training, or

was unusually difficult to handle, he was not used. After the training session the Ss were kept in the restraining cages for fifteen minutes before being returned to their home cages.

After the Es had been trained, they and the control subjects (Cs) were then given test periods of ten to fifteen minutes in the field. Records were kept of the latencies of rearing responses during training, latencies of the first rear in the test period, and the number of rears minute-by-minute throughout the test period. Three replications of this experiment were run with variations as described below.

Experiment I. Six Ss were used in the E group and six in the C group. The Es were taken from their home cages and taken to the experimental room as described above. Each one was given twenty training trials at three minute intervals and was then returned to the home cage after a fifteen minute delay in the restraining cage. The C group was then brought into the experimental room in the same manner and each was given a test period of ten minutes of free rearing in the field. When this was completed the Es were returned to the experimental room where they were also given a ten minute period of free rearing. Three Es and three Cs were run on two succeeding nights.

Experiment II. Again there were six Cs and six Es. These Ss were given the same treatment and tests with one exception. The six Es were given ten training trials one night followed by ten training trials the following night with the test period on the third night. The Cs were tested on the first and second nights. Following the first experiment it was decided to keep additional records of the stage of rear the animal was in when removed and to extend the test period to fifteen

minutes for both Es and Cs. By stage of rear is meant whether the animal was in a full rear, going up, coming down from a full rear, or whether he was caught after his front feet were again on the floor. The test period was extended to see what happened to the response after ten minutes.

Experiment III. This replication was started with five Es and five Cs but one of the Es was discarded because of failure to meet the time criterion for rearing. Otherwise this replication was conducted exactly as Experiment II.

Experiment IV. A question came up during the running of the above experiments as to how could one be certain that the rearing behavior was being conditioned and was not simply due to exposing the Es to the situation twenty times. This portion of the study was devoted to answering this question. Two groups of three Ss were used. One group was conditioned in exactly the same manner as the Es in Experiments II and III, i.e., they were given ten training trials one night, ten the following night, and on the third night they were given a ten minute test period. The three Ss of the other group were placed individually in the situation where they were allowed to remain fifteen seconds (the mean latency for some 200 training trials in the other experiments) and were then removed (reinforced) when they were performing some response other than rearing. If they reared during the first fifteen seconds then they were allowed to remain in the situation for fifteen seconds following the last rear they gave. In other respects the two groups were treated alike. The hypothesis for this experiment was that the animals conditioned for rearing would give significantly more rears than

the animals conditioned for "not rearing."

Analysis of the Data. Several statistical techniques have been utilized in the analysis of the results obtained from these experiments. The major technique for which the experiments were designed was the Wilcoxon-Mann-Whitney (26, 51) nonparametric t because of the real possibility of skewness and heterogeneity of variance and the small samples in each experiment and replication. The Chi-square technique for combining probabilities (5) was used. It was decided, however, before the experiment, to use other techniques in an analysis of the overall data if the assumptions were met. As a result of this decision, parametric t was used as a check on the overall data. Rank order correlation coefficients were also calculated for various aspects of the data.

Results

The number of rears minute-by-minute and animal-by-animal for both E and C groups in the test period are shown in Appendix Tables XII and XIII. The latencies to each full rear in the training sessions are shown in Appendix Table XIV. The means of the number of rears per minute for the Es and Cs are shown graphically in Figure 2, where it is seen that the E groups are clearly superior to the C groups in the number of rears given in the total test period. Table II presents the total number of rears in the ten minute test period for the E and C groups along with probabilities for each replication calculated by the Wilcoxon-Mann-Whitney formula for nonparametric t. These probabilities were combined by the Chi-square technique and this probability is shown

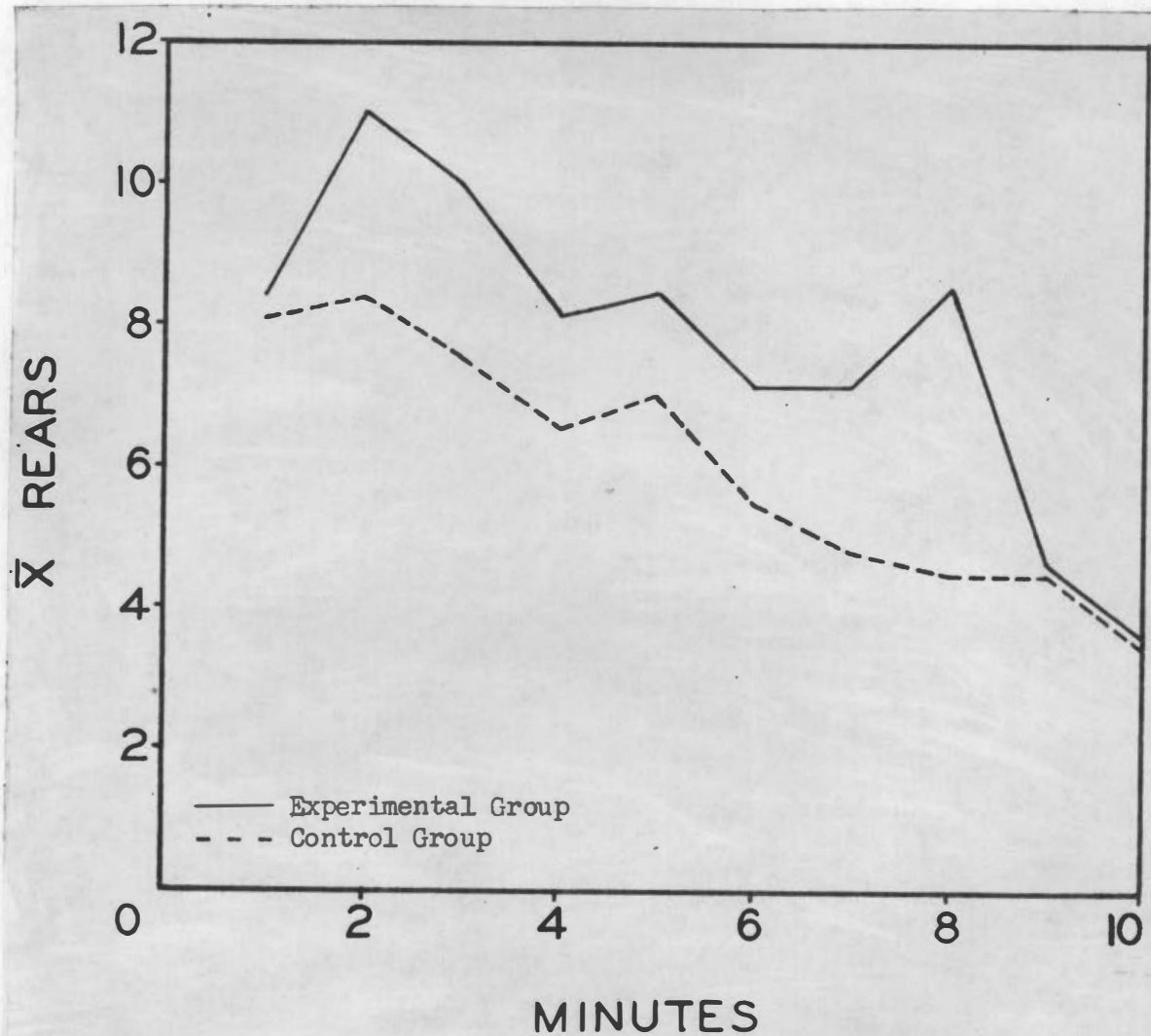


Figure 2

Mean Number of Rears per Minute in the Test Period of Es Given Hand Removal Reinforcement and Cs not Given Reinforcement

TABLE II

NUMBER OF REARS IN TEN MINUTE TEST PERIOD FOR EACH EXPERIMENT
SEPARATELY FOR HAND REMOVAL (E) AND CONTROL (C) RATS AND
LATENCY (SEC.) TO FIRST REAR IN THE TEST PERIOD

Experiment I				Experiment II				Experiment III				
Rears		Latency		Rears		Latency		Rears		Latency		
E	C	E	C	E	C	E	C	E	C	E	C	
93	49	16	14	43	38	3	4	86	46	5	7	
114	75	47	13	82	9	11	7	45	39	26	5	
54	40	90	31	81	20	2	1	85	67	14	2	
62	108	95	9	65	80	22	7	87	75	9	20	
127	78	9	14	79	60	24	5		74		4	
69	91	7	6	68	76	9	3					
$\bar{X}$	86.5	73.5	44.0	14.5	69.7	47.2	11.8	4.5	75.8	60.2	13.5	7.6
SD	27.1	23.2			13.4	26.9			17.6	14.9		
P = .242				P = .066				P = .095				

P for Experiments I, II, and III combined = .023

P for Experiments II and III combined = < .01

in the table.

No one of these individual probabilities reaches the accepted .05 point. However, they are in the same direction and when combined the probability reaches the .02 point. It is to be remembered that Experiment I was conducted using massed training trials while in Experiments II and III distributed training was used. The two probabilities for Experiments II and III are smaller than for Experiment I. Massed training actually increased mean rearing but tended also to increase variability. The combined probability for Experiments II and III is less than .01. An overall parametric t for the number of rears given by all members of the C and E groups in the ten minute test period was calculated. The resulting t value was 2.024 which for thirty-one degrees of freedom yields a one-sided probability of .03, favoring the E group.

Further analyses of the data were suggested by Experiment I, namely, that rearing in the E groups showed the greatest superiority to the C groups in the seventh and eighth minutes of the test. As a result, the probabilities for the combined seventh and eighth minutes of the test period were calculated for each experiment. (Why the effect was largest at this point in time is not immediately obvious.) Table III shows the data for the seventh and eighth minutes. The combined probabilities for these two minutes was .008 (rounded). The t value for the seventh and eighth minutes was 2.192 which for thirty-one degrees of freedom gave a one-sided probability of .02.

In addition to these statistics the probabilities for the second through the tenth minutes of the test period, the middle six minutes (three through eight), the first five minutes, the second five minutes--

TABLE III

NUMBER OF REARS IN SEVENTH AND EIGHTH MINUTES OF TEST PERIOD
FOR EACH EXPERIMENT SEPARATELY FOR HAND REMOVAL (E)
AND CONTROL (C) RATS

Experiment I		Experiment II		Experiment III	
E	C	E	C	E	C
16	1	3	7	21	2
27	18	16	0	3	5
21	5	18	0	17	12
14	19	12	6	20	19
33	10	9	8		16
6	20	14	10		
$\bar{X}$	19.5 12.2	12.0	5.2	15.3	10.8
SD	8.8 7.3	4.9	3.8	7.1	6.4
P = .120		P = .021		P = .143	

P for Experiments I, II, and III combined = .0075

for all three experiments--and all fifteen minutes for Experiments II and III were calculated. The combined one-sided probabilities for these intervals were found to be .02, .02, .06, .06, and .04 respectively with all differences favoring the E group.

To obtain an index of reliability or consistency of the rearing response, the rank difference (rho) correlation coefficient was calculated between the odd and even minutes of the test period and between the first five minutes and the second five minutes of the test period for both E and C groups. The odd-even correlation coefficient was .42 for the E group and .87 for the C group. The correlation between the first five minutes of the test period and the second five minutes of the test period for the E group was .35 and for the C group it was .61. All these correlation coefficients were significant at the 5 per cent level or better. It is noteworthy that the values were higher for the C group. Apparently the hand reinforcement acted to displace the rank of some Ss from training to test.

Rank difference correlations were also calculated relating the number of test rears with whether the Ss, during the training period in Experiments II and III, were caught while in a full rear (FR), coming down from a full rear (CD), or after the front feet were again on the floor (AD). The stages of the rearing response at the time of removal are shown in Appendix Table XV. The correlation coefficients are shown in Appendix Table XVI. The main values of interest here were those for the ten minute period and the seventh and eighth minutes. For the FR measure these rhos were, respectively, .275 and .472. For the other two measures combined (AD and CD) the corresponding values were -.258 and

-0.361. While the N is too small (ten) to warrant much extrapolation there is a tendency for a greater number of FR reinforcements to be associated with a larger number of test rears.

Figure 2 (p. 27) shows that the rearing response for both the experimental and control groups follows fairly closely the usual declining extinction curve. To check on the significance of this downward trend the "Sign Test of Significance" (52) was used. A count was made of the number of Ss showing a decrease or an increase in rearing responses from the first five minutes of the test period to the second five minutes. In the experimental group it was found that fourteen Ss showed a decrease, and two showed an increase. Fourteen events in the same direction out of sixteen observations was significant at the 1 per cent level of confidence. The control group showed fifteen decreases and two increases, a finding again significant at the 1 per cent level of confidence. These probabilities can be combined by checking the number of decreases in all observations (both experimental and control). This was done and it was found that there were four increases in the second five minutes of the test period out of thirty-three observations. This was significant at considerably less than the 1 per cent level of confidence. It should be noted that all increases were of small magnitude compared to decreases (mean of 6 and 18, respectively).

The latencies of the first rears in the test period for the experimental and control groups were shown in Table II (p. 28). The mean latency for the experimental groups was 24.3 seconds with a standard deviation of 29.9. For the control groups the mean latency was 8.9 seconds with a standard deviation of 7.5. An F test for the

homogeneity of variance gave a probability of less than .01. The non-parametric t value for the overall data was 2.691 which with thirty-one degrees of freedom yielded a two-sided probability of .01. The probabilities calculated for the separate experiments and then combined gave a combined two-sided probability of .048.

The mean latency for the experimental groups was almost three times as long as for the control groups. This suggested that the conditioning process tends to delay significantly the first response in the test period. It should be noted that the E group exceeded the C group in rearing responses despite this fact. This led to an examination of the latencies for each S in the twenty training trials. A comparison of the mean latencies for the first ten training trials with the mean latencies for the second ten training trials showed that the latencies for thirteen Ss increased, one was equal, and two decreased. This was significant at the 1 per cent level of confidence and indicated a real effect, namely, that as training trials increase, latency also increases and carries over to the test period. The correlation coefficient (ρ) between the mean latency of the first ten training trials to the mean latency for the second ten training trials was .04. The mean latency in seconds by blocks of five training trials was 6.4, 7.9, 8.9, and 12.8.

In Experiment IV, which was a control on the number of introductions in the field and the number of responses given by the Ss, the total number of rears in the ten minute test period for the three Ss conditioned not to rear were 62, 55, and 58. The total number of rears for the three Ss conditioned to rear were 74, 98, and 111. The

minute-by-minute data and the latencies of first rear in the test period are shown in Appendix Tables XVII and XVIII respectively. A nonparametric t for three out of three events which do not overlap gave a one-sided probability of .05. This probability was obtained in spite of the fact that the "not to rear group" gave nearly twice as many rears (48, 36, and 37) during the training period as the group conditioned to rear (20 rears each). The groups were, of course, perfectly matched on number of exposures to the situation so that it can be inferred that these two variables did not account for the results.

Discussion

The major results of these experiments were as follows:

- (1) The rearing response can be conditioned by hand removal and maintained over an appreciable period of time in satiated non-rewarded albino rats.
- (2) As training trials increase for the experimental group, the latency for this group also increases and this retardation carries over to the test period; however, the differences are significant in spite of this.
- (3) The conditioned rearing response as well as the unconditioned rearing response extinguishes in much the same manner as other learned responses.
- (4) The special control experiment (Experiment IV) which controlled for the number of introductions into the field and for the number of rears given by the groups demonstrates that these factors are not the reason for the significant differences in the other experiments, but that these are due to the reinforcing effect of "removal" from the situation while in a rear.
- (5) The

animals tend to maintain their relative position as to number of rears throughout the test period for the control group, but the conditioning introduces greater variability in the experimental groups and appreciably reduces reliability. (6) There is some relationship between the stage of rear and the number of rears given in the test period since the correlations are positive and moderate between the number of full rears in conditioning and the number of test rears in ten minutes, and for the number of rears in the seventh and eighth minutes while they are negative and moderate for the corresponding periods with "after down" and "coming down" stages. (7) For some unknown reason the seventh and eighth minutes of the test period are particularly sensitive to hand removal reinforcement and show the highest correlation between "full rear" and number of test rears.

The fact that the experimental groups showed a significant increase in the number of rearing responses over the control groups demonstrated that the rearing response could be conditioned and maintained by using simple hand removal from a situation. Guthrie's principle of reinforcement would explain this phenomenon by saying that the last response given in a situation before removal would prevent the animals from unlearning the rearing response since they no longer have the opportunity to give the response to the original cues. The increase in response strength resulting from a number of "reinforcements" fits very nicely into Guthrie's (7) idea that each time the organism gives a response in a hierarchy of cues the response occurs to different cue patterns in such a way that there are more cues which come to elicit the response. Since the response was one which was already in the

repertoire of the animals and might be described as a "protective" or "exploratory" kind of behavior, no artificially induced drive was necessary. The animals were satiated for food and water and it was not immediately obvious what drive, if any, was being reduced by what drive-reducing agent to produce reinforcement as defined by Hull (11). It is also difficult to see how Miller (28) would explain the present results in terms of a reduction of stimulus intensity as a necessary condition for learning since the hand removal would seem to be an increase in the intensity of stimulation rather than a decrease.

CHAPTER III

COMPARISON OF THREE SITUATIONS DESIGNED TO TEST THE SKAGGS-ROBINSON HYPOTHESIS AND A TEST OF GENERALIZATION DECUREMENT

It has been demonstrated that the rearing response can be conditioned and reinforced by hand removal from an open field. The experimental animals learned to rear at a significantly higher frequency than the control animals when the reinforcing agent was hand removal from the situation while they were still rearing. Once conditioned, the response followed much the same extinction curve as other conditioned responses. It was noted that the rearing response was one which was already in the repertoire of the animal's behavior and that the problem was one of conditioning the experimental group to give significantly more responses than a control group which did not have conditioning trials. It was shown that the level of responding which the control animals brought to the situation (the "normal" rearing response) also followed the usual declining extinction curve. It followed that this rearing response could be used in the proposed test of the Skaggs-Robinson hypothesis.

The following series of experiments leading to a test of the Skaggs-Robinson hypothesis evolved from what is known of similarity and its effects on the amount of retroactive inhibition. Many experiments (23) have shown that variations in the stimulus situation produce variations in the amount of retroactive inhibition. When the stimulus remains operationally identical and the response constant, learning

efficiency reaches a high level and retroactive inhibition is at a minimum. When complete dissimilarity of the stimulus is approached, retroactive inhibition is also minimal, but when similarity of the stimulus is somewhere between identity and complete dissimilarity the amount of retroactive inhibition is at a high level. Following these ideas on retroactive inhibition, three stimulus situations were constructed such that there were two at the extremes of a similarity continuum and one which was as near the middle as possible of the similarity continuum, between the two extremes. These situations (A, B, and C) were constructed and tested as follows: 1) to determine whether the situations were equal in the number of rearing responses each would elicit from Ss trained and then tested in the same situation, and 2) to test the generalization decrement function from one situation to the others.

The working hypotheses were that the situations would be equal in the number of rearing responses elicited when Ss were trained and tested in the same situation, and when Ss were trained in one situation and one-third tested in the same situation and one-third tested in each of the other situations, the interference effects for those tested in the same situation would be less than for those tested in different situations. Further, if a group of Ss were trained in B and a third of them were tested in B, a third in A, and a third in C, the decremental effects should be approximately equal from B to A and from B to C.

Experiment I

The purpose of this experiment was to test the hypothesis that the three situations were equal in the number of rearing responses they would elicit from Ss trained and tested in the same situation--i.e., the number of responses elicited from a group trained and tested in situation A would be equal to the number of responses elicited from a group trained and tested in B and to a group trained and tested in C.

Method

Subjects. The Ss were fifteen experimentally naive satiated male albino rats of the local Tennessee strain, 70-150 days old at the beginning of the experiment. They were housed throughout the experiment in groups of three in a portable bank of cages.

Apparatus. Three situations (A, B, and C) were constructed. Situation A was the same as the one used in the first series of experiments on the reinforcing effect of hand removal from a situation. It was circular in shape with twelve inch walls open at the top. The floor was approximately 415 square inches in area. The floor was of ordinary plywood and the walls were of smooth cardboard. The whole interior was painted a flat black. The field was lighted by a 7.5 watt white frosted bulb in an ordinary goose-necked desk lamp which was mounted so that it was to one side and about two inches above the wall of the situation.

Situation B was in the shape of a regular hexagon with a floor

area of approximately 415 square inches. The floor was covered with size 2.5 black grit sandpaper. The walls were twelve inches high and of unpainted corrugated cardboard with the smooth side turned inward. Each side of the hexagon was approximately twelve inches in length. The corresponding side walls had an eight inch panel of the same kind of sandpaper that was on the floor, centered and fastened to the wall panels. The situation was lighted in the same manner as in situation A with the exception that the position of the light was moved 90° from its position in A.

Situation C was in the shape of an equilateral triangle with a floor area approximately 415 square inches. The floor was of plywood painted a flat black and covered with unpainted .25 inch wire mesh. The walls were twelve inches high and were made of black painted corrugated cardboard with the corrugated side turned inward. The walls were also covered with the same kind of wire mesh as the floor. Situation C was again lighted by a 7.5 watt frosted bulb mounted in the same manner as in A and B but rotated 180° from its position in A.

The three situations were set up in a black painted experimental room which was lighted only by the three 7.5 watt bulbs over each of the three situations. The temperature in the room did not vary more than ten degrees throughout the experiments.

Procedure. Five Ss were given ten conditioning (training) trials in each of the three situations. The training and test periods were exactly the same. Each S was given training trials in the situation in which he was to be tested. The trials were given at five

minute intervals. A training trial consisted of introducing a S into the situation where he was allowed to remain until he reared. The rearing response was again defined as the S's body making an angle of approximately 45° or more with the floor. He was caught while in the rearing response and returned to a restraining cage where he remained until the other four Ss in this group had a training trial. This procedure was continued until five training trials had been given. At this point in training a fifteen minute interval was introduced followed by the next five training trials. After the ten training trials the Ss were returned to the restraining cages where they remained until the training of the Ss in the other groups had been completed. Each group of five Ss was then given a ten minute test period in the situation in which they had been conditioned. A record was kept of the latencies during the training trials, of the latency of the first rear in the test situation, and of the number of rears animal-by-animal and minute-by-minute during the test period.

Analysis of the Data. This experiment was designed for nonparametric anova following the X^2_H procedure developed by Kruskal and Wallis (19). From the first series of experiments it was seen that significant results might be expected to appear early in the test period, in the seventh and eighth minutes of the test period, and in the total number of rears in the ten minute test period.

Results

The number of rears minute-by-minute and animal-by-animal for both E and C groups is shown in Table XIX in the Appendix. Appendix

Table XX shows the latencies of the responses during training. Table IV presents the data for the total number of rears in the ten minute test period and the latencies of the first rear in the test period. The χ^2_H value obtained in comparing the three groups for the first minute was 1.860 which for two degrees of freedom gave a P of .41. Chi-square for the first two minutes was 5.519 with a P of .07; for the first five minutes Chi-square was 3.85 with a P of .20; for the second five minutes it was .504 with a P of .76; for the seventh and eighth minutes it was .321 with a P of .75; and for the total number of rears in the test period this value was 2.088 with a P of .36. The value for the latency of the first rear in the test period for the three groups was 1.641 with a P of .45. The mean number of rears in situation A was larger than the means for the other situations. All these probabilities were two-sided since the direction of the differences was not predicted.

Discussion

The analysis of the data for the various intervals of time and for the latency of the first rear in the test period indicated that there were no significant differences in the number of rearing responses that the situations elicited when the animals were trained and tested in the same situation. While there were no significant differences in the three groups in latency of the first test rear, it is of interest and importance to note that the Ss trained in A and tested in A had a mean latency of 12.2 seconds. The mean latency for B was 17.0 seconds and the mean for C was 28.8 seconds.

TABLE IV

TOTAL NUMBER OF REARS IN TEN MINUTE TEST PERIOD AND THE LATENCIES
OF THE FIRST REAR IN THE TEST PERIOD OF THREE GROUPS GIVEN
TWENTY TRAINING TRIALS AND TESTED IN THE SAME SITUATION

	Situation A		Situation B		Situation C	
	Rears	Latency	Rears	Latency	Rears	Latency
	131	2	52	30	67	4
	47	30	47	6	41	75
	61	14	80	5	42	15
	69	3	75	4	71	29
	99	12	35	40	59	21
$\bar{X}$	81.4	12.2	57.6	17.0	56.0	28.8
Median	69.0	12.0	52.0	6.0	59.0	21.0

P for number rears in three situations = .36

P for latency to first rear = .45

Experiment II - Generalization Decrement I

The first in this series of experiments on generalization was designed to determine the relative position on the cue continuum of similarity of the three situations A, B, and C. Situation B had been constructed so that it appeared to be about midway between A and C. The working hypothesis was that Ss trained in B and a third of them tested in B, a third in A, and a third in C would show a higher responding level in B and a lower level in both situations A and C. The decrement from B to A and B to C should be approximately equal if B were approximately midway along the cue continuum from A to C.

Method

Subjects. The Ss were fifteen experimentally naive male albino rats of the local Tennessee strain, 70-150 days old at the beginning of the experiment. They were housed throughout the experiment in groups of three in a portable bank of cages in which food and water were present at all times.

Apparatus. The apparatus consisted of exactly the same three situations (A, B, and C) described in the preceding experiment.

Procedure. The fifteen Ss were given ten training trials in situation B. Nine Ss were run and tested one night, and six were run and tested on the second night. Three Ss at a time were taken from their home cages and placed in small restraining cages to be taken into the experimental room. Each S, after a fifteen minute delay in

the testing room, was given a training trial at three minute intervals until the total of ten training trials had been given. They were then removed to other restraining cages until the other two groups of three had been given training trials in exactly the same manner. The first three were then returned to the small restraining cages to be returned to the experimental room for the test period. Another fifteen minute delay was introduced for the Ss to become habituated to the room. Each S was given a ten minute period of free rearing as a test. Three of the Ss were tested in B, three in A, and three in C. The following night six Ss were given ten training trials and a test period in exactly the same manner as the nine Ss on the first night. The time between the training trial and test period was extended to match the time consumed in training and testing the other nine. Two of them were tested in B, two in A, and two in C. The data were then grouped for the Ss tested in A, the Ss tested in B, and the Ss tested in C. Records were kept of the latencies during the training, the number of rears in thirty second intervals for the ten minute test period, and of the latency of the first rear in the test period.

Analysis of the Data. This experiment again was designed for use of the Kruskal and Wallis X^2_{H} technique of nonparametric anova. The data were analyzed for significance of differences during the first half minute, the first minute, the first one and one-half minutes, the first two minutes, the first five minutes, the second five minutes, the seventh and eighth minutes, the total ten minute test period, and for the latencies of the first rear in the test period.

Results

The number of rears for each animal for each minute of the test period is presented in Table XXI of the Appendix. Training trial latencies are shown in Appendix Table XXII. Table V presents the ten minute totals and the latencies of first rear in the test period. The χ^2_H value obtained in comparing the three groups in the first half minute was 5.559 which for two degrees of freedom gives a P of .03; for the first minute it was 5.085 with a P of .04; for the first minute and a half it was .563 with a P of .23; for the first five minutes it was 1.377 with a P of .25; for the second five minutes it was .504 with a P of .39; and for the total ten minute test period it was 1.087 with a P of .15. Fisher's Exact Test (5) applied to the number of rears in the first minute comparing the Ss tested in B which were above and below the median (9.0) in the first minute with the Ss tested in A and C which were above and below the median for the first minute yields a P of .019. The χ^2_H value comparing the latencies of the first rear for the three groups in the test periods was 3.206 with a P of .10. The mean number of rears in A for the total test period was again greater than for the other situations. These probabilities are all for one-sided values since the directions were predicted.

Discussion

In the previous experiments in this study it was suggested that the effects of conditioning would be apparent early in the test period. This experiment showed that generalization decrement was significant for periods up through the first minute but had largely disappeared by

TABLE V

TOTAL NUMBER OF REARS IN TEN MINUTE TEST PERIOD AND LATENCIES TO
FIRST REAR OF ANIMALS GIVEN TEN TRAINING TRIALS
IN B AND TESTED IN A, B, AND C

	Situation A		Situation B		Situation C	
	Rears	Latency	Rears	Latency	Rears	Latency
	32	3	42	5	28	5
	66	12	59	3	62	7
	63	10	47	5	40	7
	74	7	41	7	49	4
	54	6	64	2	74	9
$\bar{X}$	57.8	7.6	50.6	4.4	50.6	6.4
Median	63.0	7.0	47.0	5.0	49.0	7.0

P for number rears in test period = .15

P for latency to first rear in test period = .10

the end of the second minute of the test period. The effect was evident, although not at a statistically significant level, in the latencies of the first rear in the test period.

During the test period in this experiment it was noted that when the Ss were being tested in situation B, they frequently stopped to lick their front feet. Further investigation revealed the fact that the sandpaper was very sharp. It seemed likely that the abrasive effects were painful to the Ss. This seemed to be a partial explanation for the decremental effects which showed up early in the test period but disappeared after the first two minutes. In any case, it was felt that these data were not sufficient evidence for the generalization decrement function. It was decided that the sandpaper should be filed to remove the sharp edges and that another experiment on this function was needed.

Experiment III - Generalization Decrement II

The purpose of this experiment was to obtain further evidence of the generalization decrement effects in the three situations after filing the sandpaper to remove the sharp edges. This procedure was changed such that a group of Ss was given a series of training trials in situation A following which one-third of them was tested in A, one-third was tested in B, and one-third was tested in C. This was a change in procedure from that followed in the preceding experiment on generalization decrement as well as a change (filing) in situation B. The argument for the change was that if the Ss were trained in A and tested in the same situation, there should be a higher level of responding than for Ss trained in A

and tested in each of the other situations. Subjects trained in A and tested in B should give more responses than those trained in A and tested in C. Subjects trained in A and tested in A should, from a Guthrian point of view, give more responses than the other two conditions because under these conditions more cues associated with the response would be present. Fewer responses would be expected in B after training in A because situation B, being somewhat like A, would have fewer cues which had been associated with the response learned in A. Situation C, with an even greater cue change from A should elicit fewer responses than either A or B following training in A. The curve should be a decreasing one from A (high) to B to C (low). This was the hypothesis tested in this experiment.

Method

Subjects. The Ss were nine experimentally naive albino rats of the Budd Mountain Rodent Farm strain, 70-200 days old at the beginning of the experiment. They were housed throughout the experiment in individual wire cages in which food and water were present at all times.

Apparatus. The apparatus were the same three situations (A, B, and C) described elsewhere with the exception that the floor of situation B had been filed to remove the sharp edges of the sandpaper.

Procedure. Three Ss were taken from their home cages and placed in small restraining cages. They were taken into the experimental room where a fifteen minute delay was introduced before training trials began. Each S in turn was taken from a restraining cage and placed in situation A. He was allowed to remain in the situation until he had

given a full rear (to a 45° angle or better). He was caught by hand while still in the rearing stage, removed from the situation, and returned to the restraining cage. Training trials were given at intervals of about three minutes until ten training trials had been given. After a fifteen minute delay in the experimental room the Ss were returned to their home cages. This procedure was continued with groups of three until all nine Ss had been given ten training trials in one evening. Twenty-four hours later the same procedure was followed in giving the Ss ten more training trials (twenty in all) after which they were returned to their home cages. Twenty-four hours after the last training trial one-third of the Ss was given a ten minute test period in A, one-third was given a ten minute test period in B, and one-third was given a ten minute test period in C. The test period consisted of placing each S in the situation and allowing ten minutes of free rearing. A record was made of the latency of the first rear for each S and the number of rears was recorded at intervals of thirty seconds throughout the test period.

Analysis of the Data. This experiment was designed to use the Kruskal and Wallis X^2_H technique of nonparametric anova. The data were analyzed for significance of differences in the number of rearing responses during the first half minute, the first minute, the first one and one-half minutes, the first two minutes, the first five minutes, the second five minutes, the seventh and eighth minutes, the total number of rears in the ten minute test period, and for the latencies of the first rear in the test period. In addition to this analysis, the trend was checked for the first minute—i.e., to determine if there

were any indication of generalization decrement after some recovery from the initial increased latency in A.

Results

Table VI shows the total number of rears in the ten minute test period and the latency of the first rear in the test period. The number of rearing responses recorded in thirty second intervals for the total ten minute test period is presented in Table XXIII in the Appendix. Training trial latencies are shown in Appendix Table XXIV. The analysis of the data showed no significant evidence for the generalization decrement function although a trend was noted for a consistent decrement from the group trained in A and tested in C. In other words, B exceeded A, and A and C were about equal in the number of rearing responses occurring under these conditions.

An analysis of the latencies of the first rear in the test period gave a one-sided probability (See Table VI) of .06. The mean latency for the Ss trained in A and tested in A was 22.3, for those trained in A and tested in B it was 11.0, and for the group trained in A and tested in C it was 6.7. The median latencies for these groups were 23, 7, and 7, respectively.

Discussion

The data on the number of rears in the test period showed no significant differences in the three groups and no consistent trend suggesting generalization decrement. For some reason the number of responses in the test period for Ss conditioned in A and tested in A did not come up to the expected level. An examination of the data for

TABLE VI

TOTAL NUMBER OF REARS IN TEN MINUTE TEST PERIOD AND LATENCIES
TO FIRST REAR OF Ss GIVEN TWENTY TRAINING TRIALS WITH
HAND REMOVAL IN A AND TESTED IN A, B, AND C

	Situation A		Situation B		Situation C	
	Rears	Latency	Rears	Latency	Rears	Latency
	33	16	69	7	49	5
	83	23	63	22	63	8
	61	28	58	4	61	7
$\bar{X}$	59.0	22.3	63.3	11.0	57.7	6.7
Median	61.0	23.0	63.0	7.0	61.0	7.0

P (two-sided) for number rears in test period = .79

P (two-sided) for latency to first rear in test period = .12

the latency of the first rear in the three test situations, along with the depressed responding level in A, suggested that some factor was working to interfere with responses in A. This effect was seen most clearly in the experiments on hand removal as a reinforcing agent which were presented in Chapter II.

Within each series of ten training trials, the trials were given at three minute intervals. The trials were massed in two groups of ten with each series of training trials and the test period given at twenty-four hour intervals. It became evident that as the number of training trials increased there was an increasing latency which transferred to the test period in the same situation. The greatest increase in latency occurred, in other words, when Ss were trained and then tested in the same situation, namely, A. Fatigue effects seem to have built up which were not dissipated, or the element of familiarity with the situation tended to delay the time to the first response. This phenomenon seems to be related to Hull's (11) concept of reactive inhibition which states that when training trials are massed, inhibition or fatigue accumulates which would have dissipated in the interval of time between training trials in distributed conditioning.

Increasing latency during training trials which transferred to the test period in the same situation and to a less extent in other situations was apparent in several of the present series of experiments. It seemed likely that if this phenomenon of delayed responding in the test period could be overcome, the response level of Ss trained in A and tested in A would be appreciably raised. The next experiment was designed in an attempt to overcome the difficulty encountered in this

experiment.

Experiment IV - Generalization Decrement III

In the previous experiment it was shown that as training trials increased under the conditions of relatively massed training trials, there was also an increasing delay in the response. It was also shown that when Ss were trained in A and then tested in A, there was a transfer of this delay in response to the test situation. This delay in response was not as pronounced when Ss were trained in A and tested in situations B and C. The reason for this seemed to be that the cue change of situations B and C largely overcame the strength of the inhibitory process which had become attached to situation A.

Taking cognizance of the transfer of delayed responding in the test period in situation A after training in A and the well established fact that distributed practice leads to more efficient learning than massed practice, it was decided that another experiment was needed which would attempt to overcome these inhibitory effects which were depressing the responding level in situation A. The hypothesis to be tested was that if the inhibitory effects could be overcome, the generalization decrement would be more apparent and show a decreasing function from A to B to C. This was to be done by lengthening the inter-training trial interval and giving fewer training trials.

Method

Subjects. The Ss were fifteen experimentally naive albino rats (five females and ten males) of the Budd Mountain Rodent Farm strain,

70-200 days old at the beginning of the experiment. They were housed throughout the experiment in individual wire cages in which food and water were present at all times.

Apparatus. The apparatus were the same three situations (A, B, and C) described in the previous experiments.

Procedure. The Ss received five training trials in situation A with a twenty minute interval between each training trial. The Ss were removed from their home cages and placed in other wire cages to be taken into the experimental room. They were taken in one group of nine and one group of seven. They were, in each case, allowed a fifteen minute delay in order to become somewhat habituated to the experimental room. After the fifteen minute delay, the Ss were given one training trial each in rotation. After the last S had had a training trial in the first rotation another delay was introduced so that twenty minutes elapsed from the time that the first training trial had been given. At the end of the twenty minutes, each S was given a second training trial followed by enough time to make up the twenty minute inter-trial training period. This procedure was continued until all Ss had been given five training trials. After the conditioning trials the Ss were allowed to remain in the restraining cages for fifteen minutes before being returned to their home cages. Twenty-four hours later the groups of nine Ss was divided into three groups of three. One group was tested in A, another in B, and the third in C. One S of this group was discarded because of atypical behavior in accord with the criterion described in an earlier experiment.

The next group of seven Ss received exactly the same treatment as the above nine. They were given five trials in A with a twenty minute inter-trial delay. Three of them were tested in A, two in B, and two in C. This served as a replication of the experiment and the results were to be combined if it were indicated.

Analysis of the Data. The Kruskal and Wallis χ^2_H technique of nonparametric anova was used in analyzing the data obtained from this experiment. The data were analyzed for significance of differences in the number of rearing responses during the first five minutes, the second five minutes, the seventh and eighth minutes, the total number of rears in the ten minute test period, and for the latencies of the first rear in the test period.

Results

The animal-by-animal data in thirty second intervals are shown in Table XXV in the Appendix. Appendix Table XXVI presents the training trial latencies. The total number of rears in the ten minute test period and the latencies of the first rear in the test period are shown in Table VII. Table VIII shows the total number of rears in the first five minutes of the test period. The χ^2_H value obtained in comparing the three groups in the first five minutes of the test period was 5.797 which for two degrees of freedom gave a one-sided P of .03; for the second five minutes of the test period it was 4.220 with a one-sided P of .075; and for the total ten minute test period it was 3.131 with a one-sided P of .105. The mean number of rearing responses made during the first five minutes of the test period by Ss trained in A and tested

TABLE VII

TOTAL NUMBER OF REARS IN THE TEN MINUTE TEST PERIOD FOR Ss GIVEN FIVE
 TRAINING TRIALS AT TWENTY MINUTE INTER-TRAINING INTERVALS
 IN SITUATION A AND TESTED IN A, B, AND C

Situation A		Situation B		Situation C	
Rears	Latency	Rears	Latency	Rears	Latency
75	19	65	14	65	8
69	20	70	28	63	8
50	14	64	34	49	10
62	31	63	22	58	14
86	22	51	24	37	24
$\bar{X}$	68.4	62.6	24.4	54.4	12.8

P for number rears in three situations (ten minutes) = .105

P for latency to first rear in three situations = .04

TABLE VIII

TOTAL NUMBER OF REARS IN THE FIRST FIVE MINUTES OF THE TEST PERIOD
 OF Ss GIVEN FIVE TRAINING TRIALS AT TWENTY MINUTE INTER-
 TRAINING TRIAL INTERVALS IN SITUATION A AND TESTED
 IN A, B, AND C

Situation A	Situation B	Situation C
Rears	Rears	Rears
50	29	39
41	26	14
53	40	41
40	41	42
51	39	28
$\bar{X}$ 47.0	35.0	32.8

P for number rears in the three situations = .03

in A was 47.0, for those trained in A and tested in B the mean was 35.0, and for those trained in A and tested in C the mean was 32.8. The mean number of rears during the total ten minute test period for each group was 68.4, 62.6, and 54.4, respectively.

The χ^2_H value comparing the latencies of the three groups for the first rear in the test period was 5.210 with a two-sided P of .04. The mean latencies for the groups were 21.2, 24.4, and 12.8, respectively.

Discussion

The data supported the hypothesis of a decreasing decremental function from A to B to C at a statistically significant level in this experiment and indicated in the data for the total ten minute test period that the inhibitory effects from A to B were very nearly equal to the inhibitory effects from B to C. Obviously, replication of this experiment is needed before completely definitive statements can be made. The effect seemed to be a real one, however, for two reasons: 1) the apparently logical argument for increasing the inter-trial training interval and reducing the number of training trials to overcome the delay in response in Ss trained and tested in the same situation, produced results in the predicted direction; and 2) the generalization decrement which was found in this experiment would have been predicted from the many studies which have demonstrated it.

As in the other experiments in this series, the latencies of the first rear in the test period showed a significantly shorter mean latency when tested in the situation which was most dissimilar to the situation in which the Ss were trained.

CHAPTER IV

TESTS OF THE SKAGGS-ROBINSON HYPOTHESIS

The purpose of the two experiments presented in this chapter was the final test of the Skaggs-Robinson hypothesis. Evidence has been presented showing several important findings which were necessary before a test of the Skaggs-Robinson hypothesis could be done within the framework of the Guthrie principle of reinforcement in the present setting. These findings were: 1) The rearing response can be conditioned and maintained by hand removal from an open field situation. 2) Three situations were set up and it was demonstrated that two of them (A and C) were at the extremes of a cue continuum with another situation (B) between extremes of the continuum. 3) The three situations were approximately equal, within the limits of sampling error, in the number of responses elicited from animals trained and tested in the same situation, i.e., trained in A and tested in A, trained in B and tested in B, and trained in C and tested in C. There was a decreasing decremental function when training took place in A and testing in A, B, and C.

The Skaggs-Robinson hypothesis states that as similarity between original and interpolated material decreases gradually from complete identity to complete dissimilarity, retention is at a maximum with complete identity, it is at a minimum about midway on the similarity-dissimilarity continuum, and rises again to a high level when there is complete dissimilarity but does not reach the same level which obtained

when there was complete similarity. If this hypothesis is correct, it seemed that a reasonable test of the hypothesis could be done by holding the response constant and varying the cues along a similarity-dissimilarity continuum. It appeared that the test could be made with the three situations previously constructed and used by giving a group of subjects original training in situation A and then dividing the group into three subgroups which would be given interpolated training in situations A, B, and C (one-third in each) and then testing them in situation A. Another test (and one obviously needed) could be made by giving original training in C, interpolated training in C, B, and A, with a test in C. Subjects treated in the former manner should show the highest level of responding in a test period when original and interpolated training occurred in the same training situation (AAA). Those given original training in A with interpolated training in B with a test in A (ABA) should show the lowest level of responding. Those given original training in A with interpolated training in the most different situation (C) and tested in A (ACA) should show a higher level of responding than the ABA group but lower than the AAA group. The two experiments presented here were designed to test this hypothesis.

Experiment I - A Test of the Skaggs-Robinson Hypothesis

Method

Subjects. The subjects (Ss) were seven experimentally naive female albino rats of the local Tennessee strain, 70-150 days old at the beginning of the experiment, and twelve (seven males, five females)

experimentally naive albino rats of the Budd Mountain Rodent Farm strain, 70-100 days old at the beginning of the experiment. All Ss were housed throughout the experiment in individual wire cages in which food and water were present at all times.

Apparatus. The apparatus were exactly the same three situations (A, B, and C) which were described in the preceding experiments.

Procedure. Nine Ss were taken from their home cages and placed in individual restraining cages. They were taken into the experimental room where they were allowed a fifteen minute interval before training began. All nine Ss were given ten training trials in situation A at approximate three minute intervals. Each S was placed in the situation where he was allowed to remain until he made a full rear. He was caught by the experimenter's right hand while he was still in the full rear and removed from the situation to the restraining cage. This procedure was continued until each S had had one training trial in rotation and then the first S was given another training trial until each had had ten training trials. They were allowed to remain in the restraining cages for a fifteen minute interval after the last training trial before they were returned to their home cages. The following night the nine Ss were again taken to the experimental room in exactly the same manner. One-third of them was given ten additional (interpolated) hand reinforced training trials in A, one-third was given ten reinforced training trials in B, and one-third was given ten reinforced training trials in C. The procedure was the same as for the original learning training trials. They were then allowed to remain in the restraining cages in the experimental room for fifteen minutes before being returned to their

home cages. Twenty-four hours later they were returned to the experimental room and each S was given a ten minute test period in situation A. Records were kept of the latencies of the rearing response during the training trials and of the latencies of the first rear in the test period. The number of rears in the test period was kept in terms of thirty second intervals throughout the test period. Three Ss of this group were discarded because they exceeded the time limit criterion of two consecutive ten minute periods during which no rear was given. The replacements were given exactly the same treatment with exactly the same intervals of time as the other Ss in this group. After this group had been finished another group of six Ss was started and treated in exactly the same manner. The time intervals were adjusted so that they were the same as for the other nine Ss. One S in this group had to be discarded because he failed to meet the time criterion. The replacement was given the same treatment as the other Ss in the two groups. The final group contained fifteen Ss.

Analysis of the Data. The same statistical analysis for three groups was done on this data for similar intervals as in the previous experiment. In addition to this analysis, the Wilcoxon-Mann-Whitney technique for nonparametric t was used in a cross comparison of the results of the present experiment with the Generalization Decrement II experiment (GD II). In the present study of the Skaggs-Robinson hypothesis the group given original training in situation A, interpolated training in A, and tested in A (AAA) was to be compared with the group in GD II which had had training in A and tested in A (AA). The Skaggs-Robinson I (Sk-R I) group which was given original training in A,

interpolated training in B, and tested in A (ABA) was to be compared to the group in the second GD experiment which had training in A and test in B (AB). The Sk-R I group given original training in A, interpolated training in C, and tested in A (ACA) was to be compared with the GD group which had training in A and test in C (AC). A comparison of the ACA group with the AC group was the important comparison because this difference between the declining AC function and increasing ACA function would be the evidence for the Skaggs-Robinson hypothesis if ACA exceeded AC in number of test rears. The Sk-R I group could not be compared with the GD III experiment results because they were not comparable in the number of training trials nor in the distribution of training trials.

Results

Table IX shows the total number of rears in the ten minute test period and latencies of the first rear in the test period. The training trial latencies are shown in Table XXVII of the Appendix. The animal-by-animal number of rearing responses is shown for successive thirty second intervals in Table XXVIII of the Appendix. The χ^2_H value for the total number of rears in the ten minute test period was .917 which for two degrees of freedom yielded a P of .32. The means for the total number of rearing responses in the ten minute test period for the three groups were 65.0 (AAA), 62.5 (ABA), and 70.6 (ACA). Chi-square for the first five minutes of the test period was 1.040 with a P of .30. The seventh and eighth minutes yielded a Chi-square value of 1.537 with a P of .24. A comparison of the latencies of the first rear gave a Chi-square of .306 with a P of .43. The mean latency for the AAA

TABLE IX

TOTAL NUMBER REARS IN TEN MINUTE TEST PERIOD FOR GROUPS IN THE Sk-R I
EXPERIMENT (ORIGINAL TRAINING IN A, INTERPOLATED TRAINING IN
A, B, AND C AND TEST IN A) AND THE LATENCIES TO FIRST
REAR IN TEST PERIOD

	Group AAA		Group ABA		Group ACA	
	Rears	Latency	Rears	Latency	Rears	Latency
	84	8	44	16	79	16
	54	50	50	26	52	34
	50	24	88	27	92	9
	61	6	90	18	71	15
	76	48	41	8	59	13
$\bar{X}$	65.0	27.2	62.6	19.0	70.6	17.4
Median	61.0	24.0	50.0	18.0	71.0	15.0

group was 27.2 seconds, for the ABA group the mean latency was 19.0, and for the ACA group the mean latency was 17.4.

A comparison of the AAA group of the Sk-R I experiment with the AA group of the GD II experiment (See Table XI) by the Wilcoxon-Mann-Whitney nonparametric t technique gave a two-sided P of .90. A comparison of the ABA group with the AB group gave a two-sided P of .78. A one-sided (ACA predicted higher than AC) P of .20 was obtained in comparing the ACA group with the AC group.

Discussion

A comparison of the three groups of the Sk-R I experiment did not show differences at the usually acceptable level of significance for any portion of the test period nor for the total ten minute test period. However, inspection of the means of the three groups did show that the AAA group mean was above the ABA group mean and that both groups were below the ACA mean. The Skaggs-Robinson hypothesis was supported by the fact that the ACA mean was greater than the ABA mean, but ACA should not have been greater than AAA. The difference between ACA and AAA was, however, within expected sample variations.

The latencies to the first rear in the test period showed no statistically significant differences when all three groups were compared. It was noted, however, that the mean latency of the first rear for group AAA was approximately one and one-half times as large as group ABA or ACA. Again a marked tendency was noted for latency to increase as training trials increased. This was particularly evident for Ss that had original and interpolated training in the same situation, namely AAA.

This delay transferred from the training situation to the test situation when these were held constant and suppressed the total number of rearing responses in group AAA. It was at this point in the study that the GD III experiment was done in an attempt to overcome this effect. The rationale for it was discussed in the previous section of this paper dealing with the GD III experiment.

The most important comparison of the three groups in the GD II experiment with the three groups of the Sk-R I experiment revealed that the difference between the ACA mean and the AC mean (See Table XI) was fairly large (the difference between the means was 12.9) and that it approached statistical significance (one-sided $P = .20$). The difference between the means for the AAA group and the AA group was 6 with a two-sided (no difference predicted) P of .89. The difference between the means for the ABA group and the AB group was .7 with a two-sided P of .79. The fact that the ACA mean was greater than the AAA mean and that the GD II experiment did not show the true decremental function made the Sk-R function questionable but it seemed significant that the function emerged in spite of this. The comparison of the means indicated that, while the effect was small and statistically insignificant, the curve of the Skaggs-Robinson effect appeared to be generated although by an artifact of a higher level of responding for the AC group than for the AA group in the GD II setting. It seemed that if the artifact could be eliminated and a typical declining GD function obtained, the level of responding for the AA group would rise above the AC group and the true function of the Skaggs-Robinson curve as stated would evolve.

Experiment II - A Second Test of the Skaggs-Robinson Hypothesis

As pointed out in the GD III experiment, it seemed that the increasing latency in training trials was transferring to the test situation and that this was particularly evident when the original training and interpolated training occurred in the same situation. The responding, in other words, in the AA group was being depressed. It was also noted in the Sk-R I experiment that the longest latency occurred in group AAA. It was also shown in the GD III experiment that increasing the inter-training trial interval and decreasing the number of training trials reduced, to some extent, the inhibitory effects which were transferring to the AA group. This gave a clearcut decremental effect which decreased from A to B to C.

The purpose of this present experiment was to make conditions the same as in the GD III experiment by increasing the inter-training trial interval and reducing the number of trials in the original and interpolated training and again testing for the Skaggs-Robinson phenomenon.

Method

Subjects. The subjects were fifteen (ten males, five females) experimentally naive albino rats of the Budd Mountain Rodent Farm strain, 70-75 days old at the beginning of the experiment. They were housed throughout the experiment in individual wire cages in which food and water were present at all times.

Apparatus. The apparatus were the same three situations (A, B, and C) described in the previous experiments.

Procedure. The fifteen Ss were removed from their home cages and placed in small individual restraining cages and taken into the experimental room. They were allowed to remain in the experimental room for fifteen minutes before the training trials began. Each S in rotation was given a training trial in situation A which consisted of placing the S in the situation and allowing him to remain in the situation until he made a full rear. He was caught, while in the full rear, in the right hand of the experimenter and removed to the restraining cage. When each of the fifteen Ss had had one training trial, enough time was allowed to elapse to make an interval of at least twenty minutes between training trials as in GD III. This procedure was continued in exactly this manner until all Ss had had five training trials in situation A. This constituted the original training. One S was replaced because he failed to meet the time criterion of giving a rearing response in two successive ten minute training periods. At the end of twenty-four hours, the fifteen Ss were divided into three equal groups. One group was given five interpolated training trials in situation A, another group was given five interpolated training trials in B, and the third group was given five interpolated training trials in C in exactly the same procedure as was followed in the original training trials. Twenty-four hours after the interpolated training trials, the Ss were again returned to the experimental room where they were given in rotation a ten minute test period of free rearing in situation A. Records were kept of the training trial latencies, the latencies of the first rear in the test period, and of the number of rears in successive thirty second intervals for the total test period.

Analysis of the Data. The same statistical techniques and comparisons were made for this experiment as were made in the Skaggs-Robinson I experiment except the results of this experiment were compared to the GD III results since the two groups were comparable in the number of training trials and had the same inter-training trial interval. Evidence for the transfer of delayed responding from training situation to test period indicated that the Ss should be matched in terms of latency of response during training. In addition the GD III AC group was matched with the Sk-R II ACA group in terms of median latency of rearing in the training trials and the Sk-R II ABA and ACA were matched in like manner and a t was calculated for the matched groups.

Results

The total number of rears in the ten minute test period and the latencies of the first rear are shown in Table X. The training trial latencies are shown in Table XXIX of the Appendix. The total animal-by-animal number of rearing responses is shown for successive thirty second intervals in Table XXX of the Appendix. Figure 3 shows the mean number of rears for the test period plotted along with the mean total test period data of the GD III experiment (Also see Table XI). These curves showed that the Skaggs-Robinson function decreased from AAA to ABA and rose again to ACA while the GD function decreased from AA to AB and decreased from AB to AC. The χ^2_H value for the total number of rearing responses in the test period for the three groups was 1.902 which for two degrees of freedom gave a P of .20. The means

TABLE X

TOTAL NUMBER OF REARS IN THE TEN MINUTE TEST PERIOD FOR GROUPS IN THE
 Sk-R II EXPERIMENT (ORIGINAL TRAINING IN A, INTERPOLATED TRAIN-
 ING IN A, B, AND C, AND TESTING IN A) AND THE LATENCIES
 OF THE FIRST REAR IN THE TEST PERIOD

Group AAA			Group ABA		Group ACA	
Rears	Latency		Rears	Latency	Rears	Latency
46	7		36	15	67	12
77	28		50	10	44	48
79	6		31	8	79	7
77	10		97	27	88	10
86	16		54	7	63	12
$\bar{X}$	73.0	13.4	53.6	13.4	68.2	17.8
Median	77.0	10.0	50.0	10.0	67.0	12.0

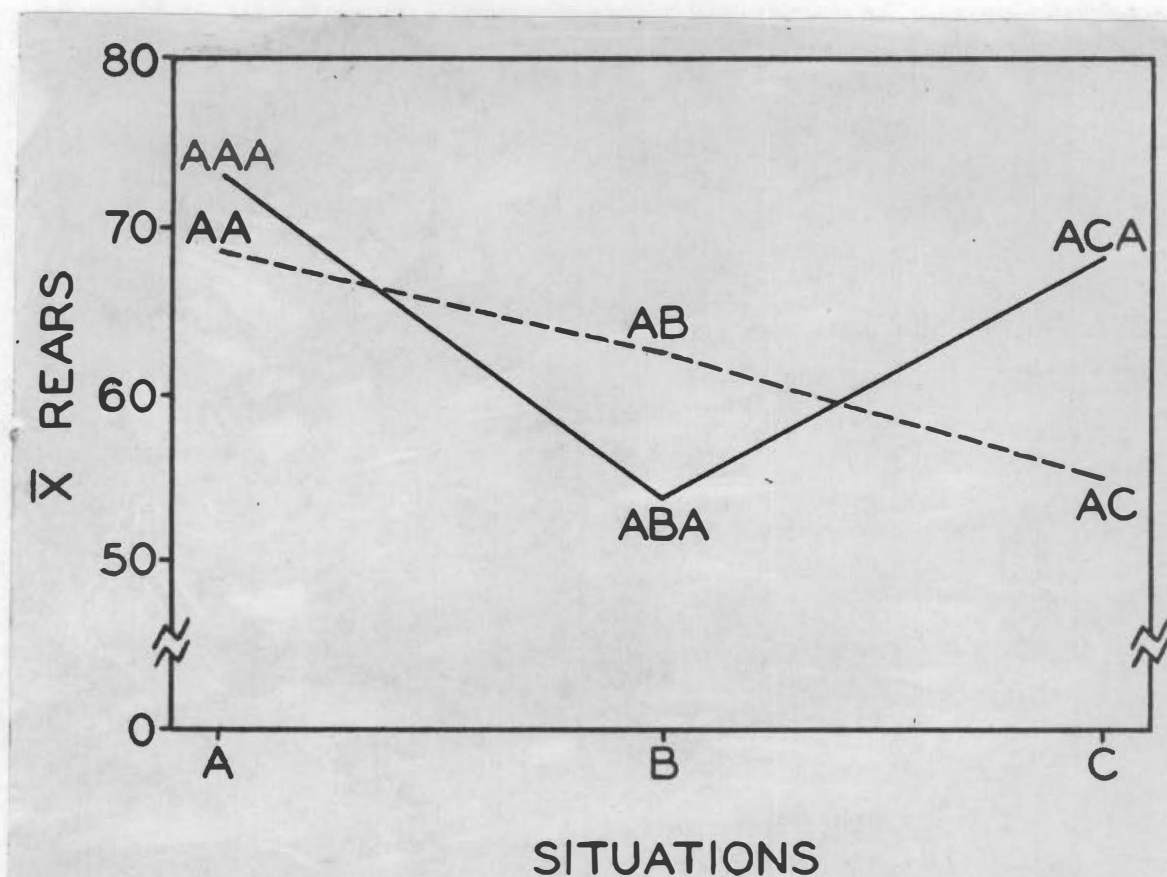


Figure 3

A Comparison of the Skaggs-Robinson (AAA, ABA, and ACA) and
Generalization Decrement (AA, AB, and AC) Functions
Generated from the Sk-R II and the GD III
Experiments

TABLE XI

MEANS FOR TOTAL NUMBER OF REARS IN THE TEN MINUTE TEST PERIOD
 FOR GD II AND GD III (AA, AB, AC) AND FOR Sk-R I
 AND Sk-R II (AAA, ABA, ACA)

	AAA	ABA	ACA
Sk-R I	65.0	62.6	70.6
	AA	AB	AC
GD II	59.0	63.3	57.7
	AAA	ABA	ACA
Sk-R II	73.0	53.6	68.2
	AA	AB	AC
GD III	68.4	62.6	54.4

for the total number of rearing responses in the test period for the three groups were 73.0 for the AAA group, 53.6 for the ABA group, and 68.2 for the ACA group. Chi-square for the first five minutes of the test period was 1.377 with a P of .26. The value for the seventh and eighth minutes was 2.092 with a P of .18. A comparison of the latencies to the first rear in the test period gave a Chi-square value of .264 with a P of .44. The mean latencies for the three groups were 13.4, 13.4, and 17.8, respectively. All the above values of P are one-sided since the directions were predicted.

A comparison of the AAA group of the present (Sk-R II) experiment with the AA group of the GD III experiment (See Table XI) for the total number of rears in the test period gave a two-sided (no difference predicted) P of .48. Group ABA compared to AB for the total ten minute test period gave a two-sided P of .22. Group ACA compared to AC gave a one-sided P of .09. The P value obtained for the ACA group compared to the AC group by simple permutations and combinations was .077. A comparison of group AAA to group ABA for the total ten minute test period gave a one-sided P of .16. ABA compared to ACA for the total ten minute test period gave a one-sided P of .38. The comparison of the ACA group with the ABA group for the first five minutes of the test period gave a one-sided P of .16. Group ACA compared to AC for the first five minutes gave a one-sided P of .13.

The data for the total ten minute test period for the GD III AC group were matched with the Sk-R II ACA group in terms of the median latency in the first five training trials. The S which had the longest median latency in the first five training trials in the AC group was

matched with the S which had the longest median latency in the first five training trials in the ACA group. The next longer latencies were matched, and so on down to the S with the shortest latency of the other group. The total number of rears for these groups was compared by the matched t technique. The t value obtained in this manner was 2.509 which for four degrees of freedom gave a one-sided P of .035. A similar comparison was made between the ABA and ACA groups of Sk-R II which gave a t of 1.527 and a one-sided P of .10.

It did not appear that the rearing response data could be accounted for in terms of the response strength as reflected by the latencies in interpolated training trials. The median latencies for the interpolated training trials were 16 seconds for the AAA group, 12 seconds for the ABA group, and 9 seconds for the ACA group. The shortest latency was expected in A with the longest one in C because the cues were the same in A but very different in C.

Discussion

A comparison of groups AAA, ABA, and ACA by the Chi-square technique yielded a one-sided P of .20 which does not reach the usually accepted level of statistical significance. Reference to Figure 3 (p. 72), however, and the differences in the means of AAA and ABA (19.4), the difference between the means of ABA and ACA (14.6), and the fact that the mean for the AAA group is higher than the mean for the ACA group, indicated that the Skaggs-Robinson function is present although it was a small effect characterized by large variability. The curves in Figure 3 show a declining decremental function from AA to AB to AC

while the Skaggs-Robinson curve falls from the higher AAA mean to the low ABA mean and then rises to a level at ACA which is lower than the AAA mean.

The generalization decrement function was shown in GD III to decrease from A (high) to B to C (low). The critical comparison was the one which compared the ACA group with the AC group. The Skaggs-Robinson hypothesis states that the ACA group would show an increase rather than a decrease over the AC group. This was exactly what happened. The P value comparing the Sk-R II ACA group with the GD III AC group was .077 when calculated by simple permutations and combinations and .09 by the nonparametric t technique. The important and statistically significant comparison of ACA and AC, matched for median latencies, gave a P of .035 which was further evidence that the Skaggs-Robinson function is a real and significant one.

One further comparison seemed to be indicated. Since AAA and ACA were the points of maximum retention or least interference and ABA was below these points or the point of maximum interference and minimum retention, it seemed that these two high points could be compared with the low point. Nonparametric t for these points was 1.286 with a one-sided P of .10. Again the difference was not a statistically large one but it is in the expected direction.

Under the assumption that the means and variances would remain the same if the sample size were increased, it was of interest to calculate an estimate of sample size which would give probabilities at the .05 and .01 levels for the basic comparisons between the

generalization decrement (GD III) function and the Skaggs-Robinson function (Sk-R II). The estimated sample size required for the .05 level between the ACA group and the AC group was 8 while the .01 level would require a sample of 18. An estimate of the sample size required at the .05 level for the comparison of the ABA and ACA groups of the Sk-R II experiment was 16 and for the .01 level it was estimated at 38.

The question came up as to whether the cue changes from situation A to B to C would be additive in their influence on the behavior of the animals. The evidence seems to indicate that they were additive although no assumption can be made as to how much each was contributing to the behavioral changes. The changes which were made from situation to situation were: changes in floor and wall texture, changes in shape of the field, changes of light position, and changes in the color of the walls. There is the possibility that several cue dimension changes may not be additive since one of the cue changes may be producing almost all of the behavioral change and the others little or none. A definitive answer to this question would require further investigation.

The evidence presented indicates that the Skaggs-Robinson hypothesis is correct in its basic assumptions. The effect has been demonstrated although it was not a large one. Further replication of the present Sk-R and GD experiments is clearly called for along with the corresponding training in C with tests in C, B, and A for the GD function and original training in C, interpolated training in C, B, and A and test in C for the Sk-R function.

CHAPTER V

SUMMARY AND CONCLUSIONS

This study has been concerned primarily with a demonstration of the Skaggs-Robinson hypothesis within the framework of the Guthrie principle of reinforcement. In accomplishing this demonstration several experiments had to be performed as basic studies. Out of these investigations several important factors evolved in addition to the test of the Skaggs-Robinson hypothesis.

In order to use the Guthrie principle of reinforcement most effectively a response already in the repertoire of the albino rat (the common rearing response) was chosen because no artificially induced need would be required to elicit the response. Hand removal from an open field situation was chosen because this was an effective way to completely change the hierarchy of cues present at the time the response occurred, and thus the last response in the situation should be learned because no other response could be associated with the cues present at the time this last response occurred. It was demonstrated that the rearing response could be conditioned and maintained by hand removal as the reinforcing agent.

Following the demonstration that rearing could be conditioned and maintained by hand reinforcement, it was necessary to set up three experimental situations to be used in the final test of the Skaggs-Robinson hypothesis. The three situations (A, B, and C) were constructed such that two of them (A and C) were at the extremes of a similarity-dissimilarity continuum in terms of the cue change from one extreme

situation to the other extreme situation. Another situation (B) was constructed such that it was approximately midway between the two extremes on the cue continuum. The three situations were then compared for the number of rearing responses each would elicit from animals which were trained and tested in the same situation. It was demonstrated that there were no significant differences in the number of responses each situation would elicit when the animals were trained and tested in the same situation, i.e., trained in A and tested in A, trained in B and tested in B, and trained in C and tested in C.

If these situations were adequate for a demonstration of the basic hypothesis, there should be a decremental function when animals were trained in one situation and one-third of them was tested in the same situation and one-third of them tested in each of the other situations because of generalization decrement which has been shown in a large number of cue change situations. It was demonstrated that when training trials were kept to a small number and were distributed at twenty minute intervals, there was a significant decreasing curve of the number of rearing responses from A to B to C.

Once these points were established, it was possible to test the Skaggs-Robinson hypothesis by giving animals original training trials in one situation (A), interpolated training trials in A, B, and C (one-third in each), and a test in situation A. This procedure substantiated the Skaggs-Robinson hypothesis in showing a decrement in response strength when some cue change was made and a recovery above this level with maximal stimulus dissimilarity.

The Skaggs-Robinson phenomenon emerged when a large number of massed training trials were employed, but the effect appeared to be artifactual because a decreasing function failed to occur under generalization decrement conditions. This artifact arose by way of the transfer of delayed latency from the training trials to the test situation when cues were held constant with massed training. This effect was partially eliminated in the second test of the Skaggs-Robinson hypothesis by reducing the number of training trials and increasing the inter-trial interval and resulted in an increased probability of a real effect. When the animals of the GD III experiment were matched with the animals of the Sk-R II experiment in terms of the median latency of the first rear in the first five training trials, the statistical significance of the effect was increased and further evidence was provided that the Skaggs-Robinson hypothesis is tenable.

The major conclusion of these nine experiments was that the Skaggs-Robinson position is a tenable one. The phenomenon was demonstrated by varying the stimuli and holding the response operationally constant.

In addition to the major conclusion of these experiments there were several other basic findings. These were: 1) The rearing response can be conditioned and maintained by using hand removal from a situation as the reinforcing agent. This is significant evidence supporting the Guthrie principle of learning and reinforcement. 2) The conditioned rearing response as well as the unconditioned rearing response extinguishes in much the same declining extinction curve as other responses learned under "reinforcement" conditions.

3) There is some relationship between the stage of rear reinforced and the number of rearing responses given in the test period. 4) As training trials increase for animals trained in the same situation, the latency of the rearing response also increases and this effect transfers to the test situation to retard the initial rearing response.

Implications and Suggestions for Further Research

This study focuses on the dissimilarity paradox first noted by Robinson, namely, that some dissimilarity produces interference while a high degree of dissimilarity brings about behavioral facilitation over the smaller degree. Previous studies failed to disclose the phenomenon. The present experiments yielded the parabolic Skaggs-Robinson function. The implications for learning theory and future research on retroactive inhibition are obviously large since the relationship between the cue similarity-dissimilarity dimension and behavior has been demonstrated from one extreme to the other.

Further research is needed in terms of replications of all the experiments done in this study. The test of the Skaggs-Robinson hypothesis in particular needs replication from both the A to C and C to A directions. Further research is also needed on the variation along single cue dimensions in the situations as well as on multiple cue changes between A and B and B and C to give more points on the A to B and B to C portions of the Skaggs-Robinson curve.

BIBLIOGRAPHY

1. Anderson, E. E. The externalization of drive: III. Maze learning by non-rewarded and by satiated rats. J. Gen. Psychol., 1941, 59, 397-426.
2. Carper, J. W. A comparison of the reinforcing value of a nutritive and a non-nutritive substance under conditions of specific and general hunger. Amer. J. Psychol., 1953, 66, 270-277.
3. Cheng, N. Y. Retroactive effect and degree of similarity. J. Exp. Psychol., 1929, 12, 444-449.
4. Dreis, T. A. Two studies in retroaction. I. Influence of partial identity. II. Susceptibility to retroaction at various grade levels. J. Gen. Psychol., 1933, 8, 157-171.
5. Fisher, R. A. Statistical methods for research workers. (10th Ed.) Edinburgh: Oliver and Boyd, 1948.
6. Gibson, E. J., & Gibson, J. J. Retention and the interpolated task. Amer. J. Psychol., 1934, 46, 603-610.
7. Guthrie, E. R. The psychology of learning. New York: Harper, 1935.
8. Guthrie, E. R. The psychology of human conflict. New York: Harper, 1938.
9. Guthrie, E. R. The effect of outcome on learning. Psych. Rev., 1939, 46, 480-484.
10. Harden, L. M. The quantitative study of the similarity factor in retroactive inhibition. J. Gen. Psychol., 1929, 2, 421-430.
11. Hull, C. L. Principles of behavior. New York: D. Appleton Century, 1943.
12. Hull, C. L. Behavior postulates and corollaries--1949. Psychol. Rev., 1950, 57, 173-180.
13. Irion, A. L. Retroactive inhibition as a function of the relative serial positions of the original and interpolated items. J. Exp. Psychol., 1946, 36, 262-270.
14. Jenkins, W. O. Behavior and the contiguity principle. Unpublished manuscript, Univ. of Tennessee.
15. Jenkins, W. O., & Postman, L. An experimental analysis of set in rote learning: retroactive inhibition as a function of changing set. J. Exp. Psychol., 1949, 39, 69-73.

16. Jenkins, W. O., & Rigby, Marilyn K. Partial (periodic) versus continuous reinforcement in resistance to extinction. J. Comp. Physiol. Psychol., 1950, 43, 30-40.
17. Johnson, L. M. Similarity of meaning as a factor in retroactive inhibition. J. Gen. Psychol., 1933, 9, 377-388.
18. Kennelly, T. W. The role of similarity in retroactive inhibition. Arch. Psychol., New York, 1941, 37, No. 260.
19. Kruskal, W. H., & Wallis, W. A. Use of ranks in one-criterion variance analysis. J. Amer. Statist. Assoc., 1952, 47, 583-621.
20. Ligon, E. M. A comparative study of certain incentives in the learning of the white rat. Comp. Psychol. Monog., 1929, 2, No. 28.
21. McGeoch, J. A. The influence of degree of learning upon retroactive inhibition. Amer. J. Psychol., 1929, 41, 252-262.
22. McGeoch, J. A. Studies in retroactive inhibition. VII. Retroactive inhibition as a function of the length and frequency of presentation of the interpolated lists. J. Exp. Psychol., 1936, 19, 674-693.
23. McGeoch, J. A., & Irion, A. L. The psychology of human learning. New York: Longmans, Green and Co., 1952.
24. McGeoch, J. A., & McDonald, W. T. Meaningful relation and retroactive inhibition. Amer. J. Psychol., 1931, 43, 588-597.
25. McGeoch, J. A., & McGeoch, G. O. Studies in retroactive inhibition. VI. The influence of the relative serial positions of interpolated synonyms. J. Exp. Psychol., 1936, 19, 1-23.
26. Mann, H. B., & Whitney, D. R. A test of whether one of two random variables is stochastically larger in a sequence of alternatives. Ann. Math. Statis., 1943, 14, 66-87.
27. Melton, A. W., & Irion, J. McQ. The influence of degree of interpolated learning on retroactive inhibition and the overt transfer of specific responses. Amer. J. Psychol., 1940, 53, 173-203.
28. Miller, N. E. Comments on multiple-process conceptions of learning. Psych. Rev., 1951, 58, 375-381.
29. Newton, K. R. An experimental investigation of several factors involved in visual recognition thresholds. Unpublished doctoral dissertation, Univ. of Tennessee, 1953.

30. Olds, J., and Milner, P. Positive reinforcement produced by electrical stimulation of septal area and other regions of rat brain. J. Comp. Physiol. Psychol., 1954, 47, 419-427.
31. Osgood, C. E. An investigation into the causes of retroactive interference. J. Exp. Psychol., 1948, 38, 132-154.
32. Osgood, C. E. Meaningful similarity and interference in learning. J. Exp. Psychol., 1946, 36, 277-301.
33. Osgood, C. E. The similarity paradox in human learning: a resolution. Psychol. Rev., 1949, 56, 132-143.
34. Perin, C. T. The effect of delayed reinforcement upon the differentiation of bar responses in white rats. J. Exp. Psychol., 1943, 32, 95-109.
35. Robinson, E. S. Some factors determining the degree of retroactive inhibition. Psychol. Monogr., 1920, 28, No. 128.
36. Robinson, E. S. The "similarity" factor in retroaction. Amer. J. Psychol., 1927, 39, 297-312.
37. Robinson, E. S., & Darrow, C. W. Effect of length of list upon memory for numbers. Amer. J. Psychol., 1924, 35, 235-243.
38. Robinson, E. S., & Heron, W. T. Results of variations in length of memorized material. J. Exp. Psychol., 1922, 5, 428-448.
39. Sand, M. C. The effect of length of list upon retroactive inhibition when degree of learning is controlled. Arch. Psychol., New York, 1939, 33, No. 238.
40. Seward, J. P. An experimental study of Guthrie's theory of reinforcement. J. Exp. Psychol., 1942, 30, 247-256.
41. Sheffield, E. D., & Roby, T. B. Reward value of a non-nutritive sweet taste. J. Comp. Physiol. Psychol., 1950, 43, 471-481.
42. Sheffield, F. D., Wulff, J. J., & Backer, R. Reward value of copulation without sex drive reduction. J. Comp. Physiol. Psychol., 1951, 44, 3-8.
43. Shrader, R. R. An experimental analysis of the reinforcement process. Unpublished doctoral dissertation, Univ. of Tennessee, 1953.
44. Sisson, E. D. Retroactive inhibition: the influence of degree of associative value of original and interpolated lists. J. Exp. Psychol., 1938, 22, 573-580.

45. Skaggs, E. B. Further studies in retroactive inhibition. Psychol. Monogr., 1925, 34, No. 161.
46. Twining, P. E. The relative importance of intervening activity and lapse of time in the production of forgetting. J. Exp. Psychol., 1940, 26, 483-501.
47. Underwood, B. J. The effect of successive interpolations on retroactive and proactive inhibition. Psychol. Monogr., 1945, 59, No. 273.
48. Voeks, Virginia. What fixes the correct response? Psychol. Rev., 1945, 52, 49-51.
49. Waters, R. H., & Peel, Z. E. Similarity in the form of original and interpolated learning and retroactive inhibition. Amer. J. Psychol., 1935, 47, 477-481.
50. Watson, B. The similarity factor in transfer and inhibition. J. Educ. Psychol., 1938, 29, 145-157.
51. Wilcoxon, F., Individual comparisons by ranking methods. Biometric Bull., 1945, I, 80-83.
52. Statistical Research Group, Princeton University, submitted to Applied Mathematics Panel, National Defense Research Committee, February 1945.

APPENDIX

GRANVILLE CREST

TABLE XII

TOTAL NUMBER OF REARING RESPONSES MINUTE-BY-MINUTE AND ANIMAL-BY-ANIMAL IN THE TEN-FIFTEEN MINUTE TEST PERIOD FOR SUBJECTS IN THE EXPERIMENTAL GROUPS IN EXPERIMENTS I, II, AND III OF CHAPTER II

S*	Minutes														
	1'	2'	3'	4'	5'	6'	7'	8'	9'	10'	11'	12'	13'	14'	15'
1	13	13	15	12	5	10	8	8	8	1					
2	3	10	10	19	9	13	12	15	1	22					
3	0	1	5	4	14	7	13	8	2	0					
4	0	4	17	9	4	7	8	6	6	1					
5	9	11	12	14	9	14	15	18	12	3					
6	10	11	11	8	10	1	2	4	11	1					
7	20	12	8	0	0	0	1	2	0	0	0	0	0	0	0
8	11	13	10	6	8	5	7	9	6	7	6	5	3	6	6
9	10	12	10	5	11	4	8	10	6	5	6	1	0	0	0
10	4	13	5	11	8	5	4	8	4	3	4	2	4	3	7
11	6	10	13	13	13	8	5	4	4	3	1	3	2	5	5
12	5	8	8	7	9	11	5	9	4	2	0	0	1	1	0
13	13	14	11	5	13	6	6	15	1	2	3	8	6	7	14
14	4	10	6	8	4	6	1	2	3	1	6	7	1	1	1
15	9	16	8	4	11	10	6	11	6	4	2	2	5	6	6
16	17	18	11	4	8	6	12	8	1	2	0	1	7	3	3
$\bar{X}$	8.4	11.0	10.0	8.1	8.5	7.1	7.1	8.6	4.7	3.6	2.8	2.9	2.9	3.2	4.2
SD	5.5	4.0	3.2	4.6	3.6	3.8	4.0	4.4	3.4	5.1	2.4	2.7	2.4	2.5	4.2

*Subjects 1-6, Experiment I; Subjects 7-12, Experiment II; Subjects 13-16, Experiment III.

TABLE XIII

TOTAL NUMBER OF REARING RESPONSES MINUTE-BY-MINUTE AND ANIMAL-BY-ANIMAL IN THE TEN-FIFTEEN MINUTE TEST PERIOD FOR SUBJECTS IN THE CONTROL GROUPS IN EXPERIMENTS I, II, AND III OF CHAPTER II

S#	Minutes														
	1'	2'	3'	4'	5'	6'	7'	8'	9'	10'	11'	12'	13'	14'	15'
1	7	10	8	14	4	1	0	1	2	2					
2	3	7	8	8	11	11	11	7	4	5					
3	5	3	7	3	7	3	3	2	4	3					
4	7	8	15	15	15	11	7	12	13	5					
5	6	8	13	7	6	12	5	5	9	7					
6	6	12	12	7	6	12	8	12	10	6					
7	6	4	0	7	7	3	2	5	3	1	1	1	0	3	3
8	6	3	0	0	0	0	0	0	0	0	0	1	1	3	1
9	10	5	2	0	3	0	0	0	0	0	1	4	0	0	0
10	8	15	12	10	10	6	4	2	6	7	12	1	2	7	6
11	11	9	6	6	8	2	4	4	6	4	0	2	2	4	7
12	13	11	9	10	8	10	6	4	4	1	5	3	3	2	1
13	10	13	4	2	7	3	2	0	1	4	2	0	0	0	0
14	10	4	6	3	1	7	3	2	2	1	0	0	1	5	3
15	14	10	6	8	5	3	7	5	5	4	5	2	2	0	3
16	7	9	11	6	9	5	12	7	4	5	6	3	0	0	1
17	8	11	10	6	12	5	7	9	3	3	3	8	5	1	3
$\bar{X}$	8.1	8.4	7.6	6.6	7.0	5.5	4.8	4.5	4.5	3.4	3.2	2.3	1.5	2.3	2.5
SD	2.5	3.4	4.2	4.1	3.7	4.1	3.5	3.8	3.4	2.2	3.5	2.1	1.5	2.3	2.2

*Subjects 1-6, Experiment I; Subjects 7-12, Experiment II; Subjects 13-17, Experiment III.

TABLE XIV

LATENCY TO REAR IN TRAINING TRIALS IN EXPERIMENTS I,
II, AND III IN CHAPTER II

Trial	Subject Number*															
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	21	22	42	6	7	2	2	5	13	11	17	3	5	8	10	20
2	4	28	2	4	2	5	2	3	3	3	1	7	2	10	7	1
3	3	3	7	2	9	8	3	12	15	2	4	3	1	3	5	2
4	22	71	7	3	6	4	2	3	4	1	9	10	2	2	12	2
5	15	14	11	22	4	2	7	3	6	5	4	8	2	3	22	4
6	2	3	2	2	6	7	4	3	12	9	2	15	2	11	22	1
7	6	2	10	5	13	2	7	23	5	3	3	8	2	2	59	7
8	3	18	13	18	8	1	6	3	4	10	8	3	9	5	2	15
9	16	2	8	20	8	2	4	15	18	28	2	14	6	3	17	13
10	5	10	6	9	19	1	5	8	38	51	14	11	3	8	7	12
11	7	3	3	13	14	5	8	17	10	15	17	7	8	11	13	5
12	5	12	5	15	30	2	7	6	6	5	9	10	3	7	4	10
13	3	21	2	7	6	3	5	9	24	25	6	2	2	9	5	4
14	11	8	17	6	51	5	1	21	3	8	13	1	15	11	16	11
15	29	9	4	17	15	2	6	18	5	14	20	21	2	15	5	11
16	8	45	3	24	18	2	5	26	15	11	9	8	2	7	4	9
17	10	1	21	21	62	8	3	16	15	81	17	4	3	20	16	8
18	8	77	42	27	19	10	2	13	5	15	15	25	30	26	6	38
19	2	11	7	15	43	6	7	5	13	10	5	11	15	20	6	10
20	26	21	27	15	23	4	4	62	13	9	8	26	7	24	12	12

*Subjects 1-6 in Experiment I; Subjects 7-12 in Experiment II;
Subjects 13-16 in Experiment III.

TABLE XV

STAGE OF THE REARING RESPONSE IN TERMS OF WHETHER THE ANIMAL WAS
IN FULL REAR (FR), COMING DOWN FROM A FULL REAR (CD), OR AFTER
FRONT FEET WERE ON THE FLOOR FOLLOWING A FULL REAR (AD)
IN EXPERIMENTS II AND III OF CHAPTER II

Trial	Subject Number*									
	7	8	9	10	11	12	13	14	15	16
1	FR	FR	FR	FR	FR	FR	FR	FR	FR	FR
2	FR	CD	FR	CD	FR	CD	FR	CD	FR	FR
3	FR	CD	CD	FR	CD	FR	FR	FR	FR	FR
4	FR	FR	FR	FR	CD	CD	FR	FR	CD	FR
5	CD	AD	FR	CD	CD	FR	FR	FR	FR	FR
6	FR	CD	AD	FR	FR	AD	FR	FR	FR	FR
7	CD	CD	CD	AD	CD	FR	FR	FR	AD	FR
8	FR	CD	AD	FR	FR	FR	FR	FR	FR	FR
9	CD	CD	FR	FR	FR	CD	FR	FR	FR	FR
10	FR	CD	FR	AD	CD	CD	FR	FR	FR	FR
11	FR	FR	FR	FR	FR	FR	FR	FR	FR	CD
12	FR	FR	FR	FR	FR	CD	CD	FR	FR	CD
13	FR	CD	FR	FR	CD	FR	FR	FR	CD	FR
14	FR	CD	FR	FR	FR	FR	CD	CD	FR	CD
15	FR	FR	CD	FR	FR	FR	FR	AD	FR	FR
16	FR	FR	CD	FR	FR	CD	FR	CD	FR	FR
17	CD	FR	CD	FR	CD	CD	FR	FR	CD	CD
18	FR	CD	FR	CD	FR	FR	FR	CD	FR	FR
19	FR	FR	FR	FR	CD	FR	CD	AD	FR	FR
20	FR	FR	FR	AD	CD	FR	FR	CD	FR	FR

*Subjects 7-12, Experiment II; Subjects 13-16, Experiment III.

TABLE XVI

CORRELATION OF THE NUMBER OF REARS IN VARIOUS TEST INTERVALS
WITH STAGE OF REAR DURING REINFORCEMENT

	Number Rears					
	15 min.	10 min.	1st 5 min.	2nd 5 min.	3rd 5 min.	7th & 8th min.
FR	.094	.275	.306	-.119	.110	.472
CD	.297	-.152	-.176	-.179	-.212	-.433
AD	-.233	-.294	-.476	.197	.109	-.079
AD & CD	-.045	-.258	-.252	.158	-.076	-.361

TABLE XVII

LATENCY TO REAR IN TRAINING TRIALS AND NUMBER OF REARS FOR GROUP
CONDITIONED "NOT TO REAR" (A) AND THE TRAINING TRIAL LATENCIES
FOR THE GROUP CONDITIONED TO REAR (B). EXP. IV, CHAPTER II.

Trial	A						B		
	S1	Rears	S2	Rears	S3	Rears	S4	S5	S6
1	17	0	25	0	19	0	34	7	12
2	40	2	17	0	75	7	15	21	11
3	40	3	21	0	26	1	37	31	5
4	24	1	19	0	21	0	16	13	18
5	85	9	83	6	35	2	56	20	6
6	49	4	34	2	12	0	14	33	13
7	41	5	21	2	40	4	13	34	5
8	12	0	13	0	24	2	7	43	31
9	25	1	21	1	22	1	8	11	10
10	20	1	14	0	15	0	3	6	5
11	10	0	12	0	13	0	20	70	4
12	27	1	15	0	10	0	45	60	17
13	12	0	12	0	18	1	102	71	7
14	40	3	69	5	50	5	47	85	3
15	66	9	23	2	15	0	128	5	19
16	32	5	17	1	25	1	7	58	7
17	17	1	60	5	5	0	9	31	4
18	7	0	41	4	27	2	88	6	6
19	12	0	26	4	34	4	27	4	3
20	31	3	27	6	53	7	105	135	9
	48		36		37				

TABLE XVIII

TOTAL NUMBER OF REARS IN THIRTY SECOND INTERVALS FOR THE TOTAL TEN MINUTE TEST PERIOD OF ANIMALS CONDITIONED "NOT TO REAR" (A) AND ANIMALS CONDITIONED TO REAR (B). EXPERIMENT IV, CHAPTER II.

Minutes	A			B		
	S1	S2	S3	S4	S5	S6
.5	2	3	0	0	0	9
1.0	5	1	2	1	1	7
1.5	7	1	1	0	5	6
2.0	3	2	0	6	9	8
2.5	7	2	7	4	5	4
3.0	4	1	1	4	2	4
3.5	5	5	2	3	3	5
4.0	4	1	3	5	4	3
4.5	2	5	2	3	6	3
5.0	2	2	4	4	10	4
5.5	2	4	3	6	8	5
6.0	3	4	4	8	7	3
6.5	3	6	0	5	6	20
7.0	3	6	2	6	15	7
7.5	4	1	3	5	3	4
8.0	2	1	1	3	2	4
8.5	4	3	5	1	1	3
9.0	0	3	4	2	5	5
9.5	0	2	7	3	4	3
10.0	0	2	7	5	2	4
	62	55	58	74	98	111

TABLE XIX

NUMBER OF REARS MINUTE-BY-MINUTE AND ANIMAL-BY-ANIMAL FOR Ss
 TRAINED IN A AND TESTED IN A (Ss 11-15), TRAINED IN B
 AND TESTED IN B (Ss 6-10), AND TRAINED IN C AND
 TESTED IN C (Ss 1-5), EXP. I, CHAPTER III

S	Minutes										Total
	1	2	3	4	5	6	7	8	9	10	
1	6	9	11	7	11	6	4	4	3	6	67
2	0	6	6	6	1	3	4	5	7	3	41
3	7	9	4	1	5	5	5	3	3	0	42
4	6	9	7	5	5	5	10	7	9	8	71
5	7	9	3	7	7	5	4	5	3	9	59
6	4	12	11	8	5	2	3	2	4	1	52
7	7	4	4	10	1	4	1	1	7	8	47
8	12	8	11	13	1	2	7	9	10	7	80
9	1	8	9	8	8	9	8	8	10	6	75
10	2	5	6	3	6	4	7	1	0	1	35
11	10	17	20	15	16	9	9	17	6	13	131
12	10	16	4	4	3	6	0	0	2	2	47
13	5	17	8	9	3	7	4	3	3	2	61
14	6	6	7	3	8	9	8	6	9	7	69
15	10	16	12	15	7	13	6	3	5	12	99

TABLE XX

TRAINING TRIAL LATENCIES (SEC.) OF Ss TRAINED AND TESTED IN A
 (Ss 11-15), TRAINED AND TESTED IN B (Ss 6-10), AND
 TRAINED AND TESTED IN C (Ss 1-5),
 EXP. I, CHAPTER III

S	Training Trial									
	1	2	3	4	5	6	7	8	9	10
1	2	10	2	1	2	1	13	23	52	37
2	11	16	8	14	22	20	88	93	21	11
3	3	10	1	1	2	2	2	2	8	11
4	10	9	2	7	5	25	11	16	6	8
5	4	3	10	12	19	15	20	19	4	20
6	6	7	42	32	6	17	47	2	35	2
7	9	10	1	2	8	2	5	13	21	4
8	35	45	63	17	5	20	23	13	11	14
9	7	18	35	45	41	89	82	28	57	5
10	3	25	8	24	8	20	38	38	13	37
11	2	1	15	1	13	10	2	15	2	9
12	6	20	10	13	12	4	8	6	28	9
13	9	13	6	5	2	7	32	27	11	35
14	8	7	17	2	2	5	3	2	5	2
15	15	50	36	62	42	40	16	87	100	49

TABLE XXI

TOTAL NUMBER OF REARS FOR EACH ANIMAL IN THIRTY SECOND INTERVALS FOR
 THE TOTAL TEST PERIOD FOR ANIMALS TRAINED IN B AND ONE-THIRD
 TESTED IN A (Ss 1-5), ONE-THIRD TESTED IN B (Ss 6-10),
 AND ONE-THIRD TESTED IN C (Ss 11-15), CHAP. III, GD I

Minutes	Subject														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
.5	4	2	3	7	2	5	6	6	5	8	4	5	1	5	3
1.0	3	6	3	4	5	6	3	3	5	5	5	3	1	5	5
1.5	0	5	5	4	5	2	4	2	3	1	3	5	3	6	6
2.0	3	5	4	4	3	4	4	3	3	4	3	7	5	3	4
2.5	3	3	4	4	6	1	3	2	4	7	4	4	2	1	4
3.0	2	3	4	6	4	0	5	6	4	2	0	5	2	4	4
3.5	1	4	4	9	4	2	4	3	2	1	5	3	3	2	3
4.0	2	4	7	5	0	2	0	0	2	3	0	4	1	1	3
4.5	1	3	3	5	2	4	3	3	0	3	0	3	2	2	5
5.0	1	2	4	3	5	5	4	5	3	1	0	1	1	2	5
5.5	3	3	2	0	3	2	2	2	1	3	0	3	2	4	3
6.0	2	4	2	5	4	0	2	1	1	4	0	2	1	3	1
6.5	2	3	3	3	2	0	3	3	3	5	2	4	2	1	2
7.0	0	1	2	2	0	1	3	3	3	3	1	3	1	2	3
7.5	1	4	3	4	0	1	1	1	1	2	1	0	4	1	2
8.0	2	2	0	3	2	1	3	0	0	1	0	0	2	3	4
8.5	1	5	4	2	5	2	2	0	0	0	0	2	1	1	5
9.0	0	3	0	2	1	3	2	1	0	5	0	2	2	0	3
9.5	1	1	2	0	0	0	3	2	0	3	0	3	2	2	5
10.0	0	3	4	2	1	1	2	1	1	3	0	3	2	1	4
Total	32	66	63	74	54	42	59	47	41	64	28	62	40	49	74

TABLE XXII

TRAINING TRIAL LATENCIES (SEC.) FOR ANIMALS TRAINED
IN B, CHAPTER III, GD I

S	Training Trial									
	1	2	3	4	5	6	7	8	9	10
1	3	7	25	9	3	19	3	13	8	2
2	20	26	20	4	37	2	40	4	9	2
3	15	16	4	5	3	14	3	9	3	3
4	16	15	16	27	4	11	8	12	19	33
5	4	7	4	1	4	5	3	6	9	11
6	18	8	2	7	9	8	8	7	14	21
7	27	4	10	21	37	18	17	13	2	4
8	25	4	26	5	16	13	18	5	14	5
9	10	10	1	12	7	6	1	5	16	13
10	15	27	12	2	2	1	3	2	2	1
11	16	7	3	23	17	12	3	11	105	18
12	10	44	3	3	42	10	9	42	30	26
13	16	48	37	24	5	27	14	30	14	75
14	26	12	2	3	5	3	5	4	3	3
15	24	1	30	15	46	22	5	10	21	10

TABLE XXIII

REARING RESPONSES IN SUCCESSIVE THIRTY SECOND INTERVALS IN WHICH
 ANIMALS WERE GIVEN TWENTY TRAINING TRIALS IN A AND TESTED IN
 A (Ss 1-3), TRAINING IN A AND TEST IN B (Ss 4-6), TRAINING
 IN A, TEST IN C (Ss 7-9), CHAPTER III, GD II

Minutes	Subject								
	1	2	3	4	5	6	7	8	9
.5	1	2	1	3	2	8	4	3	4
1.0	2	3	4	8	2	4	3	4	5
1.5	7	0	6	2	8	7	4	5	6
2.0	4	4	6	5	7	5	3	4	6
2.5	2	1	3	5	2	4	4	4	3
3.0	2	2	2	2	3	5	2	2	4
3.5	1	7	7	2	3	4	5	5	4
4.0	2	7	5	7	4	4	2	4	3
4.5	3	4	4	5	4	2	1	5	2
5.0	0	9	2	2	3	1	2	2	3
5.5	2	8	7	5	2	0	3	4	2
6.0	2	5	8	6	1	0	1	2	2
6.5	0	5	2	4	4	2	0	6	2
7.0	0	1	2	1	6	4	1	1	3
7.5	0	3	1	4	0	1	3	3	3
8.0	1	4	0	0	0	0	4	1	1
8.5	1	4	0	1	2	2	3	1	1
9.0	2	3	1	4	4	1	1	2	0
9.5	1	6	0	0	3	2	0	1	4
10.0	0	5	0	3	3	2	3	4	3
Total	33	83	61	69	63	58	49	63	61

TABLE XXIV

TRAINING TRIAL LATENCIES (SEC.) FOR GD II EXPERIMENT IN WHICH
ALL ANIMALS WERE GIVEN TWENTY TRAINING TRIALS IN A

Trial	Subject								
	1	2	3	4	5	6	7	8	9
1	7	10	8	13	3	9	3	12	3
2	10	10	8	3	9	6	5	7	4
3	11	14	7	4	5	9	20	9	7
4	8	19	30	3	5	7	15	11	7
5	17	15	29	14	8	12	13	4	6
6	12	19	8	5	11	5	30	6	6
7	14	17	17	16	20	5	22	4	4
8	8	31	8	11	14	10	55	11	6
9	13	63	25	20	12	4	57	12	10
10	13	19	18	20	8	2	67	5	7
11	21	95	23	13	17	5	16	5	7
12	20	16	8	13	7	7	28	9	6
13	23	25	12	12	8	7	24	3	5
14	10	34	5	5	22	2	17	2	9
15	22	9	9	9	4	5	15	2	2
16	15	25	7	5	19	5	37	2	5
17	24	19	4	3	6	7	40	2	11
18	21	31	4	5	7	5	92	2	11
19	25	28	2	6	3	3	8	4	5
20	14	15	12	8	5	7	52	2	8

TABLE XXV

REARING RESPONSES IN SUCCESSIVE THIRTY SECOND INTERVALS IN WHICH ALL
Ss WERE GIVEN FIVE TRAINING TRIALS IN A AT TWENTY MINUTE
 INTERVALS AND WERE TESTED IN A (Ss 1-5), B (Ss 6-10),
 AND C (Ss 11-15), CHAPTER III, GD III

Min.	Subject														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
.5	6	0	1	1	2	2	2	4	1	0	4	1	4	4	3
1.0	8	6	6	3	7	5	6	3	5	3	5	0	4	3	2
1.5	8	7	5	4	3	0	4	3	1	3	6	2	4	6	3
2.0	3	4	7	5	6	2	5	1	8	5	2	2	7	5	5
2.5	10	4	9	6	6	3	2	6	3	5	5	1	3	6	3
3.0	4	4	4	4	5	2	2	4	4	3	4	2	3	5	2
3.5	2	2	7	6	7	5	2	4	3	6	3	1	5	4	0
4.0	6	7	7	5	2	4	3	5	2	2	4	1	2	4	3
4.5	1	4	5	3	8	4	0	7	9	7	3	1	3	4	5
5.0	2	3	2	3	5	2	0	3	5	5	3	3	6	1	2
5.5	0	7	2	5	2	6	5	4	2	4	6	2	1	4	3
6.0	0	0	3	3	7	4	0	5	1	3	5	1	3	2	3
6.5	0	2	4	3	5	5	4	5	5	3	2	4	2	2	2
7.0	0	0	8	4	0	5	4	3	3	2	4	3	2	2	1
7.5	0	0	2	3	0	4	3	1	2	2	0	2	2	2	4
8.0	0	2	4	4	0	1	3	2	4	4	0	2	4	0	0
8.5	0	3	1	4	0	1	2	3	0	2	1	5	3	2	2
9.0	0	5	2	4	0	2	1	1	1	1	0	0	4	1	2
9.5	0	2	2	3	3	3	2	0	6	2	0	2	2	4	0
10.0	0	0	5	2	1	3	1	1	5	2	1	2	1	2	4
Total	50	62	86	75	69	63	51	65	70	64	58	37	65	63	49

TABLE XXVI

TRAINING TRIAL LATENCIES (SEC.) FOR Ss GIVEN FIVE TRAINING TRIALS
IN A AT TWENTY MINUTE INTERVALS, CHAPTER III, GD III

S	Training Trial				
	1	2	3	4	5
1	9	7	7	4	15
2	22	25	8	35	45
3	7	22	9	5	26
4	11	5	4	6	19
5	8	6	9	3	2
6	8	21	10	18	17
7	9	13	5	7	3
8	9	17	29	18	16
9	8	15	21	20	32
10	11	8	21	15	16
11	21	21	11	3	4
12	31	24	52	21	9
13	13	20	2	4	5
14	7	10	7	9	16
15	3	3	4	3	24

TABLE XXVII

TRAINING TRIAL LATENCIES (SEC.): THE FIRST TEN TRAINING TRIALS FOR ALL Ss WERE IN SITUATION A; THE SECOND TEN TRAINING TRIALS (11-20) OF Ss 1-5 WERE IN A; THE SECOND TEN TRAINING TRIALS (11-20) FOR Ss 6-10 WERE IN B; AND THE SECOND TEN TRAINING TRIALS (11-20) FOR Ss 12-15 WERE IN C
CHAPTER IV, Sk-R I

TT*	Subject														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	7	12	14	8	9	31	57	15	14	23	28	55	7	10	13
2	15	4	15	5	6	6	28	3	5	9	57	44	6	7	4
3	17	4	51	4	12	5	261	3	13	25	146	62	8	5	16
4	17	13	20	2	40	40	99	4	16	3	30	6	10	12	14
5	2	4	30	8	16	17	36	14	5	20	96	59	8	34	13
6	14	17	31	5	27	47	40	3	17	44	72	25	24	10	6
7	5	9	18	6	11	6	11	6	8	9	607	107	9	21	9
8	9	41	36	8	18	7	30	4	41	107	203	20	12	12	11
9	30	6	31	6	20	4	13	9	27	47	605	150	7	9	17
10	9	65	8	5	36	5	3	7	15	122	10	66	19	17	8
11	27	19	26	8	47	34	107	13	16	66	8	61	4	7	12
12	50	36	35	23	70	57	113	7	22	102	56	67	9	20	8
13	33	4	3	16	46	33	86	10	12	64	40	65	20	39	7
14	4	29	74	26	17	5	46	20	26	3	6	8	12	15	5
15	52	13	2	22	15	4	52	36	18	186	5	50	8	20	7
16	12	19	76	12	16	5	9	13	57	44	28	67	9	10	11
17	4	50	126	31	6	27	5	37	4	167	4	54	24	12	10
18	62	62	51	11	32	16	97	8	16	3	2	4	15	9	5
19	5	5	163	49	48	25	20	21	12	51	27	113	19	47	3
20	96	8	53	5	13	5	30	8	30	100	59	58	42	11	4

*Training Trial

TABLE XXVIII

TOTAL NUMBER OF REARS IN SUCCESSIVE THIRTY SECOND INTERVALS OF Ss
 RECEIVING TEN ORIGINAL TRAINING TRIALS IN A; ONE-THIRD RECEIVED
 TEN INTERPOLATED TRAINING TRIALS IN A AND WAS TESTED IN A
 (AAA); ONE-THIRD RECEIVED TEN INTERPOLATED TRAINING
 TRIALS IN B AND WAS TESTED IN A (ABA); AND ONE-
 THIRD RECEIVED TEN INTERPOLATED TRAINING
 TRIALS IN C AND WERE TESTED IN A (ACA)
 (CHAPTER IV, Sk-R I)

Min.	AAA					ABA					ACA				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
.5	2	0	2	5	0	3	1	1	3	1	4	0	5	3	4
1.0	3	3	3	5	2	2	0	5	4	0	3	1	3	4	5
1.5	3	2	5	4	2	2	1	4	4	0	4	1	6	2	0
2.0	4	3	3	5	5	0	0	7	4	0	5	1	7	6	5
2.5	2	7	1	3	5	4	2	3	3	1	8	0	3	2	3
3.0	7	6	2	2	4	4	2	7	7	0	5	3	7	6	4
3.5	3	6	2	4	6	2	3	2	5	2	3	3	8	4	4
4.0	5	9	1	3	6	2	3	9	7	2	3	2	6	2	4
4.5	2	4	5	0	2	2	1	5	5	4	14	4	1	1	4
5.0	6	2	4	2	6	4	3	4	3	2	6	3	7	0	2
5.5	6	1	4	0	15	2	4	5	7	2	0	4	6	2	5
6.0	6	2	3	1	7	3	4	4	1	5	4	7	6	3	6
6.5	2	1	1	3	5	1	2	1	4	4	4	5	2	4	4
7.0	2	2	4	4	1	3	4	6	4	3	7	3	3	5	2
7.5	6	4	3	5	2	3	4	4	5	4	2	3	4	6	0
8.0	4	1	3	2	0	4	4	2	5	1	3	3	4	4	1
8.5	7	0	1	2	1	2	3	9	5	0	3	2	2	6	0
9.0	7	1	0	5	2	1	5	5	5	2	0	3	3	6	1
9.5	4	0	2	4	2	0	0	3	4	3	0	2	6	3	2
10.0	3	0	1	2	3	0	4	2	5	5	1	2	3	2	3
Total	84	54	50	61	76	44	50	88	90	41	79	52	92	71	59

TABLE XXIX

TRAINING TRIAL LATENCIES (SEC.): THE FIRST FIVE TRAINING TRIALS
 (ALL AT TWENTY MINUTE INTERVALS) FOR ALL Ss WERE IN A; THE
 SECOND FIVE TRAINING TRIALS (6-10) OF Ss 1-5 WERE IN A;
 THE SECOND FIVE TRAINING TRIALS (Ss 6-10) WERE IN B;
 AND THE SECOND FIVE TRAINING TRIALS FOR Ss 11-15
 WERE IN C (CHAPTER IV, Sk-R II)

S	Training Trial									
	1	2	3	4	5	6	7	8	9	10
1	22	9	12	9	7	17	7	6	9	21
2	10	28	33	24	49	41	12	37	8	56
3	24	22	61	105	57	12	2	2	2	7
4	16	5	11	13	2	9	15	8	9	6
5	15	16	38	26	19	23	14	25	16	15
6	7	24	11	13	13	27	24	7	30	31
7	19	17	29	17	17	14	2	3	4	5
8	7	31	15	21	43	6	2	20	13	25
9	16	18	6	4	9	61	7	6	26	12
10	24	11	9	9	25	14	10	7	11	16
11	18	11	10	4	13	9	15	15	5	11
12	45	32	50	141	50	57	45	165	95	85
13	9	2	3	21	3	14	6	17	9	3
14	31	34	4	3	4	12	2	2	29	2
15	15	17	7	9	8	12	2	2	2	7

TABLE XXX

TOTAL NUMBER OF REARING RESPONSES IN SUCCESSIVE THIRTY SECOND INTERVALS WHERE ALL Ss HAD FIVE ORIGINAL TRAINING TRIALS IN A AT TWENTY MINUTE INTERVALS; ONE-THIRD RECEIVED FIVE INTERPOLATED TRAINING TRIALS IN A AND WAS TESTED IN A (AAA); ONE-THIRD RECEIVED FIVE INTERPOLATED TRAINING TRIALS IN B AND WAS TESTED IN A (ABA); AND ONE-THIRD RECEIVED FIVE INTERPOLATED TRAINING TRIALS IN C AND WAS TESTED IN A (ACA), CHAPTER IV, Sk-R II

Min.	AAA					ABA					ACA				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
.5	5	2	3	4	2	2	3	3	1	7	4	0	4	4	6
1.0	5	2	5	2	2	4	8	3	4	7	6	1	4	6	5
1.5	5	3	6	6	3	5	5	4	6	4	7	3	7	10	5
2.0	7	3	5	3	2	3	5	4	5	1	6	4	5	4	0
2.5	6	4	4	6	5	7	1	4	6	2	3	1	7	10	5
3.0	5	7	7	7	4	5	4	3	4	4	3	4	8	8	3
3.5	1	5	7	7	4	6	2	2	6	5	5	3	6	3	4
4.0	1	5	4	0	2	2	2	3	6	2	2	8	2	3	2
4.5	1	4	4	8	4	1	3	1	6	3	3	5	1	2	4
5.0	2	3	3	7	6	0	4	0	6	5	3	3	11	1	4
5.5	3	5	4	7	3	0	3	0	10	4	2	0	4	4	2
6.0	5	4	6	3	4	0	3	3	3	4	2	2	2	8	2
6.5	0	6	4	1	8	0	2	0	3	3	0	0	2	5	1
7.0	0	4	1	5	3	0	0	1	6	1	2	1	6	2	3
7.5	0	4	3	1	6	0	0	0	7	1	3	1	2	0	4
8.0	0	4	4	0	7	0	0	0	5	0	5	0	2	2	2
8.5	0	4	6	2	3	0	0	0	8	0	3	0	1	3	2
9.0	0	2	2	3	6	0	1	0	2	0	2	0	0	3	4
9.5	0	3	1	2	6	0	3	0	2	0	4	4	2	4	2
10.0	0	3	0	3	6	1	1	0	1	1	2	4	3	6	3
Total	46	77	79	77	86	36	50	31	97	54	67	44	79	88	63