SOME EFFECTS OF OVERLEARNING AND PREREVERSAL CUES ON REVERSAL LEARNING IN SQUIRREL MONKEYS

by

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PREFACE

It is apparent that the explanation of discrimination reversal learning in terms of an underlying relationship between resistance to extinction and amount and type of original learning depends on the isolation and specification of variables affecting this relationship. Various types of instrumental training with animals appear to offer excellent approaches to this end.

These experiments were designed and conducted to explore further the importance of two variables, overlearning and prereversal "information," to discrimination reversal learning in squirrel monkeys.

I would like to express my deep appreciation to Dr. Henry A. Cross and Dr. Larry T. Brown for their constant encouragement, suggested improvements, and valuable guidance during the entire course of this research, and to my committee members, Dr. William W. Rambo and Dr. Richard Rankin, for their constructive criticism. My special indebtedness goes to Captain James B. Carpenter, USAF, for the invaluable assistance and unstinted amount of time which he devoted during the conduction of these experiments.

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CHAPTER I

INTRODUCTION

Discrimination learning, the learning by an organism to approach consistently one stimulus complex (the "positive" stimulus) and not to approach another (the "negative" stimulus) paired with it, has been subjected to an increasing amount of investigation during the last several years (e.g., Harlow, 1959).

One controversial aspect of discrimination learning revolves about the effects of overlearning. "Overlearning" is generally used to refer to the continued presentation of reinforced trials *after* asymptotic learning has occurred. The effects of overlearning have often been studied within the context of reversal learning. In its most simple form the procedure employed in reversal training involves two stages. In the initial stage, approach responses to one of two discriminanda are reinforced while approaches to the other are not. In the second stage, generally introduced when the appropriate response has been learned or overlearned, the reward conditions are reversed and a response to the previously unreinforced cue is now reinforced and vice versa. This second stage is known as "discrimination reversal."

In a runway situation, running speed is used to measure discrimination learning and discrimination reversal learning; while in a simultaneous discrimination situation, percentage choice of the positive or rewarded stimulus is used as the measure. Findings employing one measurement can not be strictly compared with findings resulting from the use of the other, and, indeed, divergent results often occur when different measurement units are utilized (cf., Capaldi & Stevenson, 1957).

Another issue of research interest within the area of discrimination learning concerns what an animal learns during habit formation. Does it learn to approach a rewarded stimulus, avoid a nonrewarded stimulus, or some combination of the two? Moss and Harlow (1947) studied this question by presenting an object alone, either rewarded or nonrewarded, and later pairing it with a new object in a discrimination learning situation. They found optimal discrimination performance when the repeated object was the nonrewarded one. This phenomenon has since been referred to as the "Moss-Harlow effect" and has been cited to stress the possible importance of avoidance rather than approach learning.

Cross and Brown (in manuscript) have extended this single-object method by introducing rewarded or nonrewarded stimuli immediately before the second or reversal stage of discrimination reversal. The reward contingencies of these stimuli are, of course, those of the reversal phase, and, hence, opposite those of the first or discrimination learning phase. This type of presentation has been referred to as a "prereversal cue condition." Cross and Brown (in manuscript) found optimal reversal performance following the prereversal presentation of the "to-be-negative" object. These results, along with those of other investigators employing similar procedures (e.g., Fletcher & Cross, 1964; Harlow & Hicks, 1957), have provided further support for the hypothesis that animals learn to avoid the negative stimulus, rather than to approach the positive stimulus, in discrimination learning.

The following experiments were designed as a further attempt to explore the effects of both overlearning and prereversal cue conditions on reversal learning in the squirrel monkey.

CHAPTER II

EXPERIMENT 1

Statement of Problems

Overlearning

A large number of studies (Bruner, Mandler, O'Dowd & Wallach, 1958; Capaldi & Stevenson, 1957; D'Amati & Jagoda, 1960, 1961, 1962; Ison & Birch, 1961; Mackintosh, 1962, 1963a, 1963b; Pubols, 1956; Reid, 1953) have demonstrated that overlearning on discrimination problems facilitates subsequent discrimination reversal. These studies have employed diversified approaches with different animal groups and various units of measurement, for example: a T-maze with response speed as the measure of learning in rats (Birch, Ison, & Sperling, 1960); a straight runway with starting time, running time, and goal-box time as the units of measurement with rats (Wagner, 1961); a cross maze with number of successive correct reversals as the measure of learning employing rats and chickens (Brookshire, Warren & Ball, 1961); and percentage of correct responses in a Wisconsin General Test Apparatus (WGTA) using human subjects (Murillo & Capaldi, 1961). A few studies have obtained these overlearning effects but only after an initial increase in resistance to extinction during early reversal trials in animals with overlearning experience (e.g., North & Stimmel, 1960).

In contrast to these findings are those of Cross and Brown (in manuscript), Hill and Spear (1963a, 1963b), Hill, Spear, and Clayton (1962), and McCulloch and Pratt (1934) which support the hypothesis that resistance to extinction increases as a function of the degree of overlearning. Cross and Brown (in manuscript), using squirrel monkeys, measured the number of correct reversal responses in a modified WGTA; while Hill and Spear (1963b) employed rats with starting and running times as their measures in a runway situation. Hill, Spear, and Clayton (1962) reported three failures to find facilitation of reversal performance by overlearning in a T maze using a fixed number of trials both for acquisition and for reversal and measuring the proportion of correct choices during each; and McCulloch and Pratt (1934) training rats to discriminate between two weights in a special open runway situation, found that as the amount of training preceding the reversal increased resistance to extinction increased and the acquisition of a new response was retarded.

The first experiment to be reported was designed primarily with a view to verifying the results of Cross and Brown (in manuscript) with respect to their observation of increased resistance to extinction in a discrimination reversal situation following overlearning. These authors found reversal performance was poorer after eighteen than after six prereversal discrimination trials. By extending the learning problem to fifty-four trials an attempt was made to counteract the possible claims that habit formation had not taken place in six initial learning trials or that overlearning was not effected by eighteen learning trials.

Inhibition versus Excitation

The second purpose of the first experiment was to reproduce Cross and Brown's (in manuscript) findings concerning the negative reinforcement effect of nonreward.

Harlow (1957) has distinguished between uniprocess and duoprocess learning theories. Uniprocess theories postulate a single underlying physiological process, excitation or inhibition. Duoprocess theories emphasize the importance of two underlying physiological processes, both inhibition and excitation. "Excitation" is commonly used to refer to an increment in habit strength resulting from reward, and "inhibition" is used to refer to a decrement in habit strength resulting from nonreward.

Representative of the uniprocess approach are Ettlinger's (1960) insistance on the sole importance of reward to habit formation and Harlow's (e.g., 1959) view that only through nonreward can incorrect responses be eliminated, enabling the correct response to emerge.

The duoprocess theories may be subdivided into three categories: the first places equal importance on excitation and inhibition processes (Behar, 1962; Fitzwater, 1952; Zeaman & House, 1962); the second emphasizes the primary role of inhibition but does not ignore the importance of excitation (D'Amato & Jagoda, 1960, 1961, 1962; Fletcher & Cross, 1964; Warren & Kimball, 1959); and the third stresses the primary role of excitation while relegating inhibition to a secondary role (Thompson, 1954).

In the experiment of Cross and Brown (in manuscript) reversal behavior was shown to be strongly affected by the nature of the prereversal condition, since four prereversal presentations of the negative object resulted in significantly more correct responses than four prereversal presentations of the positive object. Therefore, three prereversal conditions were employed to provide a replication of the above experiment: (a) four positive single-object trials, (b) four negative single-object trials, and (c) a standard two-object reversal trial.

Method

Subjects

Eight mature, male squirrel monkeys from the Primate Laboratory of the Department of Psychology at Oklahoma State University were employed as subjects (Ss). These animals had been used in one previous experiment (Cross & Brown, in manuscript), and their selection was made on the basis of their level of performance in this study, i.e., those animals were used which had shown the greatest discrimination-learning ability. This procedure helped to insure high performance and maximal overlearning during the original learning phase of the experiment.

The Ss were housed two to a cage and had water available at all times.

Apparatus

A modified, small-scale WGTA was utilized. This was a metal box, 30 x 14 x 14 in., divided into two compartments by a series of horizontal bars. One compartment housed the S during testing; the other, the test area, was illuminated by a 25-w. light bulb and was equipped with a sliding test tray, 13½ x 9 x 3/4 in., containing three food wells.

In the end wall of the test area there was a one-way mirror with a black curtain at its base which prevented the S from observing the experimenter's (E's) movements. The food wells were located 2½ inches from the front edge of the tray and also from each other. The discrimination stimuli were pre-constructed, multidimensional laboratory "junk" objects.

Procedure

Adaptation. Since all Ss had had experience with the discrimination procedure to be employed, the Ss were handled and tested with stimulus objects for only five days prior to test commencement. A twenty-two-hour food-deprivation period was introduced before each testing period during adaptation and this schedule was maintained throughout the experiment.

Training and Testing. All eight Ss received three sequences consisting of nine problems each, the nine problems being factorial combinations of three original problem lengths (6, 18, and 54 trials) and three prereversal cue conditions (positive, negative, and standard). For the positive condition the S received four rewarded prereversal presentations of the object which had been negative during initial discrimination learning but which was to be positive during reversal learning; conversely, for the negative condition the S received four nonrewarded trials to the object which had been positive during original learning but which was to be negative during the reversal trials. In both conditions, of course, objects were presented singly and in the center food well.

The standard cue condition involved the single simultaneous presentation of both stimulus objects with the previously positive object now negative and the previously negative object now positive.

Reversal training, begun immediately following presentation of the appropriate prereversal condition, consisted of six discrimination trials in which reward contingencies were reversed from those of the initial discrimination problem.

In all cases inter-trial intervals of approximately ten seconds were maintained without interruption in progressing from original discrimination learning, through presentation of prereversal conditions, to the reversal trials. The order of presentation of the nine problems comprising each of the sequences was randomly determined. Within each of the problems the left-right position of the rewarded stimulus was randomly determined, with the exception that equal numbers of presentations to each side were provided. The same randomization procedure was followed in presenting the six reversal trials. Each S received one problem daily and the three sequences of nine problems each were presented without interruption, so that the Ss were tested for a total of twenty-seven successive days.

To insure that the effects of individual stimulus preferences were minimized, new pairs of stimulus objects were used daily and each object was randomly assigned as positive to four Ss and as negative to the remaining four Ss.

Results

Discrimination Learning

Each S received nine problems, three sequences x three prereversal conditions, under each of the three problem lengths. For purposes of data analysis, the number of correct responses during the last five trials on each of the twenty-seven problems was first determined for each animal. These data are shown in Appendix A. The median number of correct responses for the nine problems under each of the three problem lengths was then determined for each animal and the median scores were analyzed by means of an analysis of variance with repeated measures on the three problem lengths. This analysis is summarized in Table I.

A progressive improvement in discrimination performance with increasing number of original learning trials is evident ($p<.01$).

TABLE I

ANALYSIS OF VARIANCE OF MEDIAN CORRECT RESPONSES IN ORIGINAL DISCRIMINATION LEARNING IN EXPERIMENT 1

Source of Variance	*df*	SS	MS	*F*
S Subjects	7	2.13	.30	
A Trials	2	6.39	3.19	11.00*
SxA Subjects x Trials	14	4.11	.29	
Total	23	12.63		

*($p < .01$)

Learning improved from the six-trial problems to the eighteen-trial problems and from the six-trial problems to the fifty-four-trial problems (Tukey's least significant difference $p < .01$ and $p < .001$, respectively). No significant difference in learning was found between the eighteen-trial problem and the fifty-four-trial problem. These comparisons may be found in Appendix E.

Reversal Learning

The measure of reversal learning used was the number of correct responses made during the six reversal trials; these data are given in Appendix C for each animal. For purposes of data analysis, each S was assigned nine scores, one score for each factorial combination of three prereversal conditions and three initial problem lengths. Since each S received three successive sequences of nine reversal problems each, the scores were computed by totaling the number of correct responses over the three sequences for each of the nine problems. These data were analyzed by means of an analysis of variance with the scores arranged in a three x three factorial design with repeated measures on both factors. A summary of the analysis is presented in Table II.

It can be seen that reversal performance (a) declined with increasing initial problem length ($p < .001$) and (b) showed maximum facilitation following the negative prereversal condition ($p < .001$). Multiple comparisons showed better performance following the six-trial problems than either the eighteen-trial problems ($p < .01$) or the fifty-four-trial problems ($p < .001$). Moreover, more correct reversal responses occurred following the eighteen-trial problems than following the fifty-four-trial problems ($p < .05$).

TABLE II

ANALYSIS OF VARIANCE OF CORRECT RESPONSES IN
DISCRIMINATION REVERSAL LEARNING
IN EXPERIMENT 1

Source of Variance	df	SS	MS	F
S Subjects	7	124.00	17.71	
A Conditions	2	225.08	112.54	42.63*
B Trials	2	209.25	104.62	20.12*
SxA Subjects x Conditions	14	36.92	2.64	
SxB Subjects x Trials	14	72.75	5.20	
AxB Conditions x Trials	4	13.17	3.29	.72
SxAxB Subjects x Conditions x Trials	28	128.83	4.60	
Total	71	810.00		

*($p < .001$)

Multiple comparisons also revealed better performance following the negative prereversal conditions than following either the positive prereversal condition ($p<.001$) or the standard prereversal condition ($p<.001$). Performance following the positive prereversal condition did not differ significantly from performance following the standard prereversal condition. All of these comparisons are summarized in Appendix F.

Figure 1 shows percent correct reversal responses as a function of both initial discrimination-problem length and prereversal condition.

Discussion

Performance during intial discrimination learning strongly suggests that overlearning occurred, although no experimental criterion was employed in its establishment. Performance during the last five trials improved from the six-trial problems to the eighteen-trial problems but showed no further improvement in the fifty-four-trial problem. This would indicate that eighteen trials were probably sufficient to establish asymptotic performance so that the thirty-six additional trials in the fifty-four trial problems may be regarded as "overlearning" trials. Reese (1964) places the beginning of overlearning, in terms of number of trials, in monkeys on single, two-stimulus problems at "some number greater than twelve and less than fifty" (p. 335).

The results of this experiment support the findings of Cross and Brown (in manuscript); Hill, Spear, and Clayton (1962); Hill and Spear (1963a); and McCulloch and Pratt (1934) that overlearning on a simultaneous discrimination problem increases resistance to extinction.

If overlearning facilitates reversal by decreasing the number of trials required for extinction of the original habit (Birch, Ison, & Sperling, 1960; Capaldi & Stevenson, 1957), there should be no objection

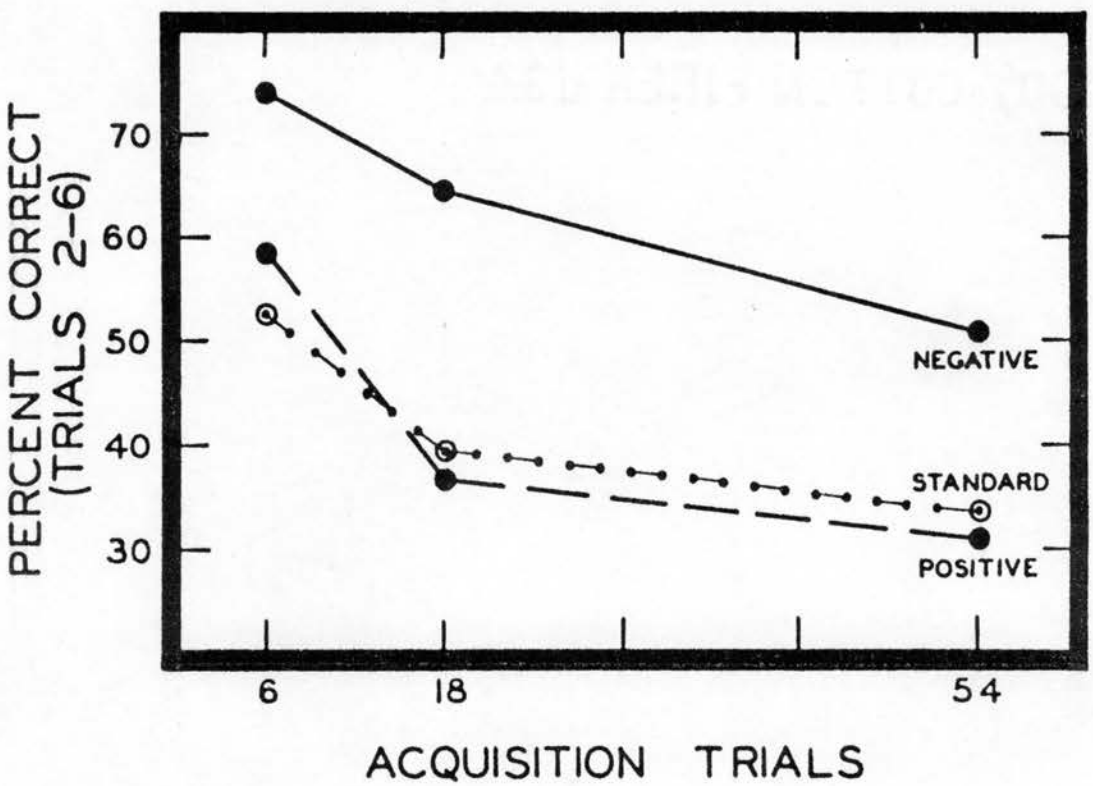

Figure 1

Percent Correct Reversal Responses as a Function of Prereversal Cue Condition and Original Problem Length to the use of a limited number of reversal trials. However, if overlearning facilitates reversal only after a period early in reversal training during which extinction is retarded (Mackintosh, 1962, 1963a, 1963b), it can be argued that a greater number of reversal trials should have been employed.

In the three experiments of Hill, Spear, and Clayton (1962), in which a fixed number of trials was also used for reversal, a failure of overlearning to facilitate reversal was likewise observed. In order to make their experimental procedure more comparable to that of other workers, Hill and Spear (1963a) introduced a reversal criterion. They found essentially the same phenomenon as before: increased resistance to extinction as a function of overlearning. Thus, either type of reversal procedure, a fixed number of trials or a reversal criterion, was found to produce results in line with those of the present study.

The findings that prereversal exposure to a single negative object facilitates reversal learning to a greater degree than does either pre-exposure to (a) a positive object or (b) a standard reversal trial reinforces the results of Cross and Brown (in manuscript), and, hence, provides further support for the hypothesis that avoidance learning plays a major role in discrimination learning (e.g., D'Amato & Lagoda, 1960, 1961, 1962; Fletcher & Cross, 1964; Warren & Kimball, 1959). Since reversal performance following presentation of the positive object was no worse than performance following presentation of a standard reversal trial, some approach learning may have occurred. Such a conclusion depends, of course, on the assumption that the prereversal presentation of a standard reversal trial has some facilitative effect on reversal performance. Only the introduction into the design of the present experiment of a control condition involving no prereversal "information" would have provided data relevant to this assumption.

In light of the results supporting the hypothesis that overlearning increases resistance to extinction, a second experiment was carried out with the view of investigating further the effects of overlearning on discrimination reversal. It was thought desirable (a) to extend the range of initial discrimination-problem length, and (b) to introduce an arbitrary criterion of reversal learning. The latter was introduced both to answer criticisms that more than six trials are necessary for the so-called "overlearning effect" to appear and to demonstrate the squirrel monkey's ability to achieve criterial reversal learning.

CHAPTER III

EXPERIMENT 2

Method

Subjects

The same eight animals that were used in Experiment 1 served as Ss in this study.

Apparatus

The apparatus was the WGTA described in Experiment 1. New stimulus objects were used, but all other aspects of the apparatus were identical to those of Experiment 1.

Procedure

Each S received six sequences which consisted of four problems each. Each of the four problems was composed of ten, twenty, forty, or eighty original learning trials followed by discrimination reversal training carried to criterion. The criterion of reversal learning was arbitrarily set at eight correct responses out of ten successive trials with the last six responses all correct.

A single problem of ten, twenty, forty, or eighty learning trials was given each S each day for four days, these four problems constituting one sequence. The experiment consisted of six sequences, each commencing the day following the last day of the preceding sequence with the exception of a three-day period between sequences three and four in which no problems were given.

With one exception, randomization procedures involving problem order and spatial position of the positive or rewarded stimulus were identical with those described in Experiment 1. Since the number of trials needed to achieve the defined criterion of learning was expected to be highly variable, the left or right stimulus position was randomly determined for blocks of twenty trials with equalization of left and right placement being assured within each block. This procedure guaranteed approximate equality of left and right positive-stimulus positioning during reversal learning.

Results

Discrimination Learning

Each S received six problems under each of the four problem lengths. For purposes of statistical comparison the number of correct responses during the last nine trials on each of the twenty-four problems was first determined for each animal. These data are given in Appendix B. The median number of correct responses for the six problems under each of the four problem lengths was then determined for each animal and the median scores were analyzed by means of an analysis of variance with repeated measures on the four problem lengths. The analysis is summarized in Table III.

It can be seen that learning improved as problem length increased ($p<.01$). Multiple comparisons (Tukey's least significant difference) revealed that learning improved (a) from the ten-trial problems to the twenty, forty, and eighty- trial problems ($p<.001$), and (b) from the

TABLE III

ANALYSIS OF VARIANCE OF MEDIAN CORRECT RESPONSES IN IN ORIGINAL DISCRIMINATION LEARNING IN EXPERIMENT 2

Source of Variance	df	SS	MS	F
S Subjects	7	1.97	.28	
A Trials	3	8.59	2.86	5.96*
SxA Subjects x Trials	21	10.00	.48	
Total	31	20.56		

*($p < .01$)

twenty-trial problems to the eighty-trial problems ($p < .05$). No further significant differences were obtained. A summary of these comparisons may be found in Appendix G.

Reversal Learning

The number of correct reversal responses to criterion are given in Appendix D for each of the eight Ss on each of the twenty-four problems (four problem lengths x six sequences). For each of the four problem lengths the median number of correct responses to criterion for the six repetitions was determined for each S. These median scores were analyzed by means of a one-way analysis of variance with repeated measures on the four initial problem lengths (See Table IV).

The analysis revealed no significant effect of original problem length on trials to criterion in reversal learning. It should be remembered, however, that precisely the same trend was observed as in Experiment 1 and in the study by Cross and Brown (in manuscript), i.e., as initial problem length increased reversal performance tended to decline.

Discussion

The fact that overlearning occurred is suggested by the outcome of tests comparing performance on the initial discrimination problems: learning appears to have reached an asymptotic level after about forty trials, since no difference was observed between performance on the forty-trial and eighty-trial problems (91% and 94%, respectively, on last nine trials); therefore, the eighty-trial problems probably afforded at least forty "overlearning" trials.

TABLE IV

ANALYSIS OF VARIANCE OF MEDIAN CORRECT RESPONSES IN DISCRIMINATION REVERSAL LEARNING IN EXPERIMENT 2

Source of Variance	*df*	SS	MS	*F*
S Subjects	7	706.06	100.87	
A Trials	3	140.12	46.71	3.11
SxA Subjects x Trials	21	314.93	14.996	
Total	31	1161.11		

Although no significant effect of original problem length on reversal learning was observed, the means were all in the direction predicted by Experiment 1 and by the experiment of Cross and Brown (in manuscript). These results may therefore be taken as affording tentative support for the hypothesis that overlearning retards extinction of responses under conditions of reversal learning. At any rate, the data certainly offer no support for the frequently reported "overlearning effect." Moreover, the use of criterion in establishing reversal learning tends to counteract criticism that the "overlearning effect" had not had a sufficient number of trials within which to appear.

While certainly not conclusive, these findings do support Harris and Nygaard (1961) in their suggestion than an increasing, negatively accelerated relationship exists between number of reinforcements and responses to extinction. While several workers have provided evidence for a nonmonotonic relationship (e.g., North & Stimmel, 1960; Murillo & Capaldi, 1961) their results have not been unambiguous or else only two or three acquisition levels have been employed within any one experimental design. By using five learning levels, Hill and Spear (1963b) attempted to meet the latter criticism and, as was true of the present experiment which employed four levels of learning, no evidence for a nonmonotonic function was obtained.

CHAPTER IV

SUMMARY AND CONCLUSIONS

Two experiments were designed to verify the results of a previous study in which it was found that (a) overlearning increases resistance to extinction, and (b) monkeys learn primarily to discriminate stimulus objects by acquiring avoidance tendencies to the nonrewarded objects.

In Experiment 1 eight squirrel monkeys were first trained on discrimination problems of three different lengths (6, 18, or 54 trials) in a Wisconsin General Testing Apparatus (WGTA). Following initial discrimination training the subjects were exposed to one of three "prereversal cue conditions" (negative, positive, or standard) in which reward contingencies were reversed from those employed in discrimination training. Immediately following exposure to a prereversal cue condition six discrimination reversal trials were administered. Each monkey received a total of twenty-seven problems, each problem consisting of (a) a discrimination problem, (b) a prereversal cue condition, and (c) six discrimination reversal trials.

In Experiment 2 the eight monkeys were trained on a total of twenty-four problems each, a problem consisting of (a) discrimination training varying in number of trials presented (10, 20, 40, or 80 trials), and (b) discrimination reversal training carried to an arbitrarily established criterion.

The results of Experiment 1 offer strong support for the hypothesis that resistance to extinction is an increasing monotonic function of degree of original learning, since reversal performance declined as original problem length increased. The results of Experiment 2 were in the predicted direction but failed to reach significance; therefore, they may be interpreted as affording only tentative support to the hypothesis.

Further, reversal performance in Experiment 1 was better following the presentation of a negative prereversal cue condition than following either the positive or standard prereversal cue conditions. These results support those of a previous study employing squirrel monkeys, and, therefore, may be interpreted as lending additional support to the hypothesis that avoidance learning rather than approach learning plays the major role in the discrimination learning of monkeys.

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APPENDIX A

CORRECT RESPONSES ON DISCRIMINATION LEARNING ON THE LAST FIVE TRIALS IN EXPERIMENT 1

ORIGINAL PROBLEM LENGTH

6 Trials

Subjects	S_1			S_2			S_3		
1	3	4	4	0	4	2	3	2	3
2	3	5	2	4	4	4	5	4	4
3	3	4	2	5	4	5	5	4	4
4	3	2	2	4	3	5	1	2	5
5	2	5	4	5	4	2	4	2	3
6	4	4	2	2	2	2	5	3	2
7	0	3	3	2	3	3	2	2	5
8	3	5	5	5	4	3	4	5	2
Σ	21	32	24	27	28	26	29	24	28

18 Trials

Subjects	S_1			S_2			S_3		
1	1	2	4	4	2	5	4	4	4
2	5	5	5	4	3	4	5	5	5
3	3	4	5	5	5	5	4	5	5
4	4	3	4	4	2	2	3	3	3
5	5	5	4	5	4	3	4	5	5
6	5	5	5	4	5	4	5	4	4
7	3	3	5	3	4	5	5	5	5
8	5	5	5	5	5	5	5	4	4
Σ	31	32	37	34	30	33	35	35	35

54 Trials

Subjects	S_1			S_2			S_3		
1	3	3	5	5	5	5	5	5	4
2	5	3	5	5	5	4	5	4	4
3	4	5	4	5	4	3	4	5	5
4	4	5	4	4	5	5	5	5	4
5	5	4	5	5	4	4	5	5	5
6	5	4	3	5	3	5	5	5	5
7	5	5	4	5	5	5	4	5	5
8	5	5	4	4	5	5	5	5	5
Σ	36	34	34	38	36	36	38	39	37

APPENDIX B

CORRECT RESPONSES ON DISCRIMINATION LEARNING ON THE LAST NINE TRIALS IN EXPERIMENT 2

Subjects	ORIGINAL PROBLEM LENGTH																							
	10 Trials						20 Trials						40 Trials						80 Trials					
	S_1	S_2	S_3	S_4	S_5	S_6	S_1	S_2	S_3	S_4	S_5	S_6	S_1	S_2	S_3	S_4	S_5	S_6	S_1	S_2	S_3	S_4	S_5	S_6
1	7	7	6	4	8	6	9	9	8	9	8	8	9	6	9	9	9	9	8	8	9	9	9	7
2	7	8	6	6	3	7	9	8	7	9	9	7	7	9	8	9	9	7	9	9	9	9	9	7
3	6	7	8	7	6	7	9	9	9	8	5	9	9	9	9	9	9	6	8	9	7	8	7	7
4	7	9	6	5	9	5	9	8	9	8	9	9	8	8	8	7	9	9	9	9	9	9	9	5
5	9	7	6	9	9	4	9	6	7	9	7	9	9	9	9	8	9	9	7	9	9	9	9	9
6	8	9	9	5	8	9	9	8	9	6	9	7	7	5	7	9	7	9	9	9	8	9	8	9
7	6	9	9	8	6	9	9	7	9	7	9	8	9	9	7	8	8	9	9	9	9	8	9	9
8	8	7	8	7	6	5	8	6	9	5	6	9	8	8	8	9	7	8	9	7	9	8	9	9
Σ	58	63	58	51	55	52	71	61	67	61	62	66	66	63	65	68	67	66	68	69	69	69	69	62

APPENDIX C

CORRECT RESPONSES ON REVERSAL LEARNING DURING SIX REVERSAL TRIALS IN EXPERIMENT 1

Prereversal Condition	ORIGINAL PROBLEM LENGTH								
	6 Trial			18 Trial			54 Trial		
	S_1	S_2	S_3	S_1	S_2	S_3	S_1	S_2	S_3
Negative	5	5	2	3	6	2	2	4	3
	3	6	5	4	2	0	2	3	3
	5	1	6	4	3	5	3	4	4
	3	5	6	3	3	2	1	2	3
	6	5	4	3	6	6	2	4	4
	6	6	3	5	6	5	5	3	3
	6	6	4	5	5	4	2	3	2
	1	3	4	3	4	4	3	4	4
Standard	4	5	3	4	2	2	2	1	2
	2	5	1	4	3	0	0	1	3
	4	3	2	0	2	2	0	1	1
	4	2	2	1	4	0	2	3	1
	5	4	4	5	3	1	3	1	4
	3	3	5	4	1	3	4	1	4
	5	2	1	2	4	4	4	0	4
	2	1	4	3	0	3	2	1	3
Positive	3	2	5	1	2	2	3	1	2
	2	5	1	2	0	3	3	4	0
	1	2	3	0	1	3	2	3	2
	4	3	6	1	3	1	1	2	2
	5	1	5	2	5	2	2	3	1
	5	5	5	4	2	2	1	2	0
	4	5	4	3	3	2	2	1	3
	3	2	3	4	5	0	2	3	1
Σ	91	87	88	70	75	58	53	55	59

APPENDIX D

CORRECT RESPONSES ON REVERSAL LEARNING TO CRITERION IN EXPERIMENT 2

Subjects	ORIGINAL PROBLEM LENGTH																							
	10 Trials						20 Trials						40 Trials						80 Trials					
	S_1	S_2	S_3	S_4	S_5	S_6	S_1	S_2	S_3	S_4	S_5	S_6	S_1	S_2	S_3	S_4	S_5	S_6	S_1	S_2	S_3	S_4	S_5	S_6
1	11	10	11	10	15	15	23	9	14	18	9	14	18	20	21	14	14	9	19	31	12	17	23	22
2	13	20	16	17	14	9	11	15	14	12	13	13	37	26	23	19	9	13	11	31	20	12	23	25
3	18	43	15	24	21	20	45	36	13	25	23	18	52	43	34	33	37	23	45	47	38	39	32	40
4	20	29	13	29	32	25	20	56	11	40	24	23	18	40	20	29	38	11	10	31	24	10	35	28
5	17	14	11	10	9	9	10	17	13	45	19	13	19	22	11	15	20	20	25	14	34	21	22	18
6	18	22	22	15	20	49	19	14	34	22	33	12	19	16	13	30	20	18	17	10	32	32	15	22
7	23	41	33	15	22	13	21	26	17	19	18	19	20	39	20	20	20	28	21	25	18	18	20	14
8	10	15	42	15	9	21	10	17	20	15	21	19	25	13	22	8	32	15	12	22	24	13	15	13
$\sum$	130	194	163	135	142	161	159	190	136	196	160	131	208	219	164	168	190	137	160	211	202	162	185	182

APPENDIX E

DISCRIMINATION LEARNING IN EXPERIMENT 1

		3.48	4.39
Treat 3	4.69	1.210**	.300
2	4.39	.910*	--
1	3.48	--	--

**($\underline{p}$ <.001), $LSD_{.001}$ = 1.031

*($\underline{p}$ <.01), $LSD_{.01}$ = .764

APPENDIX F

REVERSAL LEARNING IN EXPERIMENT 1

TRIALS

		6.958	8.458
Treat 1	11.083	4.125***	2.625**
2	8.458	1.500*	--
3	6.958	--	--

***(p <.001), $LSD_{.001}$ = 2.267
**(p <.01), $LSD_{.01}$ = 1.746
*(p <.05), $LSD_{.05}$ = 1.314

CONDITIONS

		7.542	7.625
Treat 1	11.333	3.791*	3.708*
3	7.625	.083	--
2	7.542	--	--

*(p <.001), $LSD_{.001}$ = 1.616

APPENDIX G

DISCRIMINATION LEARNING IN EXPERIMENT 2

		7.29	8.31	8.40
Treat 4	8.64	1.35**	.33*	.24
3	8.40	1.11**	.09	--
2	8.31	1.02**	--	--
1	7.29	--	--	--

**($p < .001$), $LSD_{.001} = .441$

*($p < .05$), $LSD_{.05} = .246$

VITA

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Candidate for the Degree of

Master of Science

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