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An Experimental Analysis of the Reinforcement Process

Raymond Robert Shrader
University of Tennessee - Knoxville

To the Graduate Council:

I am submitting herewith a thesis written by Raymond Robert Shrader entitled "An Experimental Analysis of the Reinforcement Process." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Psychology.

W. O. Jenkins, Major Professor

We have read this thesis and recommend its acceptance:

E. Ohmer Milton, Willis Moore

Accepted for the Council:
Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

August 10, 1953

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Dean of the Graduate School

AN EXPERIMENTAL ANALYSIS OF THE REINFORCEMENT PROCESS

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

Raymond Robert Shrader

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CHAPTER I

INTRODUCTION

Theoretical Background

The reinforcement process as it applies to learning theory has been the subject of an increasing amount of attention in recent years. This attention is reflected in the controversial question of whether or not reinforcement is a necessary condition for learning and it is reflected even more so, for those who adopt an affirmative position on the question, in their attempt to demonstrate the relationship between reinforcement and learning. Whatever the bias of the theorist there has been an overall concern with making more explicit the reinforcement process. With regard to this latter problem we find several points of view as to the nature of reinforcement.

Thorndike (21) made reinforcement synonymous with the "law of effect." The law of effect states essentially that if a satisfying state of affairs follows a response to a stimulus there is a strengthening of the connection between the stimulus and response. A satisfying state of affairs was defined operationally as one in which the animal did nothing to avoid, often doing things to maintain it. A novel elaboration of the "law of effect" proposed by Thorndike was the "spread of effect." Thorndike stated that the action on a rewarded response "spread" to adjacent stimulus-response connections in such a way that non-reinforced connections adjacent to a reinforced connection would be learned with increasing effectiveness the closer they were to the reinforced stimulus response

bond. A more sophisticated treatment of "effect" was made by Hull (5) in his formulation of reinforcement. Tissue need-reduction, or drive reduction was substituted for a "satisfying state of affairs." Miller (12), one of Hull's pupils, defined drive reduction in terms of a decrease in strong stimulation. On a different level of analysis Wolpe (23) posited a neurophysiological mechanism; Skinner (20) defined reinforcement operationally in terms of the presentation of a certain kind of stimulus in a temporal relation with either a stimulus or a response—the reinforcing stimulus being defined by its power to produce the resulting change. For those who espouse association by contiguity as a necessary and sufficient condition for learning, reinforcement becomes simply one of the conditions of learning. Guthrie (3), the leading advocate of this latter position, maintains that a reinforcing stimulus acts to strengthen behavior by changing the situation so that previously developed associations between the stimuli and the response remain unaffected. Reinforcement here may be defined as the presentation of stimuli that take the organism out of the situation by changing its behavior.

In addition to those theories which adopt a single principle, i.e., drive-reduction, or contiguity, to explain learning, some theorists, Skinner (20) and Mowrer (14), attempt to bridge the gap by advocating dualistic principles (drive reduction for one type of learning, contiguity for another) while Tolman (22) puts forth a pluralistic theory.

It would seem that in order to be parsimonious a theory should be as general as possible, yet at the same time one that does not do violence to the empirical facts of learning and furthermore one that is amenable to

experimental testing. In line with this reasoning there are psychologists today who believe that dualistic theories are not warranted, that is, that single principle theories can adequately handle that class of behavior called learned. However, even though there is agreement on this latter point, there still remains the question of selection of one or another single-principle theory. When drive reduction theory and contiguity theory are examined with regard parsimony in relation to reinforcement, it can readily be seen that reinforcement from the drive reduction point of view differs from reinforcement from the contiguity point of view in that drive reduction might be a special case of reinforcement by contiguity by removing the organism from the situation. On the other hand it is difficult to see how stimuli that remove an organism from the situation could per se be interpreted as drive reducing since obviously stimuli that remove the organism from the situation by changing its behavior may do so either by way of increment or decrement in total stimulation. It logically follows then that if a test situation can be designed in which behavior is changed without drive reduction, or behavior is changed with drive increment (increased stimulation), and this is accompanied by learning, that such learning will constitute strong evidence in favor of the contiguity viewpoint and strong evidence against the drive reduction position.

Statement of Problem and Related Background Material

This paper will deal primarily with an attempt to present experimental evidence of the second variety mentioned above, that is, to

demonstrate learning in the presence of increased stimulation while ruling out the possibility of drive reduction.

Previous studies directly relevant to the experimental investigations reported herein have been conducted by Sheffield et. al. (19), Jenkins and Brush (7), Horowitz (4), Ligon (7), and Jenkins and Cunningham (9).

Sheffield (19) demonstrated that mature male rats, reared from infancy segregated from females, would learn to run to a female in heat when they were permitted to mount and effect intromission without ejaculation. The reinforcement here is clearly one of drive increment and at the very least it is not drive reducing. Sheffield concludes that these findings are in conflict with drive-reduction theory while lending support to contiguity theory.

Jenkins and Brush (7) conditioned a group of pigeons at eighty per cent satiated body weight in a modified Skinner box on a twelve minute APR (a periodic reinforcement) schedule until their pecking behavior stabilized; the birds were then assigned to one of three groups: one experimental and two control. The experimental birds were extinguished by having a flash of light substituted for food on a twelve minute APR schedule, that is, the experimental birds received increased stimulation during extinction. The control birds were extinguished under normal control conditions. Jenkins and Brush reported a significant difference in responding between the experimental and control birds at the one per cent point in favor of the experimental birds. The results of this experiment are in line with Sheffield's findings of superior performance with increased stimulation.

Furthermore it was reported that the superiority of the light-up group was greater in the second half of extinction. The explanation for this was that the effects of generalization decrement were most pronounced early in extinction and maintained less of an effect late in extinction permitting the reinforcing effect of light-up to strengthen behavior.

Generalization decrement was hypothesized to account for the differential responding of the experimental birds early and late in extinction because the cue situation, previously associated with pecking, was changed much more radically for the experimental birds by the introduction of light-up than for the control birds. The phenomenon of generalization decrement is such that the more a situation associated with a response is changed on a subsequent occasion the less the probability that the response will occur. It is significant that the light-up birds were superior to the control birds throughout extinction despite generalization decrement.

In another experiment Horowitz (4), using pigeons at 100 per cent satiated body weight, exposed the pigeons to three conditions in a Skinner apparatus. One group had the cue of the food magazine turning following pecking at an illuminated window; one group had the magazine turn and were exposed to the sight of food in the magazine following pecking; and one group, the control group, was exposed to neither the magazine turning nor the sight of food. An analysis of Horowitz's results by Jenkins (7) shows that the noise plus sight-of-food-group, and the noise-group, as compared to the control group were both superior in terms of increased responding from the first to the last hour of responding, with a non-parametric analysis

of variance yielding a F-value of less than .01. The sight-of-food-noise-group was slightly superior to the noice-group indicating that a two cue change was superior to a one cue change in terms of reinforcement.

Jenkins (7) reports a reanalysis of some of Ligon's (11) data from a study in which rats ran a maze to different incentives. The analysis pertinent to the present problem involved several groups of rats at different levels of food deprivation. In one experiment two groups of rats, with twenty-one hours of food deprivation, were placed in the maze. The goal box incentive for one group was the sound of a buzzer; the other group received food in the goal box. The buzz-only group ran faster than the food-only group in the first ten trials. The speed of both groups was about the same for the next five trials and the food group was superior for the remaining ten trials. For groups with six and twelve hours food deprivation, the buzz-only group was superior for all but the first of the initial fifteen trials, while the food-only group was superior in the last ten trials. This indicates that at least initially increased stimulation associated with an irrelevant drive, was superior to a reward associated with a relevant drive. Such evidence is difficult for a drive reduction theory to explain but is in no wise contradictory to a contiguity point of view.

Other evidence having an indirect bearing on the implications of increased stimulation as reinforcement but a direct bearing on contiguity reinforcement versus drive reduction is that reported by Sheffield and Jenkins (18) and Jenkins and Cunningham (9) on the 'spread of effect.'

Jenkins and Cunningham stated:

> In brief, the 'spread of effect' is typified by a bi-directional gradient of repetitions of incorrect responses neighboring correct or rewarded responses where Ss are instructed to guess a number to each of a series of individually presented word-stimuli. As orginally described by Thorndike, the frequency of repetition of the non-rewarded responses decreases with increasing remoteness of the errors from the rewarded response in both a preceding and following direction. Thorndike interpreted the gradient as the 'spread' of the action of reward from the reinforced connection to adjacent stimulus-response bonds, and bonds, and presented the findings as proof of the automatic effects of reward.

They then pointed out that the "spread of effect" phenomena can be explained more parsimoniously by the guessing sequence hypothesis previously proposed by Jenkins and Sheffield (10). According to this hypothesis a subject tends to guess numbers in a predictable sequence. For example, a subject may consistently guess seven after having said six. Therefore if a number such as six is the constant response to a certain word, the next time through the list of words, the succeeding number, seven, is likely to be repeated because of the predisposition to repeat seven after six. Since in the typical 'spread of effect' experiment the correct responses tend to be learned and repeated, the same sequence of numbers is likely to be given following a correct number. That is, the subject mentioned above may have learned to say six to the word "dog" and the guessing sequence hypothesis would predict that he would say seven to the next word in the list even though such a response was not reinforced.

The gradient of the 'spread of effect' was accounted for by assuming that the guessing tendency will decrease with increasing remoteness from the rewarded response because of such interfering effects as additional rewarded responses.

Jenkins and Cunningham found that when the typical and well known 'spread of effect' experimental design was changed by systematically varying the order of presentation of the stimulus words in the typical word-number situation the 'after' gradient could be predicted from the number guessing hypothesis while the evidence did not indicate gradient effects according to Thorndike's hypothesis. Furthermore, in a second experiment they found that when subjects were instructed to write numbers at random an analysis of the data revealed that a strong tendency appeared for subjects to respond sequentially. More than two-thirds of the responses fell within plus or minus two units of the preceding number.

This experiment demonstrates that the well-known spread of reward of 'effect' explanation for the empirical phenomenon of 'spread of effect' can be more adequately explained from the contiguity position than from the effect position. The contiguity explanation is that subjects have well established guessing sequence habits which show up when certain numbers are anchored in relation to certain words in a classical 'spread of effect' experimental design.

The results of these experiments can be summarized in several generalizations pertinent to reinforcement and learning theory.

First: a cue change which changes the organism's behavior following a response may be of an increased stimulation variety and yet demonstrate reinforcing qualities by strengthening the response.

Second: cue changes affecting two sensory modalities simultaneously may be more effective than a cue change affecting one sensory modality.

The two cue change may be more effective because of the increased removal from the situation by the increased behavior change.

Third: reinforcement by way of increased stimulation may retard the extinction of a conditioned response.

Fourth: in a situation where responses have been associated in a sequential manner prior to testing and where one member of a series is repeated this repetition structures the situation for the action of association without drive reduction or reward.

Statement of Hypotheses

The designs of the experiments to follow were based on the above generalizations. The specific hypotheses tested were:

1. a) During extinction the strength of behavior will be maintained by a cue change associated with increased stimulation.

1. b) The effects of a cue change associated with increased stimulation in the extinction of a laboratory induced behavior will be greater in the second half of extinction because of the differential effect of generalization decrement.

2. Operant level responding under conditions of reinforcement, associated with increased stimulation will be greater than operant level responding without increased stimulation.

3. a) The gradient of repetition following rewarded repeated numbers will be steeper than the gradient following chance repeated numbers.

3. b) The level of repetition will be lower following rewarded repeated numbers than under guessing conditions.

3. c) There will be no gradient following rewarded non-repeated numbers.

Evidence in favor of hypotheses 1. a), 2, and 3. a), b), c) will constitute positive evidence in favor of contiguity theory and negative evidence for drive reduction theory.

Evidence in favor of hypothesis 1. b) while constituting evidence in favor of contiguity theory does not directly test drive reduction theory.

CHAPTER II

THE EXPERIMENTS

The First Light-Up Experiment

Problem

In the first experiment the problem consisted of a comparison of pecking behavior of two groups of pigeons during extinction. The experimental group received increased stimulation (light-up) during extinction, while the control group did not.

Subjects

Seven mature pigeons were used.[1] The birds had no previous laboratory history which in any known way would affect the results of the experiment.

Apparatus

The apparatus, originally developed by Skinner and modified by Jenkins (8), consisted of four semi-sound proof boxes, each divided by a partition into two compartments. The compartment in which the animal was placed was bare except for a celluloid pecking window at head height

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[1] Originally it was intended that eight birds be used but one bird had a history of erratic pecking behavior in the latter part of the stabilization period, and also in the first few hours of extinction. Since its behavior (a sharp decrease in pecking responses) could not be related to the conditions of treatment, that is, the behavior was not predictable from a knowledge of pigeons in like situations, it was discarded.

located in the dividing partition, and a food port, located on a shelf below the window, through which the animal could be given food. The animal compartment was lighted indirectly from a seven and one-half watt source of light in the other compartment. The second compartment contained the mechanism for presenting food to the animal, and a projector which was focused so that a 150 watt beam of light could be projected through the pecking window into the animal compartment. A switch in the recording room was wired to the projector so that the experimenter could operate the projector manually. The mechanisms in the boxes were electrically wired so that each pecking response on the window was recorded automatically on a counter and on an ink recorder in a recording room adjacent to the laboratory. The food mechanism could be set so that the bird would automatically receive food following each peck or burst of pecks on the pecking window. This procedure is known as 100 per cent reinforcement, hereinafter called 100 per cent R. The food mechanism could also be set so that the pigeons would receive food randomly but on the average of every three minutes for pecking, or randomly but on the average of every six minutes. These procedures will be known as three minute APR and six minute APR, respectively. Finally, the food magazine could be disconnected so that the bird would receive no food. This latter was the procedure used under normal extinction conditions.

Procedure

The birds were starved over a period of two weeks to about eighty per cent of their satiated body weight. They were then conditioned on a six minute APR schedule one-half hour per day for thirty-five days until

their behavior stabilized, that is, until the amount of variation in number of responses for each subject from day to day over a five day period was slight. The birds were then divided into two groups of three controls and four experimentals each. The groups were matched on the basis of their records during the stabilization period. The birds were then put on a one hour a day conditioning schedule for an additional eight hours.[2]

The birds were maintained at eighty per cent satiated body weight and extinguished at the rate of two hours a day for twelve days. During extinction the experimental pigeons were put on a three minute APR light-up, that is, the projector would be activated and the light flashed through the pecking window at the same frequency, for the same length of time, and in the same random order that had been previously associated with food. This was done manually by the experimenter. It might be said that the light was substituted for food. The control group received normal extinction treatment.

The Second Light-Up Experiment

Problem

The problem in the second light-up was to compare the pecking behavior of three groups of pigeons receiving three different treatments

[2] Since the birds were to be extinguished in two hour sessions, the one hour treatment was introduced here to lessen the effects of generalization decrement by way of change in schedule from conditioning to extinction.

with regard to increased stimulation during extinction, following conditioning.

Subjects

Twelve mature pigeons were used.[3] The birds had a previous laboratory history of APR conditioning and extinction but no "increased stimulation" history.

Apparatus

The apparatus used in the previous study was modified by tying the electrical circuit of the projector into the food magazine circuit so that a flash of light on the pecking window could be substituted for food in the food port. The only difference between the first experiment and the second one in terms of activating the light circuit was that in the second experiment the light flashed on automatically when the bird pecked, while in the first experiment the light was turned on manually by the experimenter. An additional source of increased stimulation was introduced in this experiment by keeping the food magazine mechanism in the circuit during extinction. The increased stimulation came by way of the sound of the magazine turning. This condition was held constant for all three groups of subjects. The birds were prevented from getting food by covering the food port with black tape.

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[3] Sixteen birds were originally used, however four of them failed to meet the criterion of conditioning and were discarded prior to light-up.

Procedure

The pigeons were starved over a period of two weeks to approximately eighty per cent satiated body weight. They were then conditioned at the rate of twenty-five reinforcements per day for eleven days on a 100 per cent reinforcement schedule. Following conditioning each bird was randomly assigned to one of three groups: a three minute APR group, a 100 per cent R group, and a control group.

The birds were then subjected to extinction procedures. The order of extinction for each bird was determined by random selection procedures so that for each extinction session there would be one bird from each of two groups and two birds from the third group. Each bird was extinguished in a single three hour period.

The three minute APR group was extinguished by having the light flash substituted for food on a three minute APR schedule. The 100 per cent R group had the light substituted for food on a 100 per cent schedule. The control group was extinguished under normal extinction conditions.

The Third Light-Up Experiment

Problem

The problem in the third light-up was to compare the operant level of pecking of three groups of pigeons subjected to different cue changes following window pecking.

Subjects

Twenty-four mature pigeons were used. The birds had no previous laboratory history.

Apparatus

The apparatus was the same as in the previous study.

Procedure

One group of birds was starved to approximately eighty per cent satiated body weight. The other group of twelve birds was kept at normal body weight. In all other respects the two groups of twelve birds each were treated identically. Each group was further divided into three groups of four each.

Group one, hereinafter known as the L/N group, had the light flash plus the sound of the food magazine operating for each peck or burst of pecks at the pecking window. Group two, hereinafter known as the L group, had the same treatment as the L/N group without the magazine noise. Group three, the control group, was extinguished under normal extinction conditions.

The Spread of Effect Experiment

Problem

The problem was to compare the rate of number repetition on the after-gradient following repetition at reward points, and non-repetition at reward points when subjects were instructed to learn rewarded repetitions;

further, to compare both of the above after-gradients with the after-gradient following chance repeated numbers without reward.

Subjects

The subjects were eighteen unselected students from an elementary class in psychology.

Apparatus

A series of twenty-one four by six inch white flash cards were used. A three letter word having no immediately discernible relationship to a number, such as, "leg —— two", was printed on each card in large black letters. A list of the words is given in Table XI in the appendix.

Each subject used two recording sheets. Each sheet was an ordinary eight and one-half by eleven and one-half lined sheet of note paper.

Procedure

The subjects were tested in a single session. The experimenter stood in front of the group and after reading the directions proceeded to hold up the flash cards one at a time at the rate of approximately one every three seconds. The instructions for the number guessing (control) phase of the experiment were as follows:

> Put your name on the upper right hand corner of your sheet.
>
> This is an experiment in writing numbers to words. You will be shown a series of twenty-one words one at a time on these cards. The series will be repeated five times. To each word you are to respond by writing any number from one to ten inclusive on a separate line of your answer sheet. One number to a line. Start on the top of the first line. Do not use any system of writing numbers, but respond as randomly as possible with the first number you think of. After you have written a number,

cover it so that you cannot see it. Do not look back at numbers that you have written.

The instructions for the experimental phase were as follows:

Put your name in the upper right-hand corner of your sheet.

This is a learning experiment. You will be shown a series of twenty-one words one at a time on these cards. The series will be repeated five times. To each word you are to respond by writing any number from one to ten inclusive on a separate line of your answer sheet. One number to a line. Start on the top of the first line. Do not use any system of writing numbers, but respond as randomly as possible with the first number that you think of.

After you have recorded a number for a word, I will say "REPEAT" or "DO NOT REPEAT." If I say "repeat" you are to try to repeat that number when next you see that word; if I say "do not repeat" you are to try not to repeat that number when next you see that word.

After you have written a number cover it so that you cannot see it. Do not look back at any numbers you have written.

The experimenter as he held up the flash cards said "repeat" for the third, eleventh, and eighteenth card; for all others he said "do not repeat."

Separate recording sheets were used for each phase of the experiment.

CHAPTER III

RESULTS

The First Light-Up Experiment

Table I shows the bird-by-bird responses in the first twelve hours of extinction, the second twelve hours of extinction and for the total twenty-four hours of extinction. The conditioning figures for each subject reflect what the bird would have done in a period of time comparable to that of extinction if it had continued to respond at the rate of the last five hours of conditioning. These latter scores provide a base line for the computation of the percentage scores in the last column of the table. The percentages were computed by dividing the extinction rate for a particular period by the conditioning figure for the same period. The percentage scores provide a more valid index of comparison of the two groups than the raw scores; the reason for this being that the conditioned rate of responding is directly related to the extinction rate, that is, in this type of procedure, what the bird did in conditioning can be used as a basis for predicting extinction behavior. In this experiment only one experimental bird had a conditioning rate higher than the lowest control bird, in all other instances the control birds exceeded the experimental birds. The percentage scores eliminate this factor and thereby allow extinction to purely reflect the effect of the experimental variable, in this case, light-up.

The results of the t test of the difference between the means of the percentages of the light-up and control subjects in the first half,

TABLE I

RAW SCORES AND PERCENTAGE SCORES FOR LIGHT-UP AND CONTROL SUBJECTS IN THE FIRST AND SECOND TWELVE HOURS, AND COMBINED TWENTY-FOUR HOURS CONDITIONING* AND EXTINCTION.

Group		Conditioning	Extinction	Per Cent**
		First Twelve Hours		
Light-up	1	29712	2748	9.2
	2	32136	5560	17.3
	3	43776	6177	14.1
	4	25603	5601	21.9
Control	5	56203	15138	26.9
	6	54840	5830	10.7
	7	32640	3830	11.7
		Second Twelve Hours		
Light-up	1	29712	1245	4.2
	2	32136	2185	6.8
	3	43776	230	.5
	4	25603	605	2.4
Control	5	56203	709	1.3
	6	54840	290	.5
	7	32640	539	1.7
		Twenty-four Hours		
Light-up	1	59424	3993	6.7
	2	64272	7745	12.0
	3	87552	6407	7.3
	4	51216	6206	12.2
Control	5	112416	15847	14.1
	6	109680	6120	5.6
	7	65280	4369	6.7

*Conditioning figures were arrived at by computing mean of last five hours of responding and multiplying by twelve or twenty-four.

**Per cent was computed by dividing extinction rate by conditioning rate.

second half, and total extinction period are reported in Table II. For the whole twenty-four hour period of extinction the light-up birds exceeded the control birds although the difference is not statistically significant. In the first twelve hours of extinction the two groups are almost exactly comparable. The difference between the two groups in the last twelve hours, however, demonstrates clearly the reinforcing effect of light-up. The difference is statistically significant at the three per cent point, computed both parametrically by t and non-parametrically because of the gross heterogeneity of variance.

The Second Light-Up Experiment

The statistical treatment of the data from the second light-up investigation varied slightly from that of the first light-up. Since the subjects were conditioned on 100 per cent reinforcement and equated on number of reinforcements and time to condition, there was no need to control for conditioning behavior in comparing the differences between groups in extinction; therefore, the raw scores, coded by dividing by 100, were used.

Table III shows the raw scores of the three groups prior to coding. The extinction period for the three groups, APR group, 100 per cent reinforcement group, and control group was divided into the first half of extinction, second half, and total extinction period. It should be noted that no entry was made for bird three, APR group in the second half of extinction and total extinction period. The reason for this being that in the third half hour of extinction the bird jammed the pecking window and

TABLE II

THE t TESTS OF DIFFERENCES BETWEEN THE MEANS OF PERCENTAGE SCORES OF LIGHT-UP SUBJECTS AND CONTROL SUBJECTS IN EXTINCTION

Group	N	Mean	S	t	D. F.	P
First Twelve Hours						
Light-Up	4	15.6	5.35	.136	5	.51
Control	3	16.4	9.09			
Second Twelve Hours						
Light-Up	4	4.5	2.69	2.38	5	.03
Control	3	1.2	.59			
Total Twenty-Four Hours						
Light-Up	4	9.6	2.92	.247	5	.39
Control	3	8.8	4.62			

TABLE III

RESPONSES, BIRD BY BIRD, IN THE FIRST HALF, SECOND HALF, AND TOTAL THREE HOUR EXTINCTION PERIOD FOR TWO GROUPS OF EXPERIMENTAL BIRDS AND ONE CONTROL GROUP

Group		First Half	Second Half	Total
APR	1	8600	6510	15,110
	2	4480	360	4,840
	3	1020	——	——
	4	4020	2690	6,710
100 Per Cent R	1	9460	1710	11,170
	2	12950	1480	14,430
	3	3082	580	3,662
	4	2220	860	3,080
Control	1	2340	700	3,040
	2	7070	1500	8,570
	3	4120	100	4,220
	4	2190	480	2,670

subsequent pecking responses were not recorded. In all comparisons between groups involving the APR group the data from bird three were used for the first half of extinction but not for the last half nor the total extinction period.

The t test of the difference between the means of the responses of the 100 per cent reinforcement group and the control group in the first half, second half, and total extinction period are reported in Table IV. The 100 per cent light-up group showed a superiority in number of responses over the control group early in extinction, late in extinction, and over the whole extinction period, the largest difference was at the thirteen per cent point, in the second half of extinction.

The t test of differences between the means of the APR light-up and control group, in Table V are consistent with the previous results. The APR group was superior at all levels of analysis in extinction, and the largest difference, at the eight per cent point, was in the second half of extinction.

In Table VI the two light-up groups are combined for a comparison with the control group. The trend is consistent with the previous results in that increased stimulation as reinforcement shows its greatest effect in the second half of extinction where the P value in this case reaches the six per cent point.

The results of the second light-up corroborate the result of the first light-up in demonstrating the overall superiority of the increased stimulation birds over the control birds in extinction. The results of the two experiments are also consistent in showing that the greatest

TABLE IV

THE t TESTS OF THE DIFFERENCES BETWEEN THE MEANS OF CODED* RESPONSES IN EXTINCTION OF THE 100 PER CENT LIGHT-UP GROUP AND THE CONTROL GROUP

Group	N	Mean	S	t	D. F.	P
First Half of Extinction (one and one half hours)						
100 per cent reinforcement	4	69.5	51.8	1.07	6	.16
Control	4	39.2	22.9			
Second Half of Extinction (one and one half hours)						
100 per cent reinforcement	4	11.8	5.1	1.23	6	.13
Control	4	7.0	5.9			
Total Extinction (three hours)						
100 per cent reinforcement	4	81.3	55.9	1.12	6	.15
Control	4	46.2	27.3			

*Responses were coded by dividing by 100 and rounding to the nearest whole number.

TABLE V

THE t TESTS OF THE DIFFERENCES BETWEEN THE MEANS OF CODED*
RESPONSES IN EXTINCTION OF THE APR LIGHT-UP
GROUP AND THE CONTROL GROUP

Group	N	Mean	S	t	D. F.	P
First Half of Extinction (one and one half hours)						
APR	4	45.2	31.2	.31	6	.39
Control	4	39.2	22.9			
Second Half of Extinction (one and one half hours)						
APR	3	32.0	30.8	1.59	5	.08
Control	4	7.0	5.9			
Total Extinction (three hours)						
APR	3	88.6	54.8	1.0	5	.18
Control	4	46.2	27.3			

*Responses were coded by dividing by ten and rounding to the nearest whole number.

TABLE VI

t TEST OF THE DIFFERENCES BETWEEN THE MEANS OF CODED RESPONSES IN EXTINCTION OF A COMBINED APR LIGHT-UP AND 100 PER CENT LIGHT-UP GROUP AND CONTROL GROUP

Group	N	Mean	S	t	D. F.	P
First Half of Extinction (one and one half hours)						
Light-up	8	57.4	41.7	.98	10	.17
Control	4	39.2	22.9			
Second Half of Extinction (one and one half hours)						
Light-up	7	21.9	21.3	1.73	9	.06
Control	4	7.0	5.9			
Total Extinction (three hours)						
Light-up	7	84.1	50.7	1.6	9	.07
Control	4	46.2	27.3			

effect of light-up is in the second half of extinction.

Summary Analysis[1]

In Table VII the results of the two experiments reported above are combined with the Jenkins and Brush (7) results to present a general picture of the course of extinction under conditions of increased stimulation. The individual P values reported do not reach commonly accepted points of significance (one or five per cent) except in the last half of extinction for two experiments. However, three additional P values crowd the point of significance, one appearing for the last half of extinction and the other two for the total extinction period. It is noteworthy, however, that all the P values except one are in the direction predicted, that is, in all three experiments the increased stimulation group was superior to the control group--except for the one case cited above where there was no essential differences between the experimental group and control group in the first half of extinction.

The chi square technique of combining P values was used to obtain the figures in the last column of Table VII. The P value, using this

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[1] R. A. Fisher, Statistical Methods for Research Workers (New York: Hofner Publishing Company, 1950), p. 99: "When a number of quite independent tests of significance have been made, it sometimes happens that although few or none can be claimed individually as significant, yet the aggregate gives an impression that the probabilities are on the whole lower than would often have been obtained by chance. It is sometimes desired, taking account only of these probabilities, and not of the detailed composition of the data from which they are derived, which may be of very different kinds, to obtain a single test of the significance of the aggregate, based on the product of the probabilities individually observed."

TABLE VII

P-VALUES FOR THREE INDIVIDUAL EXPERIMENTS AND COMBINED P-VALUES FOR ALL EXPERIMENTS

Exp.	P	Combined P
	First Half of Extinction	
I	.20	
II	.51	
III	.17	.085
	Second Half of Extinction	
I	.04	
II	.03	
III	.06	.003
	Total Extinction	
I	.10	
II	.39	
III	.07	.021

technique, should be interpreted as the probability of obtaining individual probabilities of a particular value, such as .085, .003, and .02, in a particular direction, for example, in favor of a hypothesis that predicts the superiority of one group over another.

The combined P levels for the three experiments in the first half, second half, and total extinction period were .085, .003, and .02, respectively. This reflects a significant similiarity in the results of the three experiments at less than the ten per cent level for the first half of extinction and less than the five per cent level for the second half of extinction and the total extinction period.

The overall analysis shows that although the P values for the separate experiments in some instances do not reach accepted points of significance, the results, except for one cited instance, are consistently in the direction predicted by the hypothesis. The significance of this directional trend is obvious from an inspection of the combined P values two of which are at less than the five per cent point, the third one being just beyond the five per cent point. Furthermore, as predicted, the greatest effect of increased stimulation shows up in the second half of extinction.

The Third Light-Up Experiment

The results reported herein are for fifteen of the twenty-four birds used in this experiment. Nine birds were discarded for failing to respond. Of the fifteen responders six were light-up noise birds, five were light-up birds and four were controls.

The rate of operant responding over the ten hours was quite erratic and a comparison of the three groups was not amenable to parametric methods. In order to determine possible trends in responding, it was decided to compute a percentage score by dividing the number of responses from the last three hours by the number of responses from the first three hours, (see Table VIII) and then employ Fisher's exact test to compare the percentage scores for each group. This means essentially that a bird-by-bird comparison was made between each of the three groups on rate of responding in the last three hours compared to rate of responding in the first three hours.

In Table IX are reported the P-values obtained from a comparison of the percentage scores for the three groups. The greatest difference found was between the light-up noise group and control group where the difference reached the seventeen per cent point. The difference between the light-up and control groups reached the twenty-six per cent point and a comparison of the light-up noise group and light-up group revealed no essential difference. Although the P-values are not statistically significant they are essentially in agreement with the results already reported from the extinction experiments, that is, they are in the predicted direction. It should be noted that the two cue change appears to be somewhat superior to the one cue change; this latter finding is in agreement with the results of Horowitz's (4) experiment reported in Chapter I, where it was found that noise plus sight-of-food was more effective as a reinforcer than noise only.

TABLE VIII

RAW SCORES* AND PERCENTAGES IN THE FIRST THREE AND LAST THREE HOURS OF A TEN HOUR OPERANT LEVEL PERIOD OF RESPONDING FOR TWO INCREASED STIMULATION GROUPS AND A CONTROL GROUP

Group	Subject	First Three Hours	Last Three Hours	Per Cent**
Light-up noise	1	1	4	400
	2	37	2	5
	3	6	4	67
	4	1	2	200
	5	5	3	60
Light-up	1	2	1	50
	2	1	8	800
	3	55	21	38
	4	16	1	6
	5	18	7	38
	6	1	3	300
Control	1	20	2	10
	2	5	1	20
	3	6	1	17
	4	1	2	200

*Coded by adding one.

**Per cent scores were computed by dividing the last three hours by the first three hours of responding.

TABLE IX

FISHER'S EXACT TEST APPLIED TO PERCENTAGE DATA OF
OPERANT LEVEL RESPONDING FOR THREE
GROUPS OF SUBJECTS

Group	*Median +	*Median -	P
Light-up-noise	4	1	.17
Control	1	3	
Light-up	4	2	.26
Control	1	3	
Light-up-noise	4	1	.34
Light-up	3	3	

* + should be interpreted as above the median; - as below the median.

The 'Spread of Effect' Experiment

The level of repetition following rewarded repeated responses falls progressively from 15.0 to 9.0 to 6.8 (see Table X). This indicates that when subjects were rewarded by the experimenter's saying "repeat" after the subject had written a number to the stimulus words at positions 3, 11, and 18, and on subsequent occasions when the subject learned to repeat the same number at the same position, a declining gradient was generated following this response. The above fulfills the conditions for a classical 'spread of effect' experiment.

In the second phase of the analysis the numbers repeated by each subject were recorded for the three positions following non-repeated rewarded responses. When the experimenter said "repeat" at positions 3, 11, and 18 and the subject did not learn to repeat, the level of repetition in the three positions following was low and no gradient appeared.

An analysis of the control data shows that when the instructions to the subjects were not to learn but simply to write numbers at random, the number guessing habits of the subject were not hindered by the distraction of learning and the level of repetition in the three positions following any randomly repeated number was raised to 26.6, 22.5, 20.5. Furthermore, the gradient of repetition under guessing habit conditions was not quite as steep as the gradient under learning conditions.

The overall results of this experiment are in the directions predicted. The level of repetition under number guessing conditions was higher than under learning (repeated rewarded) conditions and a gradient

TABLE X

MEAN PER CENT REPETITION OF NUMBERS BY EIGHTEEN SUBJECTS FOLLOWING REPEATED REWARDED NUMBERS, NON-REPEATED REWARDED NUMBERS, AND RANDOMLY REPEATED NON-REWARDED NUMBERS

	Position Following Repetition		
	1	2	3
Repeated Rewarded	15.0	9.0	6.8
Non-repeated Rewarded	8.0	9.6	7.2
Repeated Non-rewarded	26.6	22.5	20.5

appeared in the absence of reward. The gradient following a repeated number under number guessing conditions was not as steep at the gradient under learning conditions. No after-gradient appeared following non-repeated rewarded responses, and the level of repetition was low.

CHAPTER IV

DISCUSSION

Increased Stimulation as Reinforcement

The evidence from the two extinction experiments indicates that, despite the initial decremental effect of cue change, the introduction of a novel stimulus during extinction tends to maintain behavior. This finding constitutes evidence in favor of hypotheses 1. a) and 1. b) which state: 1. a) During extinction the strength of behavior will be maintained by a cue change associated with increased stimulation; and 1. b) The effects of a cue change associated with increased stimulation in the extinction of a laboratory induced behavior will be greatest in the second half of extinction because of the differential effect of generalization decrement.

The results from the operant experiment, while not constituting strong evidence in favor of hypothesis 2, indicate a trend in the direction predicted by the hypothesis. Hypothesis 2 states: Operant level responding under conditions of reinforcement associated with increased stimulation will be greater than operant level responding without increased stimulation.

A brief review of the present experiments along with experimental evidence from other sources in relation to increased stimulation as reinforcement should help to make clear the implications of this research to learning theory. Experiments designed to show the effect of increased

stimulation have been conducted on (1) the acquisition of behavior (conditioning), and (2) on the maintenance of conditioned behavior.

Two experiments using pigeons, Horowitz's (4), and the writer's experiment, relevant to the role of increased stimulation in learning, show that removal from the situation by a change in behavior as a consequence of stimuli impinging on the auditory receptors, or the visual receptors, or both are effective in increasing the rate of responding. Preliminary evidence indicates that a two cue change is more effective than a one cue change.

Ligon's experiment (11) and Sheffield's experiment (19) strongly indicate that an increase in stimulation, in one case by an auditory stimulus and in the other case by way of increase in sex "drive," can serve as a reinforcer in conditioning behavior. These experiments in addition to demonstrating learning in the presence of increased stimulation also add generality to the evidence by demonstrating the phenomenon using a different class of organisms (rats) and a different experimental setting from those used in the previously mentioned experiments.

Three experiments, one by Jenkins et. al. (7) and two by the writer, show that an increase in visual stimulation which changed the organism's on-going behavior played a positive role in the maintenance of a learned behavior in pigeons.

The Contiguity Explanation

Contiguity theorists maintain that the mechanism of reinforcement is a cue change that removes the organism from the situation by changing

its behavior. Such a state of affairs serves to produce learning by changing on-going behavior so that the organism cannot learn new behavior to the cue situation; therefore, on subsequent occasions in a like situation the organism will do what it last did in that situation. It logically follows that the more the animal's behavior is changed, without physical impairment, the greater will be the learning.

It also follows that the more the total cue situation, previously associated with a response, is changed the greater will be the decrement in responding. This is the phenomenon of generalization decrement previously described in Chapter I. The implication of generalization decrement to the phenomenon investigated in the present study is that in all instances the experimental birds had a novel cue change introduced in extinction, while the control animals did not; therefore, any reinforcing effect that the cue change might have by way of removing the organism from the situation must have first overcome the decremental effect of total cue change from conditioning to extinction.

The results of the three experiments conducted by the writer can be explained by the above generalizations without additional assumptions. For example, the light-up associated with pecking is known to have behavior changing characteristics. Birds observed during an experimental session showed an appreciable decrease in responding; obviously, this was a change in behavior. Furthermore, it was found that a two-cue change (increase change in behavior) was somewhat more effective than a one cue change even when the level of responding was extremely low as in the operant study. In the operant study, it should be recalled that the birds

had no previous history of conditioning, that is, pecking the window in the apparatus had never been reinforced. When placed in this free responding situation it was assumed that in the course of activity some animals would occasionally peck the window in addition to pecking other parts of the box. This assumption was justified—fifteen of the twenty-four birds pecked the window at least once. Those that had increased stimulation following pecking showed an increase in rate of responding over the control birds from the first three to the last three hours of the experimental session. The results of Horowitz's (4) study add generality to the present findings.

Preliminary data from the second light-up also indicate that there is a direct relationship between amount of behavior change (removal from the situation) and reinforcing effect of cue change. In that experiment there were two light-up groups, a three minute APR group, and a 100 per cent reinforcement group. When the data were analyzed for the first half of extinction (prior to losing the lowest responding APR bird) the 100 per cent reinforcement birds were superior to the APR birds at the 23 per cent point. It is assumed here that light-up following every peck or burst of pecks is more of a removal cue than light-up on a three minute APR schedule.

The results of the latter experiment also showed evidence of a loss in generalization decrement in extinction when a cue previously associated with feeding was reinstated in extinction. In the second light-up, all birds were exposed to the sound of the food magazine's turning during extinction. The magazine's turning had also been

associated with pecking in the conditioning phase of the experiment. The reinstatement of this cue was one factor that accounted for the relatively high rate of responding of the birds in the second light-up compared to the birds in the first light-up. One way to put it is that the birds in the second light-up were extinguished in a situation more like the conditioning situation than were the birds in the first light-up.

A drive reduction theorist might claim that the high rate of responding in the second light-up could easily be accounted for in terms of secondary reinforcement. This explanation with other drive reduction arguments will be commented on in the section to follow.

The Drive Reduction Explanation

The drive reduction position on reinforcement maintains that in order for learning to take place there must be a decrease in stimulation (drive reduction) or a stimulus must be present that has previously been closely associated with the reduction of a drive (secondary reinforcement).

It should be pointed out that those who advocate contiguity theory do not take issue with the empirical evidence for learning demonstrated by those who hold to a drive reduction position; they merely point out that contiguity theory can adequately handle the drive reduction evidence plus the evidence that is embarassing to the drive reduction position. It might be said that that class of behavior explained by drive reduction constitutes but one case of behavior explained by contiguity theory. For example, no one would deny that food for a hungry organism is a very effective reinforcer and no one would deny that, given a sufficient period of

time, ingested food provides an effective means of removing the cues associated with food deprivation (drive reducing) but issue is taken with the notion that learning can occur only as a consequence of drive reduction or its surrogate, secondary reinforcement, or its step child, tertiary reinforcement. The single-principle statement of reinforcement by contiguity maintains that food for a hungry organism is a very effective way of changing the organism's behavior so that it will do what it last did prior to eating. Also it might be noted that eating is strongly associated with behaving "activity," and activity, in turn, is associated with food. It seems reasonable that these pre-experimental habits are carried over to the experimental setting. Hypothesizing reduction in stimulation as a necessary condition for learning may be superfluous. In fact, as Jenkins (7) points out, there may be a hidden fallacy in interpreting eating, drinking, etc., as drive reducing in that the actual behaviors involved in these terminal responses may constitute an increase in stimulation. This question can be tested experimentally.

It is believed that a prohibitive number of assumptions must be made in extending drive reduction theory to account for the evidence from the experiments reported in this paper. The possible explanations for the phenomenon of increased stimulation as reinforcement would probably make use of two assumptions: first, that some uncontrolled drive was reduced by light-up, or, second, that the light-up was a secondary reinforcing agent.

With regard to the first assumption it might be said that pigeons have an innate drive to seek light and the increased rate of responding

merely reflects the reduction of this drive. Evidence from another source indicates that this is highly unlikely. Jenkins (7) demonstrated that when a period of black-out (turning off the source of light) was substituted for food in extinction the cue change associated with black-out maintained behavior. Since both increase in stimulation and decrease in the same source of stimulation have been shown to maintain behavior, it is unlikely that pigeons have a "natural" drive to seek light or dark.

It is possible that other drives might have been operating such as an exploratory drive, or a curiosity drive—or even sex—and they were reduced by the animals activity in the apparatus. The possibility of such assumed drives cannot be refuted. It seems, however, to be more parsimonious to account for the phenomenon of learning with a single general principle than to "invent" drives to account for every exception to the drive reduction position.

The secondary reinforcement explanation of the reinforcing effect of light-up would necessitate making an assumption that sometime in the past history of the organism, increase in visual stimulation had been associated with the reduction of a drive and this was associated with pecking at something similar to a pecking window. This rather tenuous explanation does not seem adequate in view of the laboratory procedures used in handling the pigeons. To the best of the writer's knowledge no systematic increase in illumination had been associated with the pigeons' pecking in their home cages. As a matter of fact, constant illumination was maintained in the animal colony.

The secondary reinforcement explanation of the high rate of responding of the birds in the second experiment compared to the lower rate of responding of the birds in the first light-up is in no way incompatible with the evidence. Secondary reinforcement in this instance can account for the high level of responding, but it does not seem that it can account for the superiority in responding associated with increased stimulation.

Guessing Habits and the "Spread of Effect"

The results of the "spread of effect" experiment constitute evidence in favor of hypotheses 3. a), 3. b), and 3. c) which state: 3. a) The gradient of repetition following rewarded repeated numbers will be steeper than the gradient following chance repeated numbers. 3. b) The level of repetition will be lower following rewarded repeated numbers than under guessing conditions. 3. c) There will be no gradient following rewarded non-repeated numbers. These results corroborate the findings of Sheffield and Jenkins (18), and can be considered additional evidence for a contiguity explanation of the "spread of effect."

The after-gradients of repetition following rewarded repetitions indicate that the non-rewarded gradient is higher than the rewarded gradient. This is interpreted from the contiguity position in terms of the distracting effect of instructions to learn on number guessing habits. This explanation is based on the empirical evidence that people in our culture have well established number guessing habits; further, that in an experiment of the "spread of effect" variety where the subjects are instructed to respond to words with numbers, the number guessing habits

will play a major role in the sequential order in which the numbers are repeated, and that, in addition, reward does not account for the rate of repetition nor the after-gradient because reward was not present. Reward of a repeated number serves to anchor the number so that previously established habits of guessing can operate. In fact, the action of a rewarded repetition with instructions to learn, appears to cause the subject to concentrate on the task and this interferes with his number guessing habits. The after-gradient following rewarded repeated responses and the after-gradient following non-rewarded repeated responses bear this out. The level of repetition is higher when the subject is not distracted with instructions to learn. Further evidence indicating that reward does not account for the after-gradient is seen in the overall low level of repetition and lack of the after-gradient following repeated non-rewarded numbers.

The contiguity position that the habits the subject brings to the situation with him can best account for the classical "spread of effect" phenomenon, without assuming the action of drive reduction by way of reward, or by way of Thorndike's "confirmatory reaction," is borne out by the experiment reported in this paper.

CHAPTER V

SUMMARY AND CONCLUSIONS

Three experiments were conducted to study the effect of increased stimulation on behavior. The experiments were designed to test the implication of drive reduction as a reinforcing agent against removal from the situation by cue change as reinforcement. In one conditioning experiment increased stimulation was introduced by a visual stimulus and a combination of an auditory stimulus with a visual stimulus. In two extinction experiments increased stimulation was introduced by an increase in visual stimulation.

The conclusion drawn from these experiments were: 1.) that increased stimulation can serve as a reinforcer in the acquisition of behavior and in the maintenance of behavior. 2.) The evidence indicates in a preliminary fashion that a two-cue change is a more effective reinforcer than a one-cue change. 3.) Increased stimulation of the variety used in these experiments is more effective in the latter stages of extinction than in the earlier ones because of the decremental effect of cue change early in extinction.

The three experiments were interpreted as evidence for the contiguity principle of reinforcement and as evidence against the drive reduction point of view.

One experiment was conducted with humans to study the implications of guessing sequence habits or the 'spread of effect' phenomenon. It was found that the level of repetition was raised when reward was omitted.

Furthermore a low level of repetition without any after-gradient occurred following non-repeated rewarded numbers in a learning situation.

The conclusions drawn from this experiment were that the number guessing habits a subject brings to the test situation in a 'spread of effect' experiment can adequately account for the 'spread' phenomenon without additional assumptions about the reinforcing effect of reward. The experiment was interpreted as evidence in favor of contiguity theory and negative evidence for the law of effect.

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APPENDIX

TABLE XI

HOURLY OPERANT RESPONSES FOR THREE GROUPS OF PIGEONS

	HOUR									
Subjects	1	2	3	4	5	6	7	8	9	10
Light-noise										
1	0	0	0	1	3	2	3	2	0	1
2	26	10	0	0	0	0	3	1	0	0
3	2	1	2	3	1	0	0	1	1	1
4	0	0	0	3	19	4	0	0	0	1
5	2	2	0	1	0	0	0	2	0	0
6	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0
Light only										
1	0	0	1	0	0	5	0	0	0	0
2	0	0	0	0	0	0	0	0	1	0
3	54	0	0	0	0	0	0	0	2	18
4	3	2	10	0	1	0	0	0	0	0
5	13	4	1	1	0	4	2	4	1	1
6	0	0	0	0	0	1	0	1	0	1
7	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0
Control										
1	3	13	3	4	5	1	0	1	0	0
2	0	0	4	3	0	0	15	0	0	0
3	4	1	0	0	1	0	0	0	0	0
4	0	0	0	0	0	0	1	1	0	0
5	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0

TABLE XII

WORDS USED ON FLASH CARDS IN "SPREAD OF EFFECT" EXPERIMENT

1. YET	11. HAM
2. SOB	12. NOD
3. FED	13. DAB
4. FIG	14. MUD
5. ROT	15. GET
6. CAP	16. LUG
7. WEB	17. FIX
8. RUG	18. GAB
9. NOR	19. DID
10. COG	20. TAG
21. TUB	

TABLE XIII

REPETITION OF NUMBERS IN THREE SERIAL POSITIONS FOLLOWING A REPEATED REWARDED NUMBER, AND FOLLOWING A NON-REPEATED REWARDED NUMBER WITH INSTRUCTIONS TO LEARN TO REPEAT REWARDED NUMBERS

	Repeated Rewarded				Non-repeated Rewarded			
Subject	0	1	2	3	0	1	2	3
1	4	0	0	0	8	0	0	1
2	12	4	2	0	0	0	0	0
3	8	1	2	0	4	0	1	1
4	4	0	0	1	8	1	2	1
5	12	2	1	0	0	0	0	0
6	11	1	0	1	1	0	0	0
7	6	1	0	0	6	0	0	0
8	5	1	0	1	7	0	2	0
9	7	1	0	1	5	0	0	0
10	9	2	2	0	3	0	0	0
11	12	2	1	0	0	0	0	0
12	4	0	1	0	8	1	1	1
13	2	0	0	0	10	0	1	1
14	5	0	0	1	7	1	0	1
15	10	4	0	2	2	0	1	1
16	9	0	1	1	3	0	0	0
17	6	1	1	0	6	0	1	1
18	7	0	1	1	5	1	1	0

TABLE XIV

REPETITION OF NUMBERS FOR THREE SERIAL POSITIONS AFTER REPEATED NUMBERS FOLLOWING INSTRUCTIONS TO WRITE NUMBERS ONE TO TEN RANDOMLY WITHOUT REWARD

Subject	0	Position 1	2	3
1	13	0	0	0
2	26	2	3	2
3	20	1	3	5
4	33	8	8	3
5	19	1	4	2
6	36	9	10	13
7	28	12	6	4
8	20	7	3	3
9	30	5	5	6
10	36	9	14	9
11	60	26	22	15
12	39	14	12	9
13	25	5	4	5
14	26	4	3	7
15	42	21	12	11
16	36	6	4	5
17	17	3	2	1
18	40	12	8	11