EFFECTS OF AGE AND SCHEDULES OF REINFORCEMENT ON EXTINCTION PATTERNS IN A HUMAN CHOICE TASK

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D.C.

TO LESLIE MARIE

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Chapter 1

INTRODUCTION

The present study attempted to evaluate the effects of varying sequences of partial reinforcement (PR) and continuous reinforcement (CR) on the extinction behavior of human subjects on a choice task. Results were compared between adults and children.

THEORETICAL FORMULATION

Cotler and Nygaard[1] concluded that continuous reinforcement before partial reinforcement leads to greater resistance to extinction than partial reinforcement before continuous reinforcement. However, Sutherland, Mackintosh and Wolfe[2] found results in opposition, concluding that partial reinforcement before continuous reinforcement leads to greater resistance to extinction than continuous reinforcement before partial reinforcement.

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[1]S. B. Cotler and J. D. Nygaard, "Resistance to Extinction Following Sequences of Partial and Continuous Reinforcement in a Human Choice Task," Journal of Experimental Psychology, II (1969), 273-274.

[2]N. Sutherland, N. Mackintosh and J. Wolfe, "Extinction as a Function of the Order of Partial and Consistent Reinforcement," Journal of Experimental Psychology, LXIX (1965), 58-59.

The results were compared between adults (college age) and children (fourth graders) on the order of sequence of acquisition. Earlier studies using rats concluded that PR-CR appeared to lead to greater resistance to extinction. Keller[3] found an interesting trend. Group 1 of his subjects was administered a PR-CR sequence and emitted significantly more responses at a higher rate for the first five minutes of extinction, while also emitting more responses at a higher rate throughout the extinction period.

Likely[4] discounted the expectancy theory and supported the sequence of PR-CR as amenable to greater resistance to extinction. Sutherland et al.[5] concluded from their findings that group PR-CR extinguished significantly more slowly than group CR-PR.

There have been two studies using human subjects concerned with CR-PR and PR-CR sequences of acquisition that are of particular interest. Cotler and Nygaard[6] found that CR-PR led to greater resistance to extinction than PR-CR.

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[3]F. S. Keller, "The Effect of Sequence of Continuous and Periodic Reinforcement Upon the Reflex Reserve," Journal of Experimental Psychology, LXIV (1962), 563-564.

[4]F. A. Likely, "Relative Resistance to Extinction of a Periodic and Continuous Reinforcement Separately and in Combination," Journal of Experimental Psychology, LVIII (1958), 183-185.

[5]Sutherland et al., op. cit., 58.

[6]Cotler and Nygaard, op. cit., 272-273.

Baw-Chyr Hu[7] found no significant difference between groups PR-CR and CR-PR.

The phenomena associated with experimental extinction have been the subject of many divergent hypotheses and have yet to have been proven unequivocally. Where Likely[8], Sutherland et al., Keller, tentatively agree and Theios and McGinnis[9], Baw-Chyr Hu have virtually the same results, the means in which the data were collected and conclusions reached are in no way equivocal. Subjects, methods and designs varied extensively throughout the studies. There is a dire need for multiple studies utilizing uniform criteria and exploring varied environments solidifying results and making conclusions and inferences relevant and applicable.

THE PROBLEM

The present study divided the subjects into two groups by order of acquisition: CR-PR and PR-CR. The university students and the grade school subjects were both administered a simple choice task to determine if either group differed in resistance to extinction.

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[7]Baw-Chyr Hu, "Resistance to Extinction Following Sequences of Partial and Continuous Reinforcement in a Human Choice Task," Acta Psychological Taiwanica, XIV (March, 1972), 104-105.

[8]Likely, op. cit., 184; see also Sutherland et al., op. cit., 58; see also Keller, op. cit., 562.

[9]J. Theios and R. McGinnis, "Partial Reinforcement Before and After Continuous Reinforcement," Journal of Experimental Psychology, LXIII (1967), 480; see also Baw-Chyr Hu, op. cit., 104

Statement of the Problem

Is there a significant difference in resistance to extinction between the groups of continuous reinforcement--partial reinforcement (CR-PR) and partial reinforcement--continuous reinforcement (PR-CR)?

Is there a significant difference in resistance to extinction between adults (university students) and children (fourth graders)?

Statement of the Hypotheses (Null Form)

There is no significant difference in resistance to extinction between the groups of continuous reinforcement--partial reinforcement (CR-PR) and partial reinforcement--continuous reinforcement (PR-CR).

There is no significant difference in resistance to extinction between adults (university students) and children (fourth graders).

Purpose of the Study

The purpose of this study was to ascertain if a significant relationship existed between responses in extinction to CR-PR. The subjects were then administered a simple choice task. Finally, the means of the responses in extinction were compared by analysis of variance to test for significant differences between age groups PR-CR and CR-PR.

Significance of the Study

Several assumptions may be made depending on the results of the experiment. If there is a significant difference between groups CR-PR and PR-CR in relationship to responses in extinction it may lead to agreement on procedures of extinguishing undersirable behavior. However, if there is a significant difference between age groups it could be assumed that different age groups respond differently to schedules of reinforcement and would require a unique method of treatment applicable to the specific age group.

Results of the study would be applicable across all fields of education, social services and general situations where interaction occurs between two human beings. Identification of reinforcement schedules may not only involve uniform treatment of social problems but would affect daily interactions of people.

DEFINITIONS OF TERMS

The subject of experimental extinction and schedules of reinforcement brings with it a number of terms that are relative to that topic. For that reason, the terms that have been related specifically to this study have been defined in this section.

Partial Reinforcement (PR)

In partial reinforcement the specified responses are rewarded on a designated intermittent schedule.[10]

Continuous Reinforcement (CR)

In continuous reinforcement every response is rewarded.[11]

Continuous Reinforcement Administered Before Partial Reinforcement (CR-PR)

After a designated number of responses, where every response is rewarded, an equal number of responses is rewarded intermittently as specified.[12]

Partial Reinforcement Administered Before Continuous Reinforcement (PR-CR)

After a designated number of responses is rewarded intermittently as specified, an equal number of responses is rewarded continuously.[13]

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[10]Horace B. English and Ava Champney English, A Comprehensive Dictionary of Psychological and Psychoanalytical Terms (New York: David McKay, 1958), p. 454.

[11]Ibid.

[12]Ibid.

[13]Ibid.

Partial Reinforcement Effect (PRE)

The partial reinforcement effect assumes that partial reinforcement leads to greater resistance to extinction than continuous reinforcement.[14]

LIMITATIONS OF THE STUDY

Finding a stimulus that was both reinforcing to grade school children and to university students was difficult. Each age group attended to the stimulus in a different manner. Purely from observation it appeared that the grade school children grasped the experiment in a different manner than the university students.

Forty subjects were used for the experiment consisting of twenty subjects from each population, grade school and university. The small number of subjects that was used for the experiment was due to time and economic limitations.

Perhaps if the acquisition series was lengthened the results would have changed significantly. Although the environments for both groups were held constant, the grade school childrens' reaction to the experimenter was quite different from that of the university students. The grade school children possibly viewed the experimenter as an authority figure and the university students viewed him as a peer.

Motivational factors may have influenced the results.

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[14]N. Sutherland et al., op. cit., 57-58.

The incentive for each groups' response and in actuality each individuals' response could not be controlled. It does seem feasible that each age group would respond differently according to age difference alone.

Chapter 2

REVIEW OF RELATED LITERATURE

The psychological literature reveals that few studies have been conducted that deal with the relationship of CR-PR and PR-CR to extinction. Among the studies that have been conducted the results have varied considerably. There is a need for further research in this area as there are many variables that have not been controlled in previous experiments which have led to varying results.

Rats as Subjects for Extinction

Keller[15] was a pioneer in examining the effects of partial and continuous reinforcement on behavior. His main concern was with the partial reinforcement effect (PRE) which states PR leads to greater resistance to extinction than CR. An attempt to confirm the PRE was made by Keller.

Keller's subjects were twenty male white rats. He divided his twenty rats into two groups. The first group was given PR at three minute intervals for two days after which thirty successive responses were reinforced for two days. In the second group (CR-PR), the sequence of reinforcement was reversed. On the last day, a three-hour

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[15]Keller, op. cit., 561-563.

extinction curve was obtained from each subject. Group 1 (PR-CR) emitted significantly more responses at a higher rate throughout most of the extinction period. Limiations of these results are that there were no significant differences between groups over the total extinction period and there were only twenty subjects involved.

Likely[16] used ninety-two male hooded rats as subjects. Water was used as reinforcement for the rats who were placed in a Skinner apparatus box. Reinforcement was then dispersed among the four equal groups in the following manner: Group 1 (PR-CR) received four days of PR followed by four days CR, Group 2's (CR-PR) reinforcement schedules were reversed, Group 3 (PR) had PR for four days, and Group 4 (CR) had CR for four days. Four days of extinction followed acquisition.

Results from Likely's study supported those of Keller's.[17] Likely found that group PR-CR was consistently superior over-all with the highest rate of extinction.

Not satisfied with the results from this study, Likely set out to draw some important variables from the study so that significant implications could be applied to further research. In doing so he developed a "prolongation ratio" from the data on the pattern of extinction. The ratio was calculated by dividing the number of responses

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[16]Likely, op. cit.

[17]Keller, op. cit., 564.

made during the second half of extinction by the number of responses made during the first half. The ratio is an index of the relative rate of extinction responding with the larger ratio reflecting greater prolonged responding. Results showed that PR anytime during acquisition significantly increased the prolongation ratio compared to CR alone. Therefore, any addition of PR to CR will decrease any advantage in extinction responses.

Elstad's[18] experiment consisted of ninety-six male hooded rats divided into four groups of twenty-four animals. Elstad studied the four groups under the following schedules: (1) PR-CR, (2) CR-PR, (3) CR, and (4) PR. All conditions for the groups were equal, excluding the amount of training. No significant difference was found among groups in resistance to extinction. The only result with any implications to the present study was the CR-PR, PR-CR order which was the same as that found in Likely's study using the prolongation ratio.

Sutherland, Mackintosh and Wolfe[19] performed a study to test acquisition schedule shifts while allowing sufficient PR training to produce a PRE. Sutherland[20] suggested

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[18]P. A. Elstad, "Resistance to Extinction as a Function of Acquisition and Extinction Schedules and Types of Measurement," Psychonomic Science, XIX (1970), 63-64.

[19]Sutherland, et al., op. cit., 56.

[20]N. Sutherland, "Visual Discrimination in Animals," British Medical Bulletin, XX (1964), 56-58.

that the PRE must be understood in terms of a two stage learning model in which the subject must first learn which aspects of the situation to attend to, and, second, which responses to emit. With CR, the attending mechanisms within the organism, called stimulus analyzers, will be correlated consistently with reinforcement, and the response thereby conditioned to these analyzers. With PR, however, no analyzers will be correlated consistently with reinforcement, and the response conditioned to these analyzers and no particular behavior will be attached to any one analyzer resulting in the subject trying new behaviors all of the time. Therefore, extinction after PR takes longer because more analyzers have been used. In addition, the order of CR in relation to PR is important with resistance to extinction affected by the earlier schedule. Placing CR before PR strengthens a number of analyzers, partially preventing the responses from being conditioned to other analyzers. Therefore, PR-CR subjects should be more resistant to extinction than subjects having CR-PR acquisition training.

Prior to experimental trials, forty hooded rats were given two days pretraining in a straight runway. The source of reward for the rats was letting them eat in the goal box for ten seconds. The day after the final acquisition trial all groups started twenty extinction trials. Eight subjects were placed in each of five acquisition groups: Group 1 (PR) had sixty PR trials, Group 2 (CR-PR) had sixty PR trials followed by 100 CR trials, Group 3 (CR-PR) had 100

CR trials followed by sixty PR trials, Group 4 (CR-60) had 60 CR trials, Group 5 (CR-100) had 160 trials. No mention was made of the type of PR schedule used. Extinction was considered complete after three consecutive trials required two minutes or longer to complete.

Results showed that PR was significantly more resistant to extinction than group CR-PR and from this the authors concluded that placing CR before PR reduces resistance to extinction as compared to PR alone. Most importantly for the purposes of the present study, group PR-CR extinguished significantly more slowly than group CR-PR. A significant conclusion reached by the authors was that the order in which CR and PR was given affected resistance to extinction. Differences between groups CR-PR and PR-CR would show up only late in extinction according to the stimulus analyzer hypothesis. When the dominant analyzers were extinguished, differences emerged. The CR-PR group extinguished more rapidly since initial PR training prevented the response from being conditioned to other analyzers; the PR-CR group kept running longer since that response was controlled by less dominant analyzers requiring fewer non-reinforced trials.

Theios and McGinnis[21] noted that in the Sutherland, et al. study, acquisition levels prior to extinction were

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[21]J. Theios and R. McGinnis, "Partial Reinforcement Before and After Continuous Reinforcement," Journal of Experimental Psychology, LXIII (1967), 480-481.

different between groups with group PR-CR having the highest acquisition level and a higher extinction asymptote. Noting that the PR-CR extinction curve dropped faster than the CR-PR curve, Theios and McGinnis stated that if the data from Sutherland, et al., had been equated to account for the different acquisition levels, the opposite conclusion might have been reached.

Theios and McGinnis used three groups with rats as subjects in a straight alley runway. The groups were: (1) CR had 160 trials, (2) PR-CR had sixty PR trials on a fifty percent randomized schedule followed by 100 percent CR trials, (3) CR-PR had 100 CR trials followed by sixty trials. Ten extinction trials per day were conducted for four days. In acquisition PR training led to slower response speeds than CR. Theios and McGinnis concluded that their data were consistent with interpretations of the PRE dealing with conditioning of the response to a stimulus or stimulus traces of nonreward, competing responses or anticipatory frustration.

Humans as Subjects for Extinction

Spradlin[22] investigated three general problems concerning different schedules of reinforcement and their subsequent effects on extinction behavior. The first problem

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[22]J. Spradlin, "Effects of Reinforcement Schedules on Extinction in Severely Mentally Retarded Children," American Journal of Mental Deficiency, LXVI (1962), 635-636.

investigated was the effect of adding CR after PR on extinction, the second, the effect of different percentages of reinforcement on the number of trials to extinction, and third, the effect of different reinforcement schedules on spontaneous recovery. The subjects were mentally retarded children between the ages of eight and eighteen scoring fifty or below on the Wechsler Intelligence Scale for Children. The apparatus had a lever which the subjects pulled for chocolate candy. Twenty subjects were randomly assigned to each of five groups: (1) CR had twenty-four trials of CR only, (2) twenty-four trials of seventy-five percent PR, (3) twenty-four trials of fifty percent PR, (4) PR-CR had fifty percent PR for the first twelve trials followed by CR for twelve trials. If the subject did not complete the acquisition series within ten minutes, he was excluded. A ten minute time limit was set on the extinction period with extinction immediately following acquisition.

The results of Spradlin's study revealed the usual PRE with group CR differing significantly from all other groups. No significant differences were found between groups fifty percent PR, and PR-CR, groups seventy-five percent PR and fifty percent PR, or between PR-CR and CR-PR although in the latter comparison PR-CR emitted more responses. Although the second day responding was greater than first day responding, no significant differences were found between groups on the second day. Spradlin stated that perhaps if a longer series of CR were added,

resistance to extinction might have been reduced. Data from Theios[23] tend to support this assumption. Spradlin also mentioned uncontrolled factors that may have influenced his data: such as deprivation level of subjects, present environment of the institution, and the subjects' previous experience with candy. The type of subjects, mental retardates, may have affected the data with the retardates possibly requiring more trials to obtain differences in responding than would normal subjects. No differences between groups in spontaneous recovery possibly was due to procedural dissimilarities between extinction days.

Cotler and Nygaard[24] investigated the effects on extinction of placing PR in a series of CR trials. Eighty-four volunteers from undergraduate psychology courses were randomly assigned each to one of four groups: (1) PR-CR-CR, (2) CR-PR-CR, (3) PR-CR-PR, (4) CR-CR-CR. Fifty percent schedules were used with the restrictions that no runs of over five consecutive reinforced trials were allowed and the last response in a reinforcement block was reinforced prior to extinction. A discrete trial procedure was used with a white light signalling the beginning of a trial and the green light signalling reinforcement. On each trial the subject was to predict if the green light was to come on. If he thought the green light was to follow the white

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[23]Theios, op. cit., 480.

[24]Cotler and Nygaard, op. cit., 270-271.

light, the subject was to press a telegraph key after the three blocks of acquisition trials were given.

Cotler and Nygaard noted that during acquisition abrupt and significant changes in response level was found when the schedules were shifted, with PR leading to a poorer performance. Group CR-CR-CR responded significantly better than any of the other groups overall, i.e., the total number of trials to complete a block of twenty key presses was less. During extinction groups CR-CR-CR performed at a significantly poorer level than any other groups; no differences were found among the groups getting PR. Analysis of early versus late extinction performance showed that during the first thirty trials, group CR-CR-CR made significantly more responses and group CR-PR-CR the least. For the last twenty extinction trials there were differences among groups. Although no significant levels were reported, the rate of decline for group CR-CR-CR was faster than the other three groups. The CR-CR-CR transformed data showed initially a much slower rate of decline to the second block of twenty extinction trials, but after this block there appeared to be no difference among groups having PR.

An experiment conducted by Baw-Chyr Hu[25] was to compare the resistance to extinction of PR-CR and CR-PR groups when the effects of differential acquisition

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[25]Hu, op. cit., 101.

asymptotes have been controlled. His experiment consisted of 180 elementary school children from the fifth and sixth grades. They were assigned randomly to one of four groups: (1) PR-CR, (2) CR-PR, (3) CR-CR, (4) PR.

The apparatus consisted of a red and white light bulb mounted on a board. The white light was turned on, signalling the subject to guess if the red light was to come on or not. A telegraph key was mounted on the board and the subject was to press it if he thought the red light would come on, and do nothing if he thought it would not.

Each group of subjects was given two blocks of acquisition trials followed by sixty extinction trials. Each acquisition block was continued until twenty key presses were made by the subject, and then the next block began. Group CR-CR was given 100 percent reinforcement in each of the two blocks of acquisition trials. Group PR was given only one block of fifty percent variable ratio reinforcement for the key pressing responses on acquisition trials. Group PR-CR and CR-PR were each given one block of 100 percent CR and one block of fifty percent variable ratio reinforcement for the key pressing responses.

The most important finding was that when the response level at the beginning of extinction is the same, partial reinforcement preceding continuous reinforcement does not lead to greater resistance to extinction than partial reinforcement following continuous reinforcement.

Chapter 3

METHODS AND PROCEDURES

To determine if there was a significant difference in resistance to extinction between individuals who received partial reinforcement before continuous reinforcement and individuals who received partial reinforcement after continuous reinforcement or a significant difference between age groups (university and grade school), this study selected a sample of fourth graders from Logan Avenue Grade School, Emporia, Kansas and a sample of students from the University of Kansas, Lawrence, Kansas. Each subject participated in an experiment which required him to guess whether a red light was to come on after a white light was presented. Each subject was then informed by the examiner if they were "right" or "wrong." The data were subjected to analysis of variance.

The subjects were all read the same instructions and informed that a white bulb would light up. The subjects were then asked to guess as to the possibility of the red bulb lighting up. Presentation of the red light along with the reinforcement, i.e., "right" or "wrong" was controlled by the experimenter.

POPULATION AND SAMPLE

The subjects for the experiment were taken from two distinct populations. Twenty subjects were chosen from the Logan Avenue Grade School Fourth grade. The mean age of these students was 10.1 years. The students were selected by the teacher on the basis of availability. No specific criterion was used for the selection of the fourth grade subjects.

The data obtained from the fourth graders were compared with the data obtained from twenty subjects from the University of Kansas. The criterion used for selection of the university subjects was enrollment at the University of Kansas on a full time basis. The mean age of the students participating from the university population was 23.7 years. Students from both populations were assigned randomly to one of two groups, CR-PR and PR-CR.

Each student was asked if he would like to participate in an experiment concerning a simple choice task. If he agreed, the instructions were read to him and questions were answered prior to the experiment.

Finding a task that was equally rewarding for fourth graders and university students was difficult. The fourth graders appeared to be more interested in the experiment than the university students, judging subjectively from their expressions. Although the experimenter made every effort to present the instructions and rewards equally, it was possible that they fluctuated.

The results of the study indicated that partial reinforcement after continuous reinforcement leads to greater resistance to extinction, with no difference between age groups. The existing data showed that partial reinforcement after continuous reinforcement led to greater resistance to extinction for both populations, adult (university students, mean age--23.7) and children (grade 4, mean age--10.1).

MATERIALS AND INSTRUMENTATION

The apparatus consisted of a white and a red light bulb mounted 12 inches apart and 2 inches from either end of a board that was 7 and 3/4 inches wide and 24 and 1/4 inches long. Each bulb was 7 and 1/2 watts and was controlled by the experimenter by means of an electrical cord and switch. The white signal light on the subject's left indicated the onset and duration of a trial. The red light was on the subject's right and indicated whether his response was correct or not. The duration of each trial was five seconds. Subjects were asked to respond following the appearance of the white light. They were asked to say "no" if they thought it would not appear.

The presentation of the signal for each trial and the reinforcing lights were controlled manually by the examiner. The experimenter could not be seen by the subjects. The experimenter responded verbally by saying "right" or "wrong" to each response made by the subject.

The following are the instructions that were read to every subject: "When the white light comes on guess whether the red light will come on or not. If you think the red light will come on, say "yes." If you think it will not come on, say "no." If you say "yes" and the red light does not come on you are incorrect. If you say "no" and the red light does not come on you are correct. If you say "no" and the red light comes on you are incorrect. There will be five seconds for each trial and you are to guess within that time period. You are to guess every time the white light comes on. If there are any questions, please ask now."

DESIGN OF THE STUDY

This experimental study made use of a simple choice task to determine if there was a significant difference in responding in extinction between groups who received continuous reinforcement before partial reinforcement. Also, to determine if responding would be different between age groups, university students and grade school students. Forty subjects were selected, twenty from fourth graders and twenty from the university population.

DATA COLLECTION

The subjects were selected according to availability and access. Once the subject was in the experimental room the experimenter read the instructions to the subject and

asked if there were any questions. If there were, they were answered and the experiment began. Upon completion of the experiment the subject was thanked for his cooperation.

Procedures for the two groups were equivocal. Questions inquiring about the purpose of the experiment were put off until the experiment was completed.

DATA ANALYSIS

The statistical tool used for analysis of the data collected was analysis of variance. This tool has been discussed in this section.

In order to test whether the means of any two groups were significantly different, the between groups (three way) analysis of variance (ANOVA) was used. This statistical model capitalizes on the integral relationship between the mean and the variance so that, by analyzing variances of two or more groups, conclusions can be drawn regarding the similarity of the means of two or more groups. Use of ANOVA reveals a primary interest in mean difference rather than variance differences.

In calculating ANOVA the sum of squares for within groups (ss_w) and between groups (ss_b) is determined along with the total sum of squares (ss_T) and between groups variance is a systematic variance always present when the means of two or more groups differ. If all means found were the same then obviously one would not have between groups variance. On the other hand, within groups variance

indicates the variability within the groups. This variance is due to chance or is sometimes referred to as error variance.[26]

The degrees of freedom for between groups and within mean squares can be obtained. The total degrees of freedom are equal to the total number of subjects less one (N-1). The between groups degrees of freedom are equal to the number of groups less one (k-1). Generally, in obtaining the within groups degrees of freedom, the method used is to subtract the number of groups from the total number of subjects.

The mean squares are found by simply dividing the corresponding sum of squares by the correct degrees of freedom. The mean square is frequently, or commonly, referred to as the variance estimate.

The value of F is then found by dividing the between mean square by the within mean square. The general formula is as follows:

$$F = \frac{\text{Between groups mean square}}{\text{Within groups mean square}}$$

After finding the F-ratio, the value is compared to a Table of F to determine if the ratio is sufficiently large to be significant at the 0.05 or 0.01 level. If the obtained F

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[26]M. Linton and P. Gallo, Jr., The Practical Statistician: Simplified Handbook of Statistics (Monterey, California: Brooks/Cole Publishing Co., 1975), pp. 156-164.

is equal to or larger than the tabled value of F, then the obtained F is considered to be statistically significant and the null hypothesis may be rejected.

Chapter 4

ANALYSIS OF DATA

A simple choice task was administered to each of forty subjects to determine if there was a significant difference during rate of responding in extinction between groups PR-CR and CR-PR and age groups (adult and children). The responses to a simple choice were subjected to analysis of variance.

RESPONSE ANALYSIS

As previously described, forty subjects were subjected to the experimental apparatus. The twenty fourth graders were divided into two groups. One group was given continuous reinforcement before partial reinforcement and one group was given continuous reinforcement after partial reinforcement. The individuals assigned to a particular group were determined by random selection. The twenty university students were assigned in the same manner.

STATISTICAL ANALYSIS

The means of all four groups, PR-CR, CR-PR, university and grade school students, were compared by analysis of variance. This statistical procedure, including theory, formulation and appropriate application of analysis of

variance has been discussed in detail in Chapter 3.

The "single classification" model of the analysis of variance was the statistical tool used to test the null hypotheses that there was no significant difference between the groups CR-PR and PR-CR, nor between the age groups of adult (university students) and children (grade school children). Listed below in Table 1 are the sum of squares, degrees of freedom, mean squares and F-values.

Table 1

Analysis of Variance of Responses During Extinction for Groups PR-CR, CR-PR and Age

Source of Variation	Sum of Squares	Mean Squares	Degrees of Freedom	F
A	19.2	19.2	1	5.289*
B	10.8	10.8	1	2.975
AB	2.7	2.7	1	0.744
S(AB)	130.67	3.63	36	
T	205.32	102.66	2	74.880*
AT	4.65	2.33	2	1.670
BT	27.45	13.73	2	10.011*
ABT	2.85	1.43	2	1.039
S(AB)T	98.73	1.37	72	
	502.37		119	

*Denotes Significant Difference

A = Order

B = Age

C = Trials

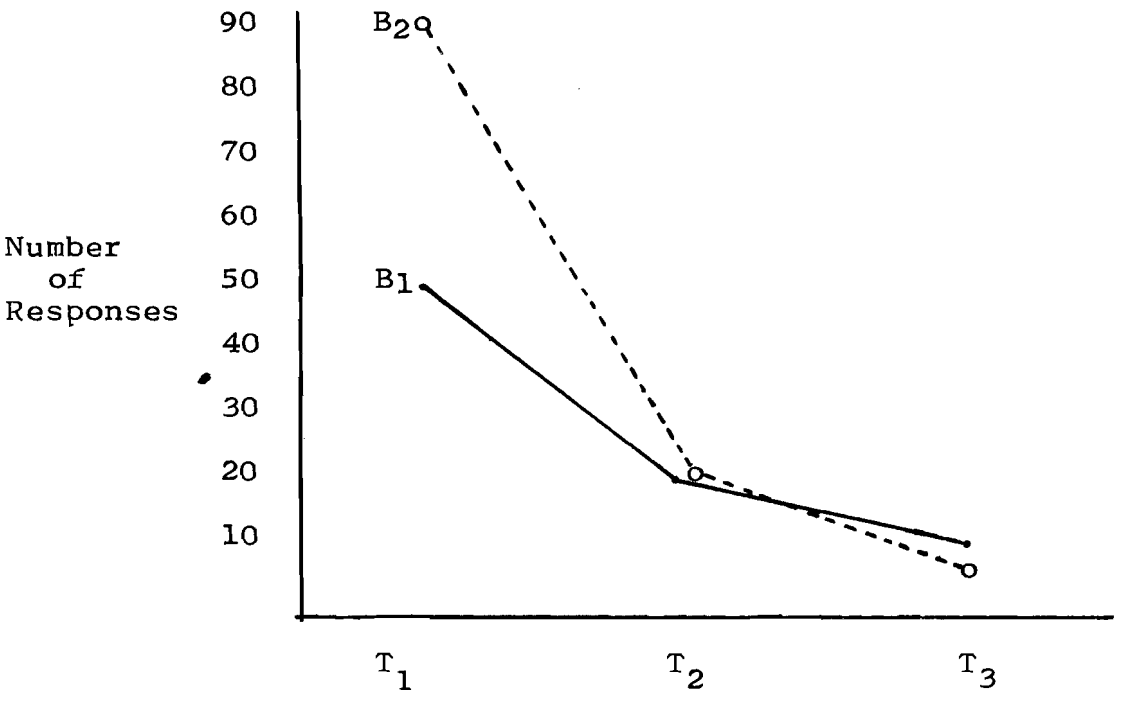
The obtained F-ratios of 5.289 for order, 74.88 for trials and 10.011 for age by trials were all significant at the 0.01 level of significance. The significant F-ratio for order led to the rejection of the first null hypothesis, concluding CR-PR or continuous reinforcement before partial reinforcement is more resistant to extinction than PR-CR or partial reinforcement before continuous reinforcement.

The significant F-ratios for trials and trials by age led to the conclusion that the university students responded more during the first phase of extinction but that there was no overall significant difference. Therefore, the second null hypothesis was accepted. Table 2 shows that the university students responded significantly more during the first ten trials of extinction. The university students responded eighty-eight times during the first ten trials of extinction, twenty-one during the second and six during the third. The grade school students responded forty-nine times during the first trial of extinction, twenty-one during the second and nine during the third.

The results of the analysis of variance indicated that all groups responded much more during the first ten trials of extinction and that the university students responded significantly more than the grade school students during the same period. It also indicated no overall significant difference among all three trials.

Table 2

Analysis of Variance of Trials by Age



B_1 = grade school students indicated by .____.

B_2 = university students indicated by o- - -o

It can be concluded that there is a significant difference between groups PR-CR and CR-PR in resistance to extinction and that CR-PR leads to a greater resistance to extinction. Also, there was no significant difference in resistance to extinction between age groups (university and grade school). However, there was a significant difference between age groups during the early part of extinction with university students being much more resistant to extinction. Although a discrete trial procedure (specified number of responses in extinction) was used, from the existing data it could be concluded that were the trials extended there would be no significant difference between age groups.

Chapter 5

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Is there a significant difference in rate of responding in extinction between individuals who receive continuous reinforcement before partial reinforcement or continuous reinforcement after partial reinforcement or between age groups (adults and children)? The results of this study in the context of the literature review, and potential significance for application are examined in this chapter.

SUMMARY

To determine which group was least resistant to extinction (CR-PR, PR-CR), and if there was a difference between age groups, the present study analyzed the responses of forty subjects to a simple choice task. All forty subjects, twenty fourth graders and twenty university students, responded to a simple choice task administered by the experimenter. The data were subjected to analysis of variance.

CONCLUSIONS

Subjects of the respective age groups tended to respond differently to trials. Older subjects responded

more during each extinction than did the younger subjects.

The subjects responded in a like manner concerning groups CR-PR and PR-CR. Group PR (compared to CR) reduces resistance to extinction. There was found to be no significant differences between age groups in respect to responding to the visual stimuli (red and white light bulbs) although older subjects responded more frequently.

Previous studies dealing with the effects of CR-PR and PR-CR on behavior have not confirmed the results of this study. However, no previous study has dealt with the differences between age groups in responding. There are several possible reasons why the results of this study did not coincide with those of other studies. The subjects in the present study were human, while subjects in all but three of the previous studies were animals. The number of subjects may have been a determining factor in the outcome of the study. More subjects may have produced a variation in results. This factor is apparent when viewing Baw-Chyr Hu's experiment. His experiment, similar to the present study, consisted of 180 grade school children. His results did not confirm results of the present study but supported a trend in its direction.

A major factor in the determination of results was the motivation of the students participating in the experiment. It is conceivable that fourth grade students and university students had a different outlook towards the apparatus. This may have initiated a particular set of

responses.

RECOMMENDATIONS

Results of a study conducted by Theios and McGinnis[27] (1967) support the results of the present study. Their study supported the results of group CR-PR extinguishing significantly more slowly than group PR-CR. A significant conclusion reached by the authors was that the order in which CR and PR was given affected resistance to extinction. Cotler and Nygaard[28] (1969), using a similar apparatus as the present experiment, favored CR-PR to resistance of extinction. Sutherland and Macintosh found results opposite to this.

The remaining studies, notably Spradlin[29], Elstad, Likely[30], Keller, and Baw-Chyr Hu favored PR-CR as more resistant to extinction. Although research to date offers no conclusive evidence of the relationships of PR and CR to resistance to extinction, an interesting trend does appear which might reconcile some of the contradictory findings.

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[27]Theios and McGinnis, op. cit., 481.

[28]Cotler and Nygaard, op. cit., 274.

[29]Spradlin, op. cit., 636; see also Elstad, op. cit., 64.

[30]Likely, op. cit., 562; see also Keller, op. cit., 564; see also Baw-Chyr Hu, op. cit., 105.

Cotler and Nygaard[31] and Theios and McGinnis studied the relationship of PR and CR to resistance to extinction and favored the CR-PR groups as most resistant to extinction. Other studies have shown a developing trend in this direction, Spradlin[32] and Baw-Chyr Hu. This is an interesting factor as PR alone is already recognized as most resistant to extinction among schedules of reinforcement. The disparity among groups is due to a number of factors. Subjects used in experiments may have been a contributing factor as some people used animals and others humans. Other controlling variables contributing to various outcomes are environment, number of subjects, and unequivocal standards within experiments. Cross validation or a reiteration of experiments detail for detail, needs to be employed to confirm results. Theios and McGinnis[33] stated that if the data from Sutherland et al., had been normalized to account for the different acquisition levels, the opposite conclusion might have been reached. Spradlin also mentioned uncontrollable factors that may have influenced the data. These were deprivation level of subjects, present environment of institution, and the subject's previous experience with candy.

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[31]Cotler and Nygaard, op. cit., 274; see also Theios and McGinnis, op. cit., 481.

[32]Spradlin et al., op. cit., 636; see also Baw-Chyr Hu, op. cit., 105.

[33]Theios and McGinnis, op. cit., 482.

Baw-Chyr Hu[34] noted that different results may be obtained with different manipulations of variables. Spradlin[35] stated that perhaps if a longer series of CR were added, resistance to extinction might have been reduced; data from Theios[36] (1962) tend to support this assumption. Another problem in research of this topic is the lack of uniformity among measures of extinction.

One consideration for future research is consideration of age groups. Results of the present research indicate that age difference may be a factor in rates of emission and extinction. Another area of consideration for further research is differentiation according to sex. Previous research has not dealt with this factor which may influence the results.

In considering the fruitfulness of this and future studies it is important to take into account the purposes. Finding which schedule of reinforcement (PR, CR) is least resistant to extinction may be beneficial to psychologists, educators and laymen alike. It may be used to control aversive behavior and promote appropriate behavior in a more satisfactory manner, e.g., extinguishing temper tantrums with designated schedules of reinforcement and reinforcing appropriate behavior with designated schedules.

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[34]Baw-Chyr Hu, op. cit., 105.

[35]Spradlin, op. cit., 636.

[36]Theios, op. cit., 481.

It is important that future research focus on both the age and subject variables and that specified criteria be cross validated. Research to date has shown these variables as a tremendous influence in results. Until uniform measures are cross validated, results will continue to be ambiguous.

The importance of research in this area is justified by the need for a consistent method of instruction and therapy across professional realms. Pinpointing the most effective or more effective therapeutic schedule may be instrumental in remediating behavior problems.

Cross sectional studies would give a more meaningful answer to the question at hand: Which schedule of reinforcement is more effective in remediating behavior problems? Results of research to date have been ambiguous and inconsistent. Many variables were responsible for this. Though contributions in this area have provided us with many stimulating questions, it is the conclusion of this researcher that significant results will not be confirmed until a uniformity of variables and criterion is established.

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