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The Comparative Effects of Two Reinforcement Schedules Applied to Groups in Teaching Arithmetic Skills

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THE COMPARATIVE EFFECTS OF TWO REINFORCEMENT SCHEDULES APPLIED TO
GROUPS IN TEACHING ARITHMETIC SKILLS

by

Ronald C. Bennett

A dissertation submitted in partial fulfillment of the requirements for the degree
of
DOCTOR OF PHILOSOPHY
in
Psychology

Approved:

UTAH STATE UNIVERSITY
Logan, Utah

1972
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ABSTRACT
The Comparative Effects of Two Reinforcement Schedules Applied to Groups in Teaching Arithmetic Skills
by
Ronald C. Bennett, Doctor of Philosophy
Utah State University, 1973

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Department: Psychology

A behavioral approach to teaching in the public school system is difficult because of the inherent difficulty of finding positive reinforcers and administering them simultaneously to large groups of students.

This study attempts to apply the same tangible reinforcers to two groups of students under different schedules of reinforcement. The students in the study were in special classes termed "learning adjustment" classes because of their failure to perform at grade level in regular classroom settings.

One group was on a continuous schedule of reinforcement using tokens and gold strike stamps as reinforcers. The second group was also on a continuous schedule of reinforcement but with a punishment contingency added. Reinforcers were the same for this group as the first group. The third group was a comparison group.

Performance rates were studied under the above schedules of reinforcement and were found to increase the number of arithmetic units completed for each group.
Achievement level change in mathematics as measured by the mathematics section of the California Achievement Test was a second major aspect of this study.

Although there was a very definite difference in the number of arithmetic units completed by the three groups there was not a corresponding difference in the amount of change in achievement level.
CHAPTER I
INTRODUCTION

The effectiveness of utilizing behavioral principles has been demonstrated in many areas of development and education. A behavioral approach to teaching in the public school system is difficult because of the need to apply it to large numbers of students simultaneously.

Finding a positive reinforcer often involves trial and error experimentation, which is time consuming. Because of this it is difficult for teachers in the public school systems to systematically apply behavioral principles to their teaching practices. Quay, Werry, McQueen and Sprague (1966) suggest that for behavioral remediation to be economically feasible for use in the public schools it is necessary to develop techniques that can be applied in group situations by as few adults as possible.

It is the purpose of this study to investigate the comparative effects of two continuous reinforcement schedules, one with a punishment contingency when applied to groups of children enrolled in "learning adjustment" classes. Three classes with a total of thirty students participated in this study. They ranged in age from seven years to twelve years. The three classes were designated Group I, Group II, and Group III at random. The students in the three classes were placed there because of the following behavioral parameters: their having average or above intellectual ability, doing below grade level work, doing less than the assigned classroom work, and demonstrating behavior
disruptive to classroom settings. Children demonstrating these behavioral problems were chosen for this study because of a need to find effective methods of motivating these kinds of students to continue their education and to learn from their academic experiences. The above classes were sponsored by the Eastern Idaho Mental Health Association on the assumption that extinction of maladaptive behaviors and the acquisition of adaptive behaviors in the educational setting are important variables in the promotion of good mental health. This study was an effort to identify methods to aid teachers that would result in the student performing in arithmetic at a higher rate during the contingency phase and subsequently demonstrating the acquisition of arithmetic skills on a standardized achievement test.

A token system was developed in the form of plastic chips, which could be traded for gold strike stamps. Tokens were made contingent on reading 20 minute units from an arithmetic text and responding with a 90 percent accuracy rate to solving problems covered by the text materials. Gold strike stamps were used as a secondary reinforcer because of the multitude of items that they could be exchanged for and thus their propensity to function as a positive reinforcer. Sherman and Baer list the following advantages in a token system:

(1) The tokens are usually much easier to present to a subject than some of the back-up reinforcers for which they can be exchanged. Indeed, certain back-up reinforcers, such as trips to a swimming pool or a wrestling match, can hardly be dispensed in experimental settings at all.

(2) A very single potent reinforcer may be used to support a great deal of behavior.
The lengthy time before actual delivery of such single reinforcers is filled with tokens, which transforms the single very potent reinforcer into many quite potent reinforcers, and thereby may be used to develop a correspondingly greater amount of behavior.

(3) When dealing with a large number of subjects... token systems can overcome much of the variability of effectiveness of reinforcers which the individual subjects are likely to display. ...

(4) When it is necessary to offer relatively mild reinforcers... a token system backed up by a variety of such mild reinforcers may function more strongly than any one of the mild reinforcers... over a period of time. (Sherman and Baer, 1967, p. 11)

Group I was on a continuous schedule of reinforcement. They were presented with a token upon the completion of each arithmetic unit. An arithmetic unit consisted of reading a designated number of pages from the text and subsequently solving problems representative of that unit with a 90 percent or above accuracy rate. Each reading unit required approximately twenty minutes to complete. This group traded their tokens for stamps every two days at the rate of three stamps per token.

Group II was on a continuous schedule of reinforcement with a punishment contingency. Each student was given seven tokens at the beginning of each two day interval. At the end of the interval the student returned all of the tokens not earned (one token was earned for each unit completed) and traded the remainder to the teacher for stamps at a rate of three stamps per token.

Group III functioned as a comparison group and classroom procedures were not altered, except they were given the same series of texts divided into twenty minute units and were administered the same pre- and post-tests as the experimental groups.
Group III, the comparison group, also used behavioral methods. The techniques used in this classroom covered each academic subject as well as behavioral conduct for each school day.

During the first three weeks of the contingency phase of the experiment this group performed under the following system: A white chip worth two points could be earned every fifteen minutes for each of the following behaviors: staying in seat, completing work, keeping quiet, keeping desk clean, and having a helpful attitude. In addition, a blue chip worth five points was awarded for each completed assignment. This covered eleven subjects through the day. In arithmetic one blue chip was given for completing the first unit, two blue chips were given for completing a second unit during the same day and three blue chips were given for completing a third unit during the same day. Each morning the chips were converted to points and upon the accumulation of 100 points a strip of colored paper was given the student to stick on a cardboard which would hold nine strips of paper. When the cardboard was full it could be traded for a small toy costing between fifty and seventy cents.

For the remaining four weeks of the contingency phase this group performed according to an assignment contract the child signed agreeing to complete a given number of units per day. (See appendix)

All three groups studied the same units when possible. However, because of the different grade levels involved this was not always possible and units were established by the teachers making them approximately equal for all students.
A major premise of behavioral theory is "that operants are controlled by stimulus consequences, those observed in the child's current situation as well as those in his past history" (Bijou and Baer, 1961, p. 33). In order to determine what stimulus consequences an operant (response) will produce, Bijou and Baer (1965) suggest the following procedure: The frequency of occurrence of a response is recorded in a given setting until an estimate of strength is obtained (baseline data). A stimulus (reinforcer) is then presented contingent upon the occurrence of the response and the consequent change in strength of the response is observed (contingency phase). If the response consistently increases in frequency (performance rate) under these conditions and decreases when the contingency is removed (extinction) that stimulus is a positive reinforcer. These procedures were adhered to in the present study.

Another similar premise of behavior principles is the rule that, "What is learned is what is reinforced" (Bijou and Baer, 1961, p. 44). This premise is being studied by comparing performance rates with subsequent changes in achievement levels on a standardized achievement test.

Achievement tests are widely used in public schools to assess student progress. A question arises as to whether a higher rate of responding to arithmetic materials during the contingency phase subsequently results in a parallel strengthening of performance on achievement tests as the above rule suggests. This study will examine performance rates in relation to subsequent achievement level.

In viewing the field of education for these kinds of students, a behavioral researcher may speculate that current methods provide
little positive reinforcement, and in some cases provide negative reinforcement.

The Problem

Operant techniques are dependent on the principle that the behavior of an organism is functionally related to reinforcement contingencies. The questions to be answered by this proposed research are: Will the presentation of the same kinds of reinforcers to groups of students effect change in their performance rates, will it result in higher levels of arithmetic achievement, and will a CRF schedule with a punishment contingency bring about a greater change in performance rate than a CRF schedule without a punishment contingency and which schedule will result in the highest achievement level?
CHAPTER II
REVIEW OF LITERATURE

This review of literature is limited to the extension of operant conditioning principles to the classroom as an adjunct to group teaching procedures. However, a brief review of animal studies and studies utilizing mentally retarded and emotionally disturbed students has been included for clarification of operant conditioning principles and techniques.

Principles of Operant Behavior

There are few basic principles in operant conditioning but there are a multitude of techniques that have been developed in the application of these principles. Ullman and Krasner (1965, p. 29) suggest "... that all behavior modification boils down to procedures utilizing systematic environmental consequences to alter the subject's response to stimuli."

Ferster and Skinner (1957) briefly summarizing operant principles, say that the behavior of an organism often changes the environment in a way which affects the organism itself. Some of these changes can be termed reinforcers because they increase the probability of that behavior reoccurring. Many events which have a reinforcing function are related biologically to the survival of the organism (food, water, oxygen, etc.). It is assumed that the capacity for these events to function as reinforcers has been part of the evolutionary development.
of the species. However, numerous other events become functionally related to the behavior of an organism as a result of their immediate pairing with those events necessary for the survival of the species. Bijou and Baer (1961, p. 55) explain the acquisition of reinforcing properties of numerous other stimuli; "In general, whenever a stimulus has been discriminative for reinforcement, that stimulus very likely (but not certainly) will acquire reinforcing value itself."

Behaviors which are functionally related to their consequences are termed operants. Bijou and Baer (1961, p. 36), list four kinds of consequences of an operant:

1. Produce positive reinforcers;
2. Remove or avoid negative reinforcers;
3. Produce negative reinforcers; and
4. Remove or avoid positive reinforcers.

Sherman and Baer (1967) summarize the basic ways in which operant behavior may be controlled by its consequences as follows:

Some stimuli when added to the environment, strengthen immediately preceding response; these are termed positive reinforcers. Some stimuli when subtracted from the environment, strengthen the immediately preceding response; these are called negative reinforcers, or quite often, aversive stimuli. Reinforcement means the strengthening of a response; thus, there are two reinforcement contingencies.

Obviously, not all stimuli have reinforcing functions. There are stimuli which, when added to the environment, weaken the immediately preceding response. These stimuli are termed punishing stimuli. ... [this] contingency is sometimes referred to as "response cost," that is, what it costs in current environmental stimuli to perform the response. In very specialized situations this contingency resembles the "time-out from positive reinforcement" operation. ... Thus response cost and the addition of punishing stimuli constitute two punishment contingencies.

[Finally] if the responsible contingency is discontinued (neutral consequences) the effect of that
contingency disappears... This undoing of the effects of such contingencies is termed **extinction**. (Sherman and Baer, 1967, p. 3-4).

In the field of learning, reinforcement has been studied almost exclusively in the acquisition and retention of behavior; however, the maintenance of behavior in strength is also an important function of reinforcement (Ferster and Skinner, 1957).

In 1933 Skinner reported experiments utilizing intermittent reinforcement and later (1938) suggested that reinforcements could be presented in many different ways. It is now known that many features of behavior can be explained by the properties of schedules.

Schedules of reinforcement are definable without reference to their effects on behavior. Reinforcement can be presented on the basis of the amount of time which has elapsed since the preceding reinforcement or it can center on the number of responses occurring since the preceding reinforcement.

Ferster and Skinner (1957, p. 2) define schedules as follows:

A given schedule may be fixed, or it may vary either at random or according to some plan. These two possibilities yield four basic schedules: fixed-interval, variable-interval, fixed-ratio, and variable-ratio. But other possibilities exist, as well as many combinations of such schedules.

The behavior of an organism under any schedule is a function of the condition present under the schedule, including the organism's behavior. These conditions can be studied in two ways (Ferster and Skinner, 1957); by comparing the effects of various schedules and by directly manipulating cogent variables.

The subsequent studies cited in this review will clarify the relationship between behavior and schedules of reinforcement.
Schedules of Reinforcement

Every nth response produces a reinforcing stimulus is a fixed-ratio schedule of reinforcement. Therefore, the highest frequency of reinforcement occurs when behavior is emitted at a maximal rate. Because of this the high rates of responding may be due to the relatively high frequency of reinforcement.

In a fixed-interval schedule of reinforcement the presentation of reinforcement occurs immediately following the first response emitted after a given period of time. This generally produces a stable state with a pause following each reinforcement, after which responding increases to a moderate value.

Because the fixed-interval schedule is based on elapsed time the organism is more likely to be reinforced on the first response following a long interval of nonresponding than is the organism on a fixed-ratio schedule of reinforcement. The fixed-ratio schedule increases the probability of a number of responses, rather than a pause, preceding the presentation of reinforcement. This results in a differential reinforcement of high rates of responding. Fixed-interval schedules have the opposite effect of differentially reinforcing low rates of responding (differentially reinforcing responses following pauses).

However, a post-reinforcement pause of shorter duration also typically occurs after reinforcement on fixed-ratio schedules (Ferster and Skinner, 1957). A number of animal studies have been conducted to analyze the effect of the schedule on this phenomenon.

Powell (1968) found little increase in post-reinforcement pause when he slowly increased FR from 15 to 30; however, thereafter post-reinforcement
pause increased as ratio size increased. There was also an increase in dispersion for all three pigeons as ratio size increased. Response rate tended to decrease for two of the three Ss but there were a number of reversals.

In a later study Powell (1969) examining the effects of two durations of food presentation on FR schedules found that post reinforcement pause could also change as a function of changes in reinforcement magnitude when FR requirements were held constant. He found that reinforcement magnitude and FR requirements interact to have a combined effect on post-reinforcement pause. Only one of the four pigeons utilized for this study responded at a higher rate as a function of longer access to food. As ratio size decreased the effect of reinforcement magnitude on post-reinforcement pause decreased.

Hendry and Van-Toller (1964) using an opposite approach examined FR responding with correlated amounts of reinforcement. They found that when smaller amounts of reinforcement were given, for higher response rates, longer inter-response time resulted. Four control rats which received consistently small amounts of reinforcement responded at a high rate typical of FR performance. The experimental animals maintained low response rates and appeared to develop superstitious behaviors. They did not learn to respond more slowly within a session, to obtain larger rewards.

Hulse and Firestone (1964) studied the effect of mean amount of reinforcement on response strength using CRF, FR2, and FR8. Acquisition rates of licking were the same for all three groups of rats. When mean volume of reinforcement was held constant, rate of responding did not
differ under the three schedules. However, resistance to extinction of the response increased as ratio size increased during acquisition. The results of this study are consistent with those found with rate in straight runways (Logan, Beier, and Kincaid, 1956) and is also congruent with results obtained in human maze performance studied by Bevan and Adams (1966).

The above animal studies are in agreement that fixed ratio schedules of reinforcement result in higher performance rates and post-reinforcement pauses of shorter duration than interval schedules. There is, however, a maximum ratio, that if surpassed brings about lowered response rates. Post-reinforcement pause on FR schedules was also found to decrease as a function of reinforcement magnitude (longer access to food). Although response strength is not strongly affected by small increases in FR schedules when mean volume of reinforcement is held constant, resistance to extinction of the response increases as ratio-size increases during acquisition. Similar results have been found with primates and human subjects.

A number of studies investigating the effectiveness of FR and FI schedules of token reinforcement in maintaining responding of chimpanzees have been done by Kelleher (1956, 1957a, 1957b, 1957c, 1958). Kelleher reports that the schedule on which tokens are presented is very important in maintaining responding in extended behavior sequences. In general, Kelleher found that FR schedules of token reinforcement were more effective in maintaining responding in chimpanzees than were FI schedules of reinforcement.

Malagodi (1967a, 1967b) using rats to study the effectiveness of schedules of token reinforcement arrived at a similar conclusion. In
one study (1967a) rats were trained to place marbles in a receptacle with each response producing primary reinforcement. Discrimination training was then given so that primary reinforcement occurred only in the presence of a clicker and illuminated receptacle. The rats were then trained to press a level to obtain a marble. The schedules of token delivery were gradually modified to either an FR or FI schedule. The rat's performance to obtain marbles was similar to the performance of rats to obtain primary reinforcement.

Malagodi (1967b) found that the performance of rats on FR schedules either increased or stopped altogether and that all pauses occurred immediately after reinforcement. His explanation of the positive difference in the effectiveness of FR schedules of reinforcement when compared to FI schedules is the same as Kelleher's. The probability of accidental reinforcement is much greater for FI schedules than for FR schedules. Pauses on FR schedules are not generally followed by reinforcement, whereas FI and VI schedules may give reinforcement on the occurrence of the first response following a pause.

Pederson (1967) studying the differential effects of schedules of reinforcement on children also found that Ss performed a level pulling task at a higher rate when on a 50% reward condition than did Ss who were under a 100% reward condition.

Whiteley (1967) reports results, working with children, which conflict with the above findings. Using kindergarten children on a double lever apparatus he found that Ss reinforced on a 50% reinforcement schedule responded at a slower rate than those on a CRF schedule.
Zeiler (1969) used cartoons as reinforcement and studied the effects of schedules on performance rates of children. When one lever was pressed, a cartoon was presented on either an FI or FR schedule. There was no consequence for pressing a second lever. Responding to the contingent lever increased and responding to the noncontingent lever decreased. There were higher and steadier response rates for those Ss on FR schedules than for those Ss on FI schedules. Additional schedule effects were demonstrated with Ss trained on FI schedules then changed to FR schedules rapidly attaining a high, steady response rate. Children initially trained on FR and then changed to FI schedules decreased to a lower more erratic response rate.

The above findings concerning post-reinforcement pause, response rates on FI and FR schedules, with the exception of Whiteley's (1967) study, are identical to results found with previously cited lower organisms.

Weiner (1964) studied the effects of response cost on the performance rates of adults ranging in age from 19 to 32. These Ss maintained a key press response on an FR 50 (at the end of 50 key presses they were given 100 points). During Phase I of his experiment there was no response cost contingency and no post-reinforcement pauses occurred. Phase II alternated from no-cost to one-point-cost per response occurring during the first five seconds after reinforcement. Phase III was the same as Phase II with an additional one point cost per response between reinforcements. Phase IV was the same as Phase III with an additional two point cost for each response occurring in the first five seconds after reinforcement. Phase V was the same as Phase IV except there was a two point cost per response continually between reinforcements. Distinctive
S^d's (colored lights) were presented with each response cost phase (0, 1, 2 points). Phase II produced post reinforcement pauses. The continuous cost contingency did not decrease or increase responding when the cost was less than the 100 point reinforcement. However, when continuous response cost was made equal to the reinforcement (Phase V) a rapid cessation of responding occurred. Phase III and IV produced high rates of responding with no post-reinforcement pause similar to FR schedules with no cost contingency.

In a later study Weiner (1967) found similar results. Humans demonstrated differential preference for alternatives with the most favorable cost to payoff contingency. Having a choice between two FR contingencies differing only on cost to payoff, they consistently chose the one providing the highest net gains of points.

The Weiner studies suggest that with human subjects there is also an interaction effect between schedule and magnitude of reinforcement very similar to that found with lower animals. However, with adult human subjects it appears that higher order decision-making can reduce or eliminate post-reinforcement pause on an FR schedule.

Operant Conditioning Principles Applied to Classroom Settings

This section reviews the literature concerned with the application of operant conditioning principles to classroom settings. This includes studies involving the mentally retarded, special education, and public school students.

Mentally retarded children. Behavior modification techniques have been used quite extensively in training and educating mentally retarded students. In a study comparing normal children with mentally retarded
children matched on MA, Johnson (1966) found that both groups learned within a few trials to respond in anticipation of reinforcement. Although response speeds of retarded Ss were much slower than those of the normals, both groups acquired the desired response at about the same rate and there was no difference in their rates of extinction.

Lovitt (1967) suggests some minor changes in a paper directed towards assessing learning disorders. His four point procedure includes baseline assessment and isolating behavioral components. However, in addition he says the goals and procedures of the referring agent should be evaluated and included if possible, and that information be transmitted back to the referring agent to enhance the agent's programming procedures. These recommendations are similar to those used in experimental animal studies but are extended to other relevant agents in the child's environment.

Redd and Birnbrauer (1969) studied the effects of contingent versus non-contingent reinforcement in relation to the presenting adult and their effect on the cooperative play of five severely retarded Ss. Using correlated amounts of reinforcement the contingent adults reinforced successive approximation of cooperative play behavior in target Ss and dispensed reinforcement to the other Ss in the group on an FI 45 second, limited hold 15 second schedule. The non-contingent adult dispensed a correlated amount of reinforcement every sixty seconds but it was not contingent on responding. Following extinction the adults reversed roles and conditioning was replicated. In both phases of this study Ss emitted cooperative play behaviors in the presence of the contingent adults and this behavior was controlled by his entry and departure. This
study indicates that contingent reinforcement was stronger than differences in sex, status, familiarity, and other aspects of the two adults. The adults presenting reinforcers acquired discriminative properties by being paired with specific reinforcement contingencies.

Whelan and Haring (1966) at the Children's Rehabilitation Unit, University of Kansas Medical Center have developed a process called "staging" to make behavioral techniques in the classroom more manageable. Staging refers to the concept of bringing a student under the control of environmental consequences before bringing another student into the classroom. Ten to fifteen "emotionally disturbed children" can be controlled using this method.

Birnbrauer, Wolf, Kidder and Tague (1965) examined the necessity of tokens in maintaining accuracy and high rates of studying, for mild and moderately retarded Ss. Seventeen Ss were taught two hours per day for one year using a token reinforcement system, knowledge of results and verbal approval for correct responding. Each student earned approximately two cents per day in tokens which were traded for an array of edibles, toys, and school supplies. One Ss behavior was not controlled enough for education under these contingencies but it was effective for the other Ss. To determine the effect of token reinforcement they were discontinued for 21 days. Three general trends were observed: Five Ss continued to perform with no measurable change, six Ss increased substantially in percentage of errors, four Ss increased disruptive behaviors and percentage of errors, and declined in amount of time spent studying. When token reinforcement was reinstated all ten Ss resumed their baseline level of performance. Token reinforcement appeared to be a very important variable in this study.
Vaughn (1968) using a token system was able to increase reading level 6 months to 1 year 9 months and math level 7 months to 2 years 5 months (Metropolitan Achievement Test) in 50 days using a gradually increasing ratio schedule (1:1 to 1:10) with eight moderately retarded Junior High school age students.

Locke (1969) using mild and moderately retarded Ss also examined the effects of token reinforcement in a more complex reinforcement setting. During pre-conditioning treatment the presence or absence of tokens (monetary) was combined with the social reinforcer "good" in either the same or an inverse relation to token delivery. He found that "good" functioned as a reinforcer and was not dependent on pre-conditioned association with tokens. However, conditioning using "good" as a consequence was enhanced by both direct and inverse association of the two classes of reinforcement.

Similarly, Gardner and Brandle (1967) studied independently the effects of instruction, verbal praise during learning, and a prize for performance. They found no difference in intentional and incidental learning, between the instruction-only group and the group given the prize for satisfactory performance. However, supportive praise enhanced both intentional and incidental learning.

Johnson (1969) used a number of positive and negative reinforcers to establish acquisition of academic skills and to extinguish disruptive behaviors in eight moderately retarded elementary school students. Attending behavior for these Ss resulted in social reinforcement from the teacher, a work record, and a reward card. The reinforcement menu was composed of small edibles and several small secondary reinforcers.
A time-out punishment contingency for disruptive behaviors was utilized and tokens were given to the group as a consequence of attending behavior. This was on a gradually increasing time interval schedule. A response-cost technique was also used on academic tasks. All eight Ss increased their task oriented behaviors and began working more independently. The group reinforcement procedure using tokens maintained a higher level of attending behavior than did social reinforcement during other periods. The reduction of non-task oriented deviant behavior did not decrease significantly for the group, however, four Ss demonstrated almost no deviant behavior during the baseline period. Two of the remaining four Ss did demonstrate a significant decrease in non-task deviant behavior.

Operant techniques have also been used successfully with severely and profoundly retarded Ss. Spradlin, Girardeau, and Corte (1965) using shaping techniques established an operant knob-pulling response in fifteen severely and profoundly retarded Ss. Their shaping procedure involved CRF for 20 to 100 responses, then shifting to a FR2, FR3, FR5, etc. These Ss showed typical high rates of responding on FR schedules with post-reinforcement pause, and low rates of responding when placed on FI schedules. Three FI schedules were studied: FI 30 second-13 sessions; FI 1 minute-20 sessions; FI 2 minute-25 sessions. Only one student demonstrated a rate increase just prior to reinforcement. Some Ss acquired the desired response when food was used as reinforcement but food would not then maintain the behavior. Deprivation made food more reinforcing for some Ss but not all. Three Ss responded at a higher rate on an FR schedule when deprived; however, the examiner explained
this increase as being a function of shorter post-reinforcement pauses. On FR schedules ranging between 25 and 350 response rate increased. Between FR 350 and FR 650 response rate varied and FR greater than 650 resulted in a decrease in response rate. Typical of FR and FI schedules these Ss maintained low rates with gradual increase when shifted from an FI to an FR schedule. Conversely, shifting from an FR to FI schedule resulted in an initial high rate of responding which gradually diminished to a low response rate typical of FI schedules.

Parline and Levinsky (1968) used a token system with a response cost contingency to extinguish five maladaptive behaviors demonstrated by four severely retarded children in a residential preschool. Tokens were presented intermittently, contingent on responses incompatible with the defined maladaptive behaviors. For two Ss physical restraint from 5 to 15 minutes was imposed for emitting maladaptive behaviors. Tokens were initially traded immediately for food and gradually increased to a one hour daily. A decrement in maladaptive behaviors occurred for all four Ss. The presentation and withdrawal of tokens was equally effective regardless of whether or not a time-out procedure was used. The range in rate of maladaptive behaviors during the baseline period was 58 to 192. The post-experimental rate of these same behaviors ranged from 50 to 86.

The above studies extending operant conditioning to mentally retarded subjects indicate that these students follow the same behavioral laws of learning as that of normal children although their response speeds are slower.
Verbal as well as tangible reinforcers were found to be effective in increasing, maintaining, and extinguishing a broad range of behaviors. They also demonstrate stable rates of responding of FR schedules and slower more erratic response rates with post-reinforcement pauses on FI schedules of reinforcement. A maximum ratio with declining results was found on FR schedules.

**Classroom settings.** Several studies have attempted to alter the behavior of an entire classroom using operant principles. Those attempting this have reported success when the total environment (classroom) is controlled. Hewett (1967) used an engineered classroom design in conjunction with a behavior modification model. He concentrated on developing a hierarchy of educational tasks, reinforcement for learning, and a functional degree of teacher structure. His reason for providing appropriate educational tasks was to present clearcut stimuli which could lead to appropriate responses. The presentation of positive reinforcement was an effort to increase or maintain response rate. The teacher structure functioned as a means of withholding positive reinforcement or presenting negative reinforcement for inappropriate responding. He used intermittent schedules giving check marks approximately every fifteen minutes. Hewett concentrated on making the learning experience positive and therefore gave check marks to be traded for tangible reinforcers once a week, as freely as possible. The teacher intervened and assigned a new task whenever the Ss performance rate was down. For maladaptive behaviors a time-out period was used during which the student could not earn check marks. Hewett says this model is feasible for use in public schools, although teachers' aides, well organized classrooms, and tangible rewards are a prerequisite for successful application.
Artuso (1969) used an engineered classroom to study its effects on attention to tasks and to look at the effectiveness of offering tangible reinforcers. His Ss were 54 children between the ages of eight and twelve years and they were assigned to six classrooms. These students demonstrated both learning and behavior problems. Two classes served as experimental groups during the first half of the year and as a control group during the second half of the year. The other two classes served as control during the first half of the year and as the experimental groups the second half of the year. Six teachers aides were used randomly in the nine classes. The control condition utilized any approach except the use of tokens or tangible reinforcers. The specific variables studied were attention to tasks measured by monitors in the classroom and achievement in reading and arithmetic as measured by the California Achievement Test. The results of this study show that the experimental design facilitated attention to tasks and resulted in significant gains in arithmetic but no differences were found in reading scores.

O'Leary and Becker (1967) used a token reinforcement model in a group of eight nine-year-old emotionally disturbed children to determine if this system could be applied by one teacher in an "average classroom." The token system consisted of giving ratings between one and ten which reflected the extent that the student remained in his seat, faced the front of the classroom, raised his hand to speak, worked, paid attention, kept his desk clear, and the accuracy of his arithmetic work. These variables were determined by an observer recording behavioral acts during a baseline period and during the experimental phase. The ratings could be exchanged for back-up reinforcers ranging in value from one to
twenty-nine cents. During the experimental phase the number of ratings given per day decreased from five to three and the number of points required for back-up reinforcers was gradually increased. In addition, the delay period between earning the points and receiving a back-up reinforcer increased from the end of the period to a four day delay. There were no punishment contingencies but group points and social reinforcement for appropriate behaviors were given. Deviant behaviors decreased for all eight Ss between baseline and the end of the experimental period. The group mean for deviant behaviors during the baseline period was 76 percent while the group mean for the same behaviors during the experimental period was 10 percent. The authors, however, suggest that other variables may have contributed to the results. These include the teacher enrolling in a psychology class which emphasized operant and social learning, the teacher being able to give more individual attention when the percentage of deviant behaviors decreased, their work being returned more promptly, new teaching material, and because a reversal procedure was not used to determine control.

Wolf, Giles, and Hall (1968) in an after-school remedial education program for underachieving 5th and 6th grade students, were able to demonstrate significant increases in academic achievement and report card grades following use of a token reinforcement system. A control group was used for comparison.

Quay, Werry, McQueen and Sprague (1966) working with "conduct problem" students were able to increase attending behavior by making the presentation of candy contingent on attending behavior. A box containing a light was attached to each of the five students' desks. The light
flashed on at random times and if the student was attending to the teacher when the light flashed on he was given a piece of candy. The ratio of reinforcement increased from CFR to FR5. Observation of attending behavior consisted of ten 15-second intervals. During the baseline period, the mean attending of the five Ss was 6.18; the mean attending rate during the experimental period was 9.09; and the mean attending rate for the last 20 days (52 days total) of the experimental period was 11.43. Attending behavior increased significantly for all five Ss in the experiment.

Knowles (1970) taught twelve teachers "precise behavior management techniques" and subsequently evaluated the effectiveness of their applying these techniques to 351 elementary school children. These Ss were in Special Education or were selected children enrolled in regular classrooms. All of the teachers using these techniques were successful in changing their Ss behaviors both at home and in the classroom. Of 58 changes attempted, 47 were rated successful, 10 partially successful, with only one failure being recorded. Some results relating to the antecedent hypothesis are as follows: As appropriate behaviors increased inappropriate behaviors decreased; there was an increase in rate of verbalization; working periods increased; correctly performing in arithmetic and reading (4 of 9 projects completed); 22 of 24 subjects increased their rate of mathematics performance (increased from one to twelve times). Token economies were effective for all teachers and when the tokens were subsequently dropped, the appropriate behaviors were maintained by social reinforcement which had previously been paired with the presentation of tokens. In addition, the attitudes of the teachers towards exceptional children, as measured by questionnaires, were improved.
O'Leary, Becker, Evans and Saudargas (1969) working with second graders found that the successive introduction of rules, educational structure, ignoring disruptive behavior and praising appropriate behavior did not consistently reduce disruptive behaviors. However, the use of a token reinforcement system in addition did reduce the frequency of disruptive behavior in five of six Ss. Extinction increased the disruptive behavior of four of the five students. Follow-up data indicated that control was transferred from the tokens to reinforcers in the educational system. However, the token system was only in effect during the afternoon and there was not generalization of appropriate behaviors to the morning classes. Academic achievement and attendance were also enhanced during the year and the authors suggest that this may have been related to the utilization of the token system.

Kuypers, Becker and O'Leary (1968) used a token system to control disruptive behaviors in an "adjustment class" of six third and fourth graders. No shaping procedures were used nor was a systematic application of social reinforcement instituted. The decrease in disruptive behaviors was significant for both the morning and afternoon classes, however, the difference between baseline behavior and contingent behavior was greater in the afternoon than in the morning. Back-up reinforcers ranged in value from five to nineteen cents. Although the changes in behavior under this program were significant they were not as effective as the more complex system used by O'Leary, Becker, Evans and Saudargas (1969).

Clark, Lachowicz and Wolf (1968) instituted a token system for five female school dropouts to do remedial workbook assignments. Significant achievement gains, as measured by tests, were seen during
the two month program. The token reinforcement system functioned as such for each of the five Ss.

Shores (1969) examined the effect of social class in terms of its effect on reinforcement. He used 80 fourth graders designated as lower or middle class and normal or under-achievers. This group was broken into eight groups of ten, with half the members in each group receiving tangible reinforcement and the other half receiving intangible reinforcement for performance on a three size discrimination task. Results of this study indicate that performance was a function of social class, type of reinforcement and responsiveness to reinforcement. Tangible reinforcers were not effective for lower class underachievers but were for middle class underachievers. Middle class achievers and lower class underachievers both performed better for intangible reinforcers. Lower class achievers performed better with tangible reinforcers.

McGrade (1968) using lower and middle-class English boys on a size discrimination task found no significant interaction between social class and reinforcers, nor was there a difference in performance as a function of social class. She did find that a signal light and candy resulted in fewer trials to criterion than did verbal conditioning ("good, find, right, and correct").

Unikel (1969) using low socioeconomic status children investigated the effects of tangible and social reinforcement on a simple discrimination learning task. Both social and tangible reinforcers facilitated performance on this learning task and this learning was also more resistant to extinction than was the non-reinforced control group.
The above studies indicate that when applying operant principles to the classroom where several students are working simultaneously, the engineered classroom provides controls that enhance the effectiveness of the reinforcers and/or punishment techniques being used. In this setting tangible and social reinforcers are effected by the history (social class) of students. This review indicates that operant principles can be effectively utilized in extinguishing inappropriate behaviors as well as strengthening appropriate behaviors and is also effective in teaching academic subjects.

**Summary**

This review of literature has shown that operant conditioning principles derived from experimental animal laboratories are an effective means of increasing, decreasing, maintaining, and extinguishing human behavior in the classroom as well as in individual applications.

The literature cited indicates that mentally retarded students follow the same behavioral laws as the "conduct problem" children and children in the normal classroom.

In general, fixed-ratio schedules of reinforcement were found to maintain higher more stable rates of responding with shorter post-reinforcement pauses. Response cost contingencies were also found to be effective in controlling inappropriate behaviors.

The most effective programs take into account all aspects of the student's environment including the physical setting of the classroom. A gradually increasing fixed-ratio schedule in conjunction with response cost contingencies to enhance control seems to be most effective in the classroom.
CHAPTER III
METHODOLOGY

Objectives and Hypotheses

The objectives of this study were to determine which reinforcement schedule would result in the highest rate of responding during the contingency phase and which would result in the greatest gain in arithmetic skill as measured by a standardized achievement test.

This study attempted to:

1. Determine if there are differences in the rate of learning arithmetic skills as a result of different reinforcement schedules.

2. Determine which reinforcement schedule would bring about the highest performance rate during the contingency phase.

3. Determine if a higher rate of working arithmetic problems during the contingency phase would result in a higher achievement level of arithmetic skill.

4. Determine if the systematic application of reinforcement contingent on working arithmetic problems would result in a higher acquisition of arithmetic skill than would teaching not systematically applying this technique.

5. Determine if performance rate could be brought under experimental control through the presentation and withdrawal of reinforcement.

The following questions were asked to serve as a guide to meet the objectives of this study:

1. Will the systematic application of reinforcement bring about higher performance rates?
2. Will continuous reinforcement with a punishment contingency bring about higher performance rates than continuous reinforcement without a punishment contingency?

3. Will continuous reinforcement with a punishment contingency bring about higher performance rates than those of a comparison group?

4. Will continuous reinforcement bring about higher performance rates than those of a comparison group?

5. Will continuous reinforcement with a punishment contingency bring about more change in levels of arithmetic achievement than continuous reinforcement without a punishment contingency?

6. Will continuous reinforcement with a punishment contingency bring about more change in levels of arithmetic achievement than those of the comparison group?

7. Will continuous reinforcement bring about more change in levels of arithmetic achievement than those of the comparison group?

8. Will performance rates return to baseline levels when contingent reinforcement is removed?

Subjects

This study was based on a sample of thirty students attending learning adjustment classes in the Idaho Falls area during the winter of 1971. Three classes with nine, ten, and eleven students made up the three groups. These students had been placed in "learning adjustment" classes by an admissions committee of teachers, administrators, and psychologists several months prior to the beginning of this study.
This sample was chosen because of the need to find effective methods to motivate these kinds of students to continue in school and to benefit from school experiences. The children used in this study demonstrated the following behavioral parameters in the regular classrooms: Having average or above academic ability, doing below grade level work, and emitting behaviors disruptive to classroom settings. The composition of the classes were as follows:

Group I: The nine students in the Ucon class ranged in age from eight years to twelve years and consisted of two females and seven males. This group was taught on a continuous schedule of reinforcement.

Group II: The ten students in the Lincoln class ranged in age from seven years to twelve years and consisted of three females and seven males. This group was placed on a continuous reinforcement schedule with a punishment contingency.

Group III: The eleven students in the Hillview class ranged in age from eight years to eleven years and consisted of two females and nine males. This group was used as a comparison group.

Assessment and Instruments

The text used was Elementary School Mathematics (Eicholz, and O'Daffer, 1971). This series of texts presents principles of mathematics in small sequential steps that were easily marked off in twenty minute units.

The unit tests consisted of items, requiring approximately ten minutes to work, adapted from: Unit and Review Tests to Accompany Elementary School Mathematics.
California Achievement Test. The California Achievement Test was used for the pre- and post-tests. National standardization of the CAT was based on a sample containing 203,684 students in grades one through twelve from 36 states. Stratified random sampling with proportional allocation was used in selecting the student sample. Stratification was based on geographic region, average, enrollment per grade, and community type.

The mathematics section of the California Achievement Tests is composed of three parts:

The CAT Concepts Section provides situations which reveal the presence or absence of basic functional abilities. These abilities include understanding and application of concepts in numerals, order relations, symbols, and measurement (Tiegs and Clark, 1970a, p. 21).

The CAT Computation Section is designed to evaluate the extent of the student's skill in the fundamental operations which are essential in addition, subtraction, multiplication, and division of positive integers, fractions, and measurement quantities. (Tiegs and Clark, 1970a, p. 22)

The CAT Problems Section is designed to test the student's ability to solve written single step and multiple step problems which involve the performance of fundamental operations and the understanding of basic concepts for their solution (Tiegs and Clark, 1970a, p. 23).

Pilot Study

The pilot study was conducted at the Emerson School "Learning Adjustment Class" in Idaho Falls, Idaho. The ten male students in this class were placed there for the same reasons as those students in the experimental groups. The purpose of this pilot study was to establish working procedural techniques and to establish gold strike stamps as a positive reinforcer for academic performance.
Each academic activity was divided into units requiring approximately twenty minutes to complete. One week prior to collecting baseline data the students in the class received letter grades for performance but no other tangible reinforcers were given. During the five days following this the teacher recorded the completion of each twenty minute unit for each of the ten students. During this baseline period no tangible reinforcers were administered.

Following the baseline period each student was given two empty gold strike stamp books and a booklet with pictures of items and a listing of the number of books required for their purchase. It was explained to their satisfaction that they could earn one token for each twenty minute unit successfully completed and that these tokens could be traded every two days for two ten-stamp size gold strike stamps per token.

For the next five days this procedure was followed and each unit was recorded by the teacher. The teacher reported this to be a very effective method of motivation and reported a minimum of problems in applying it to his class.

A simple significance of the difference between two means for correlated samples (t-test) was used to analyze the difference in performance levels from the baseline phase to the contingency phase.

Table 1 presents data on the performance of the group under baseline and contingency conditions.

An inspection of the data shows a significant increase in performance rate with the introduction of tokens and gold strike stamps made contingent upon performance.
Table 1. Means and standard deviation (pooled variance) on baseline and contingency performance levels.

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>S.D.</th>
<th>t-test*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline phase</td>
<td>21.2</td>
<td>15.07</td>
<td>7.03</td>
</tr>
<tr>
<td>Contingency phase</td>
<td>31.8</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*t significant at the .001 level.
CHAPTER IV
RESULTS AND DISCUSSION

Analysis of Data

The following questions served as a guide for this study. Data will be presented in this section as it relates to each question.

Question 1: Will the systematic application of reinforcement bring about higher performance rates?

Table 2 presents data on performance rates increases between baseline and contingency phases under three conditions.

Table 2. Means and standard deviations (pooled variances) for baseline and contingency phases under three conditions.

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean (Baseline)</th>
<th>Mean (Contingency)</th>
<th>S.D. (Baseline)</th>
<th>S.D. (Contingency)</th>
<th>t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>3.67</td>
<td>5.59</td>
<td>3.98</td>
<td>4.38**</td>
<td></td>
</tr>
<tr>
<td>Group II</td>
<td>3.90</td>
<td>7.65</td>
<td>3.75</td>
<td>5.12*</td>
<td></td>
</tr>
<tr>
<td>Group III</td>
<td>1.27</td>
<td>2.16</td>
<td>1.76</td>
<td>3.38**</td>
<td></td>
</tr>
</tbody>
</table>

* t significant at the .001 level.
** t significant at the .01 level.
From Table 2 it may be seen that there is a significant increase in performance rate between the baseline phase and the contingency phase for all three groups. Group I and III increases are significantly different at the .01 level and Group II at the .001 level.

Question 2: Will continuous reinforcement with a punishment contingency bring about higher performance rates than continuous reinforcement without a punishment contingency?

Table 3 presents data on performance rates for Groups I and II during the contingency phase.

Table 3. Means and standard deviation (pooled variance) for Group I and Group II for the contingency phases.

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>S.D.</th>
<th>t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>5.99</td>
<td>.673</td>
<td>3.06*</td>
</tr>
<tr>
<td>Group II</td>
<td>7.65</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*t significant at the .01 level.

From Table 3 it may be seen that Group II, which was on a continuous reinforcement schedule with a punishment contingency performed at a significantly higher rate during the contingency phase than did Group I, which was on a continuous reinforcement schedule.

Question 3: Will continuous reinforcement with a punishment contingency (Group II) bring about higher performance rates than those of a comparison group (Group III)?
Table 4 presents data on Groups II and III for the contingency phase of the study.

Table 4. Means and standard deviations for Group II and Group III for the contingency phases.

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>S.D.</th>
<th>t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group II</td>
<td>7.65</td>
<td>1.359</td>
<td>12.97**</td>
</tr>
<tr>
<td>Group III</td>
<td>1.76</td>
<td>.484</td>
<td></td>
</tr>
</tbody>
</table>

**t significant at the .001 level.

From Table 4 it may be seen that Group II, which was on a continuous schedule of reinforcement with a punishment contingency performed at a significantly higher rate during the contingency phase than did Group III, which was the comparison group.

Question 4: Will continuous reinforcement bring about higher performance rates than those of a comparison group?

Table 5 presents data on Groups I and III for the contingency phase of the study.

Table 5. Means and standard deviations for Group I and Group III for the contingency phase.

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>S.D.</th>
<th>t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>5.59</td>
<td>1.586</td>
<td>6.99**</td>
</tr>
<tr>
<td>Group II</td>
<td>1.76</td>
<td>.484</td>
<td></td>
</tr>
</tbody>
</table>

**t significant at the .001 level.
From Table 5 it may be seen that Group I, which was on a continuous schedule of reinforcement performed at a significantly higher rate during the contingency phase than did Group III, which was the comparison group.

Questions 5, 6, and 7 will be considered together.

Question 5: Will continuous reinforcement with a punishment contingency bring about more change in levels of arithmetic achievement than continuous reinforcement without a punishment contingency?

Question 6: Will continuous reinforcement with a punishment contingency bring about more change in levels of arithmetic achievement than those of the comparison group?

Question 7: Will continuous reinforcement bring about more change in levels of arithmetic achievement than those of the comparison group?

Table 6 presents data on the achievement level change for each of the three groups.

Table 6. Analysis of co-variance for the three groups on the California Achievement Test.

<table>
<thead>
<tr>
<th></th>
<th>Adjusted Means</th>
<th>Source</th>
<th>D.F.</th>
<th>M.S.</th>
<th>Adjusted F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>307.4</td>
<td>Treatment</td>
<td>2</td>
<td>855.86</td>
<td>.158*</td>
</tr>
<tr>
<td>Group II</td>
<td>307.4</td>
<td>Reg.</td>
<td>1</td>
<td>846.04</td>
<td></td>
</tr>
<tr>
<td>Group III</td>
<td>302.3</td>
<td>Error</td>
<td>27</td>
<td>542.36</td>
<td></td>
</tr>
</tbody>
</table>

*F not significant.
It may be seen from Table 6 that there was no difference between groups in the amount of change from pre to post-test on achievement scores.

Question 8: Will performance rates return to baseline levels when contingent reinforcement is removed?

Table 7 presents data on the baseline and the extinction phase for each of the three groups.

Table 7. Baseline and extinction phase means for the three groups.

<table>
<thead>
<tr>
<th></th>
<th>Baseline Means</th>
<th>Extinction Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>3.67</td>
<td>5.78</td>
</tr>
<tr>
<td>Group II</td>
<td>3.90</td>
<td>9.10</td>
</tr>
<tr>
<td>Group III</td>
<td>1.27</td>
<td>1.00*</td>
</tr>
</tbody>
</table>

*Returned to below baseline rate.

It may be seen from Table 7 that neither Group I nor Group II returned to baseline performance rate. However, Group III did return to below baseline performance rate.

Discussion

It was the purpose of this study to determine if the presentation of the same kinds of reinforcers to groups of students would result in an increase in performance rates.
The data indicate that there was a definite increase in the number of arithmetic units successfully completed by each of the three groups. One student from Group I and one student from Group III did not increase their performance rate during the contingency phase of the experiment. However, the student in Group I was performing at a higher rate during the later part of this phase and continued to do so during the extinction phase.

A second objective of this study was to determine if a CRF schedule with a punishment contingency would bring about a greater change in performance rate than a CFR schedule without a punishment contingency.

Group II, performing with a punishment contingency averaged a little over two units per week per student more than the students in Group I, who were on a CRF schedule. There were only two students in Group I who performed at the same or a higher rate than the class average of Group II.

A third objective of this study was to determine if a CRF schedule with a punishment contingency would bring about higher performance rates than those of a comparison group.

Group II, performing with a punishment contingency averaged almost six units per week per student more than the students in Group III, who were used as a comparison group. Group II, however, averaged almost three units per week per student more than the students in Group III during the baseline period. Every student in Group II increased their performance rate during the contingency phase. In Group III one student decreased in rate and two students performed at the same rate during the contingency phase as during the baseline phase. The highest average performance rate during the contingency phase in Group II was 9.3 units per week and the
lowest rate was 5.4 units per week. In contrast to the above, the student performing at the highest rate in Group III during the contingency phase completed an average of 2.3 units per week and the lowest completed only 1 unit per week.

A fourth objective of this study was to determine if a continuous schedule of reinforcement would bring about higher performance rates than those of a comparison group.

Group I, performing on a CRF schedule, completed almost four units per week per student more than students in the comparison group. The range in performance level for Group I during the contingency phase was from 8 to 3.5 units per week per student. Group I averaged 2.4 units per week per student more than Group III during the baseline period.

Although Group III performed under behavioral contingencies similar to those of Groups I and II, there were some major differences. Group III's contingencies were not as specifically defined and more points could be earned for good behavior, which was determined by teacher judgment, than could be earned by academic performance. In the assignment contract, moving back into the regular classroom may not have been reinforcement, although it was considered to be that by the teacher.

A fifth objective of this study was to determine the effects of different schedules of reinforcement on achievement level change as measured by the arithmetic section of the California Achievement Test.

Although there were systematic differences in the number of arithmetic units successfully completed under different schedules there were no corresponding changes in achievement gain for any group over any other group. From this study it would appear that working arithmetic
problems correctly does not necessarily indicate that the student is learning from this exercise. It is also possible that the students did learn the new concepts involved but not thoroughly enough to transfer them to other problems requiring the use of these concepts. A third explanation may be that the student did not learn the concepts well enough to retain them until the post-test was administered.

The last question considered by this study was: Will performance rates return to baseline levels when contingent reinforcement is removed? Only Group III returned to baseline level performance rates.

Both Groups I and II performed at higher rates during the extinction phase than the group average for the seven week contingency phase. The students in both of these groups increased their performance rates from the first week to the last week of the contingency phase. Most of these students continued this increase into the extinction phase of the experiment. These results were not unexpected since the teachers in all three groups paired social reinforcement with the presentation of tangible reinforcers.

A possible explanation of Group III's return to baseline may center around the teacher's use of contingent reinforcement for good behavior. Good behavior was not recorded in this study but it may have continued as a major consideration during the extinction phase and performance rates dropping may have reflected the teacher's emphasizing good behavior over academic performance.
CHAPTER V

SUMMARY

This study compared the effects of two reinforcement schedules applied to two groups of students enrolled in "learning adjustment" classes in the Idaho Falls area during the school year 1970-71. These classes were composed of students not performing at grade level in the regular public school classroom. A comparison group from the same population was also utilized. The classes were held in three different schools and selection of the students in each class had been completed several months prior to this study. A total of thirty students ranging in age from seven to twelve years participated in the study.

The same series of arithmetic textbooks were used by the three classes and study units requiring approximately twenty minutes to complete were established for each level. A ten-minute test was administered following each unit requiring a 90 percent accuracy level to complete the unit.

Tokens were used in both experimental groups and subsequently traded for stamps at the rate of three stamps per token.

Group I was on a continuous reinforcement schedule. They were given a token upon the completion of each unit and traded these tokens every two days for stamps.

Group II was also on a continuous reinforcement schedule but a punishment contingency was added. Each student in this group was given seven tokens at the beginning of each two day interval. At the end of
each interval the student returned to the teacher those tokens not earned and traded the tokens earned for stamps.

Group III was used as a comparison group. This group was given points for academic performance as well as "good" behavioral conduct, which earned tangible reinforcers during the first three weeks of the contingency phase of the experiment. During the last four weeks of this phase they performed according to an assignment contract the student signed agreeing to complete a given number of units per day. Fulfillment of this contract gave the student a chance at a grab bag and fifteen minutes free time at the end of each day.

The pre- and post-test used to measure achievement level change was the Mathematics section of the 1970 edition of the California Achievement Test.

The findings of this study can be summarized as follows:

The application of tangible reinforcers resulted in the successful completion of more arithmetic units for all three groups.

Continuous reinforcement with a punishment contingency resulted in higher performance rates than did continuous reinforcement at the same rate but without a punishment contingency.

Continuous reinforcement with a punishment contingency resulted in higher performance rates than those of a comparison group.

Continuous reinforcement without a punishment contingency also resulted in higher performance rates than those of the comparison group.

Although there were very definite differences in the number of units completed under different schedules of reinforcement there were no corresponding differences in achievement level change between the three
groups as measured by the mathematics section of the California Achieve-
ment Test.

A return to baseline level performance rates during extinction was
demonstrated by the comparison group but not by the two experimental
groups. A possible explanation of this phenomenon is that social
reinforcement which was paired with the presentation of tangible
reinforcers during the study may have maintained high performance rates
for these two groups during extinction.
LITERATURE CITED


ASSIGNMENT CONTRACT

I ___________________________ do solemnly promise to complete
___________ major assignments on this day of ______________.

If, at the end of the day these assignments are completed, I
will have a chance for the grab bag, fifteen minutes free time, and I
will be moved one more step closer to my regular classroom.

Because of the above mentioned rewards I will receive upon
completion, I will not receive points for these assignments. I
realize that my regular classroom does not give points, only grades,
so I will get used to that now.

Signed ___________________________

Witnessed by _______________________

White chips ______________

This contract is completed

Signed ___________________________
VITA

Ronald C. Bennett

Candidate for the Degree of

Doctor of Philosophy

Dissertation: The Comparative Effects of Two Reinforcement Schedules Applied to Groups in Teaching Arithmetic Skills

Major Field: Psychology

Biographical Information:

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Education: Attended elementary school in Grace, Idaho and Dayton, Idaho; graduated from high school in Burley, Idaho, 1958; received Associate of Science Degree from Ricks Junior College, Rexburg, Idaho in 1964; received the Bachelor of Science Degree from Utah State University in 1966, with a major in Psychology and a minor in History; did graduate work and completed requirements for the Master of Science degree specializing in School Psychology, at Utah State University in 1970; continued at Utah State University for the degree of Doctor of Philosophy; completed requirements for Doctor of Philosophy degree in 1973.