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The Effects of Abrupt and Graduated Temporal Reductions on Academic Behavior

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THE EFFECTS OF ABRUPT AND GRADUATED TEMPORAL

REDUCTIONS ON ACADEMIC BEHAVIOR

by

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James Pezzino

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ABSTRACT

The Effects of Abrupt and Graduated Temporal

Reductions on Academic Behavior

by

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The author investigated the effects of abrupt and graduated temporal reductions on academic performance. Six elementary school children who were referred to a remedial special education classroom received token reinforcement contingent on the number of correct math problems answered during daily sessions. A multiple baseline across subjects design with replication of baseline and experimental conditions was employed. The design also balanced the order of exposure to an abrupt reduction in time limits (20 - 5 - 20 min.) and a graduated sequence of time reductions (20 - 15 - 10 - 5 - 20 min.). Children also performed copying tasks daily under a constant time limit in order to assess the degree to which the effects of temporal manipulations on one academic behavior (math) generalized to another academic behavior (copying). The findings demonstrated that as a result of systematic temporal reductions students completed more math problems correctly in five minutes than twenty minutes of baseline. More specifically, the findings demonstrated that graduated temporal reductions markedly enhanced the math performance of slow learners. Furthermore, when students were exposed to an abrupt temporal reduction first their math performance declined, whereas, abrupt temporal reductions which followed graduated temporal reductions markedly enhanced both rate and number of correct math problems. A return to baseline conditions demonstrated that the improved math rates were not completely reversible. Additionally, improved math performances were found to be enduring as indicated by two follow-up math probes conducted two and five weeks after the study. Although copying performance improved over the duration of the study, these improvements did not closely correspond with the math time manipulations. Therefore, the effects of temporal manipulations on math performance did not appear to generalize to a non-reinforced behavior (copying words) that was performed under constant time limits.

(108 pages)

CHAPTER I

INTRODUCTION

In an effort to meet the individual needs of students and facilitate their acquisition of academic behaviors, special education teachers have frequently expanded the time limits of academic assignments beyond what would normally be allotted in a regular classroom (Heidman, 1973; Peterson, 1973). The additional time to complete academic work was commonly thought to decrease "pressure" associated with more rigid time limits. This strategy takes on additional relevance because many workers in the field believe that retarded children are more easily frustrated than other children (Goldstein and Seigle, 1971), and because retarded individuals are often characterized as being relatively slow in the acquisition of academic skills (Rothstein, 1971).

Unfortunately, the tactic of expanding temporal limits for slow learners to complete their academic assignments has largely been based on common sense rather than on empirical findings. There is some evidence, however, which suggests that the opposite tactic, that is, reducing temporal limits may increase the rate of academic and non-academic behaviors. For example, Ayllon and Haughton (1962) demonstrated that the poor eating habits of institutionalized schizophrenics improved when access to the ward dining room was systematically reduced.

Other findings have indicated that the academic behavior of children would improve as the result of reductions in time limits. Hopkins, Schutte, and Garton (1971) found that first and second graders increased their rates of written work when the total amount of time allotted to complete the assignments was gradually reduced. Ayllon and Kelly (1972) conducted a study in which the amount of time given students to complete mathematics and writing assignments varied. Their findings also suggested that the rate of correct academic performance increased as time limits were reduced.

Ayllon, Garber, and Pisor (1976) attempted to systematically restrict temporal limits to enhance the academic performance of three educable mentally retarded children. The authors reported that graduated temporal reductions resulted in marked increases in the rate of correct responding. Abrupt temporal reductions, however, resulted in decreases in the rate of academic performance.

While several temporal reduction techniques have been discussed in the literature, little is clearly understood regarding the effectiveness of these techniques since (a) most studies have used time reductions only as a convenient method of solving procedural problems rather than focusing on temporal reductions as an important independent variable in its own right, (b) several studies have manipulated temporal limits and other variables simultaneously thereby confounding the findings, and (c) studies conducted to date have not employed experimental designs which clearly demonstrate causality between time limits and performance.

Rather than altering temporal limits for completing a task, behavioral approaches have typically employed contingent rewards to enhance the performance of slow learners. In the present study the investigator integrated a temporal reduction procedure with a token economy procedure. More specifically, the effects of abrupt and graduated temporal reductions on the academic performance of slow learners who were responding on a token economy system were investigated. Furthermore, this study attempted to assess the durability of these effects and the degree to which they generalized to another academic behavior.

Statement of the Problem

To date, very few studies have attempted to investigate the effects of systematically restricting announced temporal limits on academic tasks. Some research has indicated that a gradual reduction of time limits may increase accuracy and rate. Unfortunately, these studies have been characterized by several methodological weaknesses. The Ayllon et al. (1976) study has been criticized because of possible biases resulting from sequence effects and teacher bias. Other studies (Garber, 1974; Hopkins, Schutte, and Garton, 1971) did not produce clear effects because more than one independent variable was manipulated simultaneously. Furthermore, few of these studies have incorporated adequate follow-up procedures to assess durability of effects over time. It is essential to know if the experimental treatment has an impact after the formal experimental procedures have been discontinued. In addition, an assessment of the degree to which the effects of systematic time restriction generalized to other academic behaviors has been lacking.

In summary, the problem is that no studies have clearly demonstrated the effects of systematically restricting time limits on the academic behavior of slow learners. Furthermore, there have been no attempts to assess the durability and generalizability of the effects of the time manipulation procedures employed.

Purpose

It was the intent of this study to:

1. Assess the effects of a graduated reduction in time slow learners were allotted to perform math problems (an academic task).

2. Assess the effects of an abrupt reduction in the time slow learners were allotted to perform math problems (an academic task).

3. Assess the effects of a history of an abrupt reduction of time limits on the academic performance of slow learners during a graduated reduction in time limits and, conversely, assess the effects of a history of a graduated reduction in time limits on the academic performance of slow learners during an abrupt reduction in time limits.

4. Assess the durability of the effects of systematic manipulation of temporal limits on the academic performance of slow learners.

5. Assess the degree to which the effects of systematic manipulation of temporal limits for one class of slow learners' behaviors (math problems) generalizes to another academic behavior (copying words).

CHAPTER II

REVIEW OF RELATED LITERATURE

The review of literature which follows has been carefully delimited to present the reader with relevant and significant synopses of available literature on the effects of temporal reductions on performance. Also included are brief overviews regarding the effects of antecedent variables on behavior, and, the effects of the limited hold contingency on behavior. It was considered beyond the scope of this research to conduct an exhaustive search of the literature on token economy systems (the interested reader is referred to Ayllon and Azrin, 1968; O'Leary and Drabman, 1971; Kazdin and Bootzin, 1972; Kazdin, 1975) or schedules of reinforcement (the interested reader is referred to Ferster and Skinner, 1957; Thompson and Grabowski, 1972). The literature summarized is intended to provide information sufficient for understanding the rationale, purpose, and scope of the present research.

The success of behavioral procedures in remediating educational deficits has been well documented (see O'Leary and O'Leary, 1972 for an anthology of such studies). The methods most commonly employed to enhance the performance of slow learners often focus on the systematic manipulation of reinforcement contingencies. For example, studies using token economies (Birnbrauer, Wolf, Kiddler, and Tague, 1964; Wolf, Giles, and Hall, 1968) and studies using free-time as a reinforcer (Osborne, 1969; Lovitt, Guppy, and Blattner, 1969) have demonstrated their usefullness in educational settings. With few exceptions, the alternative or supplemental method of improving academic performance by manipulating antecedents such as announced temporal limits has not been evident in the behavioral approaches.

Inasmuch as announced temporal restrictions limit the amount of time in which reinforcement is made available, it is similar to the limited hold contingency. Limited hold refers to a restriction placed on a reinforcement schedule requiring that the response eligible for reinforcement (e.g., a correctly completed math problem) be emitted within a particular time limit or reinforcement is withheld. The limited hold contingency has been described as an effective way to increase rate of responding under interval reinforcement schedules (Sulzer-Azaroff and Mayer, 1977, pp. 353-355) and data derived from animal research have demonstrated that the imposition of a short limited hold contingency has the effect of increasing response rates (Reynolds, 1968). Even though antecedents (e.g., setting events in the form of verbal instructions) have long been recognized as powerful behavior change agents (Bijou and Baer, 1961, pp. 21-22), and the limited hold contingency has been described as capable of producing high rates of performance (Ferster and Skinner, 1957; Sulzer-Azaroff and Mayer, 1977), to date, very few studies have attempted to investigate the effects systematically manipulating announced temporal restrictions on academic performance.

A limited amount of data are available which suggest that the rates of certain functional behaviors can be increased by gradually reducing temporal limits. Ayllon and Haughton (1962) used a food reinforcer in conjunction with a temporal reduction procedure in an attempt to improve the eating behavior of institutionalized schizophrenics. Several subjects were chosen because they had a history of refusal to eat and, prior to the study, these subjects had remained relatively unaffected by one or more of the following treatments: spoonfeeding, tubefeeding, intravenous feeding and electroshock. The temporal reduction procedure consisted of gradually limiting access to the ward dining room from 30 minutes to 5 minutes. The subjects demonstrated improved eating behaviors as a result of reducing the time limits from 30 minutes to 20 minutes, and from 20 minutes to 15 minutes. Only under the stringent time limit of 5 minutes did the subjects show a temporary drop in eating performance. Unfortunately, the authors focused principally on the reinforcement aspects of the treatment rather than the temporal reduction aspects as well. Although changes in rate of eating as a function of the temporal reductions were not reported, it is apparent that eating rates increased progressively each time the temporal limits were further reduced because the percentage of food eaten remained relatively stable while the time allottments continued to decrease.

Sanok and Ascione (1978) investigated the effects of graduated temporal reductions, tangible rewards, and praise on the prolonged eating behavior of a 5 year old. The authors employed a changing-criterion single-case design in both the home and other settings. The results showed that the institution of graduated time limits of 30, 25, and 20 minutes produced reductions in the amount of time the subject used to finish meals. The data indicated that the subject met the announced time limits 100% of the time during the initial treatment phases and, when the reinforcement contingencies were varied, the subject met criteria from 91 to 95% of the time. Outside the home setting, however, the subject complied with the announced time limits only 43% of the time. The authors reported that responding continued to meet the most restrictive requirement as indicated by a four- and eight-week followup. These findings lend further support to the notion that the announced temporal reductions can effectively increase rate of performance.

Other data have suggested that the procedure of gradually reducing time limits can increase both the rate and the accuracy of academic performance. Hopkins, Schutte, and Garton (1971) found that 24 first and second graders increased their rate of completing written work when they were allowed to go to a playroom after their papers had been scored. Subsequently, the total amount of time allowed for students to complete their assignments and then play was gradually reduced from 50 to 35 minutes. The authors reported that a progressive increase in work rates was correlated with these temporal reductions. Furthermore, there was a clear tend toward fewer errors as the study progressed and the time limits were further reduced. Unfortunately, because the availability of reinforcement and the opportunity to engage in printing were manipulated simultaneously it was impossible to determine which variable was responsible for the rate increases. The findings were also confounded because the teacher gradually increased the length of the assignments during the course of the experiment. Also, because Hopkins, et al., did not employ an experimental design which controlled for practice effects, it is possible that such effects were responsible for the rate increases. Once again, the researchers were not concerned with some of the aforementioned problems because the main focus of the study was on the reinforcing properties of free-time activities rather than the effects of time limits on academic performance. In fact, the authors only mention the temporal reductions in passing as a potential way of providing the teacher with extra teaching time. Whether recognized or not, however, their data suggest that limiting time may increase rate of performance.

In a study which used time limits more purposely, Ayllon and Kelly (1972) varied the amount of time given students to complete their academic assignments. The problems of changes in magnitude of reinforcement encountered in the Hopkins, et al., (1971) study were controlled for by a constant token reinforcement schedule. Therefore, the only independent variable manipulated was the amount of time to respond. The study employed a reversal design with time limits of 15, 7, 15, 3, 1, and 3 minutes. The results showed that the rate of correct responding steadily increased as the time limits decreased. Unfortunately, because no reversals occurred when time limits were reversed, it was not possible to rule out the possibility that practice effects were responsible for the rate increases.

Garber (1974) conducted a study employing a multi-baseline design with special education students to determine if decreases in temporal limits would result in increases in the rate of academic performance. The design used, helped control for the problems of irreversibility and practice effects encountered in the previous studies. The academic behavior consisted of ten math problems which were at either of two levels of difficulty. The students were reinforced on a token economy system. Once again, the results suggested that rate increases in academic performance corresponded with each reduction in temporal limits, however, the data were confounded in that the independent variable, temporal limits, and academic complexity were manipulated concurrently making it impossible to determine if rate changes were due to the change in math complexity or some characteristic of the temporal shifts.

In a more recent study, Ayllon, Garber, and Pisor (1976) attempted to systematically restrict temporal limits to enhance academic performance in three educable mentally retarded children. Subjects received token reinforcement contingent on the number of correct math problems answered during daily session. A reversal design was used to evaluate the effects of an abrupt reduction in time limits compared with a graduated sequence of reductions. The authors reported that the graduated sequence of temporal reductions resulted in an increased rate of correct responding ranging from 125% to 266%. In contrast, the authors reported that abrupt reductions in time limits produced interfering emotional behaviors (e.g., complaining that they "can't finish in time") and resulted in rate decreases in academic performance from 25% to 80%. As in the Hopkins et al., (1971) study, former baseline rates were not recovered after the time limits were again expanded. The findings are also questionable in that all the students were exposed to the abrupt time reduction first. It is possible that rate increases in the graduated temporal phases were attributable to improved academic skills acquired during the prior abrupt phase. The authors suggested that a multiple baseline across subjects would better control for possible biases emanating from sequence and practice effects. Another possible source of bias in this study is that teachers who may or may not have been blind to the purpose, developed twenty new problems per daily session for each student rather than preselecting the items from a large pool. Such a procedure may have introduced a teacher bias that could have affected the results.

Summary Statements

In reviewing the research literature on the effects of temporal reductions on performance, the following conclusions were drawn:

1. To date very little research has been conducted to determine the relationship between time limits and academic performance. Further, the relationship between abrupt temporal reductions, graduated temporal reductions, and performance is not known.

2. Although other behavioral treatment approaches have proven successful in the remediation of educational deficits, temporal reduction techniques have remained largely ignored.

3. Temporal reduction techniques appear similar to the limited hold contingency which has been used to effectively increase rates of performance.

4. A limited number of studies are available which suggest that temporal reduction procedures result in rate increases, however, these studies either have not focused on temporal reduction techniques as important independent variables and/or they have been plagued with methodological problems which have obscured their findings.

5. Little or no data is available regarding the durability or generalizability of the effects of temporal reductions on academic performance.

CHAPTER III

METHOD

Subjects and Setting

Six elementary school students from a public school in central Arkansas who had been referred to a remedial classroom for special education services served as subjects. All subjects spent part of the day in a regular classroom. Three subjects were female, three were male. They ranged in age from 7 years 11 months to 9 years 1 month, with a mean age of 8 years 4 months. All subjects demonstrated a math grade level score of at least 1.5 years below their grade level as measured by the Peabody Individual Achievement Test. Subjects who performed over 50% of the math problems correct during the first baseline were given math items of increased difficulty (by one level according to the Individualized Computational Skills Program - ICSP). Subjects who did not drop below the 50% correct level during the first baseline were eliminated from the study. (See Appendix A for informed consent form, signed by all parents. See Appendix B for individual subject data). This study was approved by the Utah State University Research Ethics Committee.

Dependent Variables

Prior to the start of the study the special education teacher generated a large pool of math problems of similar type and difficulty for each subject. The type of problem assigned to each subject was determined by the placement test of the ICSP. (See Appendix C for description of ICPS placement test and math items.) Each pool consisted of practice problems provided in the ICSP and teacher-generated problems of similar type and difficulty. Each pool of problems contained approximately 500 items.

The principal dependent variable consisted of the number of mathematic problems completed correctly during a specified time period out of a possible 20 problems per session. If the 20 randomly selected problems were completed before the specified time period had elapsed that time was recorded. For each daily session the time elapsed was divided by the number of problems completed correctly to compute the rate of correct math problems.

In addition to the principal dependent variable (rate of correct math problems) another academic behavior was selected in order to assess generalization effects. This behavior consisted of copying words correctly from randomly preselected paragraphs from the subjects' current reading text. This word copying task was similar to the task used in the Hopkins et al., (1971) study. Prior to the start of the study the special education teacher generated a pool of paragraphs of similar type and difficulty for each subject, as she did with the math problems. The paragraphs were chosen according to each subject's current level of reading ability as determined by the Peabody Individual Achievement Test. Each paragraph contained between 30 and 40 words. One paragraph was randomly preselected from each subject's pool for each daily session. This behavior was measured, computed, and recorded each session just as the dependent variable (math problems), however, there was no variation in time allocated to complete the paragraphs; all subjects were allowed 10 minutes to complete each paragraph.

Each letter of the copying assignment was scored as being correct or as an error. Only words without any errors in them were counted toward correct rate of copying. The criteria used in determining whether a letter was correct or an error was based on a modification of the criteria employed by Hopkins et al., (1971, See Appendix D).

Throughout the study the teacher recorded the frequency (and/or duration) of the following behavior categories:

1. Complaints, such as, "Can't finish in that time."
2. Foul language
3. Loud or offensive noises, such as a "Bronx cheer"
4. Crying or whining
5. Throwing paper, pencil, or other objects
6. Stomping feet or hands
7. Other behaviors: If the teacher observed any other behaviors she considered emotional she specified this behavior and recorded it.

Behaviors similar to those described above were reported anecdotally as emotional indices by Ayllon et al. (1976, see Appendix E for sample data sheet). Since this was an initial attempt to collect information on the emotional indices that Ayllon et al. (1976) identified, no attempt was made to operationally define the behavior categories nor to train observers on a reliability criteria.

Token Economy System

A token reinforcement system similar to that used by O'Leary and Becker (1967) was implemented. A plastic cup was located on the top of each subject's desk. One token was placed in the cup for each math problem correctly answered. The teacher delivered the tokens promptly (within 30 seconds) at the end of each session or upon completion of the math items (whichever occurred first).

Tokens were exchangeable for a variety of privileges and/or items later each day. The back-up reinforcers ranged in price from five to 50 tokens and included such items and activities as hall passes, free time, toys, comics, etc. (See Appendix F). The token economy system was employed throughout all experimental, baseline, and follow-up conditions for the math problems.

Experimental Design

A single subject design was employed in this study. The single subject design was particularly appropriate in the remedial classroom setting where there were students possessing a wide variety of academic skill levels. In many instances these students were to be "fitted" with individual education plans designed to meet their unique needs. In the single subject design, the effects of the experimental variable may be immediately observed on response rates, providing the teacher with data relevant to each subject's progress during the study. In contrast, a between-group approach would have demonstrated group differences after manipulations of the independent variable(s), with focus on mean differences instead of the behavior of individual subjects. As Kazdin (1973) points out:

> averages from group data usually have no analogue in representing the behavioral process of individuals. The form or shape of the function obtained with group data does not necessarily represent the behavior change process of the individual. Several subjects may be affected differently by the experimental manipulation. This is obscured in the between-group analysis. (p. 518)

A multiple baseline across subjects design with reversals and replication of baseline and experimental conditions was employed. The multiple baseline design required that the experimental manipulation be introduced in sequential fashion and at different points in time for each subject (Baer, Wolf, and Risley, 1968). If changes in behavior were due to the presentation of the experimental condition, the changes will have occurred sequentially as the experimental condition was presented to each subject (and not before). Thus, the design controlled for the influence of extraneous variables such as the effects of time per se, or the effects of baseline conditions.

The reversal component of the experimental design was incorporated to determine whether baseline behavior was recoverable after both an abrupt reduction in time limits and after a graduated reduction in time limits. It was possible that baseline rates would not be recoverable, however, since all subjects were exposed to both an abrupt and graduated time manipulation in one sequence or another it was useful to have data on the similarity of performance at the onset of the second condition in comparison to the initial condition.

Baseline

All subjects were exposed to baseline conditions during which subjects were allowed 20 minutes to complete their math tasks. Baseline 1 lasted for three sessions for S1 and S4, six sessions for S2 and S5, and nine sessions for S3 and S6. Baselines 2 and 3 were identical to baseline 1 except each lasted five sessions for all subjects.

After the first three sessions of the first 20 minute condition (baseline 1), subjects were matched on number of correct math problems and were then assigned accordingly to either the Abrupt-Graduated Condition (ABACDBA) or the Graduated-Abrupt Condition (ACDBABA).

Abrupt-Graduated Condition

Abrupt-Graduated refers to the condition in which subjects (S1, S2, and S3) were exposed first to an abrupt temporal reduction (ABA) and then were exposed to a graduated temporal reduction (ACDBA). In other words, this condition allowed three of the subjects (S1, S2, S3) to be exposed to the experimental manipulations in an ABACDBA (20-5-20-15-10-5-20 minutes) sequence.

Graduated-Abrupt Condition

Graduated-Abrupt refers to the condition in which subjects (S4, S5, and S6) were exposed first to a graduated temporal reduction (ACDBA) and then were exposed to an abrupt temporal reduction (ABA). In contrast to the Abrupt-Graduated Condition (ABACDBA), the Graduated-Abrupt Condition allowed three of the subjects (S4, S5, S6) to be exposed to the experimental manipulations in an ACDBABA (20-15-10-5-20-5-20 minutes) sequence. These two conditions (Abrupt-Graduated and Graduated-Abrupt) had the effect of balancing the order of subjects' exposure to the experimental temporal variables.

General Procedure

The teacher began each session in the Abrupt-Graduated Condition and the Graduated-Abrupt Condition by informing each subject individually of the number of minutes available for math work. For example, during the 20 minute phases the teacher said, "Today you have 20 minutes to complete your mathematics assignment." The teacher conducted sessions with only one experimental subject in the room at the same time. The general procedure was the same for each daily session with only the specified time allotment changing as indicated for a particular baseline or experimental condition.

A stopwatch was used by the teacher to measure the time needed by each subject to complete the 20 problems. In addition, a timer with a bell was set to ring at the end of the specified time period. Subjects were instructed to stop working when the timer rang even if they had not completed all of the problems. Subjects were also instructed to raise their hands as they had completed all of the problems.

Promptly (within 30 seconds) after the timer rang or the subject raised his/her hand (whichever occurred first), the teacher went to the subject's desk to grade the assignment, and to give tokens and social praise for correct math work. As previously indicated the subjects received one token per correct math problem. Social praise consisted of pairing one positive comment with each token delivered.

When a subject used all of the allotted time on the math problems tokens, praise and feedback were dispensed, afterwhich the subject returned to his/her regularly scheduled room. If a subject completed the assigned math problems prior to the specified time s/he remained seated for the specified time (i.e., 20, 15, 10, or 5 minutes) plus the approximate amount of time (1 to 3 minutes) it typically took the teacher to dispense tokens, praise and feedback. As can be seen, the amount of time subjects spent in the experimental setting was held constant by requiring all subjects to remain in the room (seated quietly) for the time allotted to complete math problems plus the time spent dispensing tokens, praise and feedback. This procedure was employed to deter subjects from either stalling on the math problems in order to increase the amount of time spent in the experimental situation, or from rushing on the math problems in order to decrease the amount of time spent in the experimental situation.

If a subject completed the math assignment prior to the end of the specified time period, rate correct was computed by dividing the total number correct by the actual number of minutes used. When a subject used the full time allocation to complete the assignment, the denominator of the rate measure was the number of minutes associated with that particular temporal phase.

The teacher also provided the subjects with the task of copying paragraphs. Copying tasks were always presented after the math tasks. Daily the teacher informed each subject individually to copy the paragraph as quickly and as accurately as he or she could. The subjects were instructed to raise their hands when they had completed the paragraph. Using a stopwatch, the teacher, in an unobtrusive manner, recorded the time taken to complete the paragraph. Rate was computed by dividing the number of correct words copied by the number of minutes used to complete the task. This procedure was used in an attempt to assess the degree to which the manipulation of temporal limits for one class of academic behaviors (math problems) generalized to another academic behavior (copying paragraphs).

Durability was assessed for both math problems and copying tasks during the two follow-up probes conducted two weeks and five weeks after each subject's last session. The procedures previously specified were utilized to collect and compute the follow-up data.

Sessions were generally conducted five days a week. The experimental and baseline sessions constituted the only opportunity for subjects to earn tokens.

The teacher was blind as to the specific purposes of the study. Purposes of the study were discussed with the teacher upon completion of the study.

Reliability

Reliability of the accuracy of (1) the number of correct problems or words, (2) the computations to determine rate, and (3) the specified time allocations were assessed by an individual observer who (1) recomputed the number of problems correct, (2) recomputed the correct rate, and (3) timed the interval allocated for a particular session. These reliability checks were made for each subject for at least one session during each baseline phase and for at least two sessions during each experimental phase.

The reliability of math problem scoring and computations for rate was computed by calculating a coefficient of agreement between the teacher and the observer's independent scoring of the event. The coefficient was calculated by dividing the total number of agreements by the total number of agreements + disagreements and multiplying by 100. Agreements and disagreements were determined on an item-by-item basis.

Reliability of duration events (e.g., actual time spent on math) were checked by calculating a coefficient of agreement between teacher and observer's independent time measurements. The coefficient was calculated by dividing the time recordings of a shorter duration by the time recordings of a longer duration and multiplying by 100.

Data Analysis

The data were treated in single subject design fashion. All assessments within and across subjects, were made by comparing graphed and/or tabulated data via visual inspection.

For math problems, the median correct rate and median number correct were graphed and assessed for all subjects as a function of the abrupt temporal phases, the graduated temporal phases, and combined phases. Additionally, rate of correct responses (numbers of correct responses per minute) for both math problems and copying paragraphs were graphed or tabulated and assessed for each individual subject as a function of each experimental condition. Median number of correct math problems and copying paragraphs were treated in like fashion.

Actual median math time spent by each subject was tabulated and a comparison was made across conditions. Actual median math time was also compared with allocated math time.

Number of emotional responses was tabulated and assessed as a function of each experimental condition. Mean differences were also assessed as a function of abrupt and graduated phases.

CHAPTER IV

RESULTS

Abrupt-Graduated Condition

Abrupt-Graduated refers to the condition in which subjects (S1, S2, and S3) were exposed first to an abrupt temporal reduction (ABA) and then were exposed to a graduated temporal reduction (ACDBA).

Rates of Math Performance

Rates were computed based on actual time used rather than allocated time available for each phase. The data in Figure 1 demonstrate that rate changes of correct math performance generally followed changes in conditions across subjects. S1 and S2 demonstrated changes in rate of math performance as the experimental phases were introduced. While S1's and S2's overall rate changes across conditions are apparent, as can be seen in Figure 1, some individual data points do overlap across temporal phases. S3 did not demonstrate clear rate changes across experimental phases until the 5 minute graduated phase was introduced. For all three subjects (S1, S2, S3) the rate of correct math performance was highest during the 5 minute graduated phase in comparison to all other phases.

Median rates of math problems and median rate changes from baseline 1 can be seen in Table 1. Introduction of the abrupt 5 minute phase resulted in median rate decreases for S1 and S3, while S2's median rate increased. Compared with the median rate during baseline 1, the return to baseline 2 resulted in an equal median rate for S1; an increased median rate for S2; and a decreased median rate for S3.

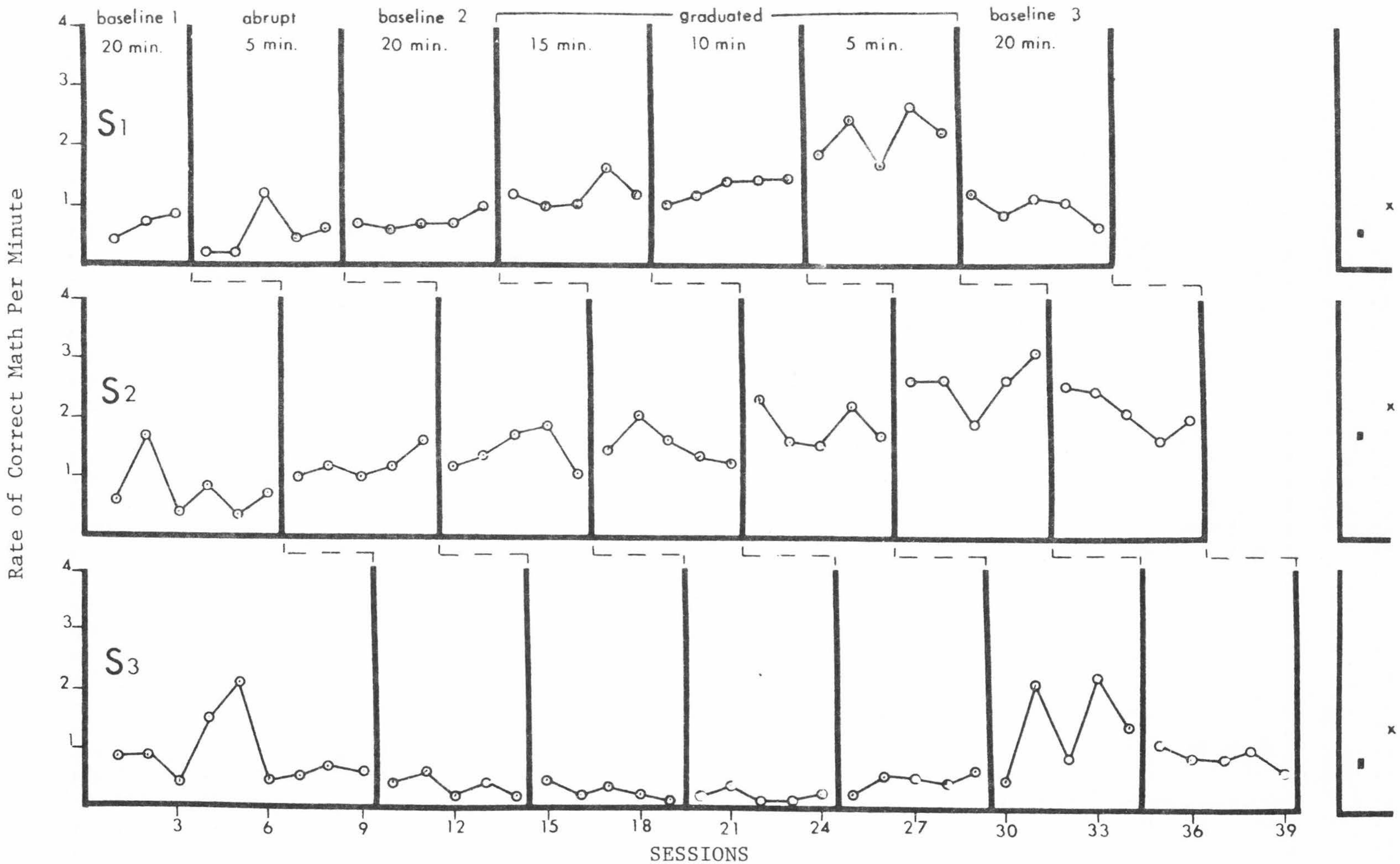

Figure 1. Rates of correct math performance (○) for subjects 1,2, and 3 during abrupt then graduated temporal reductions. Included are rates from the two week (▪) and five week (×) follow-up probes.

Table 1

Median Rates (Correct/Minute) of Math Problems and Median Rate Changes from Baseline 1 for Abrupt-Graduated Subjects (S1, S2, S3)

Temporal Phases (allocated time in minutes)	S1		S2		S3	
	Median Rates	Rate Changes[a]	Median Rates	Rate Changes[a]	Median Rates	Rate Changes[a]
20 baseline 1	.7		.6		.6	
5 abrupt reduction	.4	-.3	1.2	+.6	.4	-.2
20 baseline 2	.7	0	1.3	+.7	.2	-.4
15 graduated reduction	1.1	+.4	1.3	+.7	.1	-.5
10 graduated reduction	1.3	+.6	1.7	+1.1	.5	-.1
5 graduated reduction	2.2	+1.5	2.6	+2.0	1.6	+1.0
20 baseline 3	1.0	+.3	1.9	+1.3	.8	+.2
20 two week follow-up	.5	-.2	1.7	+1.1	.9	+.3
20 five week follow-up	1.0	+.3	2.2	+1.6	1.2	+.6

[a]Rate increases from baseline 1 are indicated by a "+" sign; decreases from baseline 1 are indicated by a "-" sign.

Compared with median rates during the previous abrupt phase, S1's and S2's median rate increased while S3's decreased. As indicated by the 5 minute phase of the graduated reduction, all three subjects (S1, S2, S3) demonstrated increased rates compared with baseline 1 and baseline 2 rates, in fact, except for S3 during the 15 minute phase, the number correct per minute increased with each graduated reduction in time allotted. Baseline 3 resulted in rate decreases for S1, S2, and S3 compared with the previous 5 minute graduated phase. Baseline 3 rates for subjects S1, S2, and S3, however, did not return to the previous baseline rates.

A follow-up probe consisting of one 20 minute phase two weeks after the completion of the study resulted in decreased rates for S1 and S2 compared with baseline 3 rates, while S3's rate was above the baseline 3 level. A second similar (20 minute) follow-up probe was conducted five weeks after the completion of the study. S1, S2, and S3 all demonstrated increased rates compared with the previous two week follow-up probe and compared with baseline 1 and 2. Reliability of correct math rate for S1, S2, and S3 was based on 12 sample observation sessions. Reliability ranged from 93.3% to 100% with a mean of 98.3%.

Number of Correct Math Problems

In Figure 2 (number of math problems completed correctly by abrupt-graduated subjects) it can be seen that the 5 minute abrupt temporal reductions resulted in decreases in number of correct math problems for S1, S2, and S3. Functional control of the subjects'

(S1, S2, S3) math performance was more clearly demonstrated in Figure 2 (number correct) than in Figure 1 (rate correct) in that abrupt changes in number correct occurrred when the abrupt temporal reduction phases were introduced (and subsequently withdrawn) in multiple baseline fashion. Introduction of graduated temporal reductions did not result in decreases in number correct as large as the decreases which resulted from the abrupt temporal reductions. In fact, subjects correctly completed approximately the same number of problems during the 5 minute graduated phases as during baseline phases but in one-fourth the time.

Median number of correct math problems and changes of median number correct from baseline 1 are shown in Table 2. Introduction of the abrupt 5 minute phase resulted in a decreased median number of correct math problems for S1, S2, and S3. Return to baseline 2 resulted in an increased median number of correct math problems for the three subjects in the abrupt-graduated condition compared with the previous abrupt 5 minute phase. Median number correct during baseline 2 was greater for S1 and S2 compared with median number correct during baseline 1, while median number correct for S3 remained below the baseline 1 level. By the 10 minute phase of the graduated temporal reduction, S1 and S2 demonstrated an increased median number of correct math problems compared with the initial 20 minute (baseline 1) phase. Even during the 5 minute graduated phase S2 and S3 obtained a greater number of problems correct compared with the 20 minute (baseline 1) phase, and S1 achieved the same number correct during this 5 minute phase as during the longer baseline 1 phase. Compared with the previous 5 minute

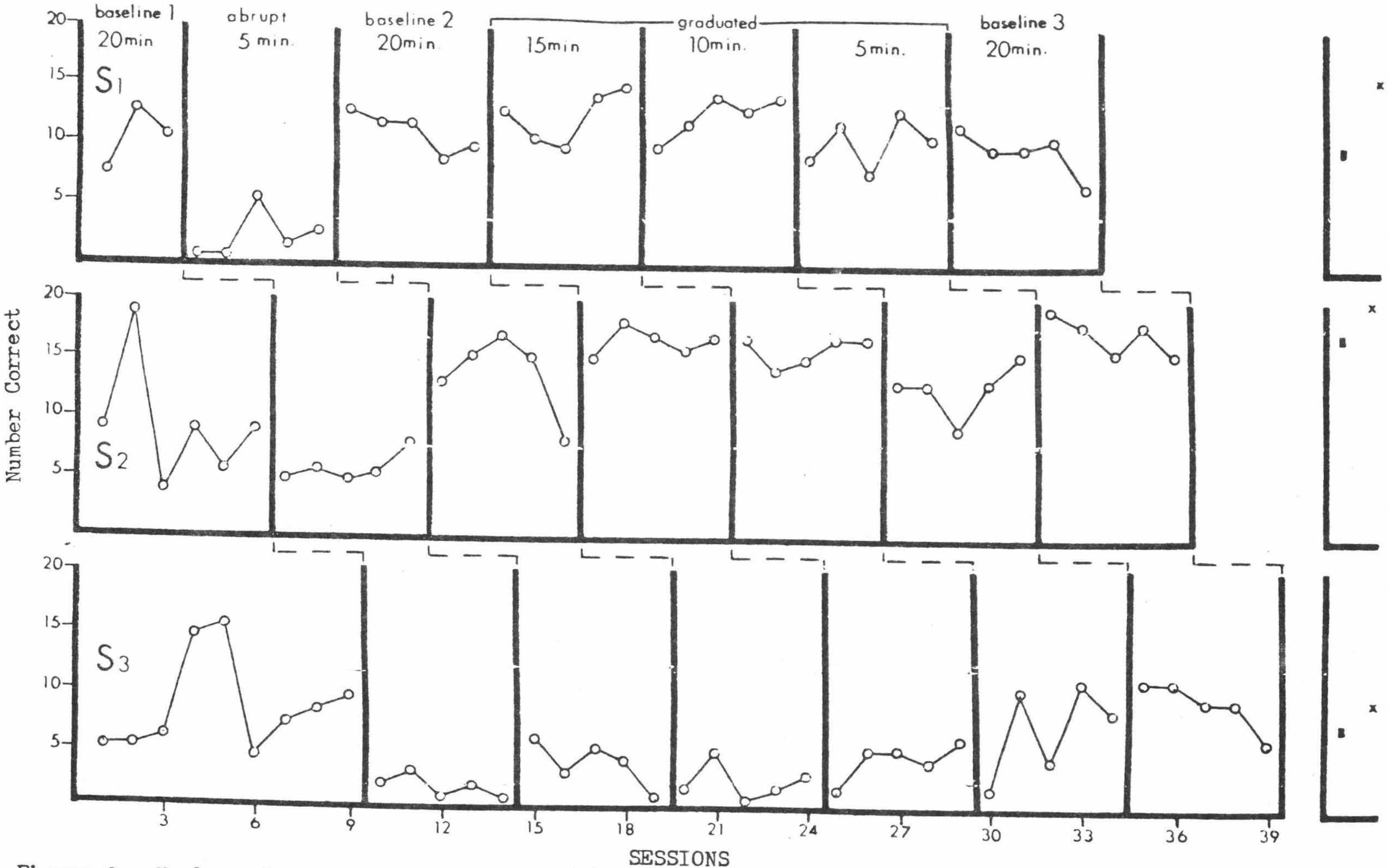

Figure 2. Number of correct math problems (○) for subjects 1, 2, and 3 during abrupt then graduated temporal reductions. Included are number correct from the two week (▪) and five week (×) follow-up probes. Math difficulty level was increased on session 2 for S1; on session 2 for S2; on sessions 4 and 5 for S3.

Table 2

Median Number of Correct Math Problems and Changes of Median Number Correct from Baseline 1 for Abrupt-Graduated Subjects (S1, S2, S3)

	S1		S2		S3	
Temporal Phases (allocated time in minutes)	Median Number Correct	Changes in Number Correct[a]	Median Number Correct	Changes in Number Correct[a]	Median Number Correct	Changes in Number Correct[a]
20 baseline 1	11		9		7	
5 abrupt reduction	2	-9	6	-3	2	-5
20 baseline 2	12	+1	15	+6	4	-3
15 graduated reduction	13	+2	17	+8	2	-5
10 graduated reduction	13	+2	17	+8	5	-2
5 graduated reduction	11	0	13	+4	8	+1
20 baseline 3	10	-1	18	+9	9	+2
20 two week follow-up	10	-1	17	+8	7	0
20 five week follow-up	16	+5	20	+11	9	+2

[a]Increases in number correct from baseline 1 are indicated by a "+" sign; decreases from baseline 1 are indicated by a "-" sign.

graduated phase, return to the third 20 minute phase (baseline 3) resulted in a decrease in median number correct for S1, and increases in number correct of S2 and S3. In comparing baseline 3 with baseline 1, S1 demonstrated a decreased median number correct, while S2 and S3 demonstrated increases (See Table 2).

During the two week follow-up probe S1 obtained a median number correct equal to the median number correct during baseline 3 and below the median number correct during baseline 1; S2 obtained a median number correct below the median number correct during baseline 3 and above the median number correct during baseline 1; S3 obtained a median number correct below the median number correct during baseline 3 and equal to the median number correct during baseline 1. The second follow-up probe, conducted five weeks after the completion of the study, resulted in a greater number correct for all three subjects (S1, S2, S3) compared with the two week follow-up probe and compared with the three previous baseline phases.

Actual Time Spent on Math

Table 3 shows the actual median amount of time S1, S2, and S3 spent working on math problems in each temporal phase. As can be seen S1's, S2's and S3's actual math times varied in almost every instance with the allocated amounts of time for math completion. That is, in most cases, S1, S2 and S3 took less time to complete math work than was permitted. Only during the 5 minute abrupt phase and the 5 minute graduated phase did S1, S2 and S3 use all of the time allocated.

Reliability of actual time spent on math for S1, S2 and S3 was based on 12 sample observation sessions. Reliability ranged from

Table 3

Actual Math Time Spent by Abrupt-Graduated Subjects (S1, S2, S3)

During Each Temporal Phase

Temporal Phases (allocated time in minutes)	Actual Median Amount of Time Used (Minutes)		
	S1	S2	S3
20 baseline 1	17.5	14	10.5
5 abrupt reduction	5	5	5
20 baseline 2	17	10	17.5
15 graduated reduction	11.5	11	15
10 graduated reduction	10	9	10
5 graduated reduction	5	5	5
20 baseline 3	11	8.5	10
20 two week follow-up	18	10	7.5
20 five week follow-up	16	9	7

92.4% to 100% with a mean of 97.5%.

Emotional Responses (ERs)

An additional focal point of this study was concerned with the effects of time limits on emotional responses, i.e., disruptive behaviors (see Appendix E for ER data collection form). The number of ERs observed during math work time for subjects in the abrupt-graduated condition (S1, S2, S3) is shown in Table 4. Each subject exhibited one ER during the initial 20 minute phase (baseline 1). The majority of ERs exhibited by all three subjects (S1, S2, S3) occurred during the abrupt (5 minute) temporal reduction phase which followed. With the exception of one ER each, exhibited by S1 and S2 during the 15 minute phase of the graduated condition, no other ERs were observed for the remainder of the study or during either of the follow-up probes.

Rate of Copying Paragraphs

The median rate of copying paragraphs for subjects in the abrupt-graduated condition (S1, S2, S3), is set forth in Table 5. Also shown in Table 5 are the experimental math conditions which were in force when the various copying rates were obtained. As can be seen, median copying rates generally increased gradually as the study progressed for all three abrupt-graduated subjects. Copying rates did not co-vary with corresponding math time allocations.

Reliability of correct copying rate for S1, S2 and S3 was based on 11 sample observation sessions. Reliability ranged from 92.1% to 100% with a mean of 97.2%.

Table 4

Number of Emotional Responses (ERs) Observed During Math Work Time For Abrupt-Graduated Subjects (S1, S2, S3)

Temporal Phases (allocated time in minutes)	Emotional Responses S1	S2	S3
20 baseline 1	1	1	1
5 abrupt reduction	3	5	19
20 baseline 2	0	0	0
15 graduated reduction	1	1	0
10 graduated reduction	0	0	0
5 graduated reduction	0	0	0
20 baseline 3	0	0	0
20 two week follow-up	0	0	0
20 five week follow-up	0	0	0

Table 5

Median Rates of Copying Paragraphs for Abrupt-Graduated Subjects (S1, S2, S3) and Corresponding Time Allocations for Math Problems

Temporal Phases for Math Problems (allocated time in minutes)	Median Rate (Number of Words Correct/Minute)		
	S1	S2	S3
20 baseline 1	2.5	1.4	2.6
5 abrupt reduction	2.5	2.0	2.9
20 baseline 2	2.3	1.7	4.8
15 graduated reduction	3.0	1.5	4.4
10 graduated reduction	3.5	2.9	5.4
5 graduated reduction	3.6	3.1	6.4
20 baseline 3	5.0	2.9	5.6
20 two week follow-up	5.4	4.6	6.8
20 five week follow-up	5.6	4.9	7.1

Note: Time allocated for copying paragraphs was 10 minutes.

Graduated-Abrupt Condition

Graduated-Abrupt refers to the condition in which subjects (S4, S5, and S6) were exposed first to a graduated temporal reduction (ACDBA) and then were exposed to an abrupt temporal reduction (ABA).

Rates of Math Performance

Rates were computed based on actual time used rather than allocated time available for each temporal phase. In Figure 3 it can be seen that rate changes of correct math performance for S4 and S5 occurred sequentially as the different experimental phases were introduced to each subject. S4 and S5 demonstrated increases in rate as each graduated phase was introduced in multiple baseline fashion. Even more apparent are the abrupt rate changes for S4 and S5 when the abrupt experimental phase was introduced (and subsequently withdrawn). Changes in S6's rate of math performance did not appear to closely correspond to changes in experimental phases, rather, S6's rate did appear to increase, however, when the 5 minute abrupt phase was introduced.

Median rates of math problems and median rate changes from baseline 1 can be seen in Table 6. As indicated by the 15, 10, and 5 minute phases of the graduated reduction, S4 and S5 demonstrated increased rates compared with baseline 1, while S6's rate fluctuated during the graduated phases, resulting in a rate for the 5 minute graduated phase equal to the rate during baseline 1. Compared with the 5 minute graduated phase, median rates during baseline 2 decreased for S4, S5, and S6. Median rates during baseline 2 for S4 and S5 remained above median rates during baseline 1, while S6's median rate during baseline 2 fell

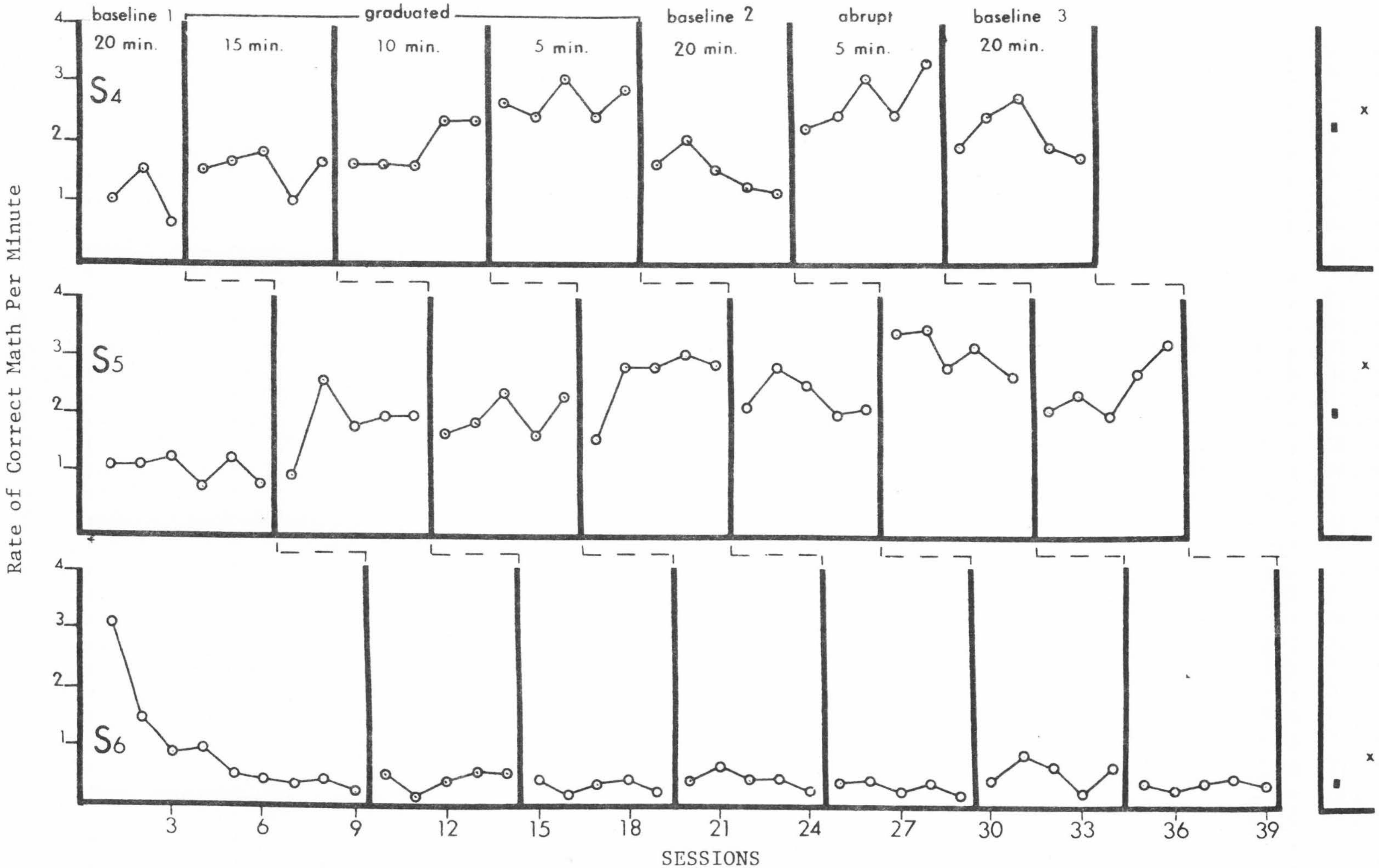

Figure 3. Rates of correct math peformance (o) for subjects 4, 5, and 6 during the graduated then abrupt temporal reductions. Included are rates from the two week (▪) and five week (×) follow-up probes.

Table 6

Median Rates (Correct/Minute) of Math Problems and Median Rate Changes from Baseline 1 for Graduated-Abrupt Subjects (S4, S5, S6)

Temporal Phases (allocated time in minutes)	S4 Median Rates	S4 Rate Changes[a]	S5 Median Rates	S5 Rate Changes[a]	S6 Median Rates	S6 Rate Changes[a]
20 baseline 1	1.0		1.2		.4	
15 graduated reduction	1.6	+.6	2.0	+.8	.5	+.1
10 graduated reduction	1.6	+.6	1.8	+.6	.2	-.2
5 graduated reduction	2.6	+1.6	2.8	+1.6	.4	0
20 baseline 2	1.5	+.5	2.1	+.9	.3	-.1
5 abrupt reduction	2.4	+1.4	3.4	+2.2	.6	+.2
20 baseline 3	1.9	+.9	2.3	+1.1	.3	-.1
20 two week follow-up	2.3	+1.3	2.0	+.8	.3	-.1
20 five week follow-up	2.6	+1.6	2.8	+1.6	.6	+.2

[a]Rate increases from baseline 1 are indicated by a "+" sign; decreases from baseline 1 are indicated by a "-" sign.

below the baseline 1 level. Introduction of the 5 minute abrupt phase resulted in median rates above those of the baseline 1 phase, and represented an increase in median rates compared with the baseline 2 phase. Median rates during the 5 minute abrupt phase were above the 5 minute graduated phase for S5 and S6, while S4's rate was lower. The return to baseline 3 resulted in median rate decreases for all three subjects (S4, S5, S6) compared with the previous 5 minute abrupt phase. Compared with baseline 1, S4 and S5 demonstrated increases in median number correct, while S6 demonstrated a decrease.

During the two week-follow-up probe S4 obtained a median number correct above that during baseline 1 and baseline 3; S5 obtained a median number correct above that during baseline 1 but below the baseline 3 level; S6 obtained a median number correct below that during baseline 1 and equal to the median rate during baseline 3. The second follow-up probe, conducted five weeks after the completion of the study, resulted in an increased rate for all three subjects (S4, S5, S6) compared with the two week follow-up probe and compared with baselines 1, 2, and 3. Reliability of correct math rate for S4, S5 and S6 was based on 12 sample observation sessions. Reliability ranged from 94% to 100% with a mean of 97.9%.

Number of Correct Math Problems

Figure 4 (number of math problems completed correctly by graduated-abrupt subjects) demonstrates that S4 and S5 did not achieve a lower number of correct math problems during 5 minute graduated or abrupt phases compared with the number correct obtained during 20 minute phases. In fact, in some cases the graduated-abrupt subjects completed a greater number of math problems in the 5 minute phases than in the 20 minute baseline phases.

Median number of correct math problems and changes in median number correct from baseline 1 are shown in Table 7. Introduction of the graduated reductions resulted in an increase in median number correct for both S4 and S5, while S6's median number correct decreased. Median number correct during baseline 2 compared with the preceding 5 minute graduated phase resulted in a decreased median number of correct proboems for S4; an equal median number correct for S5; and an increased median number correct for S6. Compared with baseline 1, S4's and S5's median number correct during baseline 2 increased, while S6's median number correct decreased. Introduction of the abrupt temporal reduction (5 minute phase) resulted in increases in median number correct for S4 and S5 compared with baseline 1 and baseline 2, while S6 demonstrated a decrease in median number correct compared with baseline 1 and baseline 2. Compared with the preceding 5 minute abrupt phase, the return to the third 20 minute phase (baseline 3) resulted in an increased median number correct for S4 and S6, while S5's median number decreased. Compared with baseline 1, S4 and S5's median number increased during baseline 3, while S6's median rate decreased.

During the two week follow-up probe all three subjects (S4, S5, S6) obtianed a median number correct exceeding that during the preceding baseline 3 phase. S4 and S5 achieved a median number correct above that during baseline 1, while S6's median number correct fell below that obtained during baseline 1. The second follow-up probe, conducted five weeks after the completion of the study, resulted in a greater

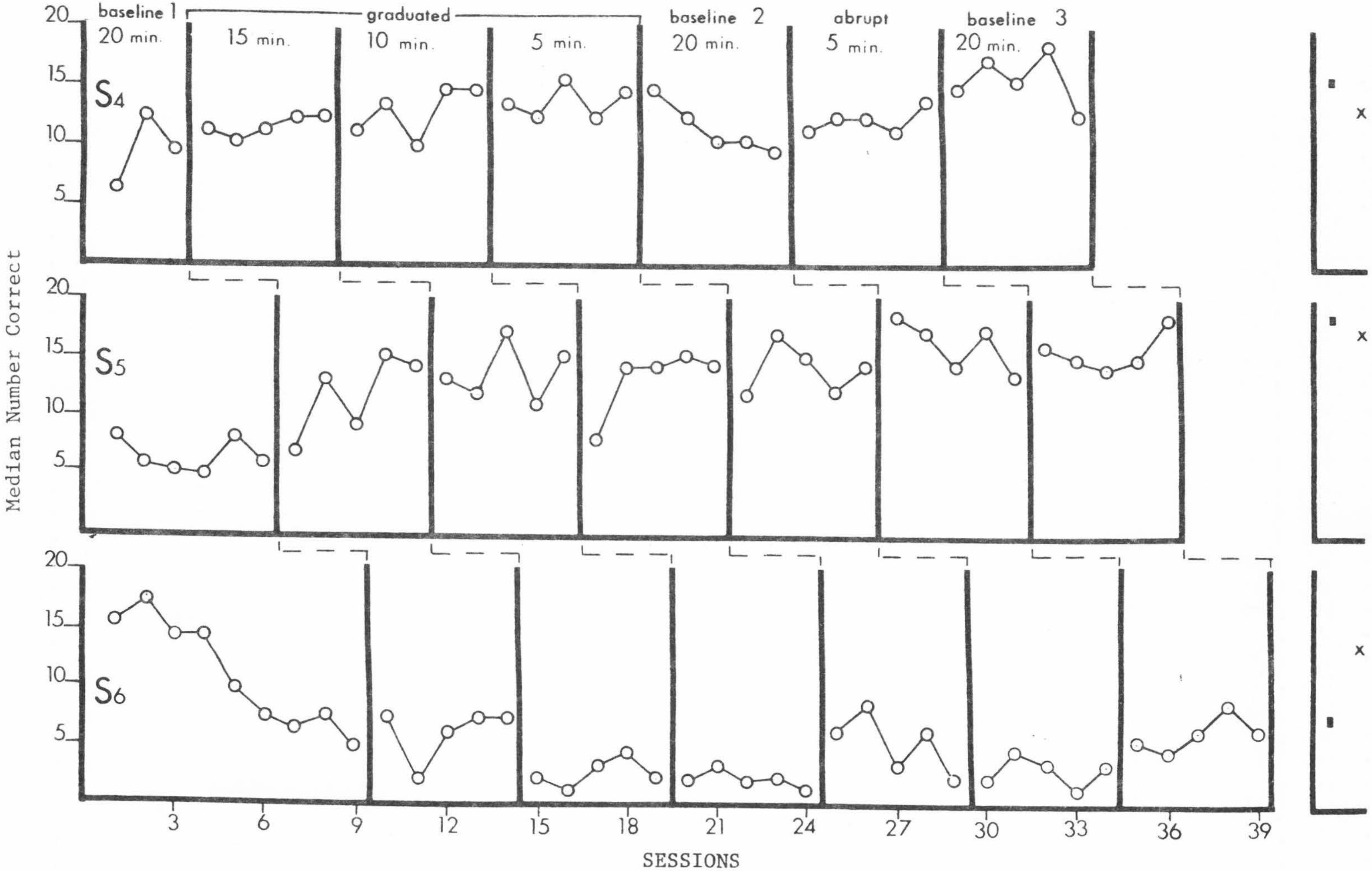

Figure 4. Median number of correct math problems (o) for subjects 4, 5, and 6 during graduated then abrupt temporal reductions. Included are number correct from the two week (▪) and five week (x) follow-up probes. Math difficulty level was increased on session 2 for S4; on sessions 1, 2, 3, and 4 for S6.

Table 7

Median Number of Correct Math Problems and Changes of Median Number Correct from Baseline 1 for Graduated-Abrupt Subjects (S4, S5, S6)

Temporal Phases (allocated time in minutes)	S4 Median Number Correct	S4 Changes in Number Correct[a]	S5 Median Number Correct	S5 Changes in Number Correct[a]	S6 Median Number Correct	S6 Changes in Number Correct[a]
20 baseline	9		6		9	
15 graduated reduction	11	+2	13	+7	7	-2
10 graduated reduction	13	+4	13	+7	2	-7
5 graduated reduction	13	+4	14	+8	2	-7
20 baseline 2	10	+1	14	+8	6	-3
5 abrupt reduction	12	+3	17	+11	3	-6
20 baseline 3	15	+6	15	+9	6	-3
20 two week follow-up	16	+7	18	+12	7	-2
20 five week follow-up	13	+4	17	+11	13	+4

[a]Increases in number correct from baseline 1 are indicated by a "+" sign; decreases from baseline 1 are indicated by a "-" sign.

number correct for all three subjects (S4, S5, S6) compared with baseline 1 and baseline 2, while S4's and S5's number correct decreased compared with the two week follow-up and increased compared with baseline 3. S6's median number correct increased compared with baseline 3 and the two week follow-up.

Actual Time Spent on Math

Table 8 shows the actual median amount of time S4, S5, and S6 spent working on math problems in each temporal phase. As can be seen in Table 8, S4's and S5's actual math time varied in almost every instance with the allocated amounts of time for completion of the math problems. That is, in most cases, they took less time to complete the math problems than was permitted. Only during the 5 minute graduated phase did S4 use all of the allocated time and only during the 5 minute graduated and abrupt phases did S5; S6's actual math completion time, however, always corresponded to the allocated times. S6 took the full amount of time permitted in every instance.

Reliability of actual time spent on math for S4, S5 and S6 was based on 12 sample observation sessions. Reliability ranged from 94% to 100% with a mean of 97.1%.

Emotional Responses (ERs)

An additional finding of this study was concerned with the effects of time limits on emotional responses, i.e., disruptive behaviors (see Appendix E for ER data collection form). The number of ERs observed during math work time for subjects in the graduated-abrupt condition (S4, S5, S6) is shown in Table 9. S4 and S6 exhibited several ERs

Table 8

Actual Math Time Spent by Graduated-Abrupt Subjects (S4, S5, S6)

During Each Temporal Phase

Temporal Phases (allocated time in minutes)	Actual Median Amount of Time Used (Minutes)		
	S4	S5	S6
20 baseline 1	8	6	20
15 graduated reduction	7	6.5	15
10 graduated reduction	7	6.5	10
5 graduated reduction	5	5	5
20 baseline 2	8	6	20
5 abrupt reduction	4.5	5	5
20 baseline 3	7	6.5	20
20 two week follow-up	7	9	20
20 five week follow-up	5	6	20

Table 9

Number of Emotional Responses (ERs) Observed During Math Work Time for Graduated-Abrupt Subjects (S4, S5, S6)

Temporal Phases (allocated time in minutes)	Emotional Responses		
	S4	S5	S6
20 baseline 1	4	0	5
15 graduated reduction	0	0	0
10 graduated reduction	0	0	3
5 graduated reduction	7	0	1
20 baseline 2	0	0	0
5 abrupt reduction	2	0	0
20 baseline 3	0	0	0
20 two week follow-up	0	0	0
20 five week follow-up	0	0	0

during the initial 20 minute phase (baseline 1). S5 did not exhibit any ERs throughout the study or during either of the follow-up probes. During the 10 minute phase of the graduated reduction S6 exhibited three ERs. During the 5 minute phase of the graduated condition S4 exhibited seven ERs and S6 exhibited one ER. During the 5 minute abrupt phase S4 exhibited two ERs. No other ERs were exhibited by S4, S5, and S6 during the remainder of the study or during either of the follow-up probes.

Rate of Copying Paragraphs

Table 10 shows the median rate of copying paragraphs for subjects in the graduated-abrupt condition (S4, S5, S6). Table 10 shows which experimental math conditions were in force when the various copying rates were obtained. As can be seen median copying rates generally increased gradually as the study progressed through the baseline 3 phase. With the exception of S6's rate, during the five week follow-up probe, median copying rates during the two follow-up probes were lower than during baseline 3.

Reliability of correct copying rate for S4, S5, and S6 was based on 11 sample observation sessions. Reliability ranged from 93% to 100% with a mean of 96.9%.

Abrupt-Graduated Condition (S1, S2, S3) Compared with Graduated-Abrupt Condition (S4, S5, S6)

Rates of Math Performance

Introduction of the abrupt temporal phase for the abrupt-graduated subjects (S1, S2, S3) resulted in decreased median math rates for two

Table 10

Median Rates of Copying Paragraphs for Graduated-Abrupt Subjects (S4, S5, S6) and Corresponding Time Allocations for Math Problems

Temporal Phases for Math Problems (allocated time in minutes)	Median Rate (Number of Words Correct/Minute)		
	S4	S5	S6
20 baseline 1	3.8	2.5	5.3
15 graduated reduction	4.0	2.8	7.2
10 graduated reduction	4.1	3.3	6.8
5 graduated reduction	4.0	3.1	7.3
20 baseline 2	4.4	2.9	6.6
5 abrupt reduction	6.2	3.1	6.7
20 baseline 3	6.9	4.2	7.1
20 two week follow-up	6.2	2.6	6.4
20 five week follow-up	4.7	3.8	8.0

Note: Time allocated for copying paragraphs was 10 minutes.

subjects S1 and S3), and an increased median math rate for one subject (S2), whereas, introduction of the abrupt temporal phase for the graduated-abrupt subjects (S4, S5, S6) resulted in increased median rates for all three subjects (see Table 11).

Median rates of math problems for all subjects during graduated temporal reductions are shown in Table 12. As indicated, median rate differences between baseline 1 and the 5 minute graduated phase resulted in increased median math rates for all three abrupt-graduated subjects (S1, S2, S3) and for two of the graduated-abrupt subjects (S4 and S5). There was no difference in median rate of correct math problems for S6 between baseline 1 and the 5 minute graduated phase. The graduated temporal reductions resulted in increased median math rates for five of the six subjects. During the graduated temporal reductions (15, 10, and 5 minutes), the abrupt-graduated subjects (S1, S2, S3) demonstrated progressively increased median math rates each time the temporal allocations were reduced. The graduated-abrupt subjects (S4, S5, and S6), however, did not demonstrate progressively increased rates during the graduated reductions, although S4 and S5 did demonstrate increased median math rates from baseline 1 to the 5 minute graduated phase. S4's and S5's rates during the 5 minute graduated phase were higher than rates during the 15 and 10 minute phases. S6's rate was the same during the 5 minute graduated phase as during baseline 1.

Number of Correct Math Problems

Compared with number correct during baseline 1, introduction of

Table 11

Median Rates of Math Problems for All Subjects

During Abrupt Temporal Reductions

Temporal Phases (allocated time in minutes)	Median Rate (number of words correct/minute)					
	Abrupt-Graduated Ss			Graduated-Abrupt Ss		
	S1	S2	S3	S4	S5	S6
20 baseline 1	.7	.6	.6	1.0	1.2	.4
5 abrupt	.4	1.2	.4	2.4	3.4	.6
Percent of Rate Change[a]	-43%	+100%	-33%	+140%	+183%	+50%

[a] Percent of rate change was computed on differences between the first 20 minute phase (baseline 1) and the 5 minute abrupt phase for all six subjects.

Note: Rate increases are indicated by a "+" sign; decreases are indicated by a "-" sign.

Table 12

Median Rates of Math Problems for All Subjects

During Graduated Temporal Reductions

Temporal Phases (allocated time in minutes)	Median Rate (number of words correct/minute)					
	Abrupt-Graduated Ss			Graduated-Abrupt Ss		
	S1	S2	S3	S4	S5	S6
20 baseline 1	.7	.6	.6	1.0	1.2	.4
15 graduated	1.1	1.3	.1	1.6	2.0	.5
10 graduated	1.3	1.7	.5	1.6	1.8	.2
5 graduated	2.2	2.6	1.6	2.6	2.8	.4
Percent of Rate Change[a]	+214%	+333%	+167%	+160%	+133%	0%

[a]Percent of rate change was computed on differences between the first 20 minute phase (baseline 1) and the 5 minute graduated phase for all six subjects.

Note: Rate increases are indicated by a "+" sign; decreases are indicated by a "-" sign.

the abrupt temporal phase for the abrupt-graduated subjects (S1, S2, S3) resulted in a decreased number of correct math problems for all three subjects, whereas, introduction of the abrupt temporal phase for all the graduated-abrupt subjects (S4, S5, S6) resulted in an increased number of math problems for S4 and S5, and a decreased number of correct math problems for S6.

As indicated by the number correct during the 5 minute graduated phase, introduction of the graduated temporal reductions for the abrupt-graduated subjects (S1, S2, S3) resulted in a number correct equal to the number correct during baseline 1 for one subject (S1) and higher than the number correct during baseline 1 for two subjects (S2, S3); introduction of the graduated reductions for the graduated-abrupt subjects (S4, S5, S6) resulted in an increased number correct for two subjects (S4, S5) compared with number correct during baseline 1 and a decreased number correct for one subject (S6) compared with number correct during baseline 1.

Figure 5 summarizes the median number of correct math problems for both abrupt-graduated subjects (S1, S2, S3) and graduated-abrupt subjects (S4, S5, S6) as a function of the abrupt and graduated temporal shifts. For the abrupt-graduated subjects (S1, S2, S3) the abrupt temporal reduction resulted in a decreased median number of correct math problems from the baseline 1 phase and an increase for the graduated-abrupt subjects in comparison with baselines 1 and 2. A return to baseline 2 for the abrupt-graduated subjects and to baseline 3 for the graduated-abrupt subjects resulted in a greater median number correct than the preceding 5 minute abrupt phase and the

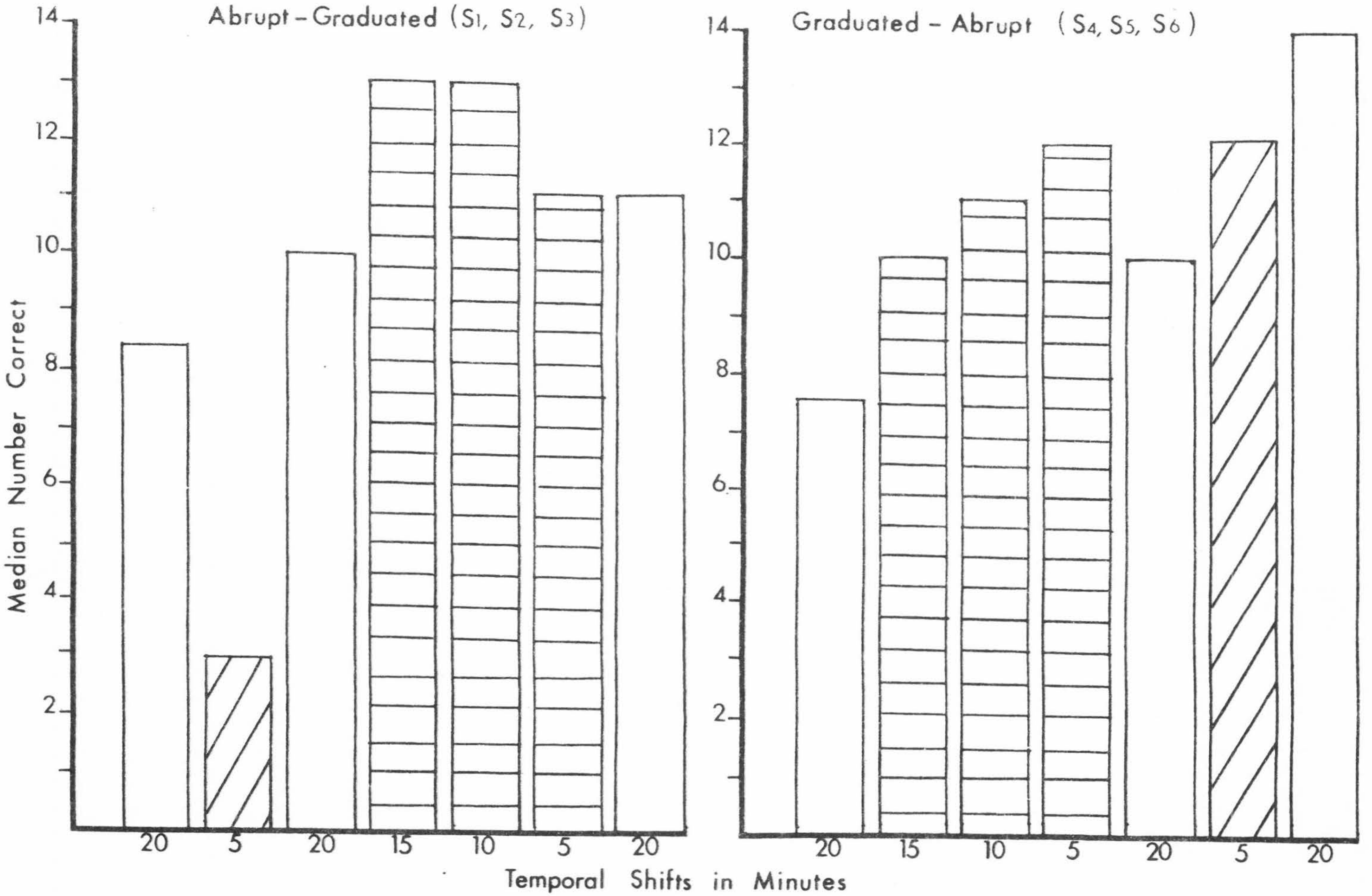

Figure 5. Median number of correct math problems for abrupt-graduated subjects (S1, S2, S3) and graduated-abrupt subjects (S4, S5, S6) as a function of the abrupt and graduated temporal shifts. The bars summarize the median numbers of correct problems for the subjects in their respective conditions (abrupt = ▨, graduated = ☰, and baseline = ☐).

baseline 1 phase. As indicated by the 5 minute graduated phases, both abrupt-graduated subjects (S1, S2, S3) and graduated-abrupt subjects (S4, S5, S6) demonstrated increased median numbers of correct problems as a function of the graduated temporal reductions. The graduated-abrupt subjects (S4, S5, S6), however, demonstrated progressively greater increases in median number correct each time temporal limits were further reduced with the greatest median number correct occurring during the 5 minute graduated phase, while the abrupt-graduated subjects (S1, S2, S3) did not demonstrate sequential increases, and the greatest median number of correct math problems occurred during the 15 and 10 minute graduated temporal phases.

In contrast to the abrupt-graduated condition (S1, S2, S3) the median number of correct math problems increased in the graduated-abrupt condition (S4, S5, S6) as a result of the abrupt reduction phase; subjects who were exposed to an abrupt reduction first (S1, S2, S3) demonstrated a decreased median number of correct math problems when introduced to the 5 minute abrupt phase, whereas subjects who were exposed to a graduated temporal reduction first (S4, S5, S6) demonstrated an increased median number of correct math problems when introduced to the 5 minute abrupt temporal phase. Additionally, the graduated-abrupt subjects (S4, S5, S6) attained a median number correct during the 5 minute abrupt phase that equalled the median number of correct math problems attained during the previous 5 minute graduated phase.

Actual Time Spent on Math

Table 13 shows the actual median amount of time abrupt-graduated

Table 13

Actual Math Time Spent by Abrupt-Graduated Subjects (S1, S2, S3)

and Graduated-Abrupt Subjects (S4, S5, S6)

During Each Temporal Phase

Temporal Phases (allocated time in minutes)	Actual Median Time Used (min) (S1, S2, S3)	Temporal Phases (allocated time in minutes)	Actual Median Time Used (min) (S4, S5, S6)
20 baseline 1	13.5	20 baseline 1	10
5 abrupt reduction	5	15 graduated reduction	7.5
20 baseline 2	15	10 graduated reduction	7.0
15 graduated reduction	12	5 graduated reduction	5
10 graduated reduction	10	20 baseline 2	8
5 graduated reduction	5	5 abrupt reduction	5
20 baseline 3	10	20 baseline 3	7.5
20 two week follow-up	10	20 two week follow-up	9
20 five week follow-up	9	20 five week follow-up	6

subjects (S1, S2, S3) compared with graduated-abrupt subjects (S4, S5, S6) spent on math problems during each temporal phase. Except for the 5 minute temporal phases in which all six subjects took the full amount of time allocated, the abrupt-graduated subjects (S1, S2, S3) spent on a greater median amount of actual time on each temporal phase than did the graduated-abrupt subjects (S4, S5, S6).

Emotional Responses (ERs)

Table 14 shows the mean number of ERs observed during math time for both abrupt-graduated subjects (S1, S2, S3) and graduated-abrupt subjects (S4, S5, S6). Subjects in the abrupt-graduated condition (S1, S2, S3) exhibited a total mean number of ERs that was greater than the mean number of ERs exhibited by the graduated-abrupt subjects (S4, S5, S6). A number of ERs for the Abrupt-graduated subjects (S1, S2, S3) were observed during the initial 20 minute phase (baseline 1) with the greatest number of ERs occurring during the subsequent 5 minute abrupt reduction phase. Graduated-abrupt subjects (S4, S5, S6) also exhibited a number of ERs during the initial 20 minute phase (baseline 1), however, most other ERs for the graduated-abrupt subjects (S4, S5, S6) were observed during the 5 minute graduated phase. The pattern of ERs across conditions (ABACDBA and ACDBABA) was also similar in that a number of ERs were observed during the first 5 minute temporal phase regardless of whether it was reached through an abrupt or a graduated temporal reduction. Additionally, very few ERs were observed during the later stages of the study for either the abrupt-graduated subjects (S1, S2, S3) or the graduated-abrupt subjects (S4, S5, S6).

Table 14

Number of Emotional Responses (ERs) Observed During Math Work Time for Abrupt-Graduated Subjects (S1, S2, S3) and Graduated-Abrupt Subjects (S4, S5, S6)

Temporal Phases (allocated time in minutes)	Mean ERs S1 S2 S3	Temporal Phases (allocated time in minutes)	Mean ERs S4 S5 S6
20 baseline 1	1	20 baseline 1	3
5 abrupt reduction	9	15 graduated reduction	0
20 baseline 2	0	10 graduated reduction	1
15 graduated reduction	.7	5 graduated reduction	2.7
10 graduated reduction	0	20 baseline 2	0
5 graduated reduction	0	5 abrupt reduction	.7
20 baseline 3	0	20 baseline 3	0
20 two week follow-up	0	20 two week follow-up	0
20 five week follow-up	0	20 five week follow-up	0

Rate of Copying Paragraphs

A comparison between Table 5 and Table 10 indicates that median copying rates generally increased gradually as the study progressed for both abrupt-graduated subjects (S1, S2, S3) and graduated-abrupt subjects (S4, S5, S6). For the graduated-abrupt subjects (S4, S5, S6), however, median copying rates did not continue to uniformly increase during the two follow-up probes. Copying rates did not co-vary with corresponding math time allocations for either abrupt-graduated subjects (S1, S2, S3) or graduated-abrupt subjects (S4, S5, S6).

CHAPTER V

DISCUSSION

One purpose of this study was to assess the effects of a graduated reduction in time allotted to perform academic tasks (math problems). The results demonstrate that a slow learner's correct rate of academic performance will increase markedly if the allocated to complete the academic task is gradually reduced. All subjects demonstrated increases in rate of correct math performance as a result of the graduated temporal reductions supporting the findings obtained by Ayllon et al. (1976), Hopkins et al. (1971), and Sanok and Ascione (1978).

This finding has potential for use in applied settings because not only did rates improve but five of six subjects actually completed more math problems correctly in five minutes than twenty minutes. Subjects S1, S2, S3, S4 and S5 demonstrated a median number correct during the 5 minute graduated phase that was greater than, or equal to, the median number correct during the initial 20 minute phase (baseline 1). In contrast, S6 demonstrated a lower median number of problems during the 5 minute graduated phase compared with baseline 1 (see Table 2 and Table 7). It is interesting to note that S6 also differed from all the other subjects in that he always worked for the full amount of allocated math time (see Table 3 and Table 8). Although many explanations might be offered, one which could account for S6's differing performance is that the ICSP Arithmetic Skills Inventory (ASI) may not have adequately assessed S6's math skill level; resulting in a pool of math items which were too diffiuclt for him. As can be seen in Appendix B, S6's level of math was more difficult than any other subject's according to the ICSP. The ASI, however, appeared to adequaltely assess math skill levels for the other five subjects. Another plausible explanation is that inappropriately difficult problems were assigned to S6 when the difficulty level of math items was increased because S6 achieved over 50% correct during baseline 1 (see Subjects and Setting in Method section, Chapter III). This same procedure did seem to result in math problems of an appropriate difficulty level for the other five subjects, however, it is worthwhile to note that S6 was the only subject whose general information score on the Peabody Individual Achievement Test was below basal (see Appendix B). S6's IQ score, however, does not appear to be deviant from other graduated-abrupt subjects' scores (see Appendix B). Regardless of the reason, S6's performance throughout the study appeared to correspond closely with the amount of time allotted to work, rather than the sequencing of the temporal shifts.

The second purpose of this study was to assess the effects of an abrupt reduction in the time allocated to perform academic tasks (math problems). The third purpose was to assess the effects of a history of an abrupt reduction of time limits on academic performance during a graduated reduction in time limits and, conversely, to assess the effects of a history of a graduated reduction of time limits on academic performance during an abrupt reduction in time limits. The second and third purposes of this study are discussed simultaneously because the abrupt temporal reduction affected subjects differentially across conditions. That is, while a graduated reduction in time limits affected all subjects similarly regardless of previous (experimental) history, an abrupt reduction in time limits effected subjects differentially depending on whether they had a history of graduated reductions or not. All subjects in the abrupt-graduated condition (S1, S2, S3) demonstrated a decreased median number of correct math problems when the 5 minute abrupt phase was introduced (see Table 2). Additionally, S1 and S3 demonstrated decreased median rates during the abrupt phase. S2's median rate, however, increased during the abrupt phase (see Table 1). In contrast to the subject's without a (experimental) history of graduated reduction (S1, S2, S3) subjects exposed to a graduated reduction sequence first (S4, S5, S6) demonstrated improved academic performance when introduced to the abrupt temporal reduction (see Figure 5). All three subjects in the graduated-abrupt condition (S4, S5, S6) demonstrated increased median rates of correct math problems during the abrupt temporal reduction (see Table 6). Additionally, S4 and S5 demonstrated an increased median number of correct problems during the 5 minute abrupt phase compared with the median number correct during the 20 minute baseline 1 and baseline 2 phases (see Table 7). It appears that after a graduated reduction history has been established abrupt reductions may be effectively employed to increase the rate and accuracy of academic performance. It is therefore quite plausible that S2's median rate increased when the abrupt reduction was introduced because of a previous (non-experimental) history of graduated reductions. Bijou and Baer (1961, pp. 8-9) have pointed out the importance of past experience (history) in determining why two children may behave quite differently when exposed to similar stimulus conditions. Furthermore, other researchers (Weiner, 1965; Smeets, Striefel, and Gast, 1974) have demonstrated that previous conditioning histories can have marked effects on human operant behavior.

The fourth purpose of this study was to assess the durability of the effects of systematic manipulation of temporal limits. This was attempted by two follow-up probes conducted two and five weeks after the completion of the last session of baseline 3 for each subject. Median math rates for subjects S2, S3, S4, and S5 during the two week follow-up increased compared with their median math rates during baseline 1. Furthermore, the median number of correct problems completed during the two week follow-up was greater than or equal to the median number of correct problems completed during baseline 1. Subjects' S1 and S6 median rates and median number correct were slightly lower than performances during baseline 1. During the five week follow-up all six subjects demonstrated increased median math rates and increased median numbers of correct problems compared with their performances during baseline 1 and baseline 2. All subjects in both conditions were demonstrating marked improvements in math performance five weeks after the study terminated. The enduring nature of the improved math behavior further enhances the attractiveness of using the systematic temporal manipulations described herein, however, it is unclear precisely why the subjects' improved math performance endured after the consequences (token reinforcement) was withdrawn and formal experimental manipulations were discontinued. Several post hoc explanations are possible. First, functional control of the math response by tokens may have been minimal. This is exemplified by math response changes as a function of temporal manipulations while the token reinforcement was held constant. If this is the case, then one would not have expected a radical change (i.e., decreased math performance) when tokens were withdrawn. Second, Sidman (1960) has suggested that irreversible changes may occur because the topography of the response has somehow changed (e.g., the students no longer counted on their fingers). Third, it is possible that math behavior came under the control of other reinforcers in the setting. Math behavior may have been maintained after token reinforcement was withdrawn because the teacher was consistently associated with token reinforcement. The teacher may have become a more powerful reinforcer after the study, thus maintaining the performance of the students without using reinforcers such as tokens (Chadwick and Day, 1971). A fourth explanation of enduring math improvement is that after token reinforcement was withdrawn, reinforcers which resulted directly from the math activities themselves maintained the behavior. Kazdin (1975) points out that many behaviors may be maintained because once they are developed, they are reinforced by their normal consequences. A final explanation of the enduring math improvements is that the teacher may have her behavior in some permanent fashion. The teacher may have continued to use the principles of behavior modification effectively after the study terminated (Patterson, Cobb, and Ray, 1973). In order to more clearly understand why the math behavior was maintained it is suggested that future researchers consider predicting resistance to extinction in advance based on systematic response maintenance procedures rather than assuming it will occur automatically.

The fifth and final purpose of this study was to assess the degree to which the effects of systematic manipulation of temporal limits for one class of academic behaviors (solving math problems) generalized to another class of academic behaviors (copying words). Although all six subjects demonstrated increased copying rates during the interim of the study, these increases did not closely correspond to the math time allocations but rather increased steadily throughout the study. These increases can be accounted for by practice effects. An explanation for the apparent lack of generalization is that the types of responses and operations required of subjects to perform the two tasks are quite different and that copying performance in no way effected the number of tokens a subject earned (i.e., math performance was differentially reinforced with tokens). The copying task was chosen, in part, because previous research by (Hopkins et al., 1971) suggested that the rate of copying words could be increased by reducing time limits, furthermore, previous findings indicated that altering one behavior can inadvertently improve other behaviors not directly focused upon. Diverse behavioral techniques have shown generalization of beneficial effects to behaviors not originally included in treatment for anxiety and fear, speech disfluencies, self-destructive behaviors, social responses, and appropriate classroom behaviors (Kazdin, 1973; Mahoney, Kazdin, and Lesswing, 1974).

These results demonstrate that graduated temporal reductions increased correct rate of academic performance for slow learners. This aspect of the findings is consistent with findings obtained by Ayllon et al. (1976). This study, however, was designed to preclude the possibility that academic improvements were merely a function of developing academic skills. As stated previously, the multiple baseline design with reversals across subjects introduced the experimental variable at different points in time for each subject and demonstrated partial reversals when baseline conditions were reinstated. As seen in Figure 1 and more clearly in Figures 2 and 3, the changes in math behavior were attributable to the presentation of the temporal phases because the math changes occurred abruptly and in sequential fashion as the experimental variable was introduced to each subject. Furthermore, this study shed additional light on the relationship between abrupt and graduated temporal reductions. Whereas Ayllon et al. (1976) concluded that abrupt temporal reductions suppress rate and result in counter-productive emotional behaviors; this study demonstrated that abrupt temporal reductions are at least as effective in improving the correct rate and number correct if a graduated reduction history is first established. This increases the attractiveness of using temporal reductions as a means of enhancing academic behavior because after an appropriate graduated history has been "built in" abrupt reductions can be employed. Abrupt temporal reductions are more efficient than graduated temporal reductions and they more closely approximate what might occur in a regular classroom or outside the classroom setting.

It is not clear why abrupt temporal reductions led to an increase in performance after a graduated reduction history. It is plausible, however, that for subjects who had a graduated reduction history the announced temporal reduction did not function as a cue which indicated the loss of positive reinforcement. Because subjects had been able to maintain a relatively high level of reinforcement during the graduated reduction phases (including the 5 minute graduated reduction phase) the 5 minute abrupt reduction phase did not function as a negative discriminative stimulus and did not result in interfering respondent behaviors (ERs, for example).

It was beyond the scope of this study to assess the effects of temporal manipulations on the acquisition of new or more difficult academic behaviors, however, it is clear that systematically manipulating temporal limits has practical advantages. It frees up more of the teacher's time to teach new skills and further individualize instruction. It is especially important that this can be accomplished without any increased cost.

It is suggested that future research effort explore the degree to which the effects of temporal manipulations generalize to new and/or different behaviors (e.g., more advanced math behaviors). This research should consider a condition in which the behavior is reinforced with tokens and a condition in which it is not.

It is suggested that future research incorporate procedures which (a) maintain an equal level of math difficulty for all subjects, (b) provide specific criteria to ensure stable (initial) baselines, and (c) operationally define ERs and provide a measure of reliability for them.

It is further suggested that future research focus upon the usefulness of the relationship between graduated and abrupt temporal reduction techniques with other (non-academic) behaviors and with other sample populations in different settings. The effects of the temporal reduction techniques described herein may, for example, have heuristic value in industry and business.

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APPENDIXES

Appendix A: Informed Consent

Informed Consent

The following statement was signed by the parents of all subjects in the study. All subjects were informed that they had the option to withdraw from the study at any time.

"I ______________________________ have been informed of the nature of the study on the effects of time limits on academic behavior and fully understand it. I give consent for my child to participate in the study. I also understand that complete confidentiality will be maintained and that my child will not be identified by name in any of the research reports."

____

Witness Date

Appendix B: Additional Subject Data

Subject S1

Experimental Condition: Abrupt-Graduated

Regular Grade Placement: 3rd.

Age: 8 years 5 months (101 months)

Race: Black

Sex: Male

Test Data:

Wechsler Intelligence Scale for Children
Verbal IQ: 86
Performance IQ: 87
Full Scale IQ: 85

Peabody Individual Achievement Test

	Grade Equivalents	Age Equivalents
Mathematics	1.4	6-7
Reading Recognition	1.5	6-9
Reading Comprehension	2.1	7-2
Spelling	2.3	7-6
General Information	2.4	7-6
Total Test	1.7	6-11

Wide Range Achievement Test

Reading	1.5
Mathematics	1.6

ICSP Math Difficulty Level

Skill Levels*

Whole Numbers-Addition	Whole Numbers-Subtraction
(Level 4-Sessions 1 & 2)	(Level 3-Sessions 1 & 2)
Level 5	Level 4

*Skill levels are arranged in order of difficulty.

Subject S2

Experimental Condition: Abrupt-Graduated

Regular Grade Placement: 3rd

Age: 8 years 1 month (97 months)

Race: Caucasian

Sex: Female

Test Data:

Wechsler Intelligence Scale for Children

Verbal IQ: 96
Performance IQ: 102
Full Scale IQ: 99

Peabody Individual Achievement Test

	Grade Equivalents	Age Equivalents
Mathematics	1.4	6-7
Reading Recognition	1.4	6-7
Reading Comprehension	2.0	6-11
Spelling	1.7	7-0
General Information	0.5	5-7
Total Test	1.3	6-6

Wide Range Achievement Test

Reading	1.3
Mathematics	1.6

ICSP Math Difficulty Level

Skill Levels*

Whole Numbers-Addition	Whole Numbers Subtraction
(Level 3-Sessions 1 & 2)	(Level 2-Sessions 1 & 2)
Level 4	Level 3

*Skill levels are arranged in order of difficulty.

Subject S3

Experimental Condition: Abrupt-Graduated

Regular Grade Placement: 3rd

Age: 8 years 11 months (107 months)

Race: Caucasian

Sex: Female

Test Data:

Wechsler Intelligence Scale for Children

Verbal IQ: 78
Performance IQ: 80
Full Scale IQ: 77

Peabody Individual Achievement Test

	Grade Equivalents	Age Equivalents
Mathematics	0.9	6-0
Reading Recognition	2.0	7-4
Reading Comprehension	2.5	7-7
Spelling	2.0	7-3
General Information	2.2	7-3
Total Test	1.7	6-11

Wide Range Achievement Test

Reading	1.2
Mathematics	1.0

ICSP Math Difficulty Level

Skill Level*

Whole Numbers-Addition	Whole Numbers-Subtraction
(Level 3-Sessions 1 & 4)	(Level 2-Sessions 1 & 4)
(Level 4-Session 5)	(Level 3-Session 5)
Level 5	Level 4

*Skill levels are arranged in order of difficulty.

Subject S4

Experimental Condition: Graduated-Abrupt

Regular Grade Placement: 3rd

Age: 8 years 2 months (98 months)

Race: Black

Sex: Female

Test Data:

Wechsler Intelligence Scale for Children

Verbal IQ: 78
Performance IQ: 70
Full Scale: 72

Peabody Individual Achievement Test

	Grade Equivalents	Age Equivalents
Mathematics	1.1	6-2
Reading Recognition	1.6	6-11
Reading Comprehension	2.2	7-4
Spelling	2.3	7-6
General Information	1.6	6-9
Total Test	1.6	6-9

Wide Range Achievement Test

Reading	1.4
Mathematics	1.2

ICSP Math Difficulty Level

Skill Levels*

Whole Numbers-Addition	Whole Numbers-Subtraction
(Level 4-Sessions 1 & 2)	(Level 2-Sessions 1 & 2)
Level 5	Level 3

*Skill levels are arranged in order of difficulty.

Subject S5

Experimental Condition: Graduated-Abrupt

Regular Grade Placement: 3rd

Age: 7 years 11 months (95 months)

Race: Caucasian

Sex: Male

Test Data:

Wechsler Intelligence Scale for Children

Verbal IQ: 74
Performance IQ: 70
Full Scale IQ: 70

Peabody Individual Achievement Test

	Grade Equivalents	Age Equivalents
Mathematics	1.1	6-2
Reading Recognition	1.4	6-7
Reading Comprehension	2.0	6-11
Spelling	1.8	7-1
General Information	0.5	5-7
Total Test	1.3	6-6

Wide Range Achievement Test

Reading	1.2
Mathematics	Kg. .4

ICSP Math Difficulty Level

Skill Levels*

Whole Numbers-Addition	Whole Numbers-Subtraction
Level 5	Level 2

*Skill levels are arranged in order of difficulty.

Subject S6

Experimental Condition: Graduated-Abrupt

Regular Grade Placement: 3rd

Age: 9 years 1 months (109 months)

Race: Caucasian

Sex: Male

Test Data:

Stanford-Binet Intelligence Test

IQ: 72

Peabody Individual Achievement Test

	Grade Equivalents	Age Equivalents
Mathematics	0.9	6-0
Reading Recognition	1.6	6-11
Reading Comprehension	2.2	7-4
Spelling	2.7	7-11
General Information	(below basal)	(below basal)
Total Test	1.3	6-6

ICSP Math Difficulty Level

Skill Levels*

Whole Numbers-Addition	Whole Numbers-Subtraction
(Level 5-Session 1)	(Level 2-Session 1)
(Level 6-Session 2)	(Level 3-Session 2)
(Level 7-Session 3)	(Level 4-Session 3)
Level 8	Level 5

*Skill levels are arranged in order of difficulty.

Appendix C: Description of ICPS-Placement Test and Math Items

The ICSP Placement Test

The placement test of the ICSP is called the Arithmetic Skills Inventory (ASI). The ASI tests the student's ability in a particular mathematics area. The first problem on the ASI tests Skill 1 in an area, the second problem tests Skill 2, and so on. Thus, the number of problems given is the same as the number of skills in a corresponding math area. For example, the skill area "Whole Numbers - Addition" is broken down into nine skills and the ASI for "Whole Numbers - Addition" has nine problems. The skills are arranged in order of difficulty.

Description of Math Items Used

After testing with the ASI it was determined that all six subjects would receive items from the following two math areas: "Whole Numbers - Addition" and "Whole Numbers - Subtraction." Following are outlines of the skills included in the two skills areas:

WHOLE NUMBERS: ADDITION

1. Add two one-digit numbers (basic facts).
2. Add three numbers that produce a sum less than 10.
3. Add three one-digit numbers whose sum is 10 or more.
4. Add two numbers up to two digits each, no regrouping.
5. Add two numbers with carrying into the tens' place only.
6. Add two numbers with carrying into the hundreds' place only (not into the tens').

7. Add two numbers with carrying into the tens' and hundreds' places.
8. Add more than two numbers with carrying into both the tens' and hundreds' places.
9. Add numbers of more than three digits with carrying all the way.

WHOLE NUMBERS: SUBTRACTION

1. Subtract two one-digit numbers.
2. Subtract using the basic facts.
3. Subtract two two-digit numbers without regrouping (no borrowing).
4. Subtract two three-digit numbers without regrouping (no borrowing).
5. Subtract two two- and three-digit numbers where the tens are regrouped to get more ones (borrowing from the tens only).
6. Subtract two three-digit numbers where the hundreds only are regrouped.
7. Subtract two four-digit numbers where the hundreds only are regrouped.
8. Subtract two three-digit numbers where both the tens and hundreds are regrouped.
9. Subtract two four-digit numbers where both the tens and hundreds are regrouped.

10. Subtract two four- and five-digit numbers (regrouping all the way).

Appendix D: Criteria for Copying

Criteria for Copying

A word was not counted toward correct rate of copying it it contained one or more of the following conditions:

1. The word contained an omission of one or more assigned letters.
2. Substitution of letters in place of those assigned were found in the word.
3. Reversals, e.g., "ꓘ" instead of "K", were found in the word.
4. The word contained one or more omissions of any part of a letter, e.g., failing to cross a "T".
5. The word was not recognizable by the teacher or by another person.

Appendix E: Data Sheet for Recording Indicies

of Emotional Behavior (ERs)

Data Sheet for Recording Indicies
of Emotional Behavior (ERs)

Subject #________ Date ________

Session #________ Experimental Condition ________

BEHAVIOR CATEGORY & DESCRIPTION	FREQUENCY	DURATION	TOTALS
1. Complaints - "Not enough time" "This is too hard."			
2. Foul Language - "Explitive delete".			
3. Noises			
4. Crying			
5. Throwing - "Threw pencil on floor."			
6. Stomping			
7. Other - "Pulled own hair."			

COMMENTS:

Appendix F: Reinforcers

Reinforcer Price List

COST	REINFORCERS
5 tokens	Hall pass
5 tokens	Write on blackboard
8 tokens	Work on terrarium
10 tokens	10 minute free time
20 tokens	Pink Panther book
20 tokens	Sesame Street book
20 tokens	Baby Animal book
20 tokens	Blowing bubbles
20 tokens	Dinosaur book
22 tokens	Pink rubber ball
25 tokens	Paddle ball
30 tokens	Large color book
30 tokens	Cat puzzle
30 tokens	Train puzzle
30 tokens	Playdough
32 tokens	Firetruck puzzle
40 tokens	Dinosaur press cuts
40 tokens	Mods press outs
40 tokens	Yellowstone press outs
40 tokens	Key chain
50 tokens	Pocket cars and trucks
55 tokens	Yo yo
60 tokens	Wiffle bat and ball

Appendix G: Raw Data

Raw Data

Session Number	Temporal Phase	No. Math Correct	Math Time (minutes)	Math Rate	Copying Rate	No ERs
			Subject 1			
1	20 min.	8	18.5	.4	3.0	1
2	20 min.	13	17.5	.7	2.5	0
3	20 min.	11	14.0	.8	1.8	0
4	5 min.	1	5.0	.2	3.1	1
5	5 min.	1	5.0	.2	1.8	2
6	5 min.	6	5.0	1.2	4.1	0
7	5 min.	2	5.0	.4	2.1	1
8	5 min.	3	5.0	.6	2.5	0
9	20 min.	13	18.5	.7	2.0	0
10	20 min.	12	20.0	.6	2.3	0
11	20 min.	12	17.0	.7	2.1	0
12	20 min.	9	13.5	.7	2.3	0
13	20 min.	10	11.0	.9	2.4	0
14	15 min.	13	11.5	1.1	2.1	0
15	15 min.	11	11.5	1.0	3.9	0
16	15 min.	10	10.0	1.0	2.1	0
17	15 min.	14	9.0	1.6	4.4	1
18	15 min.	15	13.0	1.2	3.0	0
19	10 min.	10	10.0	1.0	3.4	0
20	10 min.	12	10.0	1.2	3.5	0
21	10 min.	14	10.0	1.4	3.1	0
22	10 min.	13	9.5	1.4	3.9	0
23	10 min.	14	10.0	1.4	5.0	0
24	5 min.	9	5.0	1.8	4.8	0
25	5 min.	12	5.0	2.5	1.5	0
26	5 min.	8	5.0	1.6	2.6	0
27	5 min.	13	5.0	2.6	4.6	0
28	5 min.	11	5.0	2.2	3.6	0
29	20 min.	12	10.0	1.2	5.0	0
30	20 min.	10	12.5	.8	4.8	0
31	20 min.	10	9.0	1.1	5.8	0
32	20 min.	11	11.0	1.0	6.0	0
33	20 min.	7	11.0	.6	3.5	0
(follow up)	20 min.	10	18.0	.6	5.4	0
(follow up)	20 min.	16	16.0	1.0	5.6	0
			Subject 2			
1	20 min.	9	16.0	.6	1.3	0
2	20 min.	19	11.0	1.7	1.4	1
3	20 min.	4	14.5	.3	1.7	0

Session Number	Temporal Phase	No. Math Correct	Math Time (minutes)	Math Rate	Copying Rate	No. ERs
4	20 min.	9	11.5	.8	1.3	0
5	20 min.	6	20.0	.3	1.4	0
6	20 min.	9	13.5	.7	3.6	0
7	5 min.	5	5.0	1.0	3.4	1
8	5 min.	6	5.0	1.2	2.0	0
9	5 min.	5	5.0	1.0	.6	2
10	5 min.	6	5.0	1.2	1.4	0
11	5 min.	8	5.0	1.6	2.4	2
12	20 min.	13	11.0	1.2	1.6	0
13	20 min.	15	11.5	1.3	2.1	0
14	20 min.	17	10.0	1.7	2.3	0
15	20 min.	15	8.5	1.8	1.7	0
16	20 min.	8	8.0	1.0	1.6	0
17	15 min.	15	11.0	1.4	1.5	1
18	15 min.	18	9.0	2.0	2.1	0
19	15 min.	17	11.0	1.6	2.2	0
20	15 min.	16	12.0	1.3	1.1	0
21	15 min.	17	14.0	1.2	.9	0
22	10 min.	17	7.5	2.3	1.9	0
23	10 min.	14	9.0	1.6	2.7	0
24	10 min.	15	10.0	1.5	2.9	0
25	10 min.	17	9.0	1.9	4.6	0
26	10 min.	17	10.0	1.7	3.0	0
27	5 min.	13	5.0	2.6	3.3	0
28	5 min.	13	5.0	2.6	2.9	0
29	5 min.	9	5.0	1.8	3.1	0
30	5 min.	13	5.0	2.6	4.7	0
31	5 min.	15	5.0	3.0	2.5	0
32	20 min.	19	7.5	2.5	2.7	0
33	20 min.	18	7.5	2.4	4.8	0
34	20 min.	16	8.5	1.9	2.8	0
35	20 min.	18	11.0	1.6	2.9	0
36	20 min.	16	8.5	1.9	4.0	0
(follow up)	20 min.	17	10.0	1.7	4.6	0
(follow up)	20 min.	20	9.0	2.2	4.9	0

Subject 3

1	20 min.	5	6.0	.8	3.5	0
2	20 min.	5	6.5	.8	3.3	1
3	20 min.	6	14.5	.4	2.9	0
4	20 min.	14	9.5	1.5	2.2	0
5	20 min.	15	7.0	2.1	1.9	0
6	20 min.	4	10.5	.4	2.6	0
7	20 min.	7	13.5	.5	2.6	0
8	20 min.	8	12.0	.7	1.5	0

Session Number	Temporal Phase	No. Math Correct	Math Time (minutes)	Math Rate	Copying Rate	No. ERs
9	20 min.	9	16.0	.6	1.9	0
10	5 min.	2	5.0	.4	1.7	8
11	5 min.	3	5.0	.6	1.8	2
12	5 min.	1	5.0	.2	2.9	5
13	5 min.	2	5.0	.4	3.6	3
14	5 min.	1	5.0	.2	3.6	1
15	20 min.	6	17.0	.4	4.8	0
16	20 min.	3	17.5	.2	4.5	0
17	20 min.	5	15.0	.3	4.4	0
18	20 min.	4	17.5	.2	4.9	0
19	20 min.	1	17.5	.1	5.2	0
20	15 min.	2	13.0	.2	4.4	0
21	15 min.	5	15.0	.3	4.1	0
22	15 min.	1	15.0	.1	4.1	0
23	15 min.	2	14.0	.1	5.0	0
24	15 min.	3	15.0	.2	5.8	0
25	10 min.	2	10.0	.2	5.4	0
26	10 min.	5	10.0	.5	4.9	0
27	10 min.	5	10.0	.5	5.6	0
28	10 min.	4	9.5	.4	4.8	0
29	10 min.	6	10.0	.6	6.6	0
30	5 min.	2	5.0	.4	6.0	0
31	5 min.	10	5.0	2.0	5.3	0
32	5 min.	4	5.0	.8	8.5	0
33	5 min.	11	5.0	2.2	6.4	0
34	5 min.	8	5.0	1.6	7.3	0
35	20 min.	11	9.5	1.2	5.5	0
36	20 min.	11	14.0	.8	5.6	0
37	20 min.	9	11.0	.8	6.2	0
38	20 min.	9	10.0	.9	5.8	0
39	20 min.	6	10.0	.6	5.6	0
(follow up)	20 min.	7	7.5	.9	6.8	0
(follow up)	20 min.	9	7.0	1.3	7.1	0

Subject 4

Session Number	Temporal Phase	No. Math Correct	Math Time (minutes)	Math Rate	Copying Rate	No. ERs
1	20 min.	6	6.0	1.0	3.8	2
2	20 min.	12	8.0	1.5	3.7	0
3	20 min.	9	14.5	.6	4.7	2
4	15 min.	11	7.5	1.5	8.0	0
5	15 min.	10	6.0	1.7	4.6	0
6	15 min.	11	6.0	1.8	4.0	0
7	15 min.	12	12.0	1.0	3.0	0
8	10 min.	12	7.0	1.7	3.6	0
9	10 min.	11	7.0	1.6	3.9	0

Session Number	Temporal Phase	No. Math Correct	Math Time (minutes)	Math Rate	Copying Rate	No ERs
10	10 min.	13	8.0	1.6	5.5	0
11	10 min.	11	7.0	1.6	4.1	0
12	10 min.	14	6.0	2.3	5.5	0
13	10 min.	14	6.0	2.3	3.0	0
14	5 min.	13	5.0	2.6	3.5	1
15	5 min.	12	5.0	2.4	3.7	5
16	5 min.	15	5.0	3.0	4.0	1
17	5 min.	12	5.0	2.4	4.8	0
18	5 min.	14	5.0	2.8	4.8	0
19	20 min.	14	9.0	1.6	5.3	0
20	20 min.	12	6.0	2.0	3.4	0
21	20 min.	10	6.5	1.5	4.4	0
22	20 min.	10	8.5	1.2	3.8	0
23	20 min.	9	8.0	1.1	5.5	0
24	5 min.	11	5.0	2.2	5.3	0
25	5 min.	12	5.0	2.4	6.2	0
26	5 min.	12	4.0	3.0	7.0	2
27	5 min.	11	4.5	2.4	4.8	0
28	5 min.	13	4.0	3.3	7.1	0
29	20 min.	14	7.5	1.9	6.9	0
30	20 min.	17	7.0	2.4	6.0	0
31	20 min.	15	5.5	2.7	6.9	0
32	20 min.	18	9.5	1.9	8.0	0
33	20 min.	12	7.0	1.7	7.3	0
(follow up)	20 min.	16	7.0	2.3	6.2	0
(follow up)	20 min.	13	5.0	2.6	4.7	0

Subject 5

Session Number	Temporal Phase	No. Math Correct	Math Time (minutes)	Math Rate	Copying Rate	No ERs
1	20 min.	8	6.5	1.2	3.7	0
2	20 min.	6	5.0	1.2	2.5	0
3	20 min.	5	4.0	1.3	2.6	0
4	20 min.	5	6.0	.8	2.4	0
5	20 min.	8	6.0	1.3	2.3	0
6	20 min.	6	6.5	.9	2.2	0
7	15 min.	7	6.5	1.0	3.6	0
8	15 min.	13	5.0	2.6	2.6	0
9	15 min.	9	5.0	1.8	3.3	0
10	15 min.	15	7.5	2.0	2.8	0
11	15 min.	14	7.0	2.0	2.7	0
12	10 min.	13	7.5	1.7	3.9	0
13	10 min.	12	6.5	1.9	3.0	0
14	10 min.	17	7.0	2.4	3.9	0
15	10 min.	11	6.5	1.7	2.8	0
16	10 min.	15	6.5	2.3	3.3	0

Session Number	Temporal Phase	No. Math Correct	Math Time (minutes)	Math Rate	Copying Rate	No. ERs
17	5 min.	8	5.0	1.6	2.3	0
18	5 min.	14	5.0	2.8	3.1	0
19	5 min.	14	5.0	2.8	3.0	0
20	5 min.	15	5.0	3.0	3.9	0
21	5 min.	14	5.0	2.8	3.2	0
22	20 min.	12	5.5	2.2	2.9	0
23	20 min.	17	6.0	2.8	2.8	0
24	20 min.	15	6.0	2.5	2.9	0
25	20 min.	12	6.0	2.0	3.8	0
26	20 min.	14	6.5	2.2	2.7	0
27	5 min.	18	5.0	3.6	2.6	0
28	5 min.	17	4.5	3.7	3.1	0
29	5 min.	14	5.0	2.8	4.0	0
30	5 min.	17	5.0	3.4	3.0	0
31	5 min.	13	5.0	2.6	3.4	0
32	20 min.	16	7.5	2.1	3.3	0
33	20 min.	15	6.5	2.3	4.2	0
34	20 min.	14	7.0	2.0	4.2	0
35	20 min.	15	5.5	2.7	4.5	0
36	20 min.	18	5.5	3.2	2.5	0
(follow up)	20 min.	18	9.0	2.0	2.6	0
(follow up)	20 min.	17	6.0	2.8	3.8	0

Subject 6

1	20 min.	15	5.0	3.0	3.9	0
2	20 min.	17	12.0	1.4	4.1	0
3	20 min.	14	16.5	.8	5.3	0
4	20 min.	14	15.0	.9	5.6	0
5	20 min.	9	20.0	.5	6.6	5
6	20 min.	7	20.0	.4	4.9	0
7	20 min.	6	20.0	.3	7.7	0
8	20 min.	7	20.0	.4	4.9	0
9	20 min.	4	20.0	.2	7.5	0
10	15 min.	7	15.0	.5	8.8	0
11	15 min.	2	15.0	.1	6.7	0
12	15 min.	6	15.0	.4	6.8	0
13	15 min.	7	15.0	.5	7.5	0
14	15 min.	7	15.0	.5	7.2	0
15	10 min.	2	9.0	.2	6.4	1
16	10 min.	1	10.0	.1	8.0	0
17	10 min.	3	10.0	.3	6.8	1
18	10 min.	4	10.0	.4	6.8	1
19	10 min.	2	10.0	.2	6.0	0
20	5 min.	2	5.0	.4	7.1	0

Session Number	Temporal Phase	No. Math Correct	Math Time (minutes)	Math Rate	Copying Rate	ERs
21	5 min.	3	5.0	.6	8.2	0
22	5 min.	2	5.0	.4	7.3	1
23	5 min.	2	5.0	.4	8.0	0
24	5 min.	1	5.0	.2	6.6	0
24	20 min.	6	20.0	.3	5.8	0
26	20 min.	8	20.0	.4	5.3	0
27	20 min.	3	20.0	.2	8.0	0
28	20 min.	6	20.0	.3	6.6	0
29	20 min.	2	20.0	.1	8.2	0
30	5 min.	2	5.0	.4	7.1	0
31	5 min.	4	5.0	.8	6.4	0
32	5 min.	3	5.0	.6	6.7	0
33	5 min.	1	5.0	.2	11.0	0
34	5 min.	3	5.0	.6	6.2	0
35	20 min.	5	20.0	.3	6.0	0
36	20 min.	4	20.0	.2	7.1	0
37	20 min.	6	20.0	.3	12.0	0
38	20 min.	8	20.0	.4	7.8	0
39	20 min.	6	20.0	.3	7.0	0
(follow up)	20 min.	7	20.0	.4	6.4	0
(follow up)	20 min.	13	20.0	.7	8.0	0

VITA

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Doctor of Philosophy

Dissertation: The Effects of Abrupt and Graduated Temporal Reductions on Academic Behavior

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Personal Information: Born at Newark, New Jersey, October 11, 1950, son of Vincent and Marie Pezzino.

Education: B.A., 1972, Psychology, University of Montana; M.S., 1975, Psychology, Utah State University; Ph.D., 1979, Psychology, Utah State University.

Training and Professional Experience:

Montana University Affiliated Program................Helena

February, 1979 - present

Job description: Associate Director; administrative duties and program development with new Center serving the developmentally disabled.

Northcentral Montana Mental Health Center...........Choteau

July, 1978 - January, 1979

Clinical training: focus on basic mental health services in rural setting.

North Hills-Family Life Services..........,N.L.R., Arkansas

September, 1976 - July, 1978

Job description: Director of Training; coordination of clinical services and in-service training of staff delivering services to handicapped population.

University of Arkansas at Little Rock

October, 1976 - September, 1978

Adjunct Instructor, College of Education; development and teaching of graduate course concerning the teaching of handicapped individuals in the regular classroom.

Attended Utah State University 9/72 - 8/76

University Affiliated Exceptional Child Center...Logan, Utah

September, 1972 - August, 1976

Jobs included: project coordinator for handicapped pre-school program; program evaluator; assistant to Director of Education.

Utah State University, Department of Special Education

Summer, 1975

Job description: coordination of workshop covering "Rights of the Handicapped," "Sexual Education and the Handicapped," "Informal Assessment of the Developmentally Disabled," "Mainstreaming Developmentally Disabled Children," and "Alternatives for the Adult Handicapped."

Four Corners Mental Health Center...........Monticello, Utah

Summer, 1974

Training duties included: diagnostic testing and treatment consultation with Caucasian and Native Americans in rural area.

Davis County School District...............Farmington, Utah

September, 1973 - June, 1974

Job description: School Psychologist Intern; clinical and educational assessment, family and marital counseling, intervention with children with emotional or behavioral problems, consultation with teachers.

Utah State University, Department of Psychology

Fall, 1972

Job description: Teaching Assistant, General Psychology.

Attended University of Montana 9/70 - 6/72

University of Montana, Department of Psychology

January, 1970 - June, 1972

Job description: Research Assistant; basic research with animals and consultation on research design paradgms,

Publications:

Extinction in rabbis under different levels of cutaneous afferent activity, Physiology and Behavior, 1974, (with N.M. Kettlewell and L.H. Berger).

Advantages of a Multidisciplinary Treatment Approach, North Hills Newsletter, 1, (4), August, 1977.

Teaching Handicapped Infants: A Guide for the Trainers of Parents, manuscript submitted for publication, 1979, (with C. Shannon).

Papers and Presentations:

Acquisition of an imitative and receptive language repertoire in a language deficient child. Paper presented at the meeting of the Rocky Mountain Psychological Association, Las Vegas, Nevada, 1973.

The effects of two levels of reinforcement on learning scores, Unpublished Masters Thesis, Utah State University, 1975.

Evaluation guidelines: A prototype. Unpublished manuscript, 1975 (with J.A. McLaughlin and R. Baer).

Delivery of preschool services to handicapped children with respect to Title XX of the Social Security Act. Paper presented to President's Committee on Mental Retardation, Logan, Utah, 1975.

Mainstreaming the handicapped preschool child. Paper presented at the meeting of the Arkansas Association of Children Under Six, Little Rock, Arkansas, 1977.

Grants:

Pezzino, James and Striefel, Sebastian. Grant to Develop Services for Handicapped Preschoolers in 5 County Area of Utah, State of Utah, 1975-1976, ($85,657).

Pezzino, James and Striefel, Sebastian. Grant for Continuation and Expansion of Services to Handicapped Preschoolers in 5 County Area of Utah, State of Utah, 1976-1977, (110,000).

Certification:

Psychologist: Basic Professional Certificate, Utah, #155409176, expires 1981.

Professional Memberships:

American Psychological Association
Council for Exceptional Children
Southern Association of Children Under Six