Using Computer Delivery to Examine Interactive and Non-Interactive Response Modes to Programmed Material

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ABSTRACT

A computer authoring program called Think Fast was used to deliver 90-frames of programmed instruction, teaching the elementary concepts of operant conditioning. Forty undergraduates progressed through the program. A group experimental design was used to compare the effect of reading frames, reading frames with blanks and answers, thinking the answers, saying the answers aloud, and typing answers to program blanks. Results indicated that typing answers to frames produced the largest increase on a 25-item fill-in-the-blank test. Moderate posttest achievement was produced by subjects who responded by saying, thinking, or reading the frames with answers. Subjects who were instructed to read frames without blanks scored lowest. Also, subjects assigned active response modes identified more written examples of operant behavior than those in the non-active condition on an application test. These results are discussed in relation to educational implications.

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Chapter 1

Programmed instruction has its roots in the work of Sidney L. Pressey in the 1920's. Pressey used a self-instructional device in which test material was presented to students and they were provided immediate feedback as to whether or not the correct answer had been selected (Skinner, 1968). In the 1950's and 60's, B. F. Skinner significantly advanced this procedure using his ideas on teaching that were based upon operant conditioning research findings (Skinner, 1954).

Skinner emphasized the need for the learner's individual control of his/her rate of progress and active participation in the learning process. Skinner advised that student errors be eliminated as much as possible and, to that end, recommended structuring programs in a linear fashion where small units of material (frames) were presented to the learner, each followed by a question requiring an active response. In turn, each response was followed by correction of the student response (Skinner, 1968).

Thus, Skinner suggested four main principles for "good" programmed instruction: 1) sequential ordering of the material, 2) lower error rate 3) immediate confirmation by providing feedback and 4) active responding (Skinner, 1968). A review of each feature follows

First, the programmed material is carefully composed and sequentially ordered. This is done by providing the students with small amounts of information to learn at one time. The small steps make it more likely that students learn each step before proceeding to the next, and the material is arranged from simple to complex to build the students' repertoire. Second, the small steps serve to maintain a high frequency of correct student responses while minimizing errors. This is used to keep students responding.

The third principle involves the confirmation of the students' responses to each frame, normally in the form of feedback as to whether or not their responses were correct.

The fourth principle requires students to make a response to each frame before progressing to a new item. For the present study, reading a program frame and constructing a response by saying or typing, operationally defines an overt, active response. Thinking the response to the question frame was considered a covert, active response. By design, programmed instruction requires the student to actively respond to program blanks. Students should respond actively in order to learn the material. Many studies

have supported the claim that active responding increases subsequent posttest achievement (Cartier, 1963; Williams, 1963, 1965; Tuel & Metfessel, 1965; Roderick & Anderson, 1968; Tobias, 1969; Tobias & Abramson, 1971; Abramson & Kagen, 1975; Silverman, 1978; Touq & Mukattash, 1984; Wesley, Krockover & Devito, 1985; and Tudor & Bostow, 1991).

Other researchers have not found any differences when they compared active responding to a non-active response mode such as passive reading (Alter & Silverman, 1962; Stolurow & Walker, 1962, Keisler & McNeil, 1962; Hartman, Morrison, & Carlson, 1963; Tobias & Weiner, 1963; Entwistle, Huggins, & Phelps, 1968). These experiments on active and non-active responding are reviewed in Chapter 2.

Statement of the Problem

The primary reason for the disparate experimental findings on programmed instruction may be the fact that variables responsible for its effectiveness have either not been clearly identified or have not been experimentally replicated.

The experimental problem in isolating the effect of overt active responding is that many independent variables are simultaneously manipulated or combined in comparative response mode experiments. For example, in

the typical comparative experiment, one group may be given printed programmed frames without blanks, while another group is given printed programmed frames with blanks. The latter group is instructed to construct overt responses to fill the blanks. Upon completion of an item, these subjects are provided with confirmation regarding the correctness of their responses. The achievement of this latter group is confounded by two important independent variables: 1) making a constructed overt response, and 2) receiving feedback Consequently, the experimenter cannot say for sure which variable was responsible for the behavior change from pretest to posttest. Indeed, it possible that these variables might interact in peculiar ways so as to produce inconsistent findings

A subsidiary problem with studies comparing instruction to other forms of learning occurs when the experimental group is given printed programmed material. Students will often read the answer before the rest of the frame (Kulhavy, 1977). For this reason alone, it can be argued that printed programmed instruction should not be used for experimental purposes

Little research has been done that compares different response modes to programmed materials using

the control of a microcomputer. This is probably due to the fact that until the 1980's, the hardware problem had not been solved, most research with programmed instruction was accomplished via paper and pencil presentation. Certainly in the 1960's and 70's the advantages of controlled frame delivery made possible only with machine delivery were not possible in most research preparations. Most teaching machines used at that time were crude. It can be argued that a fair evaluation of programmed instruction, as initially described by Skinner, was not possible without the precise structuring of contingencies afforded by a sophisticated teaching machine (Tudor & Bostow, 1991, p. 361).

More recently, Tudor & Bostow (1991) conducted an experiment using a group experimental design to isolate the essential features of programmed instruction. They used computers to control the delivery of programmed frames so that students progressed according to the programmer's intention, that is, in small steps from simple to complex in order to encourage learning. The results strongly supported the necessity of active responding to the program. Students who could either covertly respond to frame blanks or who were required

to type frame answers attained significantly better scores on the posttest measures than passive readers.

Purpose of the Study

To evaluate the generality of Tudor & Bostow's (1991) findings the present study was a systematic replication. This consisted of repetition of the experiment but included purposely altering features of the experiment. The purpose of this systematic replication was to supply further evidence, across a variety of different conditions, that activity when using programmed instruction increases posttest achievement. The intention was to examine the same features of "good" programmed instruction that Tudor & Bostow (1991) researched, by using a similar group experimental design, but to change some of the features of the experiment. In particular, the study materials, response modes, authoring software and applied dependent variable differed. Two chapters from the book, Analysis of Behavior (Holland & Skinner, 1961, pp. 41-60) were used as the programmed material. The study systematically compared passive reading, passive reading with blanks, reading and thinking the answer to blanks, reading and saying aloud the answers, and finally reading and overtly typing the answers. Achievement was measured by written responses to a 25-

item pre-posttest measure and by identifying the principles learned as illustrated in written examples of behavior.

Since past experiments have been equivocal due to the confounding influence of extra variables and little control over students' behavior during the program, a microcomputer was used to deliver the material for the present study.

The sequence for this study involved four steps. First, subjects completed a 25-item fill-in-the-blank pretest exercise. Second, all groups worked through an identical content program. Third, all read their frames delivered by a microcomputer in order to control the presentation sequence and to avoid the problems associated with receiving feedback before responding, as reported by Kulhavy (1977). Fourth, subjects received a 25-item fill-in-the-blank posttest and a 20-item fill-in-the-blank application test. It was hoped that employing a group design would allow for a clear and valid comparison of each response mode in isolation.

CHAPTER 2

Review of the Literature

Programmed Instruction

Background. Historically, the first teaching machine was developed by Sidney L. Pressey in 1926 at Ohio State University (Callendar, 1969, p. 3). It was originally developed as a self scoring machine to facilitate the taking and scoring of objective examinations. The machine soon demonstrated its ability to actually teach (Bower and Hilgard, 1981, p. 564). With Pressey's machine, students would read the question presented in the aperture and select an answer from several choices. If the correct response was made, then they would progress to the next question, if not, the question would remain until a correct choice was made. The devices used by Pressey and his students provided drill and practice on skills previously learned or [at best] on skills learned by trial and error during the drill sessions. The items did not systematically build new repertoires of skills.

In 1954, B.F. Skinner published a paper entitled "The Science of Learning and the Art of Teaching." Skinner asserted that a "technology of teaching" ought to be instituted in schools. To this end he advocated the use of teaching machines that would manage learning contingencies for the student. Using Skinner's early

machine, students were presented with a question and required to write the response (answer) in the space provided. Then, as the printed tape advanced, the correct answer appeared for comparison with what they had written. Skinner's machine differed from Pressey's in two important ways. First, Skinner's students constructed their own overt responses, whereas Pressey used a multiple-choice format. Skinner did not like the multiple choice format. He preferred constructed responses in which students were asked to write out definitions, answers or examples (Vargas, 1986, p. 738). Second, Skinner sequenced the material so that they became a program in which the responses of the students were shaped as they learned. Pressey, on the other hand, used his device as a test that occurred after prior study.

Programmed Instruction Principles. Whatever the skill to be learned, the principles of Skinnerian linear programming remained similar. First, the material of the program was so structured that students had to make a series of responses to a series of problems either by writing an answer, performing a physical task, or merely speaking the response covertly or aloud (Callendar, 1969, p. 17). The emphasis was on the need to interact with the program. Second, through

the program, students received immediate confirmation (and presumably reinforcement) of the correctness of their answer before proceeding to the next step.

Another Skinnerian tenet was that students should be allowed to proceed at their own pace. In programmed instruction, students are given the material in small steps to allow for progressive development of learned skills and knowledge, and to minimize errors and increase the frequency of reinforcement.

Callendar (1969) observed that the onus of learning was upon the student and the teacher's role in this form of instruction was to write an appropriately designed program geared towards developing the student's repertoire. In contrast to the conventional teaching situation, this meant that the main work of the teacher using programmed instruction occurred during the preparation rather than the delivery (or presentation). This preparation included analysis of the task to be performed, construction of the program frames, sequencing the frames, and deciding the mode of presentation. Furthermore, there was no *marking* in the traditional sense, since students were *corrected* immediately following their response to each question. Skinner (1968) reasoned that students would benefit from such a program because they were engaged and

actively responding and also they received immediate confirmation as to the accuracy of their responses.

Response Modes

The importance of overt responding has been investigated extensively. Many gradations of overtness of response have been investigated from writing the response to a frame at one end of the continuum, to reading the program material as text with no response requirement at the other. Results from most studies have been inconclusive. The following is a representative sample of the major works published in this area.

Keisler and McNeil (1962) compared covert and overt response modes, using a teaching machine, to present material to 198 primary grade children. A 432-frame program was used to present the principles of physical science. The children were divided into two experimental groups. The overt response group students were required to respond by pressing a button to select the appropriate picture which illustrated the principle being taught. The covert group *simply observed* the program frames for five seconds before the machine automatically advanced to the next frame. Both experimental groups learned significantly more than an uninstructed control group, but the difference was not

significant. The authors suggested that the failure to find a difference between response modes was due to the fact that the teacher interview and recall posttest required responses not made during the program. In addition, they speculated that errors made by students, even if corrected, may have confused overt responding students' association of correct answers to principles. This did not occur for covert responders as no response requirement existed. The presentation of incorrect choices in the multiple-choice format may have increased the likelihood of future errors.

Goldbeck and Campbell (1962) compared overt, covert and reading response contingencies using a 35-item program designed to teach history and geography. Sixty-three junior high school subjects participated in this experiment. Subjects either wrote their answers, were instructed to *think* of the *correct* answers, or read completed frames with the key words underlined. Covert and overt responders received confirmation of the correct response. The posttest consisted of 35 independent factual items that were previously experienced through the program. However, each item was modified to include three versions: easy, intermediate and difficult. The results indicated that

overt responding increased achievement most significantly with *the intermediate* items. Overt group achievement averaged 4 questions higher than the reading group achievement and 8.4 questions higher than covert group achievement. Unusually, requiring overt responding with easy items actually decreased posttest scores. No differences occurred for high *difficulty* items.

Cartier (1963) compared overt and covert responding using a 305-frame program which taught *Principles of Missile Guidance*. Freshmen Air Force cadets (N=1,957) were assigned the instructional program as part of their required homework. They were divided into five groups. Three groups wrote their responses in the booklet. Two groups *thought* their responses. The types of program questions included multiple-choice recall and written responses to frames. Results of the posttest suggested that writing responses increased achievement more than *thinking* the correct response. In fact, 65% of the overt responders scored 80% or better on the posttest compared to only 36% of covert responders. Unfortunately, the superiority of overt responding decreased on the delayed test (ten weeks later) and was no better than covert responding.

Hartman, Morrison and Carlson (1963) investigated the effects of requiring a constructed response in programmed material versus simply reading the same material. They used a 1500-frame program designed to teach IBM machine operations to 493 customer trainees. The results indicated that there were no significant differences in mean poststudy quiz scores between the two formats. The only difference found was in the time required to experience the program frames. Subjects instructed to read required significantly less time than those asked to make a constructed response. It is difficult to draw conclusions from this study due to the great variability of individual subjects.

Tobias and Weiner (1963) asked 62 college undergraduates to work on a 90-frame linear program dealing with binary numbers designed to give a general conceptual understanding of numbering systems. The response modes included writing responses to program blanks, *thinking* of responses to program blanks, or simply reading completed frames. The active responders received confirmation as to the correctness of their responses. All subjects completed two posttests; one given immediately after the program, and one given six weeks later. The results indicated no differences in achievement on immediate recall or on delayed recall

among the three groups. As a post hoc speculation, these experimenters suggested that the quality and length of the program contributed to the lack of experimental group differences. They recommended using a longer and standardized program in order to properly examine the response contingencies.

Williams (1963) compared actively writing answers, selecting answers from a multiple-choice format, reading with keywords underlined and reading without underlining. She employed 128 college subjects. Subjects progressed through 192-frames from The Analysis of Behavior (Holland and Skinner, 1961). The *correct* response only appeared on the following page for overt, active responders and not for the two non-active reading groups. Results from 20 fill-in-the-blank items and two essay type questions favoured active responding. Specifically, requiring either a multiple choice or written response produced a higher number of correct posttest responses (M=23 35) than non-active responding (M=20.65).

In a subsequent experiment, Williams (1965) administered two versions of a program to 108 sixth grade subjects. A 120-frame program on "animal science" was used. Subjects had not been exposed to the material prior to the study. *The frames included*

familiar and technical words. With one version of the program, children were required to construct and write their responses. Another version required them to select the correct response from a list of alternatives. All subjects were presented with the correct answer on the following page. The 32-item pre-posttest measure was divided equally into 16 constructed responses and 16 multiple choice questions. Differences between the response modes only appeared in an analysis of *technical* terminology. The constructed response subjects achieved on average, 1.31 more questions correct, a statistically significant result. Williams concluded that active, constructed responding was beneficial when a program contained technical terminology, that is, responses which were not typically within the range of these subjects' verbal repertories.

Entwistle, Huggins and Phelps (1968) contrasted two response modes using a FORTRAN arithmetic program. One-hundred engineering undergraduates were randomly allocated to either a constructed response or reading-only group. Subjects were given both an immediate and an unannounced delayed (two-days) posttest. Results suggested no difference between the groups. Surprisingly, this was also true when *technical* terms

were used as the required responses. These results conflicted with earlier data claiming an advantage for constructed responding when learning *technical* material.

Tobias (1969) conducted an experiment using two response modes in an attempt to reconcile previous findings between program technicality and active responding. The instructional program consisted of 143-frames designed to teach the principles of cardiovascular function to undergraduate college subjects. *Fifty-four familiar* and eighty-nine technical items were used. The overt, constructed response mode required subjects to write their responses to program blanks, whereas the reading group completed program without making observable responses. The results indicated that the constructed-response group achieved more on technical, but not on familiar subject matter than the reading group by a margin of 9.4%. Tobias concluded that the constructed response contributed most to learning when responses are not yet part of the repertoire, that is, unfamiliar.

Tobias and Inger (1976) tested the hypothesis that constructed responding and feedback would be especially advantageous to subjects with low levels of prior

familiarity. They used a 37-frame program that dealt with Hebrew rituals. A total of 104 subjects were recruited from Catholic and Jewish parochial schools. Level of prior achievement was established by pretest scores. The results suggested that constructed responding was especially beneficial for subjects with low pretest scores.

More recently, Touq and Mukattash (1985) evaluated the effects of covert and overt response modes in learning a foreign language. They used a printed instructional program to teach English grammar and reading comprehension to non-English speaking persons. One group wrote their responses to program prompts whereas another covertly *thought* of the correct answers. The immediate posttest consisted of 20 multiple-choice items and 10 fill-in-the blank items. The same test was given four weeks later in order to detect response mode learning differences over time. The results indicated that overt responding produced higher achievement scores on immediate and delayed retention tests. Speculations about the effects were made with caution because many of their subjects had pre-existing experience with English and the criterion used to determine the subjects' achievement in English was their school grade, and these were not reliable.

Summary of Programmed Instruction

Anderson (1967) and Tobias (1973) analyzed the results of many experiments evaluating activity in relation to programmed instruction. Both concluded that past research studies have been inconsistent. Some studies found significant increases in post-study achievement when subjects responded overtly during a program (Cartier, 1963; Williams, 1963, 1965, Roderick & Anderson, 1968, Tobias, 1969, Tobias & Abramson, 1971, Abramson & Kagen, 1975 and Touq & Mukattash, 1984). Other researchers found no significant differences for the type of response subjects made during a program (Alter & Silverman, 1962, Hartman, Morrison, & Carlson, 1963; Tobias & Weiner, 1963, Keisler & McNeil, 1962; Stolurow & Walker, 1962). Actually, one researcher even found decreased achievement when subjects responded overtly to low difficulty items (Goldbeck & Campbell, 1962).

Some authors have attempted to reconcile these disparate findings. For example, Holland & Kemp (1965) examined comparative response mode experiments and found that the degree to which the subjects' response is related to the critical content determines whether or not differences were found. Kemp & Holland (1966) claimed that a lot of earlier programs contained

irrelevant and excessive verbal stimuli which served to overprompt the responses and decrease learning. Still others have considered the nature of the program's content. For example, Tobias (1969) suggested that active, overt responding benefitted the learner only when a program contained *unfamiliar* material. He conjectured that active responding may be of greatest benefit during the early stages of the acquisition of knowledge. There exists some empirical evidence to support this *familiarity* hypothesis (Williams, 1963, 1965, Tuel & Metfessel, 1965, Roderick & Anderson, 1968, Tobias, 1969; Tobias & Abramson, 1971 and Abramson & Kagen, 1975). Nevertheless, other researchers found results which conflicted with this hypothesis (Entwistle, Huggins & Phelps, 1968).

Tudor and Bostow (1991) suggested that an analysis of the procedure typically used in overt response experiments may help explain the abundance of contradictory results. Comparative experiments in programmed instruction often confound the effects of independent variables by not isolating the variable responsible for subject achievement. The resulting interpretative problems make the separate and inter-independent effects of each variable difficult to determine. Certainly, this was the case for some of

the studies reviewed (Keisler & McNeil, 1962; Goldbeck & Campbell, 1962; and Cartier, 1963)

A second problem in printed programmed instruction experiments is that subjects may read or work through the frames in an improper sequence. For example, subjects could read the answer before reading the frame, thereby obtaining premature confirming stimuli (Kulhavy, 1977). For this reason printed programmed instruction may be inadequate as a medium for evaluating the effects of subject responding on achievement. Using a microcomputer circumvents the problems associated with printed program materials. The following is a review of research employing a computer to help achieve control of the deliver of study materials.

Computer-Based Instruction

The recent widespread use of computers in a variety of settings has made Computer-Based Instruction (CBI) a mode of instruction in many disciplines. When learning with computer delivery, subjects must interact with the material as the programmer intended. Software can be programmed so that bypassing sections of information is not possible, unlike printed programmed materials. Subjects using CBI may be prohibited from gaining access to correct answers before actually

composing their own responses. Some researchers have supported the claim that CBI is better in managing subjects' Active responses than other competing media (Anderson, Kulhavy, & Andre, 1972).

As with programmed instruction research, experiments investigating the utility of CBI have not unambiguously identified the variables responsible for achievement gains. The primary problem is that the results from many CBI experiments frequently contain the combined effects of many independent variables. The claim here is that methods such as the use of examples and matched non-examples, individualized pacing, corrective feedback after response, and a close correspondence between instruction and test items tend to be used in the design of CBI lessons but not in the treatments being compared (Clark, 1985). In addition, these comparative studies often differ with regard to the medium of instruction and correction of responses made. That is, the CBI subjects had the benefits of computer delivery and were often required to make a correct response before receiving feedback and moving to the next frame while subjects using printed programmed instruction did not have such a correction procedure. This problem frequently appears in experiments comparing printed programmed instruction to

CBI. The following literature review is indicative of these problems.

Avner, Moore, and Smith (1980) attempted to control the medium confound by using microcomputers to deliver instructional material to all subjects. This study was designed to provide evidence to support the use of CBI. They employed 700 undergraduate chemistry students to experience CBI in one of two forms, both were identical in content and graphics. One form was called the *active* condition because it required subjects to make overt responses. Subjects using the other form, called *passive*, could progress through the program by pressing a key. Instead of the typical recall posttests, these experimenters rated subjects' observable laboratory performance. In particular, laboratory "decisions" were monitored. Unfortunately, a precise description of this dependent variable was not provided. The results indicated that subjects who responded actively made fewer errors during laboratory sessions. In regards to laboratory decisions that required "high" understanding, 57% of the active responding subjects performed without errors compared with 30% of the non-active subjects. No significant difference was found when the same subjects made laboratory decisions which required "low" understanding

(e.g., following instructions) as 69% of the active responders were errorless compared with 77% of the non-active subjects. These results were further influenced by both the response mode and provision of feedback. Only the active responders received feedback following responses. Apart from subject responding, this factor alone could have influenced the experimental outcome.

Lundgren, (1985) compared the effects of programmed-text instruction and computer-based instruction on achievement in learning English grammar. A 78-item fill-in-the-blank pretest-posttest evaluated written subject achievement. Group 1 read printed programmed frames and wrote their responses on paper. Group 2 read identical frames but typed their responses using a computer. The results conflicted with previous research comparing these two presentation media. Programmed instruction produced a higher mean number of correct responses (M=62.1) than did CBI (M=58.0). This small difference was not statistically significant. One possibility for these usual findings may the fact that subjects using printed frames were allowed to review past frames. This was not possible with the computer delivered frames. This review feature probably affected the results.

In sum, the studies comparing CBI to other presentation methods are confounded with combined independent variable effects. Studies which systematically isolate the variables responsible for achievement differences need to be performed.

Computer-Delivered Programmed Instruction

More recently, researchers have attempted to isolate the advantages of programmed instruction through computer delivery (Tudor and Bostow, 1991). Since the present experiment was a systematic replication of that study, it will be described here in some detail.

In their experiment, Tudor and Bostow (1991) used a group experimental design with five conditions to isolate independent variables. They were: non-active reading (Group 1), non-active reading with feedback presented (Group 2), covert responding to frame blanks and feedback (Group 3), actively typing answers to blanks without correction (Group 4) and typing answers to blanks with correction (Group 5). Fifteen subjects were randomly assigned to each experimental condition. After an initial pretest, each subject progressed through 315 frames of computer-delivered programmed instruction. These frames were designed to teach the topic of preparing automated instruction. Upon

completion of the frames, each subject supplied written answers to a 47-item fill-in-the blank posttest. The wording of these test questions was similar but not identical to program frames.

No significant differences were observed on the 47-item pretest. On the same 47-item posttest, the means ranged from 35.0% correct in Group 1 to 49.0% in Group 5. Subjects who responded by typing answers to blanks (Groups 4 and 5) answered more posttest questions correctly than those who read frames without blanks (Groups 1 and 2). In fact, the active, overt constructed and non-active reading groups were separated by 14.3%.

Subjects were also required to applied what they learned from the program. They were given a list of the steps or rules necessary for operating an automatic washing machine. Using a paper response sheet, they were asked to design and construct two instructional frames for computer presentation. The experimenters discovered that subjects who responded actively (Groups 3, 4 and 5) not only gave more correct test responses but also could write better frames than non-active responders (Tudor and Bostow, 1991, p. 367).

The results showed that subjects who responded overtly to program blanks produced a higher percentage

of technically correct programmed frames than subjects who read frames without blanks. Covert responding subjects performed better than Group 1 readers. Group 3 was not significantly different from Groups 4 and 5, even though separated by a 15% difference on posttest scores.

In sum, active responding, whether covert or overt, resulted in greater posttest gains than non-active responding.

Research Hypotheses

All of these hypotheses are phrased in directional hypothesis form wherever a difference between means is predicted. They are based on the findings of the Tudor & Bostow (1991) study that the addition of features of "good" programmed instruction will strengthen posttest achievement.

1. Students who type answers to program frames (Group 5) will correctly answer more posttest and applied items than all other groups.
2. Students who say answers aloud to program frames (Group 4) will correctly answer more posttest and applied items than Groups 1, 2, and 3.
3. Students assigned to "think" answers to program frames (Group 3) will correctly answer more posttest and applied items than Groups 1 and 2.
4. Active Groups 3, 4 and 5 will answer more posttest items correctly than non-active Groups 1 and 2.
5. Active Groups 3, 4 and 5 will answer more applied items correctly than non-active Groups 1 and 2.

CHAPTER 3

Method

Subjects

The subjects in this study were 40 undergraduate students at the University of Victoria. They were enrolled in either an introductory history (n=28) or philosophy (n=12) course. Thirty-two subjects were first or second year undergraduates while the remaining eight were in their third or fourth year of study. Twenty-five females and fifteen males participated and their ages ranged from 18 to 38 (*M*=20.52, SD=4.7).

Recruitment for this project was made through oral presentations to the introductory classes. The nature of the study was explained along with expected participation time and involvement (see Appendix 1). Subjects were informed that participation required an 1.5-hour (maximum duration) session. It was explained that participation was completely voluntary and that they had the right to withdraw at any time without indemnity.

All received $5 for participating in the study. Completion time was dependent upon the experimental group assigned and the rate at which each subject worked through the program. However, the mean session time was 73.6 minutes (SD=15.4).

Setting

Each subject met the experimenter in a laboratory located in the basement of the Cornett Building (Room A080) at the University of Victoria. This laboratory was equipped with two experimental spaces and a central experimenter space. Both rooms were equipped with the apparatus (listed below) required to operate the Think Fast program. Thus, two subjects could--and sometimes did--participate at the same time. Usually, however, there was only one subject present.

Apparatus and materials

Each room in the laboratory was equipped with an IBM compatible microcomputer with two disk drives, keyboard, and monitor. The Think Fast program was loaded onto one disk drive and data on subject accuracy and speed were recorded on a separate disk in the other disk drive.

Think Fast. Think Fast is a fluency-building computer program designed by Parsons (1984) to help subjects master verbal concepts and facts. Typically, users of Think Fast are instructed to proceed through the material at their maximum speed while maintaining accuracy. This feature of the program was not employed. Instead, Think Fast was employed primarily

as an delivery system to present program frames in a sequential order.

Think Fast displays a computer screen representative of a study card. There are usually two parts to a study card. One component is the statement or question, while the other is the answer. Think Fast displays the question at the top of the computer screen and the answer at the bottom. These cards can be presented in several ways, three of which were relevant to the current investigation.

1. In the *Browse* mode, Think Fast typically displays both the question and answer components of a study card. For example, the question, "Both positive and negative reinforcement '_____' the rate of response" would be displayed at the top of the computer screen and the answer "increase" simultaneously displayed at the bottom (see Appendix 2). Subjects used this mode to scan the material as long as they wished, and simply pressed the *spacebar* to advance to the next card. They repeated this procedure until the last card was reached. This mode was employed for Group 2. For Group 1, the Browse mode was modified such that the full statement without blanks appeared (see Appendix 3).

2. In the *Say Answer* mode the question was displayed with a *keyword* missing and the answer component was not displayed without appropriate responding. Using the above example, the top of the screen would show, "Both positive and negative reinforcement '_____' the rate of response", and the answer box at the bottom of the screen remained blank (see Appendix 4). The subjects were instructed to respond in a specific manner--for example, say the answer "increase" aloud--and then press the spacebar. Depression of the spacebar caused the missing keyword component to appear in the bottom box. Subjects self-scored their responses by pressing "C" (correct) or "I" (incorrect) and repeated this procedure until the last card was completed. This mode was employed for Groups 3 and 4.

3. In the *Type Answer* mode the question was displayed with a keyword missing and the answer component was not displayed. Using the above example, the top of the screen would show, "Both positive and negative reinforcement '_____' the rate of response", and the answer box at the bottom of the screen remained blank (see Appendix 5). This response mode required subjects to type the answer component.

The correction procedure for the Type Answer mode differed from the other response modes. The program

immediately indicated the correctness of each keystroke (see Appendix 5). Even one incorrect keystroke resulted in that response counted as wrong. Subjects who keyed in the wrong keystroke more than four times were presented with the correct letter; however, the response to that frame was recorded as incorrect. The nature of this response mode required subjects to type each letter of the answer component before progressing to the next frame. Again, subjects repeated this procedure until the last card was completed. The Type Answer mode was employed for Group 5.

Study content

A 90-frame behavior analysis program excerpted from the book Analysis of Behavior (Holland and Skinner, 1961, pp. 41-60) was delivered via Think Fast. These frames covered the elementary concepts of positive and negative reinforcement (Appendix 6). The material was entered into the Think Fast program using its utility package.

This experiment required two versions of the 90-frame program. Version #1 contained question frames without blanks. This version was presented to Group 1 in order to simulate passive reading. Version #2 contained question frames with blanks. This version was used for the remaining four experimental groups.

Dependent Measures

Pretest-Posttest. The primary dependent variable was each subject's written responses to a 25-item fill-in-the-blank pretest and posttest (see Appendix 7). These items were selected from the 90-frame program. Each question on the pretest-posttest contained a sentence with one or more a blanks to be filled in by the subject. These blanks corresponded to the missing *keyword* answers presented in the program sequence. Program content was proportionally represented in the sample of pretest-posttest questions (see Table 1). The questions were randomly ordered using a table of random numbers and presented using the Think Fast program in the *Browse* mode (Version 1). After reading a question, the subject wrote the answer on the corresponding blank listed on a paper answer sheet. Depression of the spacebar advanced to the next question. The completed answer sheets were collected by the experimenter and scored using an answer key (see Appendix 8).

Applied test. Another dependent variable was each subject's written responses to 12 exemplars illustrating the principles and concepts taught with the 90-frame behavior analysis program. These examples

Table 1

A Summary of the Percentage of Questions Representing Each Operant Conditioning Principle

90-Frame Study Deck

Positive reinforcement = 62.0%

Negative reinforcement = 13.0%

Extinction = 18.0%

Forgetting = 2.0%

DRO = 4.5%

Establishing operation = 1.8%

25-Item Pretest-Posttest

Positive reinforcement = 52.0%

Negative reinforcement = 16.0%

Extinction = 20.0%

Forgetting = 4.0%

DRO = 4.0%

Establishing operation = 4.0%

20-Item Application Exercise

Positive reinforcement = 55.0%

Negative reinforcement = 20.0%

Extinction = 20.0%

Forgetting = 0%

DRO = 0%

Establishing operation = 5.0%

of behavior were excerpted from the book Principles of Everyday Analysis of behavior (Miller, 1980). Subjects were asked to read each example and attempt to answer the questions which followed based on what they had learned from the behavior analysis program. A total of 20 fill-in-the-blank questions were used (see Appendix 9). Once again, the questions were randomly ordered and presented using the Think Fast program in the *Browse* mode (Version 1). After reading a question, the subject wrote the answer on the corresponding blank listed on a paper answer sheet. Depression of the spacebar advanced to the next question. The completed answer sheets were collected by the experimenter and scored using an answer key (see Appendix 10).

Subject attitude survey. Seven questions were used in an attempt to assess subjects' attitudes towards the main components of this study. For example, subjects were asked how they felt about the use of a computer as an instructional device (see Appendix 11). Each item was rated by the subject on a scale from one to five, in the following manner:

Disagree		Somewhat		Agree
1	2	3	4	5

Subjects were asked to read each question and circle the number that most closely reflected how they

felt. The completed answer sheets were collected by the experimenter.

Procedure

The experimenter outlined the nature of the experiment to four introductory arts classes. Upon conclusion of the oral presentations, a sign-up form was distributed. Those who were interested in participating wrote their names and telephone numbers on the forms. On the same form were several questions used to determine the student's suitability for participation (see Appendix 12). One critical question asked students to identify psychology courses they had taken previously or in which they were currently enrolled. Students who had psychology course experience were not contacted.

Eligible students were contacted by telephone and individual appointments were arranged. During these appointments a longer demographic questionnaire required subjects to indicate personal characteristics, including: age, year of study, and study major (see Appendix 13). Also, subjects were asked to list any courses they had taken which employed computers, behavior analysis material, psychology material, and/or programmed instruction.

Subjects were randomly assigned to one of five

experimental conditions using a table of random numbers: passive reading, passive reading with blanks, covert responding, overt responding (saying) and overt responding (typing). The experimenter read instructions to each subject dependent upon group assignment (see Appendix 14). The experimenter sat outside the computer room for the duration of each session and alerted subjects to this fact in order to insure instructions were followed.

The stimuli presented to each experimental group is summarized in Table 2. Subjects in Group 1 were instructed to work through the "Browse" mode of Think Fast using Version #1 of the 90-frame behavior analysis program. They were told to read the programmed frames and progress through the frames as if reading prose from a book. The definition component appeared at the top of each computer screen without any blanks while the answer box below displayed an "X". This was similar to Tudor and Bostow's (1991) Group 1.

Subjects in Group 2 were instructed to work through the "Browse" mode of Think Fast using Version #2 of the 90-frame behavior analysis program. They were told to read each frame but were not asked to make any constructed response, even though, a *keyword* was replaced with a *blank*. The omitted *keywords* were

Table 2

A Summary of the Experimental Design Including Response Contingencies, Post-Response Stimuli, and Subjects Required

	Group 1	Group 2	Group 3	Group 4	Group 5
Interaction	None	None	Covert	Overt	Overt
Reading	Yes	Yes	Yes	Yes	Yes
Blanks	None	Yes	Yes	Yes	Yes
Response	None	None	Think	Say	Type
Confirmation	None	Yes	Yes	Yes	Yes
N	08	08	08	08	08
Deck Version	01	02	02	02	02

identical to the original Holland and Skinner (1961) text. The correct answer to each item blank appeared simultaneously at the bottom of the computer screen. Group 2 subjects were to read all of the material and then press the spacebar to progress through the frames. Groups 1 and 2 represented non-interactive or passive reading contingencies (i.e., there were no response requirements related to the item content).

Subjects in Group 3 were instructed to work through the *Say* mode of Think Fast using Version #2 of the 90-frame behavior analysis program. These subjects were asked to read each frame and to think the correct answer to themselves. Confirmation (the correct response) was provided after the subject pressed the spacebar. This mode was similar to Tudor and Bostow's (1991) Group 3. Subjects were further instructed to press "C" if the answer they thought corresponded with the program answer and to press "I" for answers that did not match their covert responses.

Subjects in Group 4 were instructed to work through the "Say" mode of Think Fast while working with Version #2 of the behavior analysis program. In contrast to Group 3, they were asked to verbalize their responses aloud. As Group 3 subjects, Group 4 subjects also self-scored their responses after the press of the

spacebar exposed the correct answer. Tudor and Bostow (1991) did not have such a condition in their study. It was included here to determine if saying the response affected learning differently than *thinking* and typing.

Subjects in Group 5 were instructed to use the *Type* mode and experienced identical frame content using Version #2 of the behavior analysis program. These subjects were instructed to read the material and fill-in-the-blanks by typing in their responses.

The following procedure was identical for each subject. Only the mode of responding within the 90-frame behavior analysis program differed contingent upon the experimental group to which each particular subject was assigned.

Set up. Before each session, the Think Fast program was loaded by the experimenter and made ready to use. Upon the subject's arrival at the laboratory, the experimenter provided a copy of the Psychology Department's volunteer subject rights. Each subject was asked to complete a demographic questionnaire also called the "Subject Profile Form." Then the group instructions for operating the Think Fast program were given verbally (see Appendix 14).

Pretest. The experimenter read aloud general instructions about the nature of the program and the tasks that followed (see Appendix 15). Using Think Fast, each subject was assisted in selecting the 25-item *pretest* option listed on the computer screen menu. Subjects were instructed to respond to the test on a paper *answer sheet* (Appendix 16). Upon completion, the subject informed the experimenter who then removed the paper pretest answer sheet and began the next stage.

Experimental groups. At this point subjects were told their group assignment. The individual group instructions were read to each subject. Group instructions were specific to the experimental group assigned (Appendix 14). Subjects were not made aware of other experimental groups until the end of the session. Within the computer program, the "study" deck option was chosen by the experimenter and the subject was asked to progress through all 90-frames, employing the response mode assigned. Subjects were told to inform the experimenter when finished.

Posttests. Two posttest exercises were presented individually to subjects. Upon completion of the 90-frame program, the Think Fast program returned subjects to the main menu. Then subjects were instructed to select the 25-item *posttest* option. Items on this

posttest were identical to items found in the pretest except for their order of presentation. Instructions for completion remained the same. For this posttest, subjects read question frames and wrote their responses on slips of paper (see Appendix 17). As subjects completed responses, they were instructed to deposit the slips of paper into a sealed 12" X 8" box before advancement to the next item. After completing this posttest exercise the box was removed by the experimenter and the subjects were told to select the *applied* option listed in the Think Fast menu. A paper answer sheet was provided for subjects to record their written responses (see Appendix 18).

Finally, subjects were given the paper and pen attitude survey, described earlier, which consisted of seven statements (see Appendix 11).

CHAPTER 4

Results

The following exploratory data analyses employed descriptive and inferential procedures to answer the research hypotheses listed earlier. These data were analyzed as they reflected achievement on (1) the 25-item pretest-posttest, (2) the 20-item application exercise and (3) the duration measures which included the time required to complete the Think Fast Program and time used to write the pretest and posttests. These data are presented in Table 3. An assessment of subjects' attitudes towards the study was also conducted.

Pretest-Posttest

Performances on the 25-item fill-in-the blank pretest and posttest was the major focus of this study. The percentages of correct responses made on the pretest and the posttest are presented in Figure 1. The symbols on this figure represent individual subject pretest and posttest scores, and the group means for each condition are the dotted horizontal lines.

Pretest scores ranged from 0 to 28% correct. In fact, 95.0% (n=38) of the forty subjects scored between 0 and 16 percent correct (see Table 3).

Table 3

Summary of Dependent Variables

Subject	Pretest	Posttest	Applied	TF time	Test time
Group 1					
1	1 (04)*	5 (20)	7 (35)	19	45
2	2 (08)	6 (24)	10 (50)	14	39
3	2 (08)	6 (24)	7 (35)	27	48
4	2 (08)	18 (72)	12 (60)	28	62
5	3 (12)	9 (36)	8 (40)	21	47
6	3 (12)	9 (36)	10 (50)	37	46
7	3 (12)	14 (56)	9 (45)	23	45
8	4 (16)	10 (40)	10 (50)	28	38
Group 2					
1	1 (04)	17 (68)	12 (60)	33	52
2	2 (08)	13 (52)	11 (55)	20	42
3	2 (08)	15 (60)	11 (55)	39	13
4	2 (08)	19 (76)	12 (60)	20	25
5	3 (12)	9 (36)	9 (45)	28	42
6	3 (12)	14 (56)	10 (50)	21	42
7	4 (16)	9 (36)	10 (50)	25	35
8	6 (24)	18 (72)	9 (45)	28	44
Group 3					
1	0 (00)	15 (60)	16 (80)	26	39
2	2 (08)	13 (52)	13 (65)	33	35
3	2 (08)	16 (64)	11 (55)	44	45
4	2 (08)	16 (64)	13 (65)	31	49
5	3 (12)	7 (28)	14 (70)	28	47
6	3 (12)	16 (64)	13 (65)	39	49
7	3 (12)	19 (76)	16 (80)	21	41
8	4 (16)	10 (40)	13 (65)	22	50
Group 4					
1	1 (04)	16 (64)	13 (65)	24	43
2	1 (04)	19 (76)	13 (65)	26	53
3	2 (08)	15 (60)	14 (70)	26	36
4	2 (08)	9 (36)	7 (35)	28	48
5	3 (12)	19 (76)	15 (75)	32	40
6	3 (12)	16 (64)	14 (70)	32	43
7	4 (16)	17 (68)	15 (75)	38	50
8	6 (24)	13 (52)	12 (60)	31	37
Group 5					
1	0 (00)	19 (76)	14 (70)	40	58
2	1 (04)	20 (80)	16 (80)	50	45
3	2 (08)	16 (64)	14 (70)	52	48
4	2 (08)	20 (80)	14 (70)	36	54
5	2 (08)	21 (84)	16 (80)	50	67
6	3 (12)	17 (68)	15 (75)	66	43
7	4 (16)	16 (64)	12 (60)	43	50
8	4 (16)	16 (64)	14 (70)	57	38

* brackets indicate percentages

Figure 1 Percentage of correct responses on the pretest and the posttest for all subjects.

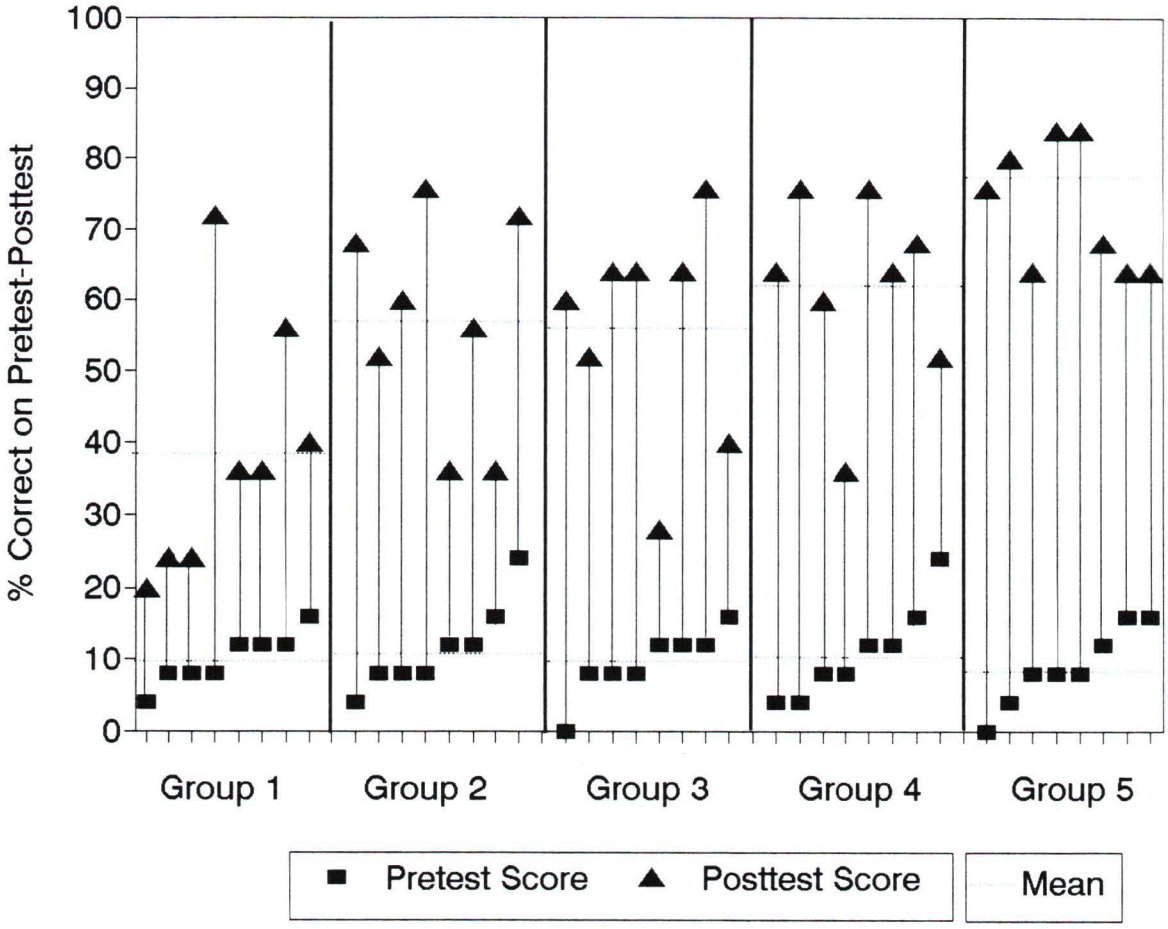
% Correct on Pretest-Posttest
100
90
80
70
60
50
40
30
20
10
0
Group 1
Group 2
Group 3
Group 4
Group 5
Pretest Score
Posttest Score
Mean

Table 4

Analysis of Variance for the Fill-in-the-Blank 25-Item Pretest

Source	D.F.	SS	MS	F	F Crit.
Between Groups	4	2.15	.53	.286 NS	2.65
Within Groups	35	65.75	1.87		

Group	Means	SD
1	2.5	.9
2	2.8	1.5
3	2.3	1.1
4	2.7	1.6
5	2.2	1.3

The remaining two subjects answered 24.0% items correctly. To see whether the groups differed statistically on the pretest a one-way analysis of variance was performed. This test determined that none of the experimental groups differed significantly, $F(4,35) = .286$, $p = .88$. Scores were ordered from lowest percent correct to highest on the pretest (see Figure 1). Clearly, there are no observable trends. The Pearson correlation coefficient between pretest and posttest was $r = -.13$, $p = .40$. There is no evidence to suggest that the subjects were not randomly assigned to the experimental groups.

An analysis of variance revealed a relationship between the type of response subjects made during the program and their score on the posttest, $F(4,35) = 5.91$, $p < .001$. Multiple comparisons were performed using Fisher's test of differences between the means (Howell, 1989, pp. 236-240). This procedure revealed that, as predicted, subjects who responded by some active means such as covertly thinking the answer (Group 3), saying aloud the answer (Group 4), or overtly typing the answers to program blanks (Group 5) answered more posttest questions correctly than those

Table 5

Analysis of Variance for the Fill-in-the-Blank 25-Item Posttest

Source	D.F	SS	MS	F	F Crit
Between Groups	4	304.150	76.03	5.91	2.65
Within Groups	35	450.25	12.86		

Fisher's protected *t* (Least Significant Difference)= 2.53

Scheffe Test comparing Groups 1 and 2 with 3, 4 and 5, $F(1, 35) = 8.58$, $p<.05$.

Scheffe Test comparing Group 1 with 2, 3, and 4, $F(1,28) = 8.70$, $p<.05$.

Scheffe Test comparing Group 1 with 3, 4, and 5, $F(1,28) = 13.83$, $p< .05$.

Scheffe Test comparing Group 5 with 1, 2, 3, and 4, $F(1,35) = 8.64$, $p< .05$.

Group	Means	SD
1	9.6	4.4
2	14.2	3.8
3	14.0	3.8
4	15.5	3.2
5	18.1	2.1

who read frames without blanks (Group 1), Fisher's $t(35)=2.53$, $p< .05$. A summary of these analyses is located in Table 5.

Surprisingly, subjects who responded to the program materials by reading the questions with blanks and answers provided simultaneously (Group 2, $M=56.8\%$) also answered significantly more posttest questions correctly than Group 1 ($M=38.4\%$), $t(14)=2.23$, $p<.05$.

There appeared to be three homogeneous subsets of groups. In one subset, Group 1 was alone with the lowest overall mean, 38.4%. Groups 2 ($M=56.8\%$), 3 ($M=56.0\%$) and 4 ($M=62.0\%$) recorded similar mean scores. The mean difference between Group 1 and Groups 2, 3 and 4 was significant, $F(1,27) = 8.70$, $p.<.05$. Notwithstanding, Group 5 subjects managed superior mean posttest scores, 72.4%. The largest posttest difference occurred when comparing the performances of Groups 1 and 5. There was 34.0% (or approximately 8.5 correctly answered items) separating these two groups. The Scheffe multiple comparison procedure was used to compare this difference (Howell, 1989, pp. 242-45). Indeed, Group 5 outperformed the rest, $F(1,35) = 8.64$, $p< .05$.

In addition, a separate analysis compared the posttest performance of subjects who had the opportunity to respond to program blanks (active responding, Groups 3, 4 and 5) with those who passively read frames without blanks (non-active responding, Group 1). This analysis indicated that activity (M=63.4%) was more effective in assisting subjects to recall the material than non-activity (M=38.4%). A Scheffe test identified this 25.0% difference as significant, $F(1,27) = 13.83$, $p < .05$.

When both Groups 1 and 2 (M=47.6%) were considered into the non-active condition and compared with the active Groups 3, 4 and 5 (M=63.4%) there was a 15.8% difference. The Scheffe test verified this difference to be significant, $F(1,35) = 8.58$, $p < .05$.

Gain Scores

In an attempt to determine the extent of behavior change, subjects' pretest scores were subtracted from their corresponding posttest scores. The individual "gain" scores and experimental group means are displayed in Figure 2. Scores increased progressively from Group 1 up to Group 5. Group 1 showed the least amount of improvement, M=31.0% (or 7.7 questions correct). Group 2, (M=45.2% or 11.3 items), Group 3 (M=46.4% or 11.6 items) and Group 4 (M=50.8% or 12.7

Figure 2 The improvement scores calculated from pretest minus the posttest score and expressed as percentage for all subjects.

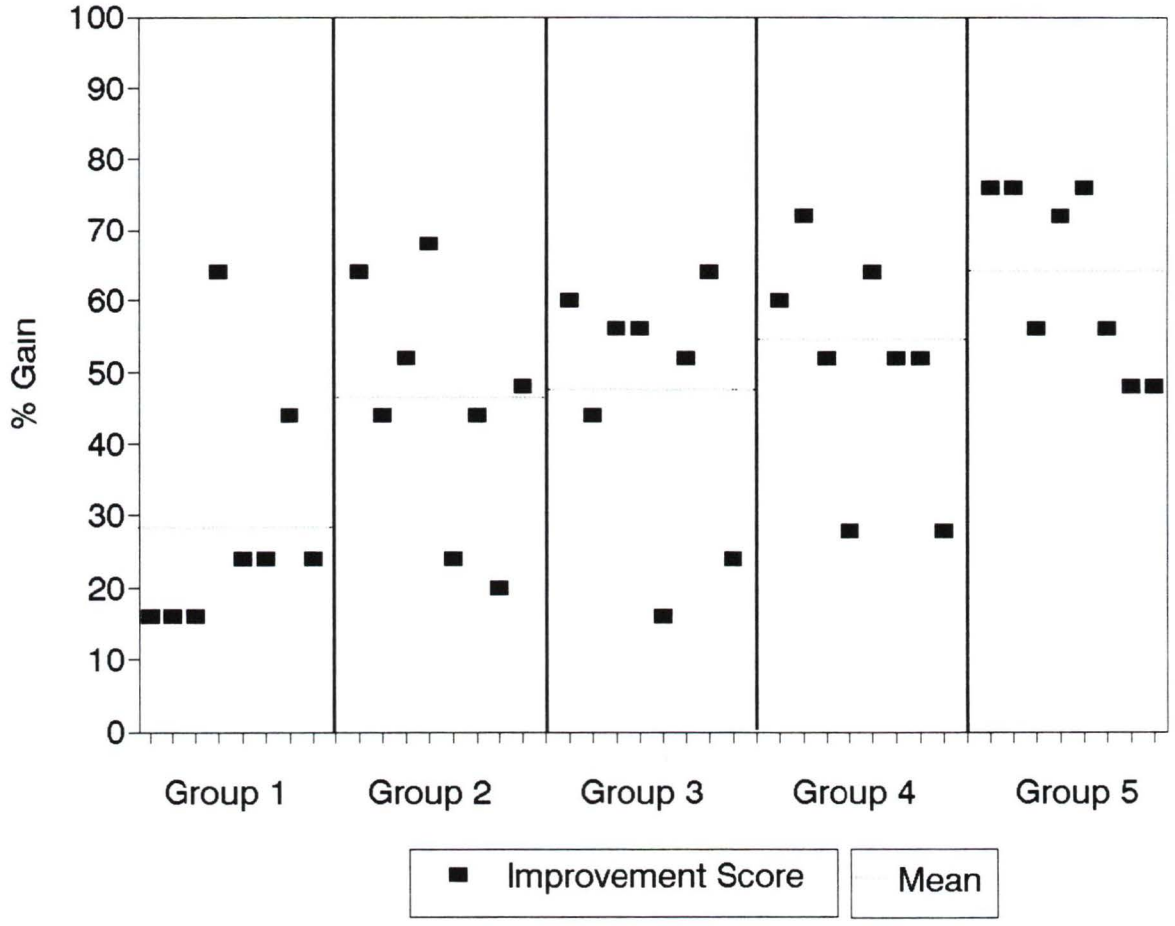
100
90
80
70
60
50
40
30
20
10
0
% Gain
Group 1
Group 2
Group 3
Group 4
Group 5
Improvement Score
Mean

Table 6

Analysis of Variance for the Gain Scores

Source	D.F.	SS	MS	F	F Crit
Between Groups	4	272.75	68.18	4.13	2.65
Within Groups	35	577.62	16.50		

Fisher's protected t (Least Significant Difference)= 2.87

Group	Means	SD
1	7.7	4.4
2	11.3	4.2
3	11.6	4.3
4	12.7	3.9
5	15.8	3.1

items) recorded similar gains. As expected, Group 5 subjects improved most, with M=63.2% (or a mean raw score improvement of 15.8 items). A one-way analysis of variance determined that the means were different, $F(4,35) = 4.13$, $p = .007$. Group 5 outperformed Groups 1, 2 and 3 while Group 4 was significantly different than Group 1, Fisher's $t(35) = 2.87$, $p < .05$.

Application Scores

A second major dependent variable was each subject's written responses to 20 items about the principles and concepts contained in twelve exemplars. Figure 3 presents the percentage of correct responses made on the application exercise. These data closely corresponded with the pattern of the posttest scores. That is, the means range from a low of 45.5% correct in Group 1 to a high of 71.5% correct in Group 5.

When the mean scores from subjects who responded actively in Groups 3, 4 and 5 were combined (M=67.8%) it was significantly higher than subjects who were instructed to simply read the program frames, Groups 1 and 2 (M=49.0%). No subjects in Groups 1 or 2 were able to answer more than 60.0% of the application questions correctly. Interestingly, subjects in Group 4 recorded a slightly lower mean score (M=64.0%) than

Figure 3. The percentage of correct responses made on the application exercise for all subjects.

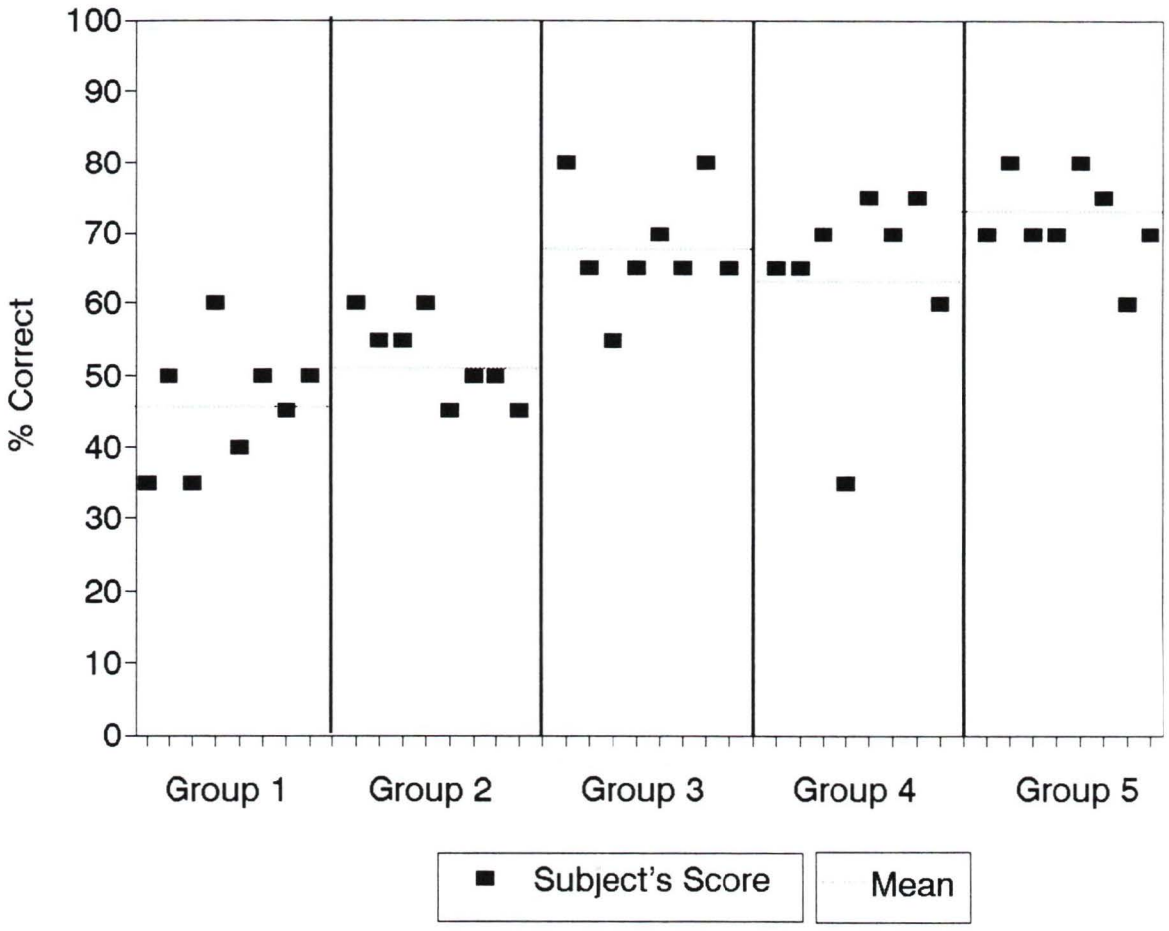
100
90
80
70
60
50
40
30
20
10
0
% Correct
Group 1
Group 2
Group 3
Group 4
Group 5
Subject's Score
Mean

Table 7

Analysis of Variance for the Fill-in-the-Blank 20-Item Application Exercise

Source	D.F.	SS	MS	F	F Crit
Between Groups	4	156.10	39.02	12.47	2.65
Within Groups	35	109.50	3.12		

Fisher's protected t (Least Significant Difference)= 2.25

Group	Means	SD
1	9.1	1.7
2	10.5	1.1
3	13.6	1.6
4	12.8	2.5
5	14.6	1.3

subjects in Group 3 (M=68.0%). Predictably, Group 5 scores were superior to other groups (M=71.5%).

An analysis of variance among the group scores indicated that there was a significant statistical difference among the group means, $F(4,35) = 12.47$, $p=.0001$. Multiple comparisons between means confirmed that the observed difference between the non-active (Groups 1 and 2) and active groups (Groups 3, 4 and 5) was significant, Fisher's $t(35)=2.25$, $p<.05$.

Think Fast Duration

Using a stopwatch, the experimenter recorded each subject's time to complete the Think Fast delivered 90-frame program. Figure 4 displays individual subject data superimposed over group means for the duration of time (in minutes) that subjects required. Under the non-active responding condition (Groups 1 and 2), subjects required approximately the same duration of time for the completion of the Think Fast program (Group 1, M=24.6 minutes; Group 2, M=26.7 minutes). Think Fast mean completion time was 30.5 minutes for Group 3 and 29.6 minutes for Group 4. As expected, typing answers in response to questions--Group 5--required the most time (M=49.2 minutes).

To verify whether these mean duration scores differed statistically a one-way analysis of variance

Figure 4 The duration of time (in minutes) required to complete the Think Fast program for all subjects.

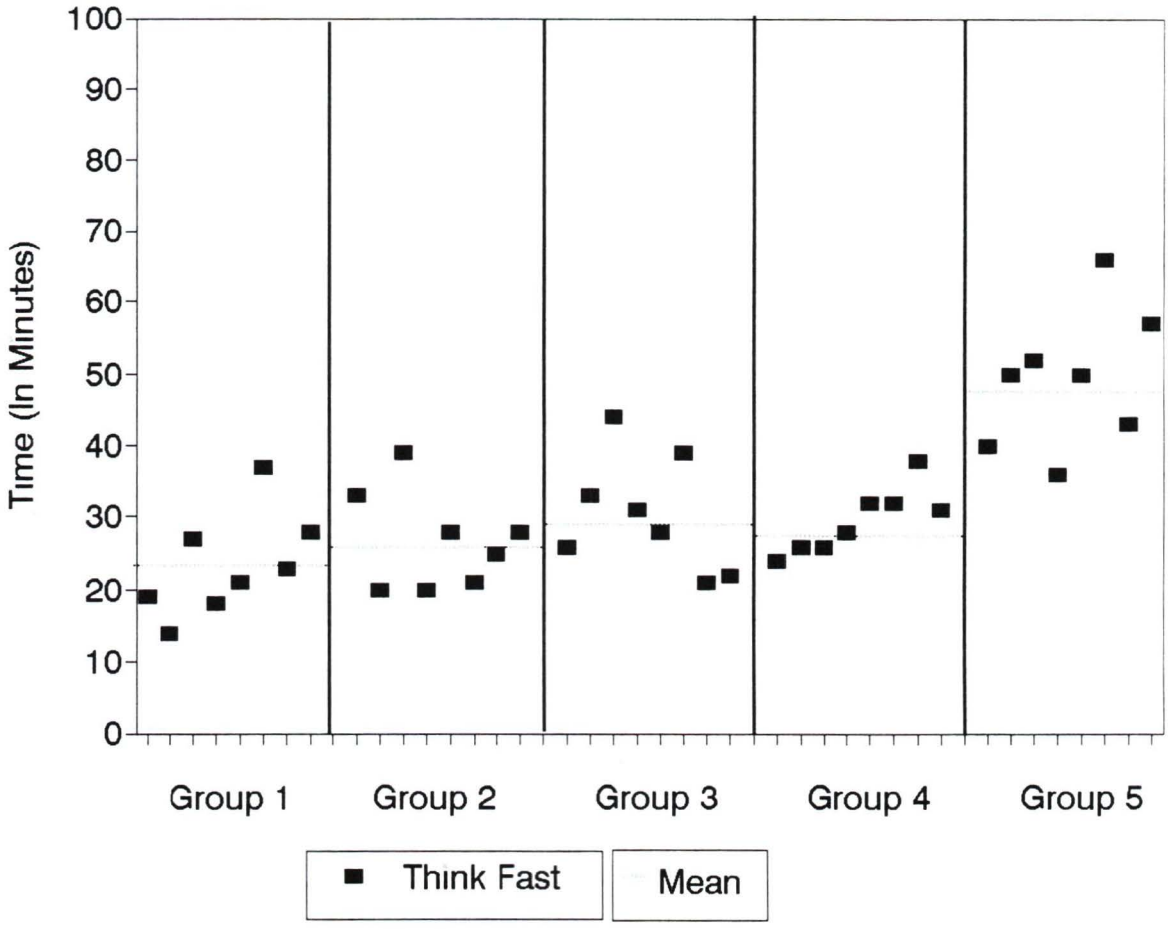
Time (In Minutes)
100
90
80
70
60
50
40
30
20
10
0
Group 1
Group 2
Group 3
Group 4
Group 5
Think Fast
Mean

Table 8

Analysis of Variance for Time to Complete the Think Fast Program

Source	D.F.	SS	MS	F	F Crit.
Between Groups	4	3098.35	774.58	14.23	2.65
Within Groups	35	1904.75	54.42		

Fisher's protected *t* (Least Significant Difference)= 5.21

Group	Means	SD
1	24.6	6.9
2	26.7	6.7
3	30.5	8.0
4	29.6	4.5
5	49.2	9.6

was conducted. A difference was indicated, $F(4, 35) = 14.23$, $p = .0001$. A multiple comparison was performed using Fisher's protected t test. Group 5 required significantly more time to complete Think Fast than all other groups, $t(35)=5.21$, $p<.05$. This was the only significant difference.

Test Taking Time

A additional analysis examined the time used to write the pretest and posttests. This measure was obtained by subtracting the Think Fast time from the total session time. The individual and mean scores are displayed in Figure 5. The means ranged from a low of 36.8 minutes in Group 2, to a high of 50.8 minutes in Group 5. On the average, Group 3 (M=44.3) and Group 4 (M=43.7)
required similar mean times to supply written answers to pretest and posttest question frames. Surprisingly, Group 1 (M=46.2) needed more time to write the tests than all but Group 5 (M=50.8). An analysis of variance indicated a difference among the group means, $F(4, 35) = 2.77$, $p=.04$. A multiple comparison showed that Groups 1 and 5 required significantly more time than Group 2, $t(35)=6.07$, $p< .05$. Other comparisons were non-significant.

Figure 5. The time (in minutes) required to write answers to pretest, posttest and applied question frames.

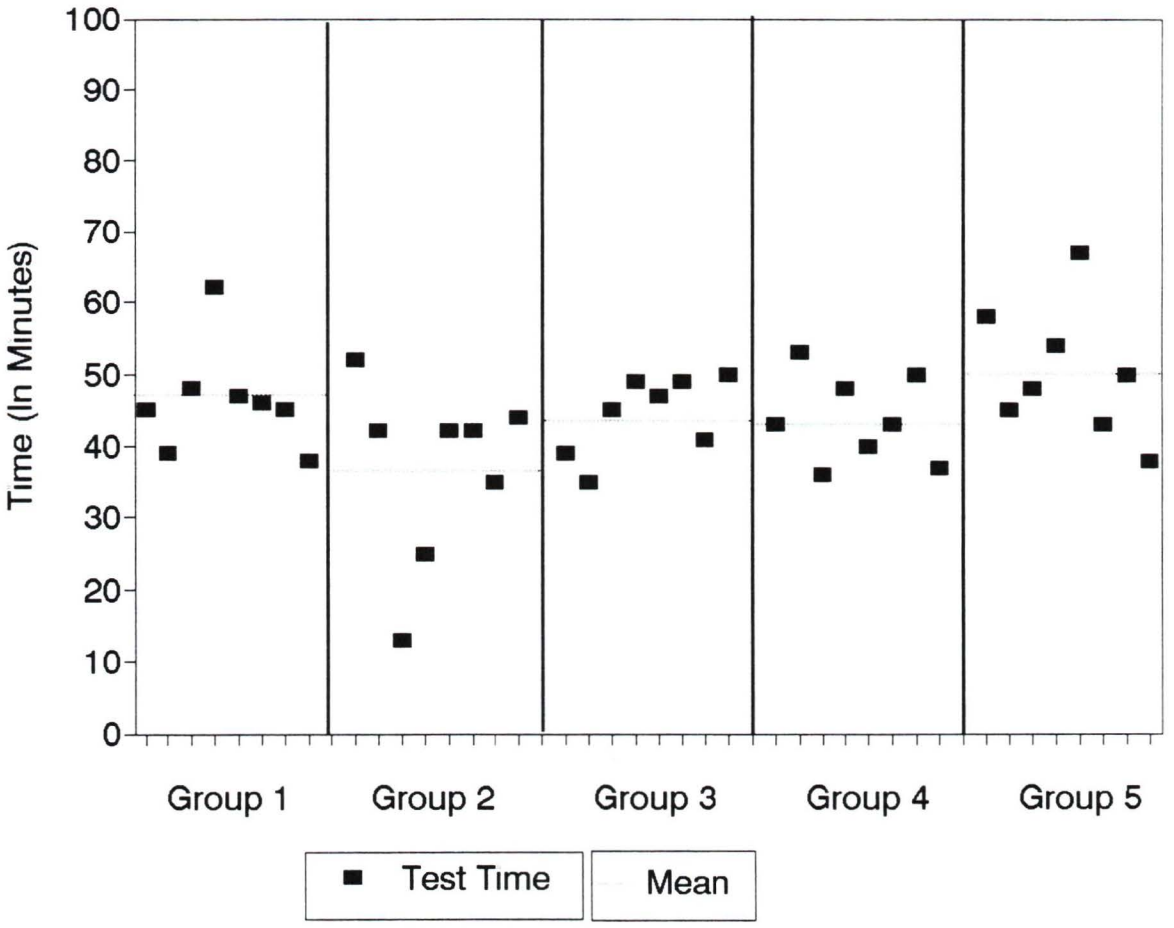
100
90
80
70
60
50
40
30
20
10
0
Time (In Minutes)
Group 1
Group 2
Group 3
Group 4
Group 5
Test Time
Mean

Table 9

Analysis of Variance for Time used to complete the Pretest, Posttest and Application Exercise

Source	D.F	SS	MS	F	F Crit
Between Groups	4	819.15	204.78	2.77	2.65
Within Groups	35	2582.62	73.78		

Fisher's protected t (Least Significant Difference)= 6.07

Group	Means	SD
1	46.2	7.3
2	36.8	12.3
3	44.3	5.4
4	43.7	6.1
5	50.8	9.7

Attitude Survey

The mean scores among groups on the attitude survey are listed in Table 10. Subjects were asked to respond to seven statements along a 5-point continuum covering a 2-point positive and negative range on either side of a neutral mid-point. Figure 6 displays the mean scores for all subjects. To determine if any statistical differences were present, a one-way analysis of variance was conducted. This procedure suggested that a difference existed, $F(4,35) = 3.06$, $p = .02$. A multiple comparison test showed that only Group 1 was different from the other groups, $t(35) = .397$, $p < .05$. That is, subjects in Group 1 tended to respond towards the negative side of the rating scale ($M = 2.5$). The other subjects rated the survey statements neutrally, or closer to the positive side of the scale (Group 2, $M = 3.3$, Group 3, $M = 3.2$, Group 4, $M = 3.4$; and Group 5, $M = 3.1$).

Correlations

The Pearson correlation coefficient was used to determine whether any of the dependent measures were significantly correlated. The results of this procedure were listed in Table 11.

Scores on the 25-item posttest were positively

Figure 6. The mean attitude score for all subjects across experimental conditions.

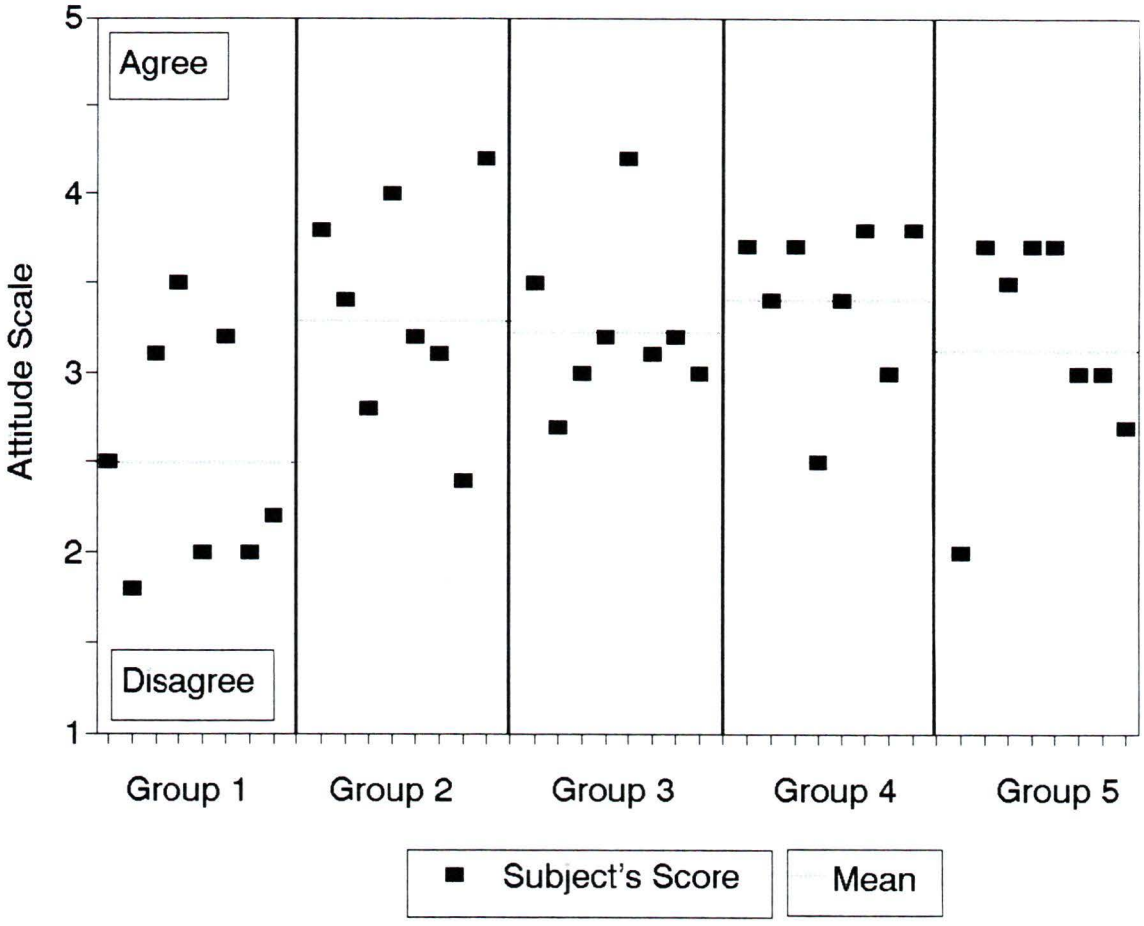
Attitude Scale
5
4
3
2
1
Agree
Disagree
Group 1
Group 2
Group 3
Group 4
Group 5
Subject's Score
Mean

Table 10

Analysis of Variance for the Seven-Item Attitude Survey

Source	D.F.	SS	MS	F	F Crit.
Between Groups	4	3.97	.99	3.14	2.65
Within Groups	35	11.04	.31		

Fisher's protected t (Least Significant Difference) = .397

Group	Means	SD
1	2.5	.64
2	3.3	.61
3	3.2	.45
4	3.4	.45
5	3.1	.60

correlated with the 20-item application exercise scores, r=.69, p<.01. In addition, the posttest was also positively correlated with gain or improvement scores, r= 95, p<.01, time spent with Think Fast, r=.44, p< 01 and attitude towards the study, r=.43, p<.01. Test taking time was not significantly correlated with any dependent variables.

Table 11

Correlation Matrix Showing the Relationship between the Dependent Variables

	Posttest	Gain	Applied	TF Time	Test	Attitude
Pretest	-.13	- 37*	- 16	03	- 16	04
Posttest		95*	.69*	44*	19	.43*
Gain			.67*	.40*	21	35**
Applied Task				46*	14	.42*
TF Time					.17	.11
Test						07

* significant at .01
** significant at .05

CHAPTER 5

Discussion

The findings of the study were interpreted in relation to the stated hypotheses. The main research hypothesis put forth was that active responders (Groups 3, 4 and 5) would correctly answer more posttest and application test items than non-active responders (Group 1 and 2). Subsidiary hypotheses considered the likelihood of differences between experimental groups. These differences were also discussed.

Pretest and Posttest

The findings of this study supported the hypothesis that activity where learning with programmed materials is concerned resulted in higher posttest scores than non-activity. Instructions for *activity* in the form of either overt or covert constructed answers (Groups 3, 4 and 5) produced better posttest scores than non-active reading instruction (Groups 1 and 2). Activity resulted in 26.3% better performance on the 25-item posttest and 20.1% better performance in identifying the concepts of operant conditioning.

During the experiment, Group 1 subjects progressed through the programmed material by pressing the spacebar. There was no opportunity to *answer*, because no blank was included. Therefore, no feedback was

possible. Overall, these subjects scored the lowest group mean posttest and applied achievement scores.

Group 2 was unusual in that subjects received both the frame with a blank within the statement and the answer simultaneously. This condition was included to determine whether the simultaneous presentation of potential program questions and answers would produce better test and task performance. Such presentation of potential answers enhanced posttest achievement scores of subjects assigned to this group. They correctly answered as items as Groups 3 and 4 in the 25-item posttest, but not on the 20-item applied test.

Surprisingly, Group 2 subjects were able to answer as many posttest questions correctly as those in Groups 3 and 4. This was contrary to the stated research hypothesis that both non-active groups would not score as high on the posttest as active responders. The data indicated that reading frames with blanks and answers provided simultaneously was as effective as *thinking* or *saying* the responses with respect to answering a later posttest. A post hoc speculation is that Group 2 subjects may have read the sentence with the blank located at the top of each computer screen and *covertly* constructed an answer before looking towards the bottom of the computer screen to look for the answer.

Therefore, Groups 2 and 3 should have similar Think Fast completion times. Indeed, the data seemed to support this speculation. When considering group averages, Group 2 (*M*=26.7 minutes) and Group 3 (*M*=30.5 minutes) used roughly the same length of time, although the Group 2 mean was closer to Group 1 (M=24.6).

It did not seem to matter whether the subjects read the frames with blanks and answers (Group 2), answered the frames by *thinking* the response (Group 3) or by *saying* the answers to frames (Group 4). The posttest averages of Groups 2, 3 and 4 were not significantly different from each other.

Application Exercise

The application analysis followed from research done by Tudor & Bostow (1991). These researchers attempted to determine whether posttest scores correlated with the ability to apply what was learned. The present measure of application, however, is much different than Tudor and Bostow's where subjects were asked to prepare automated instruction frames based on concepts covered in the program. They found that active responders not only gave more correct posttest answers but could also write better programmed frames than their non-active counterparts.

Similarly, the present study found that active responding groups (Groups 3, 4 and 5) as a whole, provided more correct posttest answers than non-active groups (Groups 1 and 2) For this study, however, a different application test was used Subjects were given 12 written examples of behavior illustrating the concepts that were taught with the programmed materials. The results provided strong evidence to support the hypothesis that active responders, either covert or overt made 18.8% more correct responses than passive readers; in fact, only three of the 16 non-active subjects answered more than 50 0% of the application questions correctly. In contrast, the three weakest performances from the active groups scored a mean of 50 0% It is interesting to note that Group 2 scored comparably to Groups 3 and 4 on the on the 25-item posttest but not on application scores. It is possible that subjects in Group 2 learned the keywords without reading as much of the question frame text as subjects in Groups 3 and 4. The lower applied scores obtained from Group 2 suggests that this was a possibility

Think Fast Duration

In terms of time to complete the Think Fast program, the non-active Groups 1 and 2 progressed

through the 90-frames faster than others. These data also indicated that mean length of time used between Groups 3 and 4 was nearly identical. These groups required more time than Groups 1 and 2. It was no surprise that Group 5 took the longest to complete the Think Fast program given the nature of the response action (i.e., entering each keystroke).

Test Taking Time

These data show that Groups 1 and 5 were different than other groups. This dependent measure may indicate a relationship between the response mode and the time used to respond to the tests. Group 5 subjects took longer to supply written answers to pretest, posttest and application test question frames but this resulted in superior posttest achievement. Group 1 subjects, however, used more time than Groups 2, 3, and 4. Test taking time may indicate the efficiency of the response mode instruction. Unfortunately, these data contained the time used to write the pretest as well as posttest measures.

Attitude Survey

The subject attitude survey data corresponded somewhat to subject achievement. On the average, subjects in Group 1 rated the whole experience nearly neutral but towards the unfavorable side. The

gradation differences among the remaining groups were small. Groups 2, 3, 4 and 5 responded similarly by indicating neutrality with a moderate interest towards the favourable side. A more sensitive instrument should be used for future studies.

Limitations of the Study

It was impossible to verify that subjects in Groups 2 and 3 did or did not *think* answers to blanks. Other researchers have noted that subjects under similar conditions will often not respond but wait instead to see what the answer is, or even *peek ahead* when printed materials permitted this (Kulhavy, 1977).

No stringent method was used to ensure that subjects in Group 4 verbalized all their responses aloud. Although the experimenter was directly outside of the experimental laboratory (to listen for verbal responses), there was no recording procedure for verification. Thus, it is possible that these subjects may not have responded verbally or correctly to all frames. Future research using the Say mode might benefit from using an audio recorder. Group 5 subjects were in a class alone. They were required to type all letters to each answer before moving to the next item. This activity ensured that each keystroke was corrected before advancing to the next item. This extra

contingency enhanced response requirement as the correction may have resulted in their superior posttest scores. In other words, it is not clear whether the action of typing or the correction procedure was responsible for the superior Group 5 scores. It would be advisable to include a typing group without the correction procedure in future studies.

All subjects were told at the beginning of the experiment that they would be writing posttest exercises. It is possible that subjects who were able to covertly construct answers before reading the actual answers (Groups 2 and 3) were more likely to do so because they were informed that their subsequent performance would be measured. Conversely, there was no method to ensure that subjects in Group 3 actually thought the answers before receiving feedback. Therefore, the question of whether there was a difference between covert and overt responding to programmed frames in relation to achievement is not fully answered by this study.

Educational Implications

One difficulty in evaluating such an experiment involves the content of the frames and the responses that are required from the subjects. Writing good programs consists of more than simply obliterating

words. Kemp and Holland (1966) examined 12 programs to determine the percentage of total words which could be removed without affecting error rate. They called this procedure the *blackout ratio*. The results indicated that experiments using programs which had the lowest blackout ratios resulted in higher posttest scores for overt responders. Thus, they suggested that studies which failed to find an advantage for overt responding were due to poor programming. That is, the subjects' responses were unrelated to the critical content which was subsequently tested. It may be interesting to determine the blackout ratios of programs used in past experiments and replicate the studies using a microcomputer to deliver the frames.

This study supported the idea that appropriate stimulus control is necessary in order for subjects to significantly increase achievement on the posttest and application test. Subjects learned to respond to appropriate stimuli as more features of "good" programmed instruction were added. That is, subjects' responses in Groups 1 and 2 were not contingent on what they read. They simply pressed a key to progress through the frames. Since Groups 3 and 4 were instructed to think or say the response, it was more likely that they would read and think about, at least,

some parts of the question frames. The stimulus control was broadest for Group 5. There may have been a stronger contingency for these subjects to read and think about each question frame because they were instructed to type each response.

Speculations about the generality of the results to other learning situations are in order. This study may have implications for classroom instruction. If an instructor wanted to use the Analysis of Behavior (Holland & Skinner, 1961) for an introductory course on operant conditioning, he/she would be advised to require active responses from students. Specifically, the data clearly supported the use of the Type Answer response mode. First, employing this mode could increase the likelihood that students constructed responses before see receiving feedback. Second, requiring the overt action of typing could allow for easier monitoring of what students actually did. As well, students would spend more time "on task" than if they were assigned to read and think or read and say aloud their responses.

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Oral Presentation Text

After introducing myself and explaining the nature of my presentation, I outlined the experiment. "There are many ways to study academic materials. For example, passively reading, reading and thinking, reading and speaking aloud, etc. The purpose of my study is to examine the effectiveness of these methods with respect to learning."

"Your participation will be no longer than 1.5 hours. Your written responses to an exercise before and after experiencing the computer program will be the primary data collected. First, you will be asked to fill-in-blanks found in 25 psychology facts selected from a textbook. This will take 15-20 minutes. Second, you will spend approximately 30 minutes using an MS-DOS microcomputer to progress through 106 computer screens containing similar psychology material. Finally, when you are done with the computer program, you will be presented with 1) a fill-in-the-blanks exercise similar to the one you initially wrote and 2) you will be given 10 examples which are representative of the concepts learned with the definitions presented by the computer program. This last part should take 20-30 minutes."

Appendix 1 (Continued)

"There are several benefits from participating in this study: 1) you get to see how an experiment is run, 2) you will receive a written summary of the study; and 3) you will be paid $5.00 for your time."

"If you are interested, please complete the sign-up form that is being passed out. Thank you for your time. Any questions?"

Think Fast (Version 2) Browse Mode For Group 2

---------- 1 of 90 ----------

Both positive and negative reinforcement _____ the rate of response.

increase

[Spacebar]=Forward; [Backspace]=Backward; [Esc] to Quit

Think Fast (Version 1) Browse Mode for Group 1

---------- 1 of 90 ----------

Both positive and negative reinforcement increase the rate of response

X

[Spacebar]=Forward; [Backspace]=Backward; [Esc] to Quit

Think Fast (Version 2) Say mode used for Groups 3 and 4

---------- 1 of 90 ----------

Both positive and negative reinforcement
_____ the rate of response.

Say and press [Spacebar] to Advance; [Esc] to Quit

Depression of Spacebar:

---------- 1 of 90 ----------

Both positive and negative reinforcement
_____ the rate of response.

increase

Score your Say; [C] = Correct; [I] = Incorrect; [Esc]

Think Fast (Version 2) Type mode for Group 5

---------- 1 of 90 ----------

Both positive and negative reinforcement
_____ the rate of response.

Type Term or [Tab] = Hint; [Enter] = Skip; [Esc] = Quit

Entering each keystroke.

---------- 1 of 90 ----------

Both positive and negative reinforcement
_____ the rate of response.

inc

Type Term or [Tab] = Hint, [Enter] = Skip, [Esc] = Quit

Confirmation of Typed Answer (no errors).

---------- 1 of 90 ----------

Both positive and negative reinforcement _____ the rate of response.

increase

Good!

One or more incorrect keystrokes entered.

---------- 1 of 90 ----------

Both positive and negative reinforcement _____ the rate of response.

increase

Wrong, too many errors!

The 90-Frame Behavior Analysis Program

The following is Version #2 of the Think Fast program used for Groups 2, 3, 4, and 5. Version #1 did not contain blanks but was otherwise identical. The symbols * * * before a blank indicates that the response component was more than one word. The two capital letters (TT) that followed a blank required a technical term as the response. The length of the blank was not necessarily the length of the answer.

1. Answer: "food","Performing animals are sometimes trained with REWARDS. The behavior of a hungry animal can be REWARDED with _____."

2. Answer: "reinforce","A technical term for REWARD is reinforcement. To REWARD an organism with food is to _____ it with food."

3. Answer: "reinforced","TECHNICALLY speaking, a thirsty organism can be _____ with water."

4. Answer: "after","The trainer reinforces the animal by giving it food _____ it has performed correctly."

5. Answer: "behavior reinforcement", "Reinforcement and behavior occur in the temporal order: 1) _____, 2) _____."

6. Answer: "after","Food given to a hungry animal does not reinforce a particular response unless it is given almost immediately _____ the response."

7. Answer: "probable","A reinforcement does not elicit a response; it simply makes it more _____ that an animal will respond in the same way again."

8. Answer: "deprived of food","Food is probably not reinforcing if the animal is not _____."

9. Answer: "less","If an animal's response is not followed by reinforcement, similar responses will occur _____ frequently in the future."

10. Answer: "reinforcement","To make sure an animal will perform, the trainer provides _____ for the response frequently."

11. Answer: "reinforced","A hungry pigeon in the park flicks dead leaves about with quick movements of its beak. This behavior is _____ whenever it uncovers bits of food."

12. Answer: "food","A pigeon is occasionally reinforced for flicking leaves about because of the common natural arrangement of leaves over _____."

13. Answer: "natural","The reinforcement used by animal trainers is deliberately arranged, while the arrangement of leaves and food in the park is _____."

14. Answer. "deprived of", Food is not reinforcing unless the animal has first been * * * _____ food for some time.

15. Answer: "probability","Reinforcing a response produces an increase in the _____ that the response will occur again."

16. Answer: "frequently","We do not observe PROBABILITY directly. We say that a response has become more probable if it is observed to occur more _____ under controlled conditions."

17. Answer: "more","When a response has been reinforced, it will be emitted _____ frequently in the future."

18. Answer: "reinforce","To get an animal to emit a response more frequently, we _____ the response."

19. Answer: "reinforce","In laboratory research, various devices are used to reinforce responses. Heat can be used to _____ the responses of a cold animal."

20. Answer: "response","An electrically operated food magazine which presents food can be used to reinforce a(n) _____ of an organism deprived of food."

21. Answer: "reinforced","If the cold (or food-deprived) organism turns on an electrically operated heat lamp (or food magazine), the response of turning on will be _____."

22. Answer: "frequently","The response of turning on the electrically operated heat lamp or food magazine will be emitted more _____ in the future if the organism is cold or hungry."

23. Answer: "response","In a typical apparatus, the depression of a horizontal bar automatically operates a food magazine. The apparatus selects bar pressing as the _____ to be reinforced."

24. Answer: "reinforced","The response of pressing a bar must be emitted at least once in order to be _____."

25. Answer: "are no","Responses such as bar pressing, flicking leaves, etc., are said to be emitted rather than elicited since there _____ (are or are no?) observed eliciting stimuli."

26. Answer: "is not","If pressing the bar does not operate the food magazine, the response * * * _____ reinforced."

27. Answer: "less","Reinforcement makes responses more frequent while failure to receive reinforcement makes responses ____ frequent."

28. Answer: "are not","No eliciting stimuli are observed for bar pressing, flicking leaves in the park, etc. Therefore, responses of this type * * * classified as reflex behavior."

29. Answer: "probability","When a pigeon is first placed in the experimental space, there is a low _____ that a peck on the key will soon be emitted."

30. Answer: "rate frequency","To say that there is, at first, a low probability of pecking the key, means that the pigeon will emit pecks at a low _____ or _____."

31. Answer: "reinforced","When the first peck on the key is _____ (TT) by food, the probability of another peck on the key is increased."

32. Answer: "rate","When pecking the key is followed immediately with food, the _____ of the response is observed to increase."

33. Answer: "reinforced","After the pigeon pecks the key and receives food, it begins to peck steadily. Presenting food is said to have _____ pecking, which has now become conditioned."

34. Answer: "response, reinforcer", "In operant behavior, the temporal order of the response and the reinforcing stimulus is first the 1) _____(TT) and then the 2) _____ (TT)"

35. Answer. "rate","It might be said that the pigeon has acquired the habit of pecking the key, but the only thing observed is an increased _____ of responding after reinforcement."

36. Answer: "reinforcement, reinforcer","When a peck is followed by food, the event is described by saying, The peck was followed by 1) _____. The food is called a(n) (2) _____. (TT)"

37. Answer: "rate, extinction","When food no longer follows pecking, the 1) _____ of emitting the response is observed to decline gradually. This process is called 2) _____."

38. Answer: "extinguished","When the rate of pecking has returned to its initial low level as a result of withholding food, the operant is said to have been _____."

39. Answer: "not"," A response is said to be extinguished when its rate has returned to its initial low level because responses have been emitted but _____ followed by reinforcement."

40. Answer: "time", "If a pigeon has not been in the box for a long time, its rate of responding upon returning to the box will be lower than previously in the box. This forgetting is due to the passage of _____ during which the response is not emitted."

41. Answer: "extinction, forgetting","Forgetting and extinction are technical terms for different processes. The response is emitted without reinforcement only in the process called 1) _____. The response is not emitted in the process called 2) _____."

42. Answer: "operant","Pecking the key is an example of behavior which operates upon the environment. Thus it is a(n) _____."

43. Answer. "reinforcer", "Operant behavior has direct effects on the environment. One consequence which results in an increase in the subsequent rate of the operant response is called a(n) _____ (TT)."

44 Answer: "operates upon","The word operant is a noun or an adjective indicating something which is operative or has an influence. Operant behavior * * * _____ the environment."

45 Answer: "reinforcer","Operant behavior has direct effects on the environment. One consequence which results in an increase in the subsequent rate of the operant response is called a(n) _____

46 Answer: "reinforced", "After a hungry infant begins crying, he is fed; soon he cries regularly when hungry. Feeding is said to have _____ crying which has now become conditioned."

47 Answer: "increase","A psychologist fed her infant son when he emitted a faint 'cooing' sound. The rate of 'cooing' when hungry was expected to (and did) _____ as a result of this reinforcement."

48 Answer: "conditioned","The mother who feeds her baby when he 'coos' increases the rate of 'cooing.' When the rate of 'cooing' has increased because of the reinforcement, the operant has become _____ (TT)"

49. Answer: "emitted", "The mother can reinforce an infant's vocal behavior only after at least one vocalization has been _____."

50. Answer: "extinguished reinforcement ","The psychologist fed the baby when he emitted 'coos,' but NOT when he cried. We should expect that crying when hungry would be 1) _____ because of the withholding of 2) _____."

51 Answer: "operants, reinforced", "Vocalizations are classed as 1) _____ behavior when they act upon the environment (social, in this case). In that case, their frequency depends on whether or not they are 2) _____ "

52 Answer: "probable, reinforced", "When you are near a drinking fountain, it is 1) _____ that you will walk to the fountain because such behavior has been 2) _____ in the past, under a similar condition of deprivation."

53. Answer: "reinforcement extinguished","If a water fountain consistently fails to operate, you cease to go to it when thirsty. Because of the lack of 1) _____ (TT), the operant has been 2) _____. (TT)"

54. Answer: "rate acts as","A hungry pigeon pecks a key and is immediately given food. The 1) _____ of the pecking response will increase since presenting food 2) * * * _____ a reinforcement."

55. Answer: "is not","If, instead of presenting food after the pigeon pecks the key, a loud noise is turned on, the rate of pecking will not increase. Presenting a loud noise * * * _____ a reinforcement."

56. Answer: "is","When pecking a key turns off a very loud noise for a few moments, frequency of pecking in the presence of the noise may be observed to increase. In that case ending the loud noise * * * _____ a reinforcement."

57. Answer: "negative","Reinforcement which consists of presenting stimuli (e.g., food) is called positive reinforcement. In contrast, reinforcement which consists of terminating stimuli (e.g., painful stimuli) is called _____ reinforcement."

58. Answer: "negative positive","Turning off a television commercial is reinforced by the termination of a(n) 1) _____ reinforcer, turning on a very funny program is reinforced by the presentation of a(n) 2) _____ reinforcer."

59. Answer: "termination", "A stimulus is called a negative reinforcer if its _____ reinforces behavior."

60. Answer: "negative reinforcer", "Elimination of a television commercial may be a negative reinforcement. If so, the television commercial is a(n) _____ _____ (TT)"

61. Answer: "positive reinforcement","If a funny program is a positive reinforcer, presenting the program is a(n) _____ _____."

62. Answer: "positive reinforcer negative reinforcer","The rate of an operant can be increased by presenting a(n) (1) _____ _____ or by ending a(n) (2) _____ _____."

63. Answer: "termination", "A man turns his face away from an ugly sight. Turning away is reinforced by the _____ of the ugly sight (a negative reinforcer)."

64. Answer: "reinforced, positive", "A food-deprived child will probably ask for food is the response "asking for food" has been 1) _____ in the past. This is an example of 2) _____ reinforcement."

65. Answer: "increase", "Both positive and negative reinforcement _____ the rate of response."

66. Answer: "emits frequently","When an infant emits the sounds'da-da,' his father cuddles him. We classify cuddling as a reinforcer when we note that the infant 1) _____ this response more 2) _____."

67. Answer: "reinforced","When the father cuddles the infant after it has said 'da-da,' the infant may smile, repeat 'da-da,' etc. If he continues to cuddle the infant frequently, we assume that the smile, etc., have _____ the father's behavior."

68. Answer: "reinforce","'What does he see in her?' might mean 'How does she _____ his courting behavior?' (TT)"

69. Answer: "more","The man who brings candy to his wife to end an argument may find later that his wife argues _____ (more or less?) frequently. An appeaser has worked as a reinforcer."

70. Answer: "less frequently","The man who brings his wife candy when she is especially agreeable may find that she argues * * *. He has reinforced responses which are incompatible with arguing."

71. Answer: "incompatible", "Two responses are incompatible when they cannot be emitted at the same time. A wife who reinforces her husband when he is agreeable may find the rate of arguments decreasing because arguments are _____ with being agreeable."

72. Answer: "not reinforcing incompatible","An undesired response can be eliminated by 1) * * * the response, or by reinforcing other responses which are 2) * * * with it."

73. Answer: "negatively reinforced","A school teacher is likely, when possible, to dismiss a class when her students are rowdy because he has been _____ by elimination of the stimuli arising from a rowdy class."

74. Answer: "increase reinforcement","The teacher who dismisses a class when it is rowdy probably causes the frequency of rowdy behavior to 1) _____, since dismissal from class is probably a (n) 2) _____ for rowdy children."

75. Answer: "decreases incompatible","A teacher who dismisses a class when it is quiet 1) _____ the probability of rowdy behavior. She is reinforcing responses which are 2) _____ with rowdiness."

76. Answer: "extinction, reinforcement", "If we consistently get no answer when we dial a number, we stop dialing. This process is called 1) _____, and is due to lack of 2) _____."

77. Answer: "decreases extinguished","If an airplane spotter never sees the kind of plane he is to spot, his frequency of scanning the sky 1) _____. In other words, his 'looking' behavior is 2) _____ (TT)"

78. Answer: "reinforced","Absenteeism increases if employees are not sufficiently _____ with wages and suitable working conditions. (TT)"

79. Answer: "extinguished", "In looking for lost car keys, one may search the same littered table top several times before this behavior is _____ through consistent failure to find them."

80. Answer: "reinforce","If people continue to buy books, music, and works of art, we conclude that these objects _____ the behavior of purchasing them."

81. Answer: "extinguished", "To stop a dog from begging for food, one should _____ the operant by never again feeding it when it begs."

82. Answer: "reinforcer","A stimulus which follows a response is called a(n) _____ if the rate at which similar responses are emitted is observed to increase."

83. Answer: "reinforced","A child has a 'temper tantrum,' screaming for candy. The mother gives the child candy and the tantrum ceases. The mother's response of handing candy to the child is _____ by the termination of the tantrum."

84. Answer: "negative", "If termination of a temper tantrum reinforces a mother's response of giving candy to her child, the cessation of noise is an example of _____ reinforcement."

85. Answer: "reinforcer reinforcement","With reference to the influence of the temper tantrum on the mother's behavior, the tantrum is a negative 1) reinforc-_____, its cessation is a negative 2) reinforc- _____."

86. Answer: "increases","When a temper tantrum results in the receipt of candy, the probability that the child will have a tantrum in the future _____."

87. Answer: "positive", "The receipt of candy as a result of throwing a tantrum is an example of _____ reinforcement."

88. Answer. "reinforce", "To avoid conditioning temper tantrums, the mother should not _____ such behavior when it is emitted."

89. Answer: "extinguish, incompatible", "Two ways of effectively preventing unwanted conditioned behavior are to: 1) _____ it by withholding reinforcement and to condition some 2) ____ behavior."

90. Answer: "forgetting", "As a result of the passage of time with no opportunity to emit the response, a response is emitted at a lowered rate, we say that ____ has taken place."

The Fill-in-the-Blank Pretest-Posttest

1. Two responses are incompatible when they cannot be emitted at the same time. A wife who reinforces her husband when he is agreeable may find the rate of arguments decreasing because arguments are _____ with being agreeable.

2. To stop a dog from begging for food, one should _____ the operant by never again feeding it when it begs.

3. A food-deprived child will probably ask for food if the response "asking for food" has been 1) _____ (TT) in the past. This is an example of 2) _____ (TT) reinforcement.

4. The mother can reinforce an infant's vocal behavior only after at least one vocalization has been _____.

5. Vocalizations are classed as 1) _____ (TT) behavior when they act upon the environment. In that case, their frequency depends on whether or not they are 2) _____.

6. A response is said to be extinguished when its rate has returned to its initial low level because responses have been emitted but _____ followed by reinforcement.

7. When you are thirsty and near a drinking fountain. It is 1) _____ that you will walk to the fountain because such behavior has been 2) _____(TT) in the past, under a similar condition of deprivation.

8. Both positive and negative reinforcement _____ the rate of response.

9. Operant behavior has direct effects on the environment. One consequence which results in an increase in the subsequent rate of the operant response is called a(n)_____.

10. In operant behavior, the temporal order of the response is first the 1) _____ (TT) and then the 2) _____(TT).

11. A stimulus is called a negative reinforcer if its _____ reinforces behavior.

12. If termination of a temper tantrum reinforces a mother's response of giving candy to her child, the cessation of noise is an example of _____ reinforcement.

13. A man turns his face away from an ugly sight. Turning away is reinforced by the _____ of the ugly sight (a negative reinforcer).

14. A food deprived pigeon pecks a key and is immediately given food. The 1) _____ of the pecking will increase since presenting food 2) * * * _____ a reinforcement.

15. As a result of the passage of time with no opportunity to emit the response, a response is emitted at a lowered rate, we say that _____ has taken place.

16. Food is not reinforcing unless the animal has first been * * *_____ food for some time.

17. In looking for lost car keys, one may search the same littered table top several times before this behavior is _____ through consistent failure to find them.

18. If we consistently get no answer when we dial a number, we stop dialing. This process is called 1) _____, and is due to lack of 2) _____(TT).

19. Elimination of a television commercial may be a negative reinforcement. If so, the television commercial is a(n) _____.

Posttest-Answer Key

1 incompatible

2 extinguish

3 reinforced positive

4. emitted

5. operants reinforced

6. not

7. probable reinforced

8. increase

9. reinforcer

10 behavior reinforcer

11 termination

12 negative

13 termination

14. operant reinforced

15. forgetting

16. deprived of

17. extinguished

18 extinction reinforcement

19. negative reinforcer

Application Exercise

1. Sarah sometimes smiled at men who she passed on campus. One day she smiled at a guy who then came right up and asked her for a date. Sarah now smiles at many of the guys whom she passes on campus and frequently gets asked out for interesting dates.

After she started getting dates, the rate at which Sarah smiled a) _____.

In this example, "getting a date" is an event that follows smiling and that increases the rate of smiling. Therefore, "getting a date" is b)_____ (TT).

The occurrence of "getting a date" after Sarah smiles is an example of what behavioral procedure?
c) _____(TT).

2. Paul got to thinking about his driving behavior one day. He looked in the rear view mirror frequently to prevent accidents, he looked carefully at side streets, parked cars, and moving cars to prevent being hit and he stopped at traffic lights and signs to prevent accidents.

From what you have learned, Paul's new driving behavior should be classified as _____.

3. Ken wasn't doing well in his sixth grade math class. When his mother and father had their regular conferences with the teacher, she informed them of the situation, adding that Ken handed in fewer than half of his homework assignments. Ken's parents then made the rule that, for any day that Ken did not hand in his homework, he would be sent to bed early as a "punishment." It was observed that, during the next few months, Ken handed in all of his homework assignments.

What behavioral procedure produced Ken's increased rate of doing his homework? _____

4. Joe's TV set went on the blink during the NFL playoffs, so he tapped it with the palm of his hand. Immediately, the picture cleared up. Now, whenever the picture goes bad, he taps the set.

Having the picture clear up is an example of a(n) a) _____.(TT)

The occurrence of the event "the picture cleared up" after Joe tapped his TV would be an example of what behavioral procedure? b) _____. (TT)

5. Dave was a slob; he would rip off his clothes at night and just throw them down. Shawn, his roommate, didn't like living with the resulting mess, so she asked Dave to please hang up his stuff. No result. So she then started looking carefully for any time that Dave did hang up even one article of clothing. When he did so, she gave him a special hand-printed ticket that read: "This ticket good for one special gift of your choosing."

If Dave started picking up his clothes, then you would call the procedure that Shawn used a) _____(TT).

If Dave started picking up his clothes, then the ticket would be called a(n) b) _____(TT).

6. Jimmy and his dad had trouble getting along with each other. Whenever his dad would ask him how things were, Jimmy always explained at great length how bad his life was. Not wanting to make the boy's sad state worse, his dad always paid attention to him and tried to comfort him. One evening Jimmy's mother suggested that perhaps Dad should stop all the attention to such sad talk. Dad stopped the attention, and Jimmy's rate of sad talk decreased.

Jimmy's dad stopped paying attention to sad talk.

Since an event following the behavior was stopped and the rate of the behavior decreased, the procedure used by Jimmy's dad would be labeled _____(TT).

7. Verna decided that her child Tom interrupted her too often. She started punishing him every time he interrupted by giving him a good spanking. She was disappointed, however, because Tom seemed to interrupt much more often than before. She concluded that punishment just doesn't work with some children.

In this example, Verna's spanking of Tom occurred after Tom's interruptions, and the rate of Tom's interruptions. This situation involves an "unpleasant" event that was a(n) A) _____(TT).

What is the name of the procedure of giving Tom a spanking? B) _____.

Therefore, what is the name of the event called a "spanking"? C) _____.

8. Marty was in second grade. One day during spelling he laid his head on the desk. The teacher asked him what was the matter, and he said, "Teacher, I have a terrible headhurt." The teacher, a kind woman, soothed him by saying, "That's too bad, Marty. Why don't you just lay your head down until it feels better?" It was noted that Marty frequently complained about headaches after that even though he had never any in the previous year, and that Marty's schoolwork became much poorer.

The teacher allowed Marty to put his head down on the desk after his complaints of a headache.

Marty's frequency of complaining about headaches A)_____.

Therefore, we can say that the teacher B)_____(TT) Marty for complaining about a headache.

9. Dave didn't like Timmy to play with his model cars because Timmy usually played too rough and damaged them. One day Dave had the idea that he would reinforce Timmy for playing nicely by giving him several M & M's whenever he played nicely with the models for 5 minutes. Timmy loved M & M's and Dave never gave him any if Timmy started to get a bit too rough. The procedure worked really well for several hours, but finally Timmy started getting too rough.

After several hours, this procedure was no longer effective because he was no longer * * * _____.

10. Gary wanted to get his students to turn their papers in on time each week, so he reminded them on Thursday to be sure to have them in by Friday. Everyone did so. Midway through the semester he stopped reminding them, and, to his surprise, they stopped handing them in on time.

What procedure did Gary use when he stopped reminding them? _____

11. Tom had the bad habit of talking in the weekly dorm meetings without putting up his hand. Mary, the chairperson of the meeting, finally started yelling at him each time he failed to raise his hand. Tom soon started to raise his hand.

Tom's hand raising is a result of what procedure? _____

12. Ward liked Bev a lot and so he went out of his way to find things about her to compliment. At first Bev liked this and smiled and thanked him. However, after she got engaged to Tom she felt embarrassed by Ward's compliments. As a result she invariably ended up ignoring them. Ward doesn't compliment her anymore.

What behavioral procedure did Bev use when she ignored Ward's compliments? _____(TT).

Application Exercise - Scoring Key

1. a) increased b) positive reinforcer
   c) positive reinforcement

2. negative reinforcement

3. negative reinforcement

4. a) positive reinforcer b) positive reinforcement

5. a) positive reinforcement b) positive reinforcer

6. a) decreased b) extinction

7. a) increased b) positive reinforcer
   c) positive reinforcement d) positive reinforcer

8. a) increased b) positively reinforced

9. deprived of

10. extinction

11. negative reinforcement

12. extinction

Subject Attitude Survey

Group: _____

Code number: _____

Date: _____

Please rate the following items by circling the number that relates most clearly to your feelings. Your responses will aid in the assessment of the materials that you just reviewed.

1. Did you like reading the program materials?

Disagree		Somewhat		Agree
1	2	3	4	5

2. Was this experience educational?

Disagree		Somewhat		Agree
1	2	3	4	5

3. Do you feel this learning is of any benefit?

Disagree		Somewhat		Agree
1	2	3	4	5

4. If you were given some everyday examples of behavior do you feel as though you could identify the concepts based on what you learned from the computer program?

Disagree		Somewhat		Agree
1	2	3	4	5

5. Did you enjoy using the computer to learn?

Disagree		Somewhat		Agree
1	2	3	4	5

6. Would you like to see computers used as a course component?

Disagree		Somewhat		Agree
1	2	3	4	5

7. Would you be willing to take a fully automated course?

Disagree		Somewhat		Agree
1	2	3	4	5

Sign-up Form: Study Methods Research

Name: _____ Date: _____

Phone Number: _____

What is the best time of the day to contact you?

Have you ever participated in an experiment before? If yes, provide brief description.

Have you previously (or currently) taken psychology courses?

List course number(s) and title(s).

N.B.. Please hand this form back to your instructor whether or not you complete it as I will recycle blank forms. Thanks for your attention.

Student Profile

Please answer the following questions as completely and in as much detail as possible. All information will be kept confidential.

Code number: _____ Group: _____

Date: _____ Age: _____

Gender. _____

Indicate your status at Uvic: Full time_____ Part time_____

What Year of study: _____

What is your major: _____

Have you ever had a course that used computers for the purpose of instruction? Yes____ No_____ If your answer was "yes" indicate the course title.

Have you ever had a course in psychology at the college or university level? Yes_____ No_____ If your answer was yes indicate the course title.

Have you ever had a course in university that covered behavior analysis? Yes_____ No_____ If your answer was yes indicate the course title.

Have you ever had a course in university that used programmed instruction as an instructional technique? Yes_____ No_____ If your answer was yes please indicate the number of them you have taken. If no, move to the next question.

Have you ever had a course in typing? Yes_____ No_____.

What would you estimate to be the number of words you could type per minute? (check one)

0-15____ 16-30____ 31-45____ 46-60____61-75____75+____

Group Instructions

Group 1

Please go through the "deck" of cards and read everything that appears on the computer screen. To progress from one card to the next, simply press the spacebar. Proceed through the deck until you reach the last card. I will be right by the door in case you need assistance. Any questions?

Group 2

Please go through the "deck" of cards and read all that appears on the computer screen. To progress from one card to the next, simply press the spacebar. There will be correct answers to blanks within the definitions presented at the bottom of the screen. I will be right by the door in case you need assistance. Any questions?

Group 3

Please go through the "deck" of cards and read all that appears on the computer screen. There will be a blank somewhere within each definition. When you see a blank in your reading, try to "think" of the correct answer in response to it. IMPORTANT. Do not say the answer aloud or even whisper. After you have "thought" the answer, press the spacebar and then enter "c" if the answer you thought of was correct or "i" if the

answer you thought of was incorrect. Proceed through the deck until you reach the last card. I will be right by the door in case you need assistance. Any questions?

Group 4

Please go through the "deck" of cards and read all that appears on the computer screen. There will be a blank somewhere within each definition. When you come across a blank in your reading, try to say aloud your answer. After each verbal response, press the spacebar and then enter "c" if the response you said aloud was correct or press the "i" key if the response you said aloud was incorrect. Proceed through the deck until you reach the last card. I will be right by the door in case you need assistance. Any questions?

Group 5

Please go through the "deck" of cards and read all that appears on the computer screen. When you come across a blank, attempt to fill-in-the-blank by typing your answer using the computer keyboard. After you have done so, the computer will provide confirmation as to the correctness of your response. The next screen will automatically appear. Proceed through the deck until you reach the last card. I will be right by the door in case you need assistance. Any questions?

Pretest-Posttest Instructions

Instructions read to students: Work through each computer screen. Try to fill-in-the-blanks by writing your answer on the answer sheet provided. If you do not know the answer, leave the corresponding space on the answer sheet blank and move on to the next question. When you see the symbols *** before a blank it indicates that there is more than one word for that response. The length of a blank is not necessarily an indication of the answer length or the number of words required. Important: Do not go back to a previous question after you have moved on to a new question. Finally, be as specific as possible (e.g., answer "negative or positive reinforcer" rather than "reinforcer"). For the 25-item posttest: As you progress through the questions write each answer on the corresponding slip of paper and deposit it into the box before you press the spacebar for the next card.

Pretest Answer Sheet

Group: _____

Codenumber: _____

Date: _____

1. _____ _____

2. _____ _____

3. _____

4. _____ _____

5 _____

6. _____ _____

7. _____

8 _____ _____

9. _____

10 _____

11. _____

12 _____

13. _____

14 _____

15. _____ _____

16 _____

17. _____

18 _____

19 _____

25-Item Posttest Answer Slips

--cut here----------

1. _____

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2. _____

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3. _____ _____

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4. _____

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5. _____

6. _____

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7. _____

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8. _____

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9. _____ _____

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10. _____ _____

11 _____

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12. _____

---

13. _____

---

14. _____ _____

---

15. _____

---

16 _____

17. _____ _____

---

18. _____ _____

---

19. _____

Application Exercise - Answer Sheet

Group: _____

Codenumber: _____

Date: _____

1. a)_____ b)_____

   c)_____

2. _____

3. _____

4. a)_____ b)_____

5. a)_____ b)_____

6. a)_____ b)_____

7. a)_____ b)_____

   c)_____ d)_____

8. a)_____ b)_____

9. _____

10. _____

11 _____

12 _____

VITA

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None

Publications:

None

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Title of Thesis. Using Computer Delivery to Examine Interactive and Non-Interactive Response Modes to Programmed Material

Author [redacted]

WILLIAM WONG

April 22, 1993