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A comparison of three behavioral systems for assessing and training first aid skills

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The Ohio State University, 1989
A COMPARISON OF THREE BEHAVIORAL SYSTEMS FOR ASSESSING AND TRAINING FIRST AID SKILLS

DISSERTATION PROSPECTUS

Presented in Partial Fulfillment of the Requirements for the Degree Doctor of Philosophy in the Graduate School of The Ohio State University

By

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* * * * *

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Many years ago as an undergraduate the writings of B.F. Skinner originally sparked my interest in the experimental and applied analysis of behavior. I would like to acknowledge this debt. Much more recently I would like to acknowledge the guidance and support of my advisory committee: Dr. T. Stephens, Dr. J. Mulick, Dr. D. Hammer, and Dr. L. Magliocca who each in his own way has made important contributions in helping others to learn. I express sincere appreciation to my family who have shown more than patience but instead have actively encouraged my curiosity about this area.

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PUBLICATIONS


FIELDS OF STUDY

Clinical Psychology
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## TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>CHAPTER</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>I.</td>
<td>INTRODUCTION</td>
</tr>
<tr>
<td></td>
<td>Basic Terminology: Task Analysis, Chaining, Prompting, Fading</td>
</tr>
<tr>
<td></td>
<td>Summary and Research Questions</td>
</tr>
<tr>
<td>II.</td>
<td>LITERATURE REVIEW</td>
</tr>
<tr>
<td></td>
<td>Delayed Prompting</td>
</tr>
<tr>
<td></td>
<td>Normal and Handicapped Learners</td>
</tr>
<tr>
<td>III.</td>
<td>DESIGN AND METHODOLOGY</td>
</tr>
<tr>
<td></td>
<td>Introduction</td>
</tr>
<tr>
<td></td>
<td>Students and Setting</td>
</tr>
<tr>
<td></td>
<td>Task Analysis</td>
</tr>
<tr>
<td></td>
<td>Baseline and Criterion Measures of Dependent Variables</td>
</tr>
<tr>
<td></td>
<td>Reliability Measures</td>
</tr>
<tr>
<td></td>
<td>Experimental Procedures</td>
</tr>
<tr>
<td></td>
<td>STARS System Training</td>
</tr>
<tr>
<td></td>
<td>Time Delay Training</td>
</tr>
<tr>
<td></td>
<td>Standard Training</td>
</tr>
<tr>
<td>IV.</td>
<td>RESULTS</td>
</tr>
<tr>
<td></td>
<td>Total Effectiveness and Efficiency Results</td>
</tr>
<tr>
<td></td>
<td>Reliability Estimates</td>
</tr>
<tr>
<td></td>
<td>Individual Effectiveness and Efficiency Results</td>
</tr>
<tr>
<td>V.</td>
<td>DISCUSSION</td>
</tr>
<tr>
<td></td>
<td>Total Effectiveness and Efficiency Data</td>
</tr>
<tr>
<td></td>
<td>Reason for Significant Overall Differences in Effectiveness and Efficiency</td>
</tr>
<tr>
<td></td>
<td>Individual Efficiency and Effectiveness Data</td>
</tr>
</tbody>
</table>
# TABLE OF CONTENTS (Continued)

## CHAPTER V. (Continued)

- Comments on the System for Training and Assessing Resuscitation Skills (STARS) ........................................ 72
- Comment on Standard Training ................................ 74
- The Present State of First Aid and CPR Training ........ 75
- Limitations of the Present Investigation .................... 82
- Advantages and Implications of Delayed Prompting ....... 85
- Understanding the Delayed Prompting Procedure .......... 88

## APPENDICES ............................................. 97

- A. Example of Rating Sheet Used to Judge Students' Performance ........................................ 98
- B. Questionnaire Administered to all Subjects after Achieving Criterion on Both Tasks ........ 99
- C. General Instructions to All Subjects ................. 100
- D. Verbatim Instructional Method for STARS Training from Seaman, Green, and Watson-Perczel, 1986 .................................. 101
- E. Examples of Information Provided to Instructors for Teaching Emergency Medical Procedures from Two Recent Publications ........................................ 103

## LIST OF REFERENCES ...................................... 104
# LIST OF TABLES

<table>
<thead>
<tr>
<th>TABLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Analysis of Tasks and Subtasks of the AHA's Single-Rescuer CPR Procedure</td>
<td>32</td>
</tr>
<tr>
<td>2. Analysis of Tasks of Emergency Evaluation of Conscious Casualty</td>
<td>34</td>
</tr>
<tr>
<td>3. Assignment of Students to Tasks and Training Conditions</td>
<td>35</td>
</tr>
<tr>
<td>4. Method of Measuring Dependent Variables</td>
<td>36</td>
</tr>
<tr>
<td>5. Totals, Means, and Standard Deviations for Error Responses for All Training Conditions and Tasks</td>
<td>44</td>
</tr>
<tr>
<td>6. Totals, Means, and Standard Deviations for Time to Criterion for All Training Conditions and Tasks</td>
<td>45</td>
</tr>
<tr>
<td>7. Trials to Criterion for All Training Conditions</td>
<td>46</td>
</tr>
<tr>
<td>FIGURES</td>
<td>PAGE</td>
</tr>
<tr>
<td>---------</td>
<td>------</td>
</tr>
<tr>
<td>1. Flow chart illustrating separate training procedures</td>
<td>37</td>
</tr>
<tr>
<td>2. Summation of error responses for all subjects under three training conditions</td>
<td>48</td>
</tr>
<tr>
<td>3. Summation of training time to achieve criterion for subjects under three training conditions</td>
<td>49</td>
</tr>
<tr>
<td>4. Summation of error responses for all subjects learning emergency evaluation only under all three training conditions</td>
<td>50</td>
</tr>
<tr>
<td>5. Summation of error responses for all subjects learning CPR only under all three training conditions</td>
<td>51</td>
</tr>
<tr>
<td>6. Summation of training time to achieve criterion for all subjects under three training conditions and both tasks</td>
<td>52</td>
</tr>
<tr>
<td>7. Error responses for three subjects under three training conditions</td>
<td>53</td>
</tr>
<tr>
<td>8. Error responses for three subjects under three training conditions</td>
<td>54</td>
</tr>
<tr>
<td>9. Error responses for three subjects under three training conditions</td>
<td>55</td>
</tr>
<tr>
<td>10. Error responses for three subjects under three training conditions</td>
<td>56</td>
</tr>
<tr>
<td>11. Error responses for three subjects under three training conditions</td>
<td>57</td>
</tr>
<tr>
<td>12. Error responses for three subjects under three training conditions</td>
<td>58</td>
</tr>
<tr>
<td>FIGURE</td>
<td>DESCRIPTION</td>
</tr>
<tr>
<td>--------</td>
<td>-------------</td>
</tr>
<tr>
<td>13.</td>
<td>Individual training time to achieve criterion for all subjects under three training conditions and both tasks</td>
</tr>
<tr>
<td>14.</td>
<td>Average student ratings of training conditions</td>
</tr>
<tr>
<td>15.</td>
<td>Individual student rating of training conditions</td>
</tr>
</tbody>
</table>
Behavior analysts have commonly considered complex skills to consist of chains of smaller responses (Ferster & Culbertson, 1982; Gold, 1976; Skinner, 1966). Each response in the chain is assumed to be associated with a unique stimulus condition which functions in two ways: first, as a discriminative stimulus setting the occasion for the subsequent response, and second, as a conditioned reinforcer for the previous response.

Two important factors that influence the effectiveness and efficiency of chaining are task analysis and prompting. A task analysis breaks a complex skill into smaller, teachable responses. The identification of discrete chaining steps is somewhat subjective. Martin and Pear (1984) suggest that the individual components selected be simple enough to be learned without great difficulty and should be followed by a clear-cut stimuli signalling their completion.

A prompt represents the substitution or addition of effective but eventually inappropriate stimuli for an
appropriate but as yet ineffective discriminative stimulus (also referred to as a task or target stimulus). Many prompting techniques have been developed to help learners make correct responses in the presence of target stimuli (Billingsley & Romer, 1983; Ford & Mirenda, 1984; Schoen, 1986; Wolery & Gast, 1984).

A set of alternative procedures that provide supplemental stimuli are stimulus shaping and stimulus fading (see Etzel & LeBlanc, 1979; Deitz & Malone, 1985 for a detailed discussion of these procedures). These techniques involve the manipulation of the configuration, size, colour, or intensity of the task stimuli themselves rather than extraneous assistance for the trainer.

Ideally many complex skills in applied settings should be performed accurately and efficiently without continued dependence on extraneous prompts or artificial alterations in task stimuli. Transfer of stimulus control from supplemental stimuli to task stimuli is often accomplished by fading the former so that few errors result. Fading is a technique that gradually and systematically withdraws supplemental stimuli. This procedure was initially investigated in an experimentally rigorous fashion by Terrace (1963 a, b) who taught pigeons to make red-green and vertical-horizontal discriminations with a minimum of errors. Compared to alternative trial and error learning relatively few error responses were observed by Terrace and
he labelled his techniques for gradually transferring stimulus control as "errorless learning." Terrace (1966, pp. 316-317) also observed that pigeons who were taught similar discriminations by different reinforcement displayed "agitated" or "emotional" behavior while subjects trained under the errorless condition remained "calm" and "attentive." It has also been suggested that there is a correlation between frequent error responses and maladaptive behavior for some human learners (Carr & Durand, 1985; Weeks & Gaylord-Ross, 1981) and that errors tend to be repeated thus decreasing the time available for instruction (Martin & Pear, 1983).

The increasing prompt hierarchy or "least to most assistance" is a frequently advocated prompting strategy (see McDonnell, 1987). This technique involves giving minimal prompts (e.g., verbal directions) at first and increasing the strength of the prompts (e.g., to manual guidance) as needed. Despite the popularity of increasing prompt hierarchies its use has been questioned because it can result in prompt dependency (e.g., see Wolery & Gast, 1984). McDonnell (1987) suggests there are two possible reasons why this may occur especially with handicapped learners. First students with handicaps may attend to stimuli or dimensions of stimuli that are manipulated during training and the salience of the actual task stimuli are diminished as the intensity of the teachers prompts
successively increase following each student error. Second, the teacher's prompts and some form of reinforcement is paired with the students' correct response. By differentially reinforcing the students' response following the teacher's prompts, the probability that the prompt will come to control the response may increase with each successive trial. The outcome is that irrelevant stimulus control of the students' response is established, and the transfer of stimulus control to the task stimulus is made more difficult. As an alternative a decreasing prompt hierarchy or "most to least assistance" provides more intensive instruction at an earlier point in time and then decreases the level of assistance (e.g., physical to verbal prompts).

Although often effective in decreasing errors, a number of other drawbacks are associated with the gradual withdrawal of supplemental stimuli. In many practical settings the level of assistance is only presumed to be reduced and has not been subject to empirical validation. For example, if prompts are faded too quickly learners may become confused; if withdrawn too slowly boredom or inattention may result. Secondly, considerable effort may be demanded in the advance preparation of different levels of prompt materials.

Rather than attempting to fade the physical characteristics of an effective prompt Touchette (1971)
and Touchette and Howard (1984) have presented delayed prompting as an alternative. This procedure has some important advantages by allowing the trainer to determine more precisely when transfer of stimulus control from prompts to task stimuli has occurred without adding or withdrawing supplemental stimuli based on subjective judgment. Secondly, the advance preparation or planning of different levels of prompt material is unnecessary.

As an example of the time delay technique consider a young child who is unable to discriminate between the letters "b" and "d" without assistance. It has been determined that when the child's teacher points to the correct letter this constitutes an effective physical prompt and allows the child to make a correct response. Every correct response using the prompt (pointing) progressively increases the delay between the task stimuli (S+) (letters "b" and "d") and prompt by 0.5 second on the next trial. Eventually as the delay between the S+ and the prompt reaches a certain period of time (e.g. 5 seconds) the child will begin to respond correctly to S+ alone before the occurrence of the prompt. Thus the delay technique has allowed the teacher to determine when transfer of stimuli control from prompt to S+ occurred while avoiding the potential drawbacks of more traditional fading procedures.
Time delay reduces the probability that irrelevant stimulus control will be established, because (a) the prompt remains constant during training and (b) it leads to correct responding almost immediately following the presentation of the task stimulus. Presumably these two conditions highlight the salience of the task stimulus and reduce the probability that the learner will come under the control of inappropriate stimuli.

A variety of successful delayed prompting procedures have appeared since Touchette's (1971) original investigation. Among others, these include, tasks such as instruction following (Striefel, Wetherby, & Harlan, 1976), manual sign reading (Smeets & Striefel, 1976), manual sign production (Bennett, Gast, Wolery, & Shuster, 1986), sight word reading (McGee & McCoy, 1981), requesting food items (Charlop, Schreibman, & Thibodeau, 1985) and task assembly (Walls, Haught, & Dowler, 1982).

A number of comparative investigations have also indicated the delay procedure to be more efficient than other more commonly used training strategies. Bradley-Johnson, Johnson, & Sunderman, (1983) compared delayed prompting and fading for teaching preschoolers easily confused letters and numbers and reported time to acquisition and error rates to be lower for the delayed prompting group. Further support was provided by Bennett, Gast, Wolery, & Shuster (1986) who found time delay to be a
more efficient strategy than other fading techniques when teaching manual sign production. Charlop & Walsh (1986) compared the efficiency of delayed prompting and modeling procedures to increase the spontaneous verbalizations of autistic children, found delay techniques to be superior.

With the exception of McDonnell (1987), Snell (1982), Walls, Haught, & Dowler (1982) and Walls, Dowler, Haught, & Zawlochi (1984) the application of delayed prompting has been confined to single or discrete tasks such as object or letter identification rather than complex sequences of behavior. Only Wall et al. (1984) and later McDonnell (1987) directly compared time delay with more common fading procedures in teaching complex chains. Finally, while subjects in these two comparative investigations varied in aptitude, no published reports have appeared applying delay techniques to nonhandicapped learners faced with acquiring complex responses.

**Summary and Research Questions**

The delay procedures summarized here have benefited considerable numbers of handicapped learners. These techniques deserve to be extended to learners and tasks where little documentation exists as to its effectiveness. This study attempts to address two practical questions: (1) Is the delay procedures suitable for normal or relatively proficient adult learners who are required to
learn a complex sequence of chained behaviors? (2) How does this procedure compare with alternative training strategies. The following section describes these questions in greater detail.
Delayed Promoting

As stated, only two disseminated studies have directly contrasted delay techniques with other prompting strategies in the context of training complex sequences of behavior (McDonnell, 1987; Walls, et al. 1984). Before describing these investigations and the issues associated with them in some detail it will be useful to return to Touchette's (1971) original experiment. Three severely retarded boys were first taught to press an illuminated red key in the presence of a white distractor key. After acquiring this colour discrimination subjects were next presented with a two choice form discrimination task (i.e., the letter E with the legs pointing up or legs pointing down). The "correct" E orientation (target stimulus or S+) was superimposed on the red color key (prompt) and the subsequent pressing of this key was reinforced. A correct response using the red prompt progressively increased the delay between the S+ and red prompt by 0.5 second on the next trial. Touchette found that as the delay between the S+ and the prompt reached about 6 seconds the boys began to
respond correctly to the S+ alone before the occurrence of the red prompt. These learners also required relatively few trials (5-16) before responding correctly to the S+ before the occurrence of the colour cue. Once the first anticipation response occurred subjects continued to respond correctly to the correct E figure prior to the onset of the prompt on virtually all subsequent trials.

Walls, et al. (1984) employed the delay technique to teach vocational task assemblies in a sheltered workshop. The number of errors, time to criterion, and number of prompts were examined under four training conditions: (a) whole task - unlimited delay (b) whole task - progressive delay (c) forward chaining - unlimited delay (d) forward chaining - progressive delay. Forward chaining refers to a procedure whereby a sequence of behaviors is taught in correct temporal order, one step at a time. Each time a step is added learners must correctly perform all the previously trained steps. Whole or total task training represents a variation of forward chaining where the student initially performs the entire sequence of required steps but then receives assistance only with those steps he or she is not able to perform. Typically the whole task training procedure is quicker but results in more errors (Spooner & Spooner, 1984). Walls et al. (1984) progressive delay techniques follows Touchette's (1971) procedure by gradually increasing the delay between target stimuli and
the prompt although 1 second rather than Touchette's 0.5 second increments were employed. Unlimited delay simply refers to a more commonly used technique whereby subjects were given as much time as needed to respond. Unlimited delay thus represents a condition where only postresponse or response contingent guidance is provided. This in contrast to progressive delay where prereponse guidance is offered to the learner. Walls et al. (1984) had originally speculated that a procedure combining progressive delay of prompts with the progressive addition of parts (i.e., forward chaining) would be best for keeping errors to a minimum. Instead they found that this training condition while effective was no more so than forward chaining - unlimited delay or whole task - progressive delay. The remaining training condition, whole task - unlimited delay was found to be significantly inferior to the other three conditions. On the basis of their results, these investigators then proposed that the inferior training approach was the combination where neither the training sequence (i.e., whole task) nor the prompt delay was progressive. As they had expected forward chaining required more time for training than whole task procedures, however, the whole task procedure can be as effective in reducing errors as forward chaining when coupled with time delay.
McDonnell (1987) contrasted delay techniques with an increasing prompt hierarchy (previously described) in teaching another complex behavior sequence (purchasing skills in a restaurant and store). He questioned whether the progressive delay procedure as used by Walls et al. (1984) was efficient within a chaining context. Instead he suggested that since chained procedures require students to make different responses in rapid succession, progressive time delay appears to be somewhat cumbersome to use because of the number of decisions teachers must make in prompting various student responses. As an easier alternative McDonnell suggested a constant delay procedure because the delay between S+ and prompt is established according to a consistent criterion reducing the number of decisions the teacher must make on each trial.

McDonnell (1984) taught four severely mentally retarded students to purchase items using increasing prompt hierarchy training with or without time delay. Under the "without delay" condition when an error occurred the trainer provided increasing levels of assistance to the student using a standardized hierarchy of prompts until he or she performed the step correctly. Under time delay conditions prompts were provided prior to the students' response. Following three consecutive correct responses at a zero delay level (e.g., cashiers request for payment (S+) and simultaneous gestural prompt from trainer) the trainer
increased the delay between $S+$ and prompt by 2 seconds. Results indicated that the time delay procedure was consistently the most efficient strategy with regard to number of errors and trials to criterion.

The limited number of subjects and tasks represented by these two investigations precludes drawing any strong conclusions regarding the relative advantages of various training methods. For example, several other recent studies have suggested that antecedent strategies are superior to consequent strategies in transferring stimulus control (Ellis, Walls, & Zane, 1980; Walls & Thvedt, 1981). These studies distinguished between two major variations of guidance. Preguidance or prompts given prior to or in conjunction with the response ("antecedent strategies") and postguidance ("feedback" or "knowledge of results") given by the trainer after the student's response. Findings so far consistently support the notion that preresponse rather than response contingent prompting is a more efficient strategy at least for disabled learners. Thus the rapid acquisition rates may be unrelated to the delayed prompt method itself but rather result from the difference in the point of application of the instruction (i.e., antecedent v.s. consequent strategies). Similarly, Handen and Zane (1987) have suggested on the basis of their review of delayed prompting research that some subjects made correct anticipated
responses on the first training trial involving a delayed prompt, indicating that the actual transfer of stimulus control may have occurred during prior zero second delay trials. Therefore, acquisition may occur during simultaneous presentation of task stimulus and prompt with the delay method functioning merely as a probe rather than a teaching procedure. It has also been observed that some subjects during discrimination learning have been observed placing their hands in front of the correct key prior to the onset of the prompt but stopped short of performing the target response (Touchette, 1971). Other typically unmeasured responses (e.g., eye movements) may also have been transferred to the task stimulus prior to the transfer of the target response. It is also possible that such anticipatory movements may have been reinforced by the appearance of the prompt. If anticipated movements were reinforced in this manner, the delay prompt procedure may simply be another form of trial and error learning in which anticipatory movements are differentially reinforced. Conversely, there is evidence against such an interpretation, based on the data available from the results of reinforced baselines among the delayed prompt research (see Handen & Zane, 1987). For example, when some subjects were given multiple opportunities to respond correctly and be reinforced they were unable to meet acquisition criteria suggesting that delayed prompt
procedures represent more than simple trial and error learning.

A number of other procedural issues remain. For example, what criteria should be used for increasing the length of the delay? McDonnell (1987) employed only one trial at a zero second delay level before increasing the delay while Walls et al. (1984) used three successful trials at zero delay before proceeding to an increased delay. Error correction procedures after incorrect responding also vary widely. Similarly, the criteria for determining when an entire task has been learned are inconsistent across studies. In addition, not all obvious dependent variables (time to acquisition, error rate, number of prompts) have been examined in all studies, or have been recorded in different ways. Handen and Zane (1987) reviewed these issues in considerable detail and concluded that determining the most appropriate training paradigm for a given subject/task remains an essential but formidable undertaking given the lack of documentation. In addition, all comparative analyses of alternative training strategies are limited by the idiosyncratic approaches of instructors. Finally, learners may come equipped with previously acquired strategies which may interact with the instructional approach in varying ways.
Normal and Handicapped Learners

Our lack of understanding of delayed prompting is more evident when nonhandicapped learners are considered. To some extent this is also true of other chaining and fading procedures generally where most of the research literature has focus on disabled learners. Normal learners are typically faced with the necessity of acquiring a great variety of behavior chains (e.g., cooking, computer programming, poems, mathematical calculations and object assembly). One set of skills that many handicapped learners are required to demonstrate with fluency and accuracy are first aid and procedures. There is considerable evidence that first aid skills are not well maintained among lay individuals (Weaver, Raimerez, Dorfman, & Raizner, 1979), among emergency medical technicians (Deliere & Schneider, 1980), and among physicians and nurses (Gass & Curry 1983). Also, there is some indication that these skills may not be mastered initially depending on the quality of training conditions (Seaman, Greene, Watson-Perczel, 1986).

Seaman et al. (1986) focused on the potential usefulness of task analysis and chaining techniques in improving first aid instruction and have provided some important initial suggestions about the feasibility and value of a behavioral system as applied to specifically to cardiopulmonary resuscitation skills (CPR). These
investigators noted that there does not exist a standard or universally accepted assessment protocol to rate CPR. This lack of behavioral specificity and dependence on instructors' subjective evaluations may to some extent be responsible for the failure of some students to master essential first aid skills.

On the basis of American Heart Association standards, discussion with instructors, and direct observation Seaman et al. (1986) developed a task analysis of CPR. They labeled their approach the, "System for Training and Assessing Resuscitation Skills (STARS)." Specifically this training system consisted of a deck of 3x5 inch cards, with one step of CPR clearly written or illustrated on each card. Instructors were then able to quickly and objectively compare students performance to the steps and illustrations on the cards. If the student performed a step incorrectly the instructor simply shifted the corresponding card from an "observation" column to a "practice" column. After completion of the entire CPR sequence by the student the instructor identified the incorrectly performed by presenting the appropriate card to the student and prompted correct performance either verbally or by modeling. Finally, the student was provided with an opportunity for independent practice before returning for another evaluation trial. Results indicated substantially fewer errors using the behavioral system when compared to standard instructional methods.
The investigation by Seaman et al. (1986) clearly reveals the potential of the behavior change procedures discussed previously (i.e., task analysis, chaining, prompting, fading) in assisting normal learners to acquire complex behavior sequences. The application of these techniques however is not meant to suggest that first aid skills are nothing more than the rote performance of certain limited chains of behavior. Rather, considerable background information about anatomy or medical conditions may be required for effective first aid intervention. Equally important may be the ability to respond appropriately in the presence of unexpected or untrained stimuli. Nevertheless, mastery of certain basic behavior chains still remains an essential component of first aid training.

Unfortunately, due to limitations of the experimental design a number of important questions remain unanswered. First, the STARS method was compared with a standard training method. As previously stated, standard methods can vary widely depending on the trainers personal idiosyncracies (Walls, Zane, & Thvedt, 1980). On this basis alone the procedures developed by Seaman et al. (1986) deserve replication. Also, it is important that this technique be extended to other first aid skills. Third, the experimental procedures employed by Seaman, et al. (1986) coincide with still another observation made by
Walls et al. (1980) that trainers will typically use verbal and modeling prompts to show the learner how a sequence is performed, then wait for an error to occur before prompting a correct response. Thus, a structured decision rule does not govern the shift from preresponse to response contingent prompting. With delayed prompting procedures preresponse prompts are scheduled to be delivered according to the learner's progress in training. A prompt is given when needed (i.e., when the learner waits for the prompt) but no prompt occurs when the learner makes a correct response within the allotted time. Thus, the trainer using preguidance rather than postguidance has a clear rule about when to prevent errors. A hesitation of x seconds by the learner signals the trainer that help should be given. The learner will probably be prompted frequently in early trials but the learners increasing mastery of the task serves to regulate the rate of reduction in trainer cues (i.e., learner controlled fading). Fourth, Seaman, et al. (1986) examined only the number of errors using standard and behavioral training during acquisition of the CPR skill and no consideration was given to training time under these two procedures. Unfortunately the amount and quality of subjects independent practice was not controlled or observed during the experimental sessions and subjects may even have practiced at home.
At this point the experiments reviewed so far can provide guidance in stating research questions more precisely. First, since the behavioral system (STARS) developed by Seaman et al. (1986) appears to be readily applicable to other first aid skills it can also be readily contrasted with behavioral strategies incorporating the delay paradigm as outlined. In other words how will dependent variables such as training time and error rates compare under these two training conditions? Secondly, it is important to compare these behavioral approaches with "standard" first aid training as suggested by various manuals and organizations (e.g., American Heart Association, 1986; Canadian Heart Foundation, 1987).

There is a tremendous amount of evidence that a few basic behavior principles are common to all types of learners regardless of ability. For example, positive reinforcement, punishment, stimulus control are principles of behavior because they describe basic functional relationships between behavior and its controlling variables. A behavior change procedure is a method of operationalizing or putting into practice a principle of behavior. Behavior change procedures obviously can and must vary widely depending on the characteristics of the learner, the setting, or demands of the task. For example, edibles, money, or social praise as used in experimentation or in practice with disabled learners may be ineffective or
even aversive for more skilled learners. It is important that such observations be made in regard to the use of the delay procedure.
CHAPTER III
METHODOLOGY

Introduction

In outlining experimental procedures I will incorporate appropriate features from the three experiments already described (McDonnell, 1987; Seaman et al. 1986; Walls et al. 1984). Although varying considerably in their approach all three investigations are directly relevant to the use of delay procedures within a chaining context.

These studies are also representative of a major dichotomization in research design, that is, the group design employed by Walls et al. (1984) contrasted with the single subject strategy used by Seaman et al. (1986) and McDonnell (1987). Those subscribing to a group approach assume they will be allowed to make statements of generality about the larger population based on the results of inferential statistical procedures from the experimental sample. On the other hand, the single subject strategy has as its purpose to explain individual variability in learning and to look for functional relations between the target behavior, other behaviors, and environmental events. Proponents of the latter approach question the
usefulness of statistical concepts and tend to rely on clear graphic representations of the data (Cooper, Heron, & Heward, 1987). Also, issues of generality are assumed to be addressed through replication with other individuals.

All students were trained on both tasks under two out of the three training strategies. While task and training conditions were counterbalanced to prevent contamination of results due to sequencing effects all students were randomly placed in the various task/training conditions. All students could be classified as normal learners, did not display physical or mental disabilities, and were not involved in special education programs.

Students and Setting

Students were selected from a number of local high schools and were paid for their participation in the experiment. The major restriction to participation was that no student who was selected had previously experienced first aid instruction. The entire experimental group of nine (7 males - 2 females) ranged in age from 12 to 16 with a mean age of 15 years.

The study was conducted in the Department of Psychology, St. Joseph's General Hospital, Thunder Bay, Ontario, Canada. Training sessions were conducted in an office equipped with a patient simulator (i.e., a Resuci Annie manikin typically used for First Aid and CPR training). Training was conducted by the experimenter with
occasional assistance from a department psychometrist to provide reliable checks.

Task Analysis

Students were taught two skill sequences (a) CPR (one rescuer, adult procedure (b) and an 14 step emergency physical examination procedure (St. John Ambulance of Canada, 1977). Following the task analysis procedure outlined by Seaman et al. (1986) a series of 3x5 index cards was constructed for the CPR skill sequence. Each card contained a single, discrete step and allowed for efficient and objective evaluation by the experimenter and were easily used by students as part of the STARS training procedure. The original CPR analysis as completed by Seaman et al. (1986) was based on American Heart Association (1980) standards, discussion with the certified instructor, and available multimedia kits. The task analysis of the emergency evaluation procedure was obtained directly from the St. John Ambulance of Canada (1977) Emergency First Aid Manual. The resulting tasks, sub-tasks, and time limits for CPR and emergency evaluation are presented in Tables 1, 2 respectively.

Baseline and Criterion Measures of Dependent Variables

Two measures were used to evaluate the efficiency and effectiveness of the three behavioral training conditions. These included topographical and sequencing errors during training trials and training time.
Measurement of student performance was conducted via rating sheets coinciding with the task analyses presented in Tables 1, 2 and allowed for rapid recording of errors, time, and number of prompts by the certified experimenter or assistant (see Appendix A). Mastery criteria included that the student complete the entire skill sequence accurately, in the proper order, and within prescribed time limits. As stated only students with no previous CPR or first aid training were selected and who were unable to perform any part of the sequence in the prescribed order at beginning of training.

Reliability Measures

Interobserver agreement measures were gathered for three of the nine students so that all training conditions were represented. The following formula was used to establish percentage of agreement: agreements/agreements + disagreements x 100 = percent of agreement.

Experimental Procedures

This study employed an alternating treatment within subjects design. The order of tasks and training conditions were counterbalanced and permitted evaluation of the three training conditions with minimal contamination as the result of sequence as two examples from Table 3 illustrate. Student 2 was first trained to perform the emergency evaluation procedure under the delayed prompting
followed by CPR again under the delay technique. Student 7 was first trained to perform CPR using STARS system, followed by the emergency evaluation task using standard training. The ordering of tasks and training conditions as presented in Table 3 allowed for the learning of two separate chained response tasks evaluated under the three training conditions and thus provided two evaluations on each student (see Table 4).

After training to mastery on both tasks students were asked to rate their satisfaction with the three training conditions on a Likert-type scale (see Appendix B).

In an attempt to hold the learning environment constant under all three training conditions, students were given identical general instructions prior to training sessions. These instructions are reproduced in Appendix C.

Finding single-subject experimental designs that allow adequate evaluation of the nonreversible behavioral effects of antecedent instructional procedures has been difficult. Nevertheless, such comparisons are needed if a data-based instructional theory or technology is to be developed. The parallel treatments design used in this study was developed for that purpose. It attempts to control for common threats to internal validity and allows for direct comparisons of the effectiveness and efficiency of three separate training procedures. Figure 1 presents a flow
chart illustrating the three training procedures applied to the two skill sequences.

"STARS" System Training

Training under the STARS system followed the procedures originally outlined by Seaman et al. (1986). First, the entire CPR and emergency evaluation sequences were modeled by the experimenter as described on the series of index cards as previously described. The student was then asked to perform or repeat the entire cycle he or she had just observed. Following completion of the task by the student the cards were used to demonstrate the steps that had been incorrectly performed. If the student still did not complete the individual step correctly the experimenter modeled the steps until it was performed correctly. Next the experimenter asked subjects to practice the previously missed steps independently (i.e., without assistance but observed by the experimenter). During this independent practice students were asked to repeat the previously missed steps three times. After completing the remedial routine students were permitted subsequent training trials where the entire sequence was again evaluated. As previously explained STARS training incorporates a number of procedures (i.e., modeling, whole or total task presentation, prompt material, increasing prompt hierarchies, guidance after errors responses are emitted,
and a considerable delay period before this guidance is provided). These important components were different from those offered in time delay or standard training.

Time Delay Training

Time delay training consisted of a two phased, constant rather than progressive delay procedure modeled after McDonnell's (1987) approach. As stated, it differed from the STARS system in a number of crucial ways. First, assistance was provided prior to the students' response rather than after. In other words, the experimenter did not wait for an error to occur before prompting a correct response. Prerresponse prompts were scheduled to be delivered according to the learners' progress in training (i.e., when the learner waited for the prompt). Thus, the experimenter has a clear rule about when to prevent errors. Second, modeling the entire chained response sequence before asking the student to perform the task was eliminated under the delay condition. During the first phase of delay training the instructor's verbal prompts (identical to instructions written on the index cards) were simultaneously paired with task stimuli ("O delay"). Following two consecutive correct performances at the O delay level the experimenter moved to the second phase of time delay training. In this phase a constant 3 second delay was inserted between the task stimulus and the
experimenter's prompts. Thus, a hesitation of 3 seconds by the learner signals the trainer that help should be given. This delay period was selected on the basis of observations of the average response latency of proficient practitioners during the task analysis. The delay used in this experiment slightly exceeded the average or normal response latency which was approximately 2 seconds. If students initiated a correct response prior to the end of the 3 second delay they were allowed to continue to the next step. If no response was made the verbal prompt was delivered and the student was allowed to continue. Finally, independent practice or remedial routines by students' using additional prompt material (i.e., index cards) was eliminated under the delay condition.

Verbal instructions given to students prior to the delay procedure were replicated from the Walls et al. (1984) experiment. "If you are sure what comes next you can go before I give you the instruction, but if you are not sure wait for me to help you." In the event of incorrect anticipatory responses by students no special error correction procedures were employed but rather the original verbal instruction was simply repeated.

According to Touchette and Howard (1984) the presence of auditory or visual time signals offers a potential distraction to both teachers and students in nonautomated field settings. They suggest that reasonably accurate
counts can be achieved using some silent verbal aids such as "one Mississippi, two Mississippi," and so on. This method was the basis for timing the delivery of prompts in this investigation.

**Standard Training**

Trainers' manuals both for CPR and first aid provide very little specific information on how to teach complex sequences of behavior (e.g. see American Heart Association, 1980, 1986; Ontario Heart Association, 1987). Appendix E provides samples of the type of guidance given to instructors and illustrates the nature of the problem. These vague suggestions provide no standards on how the instructor should reinforce, model, chain, prompt, or fade his or her instructions. In many cases the student is left at the mercy of idiosyncratic instructional techniques. Nevertheless, it does seem safe to argue that neither the STARS nor Time Delay Training is presently in use in standard training programs. It is also argued on the basis of available instructional manuals and repeated observations of actual courses that standard training appears to involve first modeling the procedure (with true or videotaped models), next the instructor then waits for the student to perform the skill, and finally the student is either praised for correct performance or the instructor brings the students' attention to error responses after
they occur. The above definition of standard training was the one employed in this investigation. If can readily be seen that this approach has important features in common with the STARS method such as modeling and postguidance.
Table 1
Analysis of Tasks (Lettered) and Subtasks (Numbered) of the AHA's Single-Rescuer CPR Procedure

A. Establish unresponsiveness
   1. Place hands on patient and shake or tap gently. Ask "Are you okay?" or "can you speak?"

B. Call for help
   2. Call out loudly, "Help!"

C. Open patient's airway
   3. Place hand nearest patient's head upon forehead and hand nearest feet around back of neck near base of skull.
   4. Elevate neck gently while pushing forehead downward (chin should point nearly straight upward).

D. Establish breathlessness
   5. Place ear over patient's mouth while looking at patient's chest. Look for chest movement, listen for air exchange, and feel for air movement.

E. Ventilate patient
   6. While maintaining the opened airway, extend index finger and thumb of hand upon forehead and pinch patient's nostrils closed.
   7. Seal mouth around patient's mouth and give 4 quick breaths while observing for chest expansion. Remove mouth between breaths to get air.

F. Establish pulse
   8. Remove hand from behind patient's neck and use fingertips to feel for pulse on the near side for minimum of 5 s.

G. Activate EMS system
   9. Call loudly for someone to call an ambulance. Shout the EMS telephone number, if known.

H. Acceptable time lapse for preceding steps: 15-30 s.
I. Perform cardiac compressions

10. Bare patient's chest; use middle and index finger of hand nearest patient's feet to trace edge of ribs up to the notch where ribs meet sternum. Place middle finger in notch with index on top of sternum.

11. Place heel of other hand on patient's sternum, just next to and touching the index finger.

12. Remove middle and index fingers (on sternum's tip) and place that hand on the back of the hand on patient's lower sternum.

13. With shoulders directly above sternum, elbows locked, and fingers off patient's chest, depress sternum downward (1.5 to 2 inches) by bending from the hips. Without bouncing or losing hand contact with sternum, count compressions as follows: 1&2&3 &4&5 & 1&2&3&4&10 & 1&2 . . . 15.

J. Ventilate patient

14. Open airway as in steps 3 and 4. Ventilate as in steps 6 and 7, two times.

K. Complete 4 compress/ventilate cycles (steps 10-14). Follow compressions by two ventilations.

L. Pulse check

15. After fourth comp/vent cycle, remove hand from behind patient's neck and use fingers to feel for pulse on near side of patient's neck.

M. Breathing check

16. Maintain open airway and place ear over patient's mouth while looking at chest. Look for chest movement, listen and feel for air exchange.

N. Acceptable elapsed time for preceding steps: 71-101 s.

from Seaman et al. (1986), p. 128.
Table 2
Analysis of Tasks of Emergency Evaluation of Conscious Casualty

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Count the pulse nothing its strength and rhythm.</td>
</tr>
<tr>
<td>2</td>
<td>Examine the skin for paleness. Examine the face, lips, inner sides of eyelids and nail beds for blueness.</td>
</tr>
<tr>
<td>3</td>
<td>Determine by touch if the body is hot and dry or cold and sweaty.</td>
</tr>
<tr>
<td>4</td>
<td>Check the nature of the breathing, noting its rate and depth.</td>
</tr>
<tr>
<td>5</td>
<td>Smell the breath.</td>
</tr>
<tr>
<td>6</td>
<td>Examine the ears.</td>
</tr>
<tr>
<td>7</td>
<td>Examine the nose.</td>
</tr>
<tr>
<td>8</td>
<td>Examine the mouth for blood and other fluids.</td>
</tr>
<tr>
<td>9</td>
<td>Feel the scalp for bumps or bruises.</td>
</tr>
<tr>
<td>10</td>
<td>Determine if the casualty can move the head and neck.</td>
</tr>
<tr>
<td>11</td>
<td>Feel along the center line of the back.</td>
</tr>
<tr>
<td>12</td>
<td>Ask the casualty to take a deep breath and cough.</td>
</tr>
<tr>
<td>13</td>
<td>Ask the casualty to pull in and push out the stomach.</td>
</tr>
<tr>
<td>14</td>
<td>Ask the casualty to move each arm and leg separately.</td>
</tr>
</tbody>
</table>
Table 3
Assignment of Students to Tasks and Training Conditions

<table>
<thead>
<tr>
<th>Students</th>
<th>Task</th>
<th>Training</th>
<th>Task</th>
<th>Training</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CPR</td>
<td>STARS</td>
<td>E.E.</td>
<td>STARS</td>
</tr>
<tr>
<td>2</td>
<td>E.E.</td>
<td>DELAY</td>
<td>CPR</td>
<td>DELAY</td>
</tr>
<tr>
<td>3</td>
<td>CPR</td>
<td>STANDARD</td>
<td>E.E.</td>
<td>STANDARD</td>
</tr>
<tr>
<td>4</td>
<td>E.E.</td>
<td>STARS</td>
<td>CPR</td>
<td>DELAY</td>
</tr>
<tr>
<td>5</td>
<td>CPR</td>
<td>DELAY</td>
<td>E.E.</td>
<td>STARS</td>
</tr>
<tr>
<td>6</td>
<td>E.E.</td>
<td>STANDARD</td>
<td>CPR</td>
<td>STARS</td>
</tr>
<tr>
<td>7</td>
<td>CPR</td>
<td>STARS</td>
<td>E.E.</td>
<td>STANDARD</td>
</tr>
<tr>
<td>8</td>
<td>E.E.</td>
<td>DELAY</td>
<td>CPR</td>
<td>STANDARD</td>
</tr>
<tr>
<td>9</td>
<td>CPR</td>
<td>STANDARD</td>
<td>E.E.</td>
<td>DELAY</td>
</tr>
</tbody>
</table>
Table 4
Method of Measuring Dependent Variables

<table>
<thead>
<tr>
<th></th>
<th>CPR</th>
<th></th>
<th>Emergency Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>STARS DELAY</td>
<td>STAND.</td>
<td>STARS DELAY STAND.</td>
</tr>
<tr>
<td>Ss</td>
<td>4 2 6</td>
<td>1 5 3</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>8 3</td>
<td>7 2 9</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>9 7</td>
<td>6 4 8</td>
<td></td>
</tr>
</tbody>
</table>
**Figure 1. Flow chart illustrating separate training procedures.**
CHAPTER IV
RESULTS

Total Effectiveness and Efficiency Results

Figures 2 and 3 present a graphic summation of effectiveness and efficiency data for all subjects under the three training conditions. Visual inspection of Figure 2 reveals considerably fewer error responses under the delayed prompting procedure when compared to both the STARS and standard training methods. A readily detectable difference in errors is not apparent when the STARS and standard methods are compared. Efficiency data in the form of a bar graph in Figure 3 readily reveals that the STARS condition involved over twice the training time than either the delay or standard conditions.

This summary data is also presented numerically in Tables 5 and 6. In addition to being subjected to visual inspection these data were further analyzed using the Mann-Whitney U test, a nonparametric statistical procedure. Calculation of the U statistic was accomplished by employing the procedure described by Ferguson (1966). Results indicated that the difference in error response between the delay and STARS procedures was significant at the .05 percent level for a one-tailed test. Similarly, the difference
in error responses between the delay condition and standard training was also significant at the .05 per cent level for a one-tailed test. No statistically significant difference in error responses were obtained between the STARS and standard methods.

Efficiency data (time in minutes) when subjected to the same statistical procedure revealed that the delay technique resulted in significantly less training time than the STARS condition. No significant differences in training time were obtained between the standard and delay conditions nor between the STARS and standard procedures.

Although no statistically significant differences were observed between the STARS and standard conditions visual inspection of Figure 3 reveals a very clear superiority of the standard procedure over STARS training. It seems that because of the small number of observations extremely large differences must be obtained to attain statistical significance. This phenomenon may also apply when the emergency evaluation or the CPR tasks are considered separately (Figures 4 and 5). While clear visual differences are present in effectiveness and efficiency none of these differences reach significance because the number of observations have been reduced. Despite this, inspection of Figures 4 and 5 again reveals the superiority of the delay method when comparing error responses, although the differences are not as pronounced.
Figure 6 also reveals a similar pattern, when total time to criterion is considered separately for the emergency evaluation and CPR procedures differences are not as pronounced. The STARS condition remains the most inefficient.

Table 7 contains information regarding the number of training trials required to achieve criterion under the three training conditions. The difference between the STARS and delay procedures is virtually nonexistent when only the average number of trials to criterion are considered. The standard procedure resulted in almost twice the average number of training trials although this difference is statistically nonsignificant. This information would thus indicate that differences in total error responses are the result of the number of errors contained in the training trials rather than the result of the number of trials and that previously discussed differences in efficiency data between the STARS and delay conditions are due to something else rather than the number of training trials.

Reliability Estimates

As stated reliability estimates were conducted for one-third of the experimental subjects so that all training conditions were represented once. Reliability estimates for error responses were 96% and for training time (to the nearest minute) 100%. Observer ratings were conducted independently but using identical rating sheets.
Individual Effectiveness and Efficiency Results

Figures 7 to 12 provide graphic information on the individual performance of all experimental subjects. It is apparent that individual students display considerable variation in error responses. For example, three students (S-5 under STARS training; S-3, S-7 under standard training) all emitted a substantial number of errors when compared to other students under the same training conditions. It is interesting to note that all of these students displayed this relatively poor performance when faced with learning the emergency evaluation task and that none were being trained under the delay procedure. At the same time a number of students displayed characteristically low error rates regardless of task or training condition (S-1, S-2, and S-8). The speed at which students approached the tasks appeared to be relatively uniform with no unusual or unexpected variations (Figure 13).

Another observation that became quickly evident was that the delay procedure was not "errorless." Despite being cautioned repeatedly in number of cases not to respond if they were unsure about the next step and that they would be provided with the prompt in a few seconds, all subjects made "anticipatory" errors (i.e., errors in advance of the prompt) under the delay condition.

A third set of observations concerns the repetition of errors. Some researchers have noted that error responses
tend to be repeated (e.g., Martin & Pear, 1983) but this was not the case here. For example, the error pattern of subject 3 who learned emergency evaluation under the standard training condition is reproduced in Table 8 and is representative of other students' performance. Error responses may appear at a certain step, may disappear on the next trial, only to reappear on a subsequent trial and so on. This pattern tended to appear regardless of task or training condition.

Also interesting was the absence of recency and primacy effects (McConnell, 1982). It has been a common observation that when students are faced with acquiring long sequences of behavior more error responses appear around the middle of the sequence with fewer errors towards the beginning or end of the sequence. In this case errors tended to occur with about equal frequency throughout the sequence.

It was further noted that the vast majority of errors were related to the sequence of steps rather than the topography of individual steps.

As stated previously, a number of investigators have commented on the appearance of emotional or "off task" behavior being associated with the occurrence of error responses. Although no formal or structured observation system was applied to so called emotional behavior, many students responded with a few mild self-deprecating or off
task comments, laughing, or giggling when confronted with their errors.

Finally, all students were asked to respond to a simple consumer satisfaction questionnaire (Appendix B) after achieving criterion. These results are presented graphically in Figure 14 (individual data Figure 15). Although differences in student ratings would not be statistically significant it appears that they were equally inclined to the delay and standard methods with the STARS condition receiving the lowest rating.
TABLE 5
Total (T) Means (M) and Standard Deviation (SD)
for Error Responses for all Training
Conditions and Tasks

<table>
<thead>
<tr>
<th>STARS</th>
<th>Delay</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-4, EE (12)</td>
<td>S-2, EE (1)</td>
<td>S-6, EE (11)</td>
</tr>
<tr>
<td>S-1, EE (6)</td>
<td>S-8, EE (4)</td>
<td>S-3, EE (39)</td>
</tr>
<tr>
<td>S-5, EE (33)</td>
<td>S-9, EE (6)</td>
<td>S-7, EE (27)</td>
</tr>
<tr>
<td>S-1, CPR (0)</td>
<td>S-5, CPR (4)</td>
<td>S-3, CPR (7)</td>
</tr>
<tr>
<td>S-7, CPR (8)</td>
<td>S-2, CPR (3)</td>
<td>S-9, CPR (5)</td>
</tr>
<tr>
<td>S-6, CPR (15)</td>
<td>S-4, CPR (2)</td>
<td>S-8, CPR (3)</td>
</tr>
<tr>
<td>T    74</td>
<td>20</td>
<td>92</td>
</tr>
<tr>
<td>M    12.3</td>
<td>3.3</td>
<td>15.3</td>
</tr>
<tr>
<td>SD   11.36</td>
<td>1.76</td>
<td>14.45</td>
</tr>
</tbody>
</table>

*S-subject (see Table 4), EE-emergency evaluation task, CPR - cardiopulmonary resuscitation task.
TABLE 6
Total (T) Means (M) and Standard Deviation (SD) for Time to Criterion (Minutes) for all Training Conditions and Tasks

<table>
<thead>
<tr>
<th>STARS</th>
<th>Delay</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-4, EE (14)</td>
<td>S-2, EE (4)</td>
<td>S-6, EE (6)</td>
</tr>
<tr>
<td>S-1, EE (7)</td>
<td>S-8, EE (6)</td>
<td>S-3, EE (9)</td>
</tr>
<tr>
<td>S-5, EE (34)</td>
<td>S-9, EE (8)</td>
<td>S-7, EE (11)</td>
</tr>
<tr>
<td>S-1, CPR (2)</td>
<td>S-5, CPR (6)</td>
<td>S-3, CPR (5)</td>
</tr>
<tr>
<td>S-7, CPR (11)</td>
<td>S-2, CPR (5)</td>
<td>S-9, CPR (4)</td>
</tr>
<tr>
<td>S-6, CPR (11)</td>
<td>S-4, CPR (4)</td>
<td>S-8, CPR (3)</td>
</tr>
<tr>
<td>T</td>
<td>79</td>
<td>29</td>
</tr>
<tr>
<td>M</td>
<td>13.2</td>
<td>4.8</td>
</tr>
<tr>
<td>SD</td>
<td>6.59</td>
<td>4.99</td>
</tr>
</tbody>
</table>

*S-subject (see Table 4), EE-emergency evaluation task, CPR-cardiopulmonary resuscitation task.
### TABLE 7
Trials to Criterion for All Training Conditions

<table>
<thead>
<tr>
<th>STARS</th>
<th>Delay</th>
<th>Standard</th>
</tr>
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<tr>
<td>S-4, EE (2)</td>
<td>S-2, EE (1)</td>
<td>S-6, EE (4)</td>
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<td>S-8, EE (3)</td>
<td>S-3, EE (8)</td>
</tr>
<tr>
<td>S-5, EE (8)</td>
<td>S-9, EE (3)</td>
<td>S-7, EE (9)</td>
</tr>
<tr>
<td>S-1, CPR (0)</td>
<td>S-5, CPR (3)</td>
<td>S-3, CPR (3)</td>
</tr>
<tr>
<td>S-7, CPR (2)</td>
<td>S-2, CPR (3)</td>
<td>S-9, CPR (2)</td>
</tr>
<tr>
<td>S-6, CPR (2)</td>
<td>S-4, CPR (1)</td>
<td>S-8, CPR (1)</td>
</tr>
<tr>
<td><strong>T</strong></td>
<td>15</td>
<td>14</td>
</tr>
<tr>
<td><strong>M</strong></td>
<td>2.5</td>
<td>2.3</td>
</tr>
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</table>
## TABLE 8
Error Pattern of S-3 Learning Emergency Evaluation Under Standard Training

<table>
<thead>
<tr>
<th>Step</th>
<th>Trails</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 2 3 4 5 6 7 8 9</td>
</tr>
<tr>
<td>1</td>
<td>X X</td>
</tr>
<tr>
<td>2</td>
<td>X X</td>
</tr>
<tr>
<td>3</td>
<td>X X X</td>
</tr>
<tr>
<td>4</td>
<td>X X X</td>
</tr>
<tr>
<td>5</td>
<td>X X X X</td>
</tr>
<tr>
<td>6</td>
<td>X X X X X</td>
</tr>
<tr>
<td>7</td>
<td>X X X X</td>
</tr>
<tr>
<td>8</td>
<td>X X X X</td>
</tr>
<tr>
<td>9</td>
<td>X X X X</td>
</tr>
<tr>
<td>10</td>
<td>X X X X</td>
</tr>
<tr>
<td>11</td>
<td>X X X X</td>
</tr>
<tr>
<td>12</td>
<td>X X</td>
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<tr>
<td>13</td>
<td>X X X</td>
</tr>
<tr>
<td>14</td>
<td>X X</td>
</tr>
</tbody>
</table>
Figure 2. Summation of error responses for all subjects under three training conditions.
Figure 3. Summation of training time to achieve criterion for subjects under three training conditions.
Figure 4. Summation of error responses for all subjects learning emergency evaluation only under all three training conditions.
Figure 5. Summation of error responses for all subjects learning CPR only under all three training conditions.
Figure 6. Summation of training time to achieve criterion for all subjects under three training conditions and both tasks.
Figure 7. Error responses for three subjects under three training conditions.
Figure 8. Error responses for three subjects under three training conditions.
Figure 9. Error responses for three subjects under three training conditions.
Figure 10. Error responses for three subjects under three training conditions.
Figure 11. Error responses for three subjects under three training conditions.
Figure 12. Error responses for three subjects under three training conditions.
Figure 13. Individual training time to achieve criterion for all subjects under three training conditions and both tasks.
Figure 14. Average student ratings of training conditions.
Figure 15. Individual student ratings of training conditions.
Total Effectiveness and Efficiency Data

The purpose of this study was to compare the effectiveness and efficiency of three training strategies. The STARS and delayed prompting procedures have only recently appeared in the behavioral literature and have not previously been subjected to comparative analyses or replications. Although both of the chained response tasks that were examined were taught to criterion under all three procedures, clear differences in effectiveness and efficiency emerged.

The data presented graphically in Figure 3 (p. 49), Figure 6 (p. 52), and Figure 13 (p. 59) can be used to answer the efficiency question. Based on the data in Figure 3 the overall inferiority of the STARS condition (when the two tasks are combined) is clear. No outstanding visible difference was observed between the delay and standard conditions when the data was combined in this manner. This graphic information was strengthened by the results of a nonparametric test indicating a statistically significant difference between the STARS and delay procedure. No
statistically significant differences were found between the STARS and standard procedure or between the standard and delay procedures. Overall, the time delay condition required 50 minutes less time than the STARS condition and nine minutes less time than standard training. Under time delay subjects spent an average time of 4.8 minutes to achieve criterion, 6.3 minutes under standard training, and 13.2 minutes under the STARS condition.

Graphic presentations of differences in error response rates are presented in Figure 2 (p. 48), Figure 4 (p. 50), and Figure 5 (p. 51). These data reveal the time delay procedure to be most effective in preventing errors. This advantage is revealed in a most pronounced fashion when the error rates for both tasks are combined (Figure 2). The superiority of the time delay is somewhat less pronounced when the two chained response tasks are considered separately (Figures 4 and 5). Again this data was subjected to statistical analysis using the Mann-Whitney U test and as stated this revealed a statistically significant advantage of time delay over both STARS and standard training. No statistically significant differences in error response rates emerged between the STARS and standard procedures.

Overall, time delay resulted in only 20 errors in total for all subjects trained under the condition. Total errors under STARS were 74 and 92 under standard training. These totals resulted in mean error rates of only 3.3 for time
delay, 12.3 for STARS and 15.3 for standard training. In addition, individual variability under time delay was much less than under either STARS or standard training (Table 5, p. 44).

Reason for Significant Overall Differences in Effectiveness and Efficiency

As stated previously, a different interpretation of the data is possible when trials to criterion are considered (Table 7, p. 46). Here standard training is shown as clearly inferior requiring 27 training trials in total for all subjects exposed to this procedure. On the other hand, the total number of training trials under STARS and time delay are remarkably similar requiring 15 and 14 trials respectively. Although the standard procedure resulted in almost twice the average number of training trials than either of the two other training conditions, this difference is still statistically nonsignificant. Again, this phenomenon is related to small total number of observations involved. The information contained in Table 7 is related in a somewhat usual way to the information previously provided on error response rates and time to attain criterion. It seems that more errors are contained within the individual trials under the STARS condition than under the time delay condition (resulting in a significant difference) but the total number of training trials remained the same. Also, it seems that the significant differences
in time are related to the fact that the independent remedial practice routines are time consuming without providing any clear advantages in effectiveness or efficiency. Similarly, the modeling procedure employed under both STARS and standard training may also be wasteful. Modeling involves the trainer demonstrating the task sequence while the student passively observes. This takes time but does not provide any clear advantages in learning. The time delay procedure starts with "hands on" experience by the student immediately at the 0 delay level with much more positive results in terms of attaining criterion.

Although the sample of subjects and tasks were small these data make a strong argument for the employment of delayed prompting in the instructional strategies provided for normal learners faced with acquiring long, chained behavior sequences. These findings were readily revealed within the context of a parallel treatments design that controlled for threats to internal validity. Overall the delay procedure was superior both with regard to effectiveness and efficiency. If the alternative training procedures introduced here had resulted in differences in only time or only in error rates judgment of superiority would have been more difficult.

A closer examination of Figure 1 (p. 37) will help to more clearly understand the reasons for the differences in
instructional time under the three training conditions. I have already discussed the time advantages involved in eliminating the traditional modeling procedure found under the STARS and standard conditions. Unfortunately there are still further disadvantages associated with the modeling component of STARS training. After waiting for the student to perform the entire sequence, the trainer provides delayed feedback in the form of the index cards indicating the missed steps. Not only must the instructor take time to sort and explain the cards to the student, he must also prepare this additional prompt material ahead of time. Using the cards, students must practice the independent remedial routine three times before repeating the entire skill sequence for the instructor. If the entire skill sequence is not performed correctly on subsequent trials by the student, the remedial routine must be repeated for any missed steps until criterion is attained. This study could find no support for the effectiveness or efficiency of these training components.

The standard training condition employed here avoided some of the components described under STARS with no important disadvantages. While the initial modeling component remained the same, students received immediate feedback about their errors and were not required to perform remedial routines or use additional prompt materials. While standard training did not display the advantages of the
delay technique it compared favorably with the STARS system on final results.

As stated, time delay completely avoids not only initial modeling while the student passively observes, it also avoids postguidance or feedback or knowledge of results on the basis of error responses. Rather, time delay is a preguidance technique where a delay between the performance of the last step and the next step in a sequence signals that a verbal prompt should be provided to the student. Training trials are conducted on the basis of "learner controlled fading" or "errorless fading."

As cautioned by previous researchers (e.g., Martin & Pear, 1983) valuable training time is not lost correcting errors. It will be recalled under the time delay procedure used each student received two initial training trials at the "0 second" level. Perhaps even more training time could have been eliminated if only one "0 second trial" had been offered but this is a question requiring further experimental manipulation.

While the trainer who uses the time delay technique may have a clear rule about when to prevent errors (i.e., a delay of 3 seconds or more), and can more exactly gauge the moment of transfer of stimulus control from prompt to naturally occurring task related stimuli, it was interesting to note that generally this technique is not error free. Despite repeated warnings to students about not proceeding
to the next step of a task unless they were sure of its correctness, most students made "anticipatory errors."

While these errors were indeed few in number compared to the results of the other training conditions, similar observations have been made by other experimenters (e.g., McDonnell, 1987) who examined response sequences performed by retarded adult learners in restaurant and store settings. On the other hand, Bradley-Johnson, Johnson, and Sunderman (1983) reported that their subjects (young children) sat quietly waiting for the prompt while learning a discrete response task.

Individual Efficiency and Effectiveness Data

When individual error response data were considered a number of unexpected peculiarities became evident. First, some researchers have suggested that errors tend to be repeated (e.g., Martin & Pear, 1983) but this did not appear to be the case here. For example, the error response pattern of S-3 was previously described (Table 8, p. 47) as being representative of a number of other subjects. An error response may appear at a certain step in the task sequence during one trial, it may disappear on the next trial, only to reappear on a subsequent trial and so on. This pattern could appear regardless of task or training condition. As stated, behavior analysts have considered sequenced tasks to represent chains of smaller responses or
steps, each associated with a unique stimulus condition which functions in two ways: as a discriminative stimulus, setting the occasion for the subsequent response and as a conditional reinforcer for the previous response. The appearance - disappearance - appearance of error responses within chained response tasks such as emergency evaluation and CPR becomes somewhat difficult to explain using this model.

Also surprising was the absence of "recency" or "primacy" effects as individual subjects performed the tasks. A common phenomenon that has been reported in the literature on memory has been that when subjects are required to recall a list, the first few or last few segments are better recalled than those segments in the middle (e.g., see McConnell, 1983). This phenomenon could not be detected in the present study and also appear difficult to explain using various models of short term memory that have been proposed. Error responses tended to occur as much in the middle as toward the beginning or end of a sequence.

It was further noted that when error responses did occur they were almost unvariably related to the sequence of the steps within the task rather than its topography. This is perhaps not surprising considering the fact that each individual steps does not require any particular proficiency in fine or gross motor coordination.
As mentioned previously a number of investigators have commented on the appearance of "emotional," "agitated," or "off-task behavior" when individuals commit errors. While no formal or structured observation system was applied to these types of behavior there were frequent incidents when students would exhibit laughing, giggling, or mild self-deprecating remarks. However, these types of behaviors could not appropriately be labelled as "agitated" "frustrated" or "disturbed" nor did such off-task behavior seriously interfere with the completion of the task sequences. While normal subjects would not be expected to display pleasurable responses when confronted with errors, it seems that handicapped learners might be more prone to display frustrated or agitated behaviors in the presence of frequent errors. It was in fact handicapped learners who served as subjects in those experiments who commented on the appearance of negative behaviors (e.g., Carr & Durand, 1985).

All students were also asked to respond to a simple consumer satisfaction questionnaire (appendix B) after achieving criterion on their assigned tasks. These results (Figure 14, p. 60) show that overall the STARS condition received the lowest rating while time delay and standard training were rated equally. These results did not attain statistical significance and in fact there appeared to be little variation in individual preferences (Figure 15,
Again these findings are difficult to interpret. It would be logical to expect that a training procedure resulting in fewer errors and less time to attain criterion would clearly receive a more positive rating but this was not always the case. It is possible that some subjects were very focused on the demands of the tasks and had little opportunity to consider their preferred training method.

Behavior analysts have derived considerable information through a closer examination of the single case and this was also one of the purposes of this study. Individual data is presented numerically in Table 5 (p. 44), Table 6 (p. 45), in Table 7 (p. 46), and in Figure 13 (p. 59). Individual data was presented graphically in Figures 7 to 12 (page 53 to 58). Examination of the numerical data in Tables 5 and 6 clearly indicates that for six out of the nine students, the emergency evaluation task was the more difficult to learn regardless of the training condition, nevertheless very poor performance relative to other students was only displayed under the STARS and standard procedure and not under the delay condition. One possibility is that the delay procedure somehow renders a task (particularly difficult) easier. However, it is also noteworthy that if the data provided by the very poor performers were eliminated and averages recalculated the superiority of the delay condition still remains although the differences would not have attained statistical significance.
Another observation that stands out is the limited variability of student performance under time delay (i.e., error response rates range from one to six). This is in marked contrast to the STARS and standard conditions where error rates ranged from zero to 33 and three to 39 respectively. This phenomenon appears to be related to the low error rates produced by time delay generally providing less opportunity for variability in the data.

Comments on the System for Training and Assessing Resuscitation Skills (STARS)

I have already discussed the generally disappointing results produced under the STARS condition but at this point it may be appropriate to examine somewhat more closely the reasons for these results within the framework of operant conditioning theory. First, Seaman, Green, and Watson-Perzel (1986) the developers of the STARS training system should be recognized as having made an important contribution in the sense of applying a comprehensive task analysis to CPR. Applied behavior analysts not only regard a task analysis as a means of assessing learner performance objectively, accurately, and efficiently but also regard it as an effective training tool (Martin & Pear, 1983; Cooper, Heron, & Heward, 1987). On the basis of the results obtained in this study it is suggested that Seaman et al.
(1986) accomplished the first objective but fell short in achieving the second. Providing learners with individual index cards containing the inaccurately performed steps and having them perform an independent remedial practice routine using the discrete steps printed on the cards did not improve the rate of learning. It was also a very time consuming procedure. As stated, time delay produced superior results and the STARS procedure was no more effective and less efficient than standard training. A closer examination of subjects trained under the STARS condition also reveals that despite the remedial practice routine of the missed steps these same errors tended to be repeated when subjects were asked to perform the entire sequence. This phenomenon occurred for four out of the five subjects trained under STARS. In fact, for one of the subject despite six remedial practice routines the same error reappeared six times. On the basis of these results, it is possible to suggest that when "clusters" of missed steps are taken out of the total chained response task and practiced independently, the stimulus control and positive reinforcement principles (associated with chaining) are interfered with and the acquisition of new behavior is not promoted.

Another pronounced aspect of the STARS condition was postponed feedback or knowledge of results. Students were not informed of their errors until the entire task sequence
was completed. There is considerable evidence in the behavioral literature that immediate feedback is more effective (Martin and Pear, 1983).

At the same time the emphasis under STARS is error correction or postguidance rather than the "errorless" or preguidance condition as provided under time delay. I have previously commented on the potential disadvantages associated with having learners commit too many errors.

Other components associated with STARS are also of questionable value. There was no evidence that modeling was a necessary procedure with this learning context but can use a considerable amount of instructional time. Finally, the preparation of extra instructional materials or prompts (i.e., the cards) is also time consuming and appeared to be of no instructional value beyond allowing objective assessment by the instructor.

Comment on Standard Training

As stated, the standard training method employed here appears to be fairly representative of a traditional instructional approach. The trainer models the behavior, the student performs and receives feedback as he goes along, and finally is asked to perform the entire sequence again. With the exception of three components (i.e., the additional prompt materials in the form of index cards, the remedial routine, and delayed postguidance) standard training
involves the same modeling and error correction procedures as does STARS training. Time delay on the other hand eliminated modeling while the subject observes, additional prompt material, and for the most part error correction.

The Present State of First Aid and CPR Training

Every year countless man-hours are devoted to the training and retraining of first aid and CPR skills. This training has become an essential requirement for employees in many and varied work settings. A small national industry of certified individuals and instructional associations has grown around the training of these skills. Despite these efforts it has been estimated that many health professionals have extremely poor skills in this area (American Heart Association, 1986). During the past 15 years a significant portion of the adult population has been trained in CPR and first aid. In some areas more than one-third of the adult nonmedical population has some information or training in these skills. Most cardiac and other accidental fatalities occur outside the hospital but still in the majority of cases CPR or other emergency procedures continue to be initiated by health professionals. It is further estimated that lay individuals do not become involved in performing these skills when necessary for reasons such as fear of doing harm, inability to remember exact sequences, and poor retention of psychomotor skills. Educationally it must be
recognized that these emergency procedures are complex skills and instructional strategies must take this into account.

I have already made reference to previous research indicating that first aid and CPR skills are not well retained among lay individuals or even among medical personnel. In fact, this problem appears to have been a major impetus for the alternative STARS instructional strategy developed by Seaman et al. (1986). As stated, a salient feature of this behavioral approach was the attempt to develop an effective, clear and comprehensive task analysis to serve as an assessment protocol for rating students' performance. However, it is clear from an examination of recent first aid and CPR instructional manuals produced by various organizations that task analysis (i.e., breaking a complex skill into teachable, smaller responses) was already an important element in attempting to train these skills (American Heart Association, 1986; Ontario Heart Foundation, 1982).

Although task analyses may vary in usefulness, the purpose of this investigation was not to determine the quality of alternative task analyses since the same breakdown of skills was employed under all training conditions. As previous researchers have already suggested (e.g., Martin & Pear, 1983) effective task analyses contain individual components simple enough to be learned without
great difficulty, and secondly, each component should be followed by a clear set of stimuli signaling its completion. Spooner, Spooner, and Ulicny (1986) have also discussed the importance of organizing a task analysis on the basis of functional clusters. For example, in a vocational chained response task that requires a learner to put on and tighten a nut. The steps of picking up the nut, orienting it to the bolt, and threading the nut may be combined into only one functional cluster. This allows more than one step to be taught at a time. Thus, the identification and development of effective task analyses involves more than a single chopping up of a chained response task into smaller steps and may be dependent on the subjective judgment of the trainer. Cooper et al. (1987) have elaborated on a number of other processes that may be involved in constructing and validating a task analysis. Due to the unique, individual behavioral characteristics (e.g., motor, physical, language repertoires) some steps may be made more difficult for some learners than others. Secondly, extensive observations of already competent individuals performing the desired skill sequence could be made. Finally, a systematic trial-and-error procedure can assist the behavior analyst in producing a functional and appropriate task analysis. An examination of most instructional manuals would seem to indicate that while task analysis is recognized as being important little attention
has been given to the more precise parameters surrounding this procedure.

Other important components of an effective training strategy besides task analysis are virtually ignored in available instructional manuals (see Appendix E for examples of comments on existing instructional procedures). Those areas which receive very little if any attention would include various forward or backward chaining methods, various prompting strategies such as "least to most" or "most to least," the nature of positive reinforcement (e.g., symbolic or material rewards), error correction procedures, types of modeling, length of training sessions, so called cognitive-behavioral strategies such as self-talk or pneumonics, overlearning, retention time, and generalization. All of these procedures and many others have already received considerable scrutiny in the learning literature but have most often been applied to handicapped learners or students paced with acquiring academic skills and certainly have not found their way into standard instructional practices for emergency medical procedures. There are a number of reasons for this. First, there has simply been very little experimental demonstration that these more arcane procedures contain any benefit for the type of students who are exposed to CPR or first aid training. Second, while many certified, CPR or first aid instructors may have been exposed to various forms of
medical education, few have extensive familiarity with learning theory. Third, procedures such as time delay, backward or forward chaining may appear difficult to understand or at least unwieldy and cumbersome to apply within this context.

Besides research evidence that students have difficulty both applying and retaining CPR and certain first aid procedures a number of other instructional problems have been noted. For example, in the process of preparing for this research I received a considerable number of anecdotal reports from certified instructors that CPR and first aid courses have limited inherent interest value for students. In other words, these skills are often boring to learn and boring to teach because of the emphasis on demonstrating the rote performance of long, inherently uninteresting response sequences. There is little opportunity to deviate from prescribed sequences. Researchers in the area of instructional design have long recognized this problem in relation to certain academic subjects and have proposed alternative, more interesting training strategies (e.g., see Gagne, 1979) for example, the use of games or contests in this area might prove beneficial for the acquisition and retention of these skills.

A second set of problems may revolve around the issue of what Mallott (1981) has referred to as "weak outcomes." A student of CPR or first aid may spend years before having to
perform such skills in a real life situation; or, more commonly the opportunity may never appear. In the face of such weak consequences it is not difficult to understand why students lack interest in acquiring and maintaining these skills.

A further problem area is related to the concept of generalization. If students were ever to be faced with an emergency medical care situation, such unexpected "real-life" predicaments may present a set of untrained stimuli where more than rote performance is required. Only a few researchers have commented on this difficult problem (Horner, Bellamy, & Calvin, 1984; Nielupski, Hamie-Nielupski, Clancy, & Veerhisen, 1986). This may suggest to some alternative training strategies were more general theoretical principles are taught and more improvisation is expected when former students are faced with a real emergency.

Another set of problems concerns the nature of the modeling or demonstration component of instruction. The present investigation demonstrated that instructor modeling while the student passively observes did not produce any gains in learning. Nevertheless, recent instructional manuals appear to have given some consideration to this part of the instructional strategy (e.g., Canadian Heart Foundation, 1987) by incorporating a variety of modeling methods. Usually this will involve a multimedia approach
including demonstration by the instructor, demonstrations as provided by various workbooks, and demonstration by videotaped models or other audiovisual material. Again very little if any research has been applied to this specific component of teaching chained response tasks. First studied in a systematic fashion by Bandura (1969), modeling techniques have since undergone considerable modification and development depending on the nature of the behavior problem (e.g., see Kanfer & Goldstein, 1986).

The experimental subjects used in this study were high school students with a mean age of 15. As stated, previous first aid or CPR instruction precluded participation in this experiment. It was found that a number of students did in fact have to be excluded since many students are required to have such courses as a prerequisite for participation in certain activities. At this point it has not been determined whether age or even other idiosyncrasies of learners will interact with the nature of instructional strategy when learning a complex, chained response sequence. For example, a group at the other end of the age spectrum, senior citizens might also benefit from this type of instruction. Senior citizens would appear to be high risk individuals but are usually ignored by various teaching organizations.

The personal idiosyncrasies of instructors is another unexamined element within this learning context. A host of personal characteristics such as sense of humor, interest,
efficiency, competency have all been examined by educational psychologists with mixed results (Gagne, 1979). Possibly interesting relationships might be uncovered as they apply to teaching of long skill sequences.

The study provided findings that indicate that a seldom used instructional technique, time delay could be used to advantage. Nevertheless, this technique must be incorporated into a total training strategy carefully considering the other factors discussed in this section.

Limitations of the Present Investigation

Although the present results indicate that time delay can produce significant advantages in effectiveness and efficiency in teaching chained response tasks to normal learners some possible limitations should be made explicit.

As discussed in the previous section the type of prompting technique is only one factor among many others in determining the quality of a total instructional strategy. Therefore, it is certainly possible that the other instructional factors involved in this experiment could have interacted with the time delay technique in unexpected ways. For example, we have already referred to a previous experiment (Walls, Dawler, Haught, & Zawlocki, 1984) who reported that the effectiveness of their progressive time delay technique appeared only when a whole task rather than a forward chaining procedure was used. Similarly, other
components of the instructional approach may also interact with the effectiveness of time delay (e.g., the quality of the task analysis, error correction procedure, length of the training sessions, nature of the task, number of successive trials to demonstrate criterion performance, and length of the delay period). It is readily apparent that if such interactions did exist that the generalizability of the present findings would be limited until further experimentation was completed.

Other more subtle interrelationships may also exist. For example, the nature of time delay may affect the relationship between trainer and student by somehow making the interaction more pleasant considering the reduction in error responses at the beginning of the training sessions. There is some evidence from other areas where behavioral techniques have been applied, that the relationship between instructor and learner is an important variable (Kanfer & Goldstein, 1986).

A somewhat related idea concerns the level of anxiety provoked under the various training conditions. For example, a student who observes the instructor perform a long chained response sequence knowing he will be required to demonstrate it at some point in a correct manner may become fearful of possible embarrassment. This may be distracting and interfere with learning. This might be prevented under the delay technique since the student is
immediately prompted at a 0 delay level while he gains "hands on" experience. Further, most embarrassing errors are prevented during later training trials when only a slight delay by the student signals the trainer to provide a prompt.

This study was focused on trials and time required to achieve criterion not with long term or post-training observations. Previous investigations have used many different definitions of "long term" follow-up after applying various training strategies. At present little if anything is known about whether time delay would make any difference on long term performance. A similar question could be raised about the effects of time delay on the generalizability of these skills. Would the nature of an instructional condition like time delay, allow students to respond more effectively to new stimulus situations? Some reviewers of the time delay technique (e.g., Handen & Zane, 1987) have suggested that it might and this will be discussed in a subsequent section.

Finally, as mentioned previously subjects in this study were normal adolescents. The effects of time delay while training on long sequenced task should also be examined on young children and adults.

It should also be emphasized that the commonly used alternating treatment design used in behavioral research is well suited for "reversible" behavior. It is not well
suited for comparing the effects of antecedent instructional procedures on nonreversible behaviors. The parallel treatment design presented here involving the counterbalancing of tasks and training conditions was used for this specific purpose. To increase confidence in the generalizability of the results two topographically different chained response tasks were selected which originally appeared to be of equal difficulty. As already discussed, one task (emergency evaluation) appeared to be somewhat more difficult to learn than CPR making interpretation of findings somewhat more difficult. Nevertheless, this particular threat to internal validity was controlled for within the present design but needs to be examined more directly within other experimental contexts.

Advantages and Implications of Delayed Prompting

Even with only two separate chained response tasks, and usually of only about one minutes duration each, significant savings in time were obtained. These tasks represent only a small portion of the skill sequences required in a comprehensive CPR or first aid course. If similar advantages could be obtained on other related tasks the overall effect would be considerable. Also, if such effects could be replicated and extended, the teaching of other important medical procedures with chained responses sequences might be effected (e.g., defibrillation,
catheterization, intravenous procedures, glucose procedures, and suctioning procedures). The potential benefits of the time delay procedure are obvious; it does not require the construction or modification of additional prompt material, often the exact moment of transfer from the instructor's prompt to naturally occurring task stimuli can be determined so valuable training time is not spent correcting errors, time is not spent training steps the student already knows, and the procedure is fairly easy to understand. While considerable attention has been given to handicapped learners typically faced with acquiring vocational assembly tasks little attention has been paid to professional and/or technical activities. Many such skills may be acquired over a period of years and more efficient training procedures are warranted. Many other medical/nursing procedures, chemical, or even engineering activities involve chained response sequences. Some might argue that the quality or nature of professional/technical activities are different and successful performance is more dependent on the correct theoretical viewpoint. Despite this argument it might be admitted that the successful rote performance of certain professional activities is still an essential part of the educational process.

A survey of the research literature did not reveal any investigation of self-directed delayed prompting. For example, a self-study program might be devised where the
student would be directed to wait only for a certain period of time and then look for the correct answer before proceeding with the next part of the task. This approach would be expected to be more efficient than allowing large a number of anticipatory errors. Such instructional strategies might also be incorporated into computer assisted or automated learning systems where prompts are delivered according to a constant or progressive time delay schedule. As stated, in this investigation a constant rather than progressive time delay procedure was employed since in a nonautomated instructional setting a progressive procedure would be too cumbersome for an instructor to apply. On the other hand, a computer could easily provide graphic or oral prompts on a progressive schedule.

As well as applied instruction, computer technology also suggests many more elaborate research designs without the possibility of contamination of interaction from other variables which are difficult to control for when human instructors are involved. For example, computer programs with graphic capabilities could be employed to construct maxi-type learning problems which represent a form of chained response tasks. However, with the very rapid advances in graphic technology more sophisticated sequenced tasks are also possible.

This study has focused exclusively on the acquisition of technical or impersonal skills as has most of the delayed
prompting literature with a few important exceptions. For example, Charlop, Schreibman, & Thibodeau (1985) employed time delay in increasing the verbalization of autistic children when requesting food items. Rather than having food bearers provide food at meal times without request they were instructed to wait a period of time in an effort to have the child verbalize a request without assistance. The strategy proved to be effective and suggests many other applications to interpersonal relations. For example, Goldstein (1986) has written extensively on helping the adolescent acquire various social skills in a step by step manner but has not considered the possibilities of the time delay technique.

Understanding the Delayed Prompting Procedure

Touchette and Howard (1984) have recently suggested that the transfer of stimulus control is provoked whenever task related stimuli are reliably followed by prompts and that further practical applications need not await a complete functional analysis. Nevertheless, further research in this area should ideally be "theory driven" and in this section I will attempt to examine what makes delayed prompting work and what if any contribution this study has made to this understanding.

The results from this investigation demonstrated that students exposed to a time delay strategy can learn long
chained response tasks more quickly and with fewer errors. These results based on normal learners, are consistent with two previous investigations (McDonnell, 1987; Walls, Dowler, Haught, & Zawlocki, 1984) which also demonstrated the superiority of the delay technique with handicapped learners.

McDonnell (1987) focused on purchasing skills of severely handicapped students in convenience stores and fast food restaurants. He points out that the superiority of the time delay technique is obviously related to the nature of the other experimental conditions to which it is being compared. In the case of his experiment time delay was compared to an increasing prompt strategy and as McDonnell points out if it has been compared to a decreasing prompt strategy different results might have been obtained. McDonnell also suggests the possibility that the differential effects between time delay and his increasing prompt strategy may have resulted from the difference in the point of application of feedback (i.e., delayed prompting at the 0 delay level represents preguidance error prevention) and increasing prompt instruction represents postguidance (error correction). In other words, the delay period itself is not critical, rather it is the antecedent nature of the instructor's guidance that is crucial.

Similar explanations are possible for the results obtained in the Walls et al. (1984) experiment. In this
case a series of vocational assembly tasks were examined and the delay technique was compared to a standard error correction procedure. Here the superiority of the delay technique did not appear unless it was offered in a whole task procedure rather than a forward chaining procedure (see Chapter 2, p. 10).

While the present research strengthens the case for time delay, the primary caution is that comparative analyses are conducted within the context of other instructional strategies which may add to or detract from the specific strategy under investigation and it is clear that additional research is needed to develop further guidelines.

So far behavior analysts have agreed that just a few essential principles are essential in understanding the acquisition, maintenance, and decrease of behavior. These include positive and negative reinforcement punishment, stimulus control, respondent conditioning, and imitative learning. A host of procedural variables have been derived from these principles and applied to unique settings and learners. It may be beneficial to ask which behavioral principles account for the efficiency and effectiveness of delayed prompting. In addition, it may also be useful to examine what principles the delayed method does not include. Handen and Zane (1987) in their comprehensive review have already discussed in detail variations in the parameters of the delay procedure. Parameters such as a
standard or progressive delay, length of the delay, error correction procedures, and mastery criteria have been applied in various ways and with mixed results. This review however focused for the most part on experiments concerned with the acquisition of discrete skills among handicapped learners but they were not able to list published reports on the acquisition of chained response tasks among normal learners.

I have already discussed the fact that modeling by the instructor, while the student passively observes his performance, produced no gains in time to acquisition. Therefore, the principle of imitative behavior does not seem to play a part in learning under the delay condition.

It was also observed that repeated practice of isolated "clusters" of the total chain under STARS produced no advantages. This appears to make sense from a stimulus control viewpoint where each link in the chain is seen to function as a discriminative stimulus setting the occasion for the subsequent response, and second, as a conditioned reinforcer for the previous response. Under the remedial practice routine of STARS it seems that these linkages within the total chain are interfered with and a considerable amount of time is lost. This did not happen under time delay where the total chain was kept intact with effective prompts.
Although stimulus control is an important principle within the time delay procedure, there is some question as to where exactly the transfer of stimulus control occurs. For example, Handen and Zane (1987) review a number of studies where subjects were observed to make correct anticipatory responses in the first training trial involving a delayed prompt. Since each of these experiments began with a number of trials of simultaneously presented task stimulus and prompt ("0 delay") suggested that the actual transfer of stimulus control may have occurred during the 0 delay trials. "Therefore, acquisition may occur during simultaneous presentation with the delay procedure functioning merely as a probe rather than a teaching procedure" (Handen and Zane, p. 325). This was certainly the case in the present experiment where after two simultaneous trials students performed many of the steps without the delayed prompt. This clearly indicates that stimulus control had already been transferred for many of the steps within the sequence prior to the delay. This in itself would not be particularly interesting phenomenon and seems to revert back to the well established notion proposed by William James that students "learn by doing" (James, 1892).

There is something more to the delay technique since many other steps still had to be prompted after a delay, although this again may represent nothing more than another
form of trial and error learning. For example, Touchette (1971) had described some of his subjects as placing their hands in front of the correct key prior to the onset of the delayed prompt. This may mean that other unmeasured responses (e.g., eye movements, hand placement) had already been transferred to the target stimulus prior to the transfer of the actual or entire response. Such "pre-transfer" or anticipatory partial responses may be reinforced by the prompt. If such partial responses are reinforced in this manner, simple trial and error learning is responsible for the effectiveness of time delay.

The issue of positive reinforcement, however, is further complicated by the results of Touchette and Howard's (1984) investigation examining the possible effects of reinforcement probability on the transfer of stimulus control. Three schedules of reinforcement were used, one involving equal reinforcement probabilities prior to and following the prompt, a second favoring unprompted responses, and a third favoring prompted responses. While error rates remained low across all three schedules somewhat faster transfer of stimulus control and acquisition was observed when reinforcement probability favored anticipated responding.

As Touchette and Howard (1984) have suggested a disparity in reinforcement density is inherent in delayed prompting. Unprompted responses within a chained response
task would lead to reinforcement earlier, instead of waiting for the prompt, the student can make a prior response and be reinforced a lot sooner. The disparity in reinforcement can be quite large when long delays are used. This situation might also be construed as an avoidable time-out paradigm (i.e., negative reinforcement). If contrast in reinforcement density provokes the transfer of stimulus control, the rate of transfer should be sensitive to manipulations of contingencies that alter reinforcement density.

On the other hand, reliable sequential pairing of task stimuli and prompts may be sufficient to provoke a shift in stimulus control and reinforcement could serve only to maintain responding (i.e., respondent or classical conditioning).

At this point there is not enough evidence either way as to what principle is in operation within the delay technique (positive or negative reinforcement, respondent conditioning, punishment stimulus control). Touchette and Howard's (1984) investigation on the effects of positive reinforcement is an important first step but their results are equivocal considering individual variability and small number of subjects. Further manipulation of the other possible elements is needed to more fully understand the delay technique.
At this point it may be useful to offer a tentative model to account for the effectiveness of the delay technique for nonhandicapped learners faced with acquiring a chained response task. During the first phase of delayed prompting which depends on the 0 delay or simultaneous pairing of prompt and task stimulus reinforcement density cannot be a crucial factor. This pairing approximates a Pavlovian paradigm and thus accounts for the transfer of stimulus control from prompts to target stimulus for many of the steps in the sequence. During phase two, when a delay inserted between target stimuli and prompt, respondent conditioning may still play a role but now also reinforcement density becomes important. The insertion of the delay means differences in reinforcement density depending on when the student responds. Also, the unique learning histories and characteristics of individual subjects may interact in unexpected ways with the respondent or operant paradigm. For example, some students may not perform well after being exposed to the respondent paradigm in effect during the first phase of delayed prompting but improve during the second phase when reinforcement density plays a role. It is also conceivable that other students are not affected by the consequences and associational learning predominates. Some support for this notion can be obtained from Touchette and Howard (1984) who found that when the probability of reinforcement was three times as
high for responses following the prompt, students still shifted to responding prior to the prompt.

Such a model is only conjecture with very limited previous experimental support. Meanwhile, the findings presented here seem to contain significant practical implications while delayed prompting technique awaits a more complete functional analysis.
APPENDICES
APPENDIX A

Example of Rating Sheet Used to Judge Student's Performance

Identifying Data: Students' Name:

Age:

School:

Task: Emergency Evaluation Training: "STARS"

<table>
<thead>
<tr>
<th>Step</th>
<th>Trials</th>
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<tbody>
<tr>
<td>1</td>
<td>2 3 4  5  6  7  8</td>
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<tr>
<td>2</td>
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Errors |
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Time |
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Note: "X" indicates error response.
APPENDIX B

Questionnaire Administered to All Subjects After Achieving Criterion on Both Tasks

1. Which method of training made you feel the most comfortable?

Please rate the first method by circling the appropriate number.
(1) very uncomfortable
(2) somewhat comfortable
(3) no reaction either way
(4) comfortable
(5) very comfortable

Please rate the second method by circling the appropriate number.
(1) very uncomfortable
(2) somewhat comfortable
(3) no reaction either way
(4) comfortable
(5) very comfortable

2. Which method of training did you feel was the most effective in teaching you the skill quickly and accurately?

Please rate the second method by circling the appropriate number.
(1) very uncomfortable
(2) somewhat comfortable
(3) no reaction either way
(4) comfortable
(5) very comfortable

Please rate the second method by circling the appropriate number.
(1) very uncomfortable
(2) somewhat comfortable
(3) no reaction either way
(4) comfortable
(5) very comfortable
APPENDIX C

General Instructions to All Subjects

Please pay close attention to the two emergency procedures I am going to teach you. Do your best when asked to perform them but don't worry if you forget a step since hardly anyone remembers the whole procedure without practicing. All I am going to do is record your time and errors as I record your performance. I will teach you the two skills in slightly different ways. I will not say anything when you perform the procedures unless you make an error or need assistance. After you have learned both skills I will ask you to rate the training procedure under which you felt the most comfortable and under which you found it easiest to learn.
APPENDIX D

Instructional Method for STARS Training (Seaman, Green, & Watson-Perczel, 1986)

Observers used STARS by placing the cards in two vertical columns on a table. They activated stop watches when the subject touched the manikin to begin CPR. The observers compared the subjects' performance to the steps and illustrations on the cards. If the subject performed a step incorrectly, the observer slid the corresponding card from its column. Omitted steps were considered incorrect or were steps that the student first omitted but later performed in the sequence. For example, if the trainee correctly performed steps 1 and followed by 6, 3, 4, and 5 then cards 3, 4, and 5 were moved from the column. The experimenter then showed the STARS cards to the subject, identified steps performed correctly, and provided praise. Then he identified any incorrectly performed step and explained how it should have been performed. If the subject expressed any uncertainty about how to perform the step, the experimenter demonstrated.

The experimenter then asked the subject to practice a remedial routine three times independently in another location. The routine consisted of all the steps missed plus any other steps that were part of the task. For example, if the subject missed step 12, then the experimenter assigned all of task "I" for practice.

After completing the routine and if time permitted, the subject returned to the experimenter to perform another training trial.
APPENDIX E

Examples of Information Provided to Instructors for Teaching Emergency Medical Procedures from Two Recent Publications

"The course should be taught in more than one session and the CPR skill itself should be broken into short segments, with each segment reinforced prior to teaching a subsequent segment." (p. 2911) (American Heart Association, 1986)

"__ good instructor will call the student's attention to the important problems of learning and make positive suggestions for improvement." (p. 8) (Ontario Heart Foundation, 1982).

"__ corrects mistakes and reinforces proper sequences." (p. 11) (Ontario Heart Foundation, 1982).
LIST OF REFERENCES


