KNOWLEDGE-OF-CORRECT-RESPONSE VS.
COPYING-OF-CORRECT-RESPONSE
A STUDY OF DISCRIMINATION LEARNING

THESIS

Presented to the Graduate Council of the University of North Texas in Partial Fulfillment of the Requirements For the Degree of

MASTER OF SCIENCE

By

David Geller, B.S.
Denton, Texas
August, 1996
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Copying prompts with subsequent unprompted practice produced better learning of simple discriminations than feedback-only of a correct response without subsequent practice. The Copy condition promoted faster acquisition of accurate performance for all subjects, and shorter response latencies and durations for 3 of 4 subjects. The data support the findings of Barbetta, Heron, and Heward, 1993 as well as Drevno, Kimball, Possi, Heward, Garner III, and Barbetta, 1994.

The author proposes that response repertoires are most valuable if easily reacquired at times after original learning. Thus, reacquisition performance data are emphasized. The data suggest that discriminations acquired by copying prompts may result in useful repertoires if a practice procedure is used which facilitates transfer of stimulus control from a formal prompt to a naturally occurring stimulus.
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CHAPTER 1

INTRODUCTION

In recent years, rapid advances have been made in computer technology. As might be expected, many educators have begun using computers for instructional purposes. Applications range from simple drill and practice to complex animations (Cyboran, 1995). Siegel and Misselt (1984) describe drill and practice as being like a flash card drill and explain its function as "...used principally for teaching paired associates or for other nongeneralizable tasks - fixed lists of items in which the instructional task is to memorize a unique response for each stimulus presented in the drill" (p. 315). On the other end of the spectrum the more complex applications include flight simulations and simulations of various types of instrumentation control panels (Cyboran, 1995). Besides the automated presentation of instructional material, computers can also keep records of the learners' performances and automatically provide feedback on those performances. Because of these characteristics the potential advantages of computer instruction over traditional instruction cannot be overstated. For example, B.F. Skinner (1968), in a discussion of his teaching machine said "An organism is affected by subtle details of contingencies which are beyond the capacity of the human organism to arrange. Mechanical and electrical devices must be used" (p. 21).

Though the computer appears to be the ideal medium to manage subtle teaching contingencies, we still need to program them. That is, we need to determine what contingencies need to be managed and how they are going to
be managed in order to promote masterful performances by a given subject. Because the computer is likely to be the only source of instruction for the learner (see Cyboran, 1995), the effective programming of stimuli and response feedback is specially important for computer-based instruction.

Categories of Feedback

According to Cyboran (1995), everyone involved in computer-based training agrees on the importance of providing feedback during instruction. He states "...the thoughtful, purposeful design of feedback is required for a successful, instructionally-sound product" (p. 18). In his analysis of academic instruction, Van Houten (1980) says "The most important ingredient ... is the use of proper feedback" (p. 13). Similarly, Markle (1990) states "...the idea that some kind of feedback improves learning is remarkable (sic) sturdy. It is now offered as one of the potential strengths of computer-assisted instruction..." (p. 1). Although there is general agreement about the importance of feedback during instruction, the selection and design of feedback systems is not straightforward. Kulhavy (1977), for example, notes that feedback is frequently "...used inappropriately, neutralizing any positive effects it might have on student performance" (p. 211). He states that most of the problems result from "presearch availability" (p. 217). This is when a learner does not have to study material because too many cues are available before he/she must respond to a question.

Perhaps one reason for the inappropriate use of feedback is the several functions ascribed to feedback and the many ways the term has been used. Authors frequently agree that there are various types of feedback, but they also often disagree on the categories into which feedback should be classified. For example, Cyboran (1995) lists some of the ways in which feedback may be
categorized. One way is by whether it functions to acknowledge, confirm, prompt or hint, judge or reinforce, correct, explain, or consequate performance. Another way is by whether feedback follows a correct response or an incorrect response, or if it is provided because of a student's repeated failures to answer a particular question correctly. A third method of categorization is by which sensory receptors are affected by the feedback. In addition to these ways of classifying feedback, Cyboran (1995) mentions other parameters such as the timing of feedback relative to the performance and the amount of information provided to the learner. Similarly, Anderson, Kulhavy, and Andre (1971) and Kulhavy (1977) review arguments that feedback might fill either a corrective or a reinforcing function, but they argue that feedback does not have a primary role of reinforcement. Lindsley (1995), following Tosti's (1978, 1986) suggestion, categorized feedback as either summative or formative. Summative feedback is provided after performance and serves to motivate the learner. It can inform learners regarding what they did do, didn't do, and/or why it was either correct or incorrect. Formative feedback is provided before the learner performs and serves to instruct by providing information. It can inform learners regarding what they should do, shouldn't do, and/or how to do it.

Research on Feedback

Copy Frames are Ineffective. One popular type of formative feedback is known as knowledge of correct response (KCR). It is usually supplied after an incorrect response, and informs the learner what to do by presenting the correct response. This type of feedback has been shown to produce better performances than presenting the correct response before the question is presented. For example, Anderson et al. (1971) studied the acquisition of information about cardiac function in a multiple-choice and fill-in-the-blank
format. The various conditions examined included KCR, and a "peek" condition, in which the correct answer was exposed on the screen before the subject had answered the current question. The subjects in the peek condition had fewer errors during training sessions, but answered significantly fewer questions correctly on a criterion test, than subjects in the KCR group. Anderson et al. (1971) state, "It is known that students do not learn much simply from copying answers into blanks ...." They suggested that a learner making a copy response might be less "attentive" and spend less time attempting to learn. Similarly, Markle (1990) questions the value of both copy frames and formal prompts when she states that a response which consists simply of copying a presented stimulus does not involve "meaningful" responding, and the benefits of such practice, if any, would be minimal.

Copy Responses Improve Learning. Other studies, however, have documented the benefits of a copying response. Barbetta, Heron, & Heward (1993) used an alternating treatments design to examine the role that active responding plays in performance acquisition. They showed 8-9 year old developmentally disabled students index cards with words written on them. The students were asked to read the words aloud. If their answers were incorrect, the teacher provided appropriate feedback and modeled reading the word. In the active responding condition, students were asked to read the word again, immediately after the modeling. In the other condition, after the correct response was modeled, the next word was presented. The student did not have an opportunity to practice the word. The data indicated that the practice condition produced performance superior to that produced by the no-practice condition. The researchers concluded that active responding by the learner was responsible for the observed differences in performance. This study was
replicated by Drevno et al. (1994) with fourth-grade students who were not developmentally disabled. These students were asked to learn definitions of science terms. Two of the students were in a gifted program, and three were considered to be academically at risk. Results of this study showed that active responding appeared to produce performance gains for all 5 subjects.

The above research suggests that copying responses can enhance the effectiveness of KCR. The purpose of the current study was to compare the effectiveness of knowledge of results to that of copying of the correct response after responding. Comparisons are made during the acquisition, retention, and reacquisition of simple discriminations in competent adult learners.
CHAPTER 2

METHOD

Participants

Four adults, ranging in age from 26 to 40 years of age, served as subjects. All subjects had basic typing skills and were naive with regard to the subject matter and purpose of the experiment. At the end of the study each subject was paid $3 for each day they attended experimental sessions. At the completion of each day's sessions, subjects received 1.5 cents for each correct response made that day.

Setting and Apparatus

Experimental sessions were conducted in varied locations including the experimenter's home, homes of the subjects, and workplace of one of the subjects. All efforts were made to use quiet locations with minimal distractions. The instructions, stimulus presentations, feedback and data collection were controlled by an AST Ascentia 800N 486DX50 notebook computer with a passive color display. Instructions, stimuli, and feedback were displayed on the computer screen centered around the horizontal and vertical midpoints of the screen. Subjects' responses consisted of typing on the computer's keyboard. Each typed character was displayed on the screen directly below the stimuli.

Stimuli and Responses. Two sets of stimuli and responses were generated and were assigned to conditions and subjects in a counterbalanced fashion. Figure 1 shows the 2 sets. Each stimulus consisted of 3 ASCII characters which were randomly selected from a group which were unfamiliar to
<table>
<thead>
<tr>
<th>SET 1</th>
<th>SET 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stimulus</td>
<td>Response</td>
</tr>
<tr>
<td>$L^1$</td>
<td>DLH</td>
</tr>
<tr>
<td>$\Gamma$</td>
<td>TFZ</td>
</tr>
<tr>
<td>$\beta$</td>
<td>VKG</td>
</tr>
<tr>
<td>$\Delta T$</td>
<td>LWC</td>
</tr>
<tr>
<td>$\alpha n$</td>
<td>DZK</td>
</tr>
<tr>
<td>$\Sigma \eta$</td>
<td>KRQ</td>
</tr>
<tr>
<td>$L \pm \delta$</td>
<td>MSZ</td>
</tr>
<tr>
<td>$\circ \leq \rho$</td>
<td>V CJ</td>
</tr>
<tr>
<td>$\Lambda \delta \gamma$</td>
<td>DKQ</td>
</tr>
<tr>
<td>$\geq \top n$</td>
<td>TDM</td>
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</tbody>
</table>
Figure 1. Two sets of stimulus-response relationships which subjects were to learn. For 2 subjects, Set 1 was assigned to the Feedback-only condition and Set 2 was assigned to the Copy condition. For the other 2 subjects, Set 2 was assigned to the Feedback-only condition and Set 1 was assigned to the Copy condition.
the experimenter. The author assumed these were also unfamiliar to the experimental subjects. Each subject encountered 20 of these abstract figures. Ten of these figures were assigned to one experimental condition, Feedback-only, and the other 10 figures were assigned to the second experimental condition, Copy. Each response consisted of typing a string of 3 randomly selected combinations of consonant letters from the English alphabet (e.g., KRQ).

Stimuli were presented on a blank screen at about the vertical and horizontal midpoints of the screen. The subjects' responses were displayed on the screen directly below the stimuli.

**General Procedures**

Upon their arrival for the initial experimental session, subjects were greeted and provided with a brief written description of the study and its general purpose, and asked to sign an informed consent form (attached as Appendix A).

With three exceptions, 2 sessions approximately 20 min long were run per day. (One of the three exceptions occurred when a subject requested an additional session. On two other occasions a subject began to type the correct responses to the stimuli during the first session and the second session was not run.) The 2 sessions were separated by a 5 min break. Each session began with a Feedback-only subsession. For the remainder of the session, Feedback-only and Copy subsessions alternated until at least 20 min had passed. Each subsession began with an on-screen presentation of the instructions for that condition. It was completed when the subject had responded to all 10 stimuli for that condition. At that time, a message on the screen told subjects how much money they had earned in that subsession. At the end of a day's sessions, subjects were paid for their correct answers. Because sessions always began
with a Feedback-only subsession, several more data points were obtained for the Feedback-only condition than for the Copy condition.

**Feedback-only Training.**

This condition began with the subject seated before the computer with the following instructions displayed on the screen:

In this segment the program will present sets of symbols. Type the 3 letters which go with each set. Before presenting the next set, the computer will tell you if your answer is correct and, if you were wrong, what you should have typed.

Pay close attention at this time and try hard to learn the correct pairing.

Press any key when ready to begin.

Each trial began with a stimulus presentation on the computer screen. At this point the subject could respond correctly, respond incorrectly, or fail to complete a response within the allowed 10 seconds. If the subject typed the correct 3 characters within 10 seconds, the printed word “CORRECT” appeared on the screen, the screen was cleared, and the next stimulus appeared. If the subject failed to type 3 characters within 10 seconds, the correct answer was displayed below the stimulus and the next trial was presented. If the subject typed 1 or more incorrect characters, the response was counted as incorrect and was followed by the written feedback “INCORRECT” and presentation of the correct answer. Then the screen cleared and the next stimulus appeared. See Figure 2 for a diagram of the procedures for this condition.
present a stimulus

complete answer within 10 seconds?

Yes

correct answer?

Yes

Display "Correct"

No

Display "Incorrect"

Display correct response in red

Next trial
Figure 2. Flowchart of procedures for the Feedback-only condition.
Copy Training.

The only difference between this condition and the Feedback-only condition was that after an incorrect response the subject was required to copy the correct answer and then the original trial was re-presented without a prompt.

This condition began with the subject seated before the computer with the following instructions displayed on the screen:

In this segment, the computer will present sets of symbols. For each set, type the 3 letters which go with the set. The computer will tell you whether your answers are correct.

If you cannot type the correct letters, the computer will give you a prompt. Use this prompt to type the correct letters. Pay close attention at this time and try hard to learn the correct answer.

Press any key when ready to begin.

During Copy training, subjects could respond in one of three ways. First, if a subject responded correctly within 10 s, the feedback "CORRECT" was displayed, the screen cleared, and a new stimulus was presented.

In the other two possibilities, if a subject was unable to respond correctly to a stimulus without a prompt, the computer repeatedly displayed "INCORRECT" followed by a prompt (the correct response in red, and three blanks for the subject to type in) until the subject made a correct response. At this point, the subject was again given the opportunity to respond without a prompt. When the subject made an unprompted correct response, a new stimulus was presented.

The inability of a subject to respond correctly without a prompt involved either responding incorrectly, or failing to complete a response within 10 s. In
the latter case, the first presentation of feedback was skipped. A flowchart for this procedure is presented in Figure 3.

**Experimental Design.** Each subject experienced both the Feedback-only and Copy instructional procedures. These procedures, or conditions, were run as alternating subsessions, each of which consisted of a randomly ordered presentation of the 10 stimuli for the appropriate condition. These subsessions were run within experimental sessions of approximately 20 minutes. Usually two sessions were run in a day. At the conclusion of the last experimental session, subjects were asked to return to the lab in 2 weeks for additional sessions in order to measure retention and reacquisition as a function of instructional condition. At this time, both sets of stimuli were presented with the Feedback-only procedures used in the original learning sessions. There was no opportunity for copying a prompt or practicing a response.

In both the original learning and the reacquisition sessions, the author used a completion criterion of responding correctly to each of the 10 stimuli for a condition over 3 sequential subsessions. In some subsessions, a subject would finally meet this criterion on the final relationship, only to respond incorrectly to a stimulus to which that subject had previously responded correctly over several subsessions. Close examination of the data would reveal that the error was a typing mistake. Such data were considered as having satisfied the criterion.

**Dependent Variables**

Data collected for each stimulus presentation included response latency, response duration, the programmed correct response, and the actual response of the subject. The dependent measures were accuracy, average latency, and average duration. Accuracy was calculated as the number of times during a subsession that the subject made the correct responses to the stimuli (In the
Present a stimulus

correct answer?

Yes

Display "Correct"

Next trial

No

Display "Incorrect"

Display correct response in red

present 3 blanks as prompt for subject's response

Display subject's response

correct copy?

Yes

Display "Correct"

No

complete answer within 10 seconds?

No

Repeat trial
Figure 3. Flowchart of procedures for the Copy condition.
Copy subsessions, only the first presentation of each of the ten stimuli was used to calculate accuracy. If a response of 3 key presses was not completed within 10 s, the program recorded an incorrect response. Average latency was the mean time from the presentation of a stimulus to the subject's first key press. If a subject did not type a key within 10 seconds of the stimulus presentation, a latency of 10 s was recorded for that trial. Average duration was the mean time from the pressing of the first key to the pressing of the third key. No duration data were recorded for trials on which a response was not completed within 10 s of a stimulus presentation. After the dependent measures were calculated for each subsession, one set of graphs was made for the Feedback-only subsessions and another set was made for the Copy subsessions.

The patterns of acquisition of individual stimulus-response relationships were also examined for each stimulus-response relationship. This was done by plotting the accuracy (correct or incorrect) of each sequential response.
CHAPTER 3

RESULTS

Figure 4 shows the number of correct responses for each 10 trial subsession for each subject during the initial Copy and Feedback-only training. This figure reveals that all subjects responded accurately with fewer trials for the Copy condition than for the Feedback-only condition. The size of the difference between the conditions varied across subjects. It was larger for subjects P and D, the subjects who required more trials to master the relationships, than for W or M.

Figure 5 shows that response latencies for subjects M and P tended to be shorter for Copy trials than for Feedback-only trials. For these subjects, latencies were longest in the early trials and steadily decreased throughout the study. For the other two subjects, latencies were shorter on early trials but fluctuated thereafter. This could be due to a procedure in which a wrong response was followed by display of the correct response. Subjects could accelerate the feedback by intentionally responding incorrectly. As the responses of subjects W and D became more accurate, their Copy response latencies became shorter than their Feedback-only response latencies.

Figure 6 shows that response durations for subjects M, D, and P, became shorter and less variable with additional practice. Response durations tended to be shorter on Copy trials than on Feedback-only trials. However, this difference narrowed as the relationships were learned. Subject W learned the relationships more quickly than the other subjects. W's response durations
Figure 4. Numbers of correct responses for each acquisition subsession for each subject.
Figure 5. Average response latencies in seconds for each acquisition subsession for each subject. Feedback-only data and Copy data are graphed separately. Feedback-only is represented by open circles and copy is represented by filled circles.
Figure 6. Average response durations in seconds for each acquisition subsession for each subject. Feedback-only data and Copy data are graphed separately. Feedback-only is represented by open circles and Copy is represented by filled circles.
were very short on even the early trials. Although initially mixed, that subject's response durations began to be shorter for Copy trials on approximately the 17th trial. This occurred even though accuracy scores continued to be similar for the two conditions until approximately the 30th trial.

The patterns of acquisition for the original learning sessions are depicted in Figures 7, 8, 9 and 10 for all subjects. Each stimulus-response relationship is represented in the left-most column by the 3 consonant response which the subject should have made. Consecutive trials were plotted horizontally. An open square represents an incorrect response and a filled square represents a correct response for each stimulus-response relationship. To make interpretation of the data easier, the stimulus-response relationships are in order of acquisition.

All subjects, except subject D, began to learn Copy relationships with fewer trials than they required with the Feedback-only relationships. The difference was less clear for subject W. All 4 subjects mastered the entire set of Copy relationships more quickly than they did the Feedback-only relationships. The trend was for relationships to be learned several at a time. Once several Copy relationships were learned, Feedback-only relationships began to enter the subject's repertoire. It appears as though subjects were learning several relationships in each condition, but several additional trials were needed for acquisition of Feedback-only relationships. Subject W mastered all relationships with fewer trials than did other subjects. This subject also mastered more relationships concurrently than did other subjects.

Figure 11 shows the number of correct responses for each 10 trial subsession for each subject during reacquisition for both the Copy and the Feedback-only conditions. All subjects reacquired (10 correct responses on 10
Copy Trials

lwc
dlh
dzk
ftz
dkq
krq
msz
vcj
tdm
vkg

Feedback-Only Trials

rgt
lpu
rmh
jgd
qnl
khf
czv
xvs
ztw
qtf

□ Incorrect ■ Correct
Figure 7. Patterns of acquisition for subject D during acquisition sessions. Successive squares represent successive trials. Empty squares represent incorrect responses. Filled squares represent correct responses. The first 10 trials for Copy and the first 14 trials for Feedback-only are not displayed. All responses during these trials were incorrect.
### Copy Trials

<table>
<thead>
<tr>
<th>Letter</th>
<th>Incorrect</th>
<th>Correct</th>
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<tr>
<td>lpv</td>
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</tr>
<tr>
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<tr>
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### Feedback-Only Trials

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<th>Correct</th>
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<tbody>
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<td></td>
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<tr>
<td>msz</td>
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<td>vco</td>
<td></td>
<td></td>
</tr>
<tr>
<td>vkg</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

☐ Incorrect  ■ Correct
Figure 8. Patterns of acquisition for subject M during acquisition sessions. Successive squares represent successive trials. Empty squares represent incorrect responses. Filled squares represent correct responses.
### Copy Trials

<table>
<thead>
<tr>
<th>khf</th>
<th>qnl</th>
<th>jgd</th>
<th>qft</th>
<th>xvs</th>
<th>czv</th>
<th>rmh</th>
<th>lpf</th>
<th>zwt</th>
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### Feedback-Only Trials

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<th>tfz</th>
<th>kq</th>
<th>dth</th>
<th>dkq</th>
<th>vkg</th>
<th>vcl</th>
<th>tdm</th>
<th>msz</th>
</tr>
</thead>
</table>

- **Incorrect**
- **Correct**
Figure 9. Patterns of acquisition for subject W during acquisition sessions. Successive squares represent successive trials. Empty squares represent incorrect responses. Filled squares represent correct responses.
Figure 10. Patterns of acquisition for subject P during acquisition sessions. Successive squares represent successive trials. Empty squares represent incorrect responses. Filled squares represent correct responses. The first 20 trials of each condition are not presented. In those 20 trials, subject P had 12 correct responses (out of a possible 200) in the Copy condition, and 1 correct response (out of a possible 200) in the Feedback-only condition.
Consecutive Subsessions
Figure 11. Number of correct responses for subjects D, M, W, and P for consecutive reacquisition subsessions. Feedback-only is represented by open circles and Copy is represented by filled circles.
trials, the relationships more quickly for the Copy training than for the Feedback-only training. They required 1, 2, 5 and 10 more sessions to reacquire 100% accuracy for relations originally trained with Feedback-only training.

T-tests, results of which are shown in Figure 12, were done on the differences between the slopes of simple regression lines for the two conditions. The t-scores represent the probability that the differences between any two slopes were due to chance, and not the experimental procedures. For the accuracy measure (number of correct responses), significance levels for Subjects W and D were between .05 and .10. For Subject M, data were significant at between the .01 and .02 level. For Subject W, the t-score did not appear on the chart of student t-scores; however, the graphs show that for 75% of the data points up to the first 100% accuracy point, performance on the Copy trials was equal to or better than that on Feedback-only trials. This subject reached 100% accuracy on Copy trials 1 session prior to reaching 100% accuracy on Feedback-only trials.

Figure 13 shows that response latencies tended to be shorter for Copy trials than for Feedback-only trials. This difference, however, began to disappear when all responses became accurate for the Feedback-only condition. Also, latencies began to reach asymptote as 100% accuracy was reached. No t-scores for differences between slopes of the response latency regression lines approached statistical significance.

Figure 14 shows that response durations tended to be shorter for Copy trials than for Feedback-only trials. T-scores for regression line slopes were statistically significant at between .10 and .20 for these 3 subjects. Data for the fourth subject were highly variable, with the 2 lines crossing on 7 occasions.
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<th>M</th>
<th>D</th>
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<td>correct responses</td>
<td>2.0655/6</td>
<td>3.061869/8</td>
<td>2.0493921/8</td>
<td>.0355174/12</td>
</tr>
<tr>
<td>response latencies</td>
<td>0.2401165/14</td>
<td>0.1896655/30</td>
<td>.2256483/30</td>
<td>.5728688/26</td>
</tr>
<tr>
<td>response durations</td>
<td>1.1489/14</td>
<td>1.048117/30</td>
<td>1.2113798/30</td>
<td>.066911/26</td>
</tr>
</tbody>
</table>
Figure 12. T-scores and degrees of freedom for the differences between the slopes of simple regression lines for feedback data and copy data from reacquisition sessions. T-tests were done on the differences between the two conditions for each dependent measure: number of correct responses, response latencies, and response durations. If the T-scores approached significance, the significance levels are noted directly below the corresponding T-score.
Figure 13. Average response latencies in seconds for subjects D, M, W, and P for consecutive reacquisition subsessions. Feedback-only is represented by open circles and Copy is represented by filled circles.
Figure 14. Average response durations in seconds for subjects D, M, W, and P for consecutive reacquisition subsessions. Feedback-only is represented by open circles and Copy is represented by filled circles.
Patterns of reacquisition are depicted in Figures 15, 16, 17 and 18. With the exception of subject W, relationships learned under the Copy conditions were reacquired more quickly, with fewer errors, than were relationships learned under the Feedback-only conditions. These figures show that, during reacquisition, Subjects P, D, and M made 52%, 42%, and 172% more errors on Feedback-only relationships than on Copy relationships, respectively. Subject W made the same number of errors in each condition. It appears that all subjects reacquired the relationships by learning several at a time.
Figure 15. Patterns of acquisition for subject P during reacquisition sessions. Successive squares represent successive trials. Empty squares represent incorrect responses. Filled squares represent correct responses.
<table>
<thead>
<tr>
<th>Copy Trials</th>
<th>Feedback-Only Trials</th>
</tr>
</thead>
<tbody>
<tr>
<td>czv</td>
<td>dkq</td>
</tr>
<tr>
<td>ipv</td>
<td>dsk</td>
</tr>
<tr>
<td>xvs</td>
<td>msz</td>
</tr>
<tr>
<td>zwt</td>
<td>tz</td>
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<td>kht</td>
<td>krg</td>
</tr>
<tr>
<td>rml</td>
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<td>gni</td>
<td>vkg</td>
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<td>lgt</td>
<td>cgu</td>
</tr>
<tr>
<td>gft</td>
<td>tdm</td>
</tr>
<tr>
<td>igd</td>
<td>dlh</td>
</tr>
</tbody>
</table>

Incorrect □ Correct □
Figure 16. Patterns of acquisition for subject M during reacquisition sessions. Successive squares represent successive trials. Empty squares represent incorrect responses. Filled squares represent correct responses.
### Copy Trials

<table>
<thead>
<tr>
<th>lwc</th>
<th>dkz</th>
<th>tfz</th>
<th>dkq</th>
<th>dlh</th>
<th>krq</th>
<th>msz</th>
<th>vkg</th>
<th>vcj</th>
<th>tdm</th>
</tr>
</thead>
</table>

### Feedback-Only Trials

| rnh | jgd | rgt | lpv | khf | czv | xvs | zwt | qft | qnl |

- □ Incorrect
- ■ Correct
Figure 17. Patterns of acquisition for subject D during reacquisition sessions. Successive squares represent successive trials. Empty squares represent incorrect responses. Filled squares represent correct responses.
Copy Trials
qft
czv
qnl
rgt
jgd
xvs
khf
lpv
zwt
rmh

Feedback-Only Trials
lwc
dlh
krq
msz
dzk
vcj
vkg
tdm
tfz
dkq

□ Incorrect ■ Correct
Figure 18. Patterns of acquisition for subject W during reacquisition sessions. Successive squares represent successive trials. Empty squares represent incorrect responses. Filled squares represent correct responses.
CHAPTER 4

DISCUSSION

This study extends the generality of the effects found by Barbetta, Heron, and Heward (1993) and by Drevno et al. (1994). It also supplements that research by showing the differential effects of both types of training on the patterns of acquisition and reacquisition of behavior. The results indicate that the Copy condition is better than the Feedback-only condition in teaching simple stimulus-response relationships. During the Copy condition, subjects required fewer practice trials to respond accurately, and some of the subjects tended to have shorter response latencies and shorter response durations. On the first reacquisition trial for each relationship, data were very similar for the Feedback-only and Copy conditions. Subsequently, however, subjects required fewer practice trials to respond accurately to Copy relationships, and most of the subjects responded to Copy stimuli with shorter latencies and durations.

Some of the observed differences were small, especially for subject W who learned the tasks more quickly than did other subjects. Interestingly, this subject reported applying several different strategies while learning the tasks, and also stated that it would have been better to have the feedback displayed for a longer time period in the Feedback-only condition. This information led the author to conclude that this subject was looking at the feedback, which included the display of the correct response, and covertly rehearsing the stimulus--response relationships. In effect, such behavior would serve to replicate the
procedures of the Copy condition. In that condition, after a subject made a wrong response, he/she was given feedback which included the display of the correct response, and then was asked to type that response. Thus, subject W's behavior might have worked to minimize the differences between the two conditions. If such covert practice does indeed minimize the difference between performances on the two conditions, then the added structure provided by the Copy condition might be more beneficial during acquisition for subjects that do not engage in such covert rehearsal.

Another factor that might have contributed to the differential success of these teaching procedures is the task complexity. The learning task in this study was relatively simple. That is, subjects could easily reproduce the correct response. Because there is little time to rehearse during the Feedback-only condition, if more complex responses were required, the Copy condition might produce a bigger difference, even with subjects that apply their own learning strategies.

In addition to the benefits the Copy procedure produced during acquisition, the Copy condition was also beneficial for reacquisition of the task. This is, perhaps, due to the increased opportunity to respond during the Copy condition.

The aforementioned cited studies used several measures of retention to assess the value of their instructional procedures. These measures of retention are important because we cannot assume that the relative degrees of mastery evidenced by "Feedback-only" and "Copy" performances will be maintained weeks or months following original learning, and superior performance which is not retained over time is usually of little consequence. On the other hand, if performance degrades rapidly but is easily reacquired, it may still be of value to
the individual. A reacquisition test provides more information than a retention test because it not only provides measures of retention, but also, allows one to determine whether a repertoire which has degraded can be easily reacquired. This study offers a good illustration of this. The very first data points for reacquisition sessions represent subjects' levels of retention. The data points show how subjects responded to stimuli 2-3 weeks after original training sessions, without additional practice. The data for the two conditions were very similar, and sometimes identical. Subjects then went on to reacquire Copy relationships more quickly, with faster response latencies and durations.

An individual rarely has the opportunity to practice a learned skill frequently. Also, an individual's repertoire typically includes a number of responses, with different probabilities of occurrence, which may be occasioned by similar stimuli. Over time, the probability of any particular response will vary. Reacquisition is very likely to be necessary, so it is important to predict how easily that response may be reacquired. This is important because a person reacquiring a skill sometime after original learning is likely to be doing so under conditions of real-world application rather than in a classroom or instructional setting. Under such conditions it can be critical that errors are minimized. To be convinced, one need only consider the example of an individual having to perform CPR 6 months or more after receiving certification training. In this study, subjects P, D, and M made 52%, 42%, and 172% more errors on Feedback-only relationships than on Copy relationships, respectively. This data makes the Copy condition appear very much superior to the Feedback-only condition in that the responses acquired under the Copy condition were reacquired at a later time with very few errors.

Another interesting difference between the Copy and Feedback-only
analyses were the patterns of acquisition generated. The data for the original learning sessions indicate that relations enter subjects' repertoires approximately 3 at a time. The repertoires grow for each condition concurrently, although the Copy repertoire is growing at a slightly faster rate. Subject W's repertoire increased by larger steps. It appears that responses entered this subject's repertoire 4 or 5 at a time. The rate at which new responses enter repertoires could be a function of the number of novel stimuli to which a learner is exposed. There might be an optimal rate at which a learner should be exposed to new material without overloading that learner. Future research might focus on determining whether a relationship of this sort does, in fact, exist.

Still, why do some question the value of "copy frames" while other research, including the present study, indicates that learners can benefit from copying prompts? The formative function of feedback coincides with two important problems of instructional design noted by Skinner (1968). The initial problem in instruction is to get a learner to make an appropriate response. The next step is to get this response to occur only under appropriate conditions, or under appropriate stimulus control. This is usually achieved by prompting. However, this process is not without its problems. It is likely to produce responding to a stimulus other than that which the designer of the instruction desires. When an occasion to respond occurs in the future without the aid of this formative feedback, the learner is not likely to be able to make the correct response. To circumvent this problem, an instructor must find a way to transfer control of that response from the prompt to the stimulus that the learner will be encountering at later times. For a response to be useful, the learner must be able to make the response at appropriate times without the aid of prompts.

Analyses, like those of Markle (1990) and Anderson, Kulhavy, and Andre
(1971), couched in terms of "meaningfulness", "attentiveness", and "attempting to learn", do little to promote improved methods of instruction. For example, it is difficult to measure "meaningfulness." One alternative approach would be to examine the extent to which experimenters structured procedures to facilitate transfer of stimulus control from the stimulus being copied to other more useful stimuli. In the Anderson et al. (1971) study no attempt was made to fade prompts in the peek condition. Subjects were exposed to the questions only once. The "peek" condition was not combined with any of the other procedures. Some subjects were permitted to review incorrect frames. It is possible they might have performed much better if they had also been able to "peek" at the answer on their first review trial. Barbetta et al. (1993) and Drevno et al. (1994) provided, concurrently with the presentation of the written stimulus, a vocal stimulus to help the subjects produce the appropriate response. This procedure appears to have helped the transfer of control from the vocal stimulus to the written stimulus. Also, Anderson et al. (1971) presented the opportunity to copy before the stimulus was observed and Barbetta et al. (1993) presented it after incorrect responses only. In this study the transfer might have been facilitated by requiring the subject to practice the copied response, under the criterion stimulus, immediately after feedback.

In summary, the present study provides some evidence that a response of copying a prompt immediately followed by a practice trial without a prompt does help an individual to learn the response initially and to reacquire it more rapidly than if that individual received the prompt as feedback only, without the opportunity to practice the response. It appears that if efforts are made to facilitate transfer of stimulus control from a formal prompt to a more desirable stimulus, the prompt can help individuals to engage in fluent performance more
quickly, and to reacquire it more easily, with fewer errors.
APPENDIX

INFORMED CONSENT FORM
INFORMED CONSENT FORM

I, ____________________________________________, agree to participate in a study designed to investigate human learning. I understand that each session of this experiment that I will attend will last for approximately 45 minutes, and that I will be required to attend approximately 10 sessions. The actual number may be slightly more or less.

I understand that my responses during this study will be held in strictest confidence and used only under conditions of anonymity. I agree to allow Mr. Geller to use the results of this research in any way thought best for publication or education. I understand that I will receive _____ dollars for each experimental session (paid at the completion of the research study), and I will receive _____ cents for each correct response during experimental sessions (paid at the completion of each session). I understand that the results of this study will provide important information about human learning. I also understand that after all the sessions have been completed, my data will be explained to me in a debriefing session.

I understand that my participation in this experiment is voluntary and that I may withdraw at any time without penalty. If I have any questions or problems that arise in connection with my participation with this experiment, I should contact Mr. Geller at (817) 534-7665, or Dr. Rosales at 565-2274.

This project has been reviewed and approved by the UNT Committee for the Protection of Human Subjects (817) 565-3940.

_________________________                   __________________________
(date)                                (signature of participant)

_________________________                   __________________________
(date)                                (principal investigator)
REFERENCES


Psychology, 76(2), 310-317.


