AN ANALYSIS OF SEVERAL VARIABLES INFLUENCING THE EFFICACY OF FLASH CARD INSTRUCTION

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We conducted four experiments using an alternating treatments design to assess the influence of several variables on children's acquisition of number facts during one-on-one flash card instruction. In Experiment 1, we manipulated the order of stimulus presentation; in most cases a higher percentage of correct responses occurred, and mastery criterion was reached in somewhat fewer sessions, when a missed problem was re-presented after the next item than when problems were re-presented in a sequential order. In Experiment 2 a comparison of error-contingent reprimands with no reprimands yielded similar results in favor of the former procedure. Experiment 3 indicated that a higher percentage of correct responses and more rapid acquisition occurred when the tutor and student were seated knee-to-knee than when a desk was positioned between them. Experiment 4 compared the rate of learning in the presence and absence of a treatment package consisting of all three variables identified as leading to more rapid learning in the previous three experiments. Children reached criterion in less than half the time when the treatment package was in effect.

DESCRIPTORS: reprimands, seating arrangement, flash card instruction, tutoring, mathematics

Flash cards are often used to teach basic facts such as the names and sounds of the letters of the alphabet (Young, Hecimovic, & Salzberg, 1983), number facts (Maheady & Sainato, 1985), sight words (Heron, Heward, Cooke, & Hill, 1983), and object labels (Olenick & Pear, 1980). Despite the importance of flash card instruction in peer tutoring and remedial work, little research has focused on factors influencing the speed of acquisition of new material taught in this manner. We therefore conducted four experiments to examine the effects of order of stimulus presentation, error-contingent reprimands, tutor-student seating position, and a combination of the three target variables on children's acquisition of number facts during flash card instruction.

GENERAL METHOD

Setting

Each student was removed from the classroom during math period for 12-min one-on-one tutoring

sessions conducted in a small room furnished with two chairs and a table. A research assistant served as the experimenter. Each treatment session was videotaped to collect interobserver agreement data as well as data on the implementation of procedures. The first author trained the experimenter by role-playing all procedures and having her practice them until she could follow each of the experimental procedures in the proper manner.

General Procedure

Item selection. Prior to beginning each experiment, each student was assessed on those number facts that were the most difficult for the student. For example, if a teacher indicated that a student was having difficulty learning addition facts, the experimenter presented each of the addition facts to the student seven times and scored the student's response as correct, incorrect, or no response (greater latency than 8 s). Those facts missed three or more times were included in a pool of 14 facts for each pair of students. These facts were matched according to difficulty (e.g., $7 + 7$ was paired with a similar problem such as $8 + 8$, and $7 + 9$ was paired with a similar problem such as $8 + 7$). These paired items were then randomly assigned to two sets, which were counterbalanced across students.

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Teaching format. All problems were written on 7.6 cm by 12.7 cm index cards with black marker using a vertical presentation format. In Experiments 1, 2, and 4, the experimenter sat facing the student in the knee-to-knee seating position with the desk containing the recording sheets on the experimenter's right. A fiber board barrier was placed on the desk so the student could not see the data sheets.

During all conditions the experimenter presented each card and stated the problem aloud (e.g., " $7 + 8 = ?$ "). If the student answered correctly, the experimenter delivered praise (e.g., said "Very good," patted the student and smiled) and scored the item as correct. If the child answered incorrectly, the experimenter said "No" in a neutral tone of voice, scored the item as incorrect, repeated the question followed by the correct answer (e.g., " $7 + 8 = 15$ "), and then repeated the trial. If the student then responded correctly, the experimenter simply said "Good" in a neutral tone of voice. This correction procedure was repeated until the student responded with the correct answer. Students rarely needed to be corrected in this manner more than once. In Experiments 2 and 4 a firm "No" was delivered in some experimental conditions.

Measure. The measure in all experiments was the percentage of items answered correctly on a daily pretest administered prior to each teaching session. During pretests, each set was presented twice, and no feedback or other consequences were provided for correct or incorrect answers. Interobserver agreement on items was taken from three randomly selected videotaped sessions for each student. A second observer viewed the tape of the entire pretest and scored the student's responses on the pretest as correct or incorrect. This scorer was always in agreement with the research assistant. Another observer also scored the videotapes on three randomly selected sessions for each student to determine whether the research assistant followed the procedure in the proper manner. Each trial was scored for the proper use of verbal praise, nonverbal approval, item presentation, and the use of the appropriate correction procedure by checking yes or no on an item-by-item checklist. Data revealed that the correct procedure was used on 96% of the

trials; the most common error was failure to provide nonverbal approval on correct trials.

Experimental design. An alternating treatments design was used in each experiment. Each student was taught two sets of items, one set using one procedure and the second set using another procedure. The order in which each set was taught during each session was determined by flipping a coin.

EXPERIMENT 1

Knight, Hasazi, and McNeil (1971) compared re-presenting flash cards that were missed after the next card with re-presenting them after all the cards in the pack of 10 cards were presented once. Their results indicated that the more immediate re-presentation procedure was more effective. However, the design did not allow firm conclusions to be drawn from their data. Therefore, the purpose of the first experiment was to assess whether the re-presentation of a missed card after one interspersed card (rapid re-presentation) leads to more rapid learning than re-presentation after all the other cards have been presented (sequential order of presentation).

METHOD

Subjects

Subjects were 4 children in a regular second-grade classroom and 6 children in a regular fourth-grade classroom who were identified by their teachers as having difficulty learning addition, subtraction, multiplication, or division number facts.

Experimental Conditions

Sequential presentation. Items were each presented in turn until all eight cards were presented. The cards were then shuffled. This procedure was repeated seven more times.

Rapid re-presentation. Items taught using this method were also presented eight times during each session. However a missed item was placed face down on the tutor's lap and re-presented after the next item. Items that were re-presented were not presented during the next set of presentations to

ensure that they were not presented more often than any other item. The cards were shuffled after each set of presentations.

RESULTS AND DISCUSSION

The results of Experiment 1, presented in Figure 1, show that in 11 of the 13 instances, criterion was obtained first with the set taught using the rapid re-presentation method. The mean number of sessions to criterion was 7.4 for problems taught using the rapid re-presentation procedure and 9.5 for problems taught using the sequential procedure. In no case was the sequential method superior to the rapid re-presentation technique. These results suggest that small but generally consistent increases in correct responding can be achieved with a simple change in the presentation format.

One potential explanation for the relative effectiveness of the rapid re-presentation procedure is the increased likelihood of a correct response when a missed problem is re-presented soon after it had been corrected. Hence, the student had more opportunity to practice a correct response to the item.

It should be noted that a problem was included in the pool of items to be taught if it had been missed three of seven times during the initial assessment. Therefore, not all items were necessarily truly "unknown." However random item assignments should have controlled for this factor.

EXPERIMENT 2

Another way to reduce the likelihood of errors is to follow them with a decelerating consequence such as a mild reprimand. Some data exist on the effects of reprimands on inappropriate behavior (Hall et al., 1971; Jones & Miller, 1974; Van Houten, Nau, MacKenzie-Keating, Sameoto, & Colavecchio, 1982); however, few data have been reported on the effects of reprimanding errors on academic performance, even though it is common practice to follow errors with a reprimand (Iwata, 1987). The purpose of the second experiment, therefore, was to examine the effects of reprimanding incorrect responses on the rate of learning.

METHOD

Subjects

The subjects were 8 children from a regular first-grade classroom and 2 children from a regular second-grade classroom who had been identified by their teachers as having difficulty learning addition or subtraction number facts.

Experimental Conditions

Correction. Whenever a child gave an incorrect answer, the experimenter said "No" in a neutral tone of voice and repeated the problem with the answer (e.g., " $7 + 8 = 15$ ") and presented the problem again (e.g., " $7 + 8 = ?$ "). All missed items were re-presented after one interspersed item.

Correction plus firm reprimand. Procedures were the same as in the correction condition except that the experimenter placed her index finger in front of the child's lip and said "No" in a firm tone of voice following an incorrect response.

Treatment Acceptability

For two of the first-grade children, one set of problems was written on the index cards with a red marker and the other set was written with a green marker. At the completion of the study these children were given a consumer satisfaction questionnaire that was orally administered by the classroom teacher who was unaware of the purpose of the experiment. The teacher wrote down students' responses to the following questions: (a) "Did you feel one set of problems was easier than the other?"; (b) "Which set was easier, the red ones or the green ones?"; (c) "Did it upset you when the tutor said No when you made an error?"; (d) "Do you think it helped you or hurt you when the tutor said No when you made a mistake?"

RESULTS AND DISCUSSION

The results of Experiment 2 are shown in Figure 2. Acquisition was most rapid for 9 of the 10 students in the correction plus firm reprimand condition. The mean number of sessions to criterion was 6.5 for problems taught with the correction plus firm reprimand procedure and 9.6 sessions for

Figure 1. The percentage of pretest problems correct in Experiment 1 in each session for 4 students in addition and subtraction and 6 students in multiplication and division under the rapid and sequential re-presentation conditions.

problems taught with the correction procedure. Once criterion was reached on either set, performance typically maintained at 100% for three consecutive sessions.

In regard to the consumer satisfaction rating, both students selected the set that was taught using the correction plus firm reprimand procedure as easier. Neither child reported being upset by the reprimands. Kathryn stated that the reprimands helped, saying “I knew when I was wrong” and David said that it helped because “We learn from our mistakes.” These comments were interesting because corrective feedback was provided in both experimental conditions. It is possible that corrective feedback is more salient when it is given in a firm manner.

The correction plus firm reprimand procedure

may have been superior to the correction procedure because it helped suppress incorrect responses that competed with learning correct responses. This explanation is supported by the tendency of students in the correction condition to emit more perseverative errors than students in the correction plus reprimand condition. Students in the latter condition were more likely to pause on a trial following an incorrect response (no response) and hence receive a prompt for the correct answer in the absence of an error. It is possible that the avoidance of reprimands negatively reinforced correct responding. Although the use of the correction plus firm reprimand procedure was not associated with any negative reactions on the part of the students, it should be noted that the experimenter delivered very frequent praise and that all reprimands were

Figure 2. The percentage of addition or subtraction pretest problems correct in Experiment 2 for 10 students during the correction (C) and correction plus firm reprimand (C + R) conditions.

brief, specifically contingent on incorrect answers, and were administered in a nonderogatory manner. It should also be noted that the experimenter used an entire session to establish rapport with each student before beginning each experiment.

EXPERIMENT 3

METHOD

Lovaas (1981) recommended that the one-on-one tutoring of developmentally delayed children should be conducted using a knee-to-knee seating arrangement without a desk or any other barrier between the teacher and child. The clinical experience of both authors with developmentally delayed and learning disabled children supports Lovaas' recommendations that children learn faster when they are seated close to the teacher with no barrier between them. However, no data have been reported to support the superiority of this method with any population. Therefore, the purpose of the third experiment was to compare the effectiveness of the knee-to-knee seating arrangement with and without a table between the experimenter and the student.

Subjects

The subjects were 6 children from a regular second-grade classroom who were identified as having difficulty learning subtraction number facts.

Experimental Conditions

Knee-to-knee. The tutor and student sat facing each other with the experimenter's knees outside the student's knees. A desk was placed on the experimenter's right so she could score the student's responses to each item. All missed items were re-presented after one interspersed item and correction plus a firm reprimand followed each incorrect response.

Desk-in-between. The tutor sat in the same position as described above; however, a desk (76.3 cm wide) was situated between them. This condition was identical to the knee-to-knee condition in all other respects.

RESULTS AND DISCUSSION

The results of Experiment 3 are presented in Figure 3. All 6 children reached criterion first in the knee-to-knee condition. The mean number of sessions to criterion was 8.3 for problems taught using the knee-to-knee procedure and 10.8 sessions for problems taught using the desk-in-between procedure. One possible explanation for the slower learning observed in the presence of the desk is that it may have served as a barrier that diminished the quality of the social contingencies delivered by the experimenter. It should be noted that the desk did not serve as a physical barrier because praise and reprimands could be physically delivered equally well in both conditions. This hypothesis should be tested by independently examining the effectiveness of praise or reprimands on performance on a task in the presence or absence of a desk or other barrier between the experimenter and the child.

The results of the previous three experiments identified three procedural factors that influence acquisition in flash card instruction. The purpose of the final experiment was to determine whether the concurrent use of all three procedures would produce even more rapid learning than occurred in their absence.

EXPERIMENT 4

METHOD

Subjects

The subjects were 2 students in a regular first-grade classroom who were identified by their teacher as having problems learning addition facts.

Experimental Conditions

Treatment package. The rapid re-presentation procedure described in Experiment 1, the correction plus firm reprimand procedure described in Experiment 2, and the knee-to-knee teaching arrangement described in Experiment 3 were simultaneously implemented.

Control. This condition consisted of the sequential presentation procedure described in Experiment 1, the correction procedure described in Experiment

Figure 3. The percentage of subtraction pretest problems correct in Experiment 3 for 6 students during the knee-to-knee (kn/kn) and desk-between conditions.

2, and the desk-in-between arrangement described in Experiment 3.

RESULTS AND DISCUSSION

The results of Experiment 4 are presented in Figure 4. Both children learned the set of problems taught with the combined treatment procedures in less than half the time required to teach the set taught by the control procedures (5 vs. 12 and 5 vs. 14 sessions, respectively). These results illustrate how a number of variables that each exhibit a small influence on learning rate when applied individually can produce a greater influence on learning rate when employed in combination.

GENERAL DISCUSSION

The results of these experiments demonstrated that students reached criterion in fewer trials when incorrect items were re-presented after one interspersed item, reprimands were delivered following incorrect responses, and the student and tutor were seated in a knee-to-knee position without a desk between them.

Figure 4. The percentage of addition pretest problems correct in Experiment 4 for 2 students in the treatment package and control conditions.

The simplicity of these procedures should make them easy to implement by resource and special education teachers as well as others who provide one-on-one tutoring services. These procedures may also be easily employed by peer tutors or by volunteer workers, with little prior training. It should also be noted that children reached criterion in half the time when all three procedures were implemented together. Use of the experimental procedure over an extended period could therefore result in a dramatic increase in learning.

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