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EFFECTS OF HIGH-PREFERENCE SINGLE-DIGIT MATHEMATICS PROBLEM COMPLETION ON MULTIPLE-DIGIT MATHEMATICS PROBLEM PERFORMANCE

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The purpose of this study was to examine the effects of a sequence of three single-digit (1 digit × 1 digit) multiplication problems on the latency to initiate multiple-digit (3 digit × 3 digit) multiplication problems for 2 students in an alternative education school. Data showed that (a) during the preference assessment, both students selected the single-digit problems in a majority of the sessions, and (b) intervention resulted in a decrease in latency between problems for both students. Results are discussed in relation to using high-preference sequences to promote behavioral momentum in academic content areas.

DESCRIPTORS: behavioral momentum, academic behavior, latency to initiate, mathematics

Providing brief and reduced assignments (Kern, Childs, Dunlap, Clarke, & Falk, 1994) and substituting difficult or unknown tasks with easy or known tasks (Cook, Guzauka, Pressley, & Kerr, 1993) are two recent approaches that have been developed to increase the fluency of academic performance. To enhance academic performance, many academic interventions (a) reduce the number of required tasks, (b) reduce the duration of the total task, or (c) substitute difficult or unknown tasks with easy or known tasks.

An alternative approach for increasing academic task performance in students with a history of academic noncompliance or lack of initiation may be derived from work on behavioral momentum (Mace et al., 1988). Following similar logic, students who typically are slow to initiate multiple-step or extended-duration academic tasks may increase initiation if the multiple-step or extended-duration (low-preference) academic task is preceded by a series of single-step or short-duration (high-preference) academic tasks. The purpose of this study was to extend the use of high-probability commands by examining the effects of a sequence of single-step single-digit multiplication problems preceding a multiple-step multiple-digit multiplication problem on the latency between the end of one multiplication problem and the beginning of the next problem.

METHOD

Participants and Setting

Allison (14 years old) and Roberta (15 years old) were enrolled in a community-based alternative education school as a result of their expulsion from the regular school

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setting for academic and social noncompliance (e.g., refusal to initiate academic tasks, refusal to follow school rules). All sessions were conducted in a classroom (15 m by 10 m) at the alternative education school.

Data Collection and Experimental Design

During the preference assessment phase, the dependent measure was worksheet selection. During baseline and intervention, latency was the dependent measure and was defined as either (a) the time between the completion of the preceding low-preference problem and the initiation of the next low-preference problem during baseline or (b) the time between the completion of the last high-preference problem and the initiation of the subsequent low-preference problem during intervention. To obtain a mean latency, the cumulative latency recorded per session was divided by the number of latency opportunities. Specifically, the investigator handed the cards to the student and (a) activated a stopwatch when the student lifted the pencil after completing either the preceding low-preference problem (baseline) or the last high-preference problem (intervention) and (b) deactivated the stopwatch when the student began the next low-preference problem. The effects of the single-digit multiplication problem sequence were assessed using a reversal (ABAB) design.

Materials and Procedure

Preference assessment. A forced-choice procedure was developed to empirically validate the hypothesis that Allison and Roberta would prefer single-digit over multiple-digit multiplication problems. Two types of worksheets were developed. Multiple-digit worksheets consisted of a series of five 3-digit multiplication problems (e.g., 648 × 794). Single-digit worksheets consisted of a series of 45 1-digit multiplication problems (e.g., 8 × 6). Problems for each worksheet were developed using a table of random numbers, omitting the numerals 0, 1, and 2. Each of the five 3-digit problems required 18 digits to complete, whereas each of the 45 1-digit problems required 2 digits to complete. The number of digits required to complete each worksheet was equated (90 total digits) so that preference would not be a function of fewer digits but rather of digit configuration.

During the preference assessment, the investigator placed one single-digit worksheet and one multiple-digit worksheet on the table in front of the participant and asked the participant to select one worksheet and to complete all problems. Sessions were conducted twice daily for 5 days. An intertrial interval (ITI) of 5 min was maintained between the two trials per day. The location of the worksheet (i.e., left, right) was counterbalanced across trials.

Interspersal of single-digit problems with multiple-digit problems. Cards for the second phase were developed with information obtained from the preference assessment. The results of the preference assessment showed that, when given a choice, both participants preferred worksheets that contained the 45 single-digit problems. These problems were defined as high-preference problems. The low-preference problems were the 3-digit multiplication problems. Two packets of cards measuring 21.6 by 27.9 cm were developed for each participant. Low-preference packets (baseline) consisted of a stack of five 3-digit problems (e.g., 593 × 679), one per card. High-preference packets (intervention) were similar to the low-preference packets with the exception that each 3-digit multiplication problem was preceded by a sequence of three 1-digit problems (e.g., 6 × 7, 7 × 4, 8 × 6, 593 × 679), one per card.

Baseline and intervention sessions were conducted in the same fashion, with the exception of the type of packet used by the participants. Throughout all sessions, no specific feedback was provided to students by investigators.

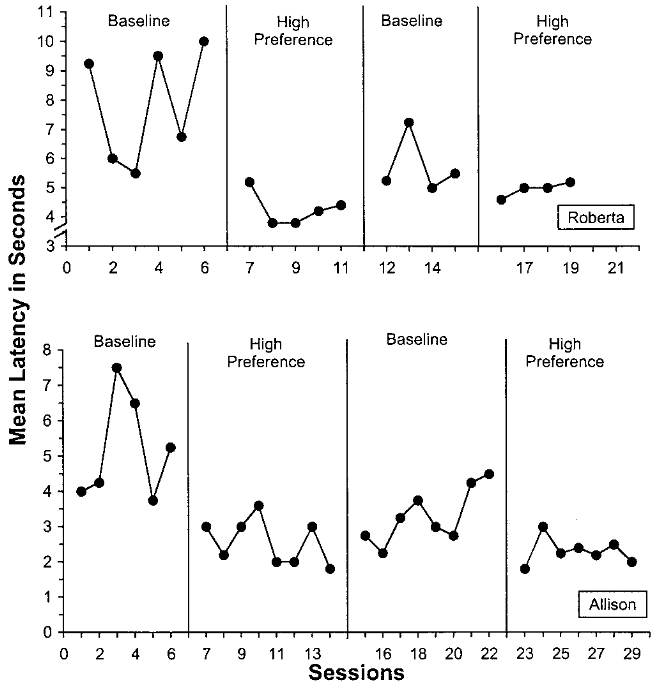

Figure 1. Mean latency (in seconds) to initiate multiplication problems with and without the high-preference sequence.

Agreement and Integrity

Integrity data were collected on all procedural components during 40% of all sessions, with agreement at 100%. Agreement data were collected on (a) worksheet selection during the preference assessment for 30% of sessions and (b) latency during baseline and intervention for 21% of sessions, with agreement at 100% and 83%, respectively.

RESULTS AND DISCUSSION

The results of the preference assessment showed that Allison selected the single-digit worksheet on 7 of the 10 trials and Roberta selected the single-digit worksheet on 9 of the 10 trials. Figure 1 shows the mean latency per session for both Roberta and Allison.

The purpose of the current study was to demonstrate the effects of completing a sequence of three high-preference mathematics problems preceding a low-preference problem on the latency to initiate the low-preference problem. The results showed that the sequence of three high-preference problems did decrease latency to initiate when compared to baseline levels of latency. It was observed that the return to baseline resulted in mean latencies that were somewhat lower than the initial baseline. This may have been due to repeated practice effects with the multiple-digit multiplication format.

These results extend research on the effects of high-probability commands in at least three ways. First, the current study extended the application of behavioral momentum to academic behavior. Previous research addressed the effects of high-probability commands on task compliance. The first step to engagement with academic stimuli is that of initiation. Both participants had a history of not initiating academic work. The incorporation of three 1-digit problems preceding a 3-digit problem decreased the time to initiate the 3-digit problem, thereby establishing a momentum-like effect between the single-digit sequence completion and the initiation of the multiple-digit problem.

Second, the current study incorporated the use of functional paper-pencil activities as the high-preference sequence. Previous studies used nonfunctional responses as high-probability commands. Using functional activities as high-preference activities when possible permits additional fluency and drill and practice during the high-preference sequence.

Third, the high-preference sequence utilized in this study relied on problem completion and not on contingent verbal praise as the reinforcer. Whereas previous research relied on one-on-one delivery of high-probability commands followed by verbal praise for each high-probability command completed, many academic settings do not permit one-on-one attention. The use of antecedent problem completion, however, does create questions as to the mechanism that is responsible for the decrease in latency between sequence completion and low-preference initiation. In the absence of experimenter praise for completion, latency may have decreased as a function of contingent positive reinforcement (e.g., completing a problem), contingent negative reinforcement (e.g., having one less problem to do), or overall reinforcement rate given specific antecedent conditions.

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