Increasing Academic Compliance with Mathematics Tasks Using the High-Preference Strategy with a Student with Autism

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ABSTRACT: The authors investigated the effectiveness of using high-preference (high-p) mathematics tasks for increasing task initiation of low-preference (low-p) mathematics tasks with a 13-year-old middle school student with autism. They used an ABAB design to determine the effectiveness of high-p tasks with to comply with low-p tasks. Results indicated that the student took less time to initiate low-p mathematics problems that were preceded by high-p mathematics problems. This study extends the literature on high-p techniques to enhance academic compliance behaviors for students with autism. The authors discuss the results and future implications.

KEYWORDS: *academics, high preference, low preference, mathematics, noncompliance*

DECREASING NONCOMPLIANT academic behaviors is a critical variable that enhances academic productivity. Specifically, noncompliance with academic demands may result in a decrease in on-task behavior and limited opportunities to participate in ongoing instruction, thus affecting academic achievement (Austin & Agar, 2005). Research has consistently indicated that there is a strong relation between on-task behaviors and academic achievement (Greenwood, Horton, & Utley, 2002). Researchers in several studies have demonstrated that the high-preference (i.e., the probability technique or high-p) strategy has improved academic performance (Lee, 2006). The high-p strategy involves a presentation of two to three preferred academic tasks (i.e., tasks that are likely to be completed with high frequency) before the presentation of a nonpreferred academic task (i.e., tasks that a student can do but in which he or she does not frequently engage). When a high-p task is presented in a sequence before a nonpreferred task—a student is more likely to comply with the nonpreferred task, a concept based on the theory of behavioral momentum (Mace et al., 1988; Nevin, Mandell, & Atak, 1983). Nevin et al. proposed that behavior possesses momentum, similar to physical momentum described by Newton's law of physical motion (Mass $\times$ Velocity $=$ Momentum). In behavioral terms, *momentum* consists of resistance to change under varying environmental conditions (analogous to mass) and response rate (analogous to velocity). Several applied researchers have demonstrated that high-p strategies based on behavioral momentum have enhanced noncompliant behaviors in persons with behavioral difficulties including noncompliance to academic tasks. (For a comprehensive review of high-p strategies, see Banda, Neisworth, & Lee, 2003; Davis & Brady, 1993; Killu, 1999; Lee, 2005, 2006.)

The high-p intervention differs from conventional sequences of instruction. Typically, content areas such as mathematics, science, and reading are taught in the morning, and areas such as music and physical education are taught in the afternoon. Although high-p research is limited with specific tasks in a subject (e.g., multiplication task in mathematics), the research may help by providing some practical guidelines for sequencing subject matter.

Belfiore, Lee, Vargas, and Skinner (1997) first investigated the high-p strategy in the area of academics. Belfiore et al. conducted a study with two children who had academic compliance difficulties. On the basis of individual-preference assessments, two to three one-digit addition problems were presented before each three-digit by three-digit multiplication problem was presented. Results indicated that participants initiated and completed mathematics problems more quickly when the addition of the high-p procedure was implemented.

In a similar study, Hutchinson and Belfiore (1998) investigated a high-p intervention for a student with academic

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noncompliance. The intervention involved presenting preferred tasks with nonpreferred tasks. Hutchinson and Belfiore observed an increase in the problem-completion rate and rate of correct digits. Similarly, Belfiore, Lee, Scheeler, and Klein (2002) demonstrated that the use of high-p tasks decreased latency to initiate mathematics academic tasks in two children with learning disabilities who had problems with academic compliance. In a similar study among elementary school-aged children, Lee, Belfiore, Scheeler, Hua, and Smith (2004) found that when combined with token reinforcers, high-p tasks enhanced the effects of high-p sequences more than did low-p and high-p sequences individually. Wehby and Hollahan (2000) conducted a study with a 13-year-old student who displayed academic noncompliance with mathematics assignments. In Wehby and Hollahan's study, when the researchers presented high-p tasks, the student took less time to initiate and spent more time doing mathematics assignments.

Although some of the emerging high-p intervention studies involved multiplication tasks, researchers have yet to investigate improving compliance and its effects for addition problems, particularly those involving missing addends. We conducted the present study for two purposes. First, the teacher identified a student with autism who needed instruction with addition and requested our assistance. Second, we investigated the effects of high-p tasks compared with those of low-p tasks for solving missing-addends problems to help the student and systemically extend the high-p technique.

Method

Participant

Brad—a 13-year-old boy diagnosed with autism and pervasive developmental disorder—received speech and language therapy services once per week and in-class paraprofessional support in inclusive classes. The Woodcock–Johnson Revised Achievement Tests (WJ-R; Woodcock & Johnson, 1989) indicated that Brad was functioning at grade level in word identification and below grade level in comprehension and problem solving. Brad was able to perform three-digit by three-digit addition problems and three-digit by three-digit subtraction problems with 100% accuracy. However, he had difficulty initiating mathematics problems, particularly missing-addend problems. Brad's teacher stated that Brad disliked solving missing addend problems although he seemed to have the requisite competency to complete them.

Setting

We conducted the study in a resource room (9 m × 4.5 m) in a middle school located in central Pennsylvania. The classroom had desks, tables, an area for group instruction (for four to five children), and two seats for independent seatwork. The specific setting for the procedures took place in one of the corners of the room; we placed a table (76 cm × 38 cm) and chair in this area. We placed a mini digital video camera approximately 1 m from the table. The video camera was installed 1 week before the study began to acclimate the participant to its presence. During the experiment, the student sat across the table and faced the video camera. The first author sat to the right side of the student and conducted all sessions. All sessions were videotaped.

Materials

Addition problems were printed on flash cards (12.7 cm × 20.3 cm). For the baseline condition, a single addition problem was printed in 16-point Times New Roman font on each card, leaving a blank space for the student to write an answer. For the intervention conditions, two three-digit by three-digit addition problems were printed on the top portion of the card, and a low-p problem (missing addend) was printed on the bottom portion. For each problem, there was enough space to write answers.

Accuracy assessment. We conducted an informal assessment to determine Brad's accuracy for missing-addend problems. We gave Brad a two-page worksheet: the first page comprised 15 three-digit by three-digit addition problems (e.g., 936 + 852 = _______), and the second sheet comprised 15 missing-addends problems (e.g., 654 + _______ = 1,065). We asked Brad to complete the problems in a single session, which took him 30 min. These results demonstrated that Brad was able to complete addition and missing addends problems with 100% accuracy.

Preference assessment. We conducted a preference assessment for three sessions. Each session involved 10 trials. In each trial, the first author presented two index cards: one with a three-digit by three-digit addition problem (e.g., 485 + 746 = _______) and the other with a missing-addend problem (e.g., 865 + _______ = 1,420). We asked Brad to pick a card that he liked and solve the problem. If he selected a card for more than 70% of the trials, it was considered to be a high-p task. Brad preferred three-digit by three-digit addition problems over missing addend problems 100% of the time. For Brad, three-digit by three-digit missing-addends problems were low-p problems. During the preference assessment, Brad had 100% accuracy in problem completion.

Dependent variable. In the present study, latency to initiate a mathematics problem (missing addend) was the dependent variable. During baseline, the time between two low-p tasks, we recorded (in seconds) the time between when Brad lifted his pencil off of the index card (completing a low-p problem) until he touched his pencil to the next index card (starting the new low-p problem). During the intervention phase, the first author recorded the time between the previous and subsequent low-p problems.

Interobserver agreement. A graduate student trained in applied behavior analysis data collection methods coded 30% of videotaped sessions to establish interobserver agreement. We calculated the agreement using the following formula: *number of seconds agreed* multiplied by *number of seconds agreed plus disagreed*, divided by 100. An average agreement of 95% was obtained (range = 93–96%).

Independent variable. The independent variable (high-p intervention) consisted of presenting a stack of cards that included two three-digit by three-digit addition problems and a missing-addend problem in a sequence. The first author provided standard instructions to complete the task. No feedback was provided to the participant during the intervention. At the end of the intervention, the first author thanked Brad for participating.

Experimental design and statistical analysis. We used an ABAB design to evaluate the effects of the high-p intervention. ABAB designs have two primary advantages: (a) the two B phases provide two opportunities for replication of the experimental effect, and (b) the experiment ends with the experimental effect intact, providing the participant with the benefit of the intervention (Kennedy, 2005). During baseline, the A phases, a stack of 10 low-p problems (missing addends) were presented to the participants. During intervention, the B phases, a stack of 10 cards, each consisting of two high-p mathematics problems and one low-p mathematics problem, were given to the participant. Data were graphed and visually analyzed using single case design techniques including stability, level, and trend in each phase and between phases.

Treatment integrity. A graduate student in educational psychology who was familiar with data collection methods independently coded 40% of the sessions for treatment integrity. The researchers developed a checklist of items that were required to be followed during the baseline and intervention sessions. The graduate student recorded *yes* if the procedure was followed by the first author and *no* for steps not followed. The following formula was used to calculate treatment integrity for each session: total number of *yes* items divided by total number of *yes* and *no* items multiplied by 100. Treatment integrity was 100% for the first baseline and 93% for the first treatment phase. Treatment integrity was 100% in the return-to-baseline phase and 93% for the second intervention phase. Overall, the average treatment integrity was 95% (range = 80–100%).

Procedure

The Institutional Review Board committee approved the present study. We obtained permission also from the school district personnel before we conducted the study. Informed consent was obtained from the parent and the participant. Initially, the first author conducted the accuracy assessment as described in the previous section with Brad. The accuracy assessment results indicated that Brad completed three-digit by three-digit addition problems and three-digit by three-digit missing addends problems with 100% accurately. Then, the first author conducted a preference assessment to determine preferences for addition digit problems or missing addends problems as described in the previous sections.

Baseline. A baseline condition was collected for four sessions. During baseline, Brad was given a stack of 10 index cards; each card had a three-digit by three-digit missing-addend problem. The first author instructed Brad to solve the problems as quickly as possible. No help was provided during baseline. At the end of task completion, Brad was thanked for working on the mathematics problems.

Intervention. During intervention phases, the first author presented a stack of 10 cards; each card had two high-p problems and one low-p problem in a sequence. The first author asked Brad to complete the addition problems as quickly as possible, beginning with two high-p problems before the low-p problem. All sessions were videotaped and later coded for data analysis.

Results

Figure 1 shows the results of Brad's initiation of low-p problems during baseline and intervention conditions. During the first baseline condition, Brad took 7–12 s to initiate low-p missing addends problems. Although the overall trend decreased, the final two data points were stable, and the intervention was applied because of time constraints. A return-to-baseline condition confirmed that the trend was similar to that in the initial baseline condition. During the first implementation of the intervention, high-p tasks were presented before low-p tasks. Brad took less than 5 s in the majority of the sessions. Brad's performance in the first intervention phase showed variability, but the overall trend was stable.

After reintroducing the baseline condition, Brad took an average of 7–8 s to initiate low-p problems. Brad's performance data showed a stable and even trend. Furthermore, after we returned to the second baseline, the data were stable and occured at the same level as the final two data points of the first baseline. After returning to the second intervention condition, Brad took 2–3 s to initiate low-p missing addends problems. The stability in this phase is clear, and there is a slightly decreasing trend. The results suggested a possible functional relation for Brad between the time to initiate low-p problems and the application of high-p problems.

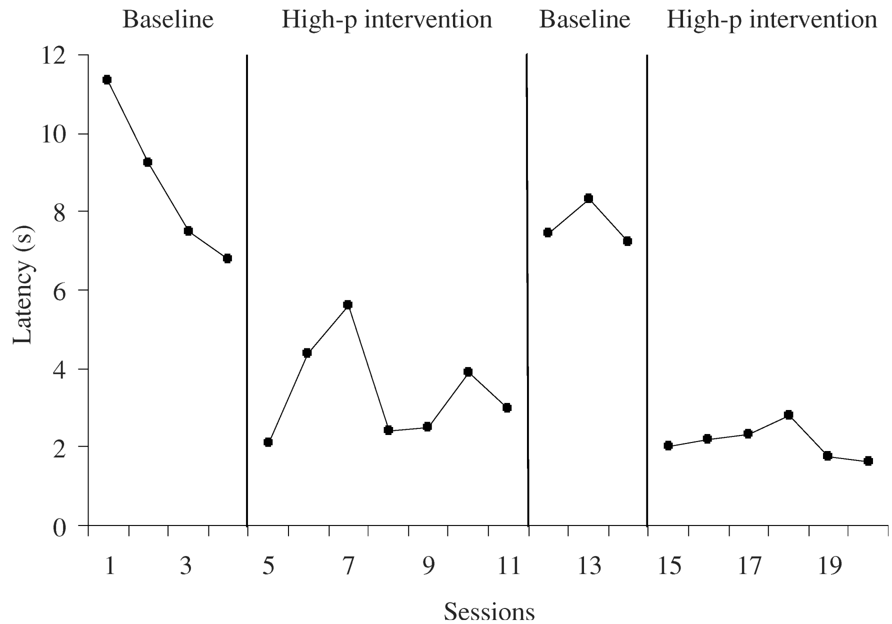

FIGURE 1. Brad's latency to initiate low-p tasks when followed by high-p tasks.

Discussion

We attempted to help a student with autism who needed practice with addition and investigate the effects of high-p tasks over low-p tasks for solving missing addends problems. The data indicated that Brad performed better during applications of high-p tasks. Also, the intervention was demonstrated and explained to the teacher, who could maintain the high-p task until Brad met his educational objective, as set by his teacher, for learning how to solve missing addends problems. Anecdotal data from the teacher indicated that Brad was more interested in missing addends problems after the intervention and showed less resistance in doing similar tasks. In addition, the teacher's comments suggested that this intervention had social validity.

In addition, results of the present study further support and extend the literature of high-p interventions to academic mathematics tasks. Specifically, our study involved addition and missing addends problems. Previous researchers have mainly concentrated on the area of multiplication problems and language skills (Belfiore et al., 1997; Hutchinson & Belfiore, 1998; Lee et al., 2004; Lee & Laspe, 2003). Results of our study appear to be similar to those reported by Belfiore et al. who, in their experiment, found that participants had taken less time initiating low-p multiplication problems that were preceded by two to three high-p problems. In addition, results of the present study further extend the application of high-p strategy to students with autism. Use of high-p problems can create frequent reinforcement opportunities for the student and may make low-p problems less aversive.

Also, results of the present study may be related to the Premack principle (Premack, 1959). According to the Premack principle, an opportunity to engage in more probable responses reinforces a less probable response or activity in individuals (Hosie, Gentile, & Carroll, 1974). In the present study, it is possible that Brad may have engaged in high-p tasks (i.e., more probable responses) that subsequently reinforced low-p tasks (i.e., less probable responses). However, an important distinction between the Premack principle and the high-p strategy is that during the Premack intervention, high-p tasks are presented only upon the completion of nonpreferred tasks (e.g., "If you finish your homework, you can go outside to play"). However, in the high-p intervention, two to three high-p tasks are presented before a low-p task (i.e., presenting two single-digit problems before a four-digit problem).

Although the results suggest that the high-p intervention was effective in decreasing the latency to complete low-p tasks, we recommend interpreting the results with caution. It is unclear why the initial baseline data phase showed a decreasing trend. It is possible that presentation of the tasks on the index cards or novelty of the presentation may have increased student motivation. Teachers typically present tasks on worksheets. However, the return-to-baseline phase strongly suggested that the high-p intervention was responsible for the decrease in latency to complete the tasks. In addition, the return-to-baseline phase rose to the same level as the final two data points of the baseline phase.

Some limitations in the present study should be noted. First, we used index cards during our experiment, whereas teachers typically use worksheets in classrooms. When investigating the effects of high-p strategies, researchers should examine the different response requirements between written and verbal responses. Second, we did not collect follow-up data because it was the end of the school year. Third, we did not collect generalization data. It is unclear whether the effects of the high-p intervention generalize to other similar mathematics tasks. Additional studies are needed to investigate generalization effects.

In conclusion, the present study, along with previous research, suggests that the high-p strategy is portable, easy to construct and implement, and practical for students who show academic noncompliance to mathematics problems. Teachers should be aware that high-p tasks may be useful only if the student already possesses some level of acquisition of the task but shows less interest in doing the task. Also, the high-p strategy is nonintrusive and may motivate students to comply with academic tasks that are aversive, which eventually may improve their performance in mathematics. Last, assessing the student's task preferences may be helpful in delivering academic instruction; including preferred content enhances academic productivity.

AUTHOR NOTES

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