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THE DIFFERENTIAL EFFECTS OF DIRECT INSTRUCTION FLASHCARDS AND MATH RACETRACK ON NUMBER IDENTIFICATION FOR THREE PRESCHOOL STUDENTS WITH DISABILITIES

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ABSTRACT

The purpose of this study was to determine the effectiveness of DI flashcards and a math racetrack procedure on the number identification for three children in a special education preschool program. A multiple baseline across number groups and participants; with a variation in the ratio of mastered to unknown number facts around the racetrack was employed. About half way through the study, when a student appeared to loss interest and motivation, an alternative reward was put in place in hopes of increasing his performance. Unfortunately, the change of reward was found to be unsuccessful, and this intervention was not seen as successful with this particular student. The results for the other two participants indicated that the DI flashcards and math racetrack were effective in increasing the accuracy, fluency and retention of the identifying basic numbers. Data collection was very practical and easy to implement in a school setting.

Key words: preschool students with disabilities, number identification, flashcards, and math racetrack

INTRODUCTION

In everyday life there are many important tasks require math. Therefore, it is apparent that math proficiency is necessary for almost any aspect of daily life, especially, school or work. According to Curico (1999), learning basic facts is not a prerequisite for solving problems, but learning facts becomes a necessity to solve problems that are meaningful, and relevant. Number identification is a prerequisite for all areas of math, and is a skill set that our society expects pre-kindergarteners to have already mastered (Shapiro, 2011). Our society expects a great deal from our education system, and schools are expected to hold students to high standards when it comes to the mastery of important academic subjects, including math (Ravitch, 2010). This continuing struggle causes great concern for parents, teachers and school policy makers (Stein, Kinder, Silbert, & Carnine, 2006). Math underachievement also poses major problems for typically developing children in general education classrooms (Shapiro, 2011), as these students do not and cannot grasp the academic concepts as they are presented. Difficulties in learning math are also common amongst children with disabilities (Garnett, 1998; Shapiro, 2011).

As noted in the Diagnostic and Statistical Manual of Mental Disorders, 4th Edition, Text Revision (DSM-IV-TR), individuals with Developmental Delays or Down Syndrome have cognitive delays and deficits, often times affecting their IQ and academic performance in school. There is a growing body of literature on the use of employing racetrack like procedures to improve the fluency and skills for students with disabilities (McLaughlin, Weber, Derby, Hyde, Violette, Barton, et al., 2011; Rinaldi&

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McLaughlin, 1996; Rinaldi, Sells, & McLaughlin, 1997). Rinaldi et al. (1997) found that employing such procedures improved both sight word recognition and comprehension with general education and special education students. A math racetrack was a game board like track that simulates a racetrack. A math racetrack contains 28 spaces on which to write math facts or numerals to be learned. Students are required to read the item and state the answer as quickly as possible before they were allowed to move to the next square containing the next item. The first author provided praise and feedback as the student tried to complete the track as fast as possible.

The use of the Direct Instruction (DI) flashcard system (Silbert, Carnine, & Stein, 1981) has been shown to be effective for teaching basic skills. Using DI flashcards in math requires the teacher to develop flashcards with the problem on one side and the math problem and its solution on the other. Which problems are used were determined through pretesting. The ratio of unknown to known facts has been suggested as 20% unknown while the remaining math facts were answered correctly during pretesting (Silbert et al., 1981). However, but little evidence has been found to support this notion (Becker, McLaughlin, Weber, & Gower, 2010; Brasch, Williams, & McLaughlin, 2008; Glover, McLaughlin, Derby, & Gower, 2010). When the student makes an error, this error card is placed back into the stack three or four cards from the top. This is done so it can reappear quickly. When the student makes an error, the teacher engages in the model, lead, and test error correction procedure (Rinaldi et al., 1997). First, the teacher models the correct problem and response. Next the student and the teacher say the problem and answer together. Finally, the student is required to make an independent response to the error card. If the response is correct, then this error card is placed three or four cards from the top (Glover et al., 2010). If the student again makes an error, the same model, lead, and test procedure occurs with the flashcard again being placed three or four cards from the top. If the student makes the correct response, then this former error flashcard is placed at the bottom of the stack. Employing DI flashcards have been effective in teaching students with disabilities sight-word recognition (Erbey, McLaughlin, Derby, & Everson, 2011; Kaufman, McLaughlin, Derby, & Waco, 2011; Ruwe, McLaughlin, Derby, & Johnson, 2011), their basic math facts (Becker, McLaughlin, Weber, & Gower, 2009; Brasch et al., 2008; Glover, McLaughlin, Derby, & Gower, 2010; Hayter, Scott, Weber, & McLaughlin, 2007; Sante, McLaughlin, & Weber, 2010), or naming colors and shapes (Travis, McLaughlin, Derby, Dolliver, &Carosella, 2012). An additional advantage of this and other flashcard system is the ease at which it can be implemented in almost any academic subject area or classroom setting, to teach specific skills quickly and easily (Van Houten&Rolider, 1989). It has been shown that students that are taught using this teaching method have performed higher on post-test compared with students who are taught using traditional methods (Sindelar& Wilson, 1991). When paired with a math racetrack, the implementation of DI flashcards in a special education preschool classroom may well a very good chance of teaching number identification, promoting the acquisition of beginning math knowledge, and has the potential to ultimately set students up for classroom success.

The purpose of this particular study was to increase the accuracy and fluency of basic number identification with three special education preschool students with disabilities. The ultimate goal was to prepare them for their transition to kindergarten. Since number identification is identified as a pre-kindergarten skill, an additional goal was to determine if DI flashcards and a math racetrack could be implemented and evaluated in a preschool classroom setting. A final purpose to attempt to determine which ratio of known to unknown numerals was the most efficacious for our participants.

METHOD

Participants and Setting

There were three participants in this study. All three participants were selected for this study by their preschool special education teacher because they were to transition to kindergarten at the end of the school year, and their teacher was concerned about their academic preparedness. For entering kindergarten, it is expected for children to be able to identify numbers 1 through 20, and the three students had not mastered this kindergarten readiness skill.

The first participant was a five-year-old Asian-American male with Down syndrome. He attended special education preschool with goals in the areas of academic, occupational therapy, physical therapy, and speech and language. Although, he tested significantly higher than his peers on the pretest, his teacher wanted him to participate in the study to prepare him for his transition to kindergarten the following year.

The second participant was a five-year-old Caucasian male with developmental delays. He attended special education preschool with goals in the areas of academic, and speech and language. The student had not learned numeral identification during the course of typical group instruction in his preschool, and so he was a good candidate for this one-on-one instructional study.

The third participant was a four-year-old Caucasian male with Developmental Delays and a suspected diagnosis of attention deficit disorder (ADD) and attention deficit hyperactivity disorder (ADHD). He attended special education preschool to work on goals in the areas of academic and social. Participant 3 was taking medication (Ritalin) to address his ADD and ADHD and help him remain focused and be less hyperactive when attending school, however his doctor and mother were in the process of finding the perfect dosage to attain maximum benefits.

This study took place in an instructional student workroom across the hall from the students' self-contained preschool classroom. These three participants attended the afternoon session of preschool and there was a total of seven students in the class. Also present in the classroom were three Instructional Assistants (IAs), the classroom teacher, and the first author. Support personnel such as physical and occupational therapists came in and out of the classroom throughout the afternoon. The researcher worked with each participant individually for ten minutes each session at an empty table in the workroom.

Materials

The researcher used flashcards, in which a single number was printed on each card. A kitchen timer was used to keep of timings on the math racetrack. The math racetrack that was used in this study (McLaughlin et al., 2011) contained printed numbers on the track four or five times each in a random order (Beveridge, Weber, Derby, & McLaughlin, 2005; Rinaldi et al, 1997) depending on the size of the set. The numbers were written in a random order to prevent participants from memorizing the order of the numbers.

Dependent Variables and Measurement

There were two dependent variables measured in this study. The first dependent variable was the number of correctly identified numbers by each participant. A correct response was defined as the participant saying the number within five seconds of the flashcard being presented. The second dependent variable was the number of errors made during each session by each participant. A response was scored as an error if a participant said an incorrect number or if a response was not made within the five-second-time allotment. If a participant incorrectly labeled a number and then self-corrected within that five seconds, an error was not recorded and the response was considered a correctly identified number.

Data Collection and Interobserver Agreement

Data were collected by the researcher at the end of each session recording the accuracy and fluency of the two targeted behavior. The researcher went through the flashcards with each participant without providing assistance or feedback to the responses of each individual. The researcher marked correct or incorrect on the data sheet for each number.

Interobserver agreement data were collected on 3 of the 10 (30%) sessions during intervention for Participant 1, 4 of the 12 (30%) sessions of intervention for Participant 2, and on 5 of the 14 (36%) sessions of intervention for Participant 3. Interobserver agreement data were collected from a videotape of these sessions taken with a digital camera. This footage was shown another undergraduate student from the same university and an independent tally, on a separate data-recording sheet for corrects and errors, was made. This data-recording sheet was identical to the one used by the researcher, excluding the table where the math racetrack times were recorded. The number of correct and incorrect responses, recorded by each observer on their individual recording sheet, was compared.

The smaller number of corrects and errors were divided by the larger and multiplied by 100 for each session. Mean agreement was 100% for all sessions.

Experimental Design and Conditions

A single subject, multiple baseline design (Kazdin, 2010) across three participants and different sets of numbers was used to evaluate the effectiveness of both the direct instruction flashcards and math racetrack to teach number identification. Participant 3 received two days of baseline before beginning intervention, Participant 1 received three days of baseline and Participant 3 received four days of baseline. Each participant was introduced to two sets of numbers, based on the data collected during baseline. The sets were introduced in a staggered fashion, and the introduction of a new set of numbers was dependent on each participant's success with the previous set of numbers.

Baseline

During baseline, the researcher individually presented numbers one through twenty on flashcards. As each number was presented.the first author said, "What number?" to the participant, and their responses were recorded. Participants were not given any feedback regarding the accuracy of their responses during this time. However, they were encouraged to try their best and verbal praise was given for participation.

DI flashcards and math racetrack

Two sets of numbers were created for each participant. The order of numbers was dependent on each participant's performance during baseline. For Participant 1, Set 1 consisted of five known numerals and two unknown numerals, and Set 2 consisted of five known numerals and three unknown numerals. For Participant 2, Set 1 consisted of three known numerals and two unknown numerals, and Set 2 consisted of five known numerals and two unknown numerals. For Participant 3, there were not any known numerals identified in baseline, so Set 1 consisted of three unknown numerals and Set 2 consisted of three known numerals and one unknown numeral.

At the beginning of each session, the researcher went through the flashcards of the current instructional set of flashcards with the participant. The set was gone through three times before taking data on the responses of the participants. During practice rounds, participants were given verbal praise and high-fives for correct responses. When incorrect responses were given a model, lead, test correction format was employed and the missed flashcard was moved three places back in the stack. Data was taken during the fourth time through the flashcards. The researcher made a pile of correct flashcards and a separate pile of incorrect cards. The same model, lead, test correction procedure was used by the researcher with the flashcards in the incorrect pile to review unknown numerals. The researcher recorded the number of correct responses and the number of incorrect responses for each participant on the data recording sheets. This recorded baseline data on numerals that participants had not received instruction on while also recording maintenance data on numerals that had been previously mastered.

At the end of each session, a math racetrack was used to practice fluency with the current instructional set of numbers for each participant. The researcher pointed to the first number on the racetrack and said, "Ready, set, go!" and started the timer for three minutes. The participants then identified the numerals on the track one at a time as the researcher pointed to each number, and they were encouraged to go as fast as they could without making mistakes. Upon completion, the amount of time in seconds it took each participant to complete the racetrack was recorded on the data recording sheets.

DI flashcards and math racetrack with toy car reward

About half way through the study, Participant 3 lost total interest in both interventions and his scores took a drastic drop. The researcher tried implementing a new reward strategy for just this participant in hopes of increasing motivation and his scores. The changed reward system was he would earn a toy racecar contingent on correctly identifying three of his four numbers included in his Set 2 flashcards. This additional condition for Participant 3 was implemented exactly like the original DI flashcards with math racetrack condition, except for a new reward system was in place.

RESULTS

Baseline

During the initial baseline period, the results for Participant 1 were at low enough of a level of performance to justify intervention. The performance for Participants 2 and 3, prior to the implementation of DI flashcards and math racetrack, were consistently very low. The baseline phase of number identification began with three sessions for Participant 1 who identified 12 numbers twice, and 10 numbers during the final session of baseline. Participant 2 had four sessions of baseline who identified three numbers twice, four numbers once and four numbers once. Participant 3 had two sessions of baseline, during which zero letters were identified.

The target numbers that were consistently misidentified during baseline were divided into two sets, and were presented to each participant in a multiple baseline design across sets. Participant 1 showed that he had not mastered the target numbers in each set during baseline. For Set 1, Participant 1 correctly identified an average .33 numbers out of 2 (range 0-1), and for Set 2 he correctly identified an average .33 numbers out of 2. For Set 1, Participant 2 correctly identified an average .25 numbers. For Set 2 he correctly identified an average .4 numbers out of 2 (range 0-1). And for both Set 1 and Set 2, Participant 3 correctly identified zero numbers during both conditions of baseline, indicating a stable flat trend.

DI Flashcards and Math Racetrack

The results of the DI flashcards and math racetrack procedure, across all three participants, are presented in Figure 1. During baseline the students showed low levels of expressive identification of numbers one through twenty. When the DI flashcards and math racetrack procedure was implemented, the students began to show progress.

The results for Participant 1 are shown in Figure 1. Following the implementation of DI flashcards and math racetrack, Participant 1 demonstrated mastery of Set 1, and for Set 2 he correctly identified an average 2.5 numbers out of 3 (range 2-3) when shown the number printed on a flashcard.

The results for Participant 2 are shown in Figure 2. Following the implementation of DI flashcards and math racetrack, Participant 2 demonstrated mastery of both Set 1 and 2. He correctly identified every number 100% of the time during the last three sessions of each set, when shown the number printed on a flashcard.

The results for Participant 3 are shown in Figure 3. Following the implementation of DI flashcards and math racetrack, Participant 3 demonstrated mastery of Set 1, correctly identifying all three numbers 100% of the time during the last three sessions of that set. During intervention of Set 2, he correctly identified an average .2 numbers out of 1 (range 0-1).

DI Flashcards with Math Racetrack with Toy Car Reward

In an effort to increase motivation and improve Participant 3's scores, after a return to baseline, the researcher gave Participant 3 the opportunity to earn a toy car contingent on him correctly identifying three out of five of the cards in Set 2. During this time, Participant 3 correctly identified the one target number for Set 2.

DISCUSSION

The results showed that two out of the three participants made progress using the intervention of DI flashcards and a math racetrack, which supports previous research showing the effectiveness of this intervention when teaching children with disabilities. This replicates our previous research in math with flashcards and a racetrack procedure (Beveridge et al., 2005; Kaufman et al., 2011), reading sight words using flashcards with a reading racetrack (Falk et al. 2003; Printz, McLaughlin, & Band, 2006; Rinaldi et al., 1996, 1997, Shahtout, McLaughlin, Derby, &Arenez, in press). All three preschool students seemed to enjoy their time spent working with the first author during each session. The two participants that improved their number identification skills using these interventions, there would be no reason to believe that they could not master additional academic subjects and materials.

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Participant 1 responded well to the intervention and showed great progress throughout the study. He enjoyed the individual attention provided by the researcher during each session, and was willing and excited to work when asked. He worked hard and remained positive during both portions of the intervention. He became very excited when he got to move on to new sets of numbers, and really responded well to specific and general praise like high fives and the occasional "you are such a smart boy!" He did not grow bored with either intervention, and never got frustrated when coming up against numbers he could not remember the name. The intervention should have continued for at least one more session at the end of Set 2 to demonstrate mastery. However, due to time constraints the researcher was unable to do so, and because of Participant 1's previous performance and response to the intervention, there is no reason to believe he would have not been able to demonstrate mastery within one or two additional sessions.

Participant 2 responded well and made progress in numeral identification. He would sometimes have a hard time transitioning from freeplay to working with the first author, so his sessions began as soon as he entered the classroom, and put his coat and backpack away. He would often times try to negotiate with the first author on how many pieces of candy he could earn for each session. However, the participant enjoyed the individual attention during each session and was especially enthusiastic about the racetrack portion of the intervention. He responded very well when he beat his previous time, showing intrinsic motivation to improve on his numeral identification.

Participant 3 did not respond well to our procedures. He was labeled as Developmentally Delayed, but his doctor was actively pursuing a diagnosis of ADD and ADHD. His parents and the classroom teaching staff often found he had a difficult time sitting still and concentrating for a small period of time. It appeared was unfamiliar with the concept of flashcards or understanding the idea of racetrack. When he was observed by the staff or one of the authors, it was often quite clear, he was uncomfortable with each intervention. During the flashcard portion of the intervention, he would often become easily frustrated when he misidentified numbers. Next, he would start to yell or try to escape from the worktable. The first author tried increasing the frequency of providing rewards to the participant. with two pieces of candy at the end of each session and giving him one piece of candy every three minutes during each 10 to 12-minute session. That change did help the participant stay on task, but it did not improve his accuracy.

Participant 3 constantly talked about red racecars and expressed his interest in these items, and so the researcher decided to provide the participant with red toy cars as rewards during the end of Set 2. The researcher chose to make the toy car rewards contingent on three accurate responses per session, and told the participant that if he were to accurately identify three of the five numbers during the flashcard portion of the session, he would earn a red Hot Wheels car. The participant became really excited whenever the researcher brought this up, and seemed to be motivated to work hard and earn a racecar. Unfortunately, as soon as he started misidentifying numbers he became extremely frustrated and totally lost interest in the tasks.

The procedure was practical to employ in a preschool classroom for two of our three participants. Each session took between 10 and 12 minutes, making it a realistic academic activity to do with a student during a school day. The actual procedures would be very easy to teach to an aide or parent, so if a teacher were unable to leave the classroom to implement the intervention, another adult would be able to do so. Data collection was simple and easy to monitor. The procedure was very inexpensive, and could be easily carried out with a teacher's classroom budget. The only materials necessary were a racetrack game board and blank flashcards. Overall, it was an easy study to be carried out in preschool setting.

In this study, participants received instruction in each current set of numbers using DI flashcards and the math racetrack. Skinner (1957) stated that verbal behavior is characterized by the functionality of the behavior, and that language taught under one circumstance may not occur under another circumstance. In this present study, numeral identification generalized across two different number activities (Stokes & Baer, 1977). In order for students to be successful in elementary school, they must also be able to generalize between numbers in different prints and sizes and academic settings to truly be considered proficient in the area of numeral identification. This results of this study showed that it could help promote such academic success at school. Since our procedures appeared to promote generalization across two sets of numerals, our procedures appeared effective for two out of our three preschool students. The lack of a clear functional relationship with Participant 3 and the delayed effect with Participant 2, indicate that more research with young children needs to occur. In our other work with preschool students, we have found differential effects with flashcards and racetrack-like procedures (Travis et al., 2012).

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FIGURES

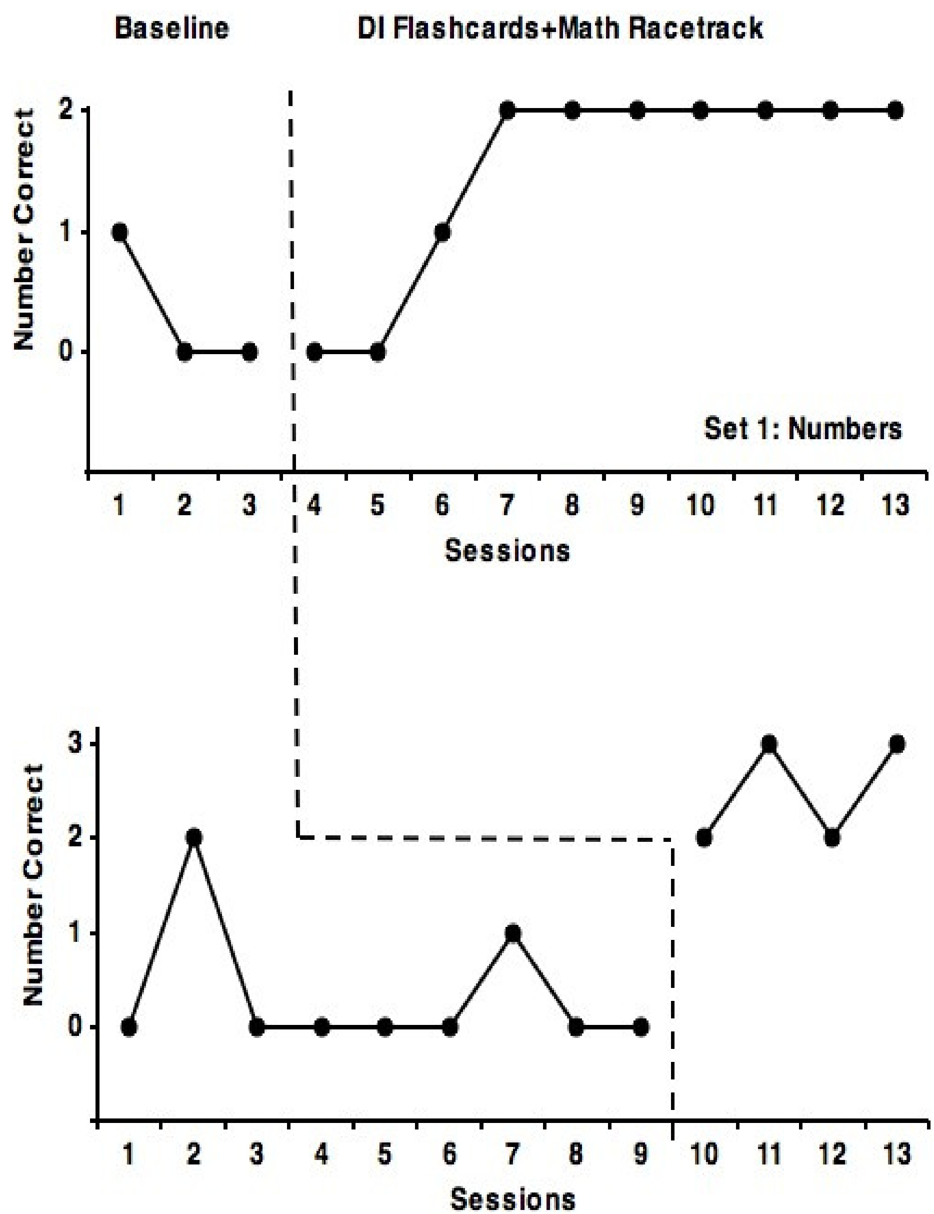

Figure 1. Number of correct identified numbers using DI flashcards for Participant 1

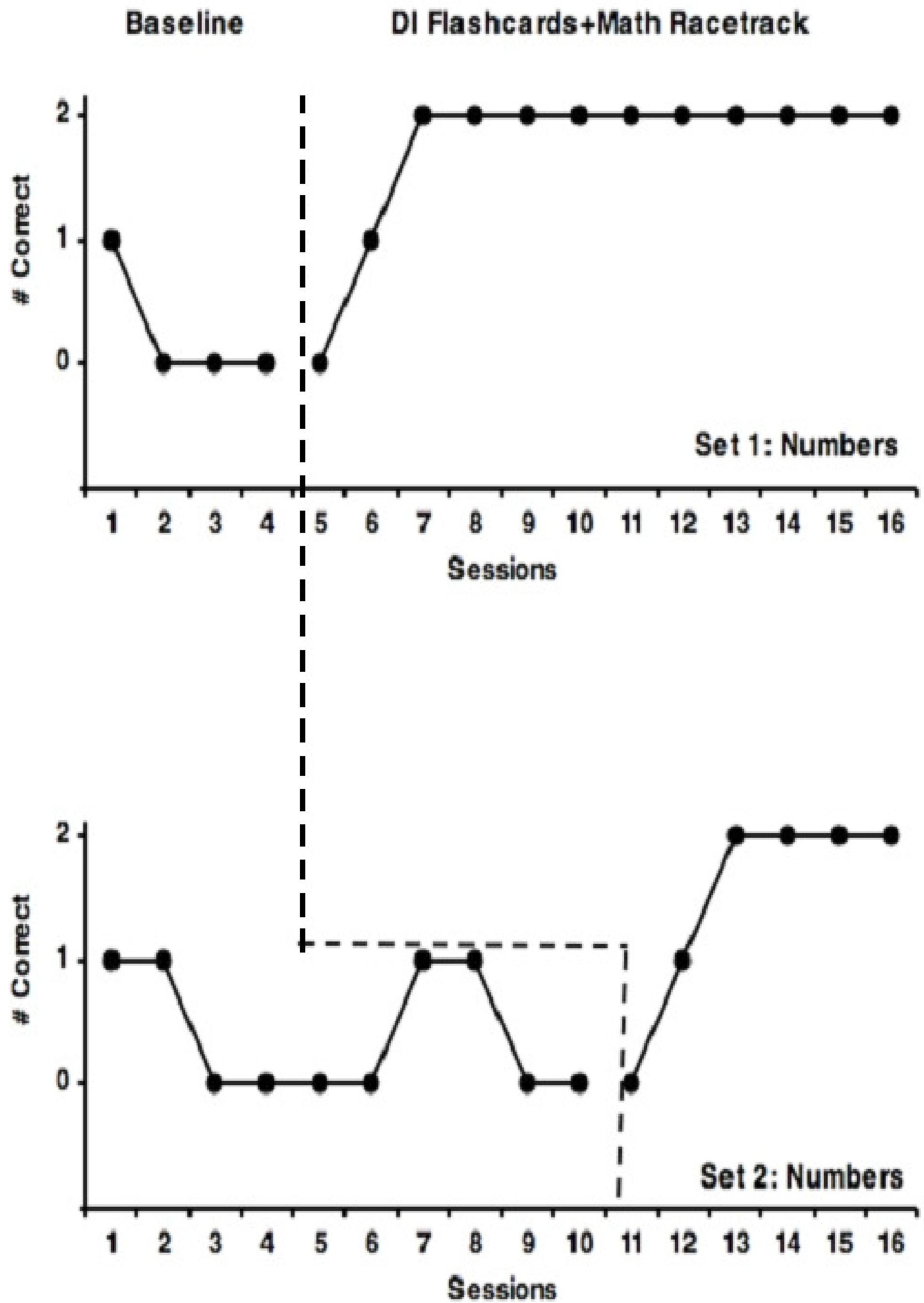

Figure 2. Number of correct identified numbers using DI flashcards for Participant 2

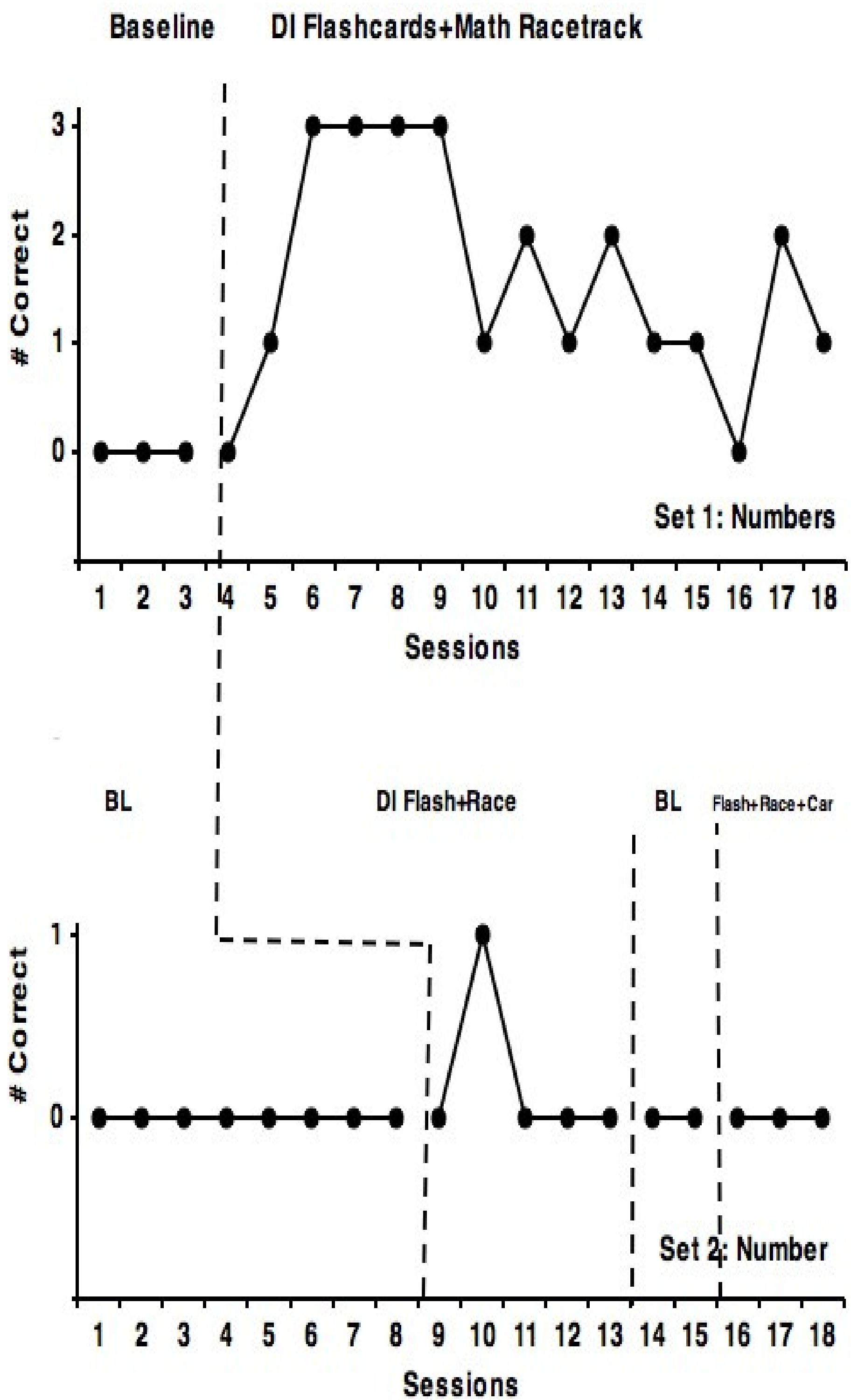

Figure 3. Number of correct identified numbers using DI flashcards for Participant 3