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An Evaluation of Constant Time Delay and Simultaneous Prompting Procedures in Skill Acquisition for Young Children with Autism

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Abstract: Previous research has shown that various prompting procedures are effective in teaching skills to children and adults with developmental disabilities. Simultaneous prompting includes proving a prompt immediately following an instruction; whereas constant time-delay procedures include a set time delay (i.e., 5 s or 10 s) prior to delivering a prompt following an instruction. These prompting procedures have been previously compared with mixed results. The current study used an alternating treatments design to compare simultaneous prompting to a constant time-delay procedure to evaluate efficacy and efficiency of each procedure, in addition to the number of errors which occurred under each condition. Results from the current study are discussed as well as limitations and future directions.

Time (prompt) delay procedures (i.e., constant and progressive time delay), involve initially presenting an instruction and immediately prompting the correct response. After a few trials of providing an immediate prompt, a short delay occurs between the instruction and the prompt. This delay may either remain a constant duration of time (i.e., constant time delay) or an incremental increase in duration on consecutive trials (i.e., progressive time delay). The purpose of this delay is to provide an opportunity for the child to respond independently (thereby transferring control of the response from the prompt to the instruction). The constant time delay has been used to teach a variety of discrete and chained behaviors, and has been identified as an evidenced-based procedure for teaching sight words and picture recognition (Browder, Ahlgrim-Delzell, Spooner, Mims, & Baker, 2009). Many variations of a constant time-delay procedure have been used to teach vocal/verbal language skills (Carbone, Sweeney-Kerwin, Attanasio, & Kasper, 2010; Charlop, Schreibman, & Thibodeau, 1985; Halle, Marshall, & Spradlin, 1979; Ingenmy & Van Houten, 1991), academic (Cates et al., 2007; Coleman-Martin & Heller, 2004; Heal, Hanley, & Layer, 2009), self-help (McDonnell & Ferguson, 1989), and leisure skills (Wall & Gast, 1997).

In addition to the constant time delay, simultaneous prompting has been used successfully to transfer stimulus control. This procedure involves presenting a prompt immediately following the instruction on all trials. There is no opportunity to respond independently, and therefore, probe trials are conducted each day of instruction to determine whether stimulus control has been transferred. Simultaneous prompting has been used effectively to teach a variety of academic tasks (Akamanoglu & Batu, 2004, Akamanoglu-Uludag & Batu, 2005, Leaf, Sheldon, & Sherman, 2010; Riesen, McDonnell, Johnson, Polychronis, & Jameson, 2003), and self-help skills (Kurt & Tekin-Iftar, 2008; Parrott, Schuster, Collins, & Gassaway, 2000; Sewell, Collins, Hemmeter, & Schuster, 1998).

Several studies have compared the constant

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time delay and simultaneous prompt procedures (Head, Collins, Schuster, & Ault, 2011; Kurt and Tekin-Iftar, 2008; Riesen et al., 2003; Schuster, Griffent, & Wolery, 1992; Seward, Schuster, Ault, Collins, & Hall, 2014; Tekin and Kircaali-Iftar, 2002). Both prompting procedures have been shown to be effective for teaching a variety of skills. For example, Schuster et al. (1992) taught sight words to elementary students diagnosed with intellectual disabilities. Although both procedures were effective in teaching sight words, the simultaneous prompting procedure required fewer trials, sessions, and training time to meet the pre-established criterion. In addition, the simultaneous prompting procedure resulted in fewer errors during teaching sessions and daily probes.

Additionally, Tekin and Kircaali-Iftar (2002) taught three children with intellectual disabilities to receptively identify animals, and both procedures were, again, equally effective. Kurt and Tekin-Iftar (2008) taught leisure skills to four children diagnosed with autism. The results showed that both procedures were equally effective in teaching leisure skills for three of the four children. Two of the children also had fewer errors with the constant time delay and the other two had fewer errors with the simultaneous prompting procedure.

Head et al. (2011) compared the procedures in teaching state capitals to four high school students with learning and behavior disorders. The results showed both procedures were effective in teaching the state capitals. There was no clear difference across students regarding the number of errors, although individual differences showed slight advantage to one or the other procedure, depending on the participant.

Although the majority of research has shown that both procedures are equally effective, there are instances where one procedure may be more effective than the other. Riesen et al. (2003) also taught academic skills (i.e., read or define vocabulary words) to four students diagnosed with moderate to severe intellectual disabilities. Results showed that, although both procedures were effective in teaching academic skills, the constant time delay procedure was slightly more effective for two participants, and the simultaneous prompting procedure was more effective for the other two participants. In a more-recent study, Seward et al. (2014) taught two solitaire card games to five high school students with moderate intellectual disabilities. The results showed both procedures were effective with four students; however, the simultaneous prompting procedure was more effective for one student. Additionally, there were fewer errors during probes in the constant time delay, and less errors in teaching with the simultaneous prompting procedure.

In general, it is important to note that both prompting procedures seem to be effective teaching procedures for students with intellectual disabilities; however, the efficiency of the two procedures has also been evaluated. For example, Tekin and Kircaali-Iftar (2002) also measured the amount of training time necessary across procedures. The results showed that the simultaneous prompting procedure resulted in less training time than the constant time delay prompting procedure. This is another important variable to be considered when evaluating these two prompting procedures.

The results from these studies suggest at least two findings. First, both procedures seem to be effective in teaching a variety of skills, with occasional individual differences in effectiveness for one or the other procedure. Second, results from the studies suggest differences in efficiency (e.g., number of errors). Overall, fewer errors were found using the simultaneous prompting procedure in two studies (Schuster et al., 1992; Tekin & Kircaali-Iftar, 2002), errors were not measured in one study (Riesen et al., 2003), and mixed results were found in the most recent studies (Kurt & Tekin-Iftar, 2008; Head et al., 2011; Seward et al., 2014). The measurement of errors, however, can be further divided between those that occur in daily probes (required only in simultaneous condition) versus training sessions. That is, errors potentially can occur when the skill is probed each day, and also during training (although this is not likely with simultaneous prompting since the correct answer is immediately prompted). In the studies conducted to date, results pertaining to errors differed across studies. These differences include simultaneous prompting resulting in fewer errors during both probes and training sessions (Schuster et al.), fewer errors

in probes for constant time delay and fewer errors in training sessions for simultaneous prompting (Seward et al.), errors were not recorded (Riesen, et al.), combined across probes and training (Kurt & Tekin-Iftar), reported only in probes because none occurred in training (Head et al.), or procedures were not clear whether errors were combined or only from training (Tekin & Kircaali-Iftar). Therefore, drawing conclusions about the differences between the two procedures regarding errors would be premature at this point.

Thus far, data from previous research shows both prompting procedures effective in teaching skills and neither prompting procedure clearly more efficient. No studies to date, however, have compared these two procedures for young children diagnosed with autism under the age of six. The purpose of this study, therefore, was to compare the constant time delay and simultaneous prompting procedures with young children with autism, and to specifically investigate the differences in errors in both daily probes and teaching sessions.

Method

Participants

Participants included one female and six males diagnosed with autism ranging in age from two to six years old. Five of the participants were receiving behavioral intervention services for approximately 30–35 hours a week in their homes. Two participants were receiving behavioral intervention services four hours a week at a university-based autism clinic.

Therapists included the undergraduate students at a local university. All therapists had completed at least one semester of intensive internship training in applying behavioral principles to teaching children diagnosed with autism. The lead therapists, the first three authors, met with other therapists on their teams prior to beginning a program to ensure that each program was conducted correctly and with high treatment fidelity.

Settings and Materials

The study was conducted in a therapy room at a university-based autism clinic for two participants and in a designated area of the home for the other five participants. Participants and therapists sat across from each other at a small table or on the floor. Preferred toys, food, and beverages were used as putative reinforcers for correct responding during sessions. Various materials such as pictures and flashcards were used to implement the various programs.

Data Collection and Response Measurement

The primary dependent variables were the number of targets to mastery criterion and number of errors during teaching and probe sessions. During sessions, data were collected on correct responses, no responses, and errors emitted during trials. A *correct response* was defined as an accurate, independent response within 5 s of the instruction. A *no response* was defined as the omission of a response within 5 s of the instruction. An *error* was defined as an incorrect response within 5 s of the instruction. The mastery criterion for each target was 100% correct during a daily probe session.

Interobserver Agreement and Treatment Integrity

Interobserver agreement (IOA) of the dependent variables was collected during 9%–100% of sessions for each participant. Interobserver agreement was calculated by comparing each observer's data using a trial-by-trial method. Agreements for each trial were defined as each observer scoring the same responses. The trials scored as agreements were summed and divided by the total number of trials and multiplied by 100%. IOA was calculated for 18% of sessions with Shawn and ranged from 95–100%. IOA was calculated for 100% of sessions with Max and ranged from 97–100%. IOA was calculated for 15% of sessions with Nick and ranged from 88–100%. IOA was calculated for 9% of sessions with Brian and was 100% across all sessions. IOA was calculated for 77% of sessions with Maria and ranged from 94–100%. IOA was calculated for 88% of sessions with Derek and ranged from 97–100%. IOA was calculated for 33% of sessions with Edward and was 100% across all sessions.

Treatment integrity was measured using a

TABLE 1

List of Participants, Ages, and Targets Selected from Current Treatment Plans

Participant	*Age*	*Target Skill*
Shawn	6	Expressive Addition
Max	2	Matching Associate Pictures
Nick	4	Expressive Adverbs
Brian	4	Expressive Adverbs
Maria	3	Receptive Picture Identification
Derek	2	Receptive Object Identification
Edward	3	Expressive Adjectives

procedural task analysis and was calculated by summing the number of steps implement correctly by the therapist, dividing by the total number of steps and multiplying by 100%. Treatment integrity was collected for 6%–18% of sessions for each participant and was 100%.

Experimental Design

An adapted alternating treatments design was used to compare the simultaneous prompting and constant-time delay procedures (Sindelar, Rosenberg, & Wilson, 1985).

Procedure

Specific target skills for each participant were identified from their individualized treatment plan. Several targets (two to four per condition, total of four to eight targets) for each specific skill were identified and randomly assigned to one of the two conditions. For example, if the specific skill was addition, three targets (e.g., 1+2, 3+4, 5+6) were assigned to the simultaneous prompt condition and three more targets (e.g., 2+4, 3+5, 1+6) were assigned to the constant prompt-delay condition for a total of six targets. Considerations were taken to ensure that targets were relatively

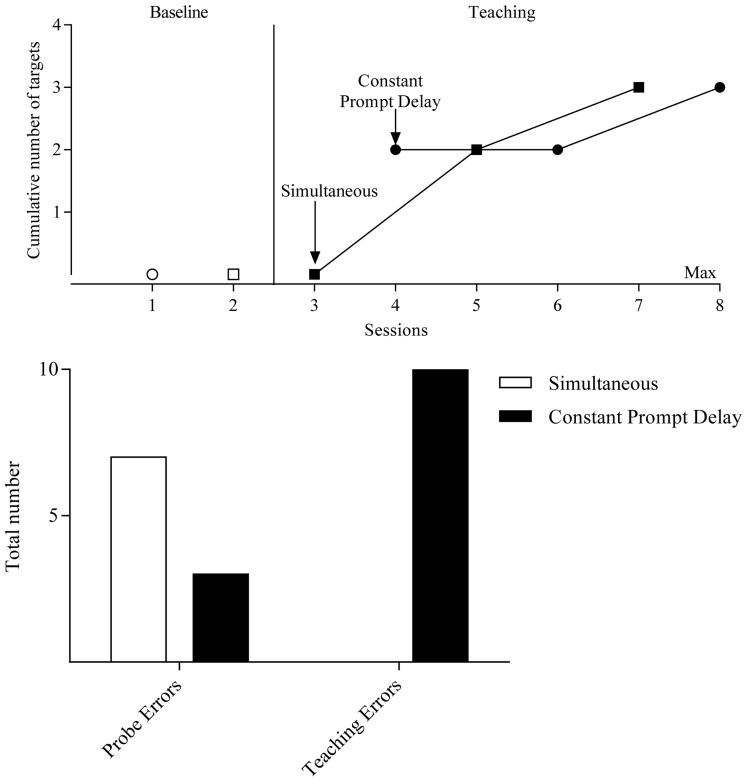

Figure 1. The top panel depicts the cumulative number of target responses that reached criterion in the constant time delay and simultaneous probe sessions. The bottom panel depicts the total number of errors during teaching and probe sessions across simultaneous and constant time delay conditions.

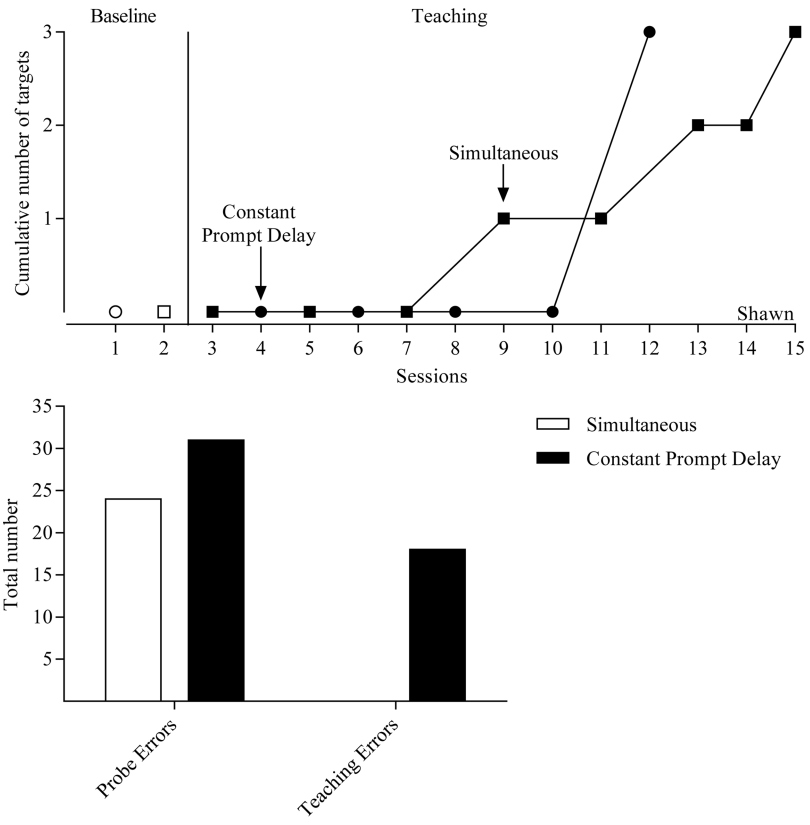

Figure 2. The top panel depicts the cumulative number of target responses that reached criterion in the constant time delay and simultaneous probe sessions. The bottom panel depicts the total number of errors during teaching and probe sessions across simultaneous and constant time delay conditions.

equal in complexity and difficulty. For example, when math problems were the target, all problem included single digits and were all either addition or subtraction. If the response was a vocal/verbal response, the responses were matched such that approximately the same number of words was required across targets. Table 1 includes a summary of the target skills for each participant.

Probe trials. At the beginning of each session, three probe trials were conducted for each target which was still in acquisition. Depending on the number of current targets, there were a total of three to 24 probe trials. For each probe trial, the therapist presented the instruction and waited up to 10 s for the participant to respond. Correct responses resulted in praise and there were no programmed consequences for errors. Following a response, or if 10 s elapsed without a response, the therapist presented the instruction for the next trial. If a target was mastered, it was removed and only the remaining targets were taught during the following session.

Teaching trials. Following the probe trials, targets which were not mastered were taught using either the simultaneous or constant time delay prompting procedures. Each target was presented five times, for a total of five to 40 teaching trials, depending on the number of non-mastered targets. All of the targets in both the simultaneous prompting and constant time delay conditions were taught in a block of five to 20 trials. The targets within each block were presented in a random order and the condition blocks were counterbalanced across sessions. Each teaching trial consisted of the presentation of an instruction, implementation of one of

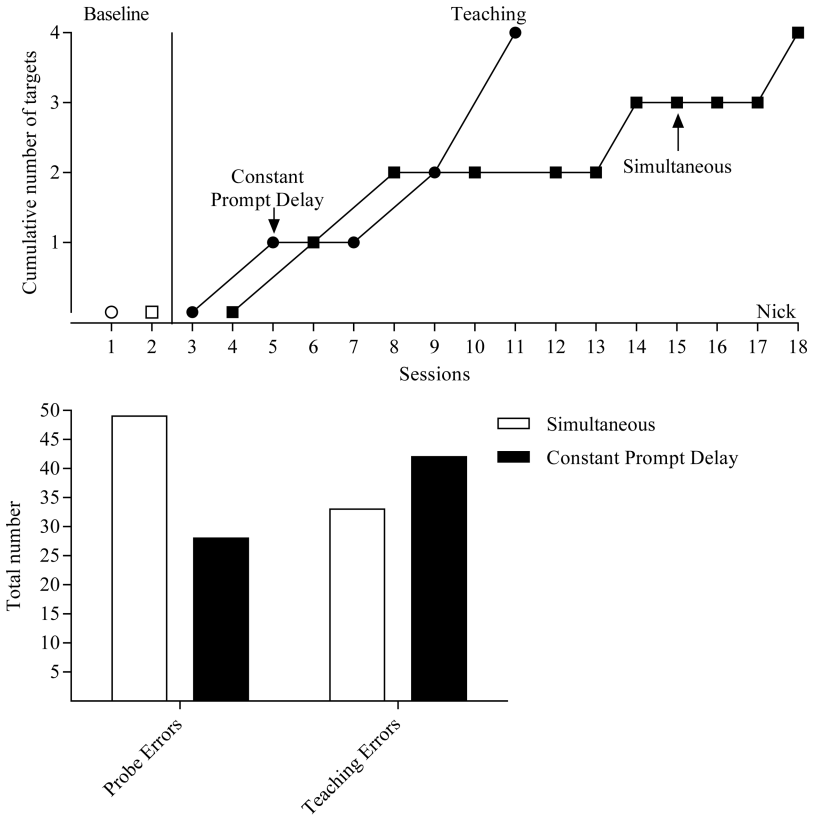

Figure 3. The top panel depicts the cumulative number of target responses that reached criterion in the constant time delay and simultaneous probe sessions. The bottom panel depicts the total number of errors during teaching and probe sessions across simultaneous and constant time delay conditions.

the prompting procedures (see below), and the delivery of a putative reinforcer based on responding.

Simultaneous prompting. During simultaneous prompting trials, an immediate prompt of the correct answer (e.g., "What is this? Say 'cat.'") was delivered after the instruction on all trials. Correct responses in this condition resulted in praise and the delivery of an edible or tangible item (e.g., a token) and the presentation of the next instruction. Incorrect or no responses resulted in no programmed consequences and the presentation of the next trial.

Constant time delay. During constant-time delay trials, an immediate prompt (e.g., "What is this? Say 'dog.'") was delivered after the instruction on the first trial of each session per target. During the remaining four trials, a 4 s delay before the prompt (e.g., "What is this?" pause for 4 s., "Say 'bird.'") was implemented. Correct responses in this condition resulted in praise and the delivery of an edible or tangible item (e.g., a token) and the presentation of the next instruction. Incorrect or no responses to the first trial in this condition resulted in no programmed consequences and the presentation of the next trial. Incorrect responses on the second to fifth trials resulted in the therapist providing corrective feedback and error correction. Error correction was implemented by saying "This is a bird, say bird" and re-presenting the instruction.

Results

Results for each participant are shown in Figures 1–7. The top panel in each figure depicts the cumulative number of target responses that reached criterion (100% correct during a

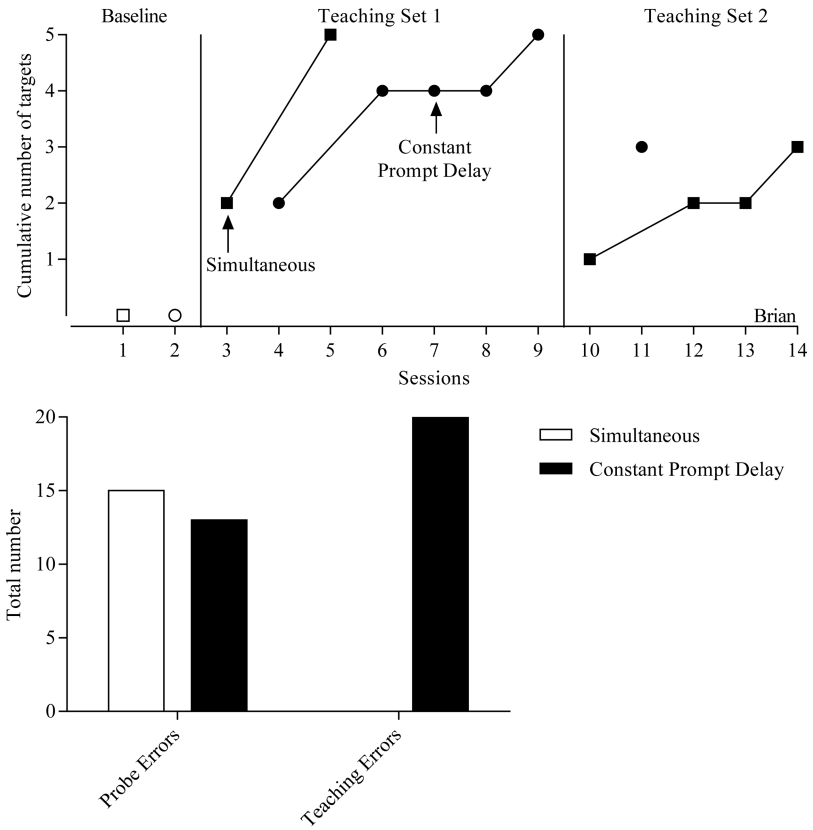

Figure 4. The top panel depicts the cumulative number of target responses that reached criterion in the constant time delay and simultaneous probe sessions. The bottom panel depicts the total number of errors during teaching and probe sessions across simultaneous and constant time delay conditions.

daily probe session) in both conditions in each session. The bottom panel depicts the total number of errors in probe and teaching sessions for both conditions.

Results for Max are shown in Figure 1. Three targets were taught in both the simultaneous and constant time delay conditions. Max reached criterion for all three targets in the simultaneous condition after four sessions, and all three targets in the constant time delay condition after four sessions. In probe sessions, Max had a total of seven errors in the simultaneous condition and three errors in the constant prompt condition. In teaching sessions, Max had a total of zero errors in the simultaneous condition and 10 errors in the constant prompt condition.

Results for Shawn are shown in Figure 2. Three targets were taught in both the simultaneous and constant time delay conditions. Shawn reached criterion for all three targets in the simultaneous condition after eight sessions, and all three targets in the constant time delay condition after five sessions. In probe sessions, Shawn had a total of 24 errors in the simultaneous condition and 31 errors in the constant prompt condition. In teaching sessions, Shawn had a total of zero errors in the simultaneous condition and 18 errors in the constant prompt condition.

Results for Nick are shown in Figure 3. Four targets were taught in both the simultaneous and constant time delay conditions. Nick reached criterion for all four targets in the simultaneous condition after 11 sessions, and all four targets in the constant time delay condition after five sessions. In probe sessions, Nick had a total of 49 errors in the simultaneous condition and 28 errors in the constant prompt condition. In teaching sessions, Nick

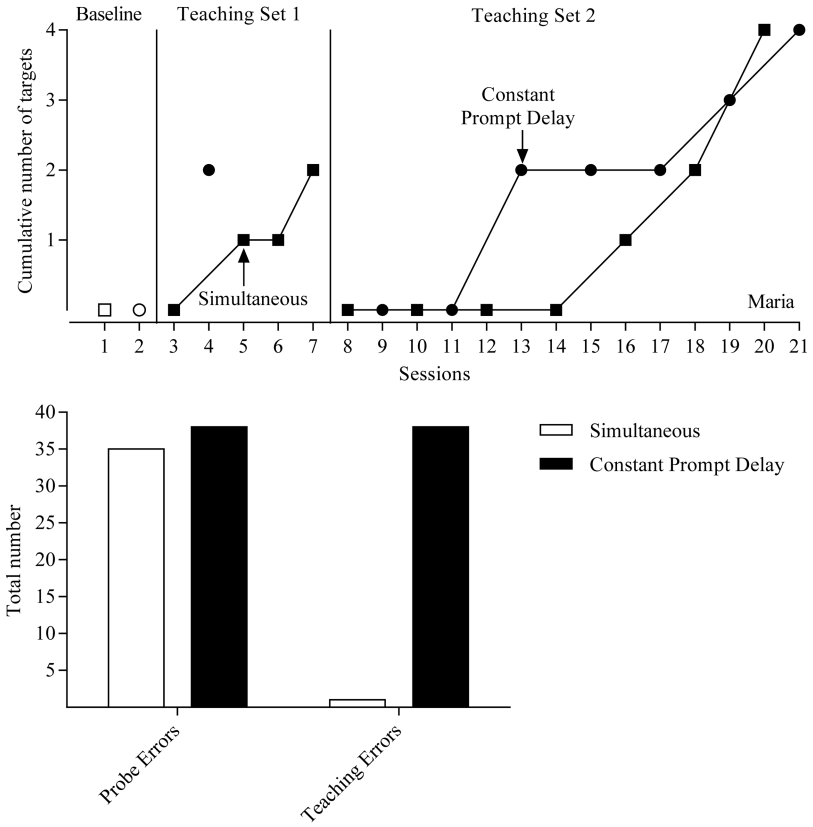

Figure 5. The top panel depicts the cumulative number of target responses that reached criterion in the constant time delay and simultaneous probe sessions. The bottom panel depicts the total number of errors during teaching and probe sessions across simultaneous and constant time delay conditions.

had a total of 33 errors in the simultaneous condition and 42 errors in the constant prompt condition.

Results for Brian are shown in Figure 4. Eight targets were taught in both the simultaneous and constant time delay conditions across two sets. In the first set, Brian reached criterion for all five targets in the simultaneous condition after two sessions, and all five targets in the constant time delay condition after five sessions. In the second set, Brian reached criterion for all three targets in the simultaneous condition after four sessions, and all three targets in the constant time delay condition after one session. In probe sessions, Brian had a total of 15 errors in the simultaneous condition and 13 errors in the constant prompt condition. In teaching sessions, Brian had a total of zero errors in the simultaneous condition and 20 errors in the constant prompt condition.

Results for Maria are shown in Figure 5. Two and four targets were taught in both the simultaneous and constant time delay conditions across two sets. In the first set, Maria reached criterion for both targets in the simultaneous condition after four sessions, and both targets in the constant time delay condition after one session. In the second set, Maria reached criterion for all four targets in the simultaneous condition after seven sessions, and all four targets in the constant time delay condition after seven sessions. In probe sessions, Maria had a total of 35 errors in the simultaneous condition and 38 errors in the constant prompt condition. In teaching sessions, Maria had a total of one error in the simultaneous condition and 38 errors in the constant prompt condition.

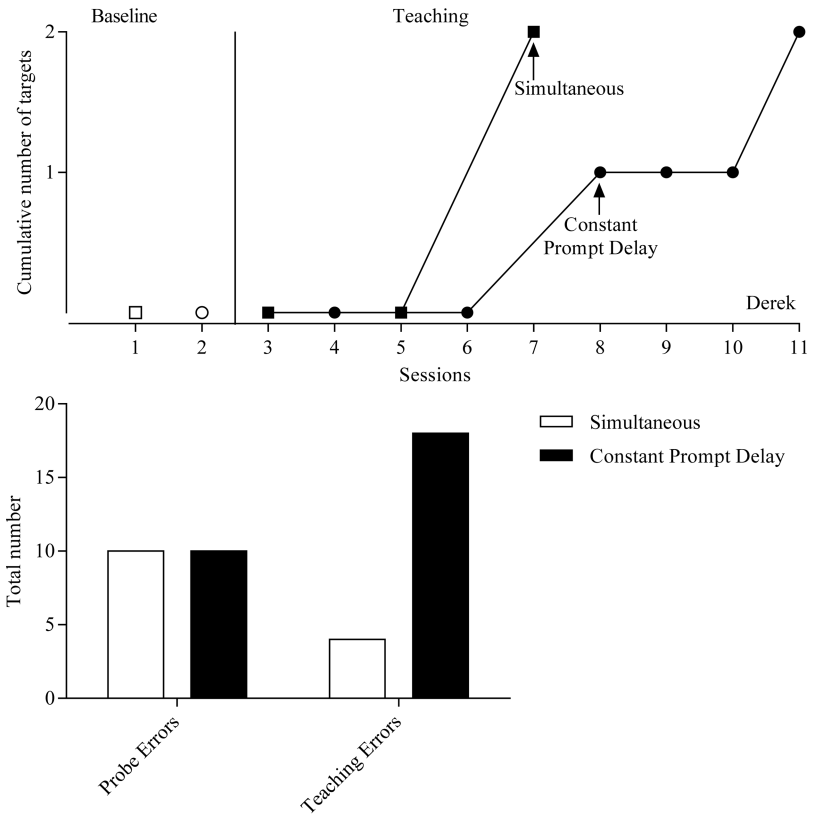

Figure 6. The top panel depicts the cumulative number of target responses that reached criterion in the constant time delay and simultaneous probe sessions. The bottom panel depicts the total number of errors during teaching and probe sessions across simultaneous and constant time delay conditions.

Results for Derek are shown in Figure 6. Two targets were taught in both the simultaneous and constant time delay conditions. Derek reached criterion for both targets in the simultaneous condition after three sessions, and both targets in the constant time delay condition after six sessions. In probe sessions, Derek had a total of 10 errors in the simultaneous condition and 10 errors in the constant prompt condition. In teaching sessions, Derek had a total of four errors in the simultaneous condition and 18 errors in the constant prompt condition.

Results for Edward are shown in Figure 7. Three targets were taught in both the simultaneous and constant time delay conditions. Edward reached criterion for all three targets in the simultaneous condition after three sessions, and all three targets in the constant time delay condition after three sessions. In probe sessions, Max had a total of 15 errors in the simultaneous condition and 23 errors in the constant prompt condition. In teaching sessions, Edward had no errors in the simultaneous condition or constant-time delay condition.

Discussion

The results from this study replicated and extended previous research in that both the constant time delay and simultaneous prompting procedures can be used to teach skills to young children with autism. Overall, the results also suggested neither the constant time delay nor the simultaneous prompting procedure was more effective. These results are consistent with the previous studies that have

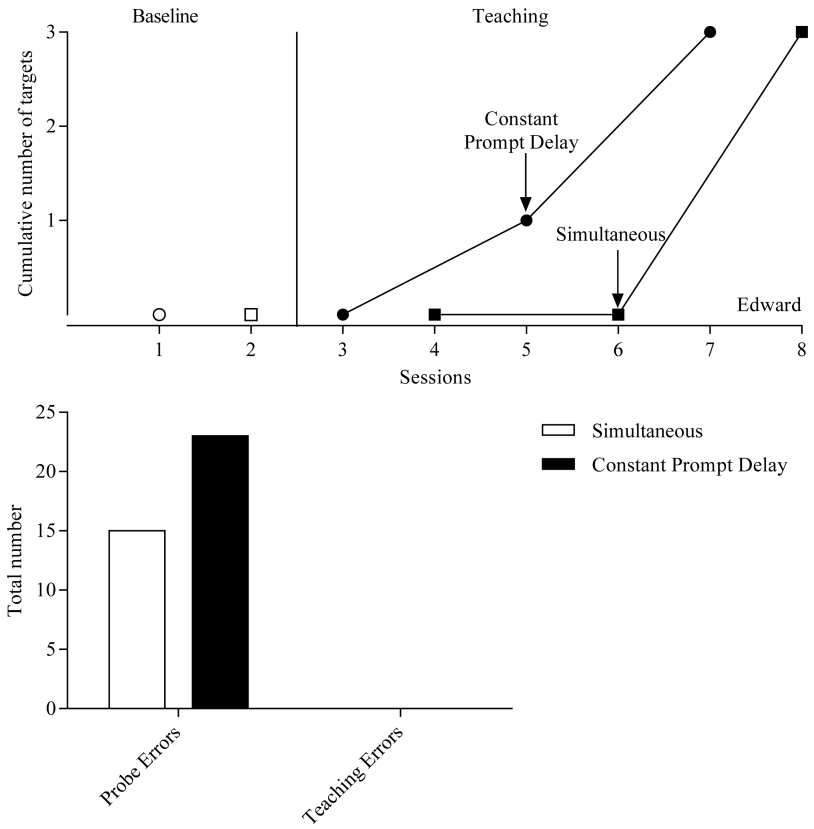

Figure 7. The top panel depicts the cumulative number of target responses that reached criterion in the constant time delay and simultaneous probe sessions. The bottom panel depicts the total number of errors during teaching and probe sessions across simultaneous and constant time delay conditions.

compared these prompting procedures, and extends this literature to young children diagnosed with autism.

In this study there were individual differences in errors in probes sessions for both prompting procedures. More errors occurred in the simultaneous prompt condition during probe sessions for Max, Nick, and Brian. More errors occurred in the constant time delay condition during probe sessions for Shawn, Maria, and Edward. No difference between conditions was found for Derek. These results, therefore, do not show either procedure to be more efficient in probe trials.

There were consistent differences, however, in errors in teaching sessions. More errors occurred in the constant time delay condition for Max, Shawn, Nick, Brian, Maria, and Derek. No errors occurred in either condition for Edward. This result is consistent with two previous studies showing fewer errors using the simultaneous prompt procedure in teaching skills (Schuster et al., 1992; Seward et al., 2014). More errors likely occurred in the constant time delay condition due to more opportunity for error inherent in the procedure. The time period between the instruction and the response (or prompt) provides an opportunity for a child to err. The simultaneous prompting procedure, on the other hand, includes an immediate prompt and therefore there is less opportunity to err.

Limitations

The results from this study should be interpreted with caution for several reasons. First,

the number of targets in each condition changed according to when the criterion was met. When a target met the criterion, it was removed from that condition; therefore, the number of targets taught in each condition could be different from one session to the next. Although there may have been differences from session to session, the two prompting procedures were conducted as they typically have been in past studies (and in applied settings). Second, the duration to implement each procedure was not recorded, and therefore conclusions cannot be made regarding whether differences existed in the duration of time to implement each procedure. Third, the frequency of IOA and treatment integrity checks was lower than the standard (25%) for some participant. This limitation is somewhat mitigated, however, by the consistently high results associated with the IOA (88–100%) and treatment integrity (100%).

Future Research

Future research should investigate maintenance and generalization of skills learned using these two prompting procedures. Previous research has shown that skills taught using constant time delay procedures result in greater maintenance than targets taught using simultaneous procedures, although this research needs to be extended to children with autism.

Future research pertaining to both prompting procedures needs to be conducted to determine whether either procedure is more effective and efficient on an individual level, and if so, how to quickly make that determination. For example, research could be conducted to determine whether children who engage in problem behavior maintained by negative reinforcement (e.g., avoidance/escape from demands) might benefit from the simultaneous prompting procedure because the instructor provides an immediate prompt, thereby potentially making escape less valuable.

Future research could also investigate whether instructors, including teachers and parents working with children in their home setting, have a preference for either prompting procedure. Relatedly, an investigation could be conducted to determine whether children have a preference for either procedure when learning new skills. The results from these possible investigations, along with the current study, are important in determining how best to effectively and efficiently teach skills to children diagnosed with autism.

Summary

The current study demonstrated that both prompting procedures can be used to teach skills to children diagnosed with autism. More errors were found when teaching skills using the constant time delay procedure, and therefore teachers should be aware of using this procedure for children with autism who engage in problem behavior maintained by avoidance or escape from demands.

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