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ORIGINAL PAPER

Comparison of Constant Time Delay and Simultaneous Prompting Procedures: Teaching Functional Sight Words to Students with Intellectual Disabilities and Autism Spectrum Disorder

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Abstract Constant time delay (CTD) and simultaneous prompting (SP) are effective response prompting procedures for teaching students with moderate to severe disabilities. The purpose of this study was to compare the efficiency of CTD and SP when teaching functional sight words to four students, 8–11 years of age, with moderate intellectual disability (ID) or dual diagnosis of moderate ID and autism spectrum disorder. An adapted alternating treatments design was used to evaluate the efficiency of CTD and SP procedures in regard to (a) percent of training errors, (b) total number of sessions, (c) mean minutes of training time, and (d) total number of trials through criterion. Results indicated that CTD resulted in fewer errors and SP required less instructional time, with mixed results for number of sessions and trials through criterion.

Keywords Constant time delay · Simultaneous prompting · Efficiency · Autism spectrum disorder · Intellectual disabilities · Direct instruction

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Introduction

Selecting effective *and* efficient procedures are of paramount importance for special education teachers due to increasing demands to demonstrate students' acquisition and generalization of skills for the purposes of mastering Individualized Education Plan (IEP) goals and objectives, as well as pressures to indicate progress on school-wide standardized tests (Odom et al. 2010; Simpson 2005). Parents of students with special needs, especially autism spectrum disorder (ASD), are increasingly asking for data-based progress reports and pursuing litigation against schools when their child progresses slowly or does not make progress (Barnhill et al. 2011). A number of effective, evidence-based procedures are reported in the special education literature to assist teachers in meeting these demands (Odom et al. 2010). Response prompting procedures are one example of evidence-based practices used to teach students with moderate to severe disabilities, including students with intellectual disability (ID) and ASD, a variety of academic and social–communication behaviors (Ledford et al. 2012). These procedures involve presentation and eventual removal of teacher prompts with reinforcement provided for unprompted and prompted correct responses (Wolery et al. 1992). Within the response prompting literature, a number of effective procedures are presented, including constant time delay (CTD), graduated guidance (GG), progressive time delay (PTD), simultaneous prompting (SP), and system of least prompts (SLP).

Questions regarding the effectiveness of response prompting procedures have been answered by numerous demonstrations and replications (Ledford et al. 2012). With this information, it is beneficial for researchers to focus on the efficiency of response prompting procedures in order to maximize instruction and refine instructional practices (Wolery and Gast 1990). Wolery and Gast (1990) indicate the importance of identifying efficient procedures that lead to (a) learning more information in the same amount of time, (b) learning an equal amount of information in less time, (c) generate a higher density of reinforcement due to fewer errors, and (d) increasing student independence. Of the available response prompting procedures, SP has received increasing attention in recent years as an effective *and* efficient response prompting procedure when compared to CTD (Head et al. 2011; Kurt and Tekin-Iftar 2008; Riesen et al. 2003; Schuster et al. 1992; Tekin and Kircaali-Iftar 2002).

Constant time delay, a near errorless response prompting procedure, includes presentation of a target stimulus and a controlling prompt to ensure a learner responds correctly to the target stimulus. During initial sessions, an instructor presents a target stimulus followed immediately by the controlling prompt (0-s delay trial, e.g., teacher holds up a flash card ["glue" written on card] and says, "What word?" and immediately provides a verbal model of the target, "Glue." The student repeats the teacher's verbal model and is reinforced with descriptive verbal praise). Following 0-s delay trials, the instructor introduces a fixed interval (e.g., 4 s) between the target stimulus and presentation of the controlling prompt to allow a student an opportunity to provide a correct response. With CTD, if a student does not know the answer, he or she can wait and the instructor will provide the correct response (Wolery et al. 1992). CTD has been used with students with various

exceptionalities across a wide age range, including students with learning disabilities (LD; Koscinski and Gast 1993), ID (Schuster et al. 1988), and ASD (Ledford et al. 2008). The literature also provides multiple examples of using CTD in both individual and small group instructional arrangements, with heterogeneous and homogenous student grouping (Ledford et al. 2012). Several studies have also used CTD with computer-based instruction (Koscinski and Gast 1993).

Simultaneous prompting (SP) is another reportedly "near" errorless response prompting procedure that involves two types of trials: (a) instructional trials and (b) probe trials. Probe trials are frequently presented in a massed trial format session immediately before an SP instructional session. On SP instructional trials, the instructor presents a target stimulus followed immediately by a controlling prompt (i.e., 0-s delay). On probe trials, the instructor presents a target stimulus and provides an opportunity for a correct response (e.g., 4-s delay), but does not provide the controlling prompt. Because students do not have an opportunity to provide an unprompted correct response on instructional trials, daily trials are necessary to determine whether and when transfer of stimulus control has occurred from the controlling prompt to the target stimulus. A reported benefit of SP over CTD is SP does not require students wait for a controlling prompt (Gibson and Schuster 1992), but it should be noted that opportunities for multiple errors are possible on probe trials because the controlling prompt is not provided. Similar to CTD, SP has been used with students with ID (Waugh et al. 2011), ASD (Akmanoglu-Uludag and Batu 2005), and LD (Johnston et al. 1996) in both individual and small group instructional arrangements (Waugh et al. 2011) to teach academic (e.g., number identification [Akmanoglu and Batu 2004] and sight words [Reichow and Wolery 2009]), communication (e.g., manual sign production; Fickel et al. 1998), and daily living skills (e.g., setting a table; Batu 2008).

Five comparison studies of SP and CTD were located in the literature. Common across all SP and CTD comparison studies were "mixed results" regarding efficacy of instruction. A review of SP by Waugh et al. (2011) found four studies comparing SP and CTD (Kurt and Tekin-Iftar 2008; Riesen et al. 2003; Schuster et al. 1992; Tekin and Kircaali-Iftar 2002). Across these four studies, Waugh et al. (2011) report both procedures were effective teaching discrete skills, but efficiency data indicated SP to be more efficient for some students, CTD more efficient for others, or no difference between procedures. Measures of efficiency included during comparison studies were sessions (and/or trials), errors, and time through criterion (see Table 1). Since the Waugh et al. review, Head et al. (2011) compared SP and CTD teaching discrete social studies facts to high school students with LD, mild ID, or other health impairments and depression. Head et al. found both procedures effective and again found mixed results regarding efficiency data (see Table 1).

Ages of participants, diagnoses of participants, instructors, and target behaviors varied across the above comparison studies. Comparisons included elementary students with mild to moderate ID (Schuster et al. 1992; Tekin and Kircaali-Iftar 2002) or ASD (Kurt and Tekin-Iftar 2008), middle school students with ASD, mild ID, and mild to moderate ID with other disabilities (e.g., visual impairment; Riesen et al. 2003), and high school students with LD, mild LD, or other health impairments (Head et al. 2011). A graduate student (Schuster et al. 1992), sibling

Table 1 Efficiency data reported by study across participants

Study	Sessions through criterion	Trials through criterion	Errors through criterion	Time through criterion
Kurt and Tekin-Iftar (2008)	CTD and SP	CTD	SP	SP
Head et al. (2011)	CTD and SP	NR	SP	CTD
Riesen et al. (2003)	NR	N/A[a]	NR	NR
Schuster et al. (1992)	SP	NR	SP	SP
Tekin and Kircaali-Iftar (2002)	CTD	CTD	SP	SP

NR not reported, *N/A* not applicable

[a] Mean instructional trials per word not reported for one participant due to participant not reaching mastery criterion with CTD during allotted time for study

tutor (Tekin and Kircaali-Iftar 2002), classroom teacher (Head et al. 2011; Kurt and Tekin-Iftar 2008), or paraprofessional (Riesen et al. 2003) implemented sessions with participants in various locations within a school (Kurt and Tekin-Iftar 2008), general education, or inclusion classroom (Schuster et al. 1992; Riesen et al. 2003), special education classroom (Head et al. 2011), or university setting or participant's homes (Tekin and Kircaali-Iftar 2002). With the exception of Kurt and Tekin-Iftar (2008), who taught students a chained task (i.e., leisure skill of using a digital camera or CD player), all comparison studies taught discrete behaviors (Head et al. 2011 [expressive identification social studies facts]; Riesen et al. 2003 [expressive identification of sight words or definitions from a general education curriculum]; Schuster et al. 1992 [expressive identification of sight words commonly found in grocery stores]; Tekin and Kircaali-Iftar 2002 [receptive identification of animal figures]).

Across all comparison studies, daily probe procedures were conducted prior to each SP and CTD session to "equalize" comparisons of procedures (Head et al. 2011; Kurt and Tekin-Iftar 2008; Riesen et al. 2003; Schuster et al. 1992; Tekin and Kircaali-Iftar 2002). When CTD is not used in a comparison study, daily probe trials or sessions are unnecessary because transfer of stimulus control is measured during CTD instructional sessions by allowing learners the opportunity to respond before the delivery of the controlling prompt. In SP instructional sessions, an opportunity for measuring transfer of stimulus control is not possible, thus the need for separate daily trials or sessions. Comparisons of effectiveness and efficiency measured by daily probe data raise concerns for some researchers because CTD is altered (comparisons included daily probe sessions for CTD), but SP is not. When comparing effective interventions, care must be taken to ensure procedures are implemented as designed and settings and participants are similar to those used in previous studies (Wolery et al. 2010). Previous comparison studies of SP and CTD reveal a lack of "fair" comparisons of these two teaching procedures with regard to efficiency measures due to the modifications to the CTD procedure, introducing potential bias in studies due to including probe sessions with CTD instructional sessions.

Due to inconclusive results in the literature regarding comparisons of efficiency for SP and CTD, the present study was conducted to extend research on the

efficiency of SP and CTD for students with moderate to severe ID or ASD. Each participant was taught two sets of sight words per instructional procedure; two sets taught with CTD and two sets taught with SP, with no modifications to either procedure, meaning daily probe sessions were not included for CTD sessions. This was done to ensure CTD and SP instructional procedures were implemented without modifications to address "equalization" reported in previous studies. Daily probe sessions may potentially increase the number of errors a student displays when using SP to teach instructional targets, but daily probe sessions are unnecessary when using CTD. Thus, using CTD without modifications may produce fewer errors than reported in previous comparison studies. We compared the two procedures to examine which procedure was more efficient regarding number of trials, sessions, mean minutes, and errors through criterion in teaching students to expressively identify functional sight words.

Methods

Participants

Participants were selected using the following inclusion criteria: (a) diagnosed with moderate ID or ASD with comorbid moderate ID, (b) received services in self-contained classroom at least part of school day, and (c) absent <10 % of school days in the past 2 months. Participants were screened to ensure that they could (a) imitate a verbal model, (b) wait at least 5 s for a prompt, and (c) sit and attend to stimuli for at least 5 minutes. Direct observation, testing, and review of student records were used to assess prerequisite skills. Participants had previously received academic instruction using CTD, but did not have history with SP. The classroom teacher (first author) had previous experience using *both* response prompting procedures. All participants had previously passed hearing and vision screenings.

Four students, one male and three females with moderate ID or dual diagnosis of ASD and moderate ID, participated in this study. All received services in self-contained classrooms and two received additional services in a general education setting. All students received community-based instruction, which targeted acquisition and generalization of functional sight words. Amy, 11 years of age, was diagnosed with Down syndrome and moderate ID. She was also diagnosed with a heart defect and speech impairment and prescribed Adderall. A school psychologist administered the *Woodcock-Johnson, 3rd edition* (WJ-III; Woodcock et al. 2001), but did not obtain a scaled score and reported Amy was "difficult to assess." In addition, Amy displayed challenging behaviors when adults provided non-preferred directives. Carla, 9 years of age, was diagnosed with Down syndrome, moderate ID, and speech impairment. Her performance on the *Wechsler Individual Achievement Test, 2nd Edition* (WIAT-II; Wechsler 2001) indicated academic achievement scores ranging between 40 and 73 (mean = 100, standard deviation = 15). Carla displayed difficulties staying engaged in academic tasks, imitating the teacher's vocal and non-vocal actions during small and large group instruction. Nina, 8 years of age, was diagnosed with moderate ID, as well as hip dysplasia, a heart defect,

speech impairment, and prescribed Reglan. Nina did not readily engage in interactions with adults and peers, but displayed interest in others by observing peers and adults on the periphery of the classroom and related areas at school. Cognitive scores for Nina were unavailable when records were reviewed. Ryan, 9 years of age, was diagnosed with moderate ID, ASD, and speech impairment. His performance on the *Stanford-Binet Intelligence Scales, 5th Edition* (Roid 2003) indicated a scaled score of 63 (mean = 100, standard deviation = 15). Ryan did not display challenging behaviors in general education or special education settings. Ryan and Amy received services in a self-contained classroom and a general education classroom and Carla and Nina received full-day services in a self-contained classroom.

Settings and Materials

All 1:1 sessions occurred in a self-contained classroom in a public school setting, with the exception of the stimulus generalization session at McDonalds restaurant. The classroom teacher (first author) conducted all experimental sessions in a corner of the classroom and sat across from participants at a table where visual distraction were removed from the walls. During experimental sessions, other students engaged in small group instruction with a paraprofessional or therapist in another area of the classroom.

Parents identified 25 potential sight words from the *Edmark: Fast Food and Restaurant* list. After the sight words were identified, two screening sessions were conducted (25 trials per session with each word presented once per session) to identify 12 unknown sight words for each participant (six words per instructional procedure). For all probe and instructional sessions, functional sight words were lowercase letters written by hand or printed in black, blue, purple, or red ink using size 16, 24, or 32 Times New Roman font (words were between 0.5 in and 1 in when written or printed on index cards), and presented on 4 in × 6 in pink, white, or yellow index cards (i.e., multiple exemplar strategy). Each word was handwritten in black ink using a Sharpie® permanent marker and randomly printed in two or more colors and font sizes. After all sight words were handwritten and printed, they were randomly intermixed and presented during probe and instructional sessions. During generalization sessions, two handheld menus were used: one menu was from a local restaurant (8.5 in × 11 in laminated cardstock paper; printed in black ink with word size ranging from approximately 0.25 in–1 in) and the other from a McDonalds restaurant (approximately 12 in × 16 in). Each menu contained all sight words targeted in this study, with the exception of six words that were printed on the local menu only (i.e., baked potato, beef stew, fried chicken, gravy, pizza, potato chips). During probe and instructional sessions, small tokens were used as secondary reinforcers that participants exchanged for candy (e.g., Skittles) or small toys (e.g., rubber ball).

Dependent Measures

Efficiency measures were used to compare CTD and SP and included (a) number of sessions through criterion, (b) number and percentage of errors through criterion,

(c) minutes of instructional time through criterion (across *all* instructional sessions, including 0 s sessions in CTD and SP sessions), and (d) number of trials through criterion. The authors use the phrase *through criterion* (instead of *to criterion*) when referring to participants' mastery of instructional targets, to denote when a participant reads target words independently 100 % of opportunities for *two* consecutive sessions. Additional measures of each instructional procedure were used to measure acquisition of sight words and included (a) unprompted correct responding, (b) prompted correct responding, (c) unprompted incorrect, (d) prompted incorrect, and e) no response. The target behavior of participants during instructional sessions was expressive identification of target sight words following presentation of the task direction, "What word?". Unprompted correct responding was defined as correct articulation of target sight words within 5 s of the instructor's presentation of "What word?". Prompted correct responding was defined as correct articulation of target sight words within 5 s of the instructor's verbal model of target sight words. Unprompted incorrect responding was defined as any word or phrase other than target sight word within 5 s of the instructor's presentation of "What word?". Prompted incorrect responding was defined as any word or phrase other than target sight word within 5 s of the instructor's verbal model of target sight words. No response was defined as the absence of a verbal response within 5 s of the instructor's presentation of "What word?" or the instructor's verbal model of target sight words.

Experimental Design

An adapted alternating treatments design (AATD) across two comparison conditions and replicated across four participants was selected to compare efficiency of CTD and SP for teaching functional sight words to students with moderate ID or dual diagnosis of autism and moderate ID. An AATD design was selected because it is a common design for researchers interested in comparing efficiency of effective procedures using nonreversible behaviors and allows for comparisons of procedures when teaching different academic targets of equal difficulty. While multi-treatment interference is possible when using an AATD design, this issue was addressed by counterbalancing sessions by time of day and ensuring no more than two consecutive sessions of the same procedure occurred across and within days. Issues related to separation of treatments were also addressed by using two sets of sight words that were independent, but equally difficult (Wolery et al. 2010).

General Procedures for CTD and SP

Two instructional sessions, one CTD session and one SP session, occurred daily. Instructional procedures were counterbalanced by time of day with no more than two consecutive sessions with the same procedure. Two comparisons of CTD and SP were conducted with three target words per procedure per comparison (six sight words for the first comparison and six sight words for the second comparison) for a total of 12 sight words for each participant. Instructional targets (food and restaurant items) were selected because they directly related to participants' community-based

outings. Word sets were compared and balanced for equal difficulty (i.e., number of syllables and visual similarity) and randomly assigned to instructional procedures and comparisons. Probe data were collected for each word set prior to instruction and following mastery during comparison conditions. Each CTD and SP session began with participants selecting a reinforcer from a field of two choices. Reinforcers were presented at the end of each instructional session regardless of student performance.

Experimental Conditions

Baseline

Prior to beginning the comparison conditions for participants, the teacher presented each target word two times each for a total of 24 trials during probe sessions. Each trial began with a general attending cue (i.e., "Are you ready?") followed by presentation of a target word and question, "What word?". If participants provided a correct response within 5 s, the teacher delivered descriptive verbal praise. No response or incorrect responses were ignored with a 3-s inter-trial interval. Potential reinforcers were identified and presented at the end of each screening session regardless of performance. Participants were reinforced on a variable ratio schedule-3 (VR-3) of reinforcement for on-task behavior (e.g., "Great job working!"), meaning on the average of every third trial the teacher praised the student for appropriate attending behaviors (e.g., in seat, looking at the teacher).

SP Daily Probe and Instructional Sessions

Due to the nature of the SP procedure, trials occurred during *two* daily sessions; a probe session (nine trials), to assess participants' reading of target sight words, followed by an instructional session (15 trials) for a total of 24 trials per day (equal to the number of trials that occurred during CTD sessions each day).

SP Daily Probe Procedures A daily probe session of target words was conducted immediately before an SP training session to evaluate transfer of stimulus control during instruction. During daily probe sessions, three trials for each target word were presented for a total of nine trials per session (replicating procedures in Schuster et al. 1992). Each trial consisted of the teacher (a) providing the attending cue and ensuring a response from the student, (b) presenting the target word and saying, "What word?", and (c) waiting 5 s for an independent response from the student. If a participant provided the correct response, the teacher provided descriptive verbal praise. An error or no response within 5 s of the discriminative stimulus was ignored. The mastery criterion for target word sets was 100 % unprompted correct responding during one probe session on a CRF schedule of reinforcement followed by one probe session on a VR-3 schedule of reinforcement. Daily probe sessions were necessary because the controlling prompt was presented simultaneously with the discriminative stimulus during instructional sessions (see

below), which did not allow measurement of *independent* reading of target sight words.

SP Instructional Sessions Each trial began with an active attending cue followed by a specific active attending response. The teacher presented the discriminative stimulus and immediately provided the controlling prompt (i.e., verbal model of the target word). If a student imitated the verbal model within 5 s, the teacher provided descriptive verbal praise and recorded a prompted correct response. No response or incorrect responses were ignored. The teacher used a 3-s inter-trial interval before beginning the next trial. As previously stated, 15 trials were presented per instructional session.

CTD Instructional Sessions

During each trial the teacher (a) first, provided an active attending cue, (b) next, ensured a specific active attending response, and (c) then presented the discriminative stimulus. Instructional sessions used a 0-s delay (i.e., teacher presented the discriminative stimulus and immediately provided the controlling prompt of a verbal model) with a 5-s response interval until 100 % prompted correct responding was observed. Following 0-s sessions, a 5-s prompt delay was implemented where the teacher obtained the participant's attention, presented the discriminative stimulus, and waited 5 s for an independent response. If the participant did not provide a response within 5 s of the discriminative stimulus, the teacher provided a verbal model of the target word and waited 5 s for the participant to imitate the verbal model. Unprompted and prompted correct responses were reinforced with descriptive verbal praise and wait errors, prompted errors, and no response were ignored. Following wait errors, the teacher informed participants to wait for the prompt if they did not know a target word. Twenty-four trials were presented per session to equalize the number of trials presented during SP probe and SP instructional sessions combined.

Review Trials

Review trials were conducted if participants met mastery criterion for a word set with CTD or SP in order to provide continued exposure to that word set. Review trials continued for a word set until the mastery criterion was observed for the other procedure and were identical to probe trials, except the teacher modeled the correct response if participants made errors. It should be noted that review trials were *not* included when reporting the effects of interventions.

Maintenance

Three maintenance sessions were conducted following instructional sessions. Maintenance sessions were conducted to assess participants' ability to read target sight words following instruction using the CTD and SP procedures. Procedures were identical to the initial probe sessions (see earlier section).

Generalization

Two types of generalization measures were collected to assess recognition of sight words from the *second word set* (see Table 2) for each participant, with each word presented two times for a total of 24 trials. Due to time constraints (i.e., end of the school year), we decided to assess the words participants most recently learned. First, generalization across stimuli (target words from the second word set on a menu from a local restaurant) was assessed in the classroom following maintenance sessions. Generalization procedures were identical to screening procedures where a student's attention was secured followed by the teacher pointing to a target word on the menu and asking, "What word?", waiting 5 s for a response. If a participant provided a correct response she received descriptive verbal praise and if she did not provide a response or responded incorrectly she was ignored. Second, generalization across stimuli and settings (target words from the second word set on a menu at McDonalds) was assessed in the community at a local McDonalds restaurant following completion of generalization measures in the classroom. Procedures were identical across generalization sessions.

Reliability

Trained observers (i.e., paraprofessionals or another classroom teacher) collected interobserver agreement (IOA) and procedural fidelity data a minimum of 20 % of sessions across conditions. IOA was calculated using a point-by-point method: number of agreements divided by number of agreements plus disagreements multiplied by 100. Procedural fidelity was calculated by dividing the number of observed behaviors by number of planned behaviors multiplied by 100. Procedural variables included (a) presenting correct stimulus each trial, (b) presenting active attending cue, (c) securing active attending response, (d) presenting correct discriminative stimulus, (e) waiting appropriate delay interval, (f) delivering correct controlling prompt and consequent event, and (g) recording data during inter-trial interval. IOA and procedural fidelity were 100 % for observed behaviors and procedural variables.

Results

Effectiveness

Constant time delay and SP were effective when teaching functional sight words to students with moderate ID or dual diagnosis of ID and moderate ID. Percent of unprompted correct responses for each participant are shown in Figs. 1, 2, 3, 4. For all participants, correct responding was 0 % for all functional sight words across three consecutive probe sessions. Introduction of CTD and SP resulted in criterion level responding for all participants across word sets with minimal differences across procedures across participants and maintained between 90 and 100 % across three consecutive probes for all participants across word sets following removal of instructional procedures.

Table 2 Target words by participant by instructional procedure

Participant	CTD		SP	
	Word set 1	Word set 2	Word set 1	Word set 2
Ryan	Milk	Pepsi	Nuggets	Juice
	Small	Chocolate	Cone	Hamburger
	Chicken	French fries	Large	Potato chips
Amy	Cone	Baked potato	Menu	Fried chicken
	Nuggets	Vanilla	Cookies	Biscuit
	Orange	Milk shake	Dinner	Strawberry
Carla	Cone	Large	Menu	Pepsi
	Orange	Cookies	Sprite	Biscuit
	Ketchup	Hamburger	Nuggets	Chocolate
Nina	Hot dog	French fries	Dinner	Potato chips
	Pickles	Gravy	Nuggets	Ranch
	Bacon	Beef stew	Pizza	Chicken

Efficiency

Errors Through Criterion

Errors through criterion were lower for CTD as compared to SP for all participants (see Table 3). Mean errors through criterion were 1.38 % for CTD (Ryan 0.5 %; Amy 3 %; Carla 1 %; Nina 1 %) and 22.88 % for SP (Ryan 32.5 %; Amy 35 %; Carla 7 %; Nina 17 %). For purposes of efficiency, CTD was more efficient when compared to SP for errors through criterion.

Sessions Through Criterion

Sessions through criterion were lower for CTD as compared to SP for Ryan and Nina, but lower for SP as compared to CTD for Carla. Sessions to criterion were equal for Amy (see Table 3). A total of 47 sessions (Ryan—15 sessions; Amy—8 sessions; Carla—11 sessions; Nina—13 sessions) were required for CTD across participants and 50 sessions (Ryan—17 sessions; Amy—8 sessions; Carla—10 sessions; Nina—15 sessions) for SP across participants. CTD was more efficient than ($n = 2$) or equal to SP ($n = 1$) for three or four participants and required one more session than SP for one participant.

Time Through Criterion

Mean training time through criterion was lower for SP when compared to CTD for all participants (see Table 3). It should be noted that differences between total time through criterion for SP and CTD were minimal with minimum mean differences at

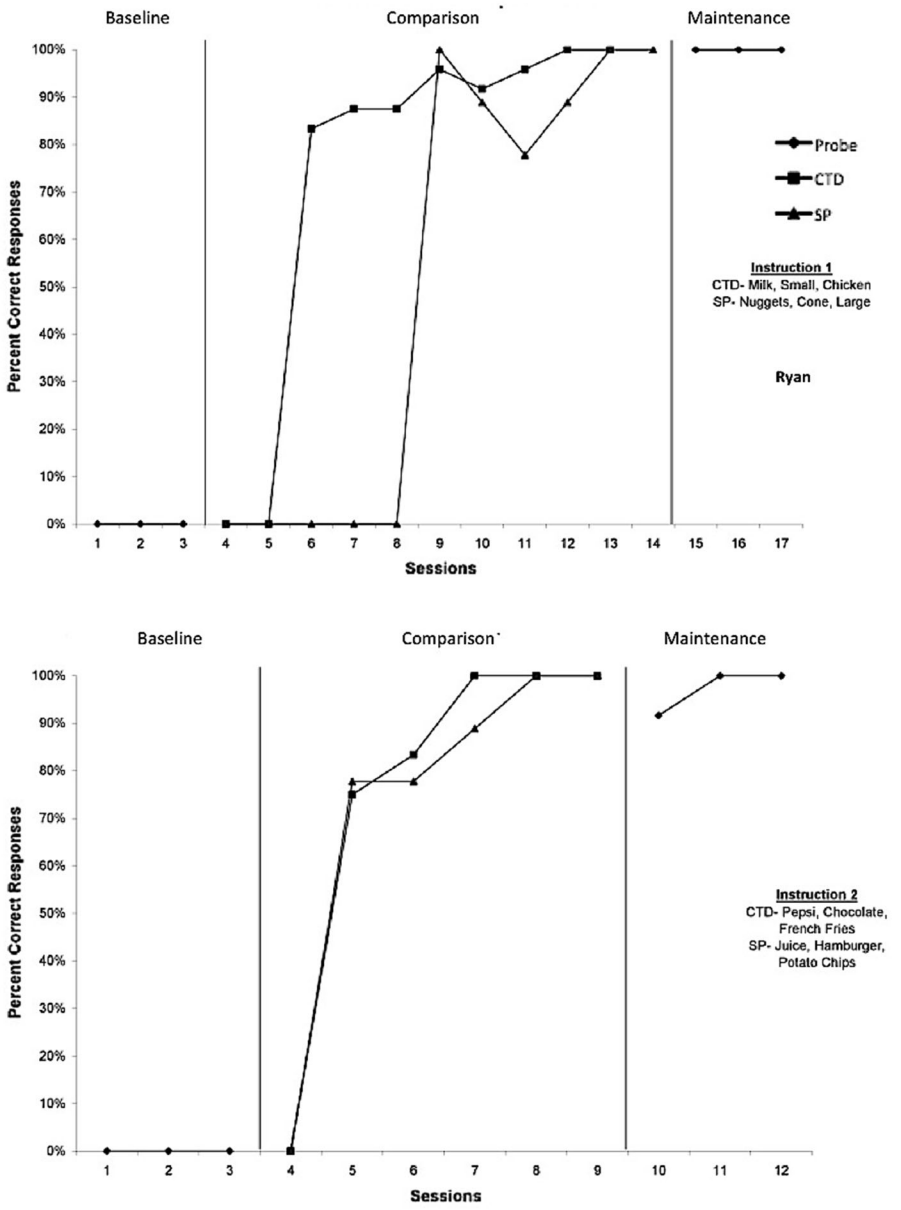

Fig. 1 Percent of unprompted correct responses during probes and comparison phases for Ryan

0.05 min for Nina and maximum mean differences at 1.38 min for Amy. Mean differences were 0.41 min for Ryan and 0.37 min for Carla. SP was more efficient than CTD in regard to time through criterion, but differences are considered minimal since all differences were <0.5 min, with the exception Amy (1.38 min).

Trials Through Criterion

Mixed results were found when comparing the number of trials through criterion. CTD was more efficient than SP for two participants (Nina: 48 less trials for CTD than SP; Ryan: 48 less trials for CTD than SP), with SP more efficient for one participant (Carla: 24 less trials for SP than CTD), and CTD and SP equal for another participant (Amy). When using CTD to teach sight words, participants typically required 192–408 trials to reach the mastery criterion and when using SP, 192–360 trials were required. When calculating trials through criterion for the SP procedure, trials that occurred during daily probe *and* instructional sessions were combined. This ensured an accurate representation and comparison of CTD and SP for total number of trials used during sight word instruction. Three participants (Carla, Nina, Ryan) met the mastery criterion in fewer sessions with the CTD or SP procedure, and as such, review trials were conducted for mastered sight words while instruction continued using the other procedure. Review trials were *not* included in calculations of effectiveness or efficiency measures.

Generalization

Generalization across stimuli (i.e., menu from local restaurant) in the classroom was 66 % (Ryan; Nina), 80 % (Carla), and 100 % (Amy) and across stimuli and settings (i.e., McDonalds) was 60 % (Carla), 75 % (Amy), and 100 % (Nina). Generalization data were not collected for Ryan in the community due to being absent during the scheduled trip. Mean percent correct responding across generalization measures was 87.5 % for Amy, 70 % for Carla, 83 % for Nina, and 66 % for Ryan.

Discussion

This study compared efficiency of instruction using SP and CTD to teach functional sight words to students with moderate ID or ASD in a self-contained setting. Both procedures were effective for teaching targets for all participants. Efficiency measures indicated that CTD was more efficient than SP with number and percent of errors through criterion across all participants. Sessions through criterion indicated that CTD was more efficient than SP for two of four participants, SP was more efficient than CTD for one participant with a difference of one session, and equal for the other participant. SP was more efficient than CTD in regard to training time through criterion, but minimal differences were noted. Trials through criterion were lower for CTD than SP for two participants, equal for one participant, and lower when using SP with one participant. Students generalized recognition of the second set of sight words to the classroom using a local menu (66–100 %) and three of four participants generalized to a community setting (60–100 %) using a menu from a fast food chain (i.e., McDonalds).

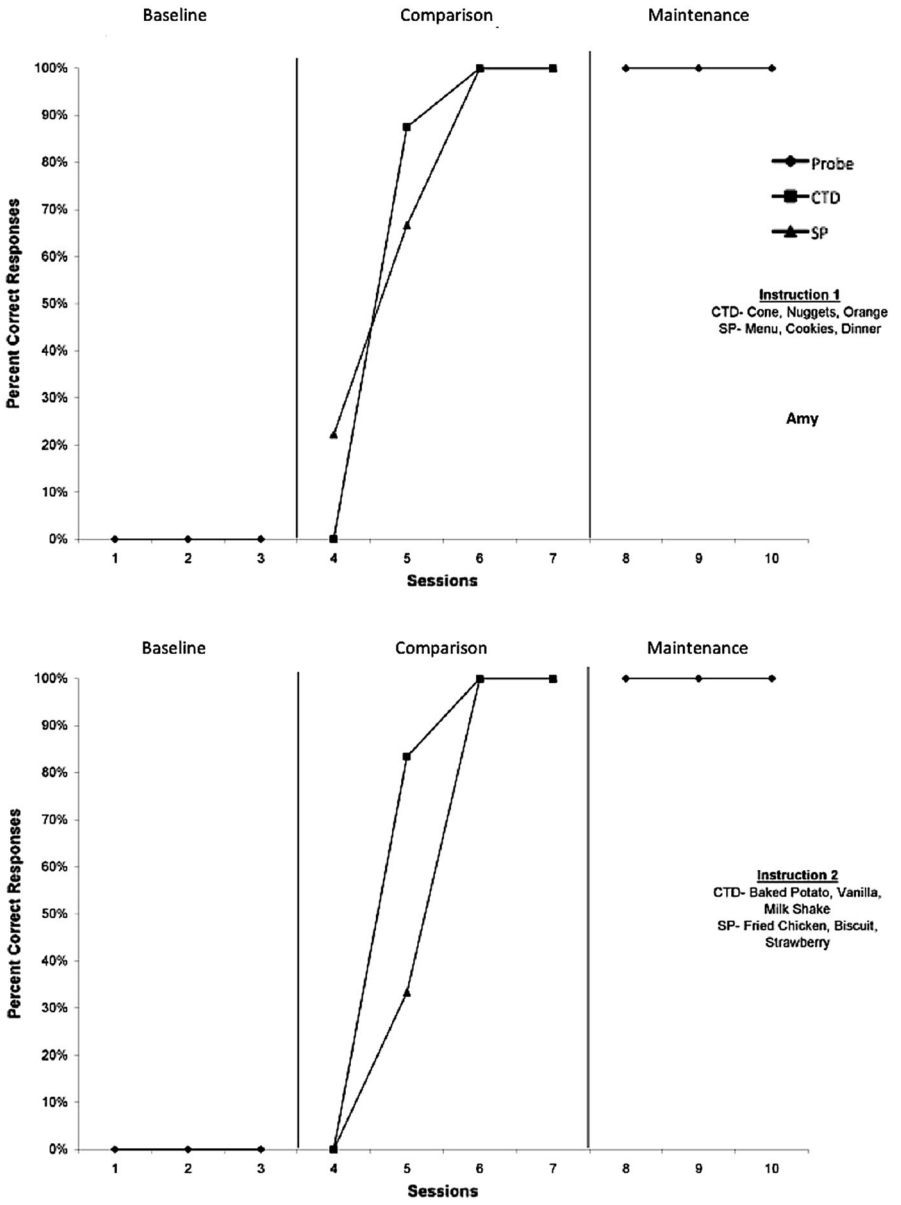

Fig. 2 Percent of unprompted correct responses during probes and comparison phases for Amy

Limitations

Limitations of this study require attention. First, information regarding cognitive scores was unavailable for two participants (Nina and Amy). Although *general information* was available for all participants, additional pre-intervention characteristics would have further assisted with the external validity of this study, specifically, assisting

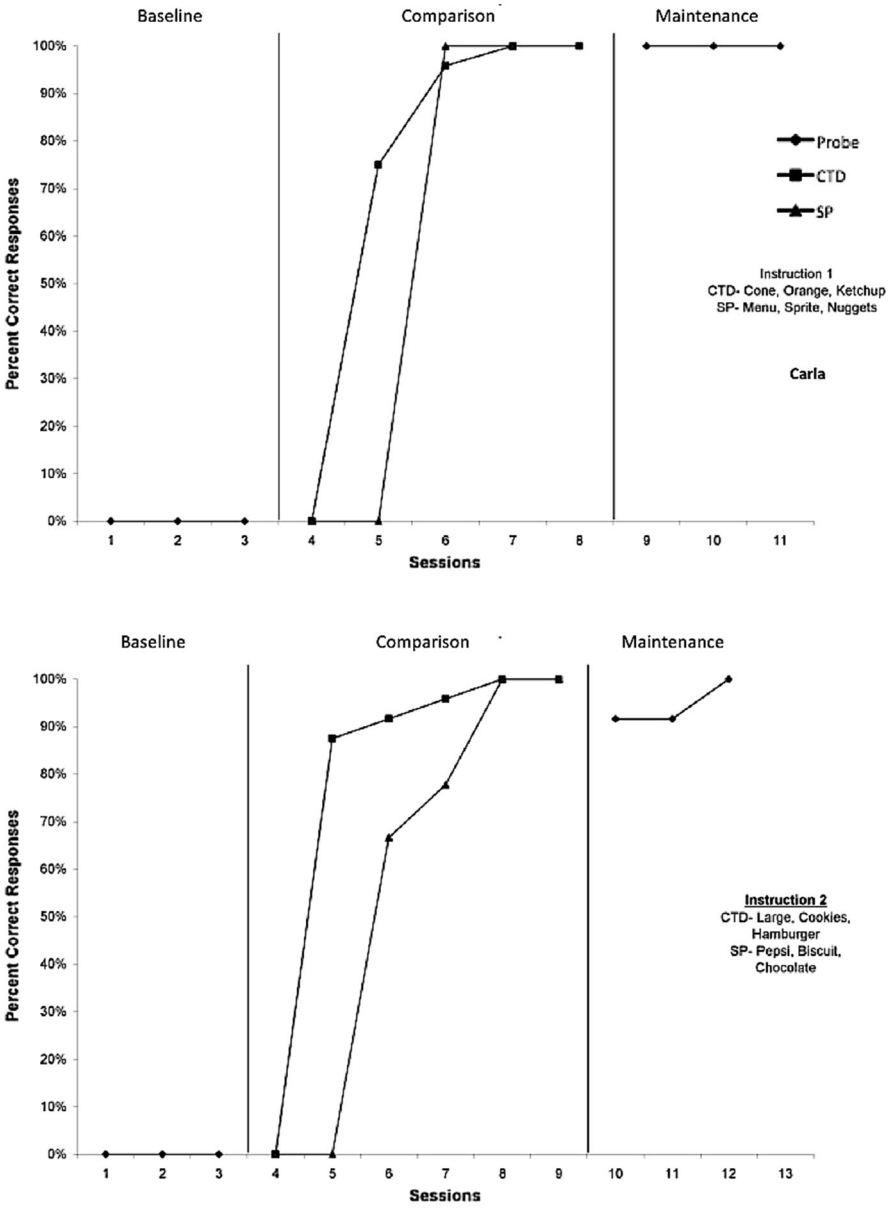

Fig. 3 Percent of unprompted correct responses during probes and comparison phases for Carla

future studies when identifying participants who display similar pre-intervention behaviors. Second, assessing generalization was limited to one set of target words for participants (second set). In addition, generalization was limited to a pretest and posttest assessment of reading sight words in novel settings. A pretest and posttest assessment of generalization does not control for threats to internal validity, precluding

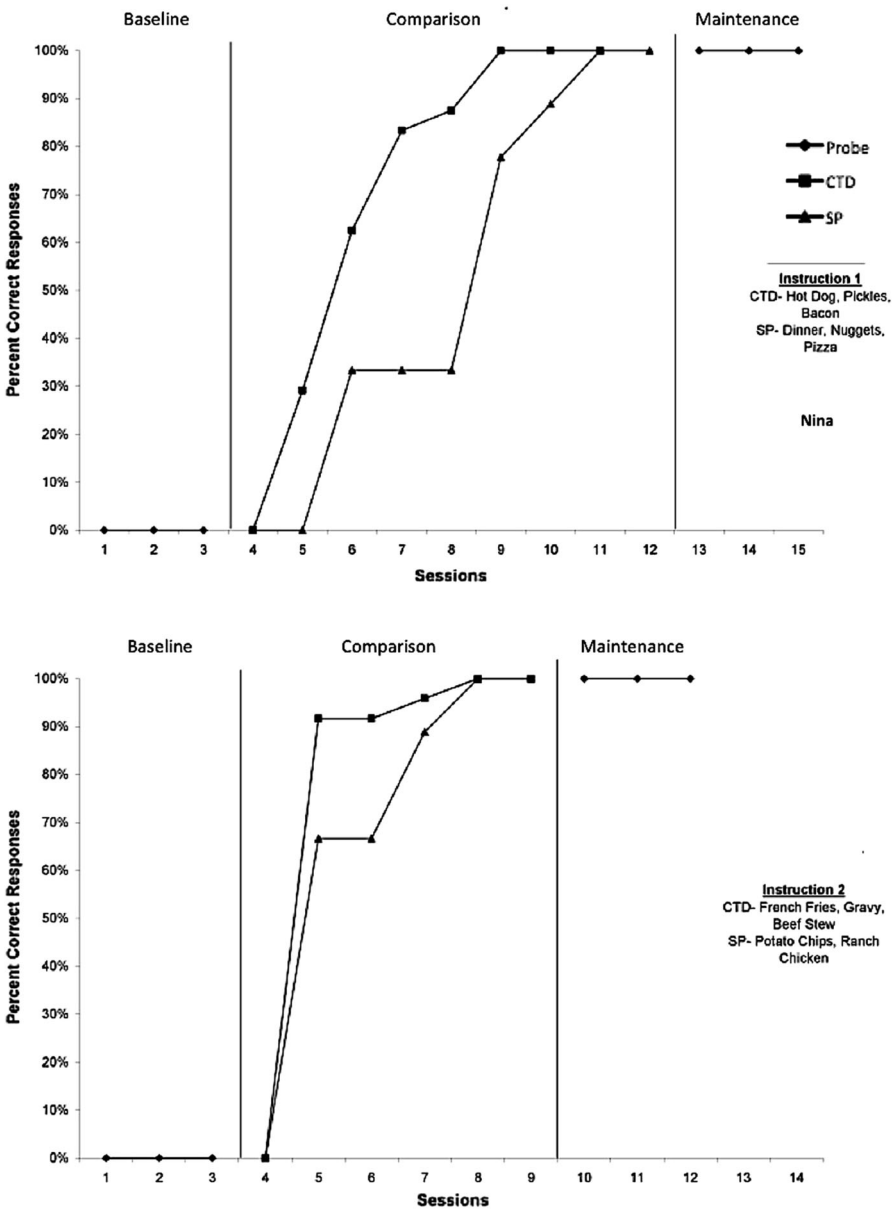

Fig. 4 Percent of unprompted correct responses during probes and comparison phases for Nina

evaluation of a functional relation within the context of a single case design. Finally, all participants had previous experience with CTD for academic instruction, but did not have experience with SP in any capacity. Although it is not possible to directly evaluate whether having experience with one procedure influences the results of a comparison study, it should be noted when interpreting the results of this study.

Table 3 Measures of efficiency of instruction through criterion

	Ryan	Amy	Carla	Nina
Percent of errors through criterion				
Word set 1				
CTD	0	2	2	1
SP	45	28	3	23
Word set 2				
CTD	1	4	0	1
SP	20	42	11	11
Mean % CTD	0.5	3	1	1
Mean % SP	32.5	35	7	17
Total sessions through criterion				
Word set 1				
CTD	10	4	5	7
SP	11	4	4	9
Word set 2				
CTD	5	4	6	6
SP	6	4	6	6
Total CTD	15	8	11	13
Total SP	17	8	10	15
Mean minutes of training time through criterion				
Word set 1				
CTD	5.50	7.00	6.00	6.71
SP	5.18	4.75	5.25	7.78
Word set 2				
CTD	5.50	5.75	5.17	7.00
SP	5.00	5.25	5.17	5.83
Mean Min. CTD	5.50	6.38	5.58	6.86
Mean Min. SP	5.09	5.00	5.21	6.81
Total trials through criterion				
Word set 1				
CTD	240	96	120	168
SP	264	96	96	216
Word set 2				
CTD	120	96	144	144
SP	144	96	144	144
Mean % CTD	360	192	264	312
Mean % SP	408	192	240	360

Implications

Results of this study did *not* replicate results of previous comparisons of SP and CTD in regard to errors through criterion and trials through criterion. All previous

comparisons reported SP was superior to CTD when evaluating errors through criterion (Head et al. 2011; Kurt and Tekin-Iftar 2008; Riesen et al. 2003; Schuster et al. 1992; Tekin and Kircaali-Iftar 2002). Two of the five previous comparison studies reported trials through criterion (Kurt and Tekin-Iftar 2008; Tekin and Kircaali-Iftar 2002), noting that CTD was superior to SP. The findings of this study produced mixed results regarding trials through criterion. In regard to sessions through criterion, this study did replicate mixed results for CTD and SP that was reported in two of four previous comparisons (Head et al. 2011; Kurt and Tekin-Iftar 2008). This study also replicated results of three previous comparisons that SP was more efficient in regard to time through criterion (Kurt and Tekin-Iftar 2008; Schuster et al. 1992; Tekin and Kircaali-Iftar 2002).

Simultaneous prompting and CTD are considered "near errorless" procedures for teaching students various academic and social–communication targets. Errors through criterion indicated a stark difference between procedures with fewer errors observed during CTD sessions, specifically, 6–32 % less errors during CTD sessions when compared to SP sessions. An increase in errors reduces the likelihood of accessing reinforcement and increases the likelihood of negative behaviors during instruction. For example, Ryan displayed 0 % correct accuracy for the first five SP sessions before he began acquiring target words. He exhibited behaviors indicating frustration (e.g., slouching with arms folded) with SP and stated, "I can't do this," "I don't know," "I give up," and finally producing no response. While opportunities for errors are present during CTD sessions, students can wait for an answer if they do not know and access reinforcement. In addition, trials through criterion indicated that CTD required 48 fewer trials for two participants to reach mastery criterion when compared to SP. In contrast, trials through criterion when using SP required 24 fewer trials than CTD for one participant, with no difference for the remaining participant. Measures of sessions and time through criterion were considered "minimal" since there was a difference of three sessions to criterion between CTD (i.e., 47 sessions) and SP (i.e., 50 sessions) and 2.21 min with time to criterion measures (i.e., CTD was 24.32 min and SP was 22.11 min). While a difference of 2.21 min is not considered a significant difference in time, it could be argued that the three additional sessions required when using SP could have been used to teach new targets using CTD with fewer errors.

Unlike other comparisons, this study did not modify CTD for purposes of "equalizing" CTD and SP. In all previous studies reviewed (see Table 1), daily probe procedures were conducted prior to CTD instructional sessions. Wolery et al. (1992) highlight that CTD is "parsimonious" in that it is "relatively simple to use" and straightforward for teachers and practitioners (p. 52). The purpose of the previous statement is not to imply SP lacks parsimony, but more so to highlight that modifications to CTD are unnecessary and create additional unwarranted steps in teaching students with moderate to severe disabilities.

The results of this study necessitate future comparisons of SP and CTD, where CTD is not modified, to accurately measure and compare efficiency of instruction, especially errors through criterion. This study supports concerns related to increased opportunities for errors when using SP to teach students with moderate ID and ASD functional sight words. With consideration of response prompting procedures as

near errorless strategies for instruction, reducing the number of errors for students with a history of academic failure and limited observational and incidental learning opportunities is crucial when selecting teaching strategies. To meet the high demands of teaching students functional behaviors in an efficient manner, it is necessary to continue comparison studies of effective procedures that are implemented as designed.

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