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Comparison of Simultaneous Prompting to Error Correction for Children With Autism Spectrum Disorder

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Abstract

This study compared simultaneous prompting with an error correction procedure for teaching three children diagnosed with autism spectrum disorder expressive labels. Using a parallel treatment design nested within a multiple probe design, the researchers taught each participant how to expressively label pictures of sports teams or cartoon characters using either simultaneous prompting or an error correction procedure. The goal was to evaluate the effectiveness, efficiency, and acquisition during teaching for each participant across the two conditions. Results indicated that both teaching procedures were effective, with high rates of maintenance, and all participants responded correctly during the majority of teaching trials.

Keywords

autism, discrete trial teaching, simultaneous prompt, error correction, prompting

Individuals diagnosed with autism spectrum disorder (ASD) display deficits in social behavior (American Psychiatric Association, 2013), play skills (Jordan, 2003), joint attention (Bruinsma et al., 2004), cognition (Karalunas et al., 2018), and language development (American Psychiatric Association, 2013). To help improve upon these deficits, researchers have developed teaching procedures that are empirically supported and would be considered evidence-based (e.g., National Autism Center, 2015). One such procedure is known as *discrete trial teaching* (DTT; Ghezzi, 2007). DTT is a systematic approach to teaching that consists of three main components: (a) an instruction, (b) the learner's response, and (c) a consequence based on the accuracy of the learner's response (Lovass, 1987; Smith, 2001). DTT is commonly used during the course of intervention for individuals diagnosed with ASD to teach a variety of skills, such as social skills (Shillingsburg et al., 2014), play skills (Weiss et al., 2017), reduction in aberrant behavior (Haq & Aranki, 2019), and language development (e.g., Rabideau et al., 2018).

A common additional component of DTT is the use of prompts (Schreibman, 1975; Tarbox et al., 2007). Prompts typically involve antecedent manipulations by the therapist that increase the likelihood of the learner engaging in the desired response (Wolery et al., 1992). Given the documented effectiveness of various prompts, it can sometimes be difficult to determine when to provide a prompt, when to fade a prompt, and what level of assistance to provide. As a result, several prompt fading systems have been developed to guide clinicians (e.g., constant time delay, most-to-least prompting, and no-no prompt; Leaf et al., 2010; Soluaga et al., 2008).

One prompting system that has been empirically evaluated is *simultaneous prompting* (SP; Morse & Schuster, 2004). In SP, the therapist provides a prompt with a zero second delay immediately following the instruction, the learner responds to the prompt, and reinforcement is provided for correct responding. As all trials are prompted, the therapist would use probe trials (i.e., unprompted trials) at the beginning of a teaching session to determine whether the learner was able to acquire the skills in the absence of the prompt.

In 2004, Akmanoglu and Batu used SP to teach receptive labels to three participants diagnosed with ASD. The researchers implemented SP using the modeling and verbal prompting to teach the three participants to receptively label numbers. The results demonstrated that SP was effective for all three participants. Ramirez and colleagues (2014) evaluated the effects of SP for teaching three adolescents diagnosed with ASD how to calculate elapsed time. The authors used a multiple baseline design and demonstrated that SP was effective in teaching all participants to calculate time.

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In 2015, Coleman and colleagues taught vocabulary words to three children who were deaf or hard of hearing using either teacher-provided SP or computer-assisted SP. Through the use of an alternating treatment design, the results showed that teacher-provided SP and computer-assisted SP were equally effective and efficient for two participants, and for one participant, teacher-provided SP was the only procedure that was effective. In addition to the studies mentioned earlier, researchers have used SP to teach participants to expressively label (e.g., Johnson et al., 1996), receptively label (e.g., Tekin & Kircaali-Iftar, 2002), read (e.g., Schuster et al., 1992), and engage in self-help skills (e.g., Parrott et al., 2000). Furthermore, SP has been compared with constant time delay (e.g., Britton et al., 2017), direct instruction (e.g., Çelik & Kasapoglu, 2014), combined with and without error correction (e.g., Johnson et al., 1996), and progressive time delay (e.g., Klaus et al., 2019).

Another procedure that can be implemented in DTT is *error correction* (EC; Rodgers & Iwata, 1991). When implementing EC procedures, the therapist provides instruction for the learner to respond, free of any prompts. If the learner engages in the desired response, the therapist provides a reinforcer. However, if the learner does not engage in the desired response, the therapist provides corrective feedback (e.g., saying "No") and typically models the correct or desired response. EC differs from prompting systems such as SP in that the goal is for the learner to acquire the desired response only through consequent events. Research on EC has documented several variations for how error correction procedures are implemented. One of these variations involves the therapist providing a statement of inaccuracy (e.g., "Nope, that is not it"; Townley-Cochran et al., 2017). A second variation involves the therapist modeling the correct response such as pointing to the correct response (e.g., Akmanoglu & Batu, 2004). Another variation involves the therapist conducting a remedial trial (e.g., Leaf, Alcalay et al., 2014 & Leaf, Leaf et al., 2014). It should be noted that these variations in EC procedures could occur in isolation or in combination (Smith et al., 2006).

Worsdell and colleagues (2005) evaluated an EC procedure that utilized remedial trials with single and multiple response repetition for 11 adults diagnosed with developmental disabilities. In this study, the researchers taught the participants sight words. The results of the study showed that the EC procedure was effective across all participants, although multiple response repetition led to more words being mastered and retained. In 2006, Smith and colleagues compared three different types of feedback within a DTT format for six individuals diagnosed with ASD. The three different types of feedback were (a) saying "no" following an incorrect response, (b) providing a model following an incorrect response, and (c) providing no feedback (i.e., extinction) following an incorrect response. Results showed that error correction was effective, but specific variations in EC were idiosyncratic across participants. In addition to these studies, researchers have compared EC with most-to-least prompting (Leaf et al., 2013) and flexible prompt fading (e.g., Leaf, Leaf et al., 2014).

Today, both SP and EC would be considered empirically supported and evidence-based as both procedures have been evaluated in more than five single-subject design studies, have been conducted across three research labs, and have been determined to be effective for more than 20 participants (e.g., Horner et al., 2005). However, researchers should continue to seek out and determine what the most effective and efficient procedures are for teaching individuals diagnosed with ASD. Doing so will help practitioners know which procedures have the best research evidence, a hallmark of evidence-based practice (Dollaghan, 2007). Thus, more research comparing different practices is warranted.

Although SP and EC have been evaluated in numerous studies and have been compared with other prompting procedures (e.g., constant time delay and most-to-least prompting), EC and SP have only been compared with each other in two studies to date. In the first study, Leaf et al. (2010) compared SP with no-no prompting to teach three children diagnosed with ASD math skills, receptive labels, or answers to "wh" questions. A parallel treatment design was used to compare the effectiveness of the two approaches. The results indicated that no-no prompt was more effective and efficient in teaching new skills than SP. In a more recent study, Drevon and Reynolds (2018) compared SP with EC for three participants, all of whom would be considered neurotypical. The researchers taught the three participants multiplication facts. The EC condition consisted of response repetition where five repetitions were required. The results showed that EC was a more effective procedure for two of the participants and was more efficient for the third.

Given that a goal of behavior analytic research should be to determine the conditions under which procedures are the most effective and efficient for individuals diagnosed with ASD, and there are only two studies that have directly compared EC with SP, future research and replications are warranted. Therefore, the purpose of this study is to compare SP with EC to teach expressive labels for three children diagnosed with ASD. Relevant dependent variables assessed include skill acquisition across the two procedures, responding during maintenance, participants' responding during teaching, presence or absence of aberrant behavior during teaching, and efficiency of the procedures.

Method

Participants

Three children independently diagnosed with ASD participated in this study. Jeremy was a Chinese American 5-year-old boy with a Wechsler Preschool and Primary Scale of

Table 1. Targets Across Participants and Conditions by Training Sets.

	Training set 1		Training set 2		Training set 3	
Participant	SP	EC	SP	EC	SP	EC
Jeremy	USC Alabama	Washington Texas	Oklahoma Notre Dame	Hawaii Kansas	Ohio State Clemson	Michigan Arizona State
Lenny	Devils Hurricanes	Blue Jackets, Sabers	Canadians Barracuda	Blackhawks Senators	Flames, Avalanche	Red Wings Coyotes
Evan	Nala Squishy	Pumba Wario	Meeko Sonic	Poof Casper	Jimmy Linus	Dug Kirby

Note. SP = simultaneous prompt; EC = error correction; USC = University of Southern California.

Intelligence–Fourth Edition (WPPSI-IV; Wechsler, 2012) IQ score of 98, a Vineland Adaptive Behavior Scales–Third Edition (Vineland-3; Sparrow et al., 2016) adaptive behavior score of 84, a Gilliam Autism Rating Scale (GARS-II; Gilliam, 2006) autism quotient of 68, a Social Responsiveness Scale (SRS-2; Constantino & Gruber, 2012) score of 51, an Expressive One-Word Picture Vocabulary Test–Fourth Edition (EOWPVT-4; Martin & Brownell, 2011) score of 92, and Peabody Picture Vocabulary Test–Fourth Edition (PPVT-4; Dunn & Dunn, 2007) standard score of 87. Jeremy received a mean of 34 hr of behavioral intervention per week that targeted learning how to learn skills (e.g., waiting, responding to instructions, and handing back reinforcers), social skills, and communication skills.

Lenny was a White 9-year-old boy with a WPPSI-IV IQ score of 72, a VABS-III score of 77, GARS- II autism quotient of 70, an SRS score of 63, an EOWPVT-4 of 84, and a PPVT-4 standard score of 80. Lenny received a mean of 33 hr of behavioral intervention per week. Lenny's behavioral intervention focused on learning how to learn skills, compliance, peer interactions, and conversational skills.

Evan was a White 3-year-old boy with a WPPSI-IV IQ score of 112, a VABS-III score of 78, an EOWPVT-4 score of 105, and a PPVT-4 standard score of 109. Evan received a mean of 23.5 hr of behavioral intervention per week that focused on learning how to learn skills, communication skills, social skills, and play skills.

Setting

All sessions were conducted in a private agency that provided behavioral intervention for individuals diagnosed with ASD. Specifically, sessions took place in the research room in the agency. There was a table and four chairs designed for a child, a treasure chest with different toys, and adult furniture in the research room.

Stimuli

Twelve pictures of professional or college sports team logos were selected as target stimuli for Jeremy and Lenny, and 12 pictures of cartoon characters were selected as target stimuli for Evan. The researchers discussed with the participants' supervisor (i.e., the person in charge of creating the participants' behavioral intervention curriculum) what expressive labels to teach within this study. The supervisor and the researcher decided on the current targets because the participants' peers were interested in the targets (i.e., sports teams and cartoon characters) and it could potentially lead to more positive social interactions with children their same age. The 12 pictures were then randomly assigned to the SP and EC conditions (i.e., six targets per condition). Targets were introduced in pairs for each condition. The term *training set* will be used from this point forward to refer to stimulus pairs that were taught concurrently within a condition. Table 1 provides a list of training sets for each participant.

Trial Types

There were two types of trials within this study. *Probe trials* consisted of the researcher presenting a stimulus and providing the learner with an instruction to respond (e.g., "Who is it?"). Participants were provided 5 s to respond to the instruction. Neutral feedback (e.g., "Thanks") was provided regardless of the accuracy of the response, and no prompts were provided. During probe trials, learner responses were scored as independent correct, independent incorrect, or no-response. An *independent correct response* was defined as engaging in the vocal response that corresponded with the presented stimulus within 5 s of its presentation (e.g., saying "Cardinals" in the presence of the picture of the Cardinals' logo after the interventionist says, "What's this?"). An *independent incorrect response* was defined as engaging in a vocal response that did not correspond with the presented stimulus within 5 s of its presentation. *No response* was defined as not engaging in any vocal response within 5 s of the stimulus presentation.

Teaching trials in the SP condition consisted of the researcher presenting a stimulus and providing the learner with an instruction to respond (e.g., "Who is it?"). An assistive prompt occurred immediately following the instruction. Participant responses were scored as independent correct,

independent incorrect, no response, prompted correct, and prompted incorrect. Independent correct, independent incorrect, and no response were defined the same as in probe trials. A *prompted correct response* was defined as engaging in the vocal response that corresponded with the presented stimulus within 5 s of its presentation following a prompt. The percentage of prompted correct responses was measured by dividing the number of trials with prompted correct responses by the total number of trials per session and multiplying by 100. A *prompted incorrect response* was defined as engaging in a vocal response that did not correspond with the presented stimulus within 5 s of its presentation following a prompt. If the participant engaged in an independent or prompted correct response, the researcher provided reinforcement (described later). If the participant engaged in an independent or prompted incorrect response or no response, the researcher moved to the next predetermined trial.

Teaching trials in the EC condition consisted of the researcher presenting a stimulus and providing the learner with an instruction to respond (e.g., "Who is it?"). Participants were provided with 5 s to respond to the instruction. If the learner engaged in an independent correct response, the researcher provided reinforcement. If the participant engaged in an incorrect response or no response, the researcher provided corrective and informative feedback (e.g., "No, it is the Cardinals"). Participant responses were scored as independent correct, independent incorrect, or no response, defined the same as in probe trials.

Dependent Variables

The primary dependent variable in this study was participant responses to probe trials as assessed during daily probes (described later). The second variable evaluated was the number of training sets for each condition that reached the mastery criterion of 100% independent correct responses across three consecutive daily probes. Third, the maintenance of learned skills from each condition was assessed via probe trials during full probes (described later). The fourth variable evaluated was participant responses to teaching trials across conditions. Fifth, participants' aberrant behavior was evaluated in the two teaching conditions. *Aberrant behavior* was defined as the participant engaging in self-injurious behavior, aggression, elopement, falling to the floor, or yelling. Finally, the efficiency of both conditions was assessed. Efficiency was measured in three different ways: (a) the number of teaching sessions to mastery, (b) the number of trials to mastery, and (c) the duration of total teaching time required to reach mastery.

Assistive Prompt Assessment

Prior to baseline, the researcher conducted an assistive prompt assessment to evaluate each participant's accuracy of responses, given a full verbal, partial verbal, or multiple alternative prompts when presented with unknown pictures to expressively label. The assessment consisted of the researcher holding up a picture and providing an instruction to respond (e.g., "What is it?") immediately followed by one of the three prompt types. The pictures used during this assessment were not used at any other point during the study. A total of 12 trials were included in the assessment (four trials of each target). The number of prompt assessments varied between participants based on responses: one assistive prompt assessment was conducted with Lenny, two assistive prompt assessments were conducted with Jeremy, and three assistive prompt assessments were conducted with Evan. The assistive prompt that the participant responded correctly to on most trials was selected as the prompt to be used during the SP condition. A full verbal prompt was determined as the assistive prompt and was used with all participants.

The results of this assessment showed that two of three participants responded at 100% correct responses when a full verbal prompt was used (Jeremy and Evan). One participant (Lenny) did not respond at 100% correct responses for any of the prompts assessed. However, Lenny engaged in more correct responses with a full verbal prompt. Thus, this prebaseline assessment was determined to be an assistive prompt assessment instead of a controlling prompt, as it did not result in 100% correct responses across all participants. However, it should be noted that during teaching Lenny responded 100% correctly to the implementation of the full verbal prompt within the simultaneous prompting condition. Thus, within teaching, the full verbal prompt did in fact serve as a controlling prompt.

Full Probes

Full probe sessions occurred prior to any teaching and following mastery of targets in the SP and EC conditions. The purpose of full probe sessions was to evaluate responding to target stimuli prior to any teaching and to evaluate maintenance following mastery of targets in both conditions. Each full probe session consisted two probe trials per stimulus for a total of 24 probe trials. The order of trials was randomized, and targets in the two teaching conditions were interspersed.

Procedure

Sessions occurred 3 to 4 days a week and lasted approximately 15 min. Each session, with the exception of the first teaching session of each set, consisted of a daily probe, followed by the two teaching conditions run in random order.

Daily probes. Daily probes were conducted to start each teaching session, with the exception of the first teaching

session. Each daily probe consisted of four probe trials for the SP training set targets and four probe trials for the EC training set targets (i.e., eight total trials). The order of trials was randomized and interspersed across the two conditions. Daily probe trials were used to evaluate mastery of training sets. The mastery criterion was 100% independent correct responses on all targets within a training set for a condition across three consecutive daily probes. If a participant reached mastery criterion on a training set in one condition and did not reach mastery criterion in the other condition, the researcher did not conduct probe trials or teaching trials for the targets that had reached the mastery criterion during daily probes.

SP condition. Each target within a stimulus set was presented 9 times for a total of 18 teaching trials per session. On each trial, the researcher provided the assistive prompt immediately following the instruction. If the participant engaged in a correct response, the researcher provided praise (e.g., "That's right!") and a token. If the participant engaged in an independent incorrect, prompted incorrect, or no response, the researcher did not provide feedback and moved on to the next trial.

EC condition. Each target within a stimulus set was presented 9 times for a total of 18 teaching trials per session. If the participant engaged in an independent or prompted correct response, the researcher provided praise (e.g., "That's right!") and a token. If the participant engaged in an independent incorrect or no response, the researcher said "No" followed by the correct response (e.g., "No, it is [the name that corresponds with the card]") and moved to the next trial.

Reinforcement system. A token economy (Ayllon & Azrin, 1968) was used across both teaching conditions. One token was provided for each correct response (independent or prompted) on each teaching trial, and the total number of tokens a participant could earn at the end of each teaching session was 36 tokens. If a participant reached mastery criterion for one training set and not the other, the researcher provided 18 tokens before teaching the targets in the other condition. If the participant earned at least 28 tokens at the end of both teaching sessions, then the participant could take a toy home from a treasure chest that contained more than 100 small toys (e.g., bouncy ball, stickers, racecar, and small figurines), with toy values ranging from US$0.25 to US$7.00.

Experimental Design

The researchers used a parallel treatment design nested in a multiple probe design (Gast & Wolery, 1988) to compare and evaluate the effectiveness of the two procedures. There are two critical components of this design. First, the researchers randomized the targets across the two teaching conditions to ensure that there was no potential for bias (e.g., assignment of easy targets to one condition) within the study. Second, the researchers counterbalanced the order of the two conditions across the sessions to help minimize the chance of multiple treatment interference. The use of the multiple probe design helped further demonstrate experimental control as it demonstrated that participants would only increase correct responding on targets after the introduction of the interventions (Kazdin, 2011). That is, responding for targets in the intervention was acquired and reached mastery criterion, while responding for targets not yet in intervention remained at baseline levels.

Interobserver Agreement

The researcher scored the participant's responses during every full probe, daily probe, and teaching sessions. A second observer independently recorded participant responses during 42.5%, 43.5%, 37.5%, and 38% of full probes, daily probes, teaching sessions with SP, and teaching sessions with EC, respectively. Interobserver agreement was calculated by totaling the number of agreements (i.e., trials in which both observers scored the same behavior) on each type of participant response divided by the number of agreements plus disagreements (i.e., trials in which the two observers scored a different response for the target behavior) and multiplying by 100. Percentage agreement across all participant responses was 98.8% (range, 97.2%–100%) for daily probes, 94.4% (range, 96.4%–100%) for full probes, 100% for SP trials, and 98.3% (range, 98.3%–100%) for EC trials.

Treatment Fidelity

Observers also measured whether the researcher correctly implemented teaching trials within the full probe sessions, daily probes sessions, and the two teaching conditions. Correct instructor behavior during the full and daily probes included (a) holding up the correct picture, (b) delivering a correct instruction to begin the trial, (c) allowing approximately 5 s for the participant to respond, and (d) providing the participant with neutral praise (e.g., "Okay" or "Thanks") regardless of the participant's response. Correct implementation during SP conditions included (a) holding up the correct picture, (b) delivering a correct instruction to begin the teaching trial, (c) presenting the assistive prompt (e.g., full verbal prompt), (d) providing social praise and tokens for a correct response (e.g., "Yes! That's right"), and (e) moving to the next trial for incorrect response. Correct implementation during EC conditions included (a) holding up the correct picture, (b) delivering a correct instruction to begin the teaching trial, (c) waiting

5 s for the participant to respond, (d) providing social praise and tokens for a correct response, (e) providing punishment and corrective feedback (e.g., "No, it's correct label"), and (f) moving to the next trial.

Treatment fidelity data were taken in 40% of full probe sessions, 40.3% of daily probe sessions, 37% of teaching sessions with SP, and 40% of teaching sessions with EC. Treatment fidelity was 100%, 100%, 99.87% (range, 99.79–100%), and 100% during daily probes, full probes, the SP condition, and the EC condition, respectively.

Results

Skill Acquisition, Mastery Criterion, and Maintenance

Figures 1 to 3 depict the results on full and daily probes for Jeremy, Lenny, and Evan, respectively. Across the *x*-axes are consecutive probes and across the *y*-axes are the percentage independent correct responses on probe trials. Each panel represents a different set.

Jeremy (see Figure 1) engaged in 0% correct responses in baseline, and then he reached mastery criterion for all training sets in both conditions. During maintenance, Jeremy's mean independent correct responses across all sets were 100% for SP targets and 94.4% (range, 75%–100%) for EC targets. Lenny (see Figure 2) engaged in 0% correct responses in baseline and then reached mastery criterion for all training sets in both conditions. During maintenance, Lenny's mean correct responses across all sets were 95.8% (range, 75%–100%) for SP targets and 93.1% (range, 75%–100%) for EC targets. Evan (see Figure 3) engaged in 0% correct responses in baseline and reached mastery criterion for all training sets in both conditions. During maintenance, Evans's mean correct responses across all sets were 81.9% (range, 50%–100%) for SP targets and 92.1% (range, 50%–100%) for EC targets.

Responding During Teaching

Table 2 displays participant responses to teaching trials across the two teaching conditions. The teaching trial data are presented per participant across sets, the totals are presented per participant across sets, and the overall total across all participants and sets. Across sets, Jeremy displayed an average of 91.3% correct responding (range, 83.3%–97.6%) in the EC condition and 99.1% corrected prompted responding (range, 99.1%–100%) in the SP condition. Across sets, Lenny displayed an average of 87.4% correct responding (range, 83.3%–90.7%) in the EC condition and 100% corrected prompted responding in the SP condition. Across sets, Evan displayed an average of 87.1% correct responding (range, 76.8%–94.4%) in the EC condition and 99.7% corrected prompted responding (range, 99.2%–100%) in the SP condition. Aggregated across participants and sets, the overall correct responding was 88.5% (range, 87.1%–91.3%) in the EC condition and corrected prompt responding was 99.5% (range, 99.1%–100%).

Displaying Aberrant Behavior During Teaching

The fourth variable measured was whether the participant displayed aberrant behavior during the two teaching conditions. Jeremy did not display any self-injurious behavior, aggression, elopement, falling to the floor, or yelling during any session in either of the conditions throughout the study. Lenny displayed four total instances of yelling throughout the study. Three of these instances occurred in the SP condition and one in the EC condition. For the SP condition, Lenny displayed an instance of yelling in the third session for Set 1 and during the first session and fourth session for Set 2; yelling behavior displayed during the SP condition consisted of Lenny yelling to let him answer the instruction independently without assistance from the researcher. For the EC condition, Lenny displayed one instance of yelling in the seventh session for Set 2. Evan did not display any self-injurious behavior, aggression, elopement, falling to the floor, or yelling during any session in either of the conditions throughout the study.

Efficiency Measures

Table 3 provides the total number of teaching sessions, the total number of teaching trials, and the total duration of teaching time for all participants. The efficiency measures are presented per set, totaled across sets per participant, and totaled across all sets and participants. Jeremy's overall efficiency results showed that the EC condition was more efficient in terms of the total number of sessions, trials, and total duration. When evaluating Jeremy's efficiency for each training set, the SP condition was more efficient in terms of sessions, trials, and time for Set 1. No difference in terms of efficiency was observed between the two conditions for Set 2. For Set 3, the EC condition was more efficient for Jeremy in terms of total teaching sessions, trials, and duration.

Lenny's overall efficiency results showed that the SP condition was more efficient in terms of the total number of sessions, trials, and total duration. When evaluating efficiency for each training set, the SP condition was more efficient in terms of sessions, trials, and time for Set 1. For Set 2, the EC condition was more efficient. For Set 3, the EC condition was more efficient for Lenny in terms of total teaching sessions, trials, and duration of teaching.

Evan's overall efficiency results showed that the EC condition was more efficient in terms of the total number of sessions, trials, and total duration. When evaluating efficiency for each training set, the EC condition was more

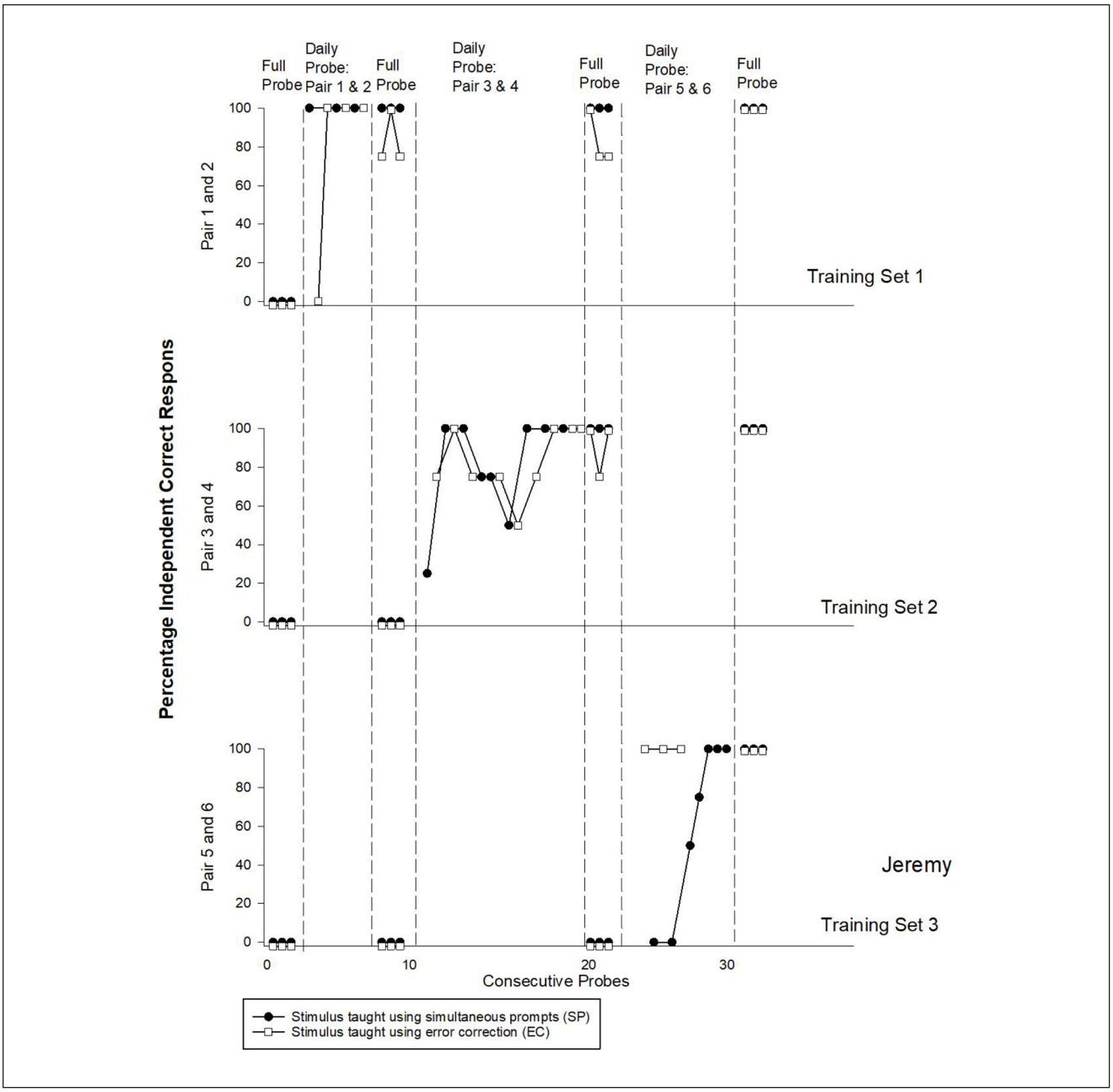

Figure 1. Percentage of probe trials correct during full probes and daily probes across three stimulus pairs for Jeremy using simultaneous prompting and error correction.

efficient in terms of sessions, trials, and time for Set 1, Set 2, and Set 3 in terms of the total number of sessions, trials, and duration of teaching.

When evaluating the efficiency results across all participants, conditions, and sets, the results indicated that the EC condition was more efficient in terms of the number of sessions (i.e., 50 sessions) compared with the SP condition (i.e., 55 sessions). The EC condition was more efficient in terms of the number of teaching trials (i.e., 900) compared with the SP condition (i.e., 990). The EC condition was also more efficient in terms of total teaching duration (i.e., 2 hr 51 min 33 s) compared with the SP condition (i.e., 3 hr 18 min 33 s).

Discussion

The purpose of this study was to compare EC with SP when teaching expressive labels for three children

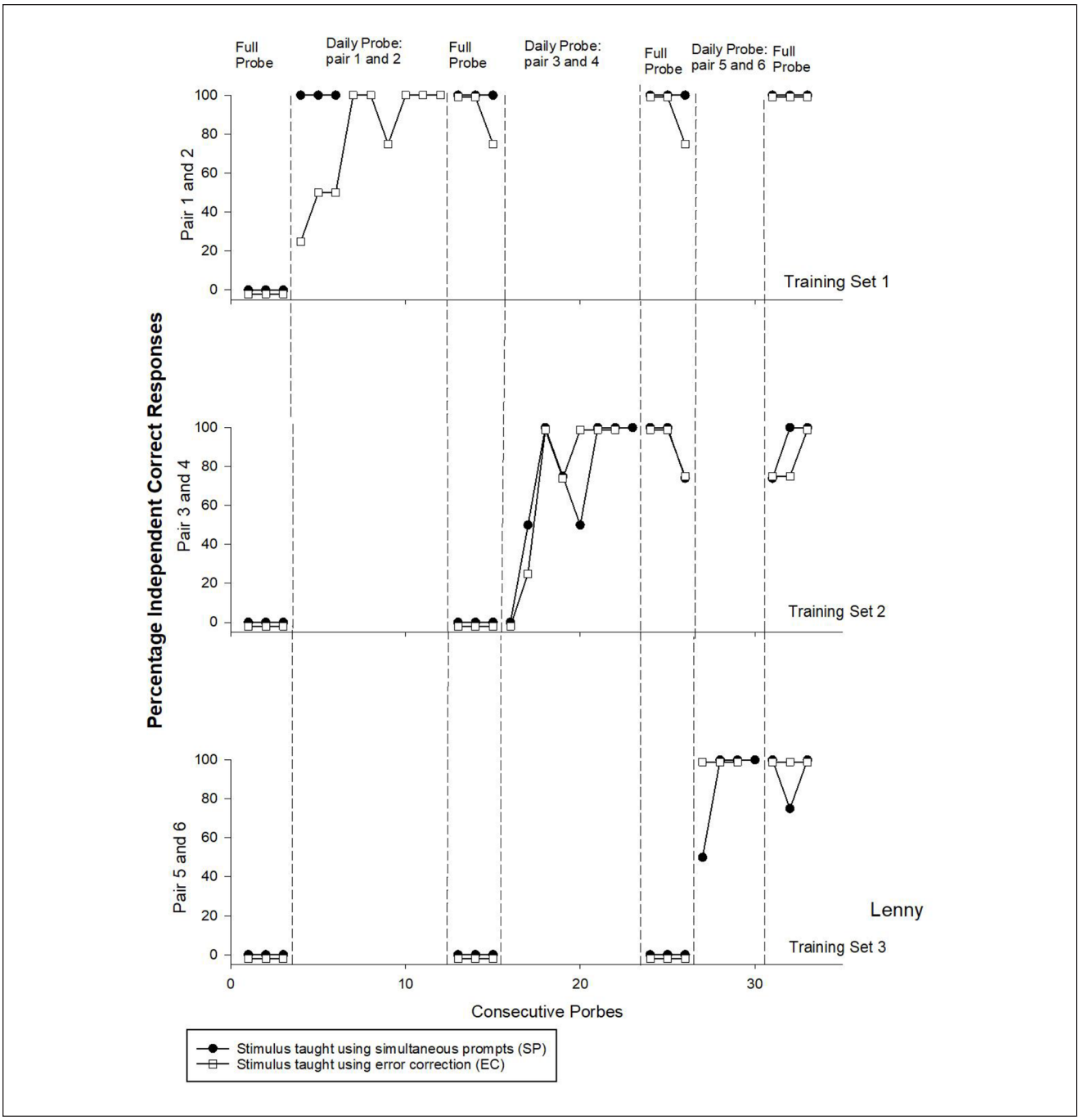

Figure 2. Percentage of probe trials correct during full probes and daily probes across three stimulus pairs for Lenny using simultaneous prompting and error correction.

diagnosed with ASD. The results indicated that both approaches were effective for all participants as all three participants reached mastery criterion on all teaching sets across the conditions. Overall, across participants and sets, the EC condition was found to be more efficient in terms of trials, sessions, and duration. Within participants, efficiency between the two conditions was idiosyncratic, with the EC condition being more efficient for two of the participants (i.e., Jeremy and Evan) and the SP condition more efficient for one participant (i.e., Lenny). The results also demonstrated that both the EC and SP conditions resulted in high levels of correct responding during teaching across participants and training sets. Finally, the results showed that neither the EC

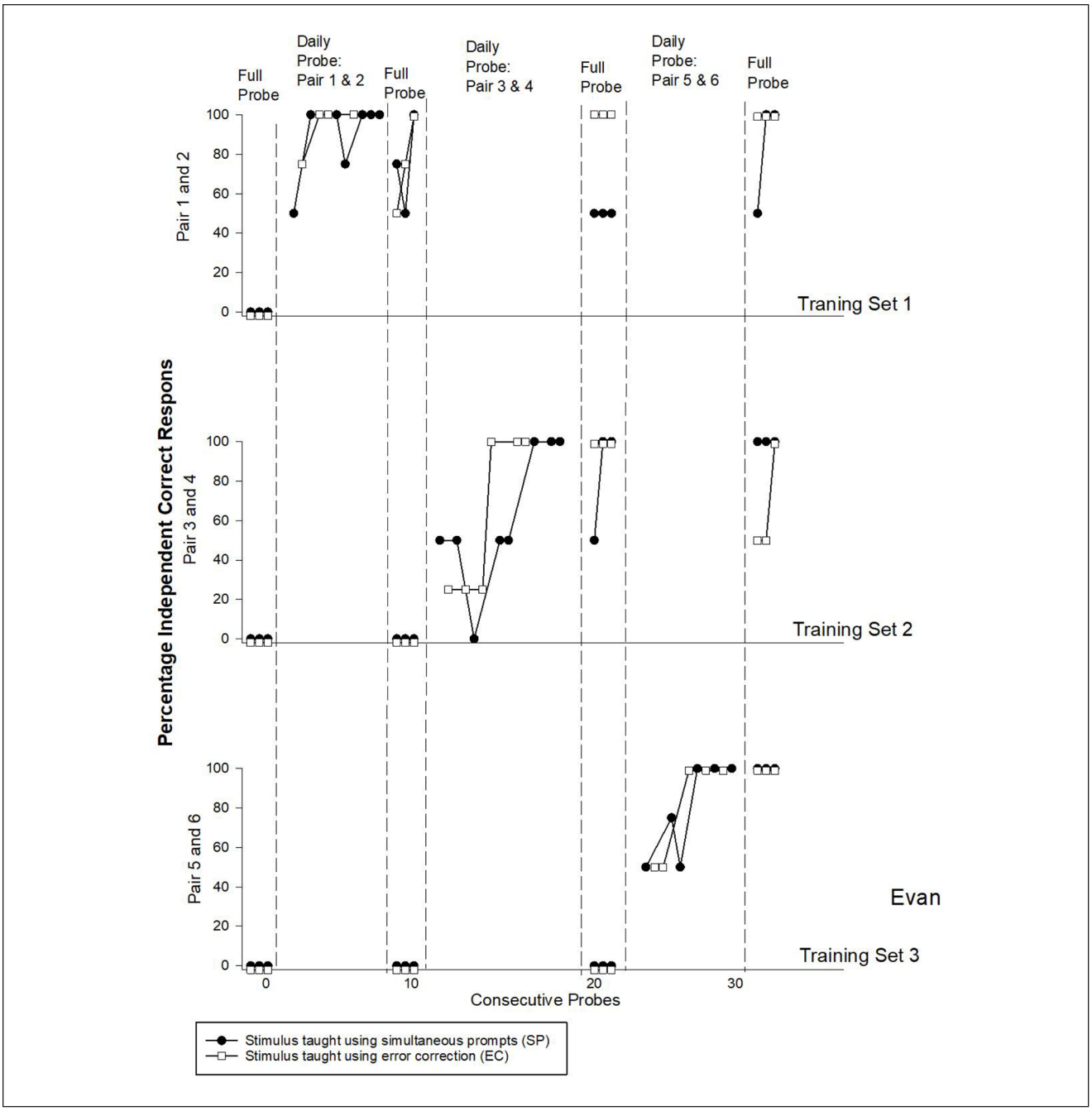

Figure 3. Percentage of probe trials correct during full probes and daily probes across three stimulus pairs for Evan using simultaneous prompting and error correction.

condition nor the SP condition resulted in frequent displays of aberrant behavior from the participants.

These results expand upon the two previous studies that have compared SP and EC. First, it further demonstrates the effectiveness of the two procedures and aligns with previous research demonstrating EC procedures to be overall more efficient than SP procedures (e.g., Drevon & Reynolds, 2018; Leaf et al., 2010). Second, the results of this study demonstrate that EC required slightly less time to teach the assigned targets when compared with the target taught in the SP condition. Although the time difference was minimal in this study (i.e., ~27 mins), when it comes to teaching time for children diagnosed with ASD every second counts, as it is time that could be spent teaching and learning new skills. Thus, teaching time can be an important factor to consider when selecting an evidence-based teaching method to use

Table 2. Teaching Trial Data Across Participants and Conditions.

		Independent correct response		Independent incorrect response		Prompted correct response		Prompted incorrect response	
Participant	Set	SP	EC	SP	EC	SP	EC	SP	EC
Jeremy	1	N/A	83.3%	N/A	16.7%	94.4%	N/A	5.6%	N/A
	2	N/A	97.6%	N/A	2.4%	100%	N/A	0%	N/A
	3	N/A	83.3%	N/A	16.7%	100%	N/A	0%	N/A
	Total	N/A	91.3%	N/A	8.7%	99.1%	N/A	0.9%	N/A
Lenny	1	N/A	89.5%	N/A	10.5%	100%	N/A	0%	N/A
	2	N/A	83.3%	N/A	16.7%	100%	N/A	0%	N/A
	3	N/A	90.7%	N/A	9.3%	100%	N/A	0%	N/A
	Total	N/A	87.4%	N/A	12.6%	100%	N/A	0%	N/A
Evan	1	N/A	94.4%	N/A	5.6%	99.2%	N/A	0.8%	N/A
	2	N/A	76.8%	N/A	23.2%	100%	N/A	100%	N/A
	3	N/A	93.3%	N/A	6.7%	100%	N/A	100%	N/A
	Total	N/A	87.1%	N/A	12.9%	99.7%	N/A	0.3%	N/A
All participants	Total	N/A	88.5%	N/A	11.5%	99.5%	N/A	0.5%	N/A

Note. "N/A" is used when the condition made it not possible to engage in the response. SP = simultaneous prompt; EC = error correction.

Table 3. Efficiency Measures of Total Sessions, Total Trials, and Total Duration Per Participant.

		Total sessions (*n*)		Total trials (*n*)		Total duration	
Participant	Set	SP	EC	SP	EC	SP	EC
Jeremy	1	3	4	54	72	0:10:19	0:13:28
	2	9	9	162	162	0:29:55	0:28:43
	3	7	3	126	18	0:25:19	0:10:24
	Total	19	16	342	288	01:05:33	0:52:35
Lenny	1	3	9	54	162	0:12:20	0:30:29
	2	8	7	144	126	0:29:54	0:24:51
	3	4	3	72	54	0:11:49	0:08:12
	Total	15	19	270	342	0:54:03	1:03:32
Evan	1	7	4	126	72	0:31:11	0:18:14
	2	8	6	144	108	0:31:12	0:22:48
	3	6	5	108	90	0:16:34	0:14:02
	Total	21	15	378	270	01:18:57	0:55:04
All participants	Total	55	50	990	900	03:18:33	0:2:51:33

Note. SP = simultaneous prompt; EC = error correction.

in teaching students diagnosed with ASD. Third, to our knowledge, this is the first to evaluate aberrant behavior exhibited by participants when the two teaching conditions are compared with one another. The results demonstrated that aberrant behavior does not occur frequently with either of the teaching procedures. This is critical information in that it further demonstrates that the provision of corrective feedback does not lead to aberrant behavior (e.g., Leaf et al., 2020) despite comments to the contrary (e.g., Mueller et al., 2007).

There are several possible explanations for why the EC procedure was more efficacious for two of the participants (i.e., Jeremy and Evan). First, during EC, the participant received differential consequences based on their responses, reinforcement for correct responses, and corrective feedback for incorrect responses. This differential corrective feedback used in the EC condition may have a function as a prompt for participants to change their answer in the next trials (Carr, 2003). Second, in the EC condition, participants received reinforcement only for independent correct responses because prompts were never provided. This required participants to look at the visual stimulus and respond correctly and consistently on each trial to receive reinforcement in this condition (Leaf et al., 2010).

During the SP condition, prompts were delivered simultaneously with the instruction, which meant that the

participants could hear the correct answer without looking at the visual stimuli and still earn a token for labeling it correctly (e.g., participant repeating the name without looking at the visual stimuli). Not attending to the stimulus presented during teaching trials could have affected participant performance during probe trials in which no prompts, reinforcement, or corrective feedback were provided.

There are several limitations in this study that warrant discussion. First, during the assistive prompt assessment, one participant did not consistently engage in correct responding (i.e., 100% correct for any of the types of prompts provided) for any of the prompts used, and the prompt that resulted in higher correct responses was used in teaching. Future researchers should evaluate the different prompts used during the assistive prompt assessment to compare the possible effects of it on skill acquisition and overall performance. Second, only one skill (i.e., expressive labels) was targeted, which limits the generalization of the efficacy of these procedures when it comes to teaching other skills. Future researchers should compare the effectiveness of EC and SP with different types of skills (e.g., self-help skills, greetings, and social skills) to examine the generality of the results. Third, all three participants had well-developed language repertoires and had previous exposure to EC and SP teaching procedures. As a result, the generality of the findings to a more diverse population of participants remains unknown. Until future researchers evaluate EC and SP procedures with more skills and more diverse populations, the results should be limited to using these procedures for a specific population and a specific skill. Fourth, generalization of the skills with different settings or people was not assessed. Future researchers should attempt to replicate these findings and evaluate the generalization of mastered skills across a variety of variables, which would help to extend the generality of the results of this study. Fifth, participant preference of the two approaches was not assessed. Given the documented effectiveness of both approaches, participant preference could be an invaluable variable for clinicians in deciding which approach to use. Future researchers should ensure measures of participant preferences of teaching methods are included.

Although this study had several limitations, the results showed both procedures were effective in teaching expressive labels to three children diagnosed with ASD. Overall, both teaching procedures were effective, and the error correction procedure was shown to be slightly more efficient for two participants (i.e., Jeremy and Evan). With that said, additional research is required to help identify the conditions under which EC or SP will be more effective, efficient, or preferred. Additional comparisons including different participant demographics, context, and skills will help to provide this information.

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