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RESEARCH ARTICLE

Teaching Children With Autism to Initiate Social Interactions Using Textual Prompts Delivered via Apple Watches®

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Abstract

Children diagnosed with autism spectrum disorder (ASD) often engage in low levels of peer social interactions; therefore, we often need to explicitly teach these skills. In the current study, we implemented a combined tactile and textual prompt, delivered via a text message sent to an Apple Watch®, to prompt social initiations from children with ASD to peers during free play. Results showed that the text message prompts increased the frequency of independent social initiations for both participants. Furthermore, 1 participant continued to emit high levels of independent social initiations during a 1-month follow-up with no prompts.

Keywords Autism · Prompting · Social interactions · technology · Text message

Individuals diagnosed with autism spectrum disorder (ASD) show persistent deficits in social communication and social interactions across multiple contexts (American Psychiatric Association, 2013). These deficits in conversational speech often make it difficult for children with ASD to engage in peer interactions. In addition, children diagnosed with ASD might not find social interactions reinforcing. As a result, children with ASD often engage in more solitary forms of play (Memari et al., 2015), which may lead to social withdrawal (Rubin, Coplan, & Bowker, 2009).

There are several methods available to practitioners to increase social interactions between children with ASD and their peers. For example, script-training procedures involve visual (textual) or auditory prompts to say a contextually appropriate response during social interactions (e.g., Groskreutz, Peters, Groskreutz, & Higbee, 2015; Krantz & McClannahan, 1993, 1998; Ledbetter-Cho et al., 2015; McDonald & Hemmes, 2003; Wichnick-Gillis, Vener, & Poulson, 2016). Although script-training procedures are effective, visual scripts require the researcher to be in proximity to the participant, and auditory scripts may be disruptive. When delivering prompts to increase social interactions for children with ASD, it is essential that the researcher use the least intrusive prompting method possible. This is important to avoid prompt dependency, increase social acceptability of the procedures, and program for maintenance and generalization. The ability to deliver effective prompts from a distance may provide the child the opportunity to engage in appropriate social skills (e.g., conversations and gross motor actions) independently, and allows peers more opportunities to engage in interactions with the child with ASD without adults intervening or competing for attention.

Advances in technology are increasing the number of ways that we can deliver prompts and teach skills (Goldsmith & LeBlanc, 2004). For example, a tactile prompt can easily be incorporated into the natural play context. Tactile prompting involves a vibrating device, such as a pocket-sized vibrating pager, that can be either activated through a transmitter by a trainer or programmed to vibrate at regular intervals. When using a tactile prompt, the individual learns to engage in a

Research Highlights
• Clinicians can teach children to respond to text-message prompts during brief, individual sessions.
• Utilizing technology (e.g., cell phones and smart watches) may allow clinicians to deliver less intrusive prompts in play contexts.
• Text-message prompts permit clinicians to deliver specific, contextually appropriate prompts.
• Smart watches are common, socially acceptable stimuli that may be ideal mechanisms to deliver prompts naturalistically.

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desired behavior following the vibrating prompt. The use of tactile prompting allows the researcher to be at a farther distance than traditional prompting methods. As a result, this prompting method also allows for fewer interruptions or distractions by the researcher, potentially making it less stigmatizing for the participant. Furthermore, the use of remote, tactile prompts may aid in the development of effective stimulus control (i.e., social initiations/responses will occur in the natural environment, e.g., in the presence of peers).

Researchers have successfully used a vibrating pager as a tactile prompt to increase the verbal initiations and responses for children diagnosed with ASD (Shabani et al., 2002; Taylor & Levin, 1998; Tzanakaki et al., 2014). Furthermore, Taylor and Levin (1998) found tactile prompting to be more effective than verbal prompting to increase the frequency of initiations compared to traditional prompting methods (e.g., verbal or gestural prompts). One potential limitation of these studies is that none of the researchers separated independent and prompted initiations or responses; therefore, it is unclear whether the increase in social interactions occurred independently of the delivery of the tactile prompt. Also, the tactile prompt was delivered every 25 s (Shabani et al., 2002) and every 60 s (Taylor & Levin, 1998; Tzanakaki et al., 2014), regardless of responding. Because a fixed time schedule was used, it is unclear whether a prompt was necessary at any given interval.

A recent method of delivering tactile prompts involves using a text message (Grosberg & Charlop, 2017). Given the current popularity and common use of cell phones, prompts delivered via text message may be considered less intrusive and more socially acceptable. In addition, in contrast with a tactile prompt alone, a text-message prompt allows the researcher to deliver a specific, contextually appropriate response. In a recent study by Grosberg and Charlop (2017), researchers increased the conversational speech of six children with autism using text-message prompts during training. The researchers conducted text-message prompt training, following baseline, until the participants were able to emit at least eight prompted or independent conversational phrases to an adult during play. After text-message prompt training, researchers conducted two 5-min testing sessions in which the cell phone was removed from the play setting (i.e., no text-message prompts were delivered) with the sibling or peer. Four participants immediately met the criterion of eight phrases, one participant required two additional training sessions with the adult and then met the criterion, and one participant required script fading to meet the criterion. Generalization probes and a 1-month follow-up probe demonstrated all participants maintained similar levels of conversational speech. Although the intervention produced an increase in conversational phrases, it is unknown to what extent these phrases were social initiations or responses. Furthermore, all the conversational partners consisted of a sibling or a known peer during brief sessions (5 min).

One rationale for using this technology is to limit the intrusiveness of prompting and increase the social acceptability of the teaching procedure. Interestingly, in the study by Grosberg and Charlop (2017), the text-message prompt was only utilized with the adult; therefore, it is unknown how effective this type of prompt might be when delivered during play with a peer. As technology becomes more advanced, so should our attempts at advancing traditional prompting methods. To our knowledge, no studies to date have utilized a smart watch to deliver text-message prompts to children with ASD during play with a peer.

The purpose of the current study was to evaluate the effectiveness of a combined textual and tactile prompt to increase social interactions in two children diagnosed with autism during free play with a peer. Specifically, we delivered the prompt as a text message sent from an Apple iPhone® to an Apple Watch® following an interresponse time (IRT) equal to 30 s. This allowed us to deliver specific, contextually appropriate phrases to the participant and avoid overprompting.

Method

Participants

Participants included two 6-year-old boys diagnosed with ASD who were receiving applied behavior analysis (ABA) services from an autism provider in central California. Buster had been receiving services from the ABA provider for 3 years. Bochy had been receiving services from the ABA provider for 3 years, 6 months. Buster and Bochy met the following prerequisites to participate: experience with free-play periods with peers; mastery and generalization of letter identification, phonics, and sight word programs; and passing the pretest. The pretest required the participant to read the training and posttraining phrases and questions four times each on white index cards. The pretest was the same for both participants. Buster passed the pretest with 100% correct, and Bochy passed the pretest with 95.8% correct. We also recruited one typically developing peer to play with each of the participants. Lucille was a 7-year-old girl who had attended peer plays regularly at the center. Lucille did not have any prior contact with either participant prior to the study.

Setting and Materials

All baseline, training, and posttraining sessions took place at the service provider's clinic located in central California. Training sessions took place in the client's individual one-on-one room (2.1 m × 2.4 m) that contained a table, two chairs, the client's program stimuli, and some play items (e.g., books, blocks, Legos, or cars). Baseline and posttraining sessions took place in an unoccupied playroom (9.3 m × 3.9 m) located

within the clinic. The playroom contained tables, chairs, and shelves with books. The playroom also contained three different pretend play sets (grocery store checkout counter, workshop, and fishing set). The researchers chose these play sets because they included a variety of items, which provided the participants and the peer opportunities to tact different items or describe how they were playing. We used an Apple iPhone® to send text messages to the participants, who wore an Apple Watch® on their wrists throughout all baseline, training, and posttraining sessions. We also used a timer to track the 30-s IRT required to deliver the textual prompt.

Response Measurement

We collected data via electronic devices using the Countee application (Peić & Hernández, 2016). Trained observers recorded the frequency of *independent initiations*, *prompted initiations*, and *independent responses* emitted by the participants. We defined *initiations* as statements or questions emitted by the participant toward a peer (e.g., "I have the wrench," "Do you want my apples?" or "Here you go"). Researchers scored an *independent initiation* when the participant stated a phrase or question without prompting if at least 5 s had elapsed since the peer said something and at least 5 s since receiving the prompt. Researchers scored a *prompted initiation* when the child stated the phrase or question within 5 s of receiving the textual prompt via text message. These statements or questions were either the same phrase or a related phrase using the same noun that was stated or asked in the textual prompt (e.g., the textual prompt read, "I have apples," but the participant instead said, "Here's the apples"). Researchers scored a *response* when the participant replied to a social initiation made by the peer with a comment or mand, within 5 s of its occurrence. For example, the peer stated, "I have the apples," and the participant responded, "I have the grapes," or the peer stated, "I like apples," and the participant responded, "Cool, do you like grapes?"

We also measured the *latency* to independent and prompted initiations. We measured latency to initiations as the number of seconds from the onset of the session to the first initiation (independent and prompted). The maximum latency to initiations was 900 s (i.e., the total session duration).

Interobserver Agreement

We assessed interobserver agreement by having a second observer simultaneously, but independently, record the frequency of the target behaviors (independent initiation, prompted initiation, response) via electronic devices during 67% (baseline and posttraining) and 100% (follow-up) of sessions for Buster, and 100% (baseline) and 50% (posttraining) of sessions for Bochy. We calculated interobserver agreement using the proportional method via the Countee application. The session was divided into consecutive 10-s intervals, the smaller number of responses was divided by the larger number of responses in each interval, all the intervals in a session were averaged, and the result was multiplied by 100 to yield a percentage. For Buster, average agreement was 97% (range 95%–99%) during baseline, 95% (range 89%–100%) during posttraining, and 94% (range 83%–100%) during the 1-month follow-up. For Bochy, average agreement was 98% (range 95%–100%) during baseline and 100% during posttraining.

Experimental Design

We used a multiple-baseline across-participants design to evaluate the effect of the text-message prompting on the frequency of independent social initiations and responses. After baseline, the researcher conducted training to teach the participants to respond to the tactile prompt and read the textual prompt on the watch until the participant met mastery criteria. Then, we conducted posttraining sessions for an additional six sessions with both participants. We also conducted three maintenance sessions with Buster during a 1-month follow-up.

Procedure

Both baseline and posttraining sessions were 15 min in duration and took place in an unoccupied playroom within a clinic in central California. The participant wore the Apple Watch® during all baseline, training, and posttraining sessions. The same peer was present for each participant throughout baseline and posttraining sessions. Before each session, the researcher told the peer with whom she was going to play (e.g., "Today you're going to play with Buster!"); we did not provide any other instructions or any formal training. At the beginning of each baseline and posttraining session, the researcher randomly selected one of the three pretend play sets by picking a picture card that represented each play set out of a bag. The researcher did not conduct more than two consecutive sessions with the same play set. The researcher stated, "We'll be playing with [play set]." Then, the researcher removed the other two play sets and instructed them to "go play!" During sessions, the researcher remained in the same room as the participant and peer but did not interact with them. The researcher was as far as possible in distance, but close enough to hear the interactions between the participant and the peer (e.g., if the children were speaking loudly, the researcher was farther away; if the children were speaking quietly, the researcher was closer). At the end of all baseline, training, and posttraining sessions, the researcher stated, "We're all done."

Baseline During baseline, the participant wore the Apple Watch® on the wrist. The researcher did not deliver any prompts or programmed consequences.

Training Training sessions took place one to four times a day, for 10 trials (i.e., 10 to 40 trials each day) after the participant completed the baseline phase of the study. During training, the researcher taught the participants how to respond to the tactile prompt and then read the textual prompt on the Apple Watch®. Training consisted of three steps: checking the watch, reading the text on the watch, and reading the text on the watch during play. The participant mastered each step when he responded correctly for at least 80% of trials during one session.

During the first step, the researcher stated, "When you feel the watch vibrate, remember to check it." The researcher delivered verbal praise (e.g., "Awesome," "Good work," or "Nice job") contingent on the participant looking at the watch when he received a text message. During the second step, the researcher stated, "Read it" after the text message occurred. We used the statements and questions during training and posttraining. These phrases included "I have the [item]," "I like [item]," "Do you want this?" "Do you like [item]?" "What [item] do you have?" and "Here you go." We chose these phrases based on clinical experience and because they would be applicable across a variety of play sets. We randomized the order of the phrases within the session and delivered one dependent on what was occurring contextually. The same prompted phrase was only delivered up to two times consecutively. The researcher delivered verbal praise contingent on the participant checking the watch and reading statement or question independently. During the third step, the researcher acted as a peer and engaged in play with the toys available within the participant's one-on-one room. The researcher delivered the textual prompt, delivered verbal praise, and responded (e.g., "Thanks for asking me. I like the car.") contingent on the child reading and stating the phrase or asking the question. If the participant did not respond to the prompt within 5 s, the researcher told the participant, "Remember to look at the watch and read."

Posttraining Posttraining sessions were similar to baseline except that (a) prior to the start of each session, the researcher told the participant, "When you feel the watch vibrate, remember to check it and read," and (b) the researcher programmed to deliver the text-message prompt following a 30-s IRT for independent social initiations and responses. For example, if the participant responded to an initiation from the peer, we reset the 30-s interval. We programmed a 30-s IRT for prompt delivery; however, the IRT averaged 60 s due to the researcher stopping or resetting the timer when the participants began to independently respond or initiate toward the peer but failed to complete the response or initiation (e.g., "Can I . . . ," "Do you . . . ," or "My . . ."). We did not score these instances as an independent initiation or response. The textual prompts contained the same phrases or questions as those used during training and were contextually relevant to what the children were playing—for example, prompting, "I have the apple," when playing with the checkout counter, or "I have the saw," when playing with the workshop. If the participant failed to check and read the textual prompt twice, the researcher stated "[Child's name], check the watch!" or "[Child's name]," while tapping on the wrist to signal to the participant to look at the watch; however, this never occurred. During posttraining, the researcher did not deliver feedback to the participant following any of the target behaviors.

One-month follow-up. The contingencies during the 1-month follow-up with Buster were identical to baseline. We were unable to complete a follow-up with Bochy due to summer break.

Results

Figure 1 displays the frequency of social initiations and responses emitted by Buster (top panel) and Bochy (bottom panel). During baseline, Buster and Bochy engaged in low levels of independent social initiations (M = 3.3 and 2.8, respectively) and responses (M = 3.7 and 1.3, respectively). We set the mastery criterion as an 80% increase from the highest

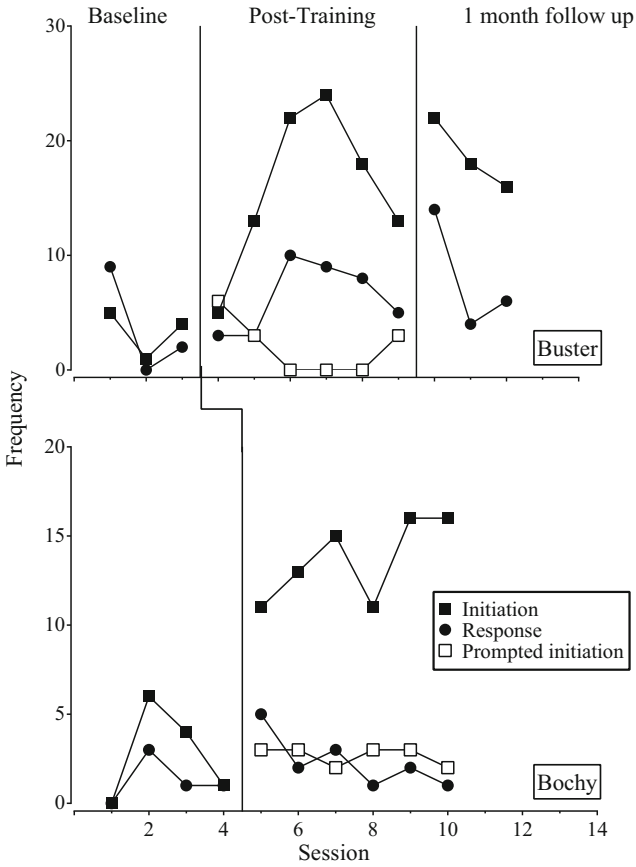

Fig. 1 Frequency of independent initiations (closed squares), responses (closed circles), and prompted initiations (open squares) for Buster and Bochy across baseline, posttraining, and 1-month follow-up phases

baseline session. To reach an 80% increase during posttraining, we set Buster's mastery criterion at 9 and Bochy's mastery criterion at 11 independent initiations. Following baseline, Buster completed the training phase in five sessions. Specifically, Buster completed the first step of training in one session (80%). Buster completed the second step of training in one session (90%); however, the researchers conducted an additional session to obtain interobserver agreement data, during which Buster scored 80%. Buster completed the third step of training in two sessions (10% and 80%, respectively). Bochy completed the training phase in three sessions, one session of each training step, and scored 100% during each session. During posttraining, the number of independent initiations increased for Buster (M = 15.8) and Bochy (M = 13.7). Buster engaged in an average of 2.0 prompted initiations, which gradually decreased across session, and Bochy engaged in an average of 2.7 prompted initiations. On average, Buster and Bochy both engaged in slightly higher levels of responses during posttraining (M = 6.3 and 2.3, respectively). During a 1-month follow-up, Buster continued to engage in high levels of independent initiations (M = 18.7) and responses (M = 8.0).

Figure 2 displays the latency to each participant's first independent and first prompted social initiation for each session. During baseline, the latency to independent initiations for Buster (top panel) averaged 336.3 s. During posttraining, the latency to independent initiations decreased (M = 41 s), whereas the latency to prompted initiations averaged 504.8 s. This indicates that the latency to independent initiations for Buster decreased by 87.8% from baseline. Additionally, it is important to note Buster engaged in independent initiations first in all but one session (Session 5), and he did not require any prompts during Sessions 6 to 8. During the 1-month follow-up, the average latency to independent initiations was 15.3 s. Overall, the latency to independent initiations during the follow-up session for Buster decreased by 62.7% compared to posttraining and by 95.4% compared to baseline.

During baseline, the latency to independent initiations for Bochy (bottom panel) averaged 287.3 s. During posttraining, the latency to independent initiations decreased (M = 94.7 s), whereas the latency to prompted initiations averaged 105.7 s. This indicates that the latency to independent initiations for Bochy decreased by 67% from baseline. Bochy emitted prompted initiations first during three out of the six posttraining sessions.

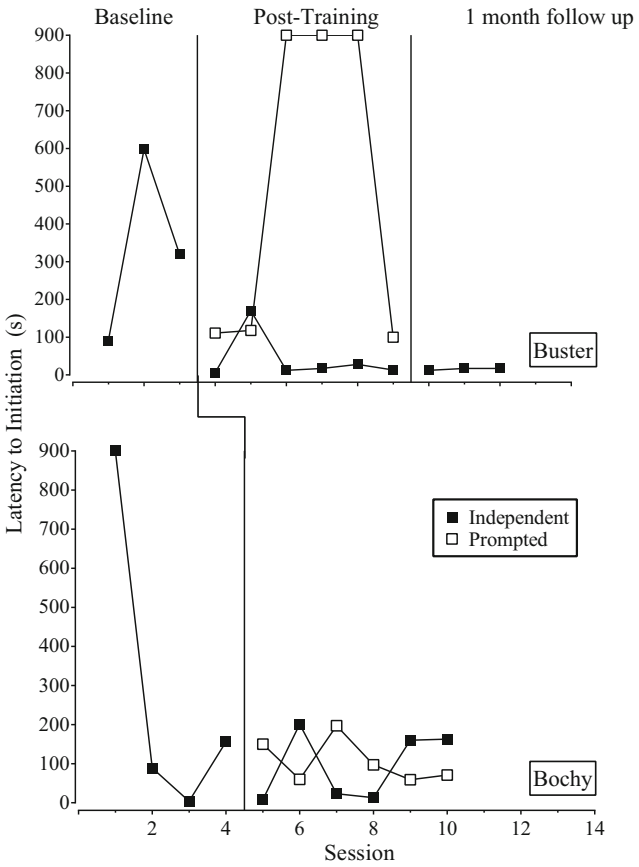

Fig. 2 Latency to independent (closed squares) and prompted (open squares) initiations for Buster and Bochy across baseline, posttraining, and 1-month follow-up phases

Discussion

The purpose of the present study was to evaluate the effects of a combined tactile and textual prompt (i.e., text message) delivered to an Apple Watch® on social initiations in two children diagnosed with ASD. Consistent with previous research, both participants emitted a higher frequency of social initiations after training; however, the frequency of responses occurred at similar levels across baseline and posttraining phases. It is important to note the participants in this study surpassed the set mastery criteria, and one participant maintained high independent initiation levels during a 1-month follow-up. Specifically, Buster averaged 12.5 more independent initiations during posttraining, and Bochy averaged 10.9 more independent initiations during posttraining.

The current study extends previous research on teaching and prompting social interactions with children diagnosed with ASD in three important ways. First, the incorporation of discrete technology (i.e., the Apple Watch®) allowed the researcher to deliver prompts unobtrusively. The success of this prompting method suggests that newer forms of technology may replace more traditional prompting methods (e.g., words printed on paper) in some contexts, particularly when teaching social behaviors. The text-message prompting also allowed for a greater distance between the researcher and the participants and their peer during the play sessions. As such, this may have increased the opportunities the participant and the peer had to engage in conversations with each other rather than with the researcher; however, we did not experimentally

test this hypothesis. Furthermore, unlike a cell phone, the participant wears the smart watch on the wrist, which may make it more accessible, allowing the individual to immediately attend to its vibration, and less likely to be lost or taken. Given that it is common to wear and check smart watches, it may be easier to generalize skills by delivering prompts through this device in settings and situations in which social interactions more naturally occur (e.g., in play settings with multiple children present). Although we were unable to conduct generalization sessions, the results of the present study provide preliminary data on the use of smart watches to deliver prompts in social contexts that future researchers may wish to explore.

Second, in the present study we collected data on the latency to independent and prompted initiations. To the researchers' knowledge, there are currently no studies in which researchers collected and evaluated data regarding latency to social initiations. Latency is an important measure in social contexts because it may be an indication that the individual is able to independently access social reinforcers. That is, it indicates that the participant is not dependent on the delivery of the prompt or the initiation of the peer. In addition, shorter latencies likely facilitate continued access to reinforcement for both play partners; long latencies might function as extinction or punishment for the peer, who may then leave. In the present study, the latency to independent initiations typically occurred prior to prompted initiations for Buster, and during Sessions 6 to 8 we never delivered a prompt (i.e., the IRT was always less than 30 s). The latency to independent and prompted initiations was less clear for Bochy. We prompted Bochy to emit an initiation prior to any independent initiations during half of the posttraining sessions. An interesting finding is that sessions that we conducted on the same day (Sessions 5–6 and 7–10) corresponded to the researcher delivering a prompt first. This may have occurred because the play set was less reinforcing after Bochy already played with a particular play set that day. Future research in this area may consider only conducting one or two sessions per day or including more toy sets to maintain interest and motivation for longer periods of time.

Third, we systematically delivered prompts using a 30-s IRT. This procedure may be beneficial to evoke behavior change while limiting intrusiveness in clinical practice. Previous research has not always specified how often prompts were delivered or the criterion for prompt delivery (Anson, Todd, & Cassaretto, 2008; Gena, 2006), or set prompts to be delivered on a time-based schedule regardless of responding (Shabani et al., 2002; Taylor & Levin, 1998; Tzanakaki et al., 2014). Using an IRT to dictate when to deliver a prompt set a guideline for the researchers to follow and allowed the participant appropriate time to independently initiate or respond, therefore avoiding overprompting. Additionally, the 30-s IRT is an objective criterion that will allow future researchers to precisely compare varying intervals of IRTs on the level of independent social interactions. Future researchers could also explore using an IRT to determine a criterion for fading prompts.

Although the results of the present study are promising, there are several potential limitations that researchers should address in future research. One potential limitation includes the delay between the iPhone sending the text-message prompt and it being received on the Apple Watch®. On average, it took 19 s (range 17–22 s) for the text-message prompt to be received and read on the Apple Watch®; therefore, the IRT was greater than 30 s due to this delay. However, there were also instances throughout the study (four times with Buster and one time with Bochy) in which the participant independently initiated a conversation with the peer during the delay to receiving the prompt. That is, we scored a prompt when the researcher sent the text message and compliance with the prompt when the participant read the prompt out loud. This suggests that we could increase the IRT while maintaining high levels of social initiations. Future researchers should account for the text-message delay time when considering an IRT requirement. Responding during the delay may also indicate a transfer of stimulus control from the prompts to the naturally occurring social context that suggests the researcher could reduce or eliminate prompts.

The types of play sets used in the study may have influenced responding. Specifically, the researcher observed a difference between the frequency of initiations dependent on the play set during a session. These differences could be because some play sets were more fun (i.e., reinforcing) than others or because the participants could tact more items in certain play sets. For example, during Sessions 4, 9, and 11, we assigned Buster to play with the workshop and he engaged in lower levels of initiations, on average, compared to the other play sets. We included three different toy sets to increase the probability of generalization and avoid possible satiation; however, these data indicate that if future researchers include different types of pretend play sets, it may be important to consider (a) conducting a pretest to determine the number of items and actions a participant is able to tact with toy sets or (b) conducting a preference assessment with the participant and peer to identify highly preferred toy sets prior to conducting social interaction sessions. Future researchers may attempt to equate play sets by using a concurrent-choice arrangement and select toy sets preferred by the participant and the peer.

We did not collect data on the frequency of the peer's initiations and responses or participant nonresponses. These data would have been beneficial to determine the extent to which the peer responded to initiations emitted by the participant because peer responses to initiations may have influenced the future initiations or responses of the participant. For example, if the peer did not respond, this may extinguish or punish initiations and result in lower levels of interaction. It may also be beneficial to conduct peer training at the onset of the study or provide instructions prior to sessions for the peer to respond to the participant initiations. Furthermore, the number of peer initiations directly influences the opportunities for responding. We observed little to

no difference between baseline and posttraining levels for responses; however, it is unknown whether this was because of limited opportunities to respond or if the participant was not responding to initiations. Future research should consider collecting data regarding peer initiations and responses and graphing participant responses as a percentage of opportunities.

The participants all had prior experience interacting with peers and receiving prompting in a play context. This history may have influenced how rapidly the participants learned to initiate social interactions. Future research should evaluate the effectiveness of this type of prompting with children who have little to no exposure to peer plays or previous prompting in the peer-play context. Furthermore, both participants in the present study could read. Future researchers may explore using smart watches to deliver prompts (e.g., emojis) for children who cannot yet read.

The current study evaluated the effectiveness of a combined tactile and textual prompt (i.e., a text message delivered via an Apple Watch®) to increase social initiations in two children diagnosed with ASD. Both participants emitted a higher frequency of independent initiations and a shorter latency to initiate during the posttraining phase of this study and during a 1-month follow-up (Buster). These preliminary results demonstrate that using smart watches to prompt social interactions with peers is a promising area that deserves additional research.

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Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional committee (Psychology Institutional Review Board, CSU Stanislaus, P-F17-72) and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed Consent Informed consent was obtained from all individual participants included in the study.

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