Teaching Children With Autism Spectrum Disorder to Report Past Behavior With the Use of a Speech-Generating Device

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In day-to-day interactions, children are expected to report their past behavior accurately, answering questions such as “Did you finish your homework?” or “Who did you see at school?” Accurately responding to questions and describing events are a noted deficit for some children with autism spectrum disorder (ASD) and a common caregiver priority for intervention (Pituch et al., 2011). For example, parents’ intervention goals may include teaching their child to report how he or she had been hurt; thus, there may be safety risks when this repertoire is missing.

Skinner (1957) described reporting past behavior as self-tacting. *Self-tacting* is verbal behavior controlled by “current stimuli, including events within the speaker [him- or her]self, generated by the question, in combination with a history of earlier conditioning” (Skinner, 1957, p. 143). This could be interpreted to mean that the question posed to the speaker in conjunction with the speaker’s private events, such as thoughts or images, evokes the response.

Palmer (2016) introduced the term *intraverbal control* to distinguish responses that are evoked by private and public antecedent stimuli, such as reporting past behavior, from intraverbal responses under strictly verbal antecedent control. Responses under intraverbal control may happen as follows: A caregiver poses a question (e.g., “What did you eat for snack?”); mediating behavior on the part of the listener occurs (perhaps a self-echoic and visual imagining of the event); and in combination, these antecedents evoke the correct vocal response (e.g., “Crackers.”), which is then reinforced (e.g., “That sounds yummy!”).

Palmer (1991) suggests one challenge to recalling past events is that there is a “failure to reinstate all of the relevant stimulus conditions” (p. 266) necessary to control

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the response. Presumably, one is asked to recall a previous event in a different context from that in which the event occurred and, therefore, associated stimuli, such as sights, smells, and sounds, are no longer present. Thus, bringing about those associated stimuli either overtly or covertly may promote accurate responding. Palmer (1991) goes on to suggest “competing responses to the same stimuli” (p. 267) may be evoked in response to the question. In other words, if the question about the past event contains stimuli that bring about other responses, it may not be that the accurate response to the question was “forgotten” but that competing responses are evoked. For example, if the question is “What did you eat for breakfast this morning?” any of the component stimuli may evoke competing responses such that one might respond to “eat” with “lunch” or to “breakfast” with “pancakes.” The longer the duration between the experienced event and the question about the event, the more opportunities there are for other responses to strengthen. To address these challenges, one might engage in problem solving such as arranging supplementary stimuli (i.e., looking through your calendar), engaging in covert recall strategies such as asking yourself a series of questions about the previous day, or engaging in a variety of conditioned perceptual responses such as visual imagining (Palmer, 1991). These strategies may result in overtly or covertly experiencing associated stimuli that were present when the event occurred that then strengthen the accurate report about the past.

If a child does not report past events correctly, the verbal community may provide additional supplementary stimuli to evoke the response. For example, when a child does not respond when asked, “Who did you see at school?” an adult might add, “Was Jessica there?” In this example, the additional antecedent verbal stimulus serves as a prompt for the child to report about which peers were present. Subsequently, when asked about “who” she has seen, the child might covertly list options of people until she comes across the accurate response. Deficits in the development of reporting past behavior may occur when existing mediating responding does not occur and the naturally occurring prompts provided by the verbal community do not develop these skills.

In a recent study, the use of echoic and tact prompts was shown to be effective at establishing reporting past behavior following a delay in vocal children with ASD (Shillingsburg, Cariveau, Talmadge, & Frampton, 2017). However, for approximately 25%–30% of the ASD population deemed minimally verbal (Anderson et al., 2007), echoic prompting strategies may not be effective. Augmentative and alternative communication (AAC) systems, such as speech-generating devices (SGDs), have been effective at improving communication skills in minimally verbal children (Baxter, Enderby, Evans, & Judge, 2012). However, very little research examining procedures to promote complex communication skills for individuals with ASD who use SGDs exists. The majority of research on AAC with the ASD population focuses on teaching simple requesting skills. This holds true when examining SGDs as well. In a recent meta-analysis of tablet use to teach communication skills to children with ASD, the authors examined 15 studies (Alzrayer, Banda, & Koul, 2014). Of these studies, all but one targeted single-step communication, meaning no navigation through screens was required, and instead, the participant selected an icon from a static display on the screen. Additionally, the majority of these studies focused on simple manding from a static display. A few studies also included single-word tacts, greetings, and niceties such as “please” and “thank you.” Although these communication skills are important,

there is a dearth of research related to complex verbal behavior using SGDs. Thus, the current study is a systematic replication of previous research (Shillingsburg et al., 2017) aimed at promoting accurate reporting of past behavior for children with ASD who communicate using an SGD.

Method

Participants, Setting, and Materials

Two males and one female diagnosed with ASD who were receiving services in an intensive, outpatient language intervention clinic participated in this study. All participants had minimal vocal speech, including limited to no vocal imitation, and communicated using an SGD. At the start of the study, all participants emitted mands, tacts, and emerging intraverbals using an SGD with dynamic displays requiring navigation through numerous folders.

Ben was 3 years, 8 months of age and had been receiving intervention for less than 6 months at the beginning of this study. Ben was primarily a Level 2 learner with some Level 3 skills according to the Verbal Behavior Milestones Assessment and Placement Program (VB-MAPP; Sundberg, 2008). His total score on the VB-MAPP was 76. At the start of the study, Ben exhibited a fluent mand repertoire, acquired new mands for items with minimal training, and primarily selected text icons on a technology device with the Proloquo2Go application (AssistiveWare, 2009) to communicate, though he occasionally typed words. Erica was 7 years, 9 months of age at the beginning of this study and had been receiving intervention for less than a year. Erica was primarily a Level 2 learner with some Level 3 skills according to the VB-MAPP with a total score of 113. Erica's primary means of communication included a combination of text icon selection and picture icons on her SGD using the Proloquo2Go application, though she occasionally typed words. Erica exhibited a fluent mand repertoire and acquired new mands for items with minimal training. Josh was 6 years, 0 months of age and had received intervention for less than a year at the beginning of this study. Josh was classified as a Level 3 learner according to the VB-MAPP with a total score of 142.5. Josh predominately responded using typing with his device using the TouchChat with WordPower application. Josh also used text selection for the core words that are displayed on the keyboard within TouchChat (Saltillo, 2018) (Fig. 1). Josh exhibited a fluent mand repertoire and acquired new mands for items with minimal training. Josh followed multistep instructions and could type words and sentences, including punctuation. Each participant's personal, individualized communication device was used for responding in the study.

Participants were required to independently navigate to the appropriate array from the device home screen. This was to foster as much independence as possible with response selection and to minimize inadvertent cues. Correct responses were always presented in an array when text or picture icon selection was used. When picture icons were used (Erica only), the choices were nonidentical pictures paired with corresponding text. Finally, the therapist avoided pointing to or handing the child his or her device following the question to recall past behavior to ensure independent responding. Figure 1 depicts example screenshots of the keyboard for typed responses, the text array

Fig. 1. Screenshot examples of response types: (1) typing, (2) text selection, and (3) picture plus text selection

for text selection responses, and the picture array for picture icon selection responses.

Measurement

Trained observers collected trial-by-trial data using pen and paper. We collected data on each participant's accurate report when asked, "What did you do in the [location]?" We scored responses as correct if the participant emitted the name of the correct activity via typing, text selection, or picture selection within 5 s of the therapist's question. We scored responses as incorrect if the response occurred after 5 s, was something other than the correct activity, or did not occur.

Interobserver Agreement and Treatment Integrity

A second independent observer collected trial-by-trial interobserver agreement (IOA) data in vivo. To calculate the percentage of IOA, we divided the number of agreements by the number of agreements and disagreements and then multiplied by 100. We collected IOA data for 48.28% of sessions for Ben, 80% of sessions for Erica, and 33.33% of sessions for Josh, resulting in a mean agreement of 100% across participants.

A second trained observer collected treatment integrity data in vivo and recorded data on a checklist outlining procedures (Table 1). We recorded a "yes" if the step was completed as defined in the protocol. We recorded a "no" if the step was not completed or completed incorrectly. We calculated a treatment integrity score by dividing the number of steps completed with fidelity (scored as a "yes") by the number of steps

completed correctly and incorrectly and then multiplying by 100. We collected treatment integrity data for 31% of sessions for Ben, 50% of sessions for Erica, and 19% of sessions for Josh, resulting in a mean integrity score of 100% across sessions for all participants.

Experimental Design

We used a nonconcurrent multiple-baseline across-participants design (Watson & Workman, 1981) to compare the effects of training on participants' accurate reports of past behavior.

Procedures

Pretraining Prior to conducting baseline, we selected three different locations (e.g., playroom, cafeteria, yellow table) and activities (e.g., coloring, reading, playing with trains) for inclusion in the study. Preference for the activities was not assessed; however, we chose activities that were regularly and independently completed by the participants. We also probed tacts of each activity name and location name in the presence of each activity and location. If necessary, we taught tacts to mastery (i.e., a correct response when probed across three consecutive days). During tact probes, the therapist took the participant to a location and presented him or her with the preselected activity on the table or carpet, depending on the location. The therapist interacted naturally throughout the activity making statements such as “Let’s do an activity” and “I like that.” Pretraining tact probes consisted of the therapist asking “Where are we?” and “What are we doing?” We reinforced correct responses with praise and a tangible item. Incorrect responses resulted in error correction. During error correction, the therapist repeated the question and provided a controlling prompt for the participant

Table 1 Treatment integrity for reporting with device: (treatment)

Step observed	Implemented correctly? (Yes, No, or Not Applicable)
Say, “It’s time to go to [location].”	Y, N, or N/A
Complete activity at the location.	Y, N, or N/A
Ask, “What did you do in the [location]?” at the correct time delay.	Y, N, or N/A
Wait 5 s for an independent response.	Y, N, or N/A
Provide praise and reinforcement for a correct response.	Y, N, or N/A
If an incorrect response or no response, repeat the question with a controlling prompt.	Y, N, or N/A
Repeat the question and provide an independent opportunity.	Y, N, or N/A
Interperse a mastered demand and then repeat the question and give an independent opportunity.	Y, N, or N/A
Provide praise and reinforcement for a correct response on the spaced trial.	Y, N, or N/A
If the participant errors or does not follow a prompt, use a physical prompt to get a correct response and terminate the trial.	Y, N, or N/A

to navigate to the correct response on his or her device. Controlling prompts most often consisted of gestural prompts but could include physical guidance as needed to ensure correct responding. Following compliance with the prompted response, the therapist faded prompts by repeating the question and allowing an independent opportunity to respond. If the participant responded correctly, the therapist interspersed a mastered task (i.e., motor imitation, one-step instruction), and then presented a final independent opportunity to promote responding to relevant discriminative stimuli. If the response was correct, the therapist provided praise and preferred tangible items. If the response was incorrect, the therapist repeated the controlling prompt and then discontinued the trial. Activities and locations are shown in Table 2.

Baseline (End-of-Day Probes Only) During baseline, the therapist and participant completed a different targeted activity at each of the three locations per day. We randomly assigned an activity to a location and the order of locations visited each day. For example, on Day 1, the participant may have engaged in coloring in the playroom, then reading in the cafeteria, and finally playing with trains on the carpet, but on Day 2 the participant may have engaged in reading on the carpet, coloring in the cafeteria, and finally playing with trains in the playroom. Each participant engaged in each activity for approximately 5 min. The therapists refrained from asking questions regarding the location or activity during or immediately after the activity and did not prompt the participant to talk about the location or activity. Following the completion of all three activities, the participant resumed his or her individualized, typical schedule. During the last 5 min of the participant's day, approximately 1.5 hr following the completion of the third activity, the therapist presented an end-of-day probe in which the therapist asked the participant "What did you do in the [location]?" for each targeted location/activity combination. Thus, there were three total opportunities to report about past behavior. The therapist provided praise and a preferred tangible item for correct responses. The therapist did not respond to incorrect or no responses and, instead, presented the next question. The mastery criterion was the correct report for three out of three of the targeted activities across 3 consecutive days, when asked during the end-of-day probes, which were conducted once daily in the lobby of the clinic throughout all phases.

Table 2 Target locations and activities for participants

Participant	Locations	Activities
Erica	Carpet	Coloring
	Yellow table	Play-doh
	Playroom	Puzzles
Josh	Cafeteria	Playing with bus
	Playroom	Reading
	Purple room	Eating
Ben	Observation room	Trains
	Carpet	Reading
	Yellow table	Puzzles

Immediate Probes (Training Phase 1) Phase 1 of training was set up identically to baseline conditions with only the addition of the immediate probes. Following the completion and cleanup of the activity in its designated location and then exiting the location, the therapist immediately asked the participant one time, “What did you do in the [location]?” Exiting the location entailed physically leaving the room where the location and activity were present such that the location and materials were no longer in sight. The therapist refrained from providing prompts to respond in this phase, and consequences were identical to those in baseline. End-of-day probes were also conducted as described in baseline; thus, in this phase, there were six total opportunities to report (i.e., three immediate reports and three end-of-day reports).

Prompting (Training Phase 2) Similar to Phase 1, following the completion of each activity in its designated location, the therapist and the participant exited the current location, and the therapist then immediately asked the participant, “What did you do in the [location]?” The therapist provided consequences exactly as described previously; however, if the response was incorrect, the therapist provided error correction.

During error correction, the therapist repeated the question “What did you do in the [location]?” while providing a controlling prompt for the participant to navigate to the correct response on his or her device, as described in pretraining. Following a correct prompted response, the therapist repeated the question and then provided an independent opportunity to respond. Contingent on correct responding, the therapist interspersed a mastered task, followed by a final independent opportunity to report the completed behavior. If the response was correct on the final independent opportunity, the therapist provided praise and preferred tangible items. If the response was incorrect, the therapist provided a controlling prompt and then discontinued the trial. End-of-day probes were conducted as described in baseline.

Caregiver Probes (Generalization) Two of the three participants’ caregivers conducted end-of-day probes with their specific child in place of the therapist-conducted end-of-day probes. On these days, the therapist engaged the participant in the activities in three locations, but at the end of the day (i.e., within the same time interval as end-of-day probes), the caregiver instead of the therapist posed the questions to the participant. A slip of paper with the questions and correct answers was given to the caregiver out of sight of the participant. Caregivers never provided prompting.

Results

Correct reporting of past behavior is shown in Fig. 2 for Erica, Josh, and Ben. Erica and Ben never reported past behavior during the end-of-day probes in baseline and tended to, instead, respond with the name of the location being asked about. Josh reported the correct past behavior one out of three opportunities with his therapist during each end-of-day probe in baseline but did not report past behavior when asked by his caregiver. Josh was observed to report the same behavior to all three questions resulting in correct responding to one of the locations by chance. For Erica, correct responding to the immediate probe and the end-of-day probe was observed as soon as the immediate

probes were introduced. Due to the observed correct responding, the immediate probes were withdrawn and end-of-day probes only (i.e., baseline conditions) were implemented. Immediate probes were withdrawn to ensure that immediately asking the participant to recall was not a necessary condition for the participant to respond correctly following a delay. Correct responding to the end-of-day probes continued to occur. Thus, for Erica, no additional intervention was necessary.

In contrast, upon implementation of immediate probes with Josh and Ben, Josh exhibited some correct responding, albeit inconsistently, and Ben exhibited no correct responding. Once prompting occurred during the immediate probes, both Josh and Ben showed an increase in correct responding on both immediate and end-of-day probes.

Fig. 2. Correct reports of past behavior during baseline and immediate probe conditions for Erica and during baseline, immediate probe, and prompting conditions for Josh and Ben

Upon withdrawal of the immediate probes, both participants continued to respond correctly to end-of-day probes and to the caregiver probes.

Discussion

The current study sought to replicate and extend the procedures described by Shillingsburg et al. (2017) by examining reporting past behavior in children diagnosed with ASD who communicate primarily with an SGD. The results show that, following intervention, all participants reported past behavior accurately to a therapist following a 1.5-hr delay, and two participants reported accurately to caregivers (not assessed for Erica). Immediate probes were effective for one participant to recall past events. For two participants, immediate probes were not sufficient to produce recall, thus prompts and error correction were provided.

For Erica, the introduction of the immediate probes resulted in immediate increases in correct reporting on both immediate and end-of-day probes, and her correct responding on end-of-day probes persisted when immediate probes were withdrawn. Importantly, correct responding was never prompted. The primary intervention entailed providing her with regular opportunities to report past behavior immediately following performing the behavior in a surrounding with similar stimuli associated with the location in which the activity was just experienced.

For Josh and Ben, the presentation of the immediate probes did not promote correct responding to the immediate probes or to the end-of-day probes. Thus, prompts and error correction were provided during the immediate probes, resulting in increases in correct responding to both immediate and end-of-day probes, despite no prompts during end-of-day probes, which persisted when immediate probes were withdrawn. Correct responding was also observed when the end-of-day probe was conducted by the child's caregiver; however, for both participants, the first caregiver probe under baseline conditions showed a reduction in correct responding. The consistent presentation of the immediate probes in the presence of associated stimuli just outside of the location in question where the activity was completed in conjunction with prompting and effective reinforcement for correct responding appears to have resulted in improved responding following a delay when asked in a more dissimilar context.

Although the current study replicated previously published procedures (Shillingsburg et al., 2017) using gestural prompts rather than echoic or tact prompts, the participants using SGDs in the current study responded differently than the vocal participants in the previous study. Specifically, both vocal participants in the previous study required additional procedures consisting of interspersed rehearsal trials that were faded in frequency as the delay to the end-of-day probe was lengthened. None of the participants in the current study required frequent rehearsal and instead only needed the immediate probe immediately following activity completion, with and without prompting, in order to respond after a lengthier delay. Potentially, the presence of the SGD in all locations and during all probes served as a supplementary stimulus that aided in bringing about associated stimuli, in some cases covertly, that evoked accurate responding when those stimuli were overtly absent. In other words, in each location, there are sights, sounds, smells, and people present as stimuli that evoke correct responding during the pretraining probes when tacting the location and activity in the

presence of both was required. Subsequently, the question posed occurred when the location and the activity were absent. However, during the immediate probes, associated and similar stimuli such as the door to the location just visited, sounds from inside that location, similar paint on the walls, and the therapist are all still present, even though the actual location and activity are now absent. These associated stimuli aid in evoking the accurate response, which is then reinforced. During the end-of-day probe, some related stimuli such as the wall paint and therapist remained and potentially aided in evoking the correct response. Additionally, for the participants in this study, as opposed to the previous study, the participants also carried their SGDs in all locations.

For Erica, it is possible that existing covert mediating strategies were already in her verbal repertoire, explaining why immediate probes without prompting were effective at promoting end-of-day reporting of past behavior. Unfortunately, data on collateral responding that might yield some evidence of this were not collected. Given that these participants lacked an echoic repertoire, it is unlikely that self-echoics were covertly occurring. However, given that visual stimuli within the SGD were regularly present and used, it is possible that visual imagining of the location and activity was occurring as a mediating response, resulting in fluent navigation to the correct folders and icons or fluent typing of responses. Previous research has shown that intraverbal responding can be enhanced with vocal children when prompts to engage in visual imagining are provided (Kisamore, Carr, & LeBlanc, 2011).

Keeping in line with Palmer's (2016) classification of the intraverbal relation, the responses observed in this study would be described as first occurring as intraverbals during direct prompting. More specifically, the response (i.e., navigating the SGD and selecting the completed activity) was under the control of the antecedent question and gestural prompts. However, stimulus control was then transferred to intraverbal control wherein both the question (i.e., public antecedent stimuli) and a mediating response, such as visually imagining the activity completed earlier in the day (i.e., private antecedent stimuli), combined evoked the response. Of course, this remains conjecture given that any private mediating events were not measurable.

There are notable limitations with the current study that future research could expand upon. First, although generalization in responding to caregivers was assessed, generalization across novel activities or locations was not assessed. This would be important to explore to ensure the development of a functional and generative repertoire. Although several activities and locations were used in the current study, reporting at the end-of-day probes on novel activities in novel locations that were never prompted or included in immediate probes would be valuable. Second, certain antecedents may influence correct responding, such as the complexity of the question or the novelty of the event encountered. In the current study, very specific questions were asked in the same manner each time (i.e., "What did you do in the [location]?"). It is not clear if questions asked in different ways would affect responding. Future research could assess if simpler or more complex questions or including a variety of question types results in increased accuracy or generalization. This study represents the first step in teaching individuals with ASD who use SGDs to recall events about common activities that occur in environments that are familiar and consistent to the participants prior to taking on more complex situations. Third, a few concerns related to the experimental design and control of extraneous variables affect the strength of the study. It is not clear whether the use of preferred tangible reinforcers was necessary in the current study or what role

repetition of the end-of-day probes with reinforcement for correct responding played in acquisition. Future research should evaluate whether social praise alone would be effective or, alternatively, should include a phase in which tangible reinforcement is faded out of the procedure. Additionally, two of the participants were introduced to the independent variable at the same time, which limits conclusions that can be drawn. Last, because responding following longer delays was not assessed, it is not clear how accuracy would maintain over time, such as the next day or over the weekend. Maintaining accurate reports over longer delays would be socially significant. Overall, the current study replicates and extends previous research on teaching reporting past behavior to nonvocal verbal children with ASD. Additionally, the current study adds to the literature on teaching communication skills other than requesting to those who communicate using an SGD. SGDs offer a variety of ways in which an individual may communicate, including text selection, icon/picture selection, and typing. As in the current study, general procedures may be effective in establishing complex communication skills across these various response topographies. However, precise procedures that are specifically suited for the varying methods of communicating with an SGD may also be needed. Future research should include replications with participants using more similar response topographies. Overall, more research exploring additional novel ways to incorporate device use in establishing a robust communicative repertoire for nonvocal verbal children with ASD is needed.

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Compliance with Ethical Standards

Conflict of Interest All of the authors declare that there are no conflicts of interest related to the current study.

Ethical Approval All procedures performed in this study were in accordance with the ethical standards of the institutional review board and with the 1964 Helsinki Declaration and its later amendments.

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

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