Teaching two boys with autism spectrum disorders to request the continuation of toy play using an iPad®-based speech-generating device

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1. Introduction

Teaching socially acceptable communication skills is a major educational priority for children with autism spectrum disorders (ASD; National Research Council, 2001; Sigafoos, Schlosser, O’Reilly, & Lancioni, 2009). Indeed, in a survey of 90 parents, communication skills were nominated as being among the top 10 educational priorities for children with ASD (Pituch et al., 2011). To this end, research in the field of applied behavior analysis has yielded a number of effective instructional procedures for teaching a range of socially acceptable communication skills to children with ASD (Fitzer & Sturmey, 2009). The specific instructional procedures that have been successfully used to teach communication skills to...
children with ASD include: (a) behavior chain interruption, (b) time delay, (c) various response prompting techniques such as modeling or graduated guidance, and (d) differential reinforcement (Duker, Didden, & Sigafoos, 2004).

For example, the interventionist might momentarily interrupt a preferred activity (e.g., toy play) to create the need (or motivation) for the child to communicate a request (I want to play). This procedure has been referred to as the behavior chain interruption strategy (Carter & Grunsell, 2001). During the early stages of intervention, when an interruption occurs, many children will often need to be prompted to communicate a request because the desired request is unlikely to occur independently. The prompt might consist of modeling the correct response (Say, I want to play). Obviously, the prompt is kept to the lowest possible level to facilitate the child’s independence and response acquisition. An important step in the instructional process, which is often necessary to ensure the child becomes independent in requesting, is to fade out prompting by, for example, waiting longer and longer before delivering the prompt (i.e., using a time delay procedure). To ensure learning and maintenance, correct responses result in continuation of the preferred activity (e.g., toy play). Continuation of the preferred activity is intended to function as natural reinforcement for the request (Skinner, 1982). The applied behavior analysis approach in general—and this set of instructional procedures more specifically—has been widely successful in teaching communication skills to children with ASD and other developmental disabilities (Sigafoos et al., 2009).

Teaching socially acceptable communication skills using the aforementioned procedures is likely to be fairly complicated when the person has little or no speech, which is the case for approximately 25% of children with ASD (Osterling, Dawson, & McPartland, 2001). These individuals are considered to be good candidates for visual/graphic communication systems (Bondy & Frost, 2003). To establish a visual/graphic communication system, Reichle, York, and Sigafoos (1991) suggested that intervention might initially aim to teach a single (graphic-mode) response that enables the child to access highly preferred objects/activities. For example, the child might be taught to request the continuation of toy play by touching a single line drawing (TOY PLAY) from the screen of a speech-generating device (SGD). The SGD could be programmed so that touching the line drawing produced relevant synthesized speech output (e.g., “I would like to play with the toy.”). Although use of a SGD is not the same as using natural speech, the speech-output function of such devices has several potential advantages compared to other alternative modes of communication, such as manual signing or picture-exchange communication. Specifically, SGDs can be programmed to produce age-appropriate communication with minimal response effort (Mirenda, 2009; Schlosser, Sigafoos, & Koul, 2009). The speech-output function of SGDs might also provide useful feedback to the user (Boesch, Wendt, Subramanian, & Hsu, 2013) and assist in recruiting listener attention.

An important question however is whether children with ASD and little or no speech can successfully learn to use SGDs to participate in communicative exchanges. Along these lines, several recent studies have shown that children, adolescents, and young adults with ASD and related developmental disabilities could be taught to use a new iPod Touch™- or iPad™-based SGD (Achmadi et al., 2012; Flores et al., 2012; Kagohara et al., 2010; Kagohara et al., 2012; Lorah et al., 2013; van der Meer et al., 2011; van der Meer, Didden, et al., 2012; van der Meer, Kagohara, et al., 2012; van der Meer, Sutherland, O’Reilly, Lancioni, & Sigafoos, 2012). The new type of SGD consists of an iPod Touch™ or iPad™ with Proloquo2Go® software (Sennott & Bowker, 2009). The system can be configured so that tapping or lightly touching screen images will produce corresponding synthesized speech output. For example, tapping the line drawing for TOYS could lead to corresponding synthesized speech output (i.e., “I would like to play with the toy.”). This new type of SGD has potential advantages in terms of being portable, relatively inexpensive, readily available, and probably highly socially acceptable given the ubiquity of such devices in schools, employment, and community settings (Mirenda, 2009).

In one relevant study, van der Meer et al. (2011) taught three individuals (aged 13–23 years) with developmental disabilities to make requests for snacks and/or toys using an iPod Touch™ with Proloquo2Go® software. To do this, preferred snacks and/or toys were offered and the participants were physically guided to touch the corresponding symbol on the iPod Touch™ screen. Correct requests were consecrated by providing the requested snack/toy (i.e., differential and natural reinforcement). Physical assistance was faded using time delay (Halle, Marshall, & Spradlin, 1979) and by giving the least amount of physical guidance necessary (i.e., graduated guidance). With these procedures, the two adolescents learned to make requests, but the young adult did not make progress. The older participant’s lack of progress appeared to stem from the requirement to interrupt other preferred activities for the SGD training. Although the results were mixed, the study demonstrated that Reichle et al.'s (1991) approach for beginning a communication intervention could be successfully applied with this new iPad™-/iPod Touch™-based SGD.

The present study aimed to extend the promising results reported by van der Meer et al. (2011) and other researchers. Specifically, we focused on teaching two young boys with ASD to request the continuation of toy play using systematic instruction and an iPad™ with Proloquo2Go® software (Sennott & Bowker, 2009). The instructional procedures consisted of a behavior chain interruption strategy to create the need for requesting (motivational operation), combined with time delay, graduated guidance, and differential and natural reinforcement (Duker et al., 2004). After the instructional procedures were implemented in the Intervention phase, we assessed whether the newly acquired requesting skills were maintained when prompting was discontinued. Next, we assessed if SGD-based requesting had generalized to other activities/objects. The effect of teaching SGD-based communication on reaching and aggression—which were considered less socially acceptable—was also monitored. These extensions and refinements to previous research were intended to provide evidence relevant to the question of whether this new iPad™-based communication system can be successfully taught to young children with ASD who present with little or no speech.
2. Method

2.1. Ethical clearance and informed consent

The relevant university ethics committee approved the study protocol and parental consent was obtained for the two boys to participate and for the publication of results. Although the boys were unable to consent due to their young age and lack of speech/language, their assent was inferred by the fact that they always accompanied research staff to the activity area and appeared to enjoy playing with the toys that were available during sessions.

2.2. Participants

Two brothers, referred by their parents for communication intervention, participated. Sean was 5 years old when the study began and Marco was 4. Both were diagnosed with autism. At intake the boys’ level of adaptive behavior functioning was assessed using the Vineland Adaptive Behavior Scales, second edition (Vineland-II; Sparrow, Cicchetti, & Balla, 2005). Sean’s scores corresponded to an overall low adaptive level. More specifically, on the receptive, expressive, and written communication subscales, he obtained age equivalencies of 1:6 (years:months), 1:7, and 1:10, respectively. His parents reported that he was able to produce a few spoken words (e.g., ball, go), but that he rarely spoke. He was also said to engage in occasional problem behaviors, such as exposing himself in public, being inconsiderate to others, and exhibiting self-injurious behavior. Marco was also assessed as having an overall low adaptive level on the Vineland-II, with age equivalencies of 0:9, 0:9, and 1:10 on the receptive, expressive, and written communication subscales, respectively. His parents reported that he rarely produced any spoken words and that most of his communication was via reaching or pointing. His parent-reported problem behaviors consisted of aggression (i.e., hitting others), loud crying, and self-injury. The boys did not appear to have any sensory or physical impairment that would contraindicate the use of the iPad®-based SGD. The parents reported that neither child had received any prior intervention to establish alternative communication skills nor had they ever used an iPad®, or any similar such device.

2.3. Setting

The study was undertaken in a (6 m × 4 m) university clinical room. The room was furnished with a (140 cm × 70 cm) table and three chairs and equipped with two (30 cm × 35 cm) clear plastic boxes with lids that could be tightly closed with two latching handles. These two plastic boxes were filled with a variety of age-appropriate toys (e.g., balls, story books, puzzles, wind-up cars, stuffed animals, music boxes, and magnets).

2.4. Personnel

The study protocol was implemented by a doctoral student in educational psychology (fourth author). An independent observer was present during most sessions to conduct inter-observer agreement and procedural integrity checks. The trainer and observer were not blind to the purpose of the study.

2.5. Preferred stimuli

A preference assessment was undertaken to ensure that there were at least some toys in the two boxes that the boys would play with consistently. For this, the boys were brought to the clinic room and shown the two boxes of toys with the lids open. The boys were told that they could play with any of the toys. For each assessment session, the boxes remained open for 5 min. The 5-min period was divided into 10, 30-s intervals. For each 30-s interval, we recorded whether or not the boys engaged in any toy play during that interval. Marco was observed for the first 30-s interval and then Sean was observed for the second interval and so forth until each child had been observed for 10, 30-s intervals. Toy play was defined as holding a toy or book with one or both hands and/or using it in an appropriate manner (e.g., bouncing the ball, inserting pieces into the puzzle frame, looking at the pictures in the book, and winding up the car and letting it roll along the floor). These 5-min assessments were repeated three times with each child. Because both boys played with toys during at least 60% of the intervals during each assessment session, we concluded that there were at least some toys in the boxes that the boys were interested in playing with. We also hypothesized that the boys would be motivated to learn to request more toy play when their toy play was momentarily interrupted during the subsequent intervention sessions.

2.6. Speech-generating device

An iPad®, loaded with Proloquo2Go® software (Sennott & Bowker, 2009), was configured with a single TOY PLAY symbol selected from the Proloquo2Go® software program. The symbol was placed in the upper left quadrant of the iPad® screen. The (6 cm × 9 cm) symbol consisted of a line drawing showing a brown teddy bear, a blue and yellow ball, and a red car. The line drawing appeared on a white background within a black-lined frame. The remaining three quadrants of the iPad® screen were blank. Selection of the symbol with a light touch or finger tap resulted in corresponding synthesized speech output (i.e., “I would like to play with a toy.”).
2.7. Response definitions, observation, and measurement

Three dependent variables were defined and recorded via direct observation and in relation to (discrete-trial) requesting opportunities. Requesting opportunities lasted 10 s and occurred when the trainer gently interrupted the child’s toy play (by taking away the toy that the child was playing with) and said, *My turn now. Let me know if you want to play with the toy.* A correct request was defined as touching the TOY PLAY symbol to produce the corresponding speech output (i.e., *‘I would like to play with a toy.’*). A request was considered correct if it occurred without any physical guidance and within 10 s of the child’s toy play being interrupted. Reaching was defined as the child moving one or both hands toward the toy being held by the trainer and/or touching the toy within 10 s from the start of the interruption. Hitting was recorded if at any time during the 10-s interruption the child hit the trainer with a closed or open hand. The presence or absence of each dependent variable was recorded for each requesting opportunity.

2.8. Session schedule, phases, and experimental design

Sean and Marco attended a 60-min clinical session one day each week over a 2-month period. During their weekly 60-min clinic visit, the boys were in the clinic room at the same time, but received requesting opportunities on a one-to-one basis. At the beginning of each clinic visit, one child was randomly selected to receive the first requesting opportunity, while the other child was allowed to play freely with the toys. After this, the other child then received a requesting opportunity and so forth until each child had received from 3 to 10 requesting opportunities during each clinic visit. Requesting opportunities were implemented in a naturalistic format and initiated only when the child had been playing with a toy for at least 30 s.

Requesting opportunities occurred under the following sequence of phases: Baseline, Intervention, Maintenance, and Generalization. Baseline started for both boys on the same day. Intervention was first implemented with Sean, while Marco continued to receive baseline opportunities in accordance with the requirements of a multiple baseline across participants design (Kennedy, 2005). When correct requesting was observed during at least 8 of 10 consecutive requesting opportunities in the Intervention phase, the boys progressed to Maintenance and then the final Generalization phase.

2.9. Procedures

2.9.1. Baseline

During Baseline, the trainer and one of the boys sat on the floor within reach of the two toy boxes. The iPad (i.e., the Talking Tom Cat Free application) and was subsequently offered.

2.9.2. Intervention

The procedures were identical to Baseline except that correct requests were reinforced by immediately giving the toy to the child. In addition, if the child did not independently touch the TOY PLAY symbol so as to activate the speech output within 10 s of his toy play being interrupted, the trainer used the least amount of physical guidance necessary to assist the participant to touch the symbol and activate the speech output. As soon as the child activated the speech output, whether prompted or independent, the trainer delivered the toy to the child and made a relevant statement (e.g., *OK, here is the toy. Your turn now.*).

2.9.3. Maintenance

The procedures were the same as in Intervention, except that physical guidance was never used to prompt correct requests. If a correct request did not occur within 10 s of the interruption, the plan was for that opportunity to lapse without the child receiving the toy. The trainer would then wait at least another 30 s before initiating the next opportunity.

2.9.4. Generalization

The procedures were the same as in Maintenance, except that the toys were not available. Instead the children were offered other objects that were identified as preferred via a second preference assessment that occurred immediately before the Generalization phase. Specifically, the children were offered several items one at a time across 10 opportunities. Items were defined as preferred if they were chosen during at least 80% of the opportunities. Based on this, Sean showed a preference for using an iPad (i.e., the Talking Tom Cat Free application) and was subsequently offered.
this game that was loaded onto a second iPad. He was allowed to play with this game for at least 30 s before being interrupted for 10 s. A correct request required him to select the original TOY PLAY symbol as in the previous phases. Marco showed a preference for potato chips and chocolate, so he was offered these two items in the Generalization phase and asked if he wanted something to eat. After this, Marco was given 10 s to make a correct request by selecting a new SNACK symbol on the SGD. Touching this symbol produced relevant synthesized speech output (i.e., “I would like a snack please.”). The SNACK symbol measured 6 cm × 9 cm and showed a colored line drawing of a bag of potato chips with the printed phrase I would like a snack please written underneath the symbol. This SNACK symbol replaced the previous TOY PLAY symbol in the upper left corner of the iPad screen. The remaining quadrants of the iPad screen were blank.

2.10. Inter-observer agreement

An independent observer collected data on the presence or absence of the three dependent variables to assess inter-observer agreement (IOA). These checks occurred during at least 62% of the interruptions (range = 62–100% of the interruptions per phase) conducted with each child. An agreement was scored if the trainer and independent observer had recorded that reaching, hitting, and correct requesting had either occurred or not occurred within the 10-s observation interval. IOA was calculated using the formula: Agreements/(Agreements + Disagreements) × 100%. IOA was always 100%.

2.11. Procedural integrity

The independent observer also collected procedural integrity data during each interruption using a checklist of the procedural steps. The checklist allowed for a 3 s discrepancy regarding whether or not the trainer had waited 10 s during each requesting opportunity/interruption. These checks also occurred on at least 62% of the interruptions (range = 62–100% of the interruptions per phase) conducted for each child. The results indicated 100% correct implementation.

3. Results

Fig. 1 shows the results for Sean (upper panel) and Marco (lower panel). The cumulative number for each response (i.e., reaching, hitting, and correct iPad-based requesting) is shown across successive requesting opportunities/phases of the study.

3.1. Results for Sean

During Baseline, Sean received 13 interruptions. He never used the iPad to make a correct request nor was hitting observed during Baseline. However, he did reach for the toy on two occasions. During Intervention, Sean received a total of 16
interruptions. Correct requesting occurred during 12 of these 16 opportunities (75%). Reaching and hitting did not occur during any of the interruptions of the Intervention phase. Consistent and steady requesting, with no reaching or hitting, continued during Sean’s Maintenance and Generalization phases. During the latter phase, Sean used the iPad®-based SGD to request access to the Talking Tom Cat Free application/game that was loaded onto another iPad®.

3.2. Results for Marco

During Baseline, Marco received 21 requesting opportunities/interruptions. He never used the iPad® to make a correct request during any of these interruptions. Instead, he would often reach for the toy (7 times or 33% of the opportunities) or hit the trainer (12 times or 57% of the opportunities). During Intervention, Marco received a total of 17 interruptions. Correct requesting occurred during the final 12 of these 17 opportunities/interruptions (70%). Reaching did not occur during Intervention and hitting showed a decreasing trend across the 17 interruptions. During Maintenance and Generalization with snacks, correct requesting occurred in response to every opportunity/interruption and reaching and hitting did not occur.

4. Discussion

The results of this study were positive in that both boys learned to use the iPad®-based SGD to request continuation of toy play. Indeed, their acquisition of the new iPad®-based requesting response was rapid with consistent use of the iPad®-based SGD emerging shortly after the Intervention phase began. Their newly acquired requesting response also appeared to have come under appropriate stimulus control in that iPad® use occurred only when toy play was interrupted. The learning that occurred during the Intervention phase also appeared to be robust, as shown by the fact that a correct request occurred during every opportunity of the Maintenance phase when prompting (i.e., graduated guidance) was not used.

The positive findings outlined above suggest that the systematic instructional procedures employed were effective in teaching Sean and Marco to use the new iPad®-based SGD to request the continuation of toy play. This claim is consistent with studies showing that similar instructional procedures have been used successfully to enable individuals with developmental disabilities to use an iPod Touch®/iPad®-based SGD for communicative requesting purposes (Achmadi et al., 2012; Flores et al., 2012; Kagohara et al., 2010; Kagohara et al., 2012; Lorah et al., 2013; van der Meer et al., 2011; van der Meer, Didden, et al., 2012; van der Meer, Kagohara, et al., 2012; van der Meer, Sutherland, et al., 2012). While our results confirm the findings of these previous studies, our study also extends this existing literature by demonstrating successful outcomes for two younger children within a naturalistic play routine. More generally, the findings support the integration of behaviorally based teaching procedures (Fitzer & Sturmey, 2009) with an appropriately configured type of assistive communication technology (Lancioni, Sigafos, O'Reilly, & Singh, 2013). In the present study, the iPad®-based SGD system appeared to be appropriately configured for, and suited to, these two children given their entry level of adaptive behavior functioning. Our positive findings also lend support to Rechle et al.’s (1991) recommendations for starting a visual/graphic communication system with individuals who have limited or no speech. The suggested starting point is to teach individuals to select a single symbol (e.g., line drawing of a toy) to request highly preferred objects/activities (e.g., access to the toy and the toy play activity). Based on the fact that neither boy had any speech or any prior history with this type of intervention, Rechle et al.’s approach was viewed as applicable.

While the instructional package appeared effective in teaching these boys to request the continuation of toy play using the iPad®-based SGD, one could question whether all of the separate components in the overall package were necessary. The boys’ performance during Baseline suggested that the mere interruption of toy play was not sufficient to induce iPad®-based requesting. It is also unlikely that differential/natural reinforcement alone would have been sufficient because without the prompting procedure there would have been no instances of iPad® use to reinforce. Graduated guidance would therefore appear to have been a necessary (and quickly effective) component of the intervention. It is also likely that iPad®-based requesting would not have maintained nor generalized without the interruption procedure, which created the need for communication, and the differential/natural reinforcement component. However, a formal component analysis, as described by Ward-Horner and Sturmey (2010), would be needed to assess the individual contribution, if any, of each separate component in the overall instructional package. Still, the overall instructional package—consisting of (a) behavior-chain interruption, (b) graduated guidance, (c) time-delay, and (d) differential/natural reinforcement—was shown to be effective and seemed quite feasible and easy for the doctoral student to implement. This general instructional approach also has considerable generality for teaching a range of skills to participants with diverse characteristics and across a range of settings (Duker et al., 2004).

Acquisition of SGD-based requesting was associated with decreases in reaching for both boys and also a decrease in hitting for Marco. This suggests that reaching and hitting were maintained by access to the toys and that intervention effectively replaced reaching and hitting with a functionally equivalent form of communication (i.e., using the iPad® to request continuation of toy play). The intervention might thus be viewed as a type of functional communication training as described by Carr and Durand (1985). The logic of functional communication training is that problem behavior can be replaced by teaching socially acceptable communication behaviors that serve the same function or purpose as the problem behavior. Recall from Fig. 1, however, that Sean had relatively few instances of reaching in baseline. This did not appear to stem from an extinction effect because reaching occurred more often during the latter half of the Baseline phase. Sean’s limited reaching might instead reflect an interruption interval that, at 10 s, was too brief to motivate a reach or set the...
occasion for reaching. This explanation is consistent with anecdotal observations suggesting that Sean was somewhat slow/hesitant in responding to stimuli overall, yet he readily played with toys when they were freely available or given to him. Regardless of why Sean showed relatively few instances of reaching, the claim for his reaching having been replaced by SGD use must be seen as more tentative than for Marco. Still, from a social validity perspective, use of the iPad-based SGD could be considered a more advanced and socially acceptable form of communication than either reaching or aggression.

The newly acquired requesting response appeared to generalize to other preferred stimuli; specifically an iPad game for Sean and snacks for Marco. However, this finding needs to be interpreted with caution because performance with respect to requesting the game (Sean) or snacks (Marco) was not assessed in Baseline. While the lack of generalization probes in Baseline is a limitation, it is perhaps most likely that the boys’ performance in the final Generalization phase was due to the instruction provided during the Intervention phase. This suggestion is consistent with the fact that neither boy showed any inclination to use the iPad during Baseline and, reportedly, had no prior exposure to this technology.

Based on the present findings and their consistency to the results of a number of previous studies, we conclude that the instructional package was effective in teaching the participants to request the continuation of toy play with a new, iPad-based SGD. The data also suggest that the newly acquired requesting skill generalized to a second preferred object. The intervention could be viewed as a type of functional communication training in that reaching and hitting were effectively replaced with a socially acceptable form of (iPad-assisted) communication.

Declaration of interest

The authors report no conflicts of interests. The authors alone are solely responsible for the content and writing of this paper.

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References


