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A further comparison of manual signing, picture exchange, and speech-generating devices as communication modes for children with autism spectrum disorders

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ABSTRACT

We compared acquisition of, and preference for, manual signing (MS), picture exchange (PE), and speech-generating devices (SGDs) in four children with autism spectrum disorders (ASD). Intervention was introduced across participants in a non-concurrent multiple-baseline design and acquisition of the three communication modes was compared in an alternating treatments design. Children's preference for using MS, PE or the SGD was also assessed. With intervention, all four participants learned to make specific requests using at least one of the three communication modes. The children also showed a preference for one mode. These results extend previous studies by demonstrating (in four new children with ASD) differential acquisition of, and idiosyncratic preferences for, three commonly used alternative communication modes. The present results further suggest faster acquisition and better maintenance with the preferred mode. We conclude that children's preferences for MS, PE, and SGDs should be considered when designing and implementing augmentative and alternative communication interventions.

1. Introduction

Many children with autism spectrum disorder (ASD) fail to develop speech or have limited/unintelligible speech (Matson, Mahan, Kozlowski, & Shoemaker, 2010). These individuals might learn to communicate using some form of augmentative and alternative communication (AAC; Beukelman & Mirenda, 2005; Schlosser, 2003). Various AAC modes have been recommended for individuals with ASD, including manual signing (MS), picture exchange (PE; Bondy & Frost, 2009), and electronic speech-generating devices (SGDs; Lancioni et al., 2007; Mirenda, 2003).

Systematic reviews of the literature provide empirical support for the use of each of these three AAC modes for individuals with ASD (Flippin, Reszka, & Watson, 2010; van der Meer & Rispoli, 2010; Wendt, 2009). However, the relative efficacy of these three AAC modes remains an open question (Mirenda, 2003; Schlosser & Blischak, 2001). To address this issue, several studies have compared how quickly children have learned to use PE versus MS (Adkins & Axelrod, 2001; Gregory, DeLeon, & Richman, 2009; Tincani, 2004), PE versus SGDs (Beck, Stoner, Bock, & Parton, 2008; Bock, Stoner, Beck, Hanley, & Prochnow, 2005) and

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SGDs versus MS (Iacono & Duncum, 1995; Iacono, Mirenda, & Beukelman, 1993; Sigafoos & Drasgow, 2001). As noted by van der Meer, Sigafoos, O'Reilly, and Lancioni (2011), the results of these comparisons have been somewhat equivocal. Consequently, these authors suggested that a child's preference for using one AAC mode over others may be an important variable to consider when designing and implementing AAC intervention.

Along these lines, two recent studies (van der Meer, Didden, et al., 2012; van der Meer, Kagohara, et al., 2012) compared not only acquisition, but also children's preferences for using different AAC modes. Specifically, van der Meer, Kagohara, et al., 2012 compared acquisition of, and preference for using, a SGD versus MS. The study focused on teaching a general request for preferred snacks or toys (e.g., "*I want to play*.") to four children (aged 5.5–10 years) with developmental disabilities. Intervention—consisting of offering preferred items, waiting 10 s for a correct request, and prompting and reinforcing correct requests—was introduced simultaneously with the MS and SGD mode in accordance with a multiple-baseline across participants and alternating treatments design. Choice-making opportunities, involving offering the children both AAC options and letting them choose one to use, occurred during and after intervention to determine if the children showed a preference for the SGD or MS mode. With intervention, all four children achieved acquisition of the SGD and three of the four also learned to use MS to make the general request. Interestingly, three children most often chose to use the SGD and showed better performance with the SGD, suggesting that preference might influence acquisition and maintenance or that acquisition might influence preference.

In the second study, van der Meer, Didden, et al. (2012) extended this comparison to three AAC modes, specifically SGD, PE, and MS. This study involved four new children with developmental disabilities aged 6–13 years. The children were taught to make a general request for preferred snacks or toys using a SGD, PE, and MS. As with van der Meer, Kagohara, et al. (2012), the children learned to request, but at differing rates and to differing degrees of proficiency with the three modes. Specifically, while all four children reached the acquisition criteria with PE and the SGD, only two also achieved the acquisition criterion during MS instruction. Also, three of the four children showed a preference for the SGD, while the fourth preferred PE. These AAC preference assessment results were similar to those obtained by van der Meer, Kagohara, et al., 2012 Furthermore, the children's AAC preferences appeared to influence the rate of acquisition and performance during follow-up sessions. Specifically, children learned to use the more preferred AAC option quicker and showed better maintenance with the more preferred AAC option during follow-up.

Interesting questions arising from these two studies include (a) whether similar results would be found with additional children with ASD, (b) whether a child's relative preference for different AAC modes are present prior to intervention and remain stable over time after intervention, and (c) whether the findings of van der Meer, Didden, et al. (2012) and van der Meer, Kagohara, et al. (2012) would have generality when teaching more specific requesting forms (e.g., "*I want to play with the ball*." "*I want to play with the doll*.") as compared to the more general requesting forms (e.g., "*I want to play*.") taught in the two previous studies of van der Meer, Didden, et al., 2012 and van der Meer, Kagohra, et al., 2012 A final question is whether parents and general teaching staff could learn to effectively implement the intervention procedures successfully applied by research staff in our two previous studies (i.e., van der Meer, Didden, et al., 2012 and van der Meer, Kagohara, et al., 2012).

The purpose of the current study was therefore to assess: (a) whether four new children with ASD diagnoses could be taught by their parents and general teaching staff to use specific requesting forms with three different AAC modes (i.e., SGD, PE, and MS); (b) whether these participants would demonstrate a preference for one communication modality over the others prior to and during intervention; (c) whether any such preferences would be stable over time; and (d) whether any such preferences would influence acquisition rates and subsequent performance during follow-up sessions. Based on the previous research reviewed above, we hypothesized that the four participants would learn to make specific requests at varying rates with the three communication modes, but that they would make the slowest progress with MS. We further hypothesized that most children would prefer using the SGD and that their relative preference for the three AAC modes would be stable over time. Finally, we predicted that the children would show better maintenance of requesting with their most preferred AAC mode.

2. Method

2.1. Ethical clearance and informed consent

The relevant university ethics committee approved the study. Consent was obtained for the children to participate from their parents. Children's assent was inferred from their general compliance throughout each session.

2.2. Participants

Four children who met the following inclusion criteria participated in this study: (a) diagnosis of ASD, (b) school-aged children of less than 18 years of age, (c) very limited or no communication skills as determined by an age equivalency of 2.5 years or less in the Expressive Communication Sub-Domain of the Vineland Adaptive Behavior Scales (Sparrow, Cicchetti, & Balla, 2005), (d) no auditory or visual impairments that would interfere with the use of AAC, and (e) sufficient motor skills to operate each of the three AAC communication modes, as determined by an age equivalency of 1.0 year or more on the Fine Motor Skills Sub-Domain of the Vineland-II.

2.2.1. Jason

Jason was a 4-year-old male diagnosed with autism and global developmental delay. On the communication sub-domain of the Vineland-II (Sparrow et al., 2005), Jason received age equivalencies of 2:5 (years:months) for receptive communication, 1:8 for expressive communication, and 3:1 for written communication. His age equivalency on the fine motor skills sub-domain of the Vineland-II was 2:11. Jason was reportedly able to use a few single words to make requests and comment on his environment, although his speech was largely unintelligible. He also appeared to attempt to communicate his wants and needs by taking people's hands and leading them. Jason had been informally introduced to PE in the past, but was not receiving any such training throughout the period of this study. This prior PE experience was independent of, and unrelated to, the current intervention. He did not have any prior experience with SGD or MS to request preferred objects.

2.2.2. Jack

Jack was a 4-year-old male diagnosed with autism. His age equivalencies were 1:3, 0:8, and 1:10 on the receptive, expressive, and written communication sub-domains of the Vineland-II (Sparrow et al., 2005). Jack received an age equivalency of 2:0 on the Vineland-II for fine motor skills. He did not have any spoken language, but had prior experience with PE that was independent of, and unrelated to, the current intervention. As a result of this prior experience, he was reportedly able to discriminate among 20 PE symbols that he used to request food items. Otherwise his communication attempts involved leading a person's hand to desired objects. He had no experience with SGD or MS for requesting preferred items.

2.2.3. Ian

Ian was a 10-year-old male diagnosed with autism, moderate intellectual disability, developmental co-ordination disorder, and epilepsy. He received age equivalencies of 2:2, 1:4, and 3:10 on the receptive, expressive, and written communication sub-domains of the Vineland-II (Sparrow et al., 2005). He received an age equivalency of 2:1 on the fine motor skills sub-domain of the Vineland-II. Ian had no formal means of expressing himself, but attempted to create his own signs for words, that were difficult to decipher. Ian also tried to sound out some words, but this was unintelligible. He would often take people's hands to direct them to what he wanted and frequently grabbed people in an apparent attempt to get their attention. Ian did not have any prior training with SGD, PE, or MS to request preferred items. Ian's mother indicated that he engaged in obsessive behavior (e.g., fixation on certain toys) and had difficulty with changes to routine.

2.2.4. Hannah

Hannah was an 11-year-old female diagnosed with autism, severe global developmental delay, and intellectual disability. On the Vineland-II (Sparrow et al., 2005), she received age equivalencies of 1:3 for receptive communication, 0:9 for expressive communication, and 2:5 for written communication. She received an age equivalency of 2:11 on the fine motor skills sub-domain of the Vineland-II. Hannah appeared to communicate her wants and needs by taking people's hands and leading them to objects. She had received training with PE and had been exposed to several gestures, as well as a BIGmack® SGD on several occasions. These prior experiences were independent of, and unrelated to, the present study. She appeared to make vocalizations to communicate pleasure and distress.

2.3. Setting, intervention context, and trainer instruction

Jason, Jack, and Ian received intervention in the dining room of their family home. Hannah received intervention sessions in a special education classroom that was part of a public primary school. For Jason, Jack, and Ian the procedures associated with this study were conducted at a table and implemented in a one-to-one format, consisting of the trainer (mother) and child. Hannah's intervention was implemented at a table in the special education classroom in a one-to-one context consisting of the trainer (teaching assistant) and Hannah.

Jack, Jason, and Ian's mothers were taught how to implement the procedures by the first author. This parent instruction involved (a) explaining the general aims, goals, and procedures of the study, (b) providing parents with step-by-step written instructions for each phase of the study and explaining these steps prior to each phase of the study, (c) modeling implementation of the steps during the first trials at the beginning of each new phase and then having the parent implement the remaining trials for that session, and (d) providing feedback at least once per week throughout each phase of the study. The same strategies were used to teach the teaching assistant how to implement the procedures with Hannah.

2.4. Preferred stimuli

Snacks and/or toys that the participants seemed to prefer, and which would be appropriate for the participants to request during the snack/leisure activity, were identified using a two-stage stimulus preference assessment (Green et al., 2008). Stage 1 involved an indirect assessment in which parents/teachers were asked to list snacks and toys that the participants appeared to enjoy and would be appropriate for the intervention. The five to six most preferred stimuli were then selected for a direct stimulus assessment, involving the simultaneous presentation of multiple items, without replacement (DeLeon & Iwata, 1996; Duker, Didden, & Sigafoos, 2004). Each participant was presented with an array of five to six items from Stage 1

(random placement) and allowed to select one. A session consisted of repeating such offers five or six times depending on whether five or six items had been placed on the tray. Items were not replaced once they had been selected. Toy and food items were assessed separately over six sessions (i.e., six sessions with toys and six sessions with foods). The most preferred foods and/or toys were identified by calculating a rank order of the percentage of times that an item was selected using the formula: number of selections/number of offers × 100%.

Preferred stimuli selected for Jason were marshmallows (75%), balloons and bubbles (both 67%), and chips (35%). Preferred stimuli for Jack were wafer biscuits (55%), K'NEX® building blocks (similar to Lego®; 43%), waterplay toy (40%), and caramel lollies (38%). Preferred stimuli for Ian were music box (100%), puzzles (40%), hide and seek game (30%), and bouncy balls (29%). Preferred stimuli for Hannah were M&M® candy (50%), bubbles (46%), chocolate (43%), and music box (32%).

2.5. Speech-generating device

Jason, Jack, and Ian were taught to request preferred stimuli using an Apple iPod Touch® with Proloquo2Go™ software (Sennott & Bowker, 2009). The iPod Touch® was placed inside an iMainGo2® speaker case to increase sound amplification. Hannah, and later Jack, were taught to use an Apple iPad® with Proloquo2Go™ software. The iPod Touch® and iPad® were configured to show a single page containing four graphic symbols (2.5 × 2.5 cm for the iPod® and 9.5 × 6 cm for the iPad®), representing requests for specific snacks and toys (e.g., CHOCOLATE, BALL). The graphic symbols were photos of the items uploaded into the Proloquo2Go™ software package. Touching each symbol activated corresponding synthetic speech-output (e.g., "*I would like some chocolate.*" and "*I would like to play with my ball.*").

2.6. Picture exchange

The PE system consisted of four laminated photos (7 cm × 7 cm) of the participant's most preferred items, with the corresponding printed word written below the photo. Photos were affixed with Velcro™ to a laminated card (22 cm × 22 cm). The pictures were randomly allocated to the four locations of the card.

2.7. Manual signing

Participants were also taught to request preferred stimuli using signs from the Makaton Sign Language System (Makaton New Zealand/Aotearoa, 1998–1999). Manual signing was represented by a laminated picture (22 cm × 22 cm) with four line drawings (8 cm × 8 cm) of the hand formations needed to make the sign for each of the children's preferred stimuli targeted for intervention.

2.8. Response definitions and measurement

For SGD use, correct responding was defined as independently (without a gestural or verbal prompt) touching the symbol on the screen of the SGD to activate the corresponding speech output in exchange for the item offered by the trainer. For PE, participants were required to independently (without gestural or verbal prompt) remove the corresponding picture from the PE card and hand it over to the trainer in exchange for the item being offered. Manual signing was defined as independent (without a gestural or verbal prompt) performance of the hand gestures to produce correct signs in exchange for the item offered by the trainer. The frequency of correct responding was calculated for each session. Sessions consisted of 12 trials (i.e., each of the four preferred items was offered three times). The order of offering items was counterbalanced across sessions.

2.9. Experimental design

An alternating treatments design was used to compare intervention performance across the SGD, PE, and MS options (Kennedy, 2005). The study phases (i.e., baseline, intervention, preference assessments, post-intervention, and follow-up) were implemented according to a non-concurrent multiple-baseline across participants design (Watson & Workman, 1981). The participants received differing lengths of baseline, but started their baselines in a staggered fashion due to their being recruited into the study at different points in time. Training was first provided to Jason, then Jack, then Ian, and finally Hannah. Jack received additional phases following his initial intervention due to lack of progress. Specifically, he received a modified intervention that involved massed-practice trials with the SGD and MS options. After this, he received a baseline with a new SGD (e.g., an iPad®), followed by an intervention to teach him to use this new SGD along with PE and MS. He then received a new preference assessment to identify additional items for him to request and a final intervention phase to teach him to request these new items.

2.10. Session schedule

Requesting sessions were conducted three to five days per week. The AAC option available (i.e., SGD, PE, or MS) was counterbalanced across sessions to prevent order effects (Kennedy, 2005). For all sessions, the participant and trainer were

seated next to each other at a table. One or two additional observers/data collectors were seated nearby on some occasions to collect interobserver agreement data and conduct procedural integrity checks.

When a participant reached criterion for one AAC device (i.e., 80% correct requesting across three consecutive sessions), teaching for that system was put on hold while it continued with the other communication systems, if necessary, until criterion was reached on the other systems. One maintenance session with the acquired AAC system was conducted after every third teaching session with the other (yet to be acquired) AAC systems.

2.11. Procedures

Participants were taught to request specific snacks or toys. To ensure symbol discrimination, participants had to select the graphic symbol from the SGD or PE board or produce the manual sign corresponding to the item being offered by the trainer. If a participant requested a different item to the one being offered, the trainer responded by saying: *We are requesting* (name of item) and pointed to the correct symbol on the SGD/PE board or modeled the correct sign. It was considered more natural to provide them with some feedback when they activated these (non-target) symbols or made the non-target sign, but counter-productive to discrimination training to consequate these non-target responses with access to preferred items. Similarly, producing a manual sign to request items during SGD or PE sessions and vice versa was ignored so as to bring the use of each device under stimulus control.

2.11.1. Pre-baseline AAC preference assessments

These assessments were undertaken to familiarize participants with each of the three communication modes (SGD, PE, and MS) and to determine if participants showed a preference for one mode over the other two before learning to use them. During these sessions, the SGD, PE, and MS options were placed on the table in randomly determined locations. The trainer briefly explained and demonstrated each communication mode (e.g., *This is a PE board. You use it like this.*). The trainer then asked the participant: *Which communication option would you like to use?* Participants were allowed 10 s to select one of the communication options. Selecting was defined as touching, holding, and/or manipulating the device. If the child did not select one of the communication options within 10 s, the next trial was initiated by again asking the participant: *Which communication option would you like to use?* Communication options were not replaced once selected. Instead, the remaining communication options were then offered. This procedure was repeated across six sessions (three offers per session) and the percentage of times that each device was selected was calculated using the formula: number of selections/number of offers $\times$ 100%. Pre-baseline preference assessments were not undertaken with Hannah due to an oversight.

2.11.2. Baseline

During this phase, a tray containing one of the participants' four preferred items was placed on the table in view, but out of reach. The SGD, PE, and MS communication options were randomly placed on the table. Each session began with the trainer asking the participant to *Let me know if you want this*, while holding the tray with the item being offered. After 10 s, the trainer moved the tray within reach and allowed the participant to take the item. This was repeated 12 times (trials) per session, with each of the four items offered three times in a counterbalanced order. This 10-s fixed-time schedule of reinforcement was provided to ensure continued motivation to participate in sessions. Participants were given approximately 20 s to consume/play with the item being offered. Responses to the SGD, PE, and MS were recorded, but had no programmed consequences.

2.11.3. Intervention

This phase was conducted in a discrete-trial format until participants reached criterion (i.e., 80% correct requesting across three consecutive sessions for each AAC mode) or, failing that, until they had received at least 10 sessions of intervention with each AAC mode. Each trial consisted of the trainer placing a tray with one of the participant's preferred items on the table, showing the item to the participant, but keeping it out of reach, and saying, *Let me know if you want this.* Training involved a 10-s time delay between the verbal cue (i.e., *Let me know if you want this*.) and the use of graduated guidance to prompt a correct request. Graduated guidance involved using the least amount of physical guidance necessary to prompt the child to make a request, with a simultaneous explanation of how to perform the action (e.g., *Press the ball icon to ask to play with a ball.* for SGD, or *Hand over the picture of the ball.* for PE, or *Move your hands in the formation of a ball to make the sign for ball.* for MS). Immediately after a correct SGD, PE, or MS request, the trainer moved the tray containing that item within reach of the participant with simultaneous social reinforcement (e.g., *Good asking.*). The participant was allowed approximately 20 s to consume/play with that item. After this, the next trial was initiated. Twelve such trials (three trials per item) were conducted per session with the order of the items being offered counterbalanced to avoid order effects.

2.11.4. Procedural modifications

Because Jack made little progress with the SGD and MS options during the initial intervention sessions, his teaching procedures were modified to include 10 massed-practice trials before each SGD and MS session. This involved implementing 10 consecutive graduated guidance trials with no time delay and no reinforcement. The aim was to provide Jack with additional practice in making the target responses. With this modification, Jack began to initiate correct requests with the SGD, but appeared to struggle to press the icons with the appropriate degree of finesse to activate the voice output. It was

therefore decided to switch to an iPad® because we thought that the larger size of icons and increased sensitivity of the screen on the iPad® would make it easier for Jack to activate the SGD. Although Jack made some progress with these modifications to the intervention process, he also rather quickly appeared to lose interest in the preferred stimuli that he was being taught to request. Therefore another stimulus preference assessment was implemented. New preferred stimuli were then chosen for intervention consisting of lollies (60%), blocks (46%), an alphabet toy (40%), and chips (24%).

2.11.5. AAC preference assessments

These assessments were undertaken after each baseline, intervention, and follow-up session to determine if participants would show a preference for using one of the three AAC systems. They were identical to pre-baseline device preference assessments, except when the participant selected a communication mode, the trainer then initiated one requesting opportunity with the chosen mode before reverting back to another baseline, intervention, or follow-up session. If the participant did not choose an option within 10 s, that AAC preference assessment trial was terminated and training continued with the AAC option that was scheduled for use in that session.

2.11.6. Post-intervention

Once the participant reached criterion for each AAC device, post-intervention preference assessments were introduced. These were identical to the previously described AAC preference assessments, except that once an AAC option had been chosen, the participant continued to request preferred items using the chosen communication method for the entire session.

2.11.7. Follow-up

Nine follow-up sessions (three for each communication mode) were conducted after Session 24 for Ian and after Session 45 for Jason (see Fig. 1). These occurred three weeks after their last post-intervention session. Ian also received a second set of [long-term] follow-up sessions beginning eight months after his previous follow-up sessions (Session 33 of Fig. 1). Hannah received follow-up after Session 68 (Fig. 1), eight weeks after her last post-intervention session. Because of a change of schools in the interim, Hannah's follow-up sessions were conducted by the first author, not by the teaching assistant. During the interval, participants did not use any of the communication modes to request their preferred items. Jack did not receive follow-up because he did not reach criterion for any of the communication modes. Procedures for follow-up were identical to the intervention phase, except no prompting occurred and participants only received access to preferred items contingent on correct requesting. Also an AAC preference assessment (as described in Section 2.11.5) was implemented after each session.

2.12. Interobserver agreement

Trainers collected data on the frequency of correct requesting and on which communication mode was selected during AAC preference assessments. To assess the reliability of the trainers' data collection, an independent observer also collected data on the frequency of requesting and communication mode chosen. For each session, percentages of agreement between the independent observer and the trainer were calculated using the formula: agreements/(agreements + disagreements) $\times$ 100. These agreement checks occurred on 32% of all sessions and ranged from 95 to 99.7% with a mean of 97.8%.

2.13. Procedural integrity

To assess procedural integrity, the independent observer had a checklist of the procedural steps and recorded whether or not the trainer had correctly implemented each procedural step in its proper sequence. Procedural integrity was assessed on 32% of all sessions and ranged from 98.8 to 99.9% correct implementation with a mean of 99.1%. A second independent observer collected inter-observer agreement data on 11% of these integrity checks with 100% agreement.

3. Results

Fig. 1 shows the percentage of correct requests during each session for each of the three AAC modes. Table 1 provides a summary of the pre-baseline preference assessments. Fig. 2 provides a summary of the results from the AAC preference assessments conducted during baseline, intervention, and subsequent phases. In baseline (Fig. 1), none of the participants ever used PE or MS to make the targeted requests. Ian and Hannah made several correct SGD-based requests during baseline. However, a stable and low baseline was evident for all children prior to introducing intervention.

3.1. Jason

When intervention was introduced, Jason reached the acquisition criterion for the SGD option on his third SGD training session (Fig. 1). Although he did not reach criterion for PE and MS, Jason achieved above 80% correct requesting in three of his PE (M = 86%, range = 33–100%) and two of his MS (M = 51%, range = 0–100%) intervention sessions. During the post-intervention phase, Jason chose to use the SGD 100% of the time. Once chosen, he then used the SGD with at least 80% proficiency. During follow-up, Jason maintained correct SGD- and PE-based requests at high levels (63–100%), but his performance dropped to between 36 and 67% correct for MS. He chose the SGD first on 100% of opportunities during the

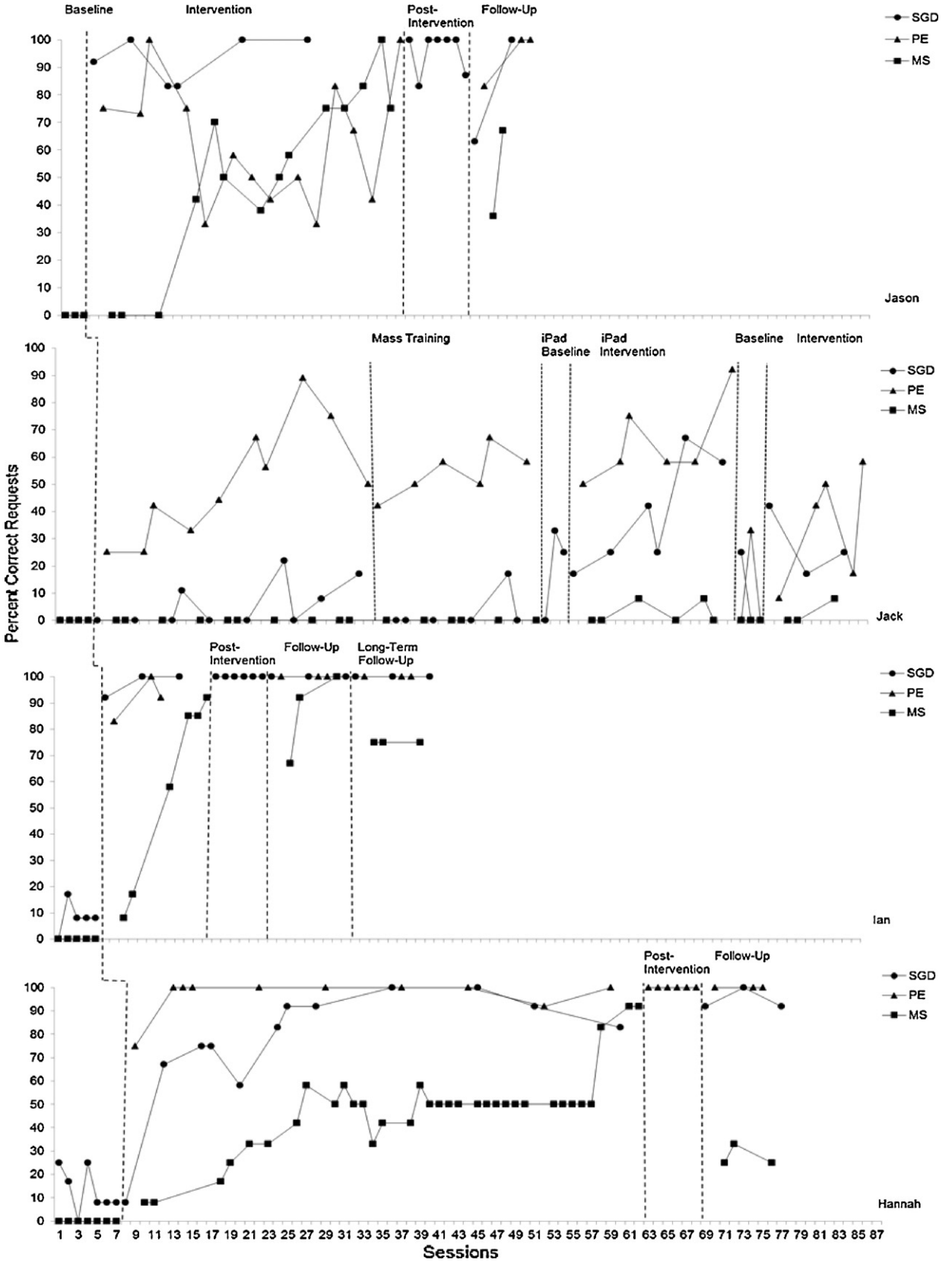

Fig. 1. Percentage of correct requests with SGD, PE, and MS across sessions for each participant.

Table 1
Percentage of selection/times offered for SGD, PE, and MS during the pre-baseline AAC preference assessments.

Child	SGD	PE	MS
Jason	100	20	6
Jack	55	45	29
Ian	86	50	29
Hannah	–	–	–

pre-baseline device preference assessments (Table 1). Overall, during baseline, intervention, post-intervention, and follow-up phases, Jason received a total of 45 opportunities to choose between the SGD, PE, and MS options (Fig. 2) and he chose the SGD most frequently (69%).

3.2. Jack

Although Jack did not reach criterion with PE, he did achieve over 80% correct requesting on a number of occasions. His performance with the PE mode averaged 52% (range = 8–92%) correct requesting. Similarly, even with modifications to the intervention procedures, he did not reach criterion with the iPod Touch® (M = 5% range = 0–22%). When the iPad® was introduced, his performance increased to an average of 35% (range = 17–67%) correct requesting. Even with additional procedural modifications, Jack made little progress with MS and did not achieve criterion within the timeframe of this study. Therefore he did not progress to the post-intervention or follow-up phases. Results from the pre-baseline preference assessment indicated that Jack chose each communication system comparably often (Table 1). During baseline and intervention, Jack received 89 AAC preference assessments (Fig. 2) and he chose PE most frequently (58%), followed by the SGD (30%).

3.3. Ian

Ian achieved criterion for SGD- and PE-based requesting on his third SGD and third PE intervention sessions (Fig. 1). He achieved criterion for MS-based requesting on his sixth MS intervention session (Fig. 1). During the post-intervention phase, Ian always chose to use the SGD and then used it with 100% proficiency. During the first follow-up, his performance maintained at 100% correct for the SGD and PE, but decreased with the MS option. During the second, long-term follow-up (after eight months), his performance with the SGD and PE option was at 100%, whereas it was at 75% for the MS option. Ian chose the SGD most frequently (86%) during the pre-baseline AAC preference assessments (Table 1). During baseline,

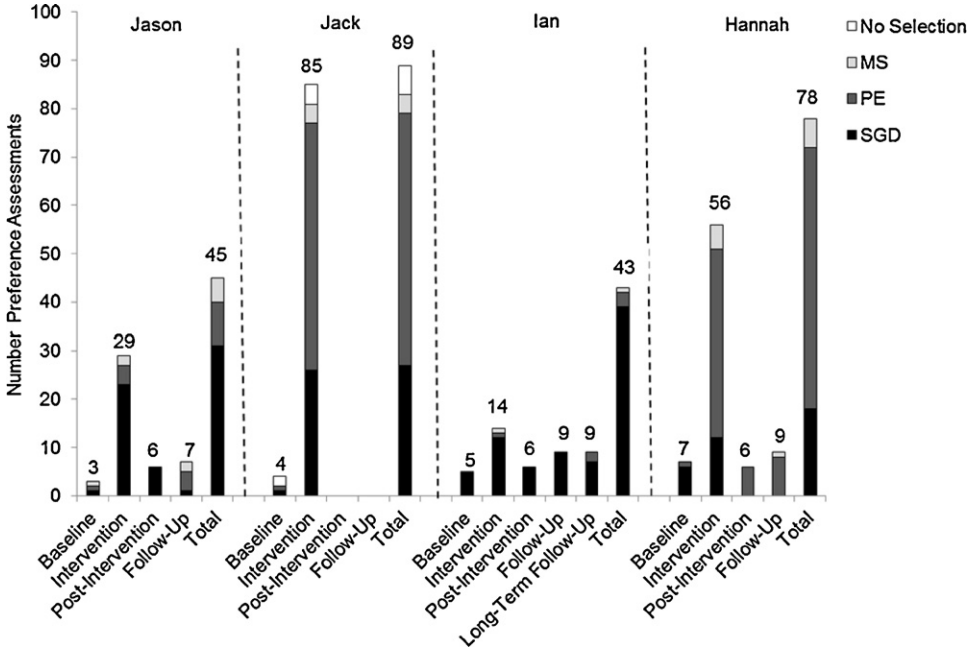

Fig. 2. Results from the AAC preference assessments depicting the number of times each communication option (SGD, PE, and MS) was chosen across phases and participants.

intervention, post-intervention, and follow-up phases, Ian received 43 AAC preference assessments (Fig. 2) during which he chose the SGD the majority of the time (91%).

3.4. Hannah

Hannah achieved acquisition criterion for PE- and SGD-based requests on her fourth and eighth respective intervention sessions (Fig. 1). She showed steady increases in the percentage of correct requests using MS, and finally reached criterion on her 34th MS intervention session (Fig. 1). During the post-intervention phase, Hannah always chose to use PE and then used it with 100% proficiency. During follow-up, SGD and PE use maintained at high levels (92–100%), while MS dropped to 25–33% correct requesting. Hannah did not receive pre-baseline AAC preference assessments. During baseline she chose the SGD 68% of the time, but overall across the total of 78 AAC preference assessments conducted during the study (Fig. 2), she chose PE most frequently (69%).

4. Discussion

The first aim/hypothesis of this study was to determine if children with ASD could learn to request preferred items using one of three different AAC systems. This aim/hypothesis was achieved/confirmed with all four participants learning to make specific requests for preferred items using at least one of the three AAC modes taught. Specifically, two participants (Ian and Hannah) reached criterion with all three communication modes, while one participant reached acquisition criterion with the SGD and one (Jack) learned to use PE with moderate proficiency. These findings are consistent with previous studies reporting that children with ASD can learn to use SGDs, PE, and MS to make requests for preferred items (Flippin et al., 2010; van der Meer & Rispoli, 2010; Wendt, 2009). Furthermore, van der Meer, Didden, et al. (2012) and van der Meer, Kagohara et al. (2012) showed that eight children with developmental disabilities learned to use SGD, PE, and MS to make general requests for snacks or toys. The present results extend the previous research by van der Meer and colleagues by demonstrating that four new children with ASD could concurrently learn to use SGD, PE, and MS to make specific requests.

The present results also extend previous research by showing that parents (i.e., Jason, Jack, and Ian's mothers) and a teaching assistant (for Hannah) could effectively apply the intervention procedures. Given that parents and teaching staff are arguably the children's more important communicative partners, this extension increases the applied relevance of the present findings, relative to van der Meer, Didden, et al. (2012) and van der Meer, Kagohara, et al. (2012), in which research staff implemented the procedures. The strategies for training these parents and the teaching assistant appeared to have been effective as evidenced by (a) the generally positive results with respect to acquisition of MS-, PE-, and SGD-based requesting, and (b) the high degree of procedural integrity. The fact that parents and the teaching assistant learned to effectively implement the procedures with relatively little training is not surprising given that our strategies for doing so were consistent with best practices for training paraprofessionals to implement similar types of behaviorally oriented teaching programs (Reid, O'Kane, & Macurik, 2011).

The findings also demonstrated variability with which children with ASD learned the three AAC modes in line with the findings of van der Meer, Didden, et al. (2012) and van der Meer, Kagohara, et al. (2012). For example, one participant (Jack) did not learn to use MS and the remaining participants mastered MS at a slower rate than the other communication modes. van der Meer, Didden, et al. (2012) provide three possible reasons for this finding: (a) it may be more difficult to learn MS because it requires recall memory whereas graphic symbols (used for SGD and PE) could be less demanding on children's working memory – only needing recognition memory (Iacono & Duncum, 1995; Iacono et al., 1993), (b) MS may be a more difficult AAC system to teach because forming signs requires more physical motions than pointing to or handing over a graphic symbol to a communication partner (SGD and PE), or (c) MS was the least preferred option, which may have reduced motivation to use it.

The second and third aims/hypotheses were to examine if children would indicate a preference for using one AAC system over the others during the early stages of acquisition and whether any such preferences would be stable over time. The initial choice-making patterns demonstrated by three of the participants (Jason, Ian, and Hannah) suggested a preference for using the SGD, while the remaining participant (Jack) chose each AAC system comparably often. Results suggested that for three participants (Jason, Jack, and Hannah), the pre-baseline and/or baseline choices for the different AAC systems were more variable, with preferences changing throughout later phases of the study as they learned to use each AAC mode. Therefore it could be hypothesized that some children might indicate an immediate preference based (perhaps) on some inherent features of the available AAC options (e.g., voice-output or dynamic display of SGDs), but that as they gain proficiency in using each AAC mode their preferences may change to reflect other features, such as ease of use. This could also explain lower rates for mastery and preference of MS in that the MS option might have less instant appeal. This in turn could mean that some children were less motivated to learn to use the MS. Further, the findings indicated that for some participants, their preferences for the three AAC modes only seemed to be stable once they achieved acquisition with each AAC mode. One implication of this finding is that preferences might be reliably assessed, and remain stable only after children have learned to use each communication mode to some [high] level of proficiency.

The final aim/hypothesis was to ascertain whether any demonstrated AAC system preferences would influence acquisition and maintenance of newly acquired requesting skills. Three participants (Jason, Ian, and Hannah) learned to use and/or achieved criterion with each communication system. In addition, the follow-up data suggested that maintenance was

higher when these three children were using their most preferred AAC mode. Interestingly, although Jason demonstrated an overall preference for the SGD prior to follow-up, his preference shifted to PE during the follow-up phase and he also performed at a higher rate with PE, than with the SGD, during the follow-up phase. This suggests that for some children, their preferences for different AAC modes may change over time and influence performance. The implication of this is that there might be value in periodically reassessing children's preferences after intervention, even when they showed a preference for a particular AAC mode during acquisition and immediately after acquisition.

The participants in the study reliably discriminated between symbols used on the PE and SGD modes. This contrasts with prior research that described the difficulties children with ASD have in learning to use aided communication systems (SGD and PE) due to the symbol discrimination (matching-to-sample) and scanning repertoire necessary to differentiate between and select symbols (e.g., Cannella-Malone, DeBar, & Sigafoos, 2009; Koul, Schlosser, & Sancibrian, 2001; Sundberg & Sundberg, 1990; Wraikat, Sundberg, & Michael, 1991). The use of photos of specific preferred stimuli in the current study may explain why participants relatively quickly learned to discriminate and select the correct symbol corresponding to the item being offered. However, further research is required to validate the hypothesis that photos of specific items could faciliate the acquisiton of SGD- and PE-based requesting (De Paul & Yoder, 1986; Johnston & Cosbey, 2012).

Activation of the iPod Touch® appeared to be problematic for Jack in that he appeared to have difficulty selecting screen icons with sufficient finesse to activate the speech output. This problem has been noted in two previous studies (Cannella-Malone et al., 2009; Kagohara et al., 2010). In an attempt to rectify this problem, we introduced an iPad®. As anticipated, the larger display appeared to be helpful and Jack's percentage of correct SGD-based requests increased. Massed-practice trials were also introduced in an attempt to teach Jack the MS-based request. However, he only made minimal progress in learning to make the sign for LOLLY. To some extent, his relatively limited progress with all three communication modes appeared to be a motivational issue in that he did not consistently select and then play with or eat the presumed preferred stimuli. Even after a second reinforcer assessment, and subsequent introduction of new preferred stimuli Jack seemed to quickly lose interest in the items he was being taught to request. The implication here is that progress in teaching AAC-based requesting to some children, regardless of mode, is likely to be compromised in the absence of powerful reinforcers.

While the overall findings were generally positive and consistent with previous research, several limitations must be considered when interpreting the present data set. First, only four children participated in this study and thus care should be taken when considering the implications of our findings with other children. However, when these results are combined with the two related studies (van der Meer, Didden, et al., 2012; van der Meer, Kagohara, et al., 2012), there are now a total of 12 children with developmental disabilities who have shown largely similar results. Still, further research involving increased numbers of children is needed to extend the generality of the findings. Second, no data were obtained on generalization of the requesting skills taught during the study to other preferred items, setting, or communicative partners. Research investigating generalization across the three AAC modes would be an obvious future direction. In addition, the present study focused only on teaching requesting or mands. It would be instructive to consider the use of MS, PE, and SGDs when teaching other communicative functions, such as tacting and intraverbal behavior (Skinner, 1957). Third, further research should examine factors that might influence a child's preference for using one AAC system over others. This is particularly relevant considering that our findings suggest that such preferences can influence performance during intervention and follow-up, a finding that was also noted by Ringdahl et al. (2009).

In summary, our results support previous findings that children with ASD and other developmental disabilities can be taught to use three common AAC systems to make requests and will also often show a preference for using one AAC system over others. The results extend the previous studies by van der Meer, Didden, et al. (2012), van der Meer, Kagohara, et al. (2012) by showing that while AAC mode preferences may be present prior to intervention, they can often change during and after the intervention phase. In addition, the present results provide further evidence to suggest that acquisition of AAC-based requesting is faster and maintenance is better when children use their more preferred AAC mode. The results thus provide more evidence to support the value of assessing children's preferences for different AAC modes when designing and implementing communication interventions.

Conflicts of interests

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

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