RESEARCH ARTICLE

Teaching Multi-Step Requesting and Social Communication to Two Children with Autism Spectrum Disorders with Three AAC Options

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Abstract
The present study involved comparing the acquisition of multi-step requesting and social communication across three AAC options: manual signing (MS), picture exchange (PE), and speech-generating devices (SGDs). Preference for each option was also assessed. The participants were two children with autism spectrum disorders (ASD) who had previously been taught to use each option to request preferred items. Intervention was implemented in an alternating-treatments design. During baseline, participants demonstrated low levels of correct communicative responding. With intervention, both participants learned the target responses (two- and three-step requesting responses, greetings, answering questions, and social etiquette responses) to varying levels of proficiency with each communication option. One participant demonstrated a preference for using the SGD and the other preferred PE. The importance of examining preferences for using one AAC option over others is discussed.

Keywords: Augmentative and alternative communication; Autism spectrum disorders; Manual signing; Picture exchange; Speech-generating devices

Introduction
Children with autism spectrum disorders (ASD) who do not speak or have limited verbal abilities are commonly taught to use augmentative and alternative communication (AAC) options such as manual signing (MS), picture exchange (PE), and speech-generating devices (SGDs; Ganz et al., 2012; Mirenda, 2003). Researchers have demonstrated that children with ASD can learn to use each of these three options (Flippin, Reszka, & Watson, 2010; Rispoli, Franco, van der Meer, Lang, & Carmargo, 2010; Wendt, 2009). Studies that have compared the acquisition rates of various AAC options provide evidence that individuals demonstrate variation in their learning of specific AAC technologies (e.g., Beck, Stoner, Bock, & Parton, 2008; Gregory, DeLeon, & Richman, 2009; Sigafous & Drasgow, 2001). Because a variety of AAC systems appear to be effective for at least some individuals, AAC team members may find it difficult to determine the best option for a particular individual.

Various guidelines have been developed to assist practitioners in selecting an appropriate AAC system to meet the communication needs of children with ASD (e.g., Reiche, 1991; Sigafous & Iacono, 1993). Research and practice should also examine the impact of particular client characteristics (e.g., preference) on resulting communication skills with specific AAC options. However, with limited access, heavy caseloads, a wide range of assessment considerations, and short timeframes for service delivery, communication specialists often find it challenging to fully explore and incorporate a client’s assessed preferences (Ruggero, McCabe, Ballard, & Munro, 2012; Verdon, Wilson, Smith-Tamaray, & McAllister, 2011). The failure to fully consider the client’s perspective may be one reason for reports indicating that on average 28% of clients do not make use of the AAC system recommended by communication professionals, despite having no improvement in other communication modes (Johnson, Inglebret, Jones, & Ray, 2006). Although it is recognized that client choice for different AAC systems should be considered (Beukelman & Mirenda, 2013), there are few guidelines on how such choices should be assessed. Research is therefore needed to investigate the development of an efficient...
method for practitioners to assess choice, and specifically the potential impact of client preferences for AAC systems on intervention outcomes.

Because individuals who use AAC have limited speech and language skills, they often struggle to verbally communicate a preference for different options. Therefore it would seem important to examine whether there are other ways in which clients might indicate which of several AAC options they would prefer. One such structured choice-making approach (e.g., Sigafoos, 1998) involves making each AAC system available and allowing the participant to choose one device by pointing to, reaching for, or touching it. Indeed, a systematic review of the literature examining this approach found that, in most studies where preference for two or more AAC options has been assessed, participants did in fact show a preference for using one AAC option over another (van der Meer, Sigafoos, O’Reilly, & Lancioni, 2011). Thus, use of this choice-making procedure to assess preference for different AAC options might be an important variable to consider when designing effective and efficient AAC interventions (Soto, Belfiore, Schlosser, & Haynes, 1993).

Along these lines, van der Meer and colleagues utilized this choice-making approach to investigate whether child preferences for using one AAC option over others influenced intervention outcomes in terms of ease and speed of skill acquisition (van der Meer, Didden, et al., 2012; van der Meer, Kagohara, et al., 2012; van der Meer, Sutherland, O’Reilly, Lancioni, & Sigafoos, 2012). Across these three studies, a total of 12 children (9 boys and 3 girls) aged 4–13 years with ASD and related developmental disabilities (e.g., intellectual disability, Down syndrome, Angelman syndrome) received intervention designed to teach a beginning requesting skill (i.e., using AAC to gain access to highly preferred stimuli). These studies compared how quickly the children learned to request using MS, PE, and SGDs. The researchers also examined the children’s preference for using each of these three AAC options. Specifically, van der Meer, Kagohara et al. (2012) compared acquisition and preference for MS and SGD, whereas van der Meer, Didden et al. (2012) and van der Meer, Sutherland et al. (2012) compared acquisition and preference for MS, PE, and SGD. Overall, the results of these three studies demonstrated that 7 of the 12 children learned to use each AAC option, and all of the children demonstrated a preference for using one AAC option (the SGD was the option that was selected most frequently). In addition, post-hoc analyses of the data from these three studies (van der Meer, Didden et al., 2012; van der Meer, Kagohara et al., 2012; van der Meer, Sutherland et al., 2012) suggested that children showed greater proficiency and better maintenance with their preferred AAC option. These findings highlight some potentially positive effects of enabling children who need AAC to choose which AAC option to use. However, this research is limited to teaching a beginning requesting skill. It is therefore unclear what effect a preference for different AAC options might have on learning other communication skills.

To investigate this question, the present study focused on teaching new and more advanced communication skills to two children (Ian and Hannah), who had participated in the van der Meer, Sutherland et al. (2012) study. Both participants had previously learned to use MS, PE, and SGD to make a one-step request for access to preferred stimuli, and both showed a preference for using one of these communication options. Ian preferred the SGD and Hannah preferred the PE. The following research questions were investigated in the present study: Can participants learn more complex and socially-oriented communication skills with each AAC system? Will preference for one AAC system over the other two remain stable or change with the introduction of more advanced communication skills? If children learn new and more advanced communication skills with each AAC system, does preference influence how efficiently they learn the new skills? Based on the research by van der Meer and colleagues (van der Meer, Didden et al., 2012; van der Meer, Kagohara et al., 2012; van der Meer, Sutherland et al., 2012), we predicted that enabling participants to choose which AAC option to use (i.e., MS, PE, or SGD) would enhance the success of the intervention in terms of speed of acquisition. Furthermore, the use of a preferred AAC option was also expected to translate into a higher percentage of correct communicative responses during follow-up sessions.

Method

Participants

The two participants, Ian and Hannah (pseudonyms), met the following inclusion criteria: (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 on the Expressive Communication Sub-Domain of the Vineland-III; (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 options, as determined by an age equivalency of 1.0 year or more on the Fine Motor Skills Sub-Domain of the Vineland-III (Sparrow et al., 2005).

Ian. Ian was a 10-year-old boy diagnosed by his pediatrician with autism, moderate intellectual disability, developmental co-ordination disorder, and epilepsy. On the Vineland-III (Sparrow et al., 2005), Ian received an adaptive behavior composite standard score of 56, indicating a low adaptive level with a mild deficit. He received an age equivalency of 1:4 (years;months) on the expressive communication sub-domain of the Vineland-III (Sparrow et al., 2005). He received an age equivalency of 2:1 on the fine motor skills sub-domain of the Vineland-III (Sparrow et al., 2005). Ian used some
idiosyncratic gestures, seemingly to depict objects and actions. However, these gestures were largely unintelligible to his communicative partners. Ian also tried to sound out some words, but these were unintelligible to unfamiliar communication partners. 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’s mother indicated that he engaged in obsessive behavior (e.g., fixation with certain toys) and had difficulty with changes to routines. Ian had learned to use the same SGD, PE, and MS systems used in this study to request preferred music and toys to criterion (80% or higher correct over three consecutive sessions) in a previous study (van der Meer, Sutherland et al., 2012). In that study he demonstrated a preference for using the SGD. During the present study Ian used each of these three AAC systems for the targeted communicative exchanges only; he did not have access to the AAC systems in any other context.

Hannah. Hannah was an 11-year-old girl diagnosed by her pediatrician with autism, severe global developmental delay, and intellectual disability. On the Vineland-II (Sparrow et al., 2005), Hannah received an adaptive behavior composite standard score of 39, indicating a low adaptive level with a moderate deficit. She received an age equivalency of 0;9 for expressive communication on the Vineland-II (Sparrow et al., 2005). She received an age equivalency of 2;11 on the fine motor skills sub-domain of the Vineland-II (Sparrow et al., 2005). Hannah communicated her wants and needs by taking people’s hands and leading them to objects. Her parents reported that she vocalized to communicate pleasure and distress. In a previous study, Hannah had learned to use the three AAC options (i.e., SGD, PE, and MS) to request bubbles, music box, chocolate pebbles, and chocolate to criterion (80% or higher correct over three consecutive sessions; van der Meer, Sutherland et al., 2012). In that study she demonstrated a preference for using PE. Hannah also used a PE system to request food and drinks during her morning and lunch breaks. She did not use a SGD or MS in any other contexts during the present study.

Setting, Intervention Context, and Instructor Instruction

Ian received intervention in the dining room of his family home. The study procedures took place at a table and were implemented in a dyad, consisting of the instructor (mother) and child. Hannah received intervention sessions at a table in a special education classroom at a regular primary school in a dyadic context consisting of the instructor (first author) and Hannah. While Hannah’s mother was aware of the intervention and observed several sessions, she expressed the concern that she was not confident in implementing the intervention. It was therefore decided that the intervention would be more beneficial to Hannah if implemented by an experienced instructor.

The participants and instructors were seated next to each other during all sessions. One or two additional observers were seated nearby on some occasions, to conduct interobserver agreement and procedural integrity checks.

The first author taught Ian’s mother how to implement the procedures. This parent instruction involved the same strategies as those used by van der Meer, Sutherland et al. (2012): (a) explaining the general aims, goals, and procedures of the study; (b) providing the parent with step-by-step written instructions for each phase of the study and explaining these steps prior to each phase; (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 verbal feedback by meeting with the parent at least once per week throughout each phase of the study.

Materials

Preferred stimuli. A two-stage stimulus preference assessment (Green et al., 2008) was used to identify snacks and/or toys that the participants seemed to prefer and would be appropriate for them to request during snack/leisure activities. 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 or 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 or six items from Stage 1 (random placement) and allowed to select one. A session consisted of repeating such offers 5 or 6 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%.

Ian’s preferred toys were a music box (100%), puzzles (40%), hide and seek game (30%), bouncy balls (29%), and cars (21%); his preferred food items were chocolate chip cookies (100%), vanilla cookies (43%), and pretzels (31%). Hannah’s preferred toys were bubbles (46%), the music box (32%), slinky (32%), windmill (30%), and hand clapper (26%); her preferred food items were chocolate-coated candies (50%), chocolate (43%), and chocolate chip cookies (32%).

Speech-generating device. Ian was taught targeted communication skills using an Apple iPod Touch™ with Proloquo2Go™ software. The iPod was placed inside an iMainGo2™ speaker case to increase sound amplification. Ian received follow-up with both the iPod and a
new Apple iPad, the latter of which was configured as a SGD. Hannah was taught to use the iPad with Proloquo2Go software. The iPod and iPad were configured to show a single page containing 15 graphic symbols (2.5 cm × 2.5 cm for the iPod and 9.5 cm × 6 cm for the iPad), with the corresponding printed word written below the symbol representing the target responses (requests for specific snacks and toys, greetings, answering questions, and etiquette). To be consistent with what participants had previously learned in the van der Meer, Sutherland et al. (2012) study, eight photos were used to represent specific toy and snack items. In an attempt to create functional equivalence between the AAC systems, Makaton (Makaton New Zealand/Aotearoa, 1998–1999) line drawings were used to represent the other communicative categories (greetings, answering questions, and etiquette). Because Makaton (Makaton New Zealand/Aotearoa) has only one line drawing to represent the manual signs HELLO and GOOD BYE and PLEASE and THANK YOU, two line drawings from the PICS for PECS picture dictionary (Pyramid Educational Products Inc., 2009) were included to discriminate between these words. This left a total of five Makaton (Makaton New Zealand/Aotearoa) line drawings to represent the remaining communicative categories. All symbols were uploaded into the Proloquo2Go software package in alphabetical order (the program only allows for symbols to be arranged in this order). Participants had to scroll up and down the screen of the iPod/iPad to view all of the graphic symbols in order to select the correct symbol in response to the instructor’s instruction. Touching each symbol activated a corresponding synthetic speech-output resulting in a phrase or sentence (e.g., touching the symbols for I WANT, and CHOCOLATE, and PLEASE resulted in, “I want ‘chocolate’ ‘please.’”).

**Response Definitions and Measurement**

The target behavior was independent use (i.e., with no additional verbal, gestural, or physical prompts) of the MS, PE, and SGD communication options for making two- and three-step requests for specific play and food items, greetings (hello and good-bye), answering (yes/no) questions, and etiquette (please and thank you). For SGD use, a correct response was defined as touching the symbol/s on the screen of the SGD to activate the corresponding speech output in response to the instructor’s instruction. For PE, participants were required to remove the corresponding symbol/s from the PE card and place them on the separate sentence strip in response to the instructor’s instruction. Manual signing was defined as performance of the hand gestures to produce correct sign/s in response to the instructor’s instruction. Approximations of the sign (e.g., touching a finger on side of the lip for LOLLY, rather than moving the finger from cheek to side of the lip) were counted as correct. A summary of the instructions and the target behaviors in the sequence of the task is provided in Table I. As shown in Table I, the task involved a sequence of 24 steps that were assessed in each session. The percentage of correct responses was calculated for each session.

**Experimental Design**

An alternating treatments design was used to compare intervention performance across the MS, PE, and SGD options (Barlow & Hayes, 1979) in four phases: baseline, intervention, preference assessments, and follow-up for both participants. The two participants received differing lengths of baseline and started their baselines at different times because they were recruited into the study at different points in time. Intervention was first provided to Ian and then to Hannah.

**Session Schedule**

Sessions were conducted 2–5 days per week in a discrete trial format. Intervention sessions were implemented until participants reached criterion (i.e., 79% or better correct responding across three consecutive sessions for each AAC option) or, failing that, until they had received at least 10 sessions of intervention with each AAC option. The 79% criterion was chosen to correspond to the way in which percentages were calculated. When a participant reached criterion for one AAC option, teaching for that option was put on hold while intervention continued with the other options. One maintenance...
Table I. Instructions and Target Behaviors.

<table>
<thead>
<tr>
<th>Instruction</th>
<th>Target Behavior: (using MS, PE, or SGD)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>It’s time to do some work, first we are going to play and then we can have a snack. Say hello.</em></td>
<td><strong>Hello</strong></td>
</tr>
<tr>
<td>We are going to play with some of your toys. What do you want to play with?</td>
<td><strong>I want _____ (label for the toy)</strong></td>
</tr>
<tr>
<td><em>(for Ian)</em> Ask to play with _____ <em>(for Hannah)</em></td>
<td><strong>I want _____ (label for the toy)</strong></td>
</tr>
<tr>
<td>What do you want to play with? <em>(for Ian)</em> Ask to play with _____ <em>(for Hannah)</em></td>
<td><strong>I want _____ (label for the toy)</strong></td>
</tr>
<tr>
<td>What do you want to play with? <em>(for Ian)</em> Ask to play with _____ <em>(for Hannah)</em></td>
<td><strong>I want _____ (label for the toy)</strong></td>
</tr>
<tr>
<td>What do you want to play with? <em>(for Ian)</em> Ask to play with _____ <em>(for Hannah)</em></td>
<td><strong>I want _____ (label for the toy)</strong></td>
</tr>
<tr>
<td>What do you want to play with? <em>(for Ian)</em> Ask to play with _____ <em>(for Hannah)</em></td>
<td><strong>Yes or No Please or Thank-you</strong></td>
</tr>
<tr>
<td>Would you like a snack? <em>(for Ian)</em></td>
<td><strong>I want _____ (label for the snack)</strong></td>
</tr>
<tr>
<td><em>(for Hannah)</em> We are going to play with some of your toys. What do you want to play with?</td>
<td><strong>I want _____ (label for the toy)</strong></td>
</tr>
<tr>
<td><em>(for Hannah)</em> Ask to play with _____ <em>(for Hannah)</em></td>
<td><strong>I want _____ (label for the toy)</strong></td>
</tr>
<tr>
<td><em>(for Hannah)</em> Ask to play with _____ <em>(for Hannah)</em></td>
<td><strong>I want _____ (label for the toy)</strong></td>
</tr>
<tr>
<td><em>(for Hannah)</em> I want _____ (label for the toy)</td>
<td><strong>Yes or No Please or Thank-you</strong></td>
</tr>
<tr>
<td>Say thank you and good-bye. <em>(for Hannah)</em></td>
<td><strong>I want _____ (label for the snack)</strong></td>
</tr>
<tr>
<td></td>
<td><strong>I want _____ (label for the snack)</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Thank you Please</strong></td>
</tr>
</tbody>
</table>

Session with the already acquired AAC option was conducted after every third ongoing intervention session. The AAC option available (i.e., MS, PE, or SGD) was counterbalanced across sessions to prevent order effects (Kennedy, 2005).

Procedures

Baseline. A tray containing all of the participant’s preferred toy items was placed on the table in view but out of reach for play-requesting trials. The same was done with a tray containing all of the participant’s preferred snack items. The SGD, PE, or MS option (counterbalanced across sessions) was placed on the table. Each session consisted of the instructor giving the instructions outlined in the task analysis summarized in Table I. After approximately 10 s, the instructor moved to the following instruction or, during requesting trials, placed the tray of toys/snacks within reach and allowed Ian to take an item (for Ian)/gave the targeted item (for Hannah). Participants were given approximately 20 s to consume/play with that item. This 10-s fixed-time schedule of reinforcement was provided to facilitate continued motivation to participate in sessions. The instructor ensured that the participant had the opportunity to engage in all 24 targeted responses within each session. Responses involving use of the SGD, PE, and MS were recorded, but had no programmed consequences.

Intervention. Intervention sessions followed the same format as baseline, except correspondence training to ensure symbol discrimination was implemented for requesting trials, and a least-to-most prompting (verbal, model, physical) hierarchy was implemented to ensure participants learned the remaining target behaviors (greetings, answering questions, and etiquette).

Two methods of correspondence training matched to individual characteristics of each child were implemented throughout intervention. For Ian, all items were placed on offer. If he selected a different item to the one he had requested using the SGD, PE, or MS system, the instructor responded by saying: *You requested* (name of item) and prompted him to select the correct item using the least-to-most prompting strategy. After the item corresponding to the request had been played with/consumed, it was not replaced to ensure Ian learned to request each of the items on offer.

Hannah 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 instructor. If Hannah selected a different symbol or made a different sign to the one being offered, the instructor 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. The order of offering items to Hannah was randomly determined across sessions. These methods of correspondence training were utilized to ensure both participants would learn to discriminate between symbols and have an opportunity to request each of their preferred items within a session.

Immediately after a correct or prompted SGD, PE, or MS requesting response, the participant was given access to the requested item with simultaneous social reinforcement (e.g., *good asking*). The participant was allowed approximately 20 s to consume/play with that item. Although lack of correspondence between item requested and item chosen (Ian)/offered (Hannah) was counted as incorrect, in line with previous research targeting correspondence training (Cannella-Malone, deBar, & Sigafoos, 2009), after participants were prompted to make a correct response, they were given access to the preferred item corresponding to the request. Correct use of the remaining targeted responses resulted in positive social feedback from the instructor (e.g., *good manners*). After this, the next instruction was initiated until all 24 opportunities for responding had been made. Any non-targeted responses made during the MS, SGD or PE sessions (e.g., using a manual sign in a PE session) were ignored so as to bring the use of each device under stimulus control.

Procedural modifications. Hannah made little progress beyond selecting the photos of the actual items to be requested with each communication option during the initial intervention sessions, consequently her teaching procedures were modified in an effort to simplify the task. It appeared that Hannah had difficulty in discriminating between the abstract symbols that were used in the three conditions to represent greetings, questions,
and etiquette. Accordingly, after Session 17, her targeted responses were reduced to making a two-step request for snack and play items (e.g., producing vocabulary and I WANT and CHOCOLATE). The aim was to focus on teaching just one abstract symbol (for I WANT). Because Hannah’s follow-up results decreased substantially after intervention finished, we decided to implement a second booster intervention in the hope of increasing her performance.

AAC preference assessments. These assessments were undertaken after each baseline, intervention, and follow-up session to determine if Ian’s preference for using a SGD and Hannah’s preference for using PE (as assessed in van der Meer, Sutherland et al., 2012) had remained stable. During these assessments, the SGD, PE, and MS (represented by a laminated card with line drawings of the hand formations needed to make the signs) options were randomly placed on the table and the instructor asked: Which communication option would you like to use? Participants were allowed approximately 10 s to select one of the options. Selecting was defined as pointing to, touching, holding, and/or manipulating the device. The instructor presented one requesting opportunity with the chosen AAC option 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.

Follow-up. During the interval before follow-up, participants did not use any of the communication options. Procedures for follow-up were identical to the intervention phase, except no prompting occurred and the participants only received access to preferred items, contingent on independent correct requesting. An AAC preference assessment was implemented after each follow-up session.

Nine follow-up sessions (three for each communication option) occurred 3 and 6 weeks after the last intervention session for each child. Follow-up commenced at Session 34 for Ian and at Session 40 for Hannah (see Figure 1). Ian also received follow-up sessions with the iPod to assess whether his ability to use the iPod would generalize to the iPad, and whether the larger-sized icons and increased sensitivity of the screen on the iPad would make it easier for Ian to activate the SGD.

Interobserver Agreement

Instructors collected data on the presence or absence of a correct communicative response on a trial-by-trial basis and on which communication option was selected during the AAC preference assessments. To assess the reliability of the instructors’ data collection, an independent observer simultaneously and independently collected the same type of data. For each session and child, a percentage of agreement between the independent observer and the instructor was calculated using the formula: [Agreements/(Agreements + Disagreements)] \( \times 100 \). For Ian, these agreement checks occurred on 33% of baseline sessions with 100% agreement, 23% of intervention sessions with 93% agreement, and 31% of follow-up sessions with 97% agreement. Checks occurred on 33% of all sessions for Hannah, with 98% agreement for baseline, intervention, and the booster intervention; and 100% agreement for follow-up.

Procedural Integrity

To assess procedural integrity, the independent observer had a checklist of the procedural steps and recorded whether or not the instructor had correctly implemented each procedural step in its proper sequence. As an example, procedural steps for intervention sessions were (a) child sits at table with communication device being used in reach and tray of items visible, but out of reach; (b) instructor gives appropriate instruction; (c) if child makes correct request move the tray within reach and let the child choose an item from the tray, or after approximately 10 seconds, if no request/incorrect request is made, model and if needed use least–most prompting; and (d) repeat steps (a)–(c) until five offers have been made for toys. If a child does not want a snack finish the session. Otherwise repeat steps (a)–(c) until three offers have been made for food. Procedural steps for device preference assessments during intervention were (a) place SGD, PE, and MS options on far side of table in random order; (b) Instructor asks: “Which communication option would you like to use?” (c) Instructor initiates one requesting opportunity with the selected communication device; prompt requesting if needed; and (d) if the child does not select a communication device within approximately 10 seconds finish the session.

For Ian, procedural integrity was assessed on 33% of baseline sessions with 90% correct implementation, 23% of intervention sessions with 97% correct implementation, and 31% of follow-up with 99% correct implementation. A second independent observer collected inter-observer agreement data on 14% of these procedural integrity checks, with 100% agreement. For Hannah, procedural integrity was assessed on 33% of all sessions, with 100% correct implementation for each phase of the study (baseline, intervention, follow-up, and booster intervention). Inter-observer agreement data were collected on 28% of these procedural integrity checks, with 100% agreement.

Results

Figures 1 and 2 show the percentage of correct responses across communicative categories (specific requests, greetings, answering questions, and etiquette) during each session for each of the AAC options for Ian and Hannah. Table II breaks down the children’s responses into five categories for Ian and shows the percentage of correct responses for these communicative categories for each AAC option across every phase of the study.
Figure 1. Percentage of correct communicative responses for each AAC option (SGD iPod, SGD iPad, PE, and MS) across sessions for Ian.

Table III breaks down responses into two categories for Hannah and shows the percentage of correct responses for these communicative categories for each AAC option across every phase of the study. Figure 3 provides a summary of the results from the AAC preference assessments conducted during each phase of the study.

In baseline, both participants failed to show mastery with the AAC systems to request a specific item, a skill they had previously learned in the van der Meer, Sutherland et al. (2012) study. Their performances on this skill were variable, and Hannah demonstrated the skill at low rates. Correct use of AAC systems for all other communicative responses was not evident for either of the participants (See Tables II and III). With the introduction of intervention, Ian learned to use each AAC system with comparable ease and speed. Hannah’s acquisition, on the other hand, was slower for each AAC system, but percentage of correct responses was consistently higher for PE. While Ian reached criterion for each AAC system and maintained correct use at high levels (except for a drop in the second follow-up session for the iPod-based SGD), Hannah did not reach criterion for any AAC system, and correct use of SGD, PE, and MS dropped in follow-up.

**Ian**

With the introduction of the first intervention session, Ian’s performance for PE increased marginally, from 29% correct in baseline to 38% in the first interven-
Questions 0% 0% 0% 17% 50% 40% 0% 100% 33%  
Item 38% 88% 38% 86% 97% 63% 83% 100% 75%  
Want 0% 0% 0% 53% 67% 65% 71% 100% 100%  
Greetings 50% 0% 0% 67% 63% 55% 71% 100% 67%  

Table II. Percentage of Correct Responses for Each Communicative Category for Baseline, Intervention, and Follow-up across SGD, PE, and MS for Ian.

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>Intervention</th>
<th>Follow-up</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>SGD</td>
<td>PE</td>
<td>MS</td>
</tr>
<tr>
<td>Greetings</td>
<td>50%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Want</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Item</td>
<td>38%</td>
<td>38%</td>
<td>38%</td>
</tr>
<tr>
<td>Questions</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>Etiquette</td>
<td>0%</td>
<td>0%</td>
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During follow-up, Ian’s correct responding increased to 75% correct and continued to increase steadily until he reached the acquisition criterion on his 6th PE training session. During follow-up, Ian’s communicative responding for PE increased to 100% correct across all three PE sessions. For MS, correct responding immediately increased to 83% in the first intervention session, from 13% in baseline. Subsequently, MS performance dropped and was variable (42% to 67%) until Ian reached acquisition criterion for MS on his 9th MS training session. In follow-up, he maintained correct MS-based communicative responding at high levels (79–92%). Correct use of SGD was also variable with introduction of intervention, ranging between 38% and 83% until Ian reached acquisition criterion on his 12th SGD training session. During follow-up, his iPod-based SGD responding ranged between 50% and 83% correct (Figure 1).

When intervention was introduced to teach the two-step requesting response for snack and play items (e.g., “I want a pretzel”), Ian showed a steady increase in correct responses, which was consistently higher than other communicative categories (greetings, questions, etiquette) for each AAC option (Table II). Across communicative categories, performance was variable between each AAC system, although slightly higher for PE. MS- and SGD-based communicative responding overlapped with one another, with better results for MS in the three sessions leading up to acquisition criterion for each system. Follow-up results clearly indicated better performance for PE and iPad-based SGD, followed by MS, with the lowest percentage of correct responding for iPod-based SGD (Figure 1).

As established in the van der Meer, Sutherland et al. (2012) study, Ian continued to choose the iPod-based SGD in AAC preference assessments throughout baseline and intervention. He received a total of 45 AAC preference assessments and chose the iPod-based SGD 82% of the time (Figure 3). This was despite acquisition being slightly more rapid, and performance slightly higher for PE and MS. During follow-up, Ian was introduced to the iPad-based SGD, which he chose to use on three out of four opportunities. His accuracy in iPad-based communicative responding was also higher (96% to 100% correct) than iPod-based communicative responding, which never exceeded 88% correct (Figure 1).

**Hannah**

Introduction of training for PE indicated an increase from 8% correct responding in baseline to 33% correct responding in the first intervention session. Performance remained stable at low levels (33–42% correct) until the procedural modification was implemented and correct PE responding increased steadily. Although Hannah did not reach acquisition criterion for PE, she achieved 75% correct responding on three PE intervention sessions. During follow-up, Hannah’s PE-based responding maintained at 56–75% correct. With the re-introduction of the intervention procedures, Hannah’s performance increased to 100% correct responding for PE. Introduction of intervention procedures for SGD resulted in low and stable responding (13–21% correct). With the procedural modification, this steadily increased to 75% correct responding in her last intervention session, but she did not reach acquisition criterion. SGD-based responding dropped to 25–44% correct in follow-up, though results indicated an upward trend. With the re-introduction of the intervention procedures, Hannah’s performance increased to 56% correct for SGD. When intervention was introduced, little improvement from baseline was evident for MS. After two sessions with procedural modifications in place Hannah’s performance for MS began to increase steadily (up to 63% correct). However, she did not reach acquisition criterion. SGD-based responding dropped to between 19% and 25% correct responding in follow-up, but indicated an upward trend. With re-introduction of the intervention, Hannah’s performance increased to 56% correct for MS (Figure 2).

With procedural modifications, Hannah produced two-step requests for snack and play items (e.g., *I WANT – CHOCOLATE*) to varying levels of proficiency with each AAC option as shown in Table III. PE-based responding was consistently higher than SGD- and MS-based responding, which overlapped with each other throughout intervention. During follow-up a clear divide in performance across AAC systems was evident, with highest correct responding for PE, followed by

<table>
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<th>Baseline</th>
<th>Intervention</th>
<th>Follow-up</th>
<th>Intervention 2</th>
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<tr>
<td></td>
<td>SGD</td>
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<td>MS</td>
<td>SGD</td>
</tr>
<tr>
<td>Want</td>
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<td>0%</td>
<td>0%</td>
<td>9%</td>
</tr>
<tr>
<td>Item</td>
<td>31%</td>
<td>50%</td>
<td>13%</td>
<td>68%</td>
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SGD, and then low levels of correct responding with MS (Figure 2).

In line with the van der Meer, Sutherland et al. (2012) study, Hannah’s preference for PE was maintained, that is, she received a total of 57 AAC preference assessments and chose the PE option 72% of the time as indicated in Figure 3. Indication of preference for PE also reflects Hannah’s better results with PE than with the other communication systems. However, in follow-up, she chose the iPad-based SGD on six out of nine occasions (see Figure 3), despite using it with less proficiency than PE.

Discussion

Procedures previously used to teach these two children a beginning requesting response using MS, PE, and SGD options (van der Meer, Sutherland et al., 2012) were applied to teach a set of new and more advanced communication skills. In relation to our first research question, results suggest the procedures were moderately successful in teaching two-step requesting for both participants, as well as three-step requesting and the more social communication skills of (a) initiating greetings, (b) answering questions, and (c) using etiquette for one of the participants. The study extends previous research (van der Meer, Didden et al., 2012; van der Meer, Kagohara et al., 2012; van der Meer, Sutherland et al., 2012) by demonstrating an approach that was successful for one participant in expanding the communicative forms and functions that can be expressed with MS, PE, and SGD. In answer to our second research question, the study also supports and extends previous research by showing that the children’s preferences for the three AAC options were consistent with that shown during their previous initial intervention. In other words, Ian’s preference for the SGD and Hannah’s preference for PE were the same as shown in the van der Meer, Sutherland et al. study. This is an important finding because it suggests that a child’s preference for using an AAC option remains stable even when they are taught new and more advanced/social communication forms and functions.

Assessing children’s preferences for different AAC options might be important with respect to the issue of inappropriate AAC device abandonment, which appears to be a common problem in the AAC field (Johnson et al., 2006). Logically, one might expect that preferred AAC options would be less likely to be abandoned. Thus, assessment of preference for different AAC options, along the lines of the present study, may be an alternative to an approach in which clinicians select an AAC option that seems suited to the child (e.g., easiest for the child to learn), but might not be preferred by the child and/or other stakeholders.

Along these lines, and connected to the final research question, preference for one of the AAC options did not seem to correspond with the child’s proficiency in learning to use that system. Despite Ian’s slower rate in learning to use the iPod-based SGD for more advanced communicative skills, he maintained his preference for using this AAC option. This was in contrast to our predictions based on findings of the previous three studies (van der Meer, Didden et al., 2012; van der Meer, Kagohara et al., 2012; van der Meer, Sutherland et al.,

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resent on each AAC option and therefore may be more abstract concepts that are more difficult to represent communication. For example, Ian’s correct communicative responding increased substantially and his preference also switched to the iPad-based SGD. This preference might have been due to a novelty effect. On the other hand, it might reflect a preference for using high-technology communication options, especially those with a large screen.

Similarly, results from van der Meer, Sutherland et al. (2012) indicated that initially Hannah appeared to demonstrate a preference for the iPad-based SGD, based perhaps upon the instant appeal of the device. However, with intervention, her preference switched to PE, the AAC option that she was most proficient at using. In the present study, this preference for PE was maintained throughout baseline and intervention. However, at follow-up she chose the iPad-based SGD more often than PE and she also chose it on several occasions in the second intervention phase. This switch in preference might be a novelty effect, in that after a break from using these AAC options, the iPad was initially appealing, but in the end Hannah returned to using the PE option with which she was most proficient.

Children with ASD may be more motivated to learn when highly reinforcing stimuli are used (Drasgow, Sigafoos, Halle, & Martin, 2009; Lovas, 2003). When considering children with ASD, who seem to have impaired reciprocal social interaction (American Psychiatric Association, 2000), the motivation for requesting-based communication could be predicted to be higher than the motivation for learning more socially-oriented forms of communication, such as greeting people and answering questions (Kagohara et al., 2012). These social forms of communication also seem to involve more abstract concepts that are more difficult to represent on each AAC option and therefore may be more difficult to teach.

Indeed, both of the participants in this study seemed to be more motivated to request preferred items than to engage in social communication. For example, Ian consistently performed better when requesting specific items with each AAC option throughout each phase of the study than he did when opportunities for more social communication were created (i.e., greetings, answering questions, and etiquette). Hannah also seemed to have struggled to learn these more social communication responses, perhaps because of less motivation, the more abstract nature of the responses, or the complexity of the task. When complexity (communicative demands) was reduced, her performance improved. Nevertheless, her requesting performance with the SGD was lower than it was for the PE option, despite the fact that the exact same symbol was used. One explanation for this finding is that Hannah needed to place the symbols on a separate sentence strip when using the PE option, whereas the SGD option involved touching the target symbol to enable voice-output. In addition, it was possible to see all of the symbols at once with the PE system but not with the SGD, whose symbols could be seen only by scrolling through the screen pages. This may have made the SGD more difficult for Hannah to use than the PE option. While it is crucial to develop equivalence between each AAC system (Schlosser, 2003), in order to compare the relative efficacy of two or more communication systems, inherent differences in response demands of MS versus PE and SGD (e.g., hand formations to produce a sign, versus pointing to a screen icon for SGD or handing over a graphic symbol for PE) may have influenced the results in terms of both intervention outcomes and preferences (Ringdahl et al., 2009; Winborn-Kemmerer, Ringdahl, Wacker, & Kitsukawa, 2009). This could explain the results with respect to use of the MS response, for which lower rates of use were observed, and it was also less likely to be chosen as preferred than the SGD and PE.

To ensure that changes in the participant’s AAC-based communication skills were a direct result of the intervention procedures rather than another intervention that took place outside of the study sessions, the children had access to the AAC systems examined here only during the study sessions (e.g., Ian was not given access to the iPod outside of the research sessions). This was a temporary restriction that covered only the period during which the two children were participating in this study. After the study, both participants had unrestricted access to their preferred AAC system and continued to receive AAC intervention. Because both participants had a clear need for AAC, we wanted to make sure that our intervention procedures were, in fact, effective in teaching them to use the AAC systems; therefore, we needed to temporarily restrict access so as to be able to control the potentially confounding variable that would have arisen if the children had access to the AAC systems outside of the study sessions. However, we recognize the ethical issues that are involved, which is why the restriction was temporary and covered in the informed consent statements that were discussed with parents. Anecdotally, restricting access to the AAC systems did not appear to have any negative effects on either of the participants (other than the typical communication breakdowns observed prior to the beginning of the research study), with both making effective use of their preferred AAC intervention when access to it was unrestricted after completing the data collection for the present study.
Limitations and Future Research

The study is limited by the relatively brief baseline phase for Ian and the need for the intervention procedures to be modified for Hannah, which compromised experimental control. Nevertheless, although Ian received only one baseline session for each communication option, each session consisted of multiple trials (24), thereby providing considerable data to establish consistently low performance across trials in baseline (apart from those incorporating the existing communicative skill previously taught in van der Meer, Sutherland et al., 2012) and justification for intervention to be implemented for each AAC system. Hannah was kept in baseline for longer periods of time (two baseline sessions for each AAC system). Furthermore, for Hannah, the modified intervention appeared to have been effective. An additional potential limitation was the use of different types of graphic symbols (photos, sign images, and line drawings) across the three AAC systems to represent target responses. Lack of functional equivalence between the AAC systems may have negatively influenced intervention outcomes (Schlosser, 2003). Interestingly, although PE graphic symbols were randomly allocated to the card across trials, making it potentially more difficult to discriminate between the symbols than was the case with SGD and MS (where the symbols were held constant in alphabetical order), the PE results were actually higher for both participants.

Although the highly structured procedures utilized in the present study were necessary for accurate data collection, they present a further possible limitation. It could be argued that prompting/cueing participants for every interaction is contradictory to the way in which children naturally learn language and did not account for changes in participants' preferences. However, the fact that participants played with/consumed the requested items throughout each phase of the study, even if they had to be prompted to make the correct request, was considered to be evidence that the items were still preferred and that changes in motivation/satiation had not occurred. In addition, the method of correspondence training implemented in this study has been demonstrated in previous research as successful in teaching participants to discriminate between symbols and correctly request items using AAC (Cannella-Malone et al., 2009; Sigafoos, Ganz, O’Reilly, Lancioni, & Schlosser, 2007; Yamamoto & Mochizuki, 1988). Cannella-Malone and colleagues also argued that this approach is consistent with the way in which picture exchange would be used in everyday contexts, where the child is expected to give a communication partner a picture and the communication partner then gives the child the corresponding real item.

Due to the way in which data had to be collected, communication skills targeted in the present study were limited because the only part of the communicative interaction that the child generated (and thereby changed the meaning of the utterance) was the single symbol for the desired item. Future research could examine ways in which the use of such structured procedures might allow for more complex and spontaneous communication in AAC interventions or whether a more naturalistic approach is better suited to achieving this outcome. Research might also assess the extent to which the communicative acts taught in the current study would generalize to more naturalistic contexts and other functional situations. For example, it would be important to evaluate whether children who have been taught in situations similar to the present context would generalize their use of these skills to less structured contexts and other environments.

Furthermore, although implementation of procedures by two different instructors, which involved different procedures for correspondence training in different settings, could be viewed as increasing generalizability of the findings, these differences may also explain variance in the intervention outcomes. Even so, the variance between the participants in the present study is more likely to be explained by Hannah’s lower adaptive functioning compared to Ian’s. However, future research might investigate whether trainer experience/ability, specific methods of correspondence training, and learning AAC skills at home versus school, has an impact on intervention outcomes.

The study would have been strengthened by assessing parents’ and teachers’ perceptions of each AAC option, the target behaviors, and the outcomes. Social validation of the practicality and utility of the preference assessment is an obvious area for future research. It would be particularly interesting to assess whether parent and teacher preferences for the different AAC options matched that of the child and if not, how this could be resolved. Social validity data might aid in the difficult decision of selecting a suitable AAC system for individuals with ASD.

Notes

1. Apple iPod/iPad is a registered trademark of the Apple Corporation, Cupertino, California, USA: www.apple.com.
2. Proloquo2Go is a registered trademark of AssistiveWare B.V., Amsterdam the Netherlands: www.assistiveware.com.
3. iMainGo2 is a registered trademark of Portable Sound Laboratories, LLC, LTD, Van Nuys California, www.portablesoundlabs.com.

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