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Speech-generating devices versus manual signing for children with developmental disabilities

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ABSTRACT

We compared speed of acquisition and preference for using a speech-generating device (SGD) versus manual signing (MS) as augmentative and alternative communication (AAC) options. Four children with developmental disabilities (DD), aged 5–10 years, were taught to request preferred objects using an iPod®-based SGD and MS. Intervention was introduced in a multiple-probe across participants design and SGD and MS conditions were compared in an alternating treatments design. A systematic choice-making paradigm was implemented to determine if the children showed a preference for using SGD or MS. All participants showed increased use of SGD when intervention was introduced, but only three learned under the MS condition. Three participants exhibited a preference for the SGD while the remaining participant demonstrated a preference for using MS. Results support previous studies showing that individuals with DD often show a preference for different AAC options and extend previous data by suggesting that acquisition and maintenance was better for the preferred option.

1. Introduction

Children with developmental disabilities (DD) often fail to develop the ability to speak (National Research Council, 2001; Peeters & Gillberg, 1999) and therefore need intervention to establish augmentative and alternative communication (AAC; Beukelman & Mirenda, 2005; Schlosser, 2003a). Various AAC options have been developed, including unaided approaches, such as gestures and manual signing (MS); and aided systems, which involve the use of external equipment to enable the individual to communicate. Examples of aided AAC include low-tech communication boards (Sigafoos & Iacono, 1993), the Picture Exchange Communication System (PECS; Bondy & Frost, 2001), and speech-generating devices (SGDs; Lancioni et al., 2007).

Two recent reviews, summarizing 58 studies, provide empirical support for the use of SGDs in communication interventions for individuals with DD (Rispoli, Franco, van der Meer, Lang, & Carmargo, 2010; van der Meer & Rispoli, 2010). Results from these reviews support a conclusion that individuals with DD can learn to use a range of SGDs for functional communication. Similarly, several systematic reviews of the literature (e.g., Goldstein, 2002; Schlosser & Wendt, 2008a,b;

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Wendt, 2009) pertaining to the use of MS provide results from more than 20 studies demonstrating that MS use can also be taught to individuals with DD.

Despite this supporting evidence, there is considerable debate within the literature regarding which of the various aided and unaided AAC options is best suited to individuals with DD (Mirenda, 2003; Schlosser & Blischak, 2001). There does not appear to be one AAC system that is appropriate for all beginning communicators (Sigafoos, Drasgow, & Schlosser, 2003). For example, studies comparing the acquisition of different AAC options have revealed few major or consistent differences in terms of acquisition for PECS and MS (Adkins & Axelrod, 2001; Gregory, DeLeon, & Richman, 2009; Rotholz, Berkowitz, & Burberry, 1989; Tincani, 2004), as well as PECS and SGDs (Beck, Stoner, Bock, & Parton, 2008; Bock, Stoner, Beck, Hanley, & Prochnow, 2005). However, few studies have compared SGDs and MS (Iacono & Duncum, 1995; Iacono, Mirenda, & Beukelman, 1993; Sigafoos & Drasgow, 2001).

The lack of any major difference in these studies suggests that how quickly an individual acquires an AAC option may not be the most critical variable to examine when considering which AAC option to implement. Because individuals with DD are a heterogeneous group, general statements about successful or unsuccessful interventions could be seen as providing relatively less guidance when selecting an AAC approach for a specific person. Selecting a suitable AAC system for an individual can therefore be a difficult process that is more likely to depend on specific task demands and individual characteristics (Sigafoos et al., 2003; Ringdahl et al., 2009; Wendt, 2009). For example, an individual's preference for using one AAC option over another may be an important variable to consider when selecting an appropriate AAC system. Giving students the opportunity to self-select their most preferred AAC option could also be viewed as one way of promoting self-determination in AAC interventions (Sigafoos, 2006), and might significantly influence progress in learning to communicate.

Indeed, several studies have assessed personal preferences between AAC devices in communication interventions for individuals with DD (Cannella-Malone, DeBar, & Sigafoos, 2009; Sigafoos, Green, et al., 2009; Sigafoos, O'Reilly, Ganz, Lancioni, & Schlosser, 2005; Son, Sigafoos, O'Reilly, & Lancioni, 2006; Soto, Belfiore, Schlosser, & Haynes, 1993; Winborn-Kemmerer, Ringdahl, Wacker, & Kitsukawa, 2009). These studies implemented a structured choice-making arrangement (e.g., Sigafoos, 1998) to identify a participant's preference for one mode of communication over another. The general approach used in these studies was to teach individuals to use two different AAC options for functional communication (e.g., requesting to play with a toy). The next step was to give the individual an opportunity to choose which AAC option (SGD versus PECS) to use. When one option was consistently chosen over another, it was considered to be the participant's preferred mode of communication.

Evidence from a systematic review of the literature (van der Meer, Sigafoos, O'Reilly, & Lancioni, 2011) pertaining to these studies indicated that, although individuals with DD did often demonstrate a preference for one AAC device over another, these studies were limited in a number of ways. Specifically, the choice-making preference assessments were post hoc in that they were undertaken only after learning to use each communication option. Also, only one of these studies (Soto et al., 1993) assessed the influence of preference on maintenance of communication skills. It therefore remains unclear whether preference can be identified during and incorporated into the beginning stages of AAC intervention and whether utilizing a learner's preferred AAC option might actually improve intervention outcomes in terms of maintenance of newly acquired communication skills.

In six of the seven studies synthesized by van der Meer, Sigafoos, et al. (2011), just two AAC options (PECS and SGD) were compared. Only one study (Iacono & Duncum, 1995) compared the use of MS and a SGD. In this latter study, however, instead of implementing a choice-making arrangement, the most effective treatment modality was considered to be participant's preferred AAC option. This may be due to some of the apparent difficulties in assessing preferences between aided and unaided AAC. Sigafoos et al. (2005) explained that it is probably more complex to assess preference for using MS versus a SGD, for example, because it would seem more difficult to present the MS option as concretely as one can present a SGD or a PECS board. They therefore suggested teaching the use of MS in the presence of one distinctive stimulus and the use of SGD in the presence of another distinctive stimulus. A choice condition could then be arranged by presenting both of these distinctive stimuli.

The present study aimed to employ such a procedure in order to assess preference for aided (SGD) versus unaided (MS) modes of AAC. Previous research highlighted the importance of utilizing more sophisticated AAC devices that allow for individuals to expand on their communication capabilities (Cannella-Malone et al., 2009), yet remain cost effective (Sigafoos et al., 2005). Therefore the present study used a new, empirically validated (Kagohara et al., 2010; van der Meer, Kagohara, et al., 2011), software application known as Proloquo2Go™ (Sennott & Bowker, 2009) run on an iPod®-based SGD, as well as signs from the Makaton (Makaton New Zealand/Aotearoa, 1998–1999) sign language vocabulary. In comparing preferences for this iPod®-based SGD versus MS, the current study also aimed to address some of the aforementioned limitations of AAC device preference studies. Specifically, we aimed to determine whether the participants made greater progress, showed increased communication ability, and showed better maintenance of the AAC system for which they showed a preference. It was hypothesized that acquisition and maintenance of the two AAC options would be better for the AAC option that the participants also showed a preference for using.

2. Method

2.1. Participants

Four children were recruited from a special education unit in a public school. All four participants met the following criteria: (a) diagnosis of intellectual/developmental disability or ASD, (b) school aged children of less than 18 years of age,

(c) very limited or no communication skills determined by an age level of 2.5 years or less in the Expressive Communication Domain of the Vineland Adaptive Behavior Scales (Vineland-II; 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 the AAC communication system, determined by an age level of 1.0 year or more on the Fine Motor Skills Domain of the Vineland-II.

David was a 10-year-old male diagnosed with ASD. On the communication sub-domain of the Vineland-II (Sparrow et al., 2005), David received age equivalencies of 3:11 (years:months) for receptive communication, 1:1 for expressive communication, and 4:3 for written communication. David did not have any spoken language. At the time of the study he was using the Informative Pointing Method (Iversen, 2007), with assistance, as a form of communication. David had limited experience with Makaton Keyword Signing and PECS for expressive and receptive language prior to the current intervention. In addition to his severe communication impairment, David had limited social skills and engaged in frequent problem behavior, including self-injurious behavior.

Tom was a 5.5-year-old boy diagnosed with Multi-System Developmental Disorder (MSDD) with autistic-like behaviors (e.g., impairment in reciprocal social communication, stereotyped and repetitive behaviors). His age equivalencies on the communication domain of the Vineland-II (Sparrow et al., 2005) were 0:11, 1:0, and 2:5 for receptive, expressive, and written communication. Tom was able to use a few single words to make requests and comment on his environment, but he rarely spoke unless he was prompted by an adult. Prior to the current intervention Tom had been introduced to Makaton Keyword Signing and PECS for receptive and expressive language, with limited success.

Zac was a 7-year-old male diagnosed with Down syndrome and ASD. He received age equivalencies of 1:3, 2:1, and 4:10 on the receptive, expressive, and written communication domains of the Vineland-II (Sparrow et al., 2005). Prior to intervention Zac used Makaton Keyword Signing and PECS for expressive and receptive language. During the current intervention Zac received a GoTalk 2.0® SGD, which his teachers started to use with him. Although Zac attempted to speak frequently, his speech was largely unintelligible.

Eli was a 5.5-year-old male with Congenital Myotonic Dystrophy and autistic-like behaviors (e.g., impairment in reciprocal social communication, stereotyped and repetitive behaviors). His age equivalencies were 0:11, 0:8, and 2:5 on the receptive, expressive, and written communication domains of the Vineland-II (Sparrow et al., 2005). Eli did not have any spoken language. He was introduced to Makaton Keyword Signing for receptive and expressive language prior to the current intervention. He could use the signs for MORE and EAT. Aside from this, Eli made few communicative attempts. He engaged in frequent stereotypic (self-stimulatory) behavior and was said to often fixate on certain objects, such as computers.

2.2. Setting and intervention context

All four participants attended the same classroom at a special education unit for children with disabilities that was part of a public primary school. Fourteen additional children were educated in this classroom by two teachers and six teaching assistants. The procedures related to this study were conducted at a table in a small room that linked to the main classroom during a morning snack/leisure activity. The procedures were implemented in a one-to-one context consisting of the trainer (trained graduate assistant) and one participant at a time.

2.3. 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 by a systematic two-stage stimulus assessment (Green et al., 2008). Stage 1 involved an indirect assessment in which both teachers were asked to list snack foods, sensory stimuli, and toys that the participants appeared to enjoy and would be appropriate for the classroom. Three to six of the most preferred food and play stimuli were then selected for a direct stimulus assessment. The direct method for assessing preferences involved the simultaneous presentation of multiple items, without replacement (DeLeon & Iwata, 1996; Duker, Didden, & Sigafoos, 2004). Each participant was presented with an array of preferred items (random placement) and allowed to select one. Items were not replaced once they had been selected, thereby eliminating the chance of the participant choosing only one or a few items, as well as allowing the trainer to develop a rank order of items in terms of preference. Play and food items were assessed separately. The top two to four food and play items were identified by calculating the percentage of times that the stimulus was selected, out of six trials (across four sessions) in which each stimuli were offered.

Preferred stimuli for David included a venting ball (46%), dental floss (43%), and water play (represented by a container filled with water and plastic toys; 29%) for toy items; fruit-leather (66%), M&Ms (40%), and chocolate and gherkins (33% each) for snack items. Preferred stimuli for Tom included toy cars (100%), bubbles (42%), and building blocks (35%) and a lollipop (86%), muesli bar (42%), and crackers (22%). Preferred stimuli for Zac included an alphabet musical toy (55%), a Hi5 CD (40%), and playing on the computer (30%) and juice (50%) and chips (20%). Preferred items for Eli were bubbles (67%), paper (43%), and an alphabet musical toy (38%) and peppermints (75%), chips (46%), and juice (31%). All participants, excluding Zac (his parents indicated a preference for teaching play items, not snacks), received baseline with both the preferred snack and play options. David initially received training to request both snack and play items. However, due to time constraints it was decided that David would be taught to request snacks only (at Session 8 of Fig. 1), while Tom, Zac, and Eli were taught to request toys only. Snacks for David and toys for the other children were identified as the more preferred options in the direct stimulus assessment.

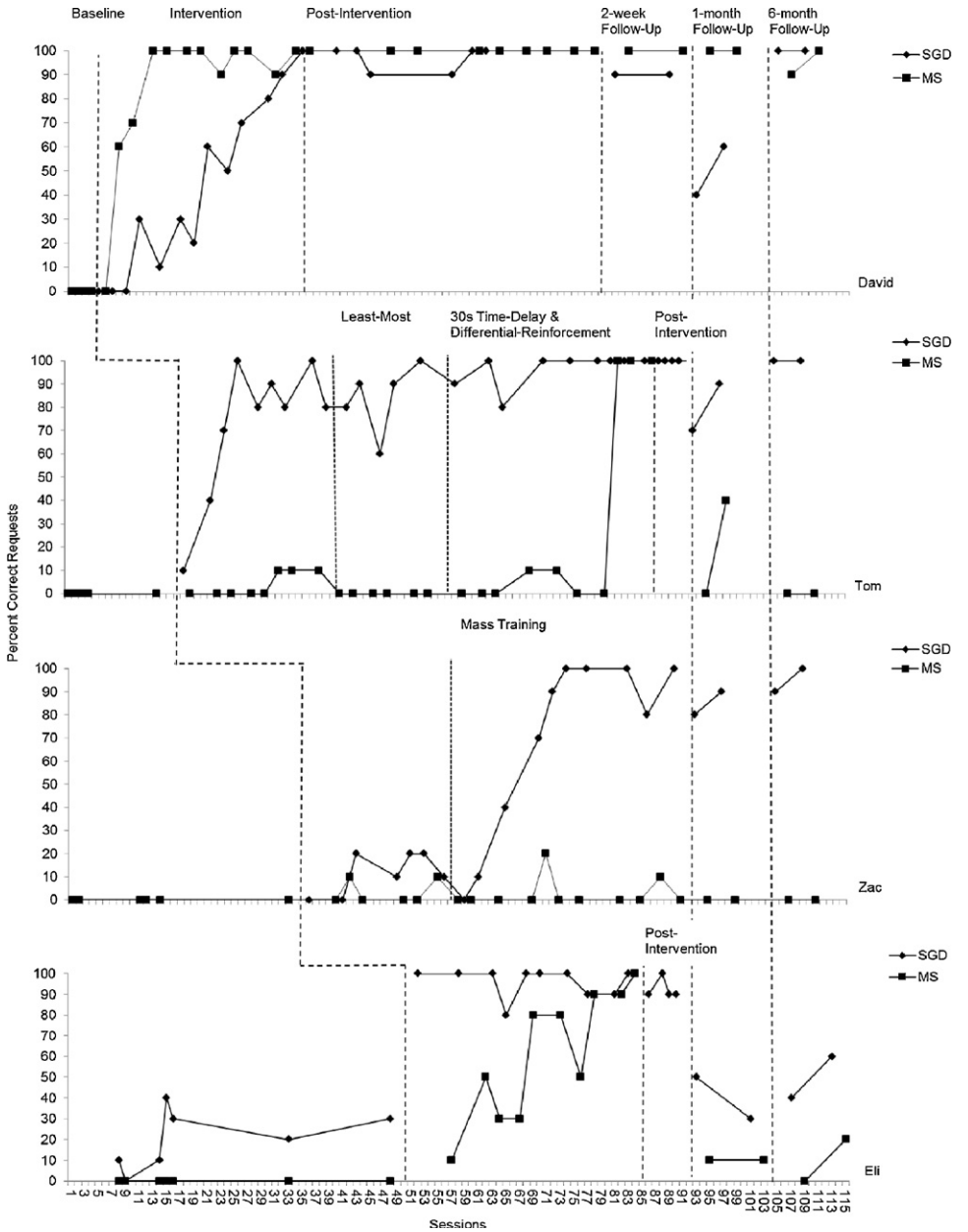

Fig. 1. Percentage of correct requests using the SGD and MS options across sessions for each participant.

2.4. Speech-generating device

Participants were taught to request their preferred toys or snacks using an Apple iPod Touch® with Proloquo2Go™ software. The iPod® was placed inside an iMainGo2® speaker case to increase sound amplification. The iPod® was configured to show a single page containing three (2.5 cm × 2.5 cm) graphic symbols, representing requests for *SNACKS*, *PLAY*, and *SOCIAL INTERACTION*. Touching each symbol activated corresponding synthetic speech-output (i.e., "*I want a snack please.*", "*I want to play.*", and "*How are you?*").

2.5. Manual signing

Participants were also taught to request preferred stimuli using manual signs from the Makaton Sign Language system (Makaton New Zealand/Aotearoa, 1998–1999). Participants were taught the signs for SNACK or PLAY. The MS option was represented by a laminated photo (16 cm × 11 cm) of the trainer making the hand formations for the signs for SNACK and PLAY.

2.6. 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 a desired item from the trainer. MS was defined as independent (without a gestural or verbal prompt) hand gestures to produce correct signs in exchange for a desired item from the trainer. The frequency of correct responding was calculated for each session consisting of 10 offers of snack or play items. The target response for David was touching the *SNACK* symbol on the SGD to activate the message "*I want a snack please.*". The *PLAY* and *SOCIAL INTERACTION* symbols were distracters. David's target response for MS was to produce the sign for SNACK. The PLAY sign (on the laminated card) was a distractor. The target response for Tom, Zac, and Eli was touching the *PLAY* symbol on the SGD to activate the message "*I want to play.*". The *SNACK* and *SOCIAL INTERACTION* symbols were distracters. The MS target response for Tom, Zac, and Eli was to produce the sign for PLAY. The SNACK sign (on the laminated card) was a distractor.

2.7. Experimental design

The study included the following phases arranged in a multiple-probe across participants design (Kennedy, 2005): Baseline, Intervention, Preference Assessment (throughout Intervention, Post-Intervention, and Follow-Up), Post-Intervention, and Follow-Up. An alternating-treatments design was also embedded within the multiple-probe to compare performance of the SGD and MS options.

2.8. Session schedule

Two to four requesting sessions were conducted three to four days per week. Each session lasted about 5 min and consisted of 10 discrete trials. The AAC option available during a session (i.e., SGD versus MS) was alternated across sessions. Whether training commenced with SGD or MS was random depending on how many sessions were implemented on the previous day of training. For all sessions, the participant and trainer were seated next to each other at a table with one or two additional reliability and procedural integrity observers seated nearby.

2.9. Procedures

Because participants were at the beginning stages of intervention they were taught to request only one type of highly preferred item. However, to ensure some level of symbol discrimination, the distractor symbols/signs were included in the SGD and MS options. If participants requested a snack when they were undertaking training to request a toy or vice versa, the trainer explained *We are learning to request toys/snack at the moment, you can request a toy/snack another time*. Activating the *SOCIAL INTERACTION* symbol on the SGD resulted in a brief spoken reply from the trainer (e.g., *I'm good thanks, how about you?*). It was considered more natural to provide participants with some feedback when they activated these (non-target) symbols/produced these (non-target) signs, but not to reinforce these with preferred tangibles. Similarly, producing MS to request items during SGD sessions was ignored in order to bring the use of each option under stimulus control.

2.9.1. Baseline

During baseline, a tray containing three different snack (toy) items was placed on the table in view, but out of the participants' reach. The SGD was placed on one side of the table in an upright orientation. A photo of the trainer signing was used to present the MS option. The photo was placed on the other side of the table, also in an upright orientation. Each session involved one block of five discrete trials for snacks and one block of five discrete trials for toys, with the order of blocks counterbalanced across sessions. The session began with the trainer telling the participant: *Here is a tray of snacks (toys), let me know if you want something*. After 10 s, the trainer moved the tray within reach and allowed the participant to take one item. This was repeated across 5 discrete trials each for snacks and toys. This 10-s fixed time schedule of reinforcement was provided to ensure continued motivation to participate in sessions. When offering snacks, participants were allowed to select one item from the tray, which was then replenished before the next offer. When offering the tray of toys, participants were allowed to select one toy and play with it for approximately 30 s before it was returned to the tray. SGD and MS responses were recorded, but had no programmed consequences.

2.9.2. Intervention

This phase was conducted in a discrete trial format until participants reached criterion (i.e., 80% correct requesting across 3 consecutive sessions for each AAC option). Either the SGD or the MS option was placed on the table (see *Session Schedule*) in reach of the child in accordance with the alternating treatments design. Each trial consisted of the trainer pointing to a tray of toys (snacks) and saying: *Here's a tray of toys (snacks). Let me know if you want something.* Training involved a 10-s time delay between the verbal cue (i.e., *Let me know if you want something*) and the use of graduated guidance to prompt a correct request. Graduated guidance involved use of the least amount of physical guidance necessary to ensure the child made a correct request, while simultaneously explaining the required response (e.g., *Press PLAY to ask to play with a toy.* or *Move your*

hand to your mouth to make the sign for SNACK.). Immediately after the speech output occurred, or the correct sign was made, the trainer moved the tray containing the toys (or snacks) within reach of the participant. The participant was allowed to select one item from the tray and consume the chosen snack or play with the chosen toy for about 30 s. After this, the next trial was initiated.

2.9.3. Procedural modifications

Because Tom made little progress with acquisition of MS during the initial intervention sessions, his teaching procedures were modified to include 10-s time delay followed by a least-to-most prompting procedure. This involved first tapping Tom's elbow, then lifting his forearm, followed by a full physical prompt if he did not make the sign correctly. However, because progress was not observed with this procedure, a 30-s time delay followed by graduated guidance, as well as differential reinforcement (where Tom was only given the opportunity to play if he independently used the sign to request to play), was introduced. Prompted trials were not reinforced.

Another participant (Zac) did initiate correct requests during the initial intervention sessions, but he appeared to have trouble physically performing the task independently for both MS and the SGD. It was therefore decided to implement massed training trials before each SGD and each MS session. This involved 10 consecutive graduated guidance trials with no time delay and no reinforcement per session to get Zac to perform the task as independently as possible.

2.9.4. AAC preference assessments

These assessments were undertaken to determine if participants would show a preference for using one of the two AAC options. These assessments occurred after every eighth session (i.e., after four MS and four SGD sessions) on average. This number varied slightly because these assessments had to occur before the first session for the day to prevent sequence effects (selecting the AAC option that was taught last; Sigafoos et al., 2005), as well as to ensure that at least two such preference assessments were undertaken during intervention for each participant.

During a preference assessment, the trainer presented the MS option on one side of the table and the SGD option on the other side of the table (alternated across sessions to control for choice being made dependent on location of the AAC option). The trainer asked the participant: *Which communication option would you like to use? Sign language on this side* (while pointing), *or the SGD on this side* (while pointing)*?* The trainer initiated one requesting opportunity with the chosen AAC option before reverting back to initiating requesting opportunities with the AAC device that was being used for that session. Choice for an AAC option was defined as physically pointing to, touching, or picking up the selected communication option. If the child did not choose an option within 10 s, the device preference assessment was terminated and training continued with the AAC option that was scheduled for use in that session.

2.9.5. Post-intervention

Once the participant reached criterion with both the MS and SGD options, post-intervention preference assessments were introduced. These were identical to previously described device 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. A minimum of four of these post-intervention preference assessments were undertaken for each participant.

2.9.6. Follow-up

David received three sets of follow-up sessions, at 2 weeks, 1 month, and 6 months. The remaining participants received two sets of follow-up sessions at 1 month and 6 months. David received four follow-up sessions two weeks after his last post-intervention session. During the two-week interval, David was on midwinter break, did not attend school, and did not use either communication option. All participants received four follow-up sessions one month after their final intervention or post-intervention session. Participants did not use either communication option for requesting preferred items during the one month interval before these follow-up sessions. Six months later, another four follow-up sessions were conducted for all participants. During the interval between the 1 and 6 month follow-up sessions, the participants had access to iPods® and iPads® for educational and leisure activities, but did not use the iPod®-based SGD or MS communication options for requesting preferred items. Procedures for follow-up were identical to the intervention phase, except no teaching occurred and reinforcement was contingent upon a correct request. A device preference assessment was implemented before each session.

2.10. Inter-observer agreement

The trainer collected data on the frequency of correct requesting, the level of prompting required during intervention for each trial, as well as which communication mode was selected during device preference assessments. To assess the reliability of the trainer's data collection, an independent observer also collected data on the frequency of requesting, level of prompting, 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. Reliability of data collection was obtained by the independent observer on 43% of all sessions and ranged from 90% to 100% with an overall mean of 99.6%.

2.11. Procedural integrity

To assess procedural integrity, the independent observer used a checklist of the procedures and recorded whether or not the trainer had correctly implemented each procedural step in its proper sequence. The independent observer assessed procedural integrity during 43% of all sessions, which ranged from 98% to 100% with an overall mean of 99.9%. A second independent observer collected inter-observer agreement data on 21% of these integrity checks with 100% agreement.

3. Results

Fig. 1 shows the percentage of correct requests during each session for both AAC modes across participants. Fig. 2 provides a summary of the results from the AAC preference assessments across each phase of the study. During baseline, participants never used MS to request snacks or toys. They did occasionally touch the MS card, pick it up, or play with it for a few seconds. Eli used the SGD to request toys or snacks on 20% of the baseline trials. It should be noted that many of these requests appeared to be made by chance as Eli repeatedly touched the icons on the SGD representing items (snack or toy) that were not being offered on that trial. Although none of the other participants activated the SGD, they did occasionally touch it, pick it up, or play with it for a few seconds. Also, during baseline, all participants often reached for the tray of snacks or toys before it was offered to them (these responses were blocked). Zac attempted to verbally request certain items from the tray, but this speech was mostly unintelligible. When the tray of snacks or toys was offered, David and Tom selected and consumed or played with items 98% of the time, Zac did so 100% of the time, and Eli did so 94% of the time.

3.1. David

David achieved acquisition of requests for snacks using MS on his 6th MS session (Session 18 of Fig. 1). He achieved acquisition using the SGD on his 13th SGD session (Session 35 of Fig. 1). During intervention, David received four device preference assessments in which he chose MS on each occasion. A second device preference assessment was undertaken for David three sessions after the first to ensure the accuracy of the initial device preference assessment because a correct response had to be prompted. Because the results were consistent, this was not repeated for other participants where a response had to be prompted. During the post-intervention phase David chose MS on 60% of sessions and used it with 100% proficiency during subsequent requesting opportunities. He chose the SGD 40% of the time and correctly used it 90–100% of the time.

During his first set of follow-up sessions, David maintained requesting for snacks using both the SGD and MS at a high level. He chose the MS option on three out of four (75%) preference assessment opportunities and used it with 100% proficiency. While MS maintained at 100% correct requesting during his second set of follow-up sessions (one month after

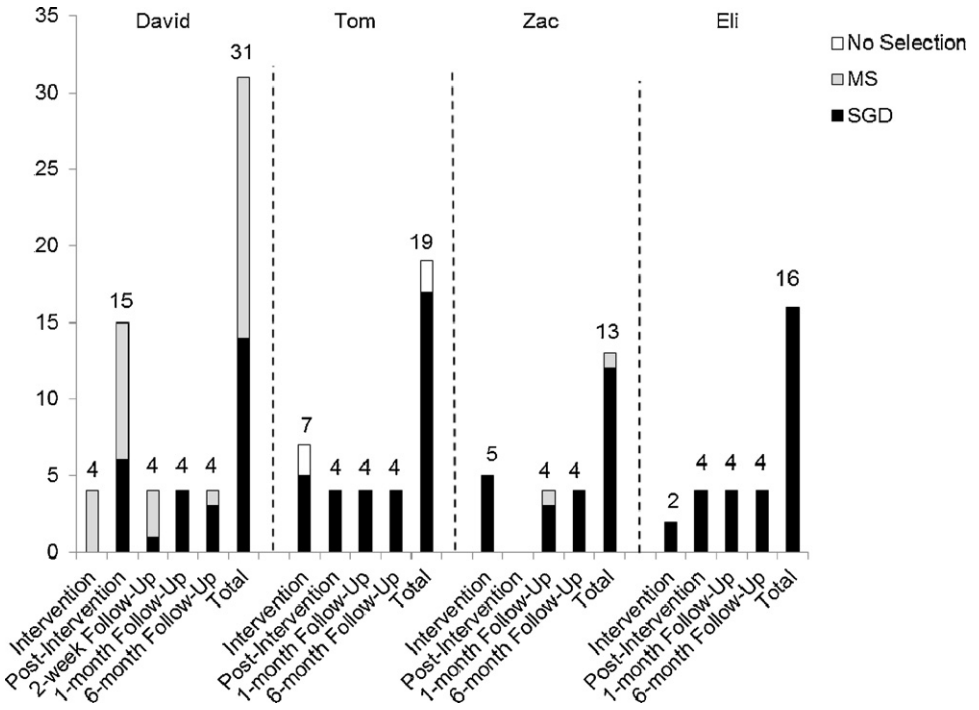

Fig. 2. Results from the device preference assessment probes depicting the number of times each communication option (SGD and MS) was chosen and number of times a device was not chosen (no selection) across each phase of the study for each participant.

the initial follow-up), SGD use dropped to 40–60% correct requesting. Interestingly, David chose the SGD on 100% of the device preference assessments, but on three out of these four occasions he did not make a correct request using the SGD. At the six month follow-up, MS use maintained at 90–100% correct and David demonstrated increased SGD performance with 100% correct requesting. Again, David showed a preference for the SGD, selecting it on 75% (3 out of 4) of opportunities. Overall David received a total of 31 opportunities to choose between the SGD and MS (Fig. 2) and chose MS (55%) on a slightly higher percentage of occasions.

3.2. Tom

Tom achieved acquisition of requests for toys using the SGD on his 6th SGD session (Session 31 of Fig. 1), but he made little progress with MS. On his 9th MS training session (Session 41 of Fig. 1), the least-to-most prompting procedure with a 10-s time delay was implemented during MS sessions. Across all MS sessions, Tom needed all three levels of prompting. By his 15th MS session (Session 59 of Fig. 1), little progress was observed and it appeared that Tom was becoming prompt dependent. Thus the 30-s time delay followed by graduated guidance, as well as differential reinforcement was introduced. Tom had shown slight improvement during initial graduated guidance sessions, but no improvement with least-most prompting; it was therefore thought that reverting back to graduated guidance with a greater time delay and differential reinforcement might increase opportunities for independent responding. With this new prompting procedure, Tom demonstrated 100% correct requesting at his 22nd MS session and achieved the acquisition criterion by his 24th signing session (Session 87 of Fig. 1). Anecdotally, throughout both SGD and MS sessions Tom demonstrated an increase in his spoken language. He often imitated the trainer's words surrounding the play activity and even spontaneously spoke several words and short phrases.

Throughout intervention Tom received seven device preference assessments. He consistently chose the SGD and used it correctly to make a request. On two occasions, however, Tom did not make a choice for MS or SGD. During post-intervention preference assessments Tom received a total of four choice opportunities. He chose the SGD on each occasion and achieved 100% correct requesting with it. Tom maintained a high level of correct requesting using the SGD during the one month follow-up and chose to use it on each device preference assessment. His MS use ranged from 0% to 40% correct. At the six month follow-up, Tom's preference for, and correct use of, the SGD (both 100%) maintained. Correct use of MS dropped completely to 0%. Overall Tom received 19 preference assessments (Fig. 2) and chose the SGD the majority of the time (89%).

3.3. Zac

Zac made little progress to request with either AAC option. With the implementation of mass training trials (Session 57 of Fig. 1), Zac achieved acquisition using the SGD on his 14th SGD session (Session 77 of Fig. 1). He failed to reach acquisition during MS sessions. Throughout intervention Zac received five device preference assessments. He chose the SGD on each of these assessments. Once he was able to use the SGD independently, he was also able to request to play correctly on these preference assessments. Zac did not progress to the post-intervention phase due to his failure to acquire use of the MS option.

Zac maintained a high level (80–90%) of correct requesting with the SGD, but he did not make any correct requests with MS during the one month follow-up. Despite not being able to make a correct request with it, Zac did choose the MS option on one preference assessment opportunity, but chose the SGD on the other three assessments. Zac maintained higher levels of correct requesting (90–100%) and preference (100%) for SGD during the six month follow-up. His MS remained at 0% correct. Overall, Zac received 13 AAC preference assessments (Fig. 2) during which he chose the SGD 92% of the time.

3.4. Eli

Eli achieved acquisition of requests for toys using the SGD on his 3rd SGD session (Session 63 of Fig. 1). However, throughout the SGD intervention sessions he made many errors, repeatedly pressing all three icons (*SNACK, PLAY*, and *SOCIAL INTERACTION*) on the SGD. Eli achieved acquisition for requesting toys using MS on his 10th MS session (Session 84 of Fig. 1). During the intervention phase he received two device preference assessments each time choosing the SGD and using it correctly to request to play with toys. During the post-intervention preference assessments Eli received a total of four choice opportunities and chose the SGD all four times in which he requested at 90–100% proficiency.

Eli's performance dropped for both the SGD (30–50% correct requesting) and MS (10% correct requesting) during the one month follow-up. He chose the SGD on 100% of choice opportunities using it with 100% proficiency on three out of four device preference assessments. As with the other participants, Eli's performance increased during the six month follow-up, with 40–60% correct requesting with the SGD and 0–20% correct requesting with MS. Although he chose the SGD on 100% of opportunities, Eli used it correctly on only one of the four occasions. Overall Eli received 16 opportunities to choose between the SGD and MS option (Fig. 2) during which he always chose the SGD (100%).

4. Discussion

All four participants learned to make augmented requests and demonstrated a preference for using the SGD or MS. Specifically, three (David, Tom, and Eli) of the four boys reached criterion on use of both communication options to request

preferred stimuli. The fourth boy (Zac) reached criterion for SGD use, but did not learn to use MS. Tom, Zac, and Eli demonstrated a preference for using the SGD, while David exhibited a slight preference for using MS. These results support findings from previous research suggesting that students with DD can learn to use various AAC systems for functional communication and will often demonstrate a preference for one communication device over another (van der Meer, Sigafoos, et al., 2011). Moreover, most of the children assessed to date in this and the previous studies reviewed by van der Meer, Sigafoos, et al. showed a preference for using SGDs over PECS (or MS), although it is important to note that studies comparing SGDs and MS are rare. In fact, the present study appears to be the only study to date that has directly compared acquisition of, and preference for, SGDs versus MS.

However, while results from this systematic review of the preference literature (van der Meer, Sigafoos, et al., 2011) and results from other studies comparing acquisition of various modes of AAC (e.g., Bock et al., 2005; Gregory et al., 2009) highlight few differences in terms of how quickly children learn to use each communication system, outcomes from the current investigation indicate differences in terms of how rapidly participants learned to use each AAC option. Specifically, three of the four participants learned to use the SGD (also their preferred communication option) more quickly than MS. A possible explanation for this difference in findings is that the majority of the previous research did not include a comparison between SGD and MS (e.g., Bock et al., 2005; Gregory et al., 2009). Of the few studies (Iacono & Duncum, 1995; Iacono et al., 1993; Sigafoos & Drasgow, 2001) that did compare SGD with MS, the results also showed better performance with the SGD option. Similarly, results from research comparing acquisition of PECS and MS indicate that PECS was learned at a faster rate than MS (Adkins & Axelrod, 2001; Rotholz et al., 1989; Tincani, 2004), but it is argueable whether these differences were clinically significant. In this and previous studies, SGD use could have been acquired faster because it might be more difficult to teach MS use, rather than it being inherently more difficult for children with DD to learn.

The findings of the present study, when considered in light of previously reviewed studies (van der Meer, Sigafoos, et al., 2011), suggest that there may not be one single mode of AAC that is best for children with DD. Thus decisions as to which AAC option to implement might be based upon an assessment of the individual user's unique abilities, needs, and their preferences for different AAC options (Sigafoos & Drasgow, 2001). A key aspect of the current study was the assessment of each child's preference for the two AAC options using a structured choice-making protocol (e.g., Sigafoos, 1998). In previous preference research (Sigafoos et al., 2005; Son et al., 2006; Soto et al., 1993), it has been argued that because participants had equal exposure to and achieved equal proficiency with each communication system prior to implementing the choice assessment, they were able to make an informed choice, and that preference for one device over another was not due to differences in performance. However, by utilising this post hoc approach, it remained unclear when a child's preference for an AAC option might first emerge and why children might prefer one AAC option over another. It was also unclear whether preferences led to improved therapeutic outcomes. By incorporating preference assessments into the initial stages of the intervention, the current study was able to determine when preferences began to emerge and whether preference might have influenced acquisition and maintenance.

Along these lines, our results indicated that for three of the four participants (Tom, Zac, and Eli), preference was evident during the early stages of intervention and appeared to remain stable during the study. For David, however, preference seemed to change as he gained proficiency with each communication option. Specifically, David learned MS rapidly and initially demonstrated a preference for this communication option. However, after learning to use the iPod®-based SGD, he then started to choose this communication option.

The results also suggested that participants were more proficient at using their preferred AAC option or perhaps it should be said that they preferred the option with which they were more proficient. Furthermore, maintenance of newly acquired communication skills was better when participants used their preferred option. These results provide the first empirical evidence to suggest that allowing individuals with DD to determine which communication option they would like to use might positively influence progress in learning to communicate. These findings support the argument by Soto et al. (1993) that AAC acquisition is interconnected with choice-making and preference.

However, similar to the literature pertaining to general choice-making and assessment of preference in individuals with DD (e.g., Stafford, Alberto, Fredrick, Heflin, & Heller, 2002), preference did change over time for one participant (David), verifying the idea that preference should be reassessed at regular intervals. Because preferences can vary it has also been suggested that an individual's preference, or the 'magnitude of preference', for one AAC option over another should be interpreted with caution (van der Meer, Sigafoos, et al., 2011). Van der Meer, Sigafoos, et al. raised the question: "How many choice opportunities are required to demonstrate a preference for one mode of communication over another?" (p. 1429). There is not yet any firm empirical basis for setting the percentage of selections from which an item can be considered preferred. Future research should investigate this issue.

Results from the present study suggest that the choice-making paradigm (e.g., Sigafoos, 1998) utilized in the preference research to date might be effectively extended to assess preferences for aided (SGD) versus unaided (MS) AAC. Prior to this study, it was unknown whether using a photo/diagram of a person signing would be a viable means of representing the MS option. David did select the MS option the majority of the time suggesting that at least one participant did understand that the photo of the trainer signing represented the MS option, enabling him to indicate a preference for an unaided mode of AAC. Future research is required to further investigate the validity of this approach, especially considering it could be argued that the SGD and MS options were not functionally equivalent. While the SGD option included symbols for *SOCIAL INTERACTION*, *SNACK*, and *PLAY*, the MS option only had two photos to represent SNACK and PLAY. Furthermore, in order to compare two conditions on symbol learning, it is crucial to equate the sets of symbol-referent associations for SGD and MS for the degree of

iconicity and for receptive understanding of the referent (Schlosser, 2003b). Linked to this, it has been argued that the response effort required for each communication system may influence preference and intervention outcomes (Ringdahl et al., 2009; Winborn-Kemmerer et al., 2009). Although signing to request to eat/play was considered comparable to using the SGD, this decision was based only upon informal methods of creating equivalency in terms of performance difficulty (Schlosser, 2003b). However, the two systems might not be comparable in terms of cognitive demands. Indeed, it has been argued that graphic symbols of the type used with the SGD are less demanding on working memory because only recognition is needed, whereas the MS option requires the use of recall memory (Iacono et al., 1993). This could be one possible reason why some participants might demonstrate a preference for SGD over MS (Iacono & Duncum, 1995).

A further potential problem of the current study is that a MS response could be emitted during SGD sessions, but not vice versa because the SGD was not available during MS sessions. This could have meant that correct MS responses were put on a more intermittent schedule (correct MS responses resulted in reinforcement only some of the time, while correct SGD responses resulted in reinforcement 100% of the time) relative to correct SGD responses, thereby weakening the teaching contingencies and potentially influencing both preferences and rapidity of acquisition. Despite this possibility, the majority of participants (David, Tom, and Eli) did learn to use both MS and SGD for functional communication suggesting that any disruption from intermittent reinforcement of the MS option was minimal and short-lived. Overall, the results of the intervention phase, showing acquisition of SGD and MS use in most cases, are consistent with previous research (Rispoli et al., 2010; van der Meer & Rispoli, 2010; Wendt, 2009) showing that systematic instructional procedures, including graduated guidance, time delay, and contingent reinforcement procedures, can be effectively applied to teach requesting for preferred stimuli using both unaided and aided AAC (Duker et al., 2004).

While David and Eli demonstrated rapid acquisition of both the SGD and MS, Zac failed to show any progress during intervention for MS and struggled to learn the SGD. Adaptation of the instructional techniques included the introduction of mass training trials. With this procedure in place Zac rapidly learnt to use the SGD, but failed to learn MS. His lack of progress with the MS option did not appear to be a motivational issue in that he did consistently select and play with preferred stimuli. In addition, it did not appear to be due to an inability to physically perform the hand gestures required to make the manual sign because he did independently request to play using MS on a number of occasions. Anecdotally, when Zac was prompted to make the sign for PLAY he also often attempted to verbalize the word *play*. As mentioned earlier, treatment outcomes for learning alternative forms of communication may vary if the new response topography is more demanding than the individual's original form of communication (Winborn-Kemmerer et al., 2009). Perhaps learning the sign for PLAY required significantly more effort for Zac than attempting to verbalize the request.

Adaptations to the instructional procedures, including least-to-most prompting and later an increased time-delay with graduated guidance and differential reinforcement did lead to acquisition of the MS option for Tom. This highlights the importance of not only implementing well established teaching procedures, but also modifying these techniques to suit the needs of each individual (Linscheid, 1999). Results also support preliminary evidence in the instructional literature on teaching the use of a new iPod®-based SGD. Similar to this previous research (Kagohara et al., 2010; van der Meer, Sigafoos, et al., 2011), two of the participants (David and Zac) in the current study did show some initial difficulty in learning to touch the target symbols on the SGD with sufficient finesse to activate speech output. Fortunately, with practice, both David and Zac became proficient with using the iPod®-based SGD.

While using the behavioral strategies described above often leads to rapid acquisition of functional communication, several problems can emerge following acquisition of an initial requesting repertoire (Sigafoos, Ganz, O'Reilly, & Lancioni, 2008). One such problem, which was evident for David and Eli, was the development of preservative requesting, which refers to making repeated requests, even after being informed to wait for the requested item or when the item is not being offered (Sigafoos et al., 2008). David initially used MS repeatedly even during SGD sessions, which Cannella-Malone et al. (2009) suggested could be an indication of preference for a particular AAC device. However, we ignored signing when it was used in an incorrect context and this appeared to be a uselful part of the training program for David because he eventually developed proficiency with the SGD and his preservative signing diminished. He also began to choose the SGD during the device preference assessments. Eli, on the other hand, developed a tendency to repeatedly press the icons on the SGD resulting in constant voice-output. Observations of this behavior suggested that this might have been automatically reinforced by the resulting synthesized speech output.

Because Eli repeatedly pressed non-target symbols on the SGD, it could be argued that he did not have good symbol discrimination abilities. However, for the most part Eli and the other participants did correctly request to play (eat) the items that were being offered, indicating good symbol discrimination abilities. Still, future research could implement additional manipulations to control for item-biased or position-biased responding, such as the procedures implemented by van der Meer, Kagohara, et al. (2011). They shifted the orientation of the iPod®-based SGD and alternated offering only toys or only snacks across sessions to test for the relevant symbol discriminations.

The results of the present study are limited in several ways and should be interpreted with caution. In line with previous research on assessing preferences for different AAC options (see van der Meer, Sigafoos, et al., 2011), the present study focused on teaching a single communicative function (i.e., requesting). It therefore remains unclear whether preference will influence learning of other communication skills. Furthermore, because we used a verbal prompt (*Let me know if you want something.*) to initiate requesting opportunities, it is possible that the participant's responses were at least partially under the control of the speech of the communication partner. This means that the participants might not have acquired the ability to request items more spontaneously. Future interventions could be improved by teaching more spontaneous communication

(Sigafoos, Drasgow, et al., 2009). The fact that only a limited communicative repertoire was taught and that generalization data to other communicative forms, contexts, and people were not collected are further limitations. Lastly, preferences across a wider range of AAC options (e.g., PECS, SGD, and MS) have yet to be investigated. Since these are the three main AAC modes taught to children with DD, a study that simultaneously compared all three options in terms of acquisition, preference and maintenance would seem relevant and timely.

Conflict of interest

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

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