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ORIGINAL ARTICLE

Within Stimulus Prompting to Teach Symbol Discrimination Using an iPad® Speech Generating Device

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Abstract This study evaluated the effects of within stimulus prompting and prompt fading to teach four preschool children with autism picture symbol discrimination using an iPad® and the Proloqu2Go application as a speech-generating device. Participants were taught to discriminate between a progressively more complex field of picture-symbols depicted on the screen of an iPad with a five-phased training procedure. All participants acquired discrimination between picture-symbols while using the iPad to mand for preferred items in a field of four picture-symbols. The results provide tentative support for a procedure to teach children with autism to discriminate between picture symbols while manding using a handheld speech-generating device.

Keywords Mand · Speech-generating device · Voice output communication aid · Autism · Stimulus discrimination

Within Stimulus Prompting to Teach Discrimination Using a Tablet Speech Generating Device

It is estimated that up to 50 % of individuals diagnosed with an autism spectrum disorder (ASD) fail to develop vocal speech capabilities naturally (Miranda-Linné and Melin 1997; Peeters and Gillberg 1999; Wetherby and Prizant 2005). As such, use of an augmentative or alternative communication system (AAC) is often indicated for individuals to acquire a functional communicative or mand repertoire (Mirenda 2003). Various methods of AAC exist including unaided systems such as manual sign language; and aided systems that include speech generating devices (SGD), the picture exchange communication system (PECS), and picture exchange (PE; Sigafoos et al. 2007). Given recent technological advances, powerful, portable, and readily available

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handheld devices such as tablet computers (e.g., the Apple iPad, Samsung Galaxy) or portable media players (e.g., Apple iPod) have been investigated as a SGD in terms of the acquisition of a mand repertoire (e.g., Lorah et al. 2013; Kagohara et al. 2013; van der Meer et al. 2012a, b; van der Meer et al. 2011).

For example, Lorah et al. (2013) compared effectiveness of the iPad as a SGD and picture exchange (PE) for five preschool-aged males with autism. All participants acquired the ability to communicate using the iPad and, furthermore, use of the iPad produced higher rates of independent manding for four of the five participants, and four of the five participants demonstrated preference for the SGD compared to PE. Additionally, van der Meer et al. (2012a, b) taught five school-aged children to mand using the iPod Touch as a SGD. All five children acquired the ability to communicate using the iPod Touch and three of the five participants demonstrated a preference for the iPod Touch when compared to manual sign language. Finally, van der Meer et al. (2012a, b) compared acquisition, maintenance, and preference in four children with developmental disabilities across three modes of AAC including manual sign, PE, and the iPod Touch as a SGD. Two participants reached mastery criterion for SGD more readily, and three participants demonstrated preference for the iPod as a SGD when compared to manual sign and PE.

Although these investigations provide evidence that handheld devices are effective as a basic SGD, one limitation is that studies, so far, have not included specific measures of discrimination between various symbols or pictures presented on the screen of the device. For example, Lorah et al. (2013) only provided training using a field of one picture-symbol on the cover of the PE communication book or iPad screen. Additionally, while van der Meer et al. (2012a, b) included distractor pictures within the field to ensure some level of discrimination, participants were taught to mand for one type of highly preferred stimulus. Finally, van der Meer et al. (2012a, b) included additional distractor symbols within the training procedures; however, one participant failed to acquire discrimination and only reached criterion for the SGD when the distractor symbol was removed. The present article extends this previous research by including procedures to train picture-symbol discrimination while using a handheld computing device as a SGD.

Stimulus discrimination results from the reinforcement of a specific behavior in the presence of a specific discriminative stimulus, increasing the likelihood of the behavior in the presence of the discriminative stimulus (Smith et al. 2006). Discrimination when using a SGD is an accurate selection of one symbol or picture in the presence of the corresponding item or referent when other stimuli are present (Andermeier et al. 2008). Although symbol discrimination may be viewed as a necessary component of SGD training, to date little research exists on effective training procedures for the development of a discrimination repertoire. Furthermore, given recent technological advances, extant strategies should be revisited and extended taking into account these new technologies.

Despite the lack of literature regarding the effectiveness of symbol discrimination training procedures when using a SGD, several procedures exist to teach individuals with autism discrimination between symbols (MacDuff et al. 2001). Two broad categories of prompting strategies exist: response prompts and stimulus prompts (Cooper et al. 2007). Response prompts rely on manipulation of external stimuli such as providing a model or making physical contact with the learner to increase the likelihood of correct responding. Alternatively, stimulus prompts rely on manipulation of antecedent stimuli or the addition of a contrived cue prior to the occurrence of a discriminative stimulus; rather, than manipulating the responder or providing extra stimuli to increase the likelihood of correct responding, following the occurrence of an antecedent stimulus (Cooper et al. 2007). That is, stimulus prompts are proactive in nature, whereas response prompts are reactive. Within stimulus prompting refers to the manipulation of the antecedent stimulus itself, rather than manipulation of other stimuli within the environment (Cooper et al. 2007). For example, manipulating the size of a flash card, in comparison to other cards in the field, to increase the likelihood of correct responding when the learner is instructed to identify the flash card. It has been suggested that the use of within stimulus prompting rather than response prompting may decrease the likelihood of response prompt dependency (MacDuff et al. 2001). Schreibman (1975) found that the use of within stimulus prompts was more successful than extra-stimulus prompts when teaching children with autism visual and auditory discriminations.

In terms of the transfer of stimulus control for the use of stimulus prompts, methods of fading are commonly used. Fading refers to the transfer of stimulus control from a contrived cue to a naturally existing discriminative stimulus by reducing the features of the contrived stimulus that increase the likelihood of correct responding, while enhancing features of the naturally existing antecedent stimulus (Cooper et al. 2007). For example, in the above example, systematically decreasing the size of the target flash card, while increasing the size of the distractor flash cards.

The PECS protocol (Bondy and Frost 1994) uses a combination of response and stimulus prompts for discrimination between picture symbols training. Discrimination between picture symbols is the primary function of Phase III of the six-phased PECS training procedure. During this phase a shaping procedure is used to systematically increase the number of pictures presented from which the learner selects. This begins with two picture-symbols on the cover of the communication board, one of a preferred item and one of a neutral item. As the learner discriminates between these picture-symbols the number of preferred and neutral picture-symbols is systematically increased. If the learner makes an error, a gestural prompt (i.e., pointing to the correct picture) may be used evoke the correct response. Finally, Bondy and Frost (1994) indicate that for a learner demonstrating difficulty with discrimination, the use of a blank symbol, or non-referent symbol, may be used to enhance discrimination. With handheld devices as a SGD (i.e., van der Meer et al. 2012a, b), the use of response prompts such as vocal feedback and gestural cues have been used for teaching discrimination.

Despite these general guidelines for teaching of discrimination for use within the PECS protocol, no explicit guidelines exist for teaching picture discrimination to learners who use a handheld computing device as a SGD. The purpose of the current study was therefore to assess whether (a) within stimulus prompts and prompt fading were effective to teach picture-symbol discrimination while using the iPad as a SGD in young children with an ASD and (b) to assess a five-phased training procedure to teach discrimination between picture-symbols while using a handheld computing device as a SGD.

Method

Participants

Three white and one African American, male, preschool aged children with a diagnosis of autism participated in the study. They had a mean age of 5 years and 2 months, as shown in Table 1. All four participants attended a specialized public educational classroom where they received 26.5 h of instruction, 30-min per week of group and individual speech therapy, 45-min per week of occupational therapy, and 8 h per month of behavioral supervision from a Board Certified Behavior Analyst. All participants had *VB-MAPP Barriers Assessment* (Sundberg 2008) scores ranging from absent to limited for both manding and echoic repertoires. Additionally, all four participants attended a classroom designed for learners scoring within Level I of the *VB-MAPP*. Teacher reports indicated that while the participants had exposure to the iPad for leisure purposes, none of the participants had any training history using the iPad as a SGD, at the onset of the study; nor had any participant had any training history with picture based communication.

Materials and Setting

During training the iPad® Version II and the application Proloqu2Go (AssistiveWare, Amsterdam, the Netherlands) were used as the SGD. Training sessions were conducted an unused area of the classroom which had a partition segregating it from the remainder of the classroom and a child-sized table, with child-sized chairs, where the instructor sat within two feet, to the left, of the participant. Preferred, low-preferred, and neutral stimuli, determined through a multiple stimulus without replacement preference assessment (MSWO) were used during training sessions.

Dependent Measures and Definitions

Rate of independent (i.e., manding within 5 s) and accurate (i.e., the picture-symbol selected on the screen of the device matched the item used for the training trial) manding were used as the primary dependent measures throughout all phases of the study; however, depending on the respective phase, the method used to assess accuracy varied. A mand was considered independent if the participant pressed an icon on the screen of the iPad with enough force to evoke the digitized output. In terms of accurate

Table 1 Participant Information

Participant	Diagnosis	Age	VB-MAPP barriers score	
			Mand repertoire	Echoic repertoire
Ian	Autism	5.5	2 (Limited)	3 (Weak)
Patrick	Autism	4.3	3 (Weak)	3 (Weak)
Alex	Autism	5.0	3 (Weak)	4 (Absent)
David	Autism	6.2	4 (Absent)	4 (Absent)

manding, during phases I-III, if the item selected (pre-trial) and the picture-symbol selected on the screen of the iPad had 1:1 correspondence, the response was scored as an independent and accurate mand. During Phases IV and V, correspondence checks (Bondy and Frost 1994) were used to assess the accuracy of independent mands and followed every independent mand. During the correspondence checks, the participant was presented with two preferred items represented on the screen of the iPad. If the picture-symbol selected on the screen of the iPad had correspondence with the preferred item selected, the independent mand was scored as accurate. Finally, percentages of independent and accurate mands were calculated across all phases. This was calculated by dividing the number of correct and accurate mands, by the total opportunities to mand, with a mastery criterion of 80 % independent and accurate mands, across two consecutive sessions, to move to the next training phase.

General Procedures

Stimulus Preference Assessment Two multiple stimulus without replacement (MSWO) assessments (DeLeon and Iwata 1996) were conducted for each participant prior to baseline and training to determine four preferred and four neutral stimuli for training purposes. First, an open-ended preference survey was provided to each of the participants' teachers to determine which items would be presented during the MSWO. The results of the MSWO preference assessment provided a rank of the participants' preferences and the four top ranked items were used for baseline and Phase V of training. Additionally, those items ranked lowest, or those items that were never selected, were used as low-preferred or neutral items for Phases III and IV.

Baseline The purpose of baseline was to evaluate whether participants could mand for a preferred item by correctly selecting the item from a field of four picture symbols. Baseline probes were collected for ten trials per session and sessions continued until stable responding was determined. A trial consisted of presentation of preferred items, either an independent mand or a no-response, followed by a latency of 5 s, and subsequent reinforcement or the delivery of a preferred item. During each baseline session, an in-vivo preference assessment was conducted, where the top four items from the MSWO were placed within the participant's view and the participant was instructed to "pick one". The item that the participant reached for was used as the target item for the trial. Next the iPad with picture-symbols of the four items presented on the screen was placed directly in front and to the center of the participant. If the participant independently manded a correspondence check was used to determine the accuracy of the independent mand. If the participant did not mand independently within 5 s, the trial was scored as incorrect/no response and the participant was granted access to a randomly selected preferred item for 30 s. If the participant manded independently and accurately for an item, the participant was granted access to that item for 30-s. If the participant manded independently and inaccurately, the participant was granted access to a randomly selected preferred item for 30 s. Following each trial, the location of the picture-symbols on the screen was changed so that no symbol appeared in the same location twice in a row. The experimenter did not interact with the participant during the baseline phase unless he manded independently.

Symbol Discrimination Training

All symbol discrimination training trials began with an in-vivo preference assessment. During this preference assessment the participant was presented with the top four items from the MSWO and he was instructed to "pick one". The item that the participant reached for was used as the target item for the respective trial. That item was kept in view and out of reach during the trial until either the participant independently manded for the item or 5 s for passed. The iPad, with the screen arranged for the specific trial (described below) was then presented immediately in front of the participant. If no mand occurred after a 5-s interval, the trial was scored as incorrect and the participant was granted 30 s of access to a randomly selected preferred item. If the participant independently but inaccurately manded for an item the trial was scored as inaccurate and he was granted 30 s access to a randomly selected preferred item. Finally, if the participant manded independently and accurately for the item the trial was scored as correct and he was granted 30 s of access to that item. Trials proceeded in this manner until ten trials were complete, which comprised one training session. During all phases, the experimenter did not interact with the participant in any way until either an independent mand was evoked or the 5-s latency for responding elapsed. That is, the experimenter never used response prompts to evoke an independent or accurate mand during any phase of the study.

Phase I The function of this phase was to shape the topography of responding (i.e., pressing a picture symbol to mand for a preferred item). Discrimination was not taught during his phase. The screen of the iPad was arranged to contain one picture-symbol, which was the item selected during the in-vivo preference assessment. This picture-symbol filled the entire screen of the device. An independent mand was scored if the participant pressed the picture-symbol on the screen of the device with enough force to evoke the digitized output. An incorrect response was scored if the 5-s latency passed without independent responding. When the participant reached a criterion of 80 % independent and accurate responding across two consecutive sessions, he proceeded to Phase II.

Phase II The primary function of this phase was to teach simple discrimination between the preferred item picture symbol and three non-referent or blank symbols. The screen of the iPad was arranged to contain one picture-symbol, which was the item selected during the in-vivo preference assessment, and three blank symbols. Collectively, these four symbols filled the entire screen of the device. If the participant selected the picture-symbol on the screen with enough force to evoke the digitized output, the trial was scored as independent and accurate. If the participant selected a non-referent space, no digitized output was evoked and the trial was scored as inaccurate. If the participant did not respond within 5 s, the trial was scored as incorrect. Following each trial, the location of the picture-symbols, on the screen was changed so that no symbol appeared in the same location twice in a row. When the participant reached a criterion of 80 % independent and accurate responding across two consecutive sessions, he proceeded to Phase III.

Phase III The function of this phase was to teach discrimination between one preferred picture symbol, one neutral picture symbol, and two non-referent or blank symbols. The screen of the iPad was arranged to contain one picture-symbol, which was the item selected during the in-vivo preference assessment; one picture-symbol that referenced a neutral item (determined through the MSWO); and two blank symbols. Collectively, these four symbols filled the entire screen of the device. If the participant selected the picture-symbol that corresponded to the preferred item with enough force to evoke the digitized output, the trial was scored as independent and accurate. If the participant selected the picture-symbol of the item that corresponded to the neutral item, with enough force to evoke the digitized output, the trial was scored as independent and inaccurate. If the participant selected a non-referent space, no digitized output was evoked and the trial was scored as inaccurate. If the participant did not respond within 5 s, the trial was scored as incorrect. Following each trial, the location of the picture-symbols, on the screen, were changed so that no symbol appeared in the same location twice in a row. When the participant reached a criterion of 80 % independent and accurate responding across two consecutive sessions, he proceeded to Phase IV.

Phase IV The function of this phase was to continue refining discrimination between picture-symbols. The screen of the iPad was arranged to contain two picture-symbols of preferred stimuli, one of which was the item selected during the in-vivo preference assessment; one picture-symbol that represented a neutral item; and one non-referent or blank symbol. Collectively, these four symbols filled the entire screen of the device. If the participant selected the picture-symbol that corresponded to the preferred item selected during the in-vivo preference assessment with enough force to evoke the digitized output, the trial was scored as independent and accurate. If the participant selected the alternative preferred picture-symbol with enough force to evoke the digitized output, a correspondence check was used to determine accuracy of responding. If during the correspondence check there was correspondence between the item manded for and the item selected, the trial was scored as independent and accurate; if there was no correspondence, the trial was scored as independent and inaccurate. If the participant selected the picture-symbol of the item that corresponded to the neutral item with enough force to evoke the digitized output, the trial was scored as independent and inaccurate. If the participant selected a non-referent symbol, no digitized output was evoked and the trial was scored as inaccurate. If the participant did not respond within 5 s, the trial was scored as incorrect. Following each trial, the location of the picture-symbols on the screen was changed so that no symbol appeared in the same location twice in a row. When the participant reached a criterion of 80 % independent and accurate responding across two consecutive sessions, he proceeded to Phase V.

Phase V Finally, Phase V was identical to baseline, and was used to assess mastery of basic picture-symbol discrimination in a field containing four picture-symbols representing four preferred stimuli. Trials began with an in-vivo preference assessment, with the items selected being either the target item or the distractor item for correspondence checks. The screen of the iPad was arranged to contain the top four items selected during the MSWO assessment. Correspondence checks were used to assess the accuracy of responding during this phase and were conducted after every independent mand. If the participant selected a picture-symbol with enough force to evoke the digitized output and there was correspondence with that item during the correspondence check, the trial was scored as independent and accurate. If the participant selected a picture-symbol with enough force to evoke the digitized output, but there was no correspondence during the correspondence check, the trial was scored as independent and inaccurate. If the participant did not respond within the 5-s latency the trial was scored as incorrect. Following each trial, the location of the picture-symbols on the screen was changed so that no symbol appeared in the same location twice in a row. Once the participant met a mastery criterion for this phase training was considered complete. Once all four participants reached mastery criterion maintenance probes were collected.

Maintenance Two maintenance data probes were collected for each participant. The duration between the completion of Phase V and the maintenance probes varied across participants, with a range of 5-to-7 weeks. Maintenance sessions were identical to those used for baseline and Phase V.

Interobserver Agreement & Procedural Fidelity

Interobserver agreement (IOA) was assessed during 35 % of all sessions. IOA data were calculated by taking the number of agreements and dividing that by the number of agreements plus disagreements and multiplying by 100. The overall agreement across all sessions and participants was 95 % (range, 80–100 %). Additionally, procedural fidelity checklists were used to ensure that the training procedures were followed to the specifications of the primary investigator. Procedural fidelity checklists were completed during every training session and indicated 100 % fidelity with teaching procedures in Phases I through V.

Experimental Design

A multiple probe design with changing criteria was used to evaluate effects of discrimination training (Gast 2010). Following baseline probes, participants were exposed to the five-phased discrimination training procedure, using a changing criterion format. That is, following mastery criteria for a phase, the participant was then exposed to a discrimination training procedure of increasing difficulty.

Results

The results depicted in Fig. 1, indicate that Phases I through V of the training procedure produced successively more complex picture symbol discrimination compared to baseline. For only one (Alex) of the four participants were there any overlapping data points when comparing baseline measures to Phase V. For that participant the percentage of non-overlapping data points was 25 %. Additionally, for Phase I of the study, all participants required the minimum number (2) of sessions necessary to reach mastery criteria. For Phase V, only one participant (Alex) required more than the minimum

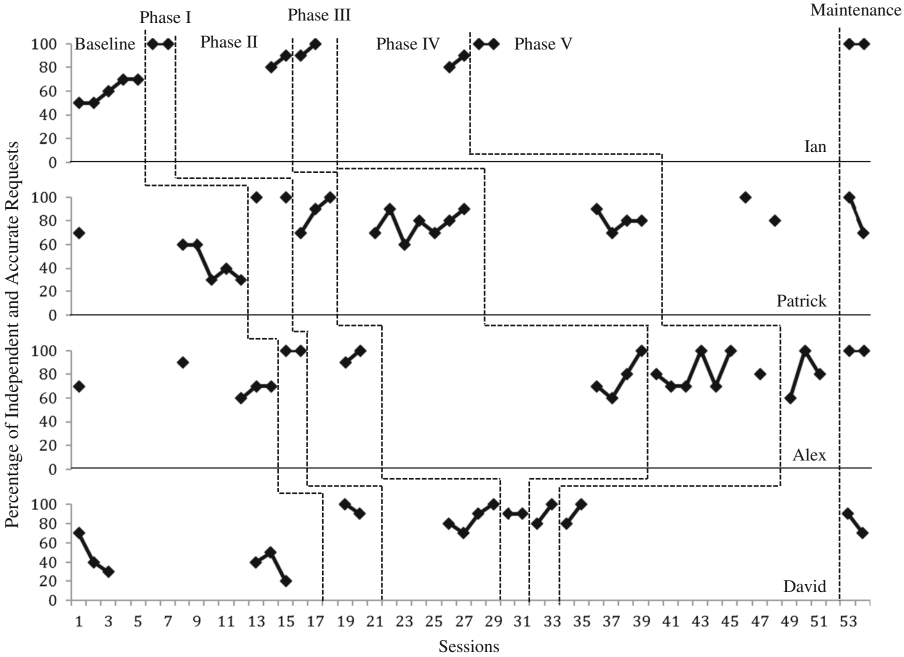

Fig. 1 Percentage of accurate and independent requests. Students progressed through the five phases of the symbol discrimination protocol and ended with probes for skill maintenance

number of sessions necessary to reach mastery criteria. Finally, the average number of sessions required to progress through all five phases of the study was 14.5 (range, 10–18), with one participant (Ian) reaching criteria for all phases after only two training sessions per phase, the minimum number of required sessions.

Ian

As shown in the top panel of Fig. 1, Ian responded at an average rate of 60 % independent and accurate manding (range, 50–70 %) during baseline. He required two training sessions to reach criterion for all phases and responded at an average rate of 100 % for Phase I; 85 % (range, 80–90 %) for Phase II; 95 % (range, 90–100 %) for Phase III; 85 % (range, 80–90 %) for Phase IV; and 100 % for Phase V. For both maintenance probes, Ian responded at 100 % independence and accuracy.

Patrick

As shown in the second panel of Fig. 1, Patrick responded at an average rate of 48 % independent and accurate manding (range, 30–70 %) during baseline. He required two training session to reach criterion for Phase I and responded at an average rate of 100 % independent manding. For Phase II, Patrick required three training sessions and averaged 87 % (range, 70–100 %) independent and accurate manding. For Phase III, he required seven training sessions and averaged 77 % (range, 60–90 %) independent and accurate manding. For Phase IV, Patrick required four training sessions to reach mastery and averaged 80 % (range, 70–90 %) independent and accurate manding. Finally, Patrick required two sessions to reach mastery criteria for Phase V and averaged 90 % (range, 80–100 %) independent and accurate manding. For maintenance, Patrick demonstrated an average of 85 % (range, 80–100 %) independent and accurate manding.

Alex

As shown in the third panel of Fig. 1, Alex responded at an average rate of 72 % independent and accurate manding (range, 60–90 %) during baseline. He required two training session to reach criterion for Phase I and responded at an average rate of 100 % independent and accurate manding. For Phase II, Alex required two training sessions and averaged 95 % (range, 90–100 %) independent and accurate manding. For Phase III he required four training sessions and averaged 78 % (range, 70–100 %) independent and accurate manding. For Phase IV, Alex required seven training sessions to reach mastery and averaged 81 % (range, 70–100 %). Finally, Alex required three sessions to reach mastery criteria for Phase V and averaged 80 % (range, 60–100 %) independent and accurate responding. During the maintenance probes, Alex responded at 100 % independent and accurate manding.

David

As shown in the bottom panel of Fig. 1, David responded at an average rate of 42 % independent and accurate manding (range, 20–70 %) during baseline. He required two training sessions to reach criterion for Phase I and responded at an average rate of 95 % (range, 90–100 %) independent manding. For Phase II, David required four training sessions and averaged 85 % (range, 70–100 %) independent and accurate manding. For Phase III he required two training sessions and averaged 90 % independent and accurate manding. For Phase IV, David required two training sessions to reach mastery and averaged 90 % (range, 80–100 %) independent and accurate manding. Finally, David required two sessions to reach mastery criteria for Phase V and averaged 90 % (range, 80–100 %) independent and accurate manding. During the maintenance probes, David responded with an average of 95 % (range, 90–100 %) independent and accurate manding.

Discussion

The purpose of this study was to evaluate the effectiveness of (a) the five-phased training protocol and (b) the use of only within stimulus prompts and stimulus fading in the acquisition of discrimination between picture-symbols on the screen of a SGD of four preschoolers with autism. The five-phased training protocol was effective in teaching discrimination between picture-symbols for all participants. These results extend the existing literature on the use of handheld computing devices as a SGD for individuals with autism and related developmental disabilities (Lorah et al. 2013; van der Meer et al. 2012a, b). Additionally, this study provides practitioners with a strategy for the teaching of discrimination between picture-symbols while using the iPad and the Proloqu2Go application as a SGD.

One interesting finding is that at no point was a response prompt needed to evoke correct responding; the use of stimulus prompts was effective in terms of discrimination acquisition within the context of the current study. That is, other than serving as the listener and reinforcing participants' mands, it was never necessary for the experimenter to interact with the participant in the role of an instructor by providing response prompts. In essence, the device itself became the instructor, thus making more salient the role of the experimenter/teacher as the listener. The use of within stimulus prompts in the present study obviated the necessity for two trainers to teach symbol discrimination (e.g., Bondy and Frost 1994), which is often impractical in publically-funded educational settings.

Perhaps equally interesting is the rapid rate at which the participants progressed through the phases of the protocol. For example, all four participants reached criteria for Phase I after two training sessions, the minimum number of sessions required. Furthermore, only one participant (Alex) required more than two sessions to reach criteria for Phase V, again the minimum number of sessions required for mastery. Despite the rapid movement through the phases for all participants, for Ian and Alex there is some discrimination ability evident within baseline, which may limit the experimental control for those participants. However, for Ian there is 0 % overlap between baseline and Phase V, and for Alex there is 25 % non-overlap between baseline and Phase V, which demonstrates some degree of experimental effect for both participants. Finally, the acquired discrimination repertoire maintained for all four participants, with two participants responding at 100 % independence and accuracy, and all participants responding above mastery criteria.

Limitations of the study include a lack of the evaluation of generalization and the incorporation of natural environment teaching within the instructional design. This study did not evaluate whether the acquired repertoire was demonstrated accurately in a setting other than where training took place. These issues await investigation in a replication and extension of this procedure. Additionally, the study did not evaluate natural or incidental training procedures, as all training took place in a discrete-manner. Such modifications should also be evaluated in future studies. This investigation did not evaluate the social validity of the training procedure in terms of teacher acceptability, which is another limitation of the research. However, previous studies using a similar population in this setting demonstrated that young children with autism might prefer the use of a handheld device as a SGD when given the opportunity to respond with either the iPad or PE (Lorah et al. 2013) or when given the choice between an iPod Touch, manual sign, and PE (van der Meer et al. 2012a, b). An additional limitation may be the number of sessions needed to reach mastery. Finally, given the rapid acquisition of the discrimination repertoire throughout the phases, a limitation may be that there was not a return to baseline prior to the introduction of the next phase, thus it is not possible to determine when the discrimination repertoire emerged. Future investigations should address these limitations within the research study.

Despite these limitations the current investigation demonstrated that within stimulus prompting and prompt fading was were effective in the acquisition of discrimination between picture-symbols when using a handheld computing device as a SGD. This study adds to the already existing literature that supports the effectiveness of handheld computing devices such as the iPad or iPod as a SGD for individuals with autism and related developmental disabilities. In this stream of research, these devices function as 'behavioral prosthetics' (Lindsley 1964), extending the capabilities of these students.

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