Effects of iPod Touch™ Technology as Communication Devices on Peer Social Interactions across Environments

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Abstract: The purpose of the study was to evaluate the use of the iPod Touch™ as a Speech Generated Device (SGD) for Functional Communication Training (FCT). The evaluation of the effects on problem behavior, the effects on generalization and maintenance of the acquired communication repertoire, and the social initiations of peers between the new SGD (iPod Touch™) and traditional devices were conducted. The study demonstrated that the iPod Touch™ produces higher levels of peer interactions when compared to the Dynavox. These effects maintained and generalized for all three participants. Additionally, the use of the iPod Touch™ as a SGD is effective for the use of FCT. Finally, the study offered support for the social validity of the use of the iPod Touch™ and application GoTalk as a SGD, as all teachers and student participants demonstrated preference for the device when compared to the Dynavox as a SGD.

Addressing communication for children with autism is a top clinical and educative priority, as the inability to functionally communicate may lead to the demonstration of problem behavior (Mancil & Boman, 2010). Communication deficits can range from a person who is completely non-vocal to those who use speech but demonstrates impairments in complex communication such as conversational skills (APA, 2013). Furthermore, it is estimated that 30% of individuals with a diagnosis of Autism Spectrum Disorders (ASD) fail to develop vocal output capabilities (Wodka, Mathy, & Kalb, 2013), thus necessitating the use of an Alternative and Augmentative Communication (AAC) systems to use while they are developing functional speech.

Children who do not acquire spoken language and are not taught how to communicate his or her needs are at a high risk for developing problem behaviors such as self-injury and aggression (Bott, Farmer, & Rhode, 1997; Chung, Jenner, Chamberlain, & Corbett, 1995; Durand & Carr, 1992; Mancil, Conroy, & Haydon, 2009; Sigafos, 2000). To address the issue of both communication and the demonstration of problem behavior, Functional Communication Training (FCT) is often used (Carr & Durand, 1985; Wacker et al., 1990). Functional Communication Training involves assessing the function of a behavior via functional analysis, and then replacing the problem behavior by teaching a communicative response (i.e., manding) that serves the same function as the problem behavior (Durand & Carr, 1987).

Functional Communication Training has been identified as an evidence-based intervention for teaching children with autism (National Center for Autism, 2015). Given the prevalence of individuals with ASD who fail to develop functional vocal behavior, the targeted replacement behavior in FCT often relies on the use of an AAC, such as manual sign (e.g., Fisher et al., 1993) and speech-generating devices (Durand, 1999). FCT can also involve the training of vocalizations as the primary communication topography (e.g., Durand & Carr, 1992).

As previously mentioned, the use of an AAC for an individual with a diagnosis of ASD who does not demonstrate functional speech is standard educational and clinical practice. One such method of AAC is a speech-gener-
ating device (SGD). A SGD is an electronic device that transmits a digitized vocal output when activated, typically by pressing a button or switching a lever. Dozens of SGD exist and they range greatly in cost and technological capabilities (Lorah, Parnell, Whitby, & Hantula, 2014).

The use of SGD as AAC has received much attention in the literature. For example, the use of a SGD has been demonstrated as effective in the acquisition of a mand (requesting) repertoire for individuals with a diagnosis of ASD (e.g., Lancioni, et al., 2007; Lorah et al., 2013; Sigafoos, et al., 2009; Son, Sigafoos, O’Reilly, & Lancioni, 2006). Furthermore, the collateral behavioral effects of the use of SGD as AAC on decreasing problem behavior and increasing social initiations are also indicated.

For example, Durand (1999) evaluated the effectiveness of a SGD in five children, aged 3.5-15 years old, diagnosed with a developmental disability to mand (request) wanted or needed items and activities. Following the successful mand training Durand noted significant decrease in the demonstration of problem behaviors of all five participants. Similarly, Olive, Lang, and Davis (2008) found mand training with the use of a SGD as an AAC decreased the demonstration of challenging behavior in a young child with ASD. Dicarlo and Banajee (2010) examined the effects of SGD training on the initiations for communication in two young children diagnosed with a developmental disability. Results of this investigation found an increase in initiations of 41% and 27%, respectively.

More recently, advances in technology in terms of portability, access, and cost have sparked a renewed interest in the use of SGD as an AAC (Lorah et al., 2014). For example, a recent review of the literature on the use of table computers and portable media players as a SGD indicated 17 studies have been published between 2007 (the year the iPod Touch™ was released) and March of 2014. A total of 57 participants were included in those 17 studies, and of those 57 participants, 93% (or 53) participants acquired the targeted communicative repertoire (Lorah et al., 2014). Thus, current research findings demonstrate that portable media technology as a SGD, such as the iPad™ or iPod Touch™, may be a viable and preferable option for teaching communication.

Given what is known about the use of traditional SGD as a method of AAC and the effectiveness of new SGD as a method of AAC, the current investigation intends to extend the literature base by a) evaluating the use of the iPod Touch™ as a SGD for FCT; b) the collateral decrease in the demonstration of problem behavior; c) evaluating the generalizability and maintenance of the acquired communication repertoire; and d) offering a comparison in terms of the social initiations of peers between new SGD and traditional devices.

Method

Participants

As indicated in Table 1, three participants, two male and one female, ranging in age from 4-5 years were recruited from a public, general education preschool in the southeastern United States. These students were selected at random from a group of 30 children diagnosed with ASD who exhibited lack of peer social interaction. For example, they often sat by themselves at recess and other activities. Each child had a diagnosis of ASD obtained independently from a physician or licensed psychologist. The Autism Diagnostic Interview-Revised (ADI-R; LeCouteur, Lord, & Rutter, 2003) was administered to obtain additional scores indicating a diagnosis of ASD. A doctorate level teacher educator and autism specialist trained to conduct the assessments for research purposes administered both instruments to all participants in the study. In addition, the Mullen Scales of Early Learning (MSEL; Mullen, 1992) was administered to determine current developmental level, particularly in the area of communication to rule out developmental functioning level as a possible confounding variable.

John. John was an African-American male with a chronological age of 5.0 years who screamed and cried. Diagnosed at the age of 4, he received services from a psychologist (1 hour, every 2 weeks) and a speech therapist (30 minutes per week). John was non-vocal and used a Dynavox for communication. According to the Mullen Scales of Early Learn-
ing, John functioned at the level of a 42 month old. According to teachers, parents, and the speech therapists, John did not socially interact with peers. The deficit in social interaction was confirmed during direct observations across environments (e.g., playground, lunchroom, classroom).

**Sarah.** Sarah was an African-American female with a chronological age of 4.0 years who pinched peers. She was diagnosed with ASD at the age of 2, and had been in therapy with a speech pathologist (30 minutes per week) and occupational therapist (1 hour per week) for the past year. Sarah was non-vocal and used a Dynavox for communication. According to the Mullen Scales of Early Learning, Sarah functioned at the level of a 31 month old. According to teachers, parents, and the speech therapists, Sarah did not socially interact with peers. The deficit in social interaction was confirmed during direct observations across environments (e.g., playground, lunchroom, classroom).

**Ben.** Ben was a Caucasian male with a chronological age of 5.0 years who hit peers. He was diagnosed with ASD at the age of 3 when he did not begin to speak. He had therapy with a speech pathologist (1 hour a week) and an occupational therapist (1 hour per week). John was non-vocal and used a Dynavox for communication. According to the Mullen Scales of Early Learning, John functioned at the level of a 36 month old. According to teachers, parents, and the speech therapists, John did not socially interact with peers. The deficit in social interaction was confirmed during direct observations across environments (e.g., playground, lunchroom, classroom).

**Peers.** The peers chosen for the study were picked at random from each child’s classroom. The random selection involved the names of each student within the classroom being written on a piece of paper and selected from a jar, by an individual not associated with the study.

**Materials**

The materials required for the intervention included a Dynavox and an iPod Touch™. The iPodTouch™ was a 3rd generation with 16GB of memory. The application used on the iPod Touch™ was GoTalk. The device was 4.8 inches by 2.3 inches and weighed 3.10 ounces. The cost of the iPod Touch™ was 400 US Dollars, including cost of applications. The iPod Touch™ has the capability of internet access, email, and text messaging as well as a camera. Multiple programs for communication are available from a simple user interface to more complex.

### TABLE 1

<table>
<thead>
<tr>
<th>Participant</th>
<th>Diagnosis</th>
<th>Chronological Age</th>
<th>ADI-R</th>
<th>Mullen Scales of Early Learning</th>
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<td>42 months</td>
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<td></td>
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<td>Repetitive Behavior 9</td>
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<td>Abnormality of Development 2</td>
<td></td>
</tr>
<tr>
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<td>31 months</td>
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<td></td>
<td>Communication 14</td>
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<td>Repetitive Behavior 12</td>
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<tr>
<td>Ben</td>
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<td>Social Interaction 24</td>
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<td>Abnormality of Development 3</td>
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</table>
The DynaVox Vmax™, is what the school district supplied to all children who required an AAC. The DynaVox™ is a full Windows OS computer with internet access, email, and text messaging. It has a 12.1 inch touchscreen display and weighs 6 lbs 5 oz. The cost for each device was $9,000.

Settings

For the iPod Touch™ condition, sessions were conducted within the participant’s schools twice a week on Tuesday and Thursday’s for 11 total sessions. Sessions for the peer social interaction comparison data were conducted on the participants’ respective playground with peers for 12 total sessions each, 3 days a week on Monday, Tuesday, and Wednesday. Two weeks following these sessions, maintenance and generalization probes were conducted. Maintenance sessions were conducted in the same locations as initial sessions. Generalization sessions occurred on the same playground as training, but with different peers than those used for training. Further generalization was assessed in each participant’s respective classroom and lunchroom.

Target Behaviors

The target behaviors for the three participants were identified during observations and teacher interviews. Target behaviors consisted of duration of peer social interaction (i.e., primary dependent variable). That is, the duration of time the peer talked and/or engaged with the participant was the primary target behavior/dependent variable. For example, if the peer were talking to the participant and/or within 3 feet and engaged in the same activity, social interaction would be recorded as occurring.

General Procedure

Functional analysis. A functional analysis was completed to identify the function of each subject’s aberrant behavior to assist in the modified mand training for the new SGD. The lead author and research assistant conducted the functional analysis in the participants’ home settings using the procedures outlined by Iwata, Dorsey, Slifer, Bauman, and Richman (1994) with the addition of a tangible condition.

The functional analysis (FA) was conducted by manipulating consequences such as escape from demands, contingent attention, and contingent tangible items to determine the function of the behavior. To identify a primary function, the relative effects of contingent reinforcement were compared to the other conditions (i.e., tangible, free play, escape, attention). After completing the FA, a tangible function was identified for each participant (see Figures 1, 2, & 3).

Mand training. Prior to the onset of the study, local Speech Language Pathologist (SLP) issued a Dynavox to each participant. Additionally, data were collected to determine that each child could independently use the Dynavox for basic mands. The subjects were then taught to use the iPod Touch™ in their respective schools using modified milieu training procedures outlined by Mancil et al. (2009). The procedures included identifying the function of the problem behavior as indicated by the functional analysis, which was a tangible function for each participant. Next, a mand/ model was used along with time delay to teach the mand as a functionally equivalent replacement behavior for the aberrant behaviors identified in the functional behavior assessment. Following the mand training, the researcher trained the classroom teachers using behavior skills training to 100% fidelity, who then provided training to their respective students. To ensure treatment integrity, 35% of the teachers’ training sessions were selected at random and evaluated. The treatment integrity for these sessions had a mean of 95% (range, 93–100%). Sessions were coded and then graphed using a multiple probe format. After ensuring each participant could use the iPod Touch™ for communication, the social interaction study began.

Experimental Design

A comparative intervention design, specifically an alternating treatment design with initial baseline and final best practice, was implemented to evaluate which strategy was most effective (Gast, 2010). During the first four sessions, baseline data were collected to obtain a minimum of three stable data points and establish the cur-
rent peer social interaction with the Dynavox. Following baseline sessions, treatment sessions were alternated between the participant using the Dynavox and the iPod Touch™ for communication on the playground. The final sessions involved a best practice and maintenance phase using the communication device that had the highest level of peer social interaction in the alternating comparisons.

Interobserver Agreement
All sessions were then coded and calculated independently by a research assistant and si-
multaneously coded by the first author to check for interobserver agreement (IOA) for 40% or greater of all sessions across all study phases. The teaching assistant who was trained to observe and tally the occurrences of the target behavior conducted these reliability checks. Total agreement was calculated for each measure and was determined by calculating the scores for these sessions and counting the number of agreements between the two observers divided by the number of agreements plus disagreements multiplied by 100 (Gast, 2010). The mean IOA across all study phases was 95% (range, 92% to 100%), 94% (range, 93% to 96%), and 97% (range, 95% to 100%) for John, Sarah, and Ben, respectively.

Independent Variable

The independent variable for this study was the communication devices, the Dynavox and the iPod Touch™. During the iPod Touch™ condition, the application used was the free version of GoTalk™.

Dependent Variable

The dependent variable for this study was duration of peer social interactions. Peer interaction was scored if a peer made unprompted verbal or nonverbal contact with the participant on the playground. The timer for interaction was started at the first moment of verbal or gestural initiation. The timer was stopped when the peer or participant moved farther than 3 feet while visually disengaging and/or stopping verbal interaction. Total duration per session was used. Peer interaction was scored only if no teacher prompt occurred. Observations of peer social interactions were synonymous with those described by Boyd, Conroy, Mancil, Nakao, and Alter (2007). In addition, frequency of interactions was used as a variable in the generalization setting as described below. Frequency of interactions was calculated by counting the number of interactions per minute with each peer in the generalization setting.

Data Analysis

This study focused on direct observations of individuals with ASD interacting with peers in different environments. Baseline data were collected using behavioral coding of the child’s observed social interaction across 16 initial sessions. These data were collected during 30 minutes of observation per day, 3 days...
per week (Monday, Wednesday, Friday). Each session was videotaped and coded immediately following the observation. The staff implemented the various interventions, while the lead author collected data during the specified time sequences. Behaviors were coded using real time collection procedures on the iPad™ Touch. The data analysis was completed using Microsoft Excel. Data points were graphed for each intervention, and presented in time-series graphs for each participant. Data analysis was based on visual inspection of the trend of data lines and magnitude and rate of behavior change between conditions (Gast, 2010). Summative data were reported on the fidelity of treatment data.

Results

Overall peer social interaction was highest in duration for the iPod Touch™ condition. In addition, peer social interaction was maintained and generalized across peers and environments (i.e., classroom, lunchroom). The results are depicted in Figures 4, 5, 6, 7, 8, and 9.

John. As depicted in Figure 4, John’s baseline with the Dynavox sessions produced durations of interaction with a peer on the playground that averaged 1.5 minutes during a 30-minute period (range, 1–2 minutes per 30 minute session, see Figure 4). Visual inspection of the data indicates a decreasing trend. This is substantial considering his interaction averaged only 5% of the total time on the playground with peers. His interaction with peers increased in magnitude during the iPod Touch™ condition, with interactions lasting an average of 7 minutes (range, 5–9 minutes per 30-minute session). There is a clear increasing trend during the iPod Touch™ conditions. During the maintenance phase with the iPod Touch™, duration of interactions remained high at an average of 8.5 minutes (range, 8–9 minutes). When compared to typical peers on the playground, the duration of interaction during maintenance was commensurate with the average time across other peers, which had a mean of 9 minutes (7 minutes to 10 minutes) across six other peers.

Following the maintenance condition, generalization probes with the iPod Touch™ were conducted across three peers and in all three environments (classroom, playground, and lunchroom) during 30-minute sessions (see Figure 7). During these conditions, frequency of interactions were also collected. The addition of these data were

![Figure 4. John's peer social interaction.](image-url)
included because certain environments are not inductive to prolonged interaction such as the classroom and lunchroom. During the classroom condition, John’s frequency of interactions averaged 8.5 (range, 8–9) with a duration average of 2.8 minutes (range, 2.5–3). During the playground generalization condition, his duration average was 9.25 minutes (range, 8–15 minutes). The generalization duration average and ranges were higher than during the initial intervention and maintenance conditions.

Figure 5. Sarah’s peer social interaction.

Figure 6. Ben’s peer social interaction.
conducted prior to the generalization data. Compared to the frequency of the classroom, the playground frequency decreased however, the decrease in frequency is directly tied to the longer duration of interactions, which inhibit having high frequency counts. The frequency of peer interaction on the playground averaged 2.25 (range, 2–3). During the lunchroom condition, John’s frequency of peer interaction averaged 5.5 (range, 5–6) with an average duration of 1.75 minutes (range, 1–2).
**Sarah.** As depicted in Figure 5, baseline data indicate that during the Dynavox condition, Sarah’s duration of interaction with a peer on the playground averaged 1 minute during 30-minute periods (range, 1–2 minutes per 30 minute session). Visual inspection of the data depicts a decreasing trend. This is substantial considering her interaction averaged less than 4% of the total time on the playground with peers. During the alternating intervention phase, Sarah’s duration of interaction with a peer on the playground remained near 5% of the total time on the playground with peers during the Dynavox condition. Specifically, her duration of interaction with a peer on the playground averaged 2.5 minutes (range, 2–3 minutes per 30 minute session). Her interaction with peers increased indicating a high magnitude during the iPod Touch™ condition, during which the duration of interaction with a peer averaged 8.5 minutes (range, 5–12 minutes per 30-minute session). As such, an increasing trend during the iPod Touch™ conditions is evident. During the maintenance phase with the iPod Touch™, duration of interactions remained high at an average of 11.25 minutes (range, 10–12 minutes). When compared to typical peers on the playground, the duration of interaction during maintenance was commensurate with the average time across other peers, which had a mean of 8 minutes (6 minutes to 9 minutes) across six other peers.

Following the maintenance condition, generalization probes with the iPod Touch™ were conducted across three peers and in three environments (classroom, playground, and lunchroom) during 30-minute sessions (see Figure 8). During these conditions, frequency of interactions were also collected. The addition of these data were included because certain environments are not inductive to prolonged interaction such as the classroom and lunchroom. During the classroom condition, Sarah’s frequency of interactions averaged 11.25 (range, 1–12), with a duration average of 6.5 minutes (range, 4–8 minutes). During the playground generalization condition, her duration average was 11.25 minutes (range, 9–13 minutes). The generalization duration average and ranges were higher than during the initial intervention conditions and similar to the maintenance conditions conducted prior to the generalization data. Compared to the frequency of the classroom, the playground frequency decreased however, the decrease in frequency is directly tied to the longer duration of interactions, which inhibit having high frequency counts. The frequency of peer interaction on the playground averaged 3 (range, 2–4). During the lunchroom condition, Sarah’s frequency of peer interaction averaged 6.5 (range, 5–8) with an average duration of 4 minutes (range, 3–6).

**Ben.** As depicted in Figure 6, during baseline, Ben never engaged with a peer on the
playground. As such, visual inspection indicates a level trend at zero. This is substantial as there were no instances of peer interaction.

During intervention, Ben’s duration of interaction with a peer on the playground remained at or below 4% of the total time on the playground with peers during the Dynavox phase. Specifically, his duration of interaction with a peer on the playground averaged 0.5 minutes (range, 0–1 minutes per 30 minute session). Visual inspection indicates a high magnitude of change during the iPod Touch™ condition. During which the duration of interaction with a peer averaged 6.5 minutes (range, 3–9 minutes per 30-minute session). As such, there is an increasing trend during the iPod Touch™ conditions. During the maintenance phase with the iPod Touch™, duration of interactions remained high at an average of 7.5 minutes (range, 7–8 minutes). When compared to typical peers on the playground, the duration of interaction during maintenance was commensurate with the average time across other peers, which had a mean of 7 minutes (5 minutes to 9 minutes) across six other peers.

Following the maintenance condition, generalization probes with the iPod Touch™ were conducted across three peers and in three environments (classroom, playground, and lunchroom) during 30-minute sessions (see Figure 9). During these conditions, frequency of interactions were also collected. The addition of these data were included because certain environments are not inductive to prolonged interaction such as the classroom and lunchroom. During the classroom condition, Ben’s frequency of interactions averaged 7.5 (range, 7–8) with a duration average of 2.25 minutes (range, 1–3). During the playground generalization condition, the duration averaged 11 minutes (range, 9–14 minutes). The generalization duration average and ranges were higher than during the initial intervention and maintenance conditions. Compared to the frequency of the classroom, the playground frequency decreased; however, the decrease in frequency is directly tied to the longer duration of interactions, which inhibit having high frequency counts. The frequency of peer interaction on the playground averaged 2 (range, 2–2). During the lunchroom condition, John’s frequency of peer interaction averaged 6.25 (range, 5–6) with an average duration of 2 minutes (range, 1–3).

Social Validity

Social validity was assessed in three ways. First, similar to many studies involving social interaction of children with ASD the teachers completed a social validity scale on their experiences after the conclusion of the study. Teachers report that the intervention was not time consuming and they would use it in the future. In addition, they reported transporting and using the iPod Touch™ device was easier and more preferred, when compared to the Dynavox.

Second, the participants (i.e., children with autism spectrum disorder) were given forced choice preference assessments to determine preference for Dynavox or iPod Touch™. All participants preferred the iPod Touch™ following the intervention. That is, for each of three trials the participants chose the iPod Touch 100% of the time for the entire 5-minute period of each 5-minute trial.

Third, the duration of play on the playground was compared to that of typically developing peers within the same class. The average duration of play on the playground for peers ranged from 5 minutes to 10 minutes. Each participant’s average duration of play fell within that range.

Discussion

The literature has seen an influx of research evaluating handheld portable multimedia players and tablets as speech-generating devices for individuals with autism (Lorah et al., 2014). Despite the promising results of such research there remains many questions within the research base. For example, to date, no research has offered a comparison of new, readily available, portable SGD’s such as the iPod Touch™ and traditional SGD such as a Dynavox. Additionally, the literature base has not investigated these new devices in terms of the effects of such devices on peer interactions or social communication. Further, the literature is lacking evidence that such new technology based SGD are effective at decreasing problem behaviors. The current study offered an evaluation all of these important ar-
eas of need within the research base, by evaluating and comparing the Dynavox and the iPod Touch™ in terms of the duration and frequency of social interactions for learners with autism and the effects of such communication training in decreasing problem behaviors.

The results of this study offer support for the use of the iPod Touch™ and application GoTalk as a SGD for learners with autism. The participants obtained efficient use of the iPod Touch™ AAC device within a 2-week period. This is a rapid rate for the acquisition of a communication repertoire for individuals with autism. Additionally, as communication initiations and responses increased for all participants, their aberrant behaviors decreased to zero levels as anecdotally noted. These findings are generally consistent with the research on Functional Communication Training (FCT).

In addition, peer social initiations were greatest for conditions where target students had iPod Touch™ technology in comparison to conditions with the Dynavox. These effects were also found to maintain at follow up. Findings of this study show the utility of an iPod Touch™ as an AAC device to increase peer social initiations in comparison to other devices and maintains. In addition, the duration of interactions increased and environments of spontaneous peer interaction increased during maintenance. Finally, all participants within the current study demonstrated a preference for the iPod Touch™ when compared to the Dynavox. These finding are similar to the results of other studies comparing portable multimedia players and tablet based SGD to other methods of AAC (i.e., Lorah et al., 2013).

One interesting finding is the consistent and increasing trend in the data paths for all participants during the iPod Touch™ conditions. Perhaps this is because, as indicated by Lorah et al. (2014) consumer technologies, such as the iPod Touch™, are a generally preferred product. This preference was clearly demonstrated by the participants during the social validity measures of the research design. Thus, this may also have been the case for the peers included within the study. That is, perhaps the peers also preferred social interaction with the participants when he or she was communicating with the iPod Touch™ SGD, when compared to the Dynavox.

Limitations of the current study include the lack of data collection in terms of peer initiations towards the participants with autism. These data would offer some insight as to what effects the use of these new technologies have in terms of enhancing peer initiations. Second, this study only analyzed computerized selection based communication methods. Future research should seek to rectify these limitations by incorporating participant interactions and multiple communication methods such as sign language or traditional picture based communication into the research design.

Despite the limitations, this study demonstrated that the iPod Touch™ produces higher levels of peer interactions when compared to the Dynavox. These effects maintained and generalized for all three participants. Additionally, the use of the iPod Touch™ as a SGD is effective for the use of FCT. Finally, the study offered support for the social validity of the use of the iPod Touch™ and application GoTalk as a SGD, as all teachers and student participants demonstrated preference for the device when compared to the Dynavox as a SGD.

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