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Review article

Using iPods® and iPads® in teaching programs for individuals with developmental disabilities: A systematic review

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ABSTRACT

We conducted a systematic review of studies that involved iPods®, iPads®, and related devices (e.g., iPhones®) in teaching programs for individuals with developmental disabilities. The search yielded 15 studies covering five domains: (a) academic, (b) communication, (c) employment, (d) leisure, and (e) transitioning across school settings. The 15 studies reported outcomes for 47 participants, who ranged from 4 to 27 years of age and had a diagnosis of autism spectrum disorder (ASD) and/or intellectual disability. Most studies involved the use of iPods® or iPads® and aimed to either (a) deliver instructional prompts via the iPod Touch® or iPad®, or (b) teach the person to operate an iPod Touch® or iPad® to access preferred stimuli. The latter also included operating an iPod Touch® or an iPad® as a speech-generating device (SGD) to request preferred stimuli. The results of these 15 studies were largely positive, suggesting that iPods®, iPod Touch®, iPads®, and related devices are viable technological aids for individuals with developmental disabilities.

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1. Introduction

Technological advances are leading to the development of an increasing number of computer-based devices and software applications that might be used in teaching programs for individuals with developmental disabilities (Ramdoss, Lang, et al., 2011; Ramdoss, Lang, et al., 2012; Ramdoss, Machalicek, et al., 2012; Ramdoss, Mulloy, et al., 2011). Recent technological advances have led to products such as the Apple iPod®, Apple iPod Touch®, Apple iPad®, and the Apple iPhone®. These devices appear to be making inroads into educational and rehabilitation programs involving persons with developmental disabilities. In addition, a number of educationally oriented applications are now available for use in conjunction with the iPod Touch®, iPad® and related devices (Shuler, Levine, & Ree, 2012). Indeed there appear to be a growing number of applications marketed for use in educational and rehabilitation programs for persons with developmental disabilities (Seeton, 2009). Furthermore, a number of anecdotal and empirical reports have appeared describing how such devices have been used in teaching programs for individuals with developmental disabilities (Friedlander & Besko-Maughan, 2012; Hager, 2010; Seeton, 2009).

In light of this emerging literature, a systematic review of the empirical evidence regarding the use of iPods®, iPads®, and related devices in teaching programs for individuals with developmental disabilities is warranted. The main objectives of the present review were to: (a) delineate the range of skills that have been successfully taught to individuals with developmental disabilities using iPod®/iPad®-based instruction, (b) delineate the range of software applications that have been used in conjunction with these iPod®/iPad®-based instructional programs, and (c) gain an overall view of the effectiveness of iPod®/iPad®-based instruction for this population.

This review was primarily intended to inform evidence-based practice in the use of iPod®/iPad®-based instruction for individuals with developmental disabilities. A secondary aim was to identify gaps in the existing database so as to stimulate future research efforts aimed at developing additional effective applications of iPods®/iPads® in the education and rehabilitation of persons with developmental disabilities.

2. Methods

A systematic search was conducted to identify empirical studies that involved the use of iPods®, iPod Touch®, iPhones®, iPads®, or related devices in intervention studies that focused on increasing academic, communication, social, and other adaptive behaviors in individuals with developmental disabilities. Identified studies that met pre-determined inclusion criteria were summarized in terms of participants, target behaviors, procedures, and results.

2.1. Search strategy

We searched Academic OneFile, ERIC, ProQuest, PsycINFO, SAGE journals online, Science Direct, and Scopus using a combination of the following free-text terms with truncation and Boolean operators: *iPod*, *iPhone*, *iPad*, *portable multimedia device*, *developmental disability*, *intellectual disability*, *autism spectrum disorders* (*ASD)*, and *autism*. The search was limited to English-language, peer-reviewed journals, but no other restrictions (e.g., date of publication) were applied.

Additional search strategies were implemented to increase the likelihood that all the potentially relevant studies were identified. First, an ancestral search was conducted by searching the reference lists of articles identified in the database search. Second, an author search was conducted on the electronic databases to identify further studies by the authors of studies that were identified from the initial database searches. Finally, a manual search was conducted on the journals that had published studies identified with the previous search strategies, including a review of the journals' homepages to identify studies that had been published online, but not yet in print. The search occurred in February 2012 and was updated in June 2012. However, because the earliest study identified by the database search was published in January 2009, the manual search of journals was limited to the period January 2008 to June 2012.

2.2. Inclusion criteria

Included studies focused on the use of an iPod®, iPod Touch®, iPod Nano®, iPhone®, or iPad®. To be included in this review, the device had to be specifically used for the purpose of teaching a new skill, increasing or decreasing a behavior or response, and/or increasing/improving one or more academic, social, communication, and/or other adaptive behaviors. The study also had to have provided intervention to at least one person with a developmental disability. Developmental disability included autism, ASD, intellectual disability and related syndromes (e.g., Down syndrome), and/or cerebral palsy. Included studies also had to provide empirical data on the effects of the iPod®/iPad®-based teaching program. Articles that did not report empirical data on the effects of the teaching program (e.g. review articles, anecdotal clinical reports) were excluded.

2.3. Data extraction

Studies that met the inclusion criteria were summarized in terms of: (a) participants (number and ages in years) (b) experimental design, (c) target behavior, (d) intervention procedures, and (e) results. Data extraction from the included studies was performed by the first author and checked by an independent rater for accuracy. In cases of disagreement on extracted data, articles were re-examined until consensus (100% agreement) was reached.

2.4. Inter-observer agreement

A total of 55 articles were identified from the initial search strategies. The abstract for each of these 55 articles was then examined, resulting in 16 articles that were retained for screening against the inclusion criteria by two independent reviewers. Agreement as to whether or not the study met the inclusion criteria was 100%. This process resulted in the retention of 15 articles.

3. Results

Table 1 provides a summary of the 15 studies that involved the use of iPod®/iPad®-based interventions in teaching programs for individuals with developmental disabilities. In Table 1, the studies are categorized and ordered by target skill, domain and date of publication.

3.1. Studies focused on teaching academic skills

One study examined the use of an iPad® for teaching academic skills. Specifically, Kagohara, Sigafoos, et al. (2012) employed an iPad® to deliver an instructional video to two children with Asperger syndrome and attention deficit hyperactivity disorder (ADHD). The study took place in the participants' classroom. The intervention was intended to teach the two students (10 and 12 years of age) how to use the spell-check function of a word processor on their computer. A delayed multiple-probe across participants design, with baseline, video modeling, and follow-up phases, was used to evaluate the effects of the iPad®-delivered video instruction. The procedures were as follows: Participants were given five words to type on the word processor and then asked to check the spelling of these words. No prompting was given, but participants were given verbal praise for making an attempt and were given an opportunity to play with some leisure game applications on the iPad® after the session, independent of their performance during the teaching session. During baseline, both participants opened the word processor application and typed some words, but neither correctly checked the spelling of words.

When the intervention phase began, the participants were given an iPad® at the beginning of the session. The iPad® was loaded with a video clip showing how to use the spell-check function on the word processing application. Participants were instructed to watch the video. The general procedures were then followed with a new set of words targeted at each session. With this video modeling intervention, both participants showed an increase in correct use of the spell check function, eventually reaching 100% correct performance. Their performance maintained at 100% correct for the follow-up sessions when video modeling was no longer provided. The results of this study suggested that the iPad®-based video modeling was effective in teaching the students to check the spelling of words.

3.2. Studies focused on teaching communication skills

Eight studies employed the iPod Touch® or iPad® for teaching or increasing communication skills. In the first study, Kagohara et al. (2010) focused on teaching a 17-year-old boy with autism, obsessive compulsive disorder (OCD), and ADHD to use an iPod Touch® to request snacks. The intervention was implemented in the classroom. The iPod Touch® was loaded with Proloquo2Go™ software (Sennott & Bowker, 2009) that allowed it to be used as a speech-generating device (SGD). Although the participant learned to touch the correct icons on the SGD to request snacks, he was not always successful in activating the speech output. The problem was conceptualized in terms of response topography; that is, the student did not select icons from the iPod Touch® screen with a sufficiently light touch to activate the speech output function. The intervention provided in this study was therefore aimed at increasing successful activation of the speech output function of the iPod Touch®.

The study involved an initial baseline phase during which the participant was given access to the snacks if he selected the correct icon on the SGD, regardless of whether or not this lead to successful activation (i.e., speech output). During the intervention phase, a delayed prompting procedure was implemented. Specifically, if the participant did not successfully activate the speech output, the trainer immediately guided the participant's hand to prompt correct activation of the SGD. After 10 such sessions, the trainer waited 5 s before providing physical prompts, resulting in an immediate increase in correct

Table 1
Summary of studies involving iPods®/iPads®.

Domain Study	Number of participants	Target behavior	Application
Academic			
Kagohara, Sigafoos, Achmadi, O'Reilly, and Lancioni (2012)	2 (10, 12)	Check the spelling of words on a computer word processor.	iPad Touch® delivered instructional video on how to check the spelling of words.
Communication			
Kagohara et al. (2010)	1 (17)	Request preferred stimuli by selecting icons from an iPod Touch®.	iPod Touch® with Proloquo2Go™ software was used as a SGD.
van der Meer et al. (2011)	3 (13–23)	Request preferred stimuli by selecting icons from an iPod Touch®.	iPod Touch® with Proloquo2Go™ software was used as a SGD.
Achmadi et al. (2012)	2 (13, 17)	Turn on iPod Touch®, unlock screen, navigate to correct icon page to request preferred stimuli.	iPod Touch® with Proloquo2Go™ software was used as a SGD.
Flores et al. (2012)	5 (8–11)	Request preferred stimuli by selecting icons from an iPad®.	iPad® with *Pick a Word* software was used as a SGD.
Kagohara, van der Meer, et al. (2012)	2 (13, 17).	Name pictures by selecting icons from iPod Touch or iPad®.	iPod Touch® and iPad® with Proloquo2Go™ software used as SGD.
van der Meer, Kagohara, et al. (2012)	4 (5.5–10)	Request preferred stimuli using either manual signs or by selecting icons from an iPod Touch®.	iPod Touch® with Proloquo2Go™ software used as a SGD.
van der Meer, Didden, et al. (2012)	4 (6–13)	Request preferred stimuli using manual signs, picture exchange, or by selecting icons from an iPod Touch®.	iPod Touch® with Proloquo2Go™ software used as a SGD.
van der Meer, Sutherland, O'Reilly, Lancioni, and Sigafoos (2012)	4 (4–11)	Request preferred stimuli using manual signs, picture exchange, or by selecting icons from iPod Touch®.	iPod Touch® with Proloquo2Go™ software used as SGD.
Employment			
van Laarhoven, Johnson, van Laarhoven-Myers, Grider, and Grider (2009)	1 (17)	Complete three tasks (cleaning bathroom, mop floor/empty garbage, clean kennels).	iPod® used to deliver instructional video showing how to complete tasks.
Burke, Andersen, Bowen, Howard, and Allen (2010)	6 (18–27)	Perform 63 scripted responses as part of fire safety training.	iPod Touch® and iPhone® used to deliver instructions.
Leisure			
Hammond, Whatley, Ayres, and Gast (2010)	3 (12–14)	Operate an iPod® to listen to music, watch video, and look at pictures.	iPod Nano® used as multimedia device including music, video, and pictures.
Kagohara (2011)	3 (15–19)	Operate an iPod Touch® to watch entertainment video.	iPod Touch® used to deliver instructional video on how to operate the iPod Touch® to watch several entertainment videos.
Kagohara et al. (2011)	3 (15–20)	Operate an iPod Touch® to listen to music/songs.	iPod Touch® used to deliver an instructional video showing how to operate the iPod Touch® to access preferred music/songs.
Transitioning skills			
Cihak, Fahrenkrog, Ayres, and Smith (2010)	4 (6–8)	Transition between school locations.	iPod® used to deliver instructional video, involving video self-modeling, on how to transition.

responses. A 10-s delay was then implemented and performance reached 100%. To demonstrate experimental control, baseline conditions were reinstated for three sessions. Performance decreased to below 30% in the new baseline phase, but when the 10-s delay procedure was subsequently reintroduced, performance increased to 100% and remained at that level during follow-up sessions when no prompts were employed. This study suggested that differential reinforcement and delayed prompting were effective in shaping the participant's response topography, which enabled him to be more successful in activating the iPod-based SGD.

The second study, by van der Meer et al. (2011), aimed at teaching three individuals with developmental disabilities to request snacks and toys using an iPod Touch® with Proloquo2Go™ software (Sennott & Bowker, 2009). A 13-year-old boy with autism and severe intellectual disability, a 14-year-old boy with Klinefelter syndrome and severe intellectual disability, and a 23-year-old woman with severe intellectual disability and seizure disorder participated. A multiple-probe across participants design (Kennedy, 2005) — with baseline, acquisition training, post-training, and follow-up phases — was implemented. During the 5-min baseline sessions, the SGD was made available to the participants, snacks or toys were in view, and participants were asked if they would like to have the snacks or toys. Independent of their responses, the participants were given access to the snacks or toys every 30 s. During intervention, physical prompting was introduced where the trainer guided the participant's hand to touch the correct icon on the iPod Touch® to activate the speech output. The first three trials were implemented with a 0-s time delay while remaining trails were implemented with a 10-s time delay. During the post-training phase, no prompting was given and access to snack and toy items were contingent on successful SGD activation. The two boys learned how to use the SGD to make requests, but the other participant did not make any progress within 40 training sessions. This study demonstrated successful application of physical prompting and differential reinforcement for teaching two of three participants to use an iPod-based SGD to request preferred snacks and toys.

The third study (Achmadi et al., 2012) focused on teaching two adolescents with ASD to operate an iPod Touch® with Proloquo2Go™ software (Sennott & Bowker, 2009). The device was configured as a SGD to enable the participants to request preferred stimuli. In this respect the present study was similar to van der Meer et al. (2011). However, the unique aspect of the present study was that the two participants were taught to turn on the iPod Touch®, unlock the screen, navigate to the correct screen page, and then select icons to request preferred stimuli. The teaching procedures, which were evaluated in a multiple-baseline across participants design, involved least-to-most prompting, differential reinforcement, and backward chaining (Duker, Didden, & Sigafoos, 2004). With these procedures, both participants learned to perform these more advanced operational steps for using an iPod Touch® as a SGD to request preferred stimuli. This is an important extension of previous research because it showed effective procedures for teaching participants to become more independent in operating this technology.

The fourth study in the communication domain (Flores et al., 2012) involved five boys (aged 8–11 years) with ASD, multiple disabilities, or intellectual disability. The technology involved an iPad®-based communication system and a picture-based communication system. The participants had experience with the picture-based system, but had no experience with iPads® and were therefore given training until they had independently requested a snack three times with the device. During this training, the iPad® was loaded with the *Pic a Word* application, which produces corresponding speech output when a photograph on the screen is touched. The picture-based and iPad®-based conditions were alternated and the frequency of requests made in each 15-min session were compared. Three participants made more requests in the iPad® condition while the other two showed no difference in the number of requests made. This study suggests that the iPad® system was comparable to the low-tech picture-based system.

The fifth article in the communication domain (Kagohara, van der Meer, et al., 2012) was a two-experiment paper. One of the experiments involved an iPod Touch® and the other used an iPad®. The two experiments described by Kagohara, van der Meer, et al. were aimed at teaching two students (13 and 17 years) to name educationally relevant pictures. Both boys had previously learned to use the iPod Touch® to request preferred stimuli as described in Kagohara et al. (2010) and van der Meer et al. (2011). The iPod Touch® and iPad® were programmed with Proloquo2Go™ software (Sennott & Bowker, 2009) so that it could function as a SGD. A multiple-probe across participants design, involving baseline and intervention phases, was used to evaluate the effects of the intervention. Follow-up sessions were conducted only in the first experiment. In the first experiment, the participants' correct naming of 12 photographs (by pointing to the corresponding, but not identical icons, on the iPod Touch®) was assessed under two conditions: open-ended instruction and closed-ended instruction. The photographs were grouped thematically and presented on three separate pages, namely Geography, Animal, and Community. The SGD was programmed to present four icons with line drawings representing each photograph in three separate pages. In the open-ended condition, the trainer asked "What do you see?" while presenting one of the pages. The participants were expected to name all the photographs on the page. In the closed-ended condition, the trainer asked "What is this?" while pointing to a specific photograph on the page. The participants were expected to name only the photograph the trainer pointed to. To maintain the participants' interest, they were given an opportunity to request preferred snacks after the closed-ended condition for each page that had been completed.

During baseline, the participants' level of correct responses was below 30%. With intervention, which consisted of least-to-most prompting (verbal, verbal plus gestural, and physical prompts), the number of correct responses increased sharply for the first participant and remained high at the one-month follow-up sessions. He performed at around 100% in the open-ended and 80% in the closed-ended conditions on most sessions. The second participant showed a slower increase in correct performance, but eventually reached 100% correct responses in the open-ended condition and 75% in the closed-ended condition. His performance decreased to between 58 and 75% correct during follow-up sessions.

In the second experiment described in Kagohara, van der Meer, et al. (2012), the same two participants were presented with 18 new images selected from a children's book. An iPad® was used as the SGD and only the closed-ended condition was implemented. The production of spoken words was also measured. Six photographs from each of three categories (body parts, foods, and household items) were presented for the students to name by selecting corresponding, but not identical, icons from the iPad®. The procedures were similar to the first experiment. During baseline the participants did not make any correct picture-naming responses using the SGD. With intervention, the number of correct responses for each participant increased. The first participant reached a 100% correct level within six intervention sessions but his performance decreased slightly as intervention continued. The second participant reached a 100% correct level by the fifth session and maintained at this level throughout the intervention. The results of these two experiments suggest students with developmental disability can successfully participate in a picture-naming exercise using an iPod Touch® and iPad® as a SGD.

The final three studies in the communication domain (van der Meer, Didden, et al., 2012; van der Meer, Kagohara, et al., 2012; van der Meer, Sutherland, et al., 2012) were conceptually and procedurally similar and produced similar results so they will be summarized here together. Each study involved four children with developmental disabilities (total of 12 children, 4–13 years of age). All three studies aimed to teach participants to request preferred stimuli by selecting icons from the screen of an iPod Touch® or iPad®. Touching the icons activated corresponding synthetic speech output via the Proloquo2Go™ software application (Sennott & Bowker, 2009). The unique aspect of these three studies is that van der Meer, Kagohara, et al. compared how quickly children learned to use the iPod Touch® or iPad® versus manual signs; whereas van der Meer, Didden, et al. and van der Meer, Sutherland, et al. compared manual signs, picture-exchange, and the iPod Touch®/iPad®-based SGD. Each study used a multiple baseline across participants design to evaluate the effects of the teaching procedures and an alternating treatments design to compare acquisition of the two or three communication methods. The studies also included assessments to determine which communication method children preferred to use. These assessments were conducted during and after acquisition training. The discrete-trial training procedures involved offering preferred items, verbal cueing (*Let me know if you want something.*), time-delay, graduated guidance, and differential reinforcement (Duker et al., 2004). In the first in this series of studies (van der Meer, Kagohara, et al.), these procedures were effective in teaching the targeted manual signs and SGD responses to three of the four children, whereas one child only learned to use the SGD. Three children also showed a preference for using — and better maintenance when using — the SGD.

In the second of these three studies, which compared manual signs, picture-exchange, and the iPod Touch®-based SGD (van der Meer, Didden, et al., 2012), all four children learned to use the picture-exchange system, and the iPod Touch®, but only two also learned to use manual signs. Three of the four children showed a preference for using the iPod Touch®. In the final study in this series, van der Meer, Sutherland, et al. (2012) found that two children learned to use all three communication methods, whereas the other two only learned either the picture-exchange system or the iPod Touch®. Three of the four children showed a preference for using the iPod Touch® and showed better maintenance of their newly acquired requesting skills with their preferred system. Collectively, these three studies provide evidence that generally well-established instructional procedures were successful in teaching nonspeaking children with developmental disabilities to use an iPod Touch® or iPad® as a SGD to make requests for preferred items.

3.3. Studies focused on developing employment skills

Two articles described interventions involving the use of iPods® for developing employment skills. In the first study, van Laarhoven et al. (2009) used a fifth generation video iPod® as a prompting device for a 17-year-old male with 1p36 Deletion syndrome and associated intellectual disability. The study was conducted in a community-based animal shelter where the participant had to complete three job-related tasks (cleaning the bathroom, mopping the floor/emptying garbage, and cleaning kennels). A multiple-probe across tasks design was employed with baseline, video prompting, and follow-up phases. Prior to the video prompting phase, training was provided on how to operate the iPod® to watch the videos (i.e., turn on the iPod®, select the appropriate video, pause video to perform the step, advance to the next video segment/step). Adults served as the video models and the video clips included voice-over narration that described each step in the task. During baseline, the participant was asked to perform the task with no access to the iPod®, no prompting, and no reinforcement. If he did not perform a step within 5 s or completed it incorrectly, the trainer completed it out of the participant's sight.

During the intervention (video prompting) sessions, the participant was given the iPod® and told which task he was required to perform that day. He was expected to attach the iPod® to his belt and operate the device independently. The participant was prompted to use the iPod® if: (a) he began performing a step without watching the video, (b) if more than 5 s elapsed with no attempts to perform a step, (c) if the participant verbally requested assistance, or (d) if a sequence error was made. To correct errors, a least-to-most prompting hierarchy was implemented where the participant was first instructed to watch the video again. If a correct response was not observed after the second viewing, a model or physical prompt was provided. The video prompts were associated with an improvement in performance. Criterion (three consecutive sessions with 85% or above correct) was reached within four sessions for all tasks. One 10-week follow-up session was conducted for the first task. Performance remained high at 89% correct. The participant's independence also increased as demonstrated by the decreased number of prompts given when the videos were introduced. Interestingly, the participant seemed to use the narration as an audio prompt while he was performing the tasks. The results suggested that this use of an iPod®, involving video and audio prompting tools, was effective for increasing task completion in an employment setting.

The second article examining the use of an iPod Touch® and iPhone® for developing employment skills was a two-experiment paper by Burke et al. (2010). Both experiments aimed to teach six participants with ASD (18–27 years of age) to make appropriate responses within a fire safety education program. The participants were expected to perform 63 scripted responses while interacting with the education program trainer/presenter. Both studies employed a cueing system using an Apple iPhone® that was wirelessly connected to an iPod Touch®. The iPhone® was programmed with prompts for each of the 63 steps so that when the trainer tapped it, the prompt was sent to the iPod Touch®, which was placed at eye level inside the participant's clothing. The trainer could thus remotely prompt participants by presenting instructions at appropriate times.

In the first experiment of Burke et al.'s (2010) study, three participants (20–27 years of age) took part. Training consisted of a standard training video created and a scripted behavioral skills training program. The cue system was implemented if the participants did not reach the criterion of 80% correct responses in a session. Responses were considered correct if the specific action was performed at the right time. A multiple baseline across participants and reversal design was used to evaluate the training program and cueing system. Baseline, behavioral skills training, cue system, follow-up and generalization probes were implemented. The sessions were conducted in front of the participants' parents and the researchers. Generalization was measured with an audience of elementary school students. One participant reached criterion with the behavioral training alone and maintained performance on follow-up and generalization probes. However, the cueing system had to be introduced for the other two participants. The first of these participants reached criterion immediately after the cueing system was introduced. The final participant reached criterion within three sessions with the cueing system. Performance deteriorated with the removal of the cueing system and then improved again when the system was reintroduced. Performance remained high during the follow-up and generalization probes.

The second experiment in the Burke et al. (2010) study examined the effects of the cueing system without prior behavioral skills training. The same task was used with three new participants (18–20 years of age) with ASD. A multiple baseline across participants and reversal design was used to examine the efficacy of the cueing system. If the participants did not meet criteria by the end of the second session, additional training was provided. In addition to the cueing system, verbal praise was contingent upon correct responses and both live modeling and rehearsal were used to correct mistakes. Two participants performed to criterion when the cue system was in place. Performance deteriorated when baseline procedures were reinstated. Because the third participant did not reach criterion with the cueing system, behavioral skills training was added and, with this, the participant reached criterion. When baseline procedures were reinstated, performance deteriorated. Criterion was reached when the cueing system was implemented again and performance remained high during follow-up and generalization probes. These two experiments of Burke et al. suggest that a cueing system comprised of an iPhone® and an iPod Touch® was an effective form of prompting in an employment setting where it may be necessary to remotely deliver prompts.

3.4. Studies focused on teaching leisure skills

Three studies were identified that focused on using iPod® devices for developing leisure skills. The first study (Hammond et al., 2010) aimed to teach three participants (12–14 years of age) with moderate intellectual disability how to independently watch a movie, listen to music/songs, and look at pictures on a third generation iPod Nano®. Video clips showing how to perform each task were recorded from the subjective point of view (as if seen through the eyes of the participant). These clips included a voice-over narration. Video modeling was presented on a laptop in the participants' classroom. A multiple-probe across participants and behaviors design was implemented with baseline, video modeling, and follow-up phases. During baseline probes, the participants were given the iPod Nano® and a relevant instruction (e.g., *Let's watch a movie*.). No other prompts were given. Trials were terminated if an error was made or if the task was completed correctly.

During the video-modeling phase, probe trials were conducted before and after the video presentation in each session. If performance did not reach 100% correct in the pre-video probe, participants were shown the video depicting the appropriate task. Immediately after watching this video, a post-video probe was conducted to assess recall and provide participants with an opportunity to practice. During baseline, none of the participants performed any of the steps correctly. When video modeling was introduced for the first task, criterion was reached within 11–15 sessions. For the second (listening to music/songs) and third tasks (looking at pictures), criterion was reached in 4–12 sessions. Follow-up data were variable and two participants required booster video sessions for listening to music/songs, while the other required booster sessions for looking at pictures. Overall, the results suggest that video modeling delivered on a laptop may be an effective approach for teaching adolescents with moderate intellectual disability to operate and iPod Nano® for engaging in age-appropriate leisure activities.

The second leisure domain study, by Kagohara (2011), was aimed at teaching three students (15–19 years of age) with severe intellectual disability to independently operate an iPod Touch® to watch movies. A seven-step video-based task analysis was created as the instructional material. The video was recorded from the subjective viewpoint and delivered on the iPod Touch®. A multiple-probe across participants design was implemented with baseline, video modeling and prompting, video-fading, and follow-up phases. Baseline sessions consisted of the trainer giving the iPod Touch® to the participants and asking if they could turn it on and watch a movie. In the initial baseline phase, a correct response was recorded if the participant performed a step within 10 s of the trainer's initial request or within 10 s of completing the previous step. If no correct attempts were made, the session was terminated. In the second baseline the participants had a chance to perform each step. If they did not complete a step correctly, the trainer completed it out of sight and returned the iPod Touch® so the participant could attempt the next step.

In the video modeling phase, the participants were given the iPod Touch® to watch the instructional video. The iPod Touch® was then reset and the participant was asked to watch a movie on the device. If the participant did not perform a step within 10 s, a least-to-most prompting procedure was implemented consisting of verbal instruction followed by gestural prompts, and finally physical guidance. A video-fading phase was introduced to fade out the use of the instructional video, but during this phase least-to-most prompting was provided if necessary. Follow-up sessions were conducted 2 and 10 or 11 weeks after the last training session.

During baseline, participants performed from 2 to 4 steps, but none of them successfully operated the iPod Touch® to watch movies. After introduction of the instructional video and prompting, performance increased steadily for all participants. In the video-fading phase, all participants reached the criterion of three consecutive sessions with 100% correct performance in 4–20 sessions. The results suggested that video modeling and least-to-most prompting were effective for teaching the students to operate the iPod Touch® to watch movies. The study was also unique in that the instructional videos were effectively delivered via the iPod Touch®.

In the third study targeting leisure skills, Kagohara et al. (2011) aimed to teach three students with severe intellectual disability to play music on an iPod Touch®. The same three participants from Kagohara (2011) participated in this study. A video-based task analysis was created showing the steps for operating the iPod Touch® to play music. A multiple-probe across participants design, with baseline, video modeling, fading, and follow-up phases, was implemented. During the baseline phase, the trainer gave the iPod Touch® to the participants and asked them if they could turn it on and play a song. If the participants did not perform a step within 10 s, the trainer completed it out of sight and returned the iPod Touch® to the participants so they could attempt the following step. In the video modeling phase, the video segment was presented on the iPod Touch® at the beginning of the session. The participants were then given the opportunity to perform each step independently. The trainer did not prompt or deliver reinforcement. Video modeling was removed in the following phase and prompts were still not provided. Follow-up was conducted at 4 and 9 weeks after training.

During baseline, none of the participants successfully operated the iPod Touch® to play music/songs, although they did perform some steps in the task analysis correctly, possibly due to their previous training in using the iPod Touch® to watch movies as described in Kagohara (2011). When video modeling was introduced, the participants successfully operated the iPod Touch® to play music/songs. Performance was maintained when video instruction was faded out and during follow up. The results suggest video modeling alone (without additional response prompting) can be an effective teaching procedure for teaching students with severe intellectual disability to operate an iPod Touch® to play music, which is a valuable and age-appropriate leisure activity.

3.5. Studies focused on teaching transitioning

One study (Cihak et al., 2010) aimed to promote independent transitioning in four students (6–8 years of age) with ASD. Specifically, the intervention involved using video modeling and a video iPod® to improve the students' movements (e.g., going from the bus to the classroom) without inappropriate behavior (e.g., pinching other students). Ten video modeling segments depicting appropriate transitioning behavior were created for each student. The videos were presented on an iPod before each of the 10 transition opportunities. An ABAB design with a follow-up phase was used to evaluate the video modeling.

During baseline, the student was observed in the transition situations and assistance was only provided if the participant demonstrated inappropriate behavior and did not transition independently. During the video-modeling phase, the iPod® was given to the participants and they were instructed to turn it on and watch the video segment. If participants did not respond independently, they were instructed to watch the video again. If participants still did not transition independently, least-to-most prompting was implemented. Participants were returned to baseline conditions after 100% correct responding occurred during three consecutive sessions in the video-modeling phase. Once performance decreased under baseline conditions, the video-modeling phase was reinstated. Follow-up probes occurred nine weeks after criterion was reached.

All participants reached criterion in the initial video-modeling phase within 9–15 sessions. Performance decreased sharply when video modeling was removed. Once video modeling was reinstated, criterion was again reached within 4–10 sessions. The high level of performance was retained at the follow-up. The results of this study suggest that prompting and video modeling delivered on an iPod® were effective procedures for promoting independent transitioning without inappropriate behaviors for students with ASD.

4. Discussion

This systematic review aimed to evaluate the use of iPods®, iPads®, and related devices in educational programs for individuals with developmental disabilities. A systematic search identified 15 studies. The results of these 15 studies were largely positive, suggesting that iPods®, iPod Nano®, iPod Touch®, iPads®, and iPhones® are viable technological aids for individuals with developmental disabilities. The results of these 15 studies also suggest that individuals with developmental disabilities can be taught to use such devices for a variety of purposes; specifically for enhancement of academic, communication, leisure, employment skills, and transitioning skills.

While the results of this review suggest the potential value of incorporating iPods®, iPads®, and related technological devices into educational and rehabilitation programs for individuals with developmental disabilities, this tentative conclusion must be considered in light of several aspects of the existing literature base. First, published literature to date has involved a relatively small number of participants (<50) with a broad age-range between 4 and 27 years and with various diagnoses or degrees of intellectual disabilities. While preschool children should probably not receive too much exposure to such devices (American Academy of Pediatrics, 2001), there would seem to be value in evaluating whether older individuals could be taught to use this technology for accessing preferred stimuli and supporting activities of daily life.

The fact that many of the participants in these 15 studies were diagnosed with autism and severe intellectual disability, suggests that individuals with serious learning impairments can be taught to operate iPods®, iPads®, and related devices. What is missing from the literature, however, are studies on individuals with more profound and/or multiple disabilities. This latter population presents unique challenges with respect to the design of technology-based interventions. For example, technological aids for this population are often highly specialized (Lancioni, Sigafoos, O'Reilly, & Singh, in press). Demonstrations that persons with profound/multiple disabilities could learn to use generic off-the-shelf technology, such as iPods® and iPads®, would represent an important practical advance. However, as reported by Kagohara et al. (2010), some individuals showed difficulty in learning to operate such devices with sufficient finesse/motor control so as to activate the device/software. This suggests that the use of such devices for persons with significant motor impairments may be contraindicated unless effective access solutions (e.g., adaptive microswitches, Bluetooth scanning switches) can be arranged (Lancioni et al., in press).

Second, the present set of 15 studies focused on target behaviors from five domains: (a) academic, (b) communication, (c) employment, (d) leisure, and (e) transitioning. While these domains cover a number of educational priorities for individuals with developmental disabilities (Pituch et al., 2011), there are some noticeable limitations and gaps in the types of skills that have been targeted. For example, only a few studies addressed academic and employment skills and no studies addressed social skills. The latter is an especially important priority for individuals with ASD and intellectual disability (Matson & Kozlowski, 2010). Future studies should also focus on using iPads® and related technologies to teach daily-living skills, such as sandwich preparation, grocery purchasing, conceptual skills (e.g., money, numbers, and time).

Eight of the 15 studies focused on using the iPod Touch® or iPad® as SGDs for enabling nonverbal individuals to communicate. However, the communicative functions targeted in these studies were limited to naming pictures (one study) or requesting access to preferred stimuli (seven studies). Use of such devices for other communicative purposes (e.g., greeting, conversation, commenting) would be an important direction for future research. It would also seem important to assess the social validity of iPod/iPad-based SGDs.

Third, there appear to be two main ways in which these devices and associated software applications have been used in the literature to date, that is, to either (a) deliver instructional (video) prompts, or (b) teach the person to operate the device to access preferred stimuli. There is an important gap in the literature given the proliferation of software applications for the Pod Touch®, iPad®, and iPhone® that are intended to teach spelling, reading, matching, and arithmetic (Shuler et al., 2012). Thus, it could be noted that in these studies, the devices have been used primarily as intervention delivery systems (e.g., presenting instructional video) or as means for the person to access preferred stimuli. This is in contrast to using the devices as interventions in themselves. For example, there do not yet appear to be any studies showing that iPad®-based applications for teaching spelling, for example, actually result in an improvement in spelling.

Still, as intervention delivery systems and as means for accessing preferred stimuli, iPods®, iPads® and related devices would seem to have some potential advantages over other types of assistive technology. Specifically, such devices are readily available, relatively inexpensive, and appear to be intuitive to operate. These devices also seem to be socially accepted and thus perhaps less stigmatizing when used as assistive technological aids (e.g., as SGDs) by individuals with developmental disabilities. Anecdotally, the participants in these studies largely appeared to enjoy using such devices and in some cases also seemed to prefer using such devices over low-tech options (van der Meer, Didden, et al., 2012; van der Meer, Kagohara, et al., 2012; van der Meer, Sutherland, et al., 2012). However, such devices also have limitations, including the need for technical competence with respect to device operation and programming and the possibility of disruption due to damage or malfunctioning.

Emerging trends with respect to such technologies include additional in-built features that may mitigate such limitations and facilitate learning in individuals with developmental disabilities. For example, some devices include microphones, forward and backward facing cameras, and multi-point touch-screen capabilities. This suggests that future educational software applications are likely to be more interactive. This in turn could mean that individuals with developmental disabilities might be able to acquire skills independently and at their own pace with minimal supervision or direct instructional support from teachers.

Overall, the studies included in this review provide evidence that iPods®, the iPod Touch®, iPhones®, and iPads® can be successfully utilized within educational programs targeting academic, communication, employment, and leisure skills for individuals with developmental disabilities. Success in learning to use such devices seemed largely to depend on the use of well-established instructional procedures based on the principles of applied behavior analysis (ABA; Duker et al., 2004). We therefore can tentatively conclude that careful implementation of ABA-based instructional procedures can make iPods®, the iPod Touch®, iPhones®, and iPads® viable technological aids for individuals with developmental disabilities.

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