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Teaching Mobile Device-Based Leisure to Adults With Autism Spectrum Disorder and Intellectual Disability

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Abstract

The use of mobile devices has become a major medium of leisure engagement for the general population. However, individuals with intellectual disabilities (ID) experience disparities in technology access, which may limit their engagement in mobile device-based leisure. Little research has examined procedures for teaching individuals with ID to engage in leisure activities with technology. Employing an iPad2, the present study examined the effects of an intervention package with most-to-least prompting on independent leisure engagement of six adults with autism spectrum disorder (ASD) and ID. In addition, the impact of teaching visual schedule use to increase their independence in leisure engagement was assessed. Results indicated that the interventions were effective in increasing the participants' independent leisure engagement and their duration of leisure engagement. Caregivers reported high degrees of satisfaction with the interventions.

Keywords

adult, age, applied behavior analysis, daily living, skills, picture schedules, visuals, alternative/augmentative (AAC), communication

Characteristics of individuals with autism spectrum disorder (ASD) include social and communication deficits as well as the presence of repetitive, stereotypical behaviors (American Psychiatric Association, 2013). These characteristics may challenge individuals in obtaining and maintaining competitive employment, developing meaningful friendships, and accessing activities in the community (Persson, 2000). Quality of Life (QOL) has gained increasing attention as an outcome measure of support services for people with ASD and intellectual disabilities (ID; Beadle-Brown et al., 2016; Burgess & Gutstein, 2007). QOL allows for consideration of broader outcome measures in determining the success of support services, including social networks, academic or employment satisfaction, family relationships, and self-determination. Although there is no universally agreed-upon measure of QOL, previous studies suggested that leisure engagement is a key component for enhancing the QOL of individuals with and without disabilities (Burgess & Gutstein, 2007; Patterson & Pegg, 2009; Schalock & Parmenter, 2000). However, it is often the case that individuals with ASD do not develop leisure skills, in part, due to their restricted interests and a lack of social skills (Orsmond et al., 2004).

Concurrent with the advancement of technology, the use of mobile devices has become a major medium of leisure engagement for the general population. The Pew Research Center's Internet & Technology Project reported that in 2019, 81% of U.S. adults owned a smartphone, and 52% of U.S. adults owned a tablet computer. The American Time Use Survey (Bureau of Labor Statistics, 2015) indicated that there was a significant increase in the use of digital media for leisure activities, including playing games and accessing social media. Data in 2014 showed a 21% increase in weekday leisure use and a 30% increase in weekends leisure use, compared with 2004. More recently, a 2018 survey showed that 55% of U.S. smartphone users played mobile games to pass the time, with 40% of women playing games on their smartphone every day, and 33% of adults 55 and older playing games on their smartphone every day (Jansen, 2019).

On the contrary, access of these devices for adults with ASD and ID has been limited, likely due to restricted resources and/or lack of accessibility (Chadwick et al., 2013; Fox, 2011; Kane et al., 2009). For instance, the results of a national survey revealed that only 54% of adults with disabilities used the internet compared with 81% of adults without disabilities (Fox, 2011). In their systematic review

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Table 1. Participant Characteristics.

Participant	Gender	Age	Diagnosis	Assessment	Score
Tom	Male	40	ASD, Moderate ID	VABS	24
Kate	Female	43	ASD, Severe ID	IQ	41
				PPVT	40
Donna	Female	45	ASD, Mild ID	PPVT	26
Lenny	Male	36	ASD, ADHD	VABS	34
			Moderate ID	IQ	40
Daniel	Male	36	ASD, ADHD	VABS	<20
			Moderate ID	IQ	34
Gabe	Male	34	ASD, Severe ID	VABS	<20
				IQ	36

Note. ADHD = attention-deficit/hyperactivity disorder; ASD = autism spectrum disorder; ID = intellectual disabilities; VABS = Vineland Adaptive Behavior Scale, PPVT = Peabody Picture Vocabulary Test.

of the research literature, Chadwick et al. (2013) noted that lack of education and training is a significant barrier to internet access of people with ID.

Given the importance of leisure engagement on QOL and changes in leisure activities due to the advancement of technology for the general population, teaching mobile-based leisure skills is an important skill for adults with ASD and ID. There is a large and expanding body of research on interventions for teaching various skills incorporating commonly available technology devices (Ibrahim & Alias, 2018). For example, Nepo et al. (2017) used a training package with most-to-least prompting to teach three adults with ASD and ID to communicate basic requests with an iPod Touch. However, much of the research in this area has focused exclusively on social and communication skills, whereas only a handful of studies has investigated strategies for teaching leisure skills to adults with ASD and ID (Jerome et al., 2007; O'Reilly et al., 2000; Vuran, 2008; Yalon-Chamovitz & Weiss, 2008).

Prevalent use of technology for leisure in the general population, lack of access to technology among people with disabilities, and potential enhancements in QOL of technology access among adults with ASD and ID, highlight the need for more research. Therefore, the present study was conducted to provide more information on teaching leisure skills to adults with ASD and ID. Specifically, we sought to evaluate the effects of a teaching package with most-to-least prompting on acquisition of independent leisure activities with the iPad2 of six adults with ASD and ID. A substantial body of research has shown that visual activity schedules are effective in promoting independence in a variety of skills for individuals with ASD and ID (Knight et al., 2015). Therefore, following acquisition of leisure activities on the iPad2, we taught participants to follow an activity schedule incorporating the skills to increase their independence with leisure.

The study investigated the following research questions: (a) What are the effects of a teaching package that includes most-to-least prompting on improving independent leisure engagement and its duration on an iPad2? (b) What are the effects of a visual schedule on the duration of leisure engagement and independent transitioning between activities? (c) What was caregivers' satisfaction with the intervention, the usefulness of the intervention, and perception of the use of technology as leisure compared with other traditional leisure activities or materials?

Method

Participants

The participants were six adults with ASD and ID, between 34 and 45 years old, who attended a vocational program and resided in a supported community home operated by a nonprofit human services agency in the mid-Atlantic region of the United States. The first author, who was the primary investigator, recruited participants by contacting clinicians, case managers, and direct care staff and assessed their independent leisure skills through interviews with their caregivers and observation. Individuals with ASD, with no independent leisure skills or independent engagement in less than three leisure activities per day based on the interviews and observation, were included in this study. Passive and sedentary behaviors such as sitting near the TV while it was on were not counted as independent leisure activities. The participants also had sufficient dexterity to tap on and navigate the iPad2, including the ability to point and to move a pointed finger on the tablet at least 12.5 cm. This skill was assessed prior to the preference assessment described below. To protect their identity and privacy, the participants' names were arbitrarily assigned. Demographic information is summarized in Table 1.

Experimental Design

To investigate the progress of each participant on the dependent variables, a multiple-probe design across participants

was used. The design allowed the authors to examine the efficacy of a most-to-least prompting procedure to teach adults with ASD to engage in leisure activities and to follow a visual schedule on the iPad2. Six participants were separated into two groups so that two sets of multiple-probe designs were formed. The interventions were implemented in a staggered manner within each group to assess the effects of the intervention on the dependent variables. The intervention for each participant was implemented only when visual analysis revealed that an acceptable baseline had been achieved (Spriggs et al., 2014) and baselines were stable based on a Tau-U baseline analysis (Parker et al., 2011).

Settings and Materials

The preference assessment, baseline and training sessions were conducted in a quiet 4 m × 6 m office in the participants' vocational program. The generalization sessions were conducted in each participant's work area (2.5 m × 3.5 m to 4 m × 6 m) during their scheduled break time. Additional generalization sessions were conducted in the vocational program in the participants' work areas or the cafeteria where they took their scheduled breaks.

After identifying the participants' preferences for leisure activities with a Multiple Stimulus without Replacement (MSWO, DeLeon & Iwata, 1996), the preferred music and corresponding game apps were downloaded and installed for the iPad2 32 GB. Once the participants acquired independent completion of a leisure activity on the iPad2 (see below) for at least 80% of the task analysis for two consecutive sessions, additional apps were installed. After all the participants acquired the use of at least four game/leisure apps (i.e., music, puzzle, matching, memory, word search, and a video), a visual schedule app, *First Then Visual Schedule*®, was installed on their devices or printed on a visual schedule for the second experiment.

Dependent Measures

Independent completion of leisure activity. Each leisure activity was task analyzed, with the activity broken down into 12 to 14 steps. For example, the task analysis of doing a puzzle on an app was (a) open game app, (b) select a puzzle, (c) select a puzzle piece, (d) put the piece in place, (e) repeat steps c and d until the puzzle is complete, and (f) close app. The level of independence for each step was recorded and the percentage of independent completion was generated every session.

Duration of leisure engagement. The duration of engagement for each activity was also recorded using a stopwatch on a cell phone. The timer was started when the participant opened a game app and stopped when the participant closed the app after the completion of the activity.

Schedule following. Schedule following consisted of (a) opening the schedule app, (b) checking the schedule, (c) opening the activity app on the schedule, (d) completing the activity app before the alarm went off, (e) closing the activity app, (f) reopening the schedule app, and (g) checking the next activity on the schedule. Steps (a) and (b) were recorded only prior to the participant completing the first activity app on the schedule because these were subsumed by steps (f) and (g) for the remaining activity apps on the schedule. The sequence was repeated until the participant completed all activities on the schedule and their independent level was recorded. The percentage of independent completion was calculated for each session.

Due to the incompatibility of the schedule app with other leisure apps, a printed out visual schedule was implemented for four out of six participants. Following the printed schedule was the same except for opening and closing the schedule app. Data were calculated in the same way as was done for the schedule app.

Interobserver Agreement

Interobserver agreement (IOA) data were collected by trained observers on 28% of the trials for Experiment 1 and 32.3% of trials for Experiment 2. IOA for independent completion of tasks was calculated by dividing the number of agreements by the sum of the number of agreements and the number of disagreements and multiplying by 100. IOA for duration data was calculated by dividing the shorter duration by the longer duration and multiplying by 100. The primary observer, the first author, was a board-certified behavior analyst. Additional master's-level staff were trained as observers through didactic teaching on data collection and by defining each of the dependent variables with examples and non-examples and also with in vivo training on data collection. The training continued until the observers obtained at least 90% agreement with the primary observer for two consecutive sessions. The average IOA of Experiment 1 was 98.5% (range = 80–100%) for independent completion of task analysis for leisure skills and was 96.5% (range = 86–100%) for the duration. The average IOA of Experiment 2 for schedule following was 99.7% (range = 93.3–100%) and that for the duration was 98.8% (range = 91.3–100%).

Procedural Fidelity

A procedural fidelity checklist was used to assess the accuracy of implementation of baseline sessions, training sessions, and generalization sessions for at least 50% of the sessions for both experiments. The instructor marked *yes* if a step on the checklist was implemented accurately or *no* if it was not. The percentage of procedural fidelity compliance was calculated by dividing the number of steps that were marked yes by the total number of steps. The procedure was

implemented as planned with 100% accuracy for both Experiments 1 and 2. The independent observers also collected data on the procedural fidelity on 28% of the sessions for Experiment 1. The average IOA was 98.9% (range = 87.5–100 %). For Experiment 2, the independent observers collected data on procedural fidelity on 32.3% of the sessions. IOA was 100% for those sessions.

Stimulus Preference Assessment

Prior to the baseline phase, the first author conducted a preference assessment to determine music and game apps that were installed on the iPad2 for each participant. First, information was collected through interviews with each participant's family and relevant support-staff members to identify each participant's daily activities. They also answered questions on the Reinforcement Assessment for Individuals with Severe Disabilities (Fisher et al., 1996) about preferred leisure activities and preferred music to identify and rank each participant's preferences. The participants' preference for those identified leisure activities was assessed through an MSWO (DeLeon & Iwata, 1996). The instructor presented physical materials or representation of leisure activities (e.g., a corresponding picture of TV shows, printed coloring page/word search, or a CD player) during each assessment. Four sets of MSWO assessments were conducted for each participant, and the hierarchy of his or her preferences was determined by averaging the results of four assessment sessions. The corresponding app for the most preferred activity was installed on the iPad2 initially, and then additional activities were added in the sequence of their preferences, with the minor modification described below, until the participant acquired 80% of independent completion of two consecutive data sessions.

Experiment 1 Procedures

Baseline. During each baseline session, the iPad2 with the preferred leisure apps on the home screen was placed on a table in front of each participant. No prompts were provided on how to use the device or to engage in the leisure app. If the participant pushed the device away, the instructor waited for 10 s and then placed the device within the participant's reach on the table again. If the participant did not engage in activities with the iPad2, a random, non-iPad-based activity was provided from the preference assessment for 30 s to maintain her or his participation and to prevent challenging behaviors from occurring. Then, the next trial followed. The session ended after 15 min had elapsed or when the participant exhibited challenging behaviors and could not be redirected within 5 min. The duration for the baseline sessions was selected as 15 min based on participants' pre-baseline levels of challenging behavior observed in the vocational setting. In addition, the participants were provided opportunities to engage in any activities from the preference assessment for up to 5 min after each session to prevent challenging behaviors, as well as reinforce their participation.

iPad2 training. During each training session, the participants were provided with a turned-on iPad2 with an identified leisure app corresponding to the results of the preference assessment. If the participant did not initiate the first step of the task analysis within 5 s of the trial or the next step within 5 s of the completion of the previous step, the instructor used most-to-least prompting to initiate and complete the step.

The most-to-least prompting procedure consisted of hand-over-hand, gestural, and verbal assistance. The prompts were presented in a sequential manner, so they could be faded out systematically and gradually. Hand-over-hand prompts were defined as placing a hand over the participant's hand and guiding the hand to engage in or complete the steps. Gestural prompts involved pointing or tapping the activity or device to increase the likelihood of performing a response that would support skill acquisition. Verbal prompts were defined as supplemental vocal stimuli that promoted correct responding. For example, the instructor might say, "What's next?" or "Choose a puzzle."

The participant's independent engagement in the steps of the task analysis was followed by social praise. The primary investigator determined whether tangible reinforcers, such as snack, were necessary for each participant and used them as needed. Those tangible reinforcers were faded out gradually. Attempts were also followed by social praise. The prompts were faded out gradually and systematically in the sequence of most-to-least until the participant acquired the skill with 80% independence for two consecutive data sessions. 80% independence was selected as the acquisition criterion based on previous research (e.g., Bouck et al., 2014).

Once the participant met the criterion for acquisition, an additional leisure app was installed and introduced. The second app was taught through a most-to-least prompting procedure described above with social praise and tangible reinforcers used as needed. This process was repeated until the participant had learned to engage independently in at least four leisure activities.

Generalization. Generalization sessions were conducted in each participant's vocational area or in the cafeteria during scheduled break time (untrained and natural setting). Generalization data were collected during scheduled break time because this was the time period during the day when participants had few structured activities and when playing leisure games was most appropriate. We did not measure generalization at other times and places, such as in the participants' homes, where playing leisure games may also

have been appropriate. No prompts or reinforcers were given during the generalization sessions. The instructor and an additional trained observer collected data on the duration of the participants' activity engagement and the independent completion of the task analysis for each activity app.

Experiment 2 Procedures

Baseline. During the baseline sessions, the participants were given an iPad2 programed with preferred leisure apps and a visual schedule app. The instructor and the independent observers continued to collect data on the duration and independent completion of the leisure engagement. In addition, the instructor and independent observers collected data on the independent completion of the task analysis for schedule following with the visual schedule app.

No prompts were provided on how to use the device or the schedule app. If the participant pushed the device away, the instructor waited for 10 s and then placed the device within the participant's reach on the table. The session ended after 15 min had elapsed or until the participant exhibited the maladaptive behaviors and could not be redirected within 5 min.

Visual schedule training. Once stable baseline data were obtained, the intervention was introduced in tiers. During this phase, the instructor and trained independent observers collected data on each participant's independent navigation of the visual schedule, access to leisure activities, and her or his duration of activity engagement. Within the visual schedule app, the visual representation of preferred activity apps that the participants chose during the generalization trials of Experiment 1 was programmed, and the alarm was set for each transition, if the activity did not have a clear ending. Participants were required to close the visual schedule app to access other activity apps. Because it was difficult for four of the six participants to discriminate icons on the schedule app from ones on the home screen, printed-out icons were used as the visual schedule for these participants. Thus, the schedule was readily available to them at all times. The instructor used most-to-least prompting to teach participants to (a) check the schedule app, (b) open the activity on the schedule, (c) close the app when the alarm went off or end of the activity, and (d) check the next activity on the schedule app.

For example, if the participant did not respond to the alarm within 5 s or completion of an activity, the instructor used hand-over-hand or other necessary prompts so that each participant would respond to the alarm and/or close the activity. If the participant did not open the corresponding activity app on the schedule within 5 s of checking the visual schedule, the instructor used prompts to open and start the game. The prompts were faded out gradually and systematically until the participant learned to independently follow the visual schedule on 80% of the steps for two consecutive data sessions. The purpose of this training was to teach participants to engage in various leisure activities for longer durations and to transition from one activity to another which would lead to more independence in daily activities. These included self-care routines and job tasks if the participant worked beyond leisure engagement.

Generalization. The generalization sessions were conducted in each participant's break area at the vocational program during their scheduled break time. No prompts were given during the generalization sessions. Due to the limited timeframe of this study, additional generalization sessions were only held for Tom and Lenny. Those sessions were conducted in the individuals' natural environments such as doctor's office during his annual examination to assess the generalization of the skills after the acquisition of independent completion of the leisure apps and the use of visual schedule. Lenny also used his iPad2 at home independently, but only anecdotal data were available.

Social Validity Measures

After the completion of the study, the participants' guardians, support staff, and master's level clinicians were asked to complete a survey with 5-point Likert-type scale regarding their satisfaction, the usefulness of the intervention, and perception of the use of technology compared with other traditional leisure activities or materials.

Results

To determine experimental effect, we analyzed the data for changes in level, trend, and variability between conditions, in addition to immediacy of effect corresponding with application of each experimental condition. In addition, the degree of the impact and stability of the intervention on the participants' performance were analyzed with percentage of non-overlapping data (PND) along with Tau-U in which a possible undesirable trend in baseline compared with intervention trend could be controlled (Parker et al., 2011).

Experiment 1

As depicted in Figure 1 and 2, the teaching procedure with most-to-least prompting procedures was effective in improving independence as well as duration of leisure engagement for all participants. While the participants did not independently complete the steps of the task analysis of the targeted leisure activity during the baseline phase with the exception of Tom, who completed the first step (opening an app), the level of independence immediately increased after the implementation of the teaching procedure. The average percentage of independent completion of task analysis during

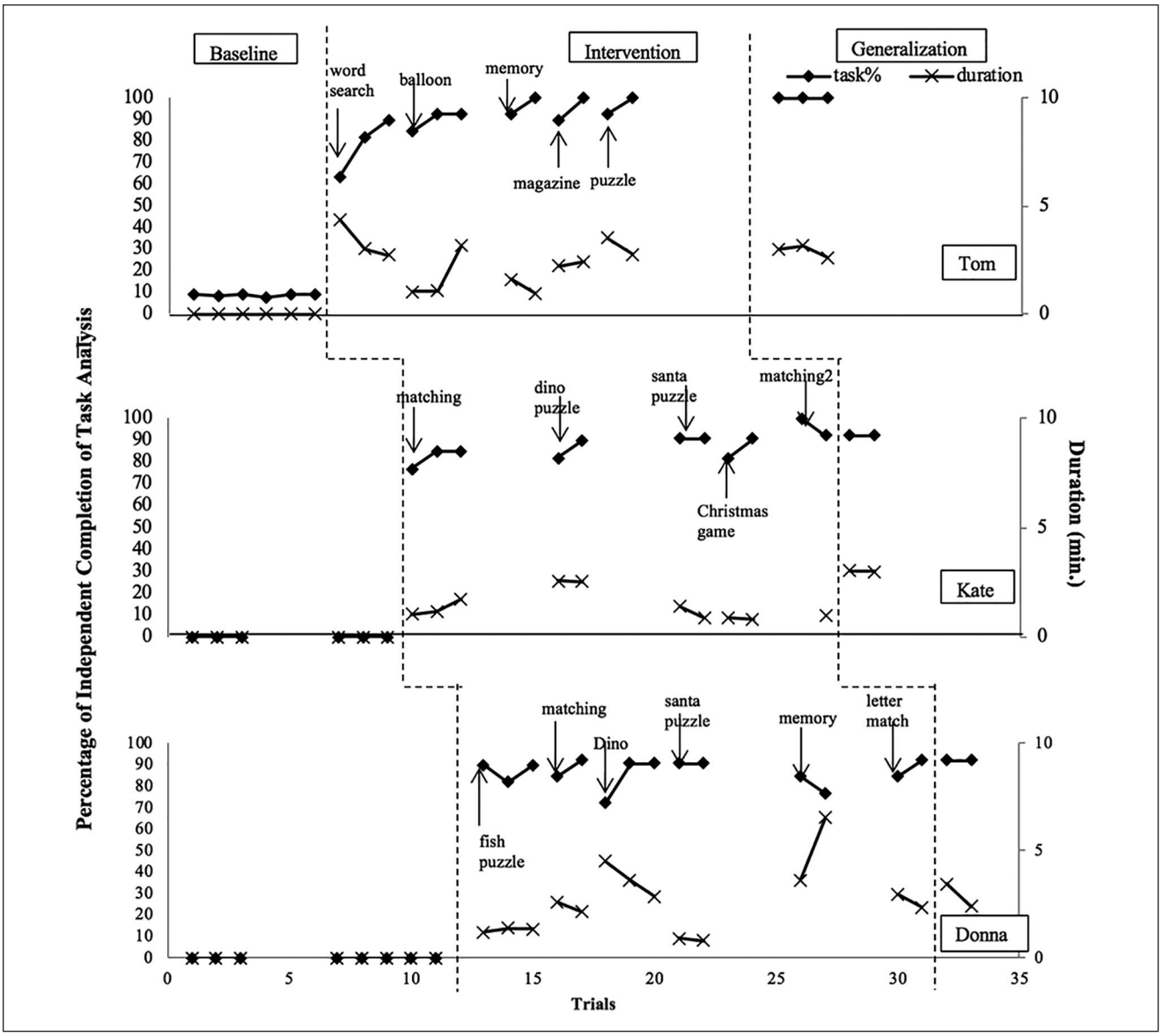

Figure 1. The percentage of independent leisure activity completion and the duration of activity engagement on the iPad 2® for Tom, Kate, and Donna during baseline, intervention, and generalization.

the intervention was 87.86% (range = 62.5–100%). In addition, all participants maintained the high level of independence during generalization trials with an average of 97.41% (range = 89.5–100%).

The teaching procedure was also effective in increasing the duration of all participants' leisure engagement (see Figures 1 and 2). During the baseline phase, none of the participants independently engaged in leisure activities with 0 min across entire baseline sessions. However, once the intervention was implemented, the duration increased immediately with an average of 2.5 min per trial (range = 0.46–11.75 min). All participants maintained the similar duration of leisure engagement during generalization trials.

For both measures, the percentage of independence and duration, data during baseline and intervention phases of all participants did not overlap (PND = 100%). For both groups and both measures, the baseline data were stable and did not require correction ($p > .05$). The aggregated Tau-U score suggested a large effect of the intervention on both independent activity completion ($\tau = 1.00$, 95% confidence interval [CI] = [0.765, 1.00], $p \leq .001$) and duration of activity completion ($\tau = 1.00$, 95% CI = [0.673, 1.00], $p \leq .001$) for both groups.

Experiment 2

As depicted in Figures 3 and 4, the visual schedule was effective in increasing leisure engagement for all participants.

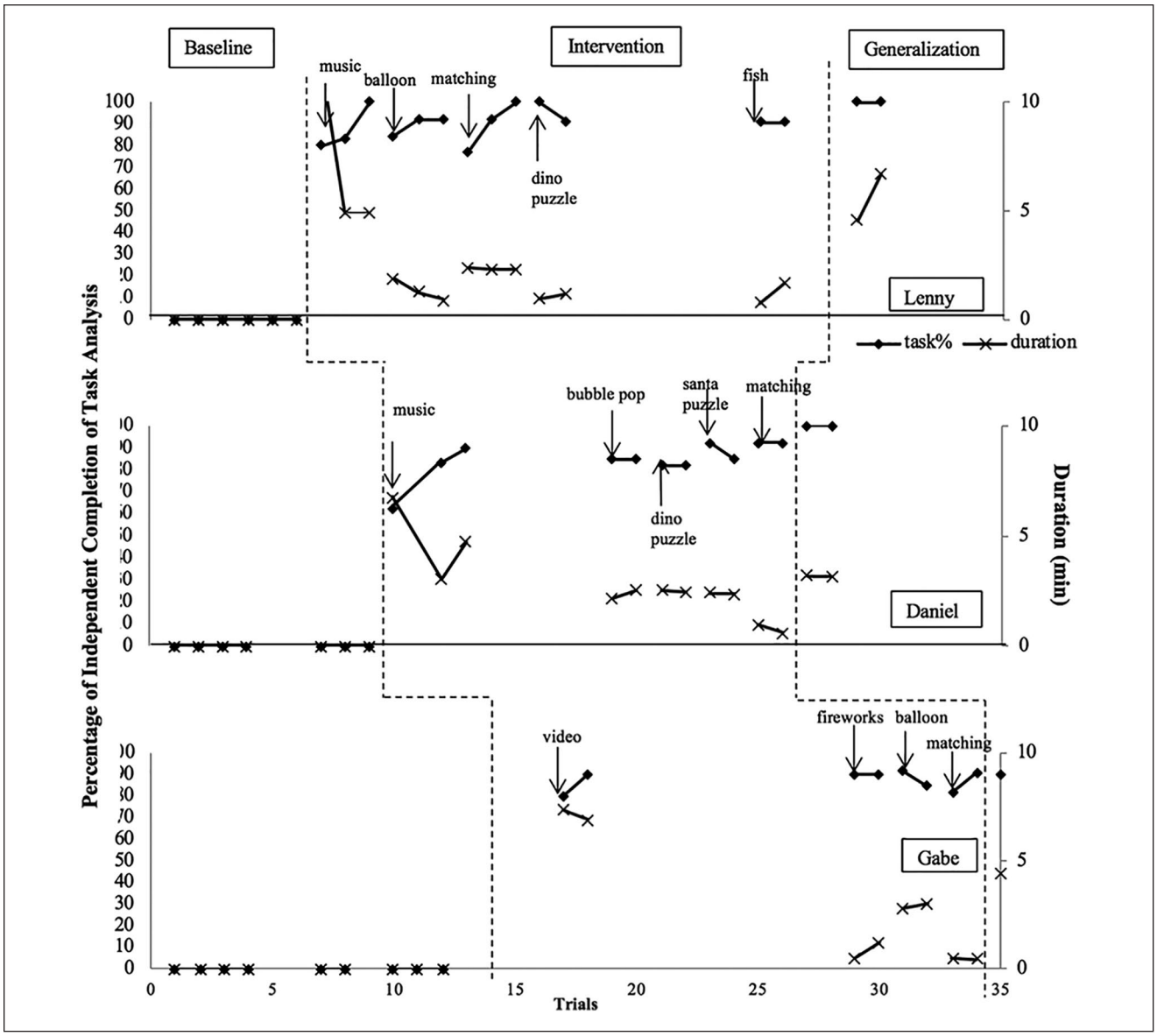

Figure 2. The percentage of independent leisure activity completion and the duration of activity engagement on the iPad 2® for Lenny, Daniel, and Gabe during baseline, intervention, and generalization.

However, the tablet-based visual schedule was not user-friendly due to compatibility issues with leisure apps. Hence, the printed visual schedule needed to be added for four out of six participants. Tom and Lenny responded to the visual schedule app but other participants kept pressing the schedule icons within the *First Then Visual Schedule* app instead of closing the schedule app to access leisure activities. In addition, the need to close the app to access leisure apps defeated the purpose of visual schedule being accessible at all times. Thus, the printed visual schedule was introduced to the other participants.

During the baseline phase, Tom and Lenny independently engaged in one leisure activity without checking the visual schedule app, but the level of their leisure engagement was low with an average of 1.2 min per trial for Tom and 1.3 min per trial for Lenny. Donna, Kate, Daniel, and Gabe did not engage in any activities during the Baseline phase. Once the intervention, iPad2-based or printed visual schedule, was implemented, the level of independence increased with an average of 83.6% (range = 66.7–100%). The duration of their leisure engagement also increased after the intervention was implemented with an average of 6.47 min per trial (range = 4.13–10.37 min per trial). All participants also maintained the high level of independence and duration during the generalization sessions. Furthermore, the data for both measures during baseline

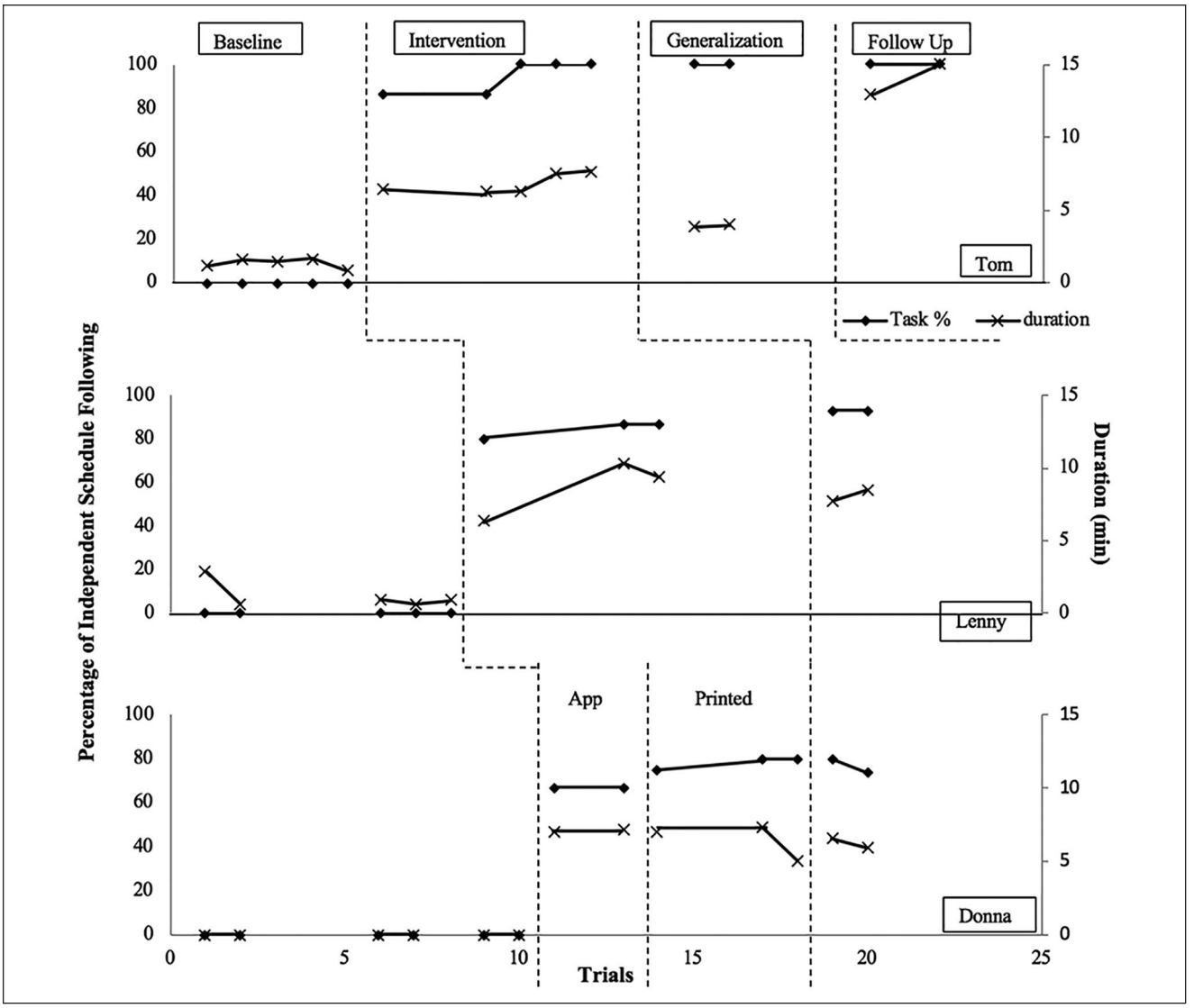

Figure 3. Percentage of independent schedule following and the duration of leisure activity engagement with the iPad 2® for Tom, Lenny, and Donna during baseline, intervention, generalization, and follow-up.

and interventions phases did not overlap (PND = 100%) and the baseline data were stable ($p > .05$). The aggregated Tau-U of 1.0 suggested a large effect for both independent schedule following ($\tau = 1.00$, 95% CI = [0.495, 1.00], $p \leq .001$) and duration of activity completion ($\tau = 1.00$, 95% CI = [0.454, 1.00], $p \leq .001$) for both groups (Parker & Vannest, 2009).

Social Validity

After the completion of both experiments, the participants' caregivers, including parents, direct care staff who observed them engage in the learned leisure skills in the vocational setting, and clinicians who were familiar with them, were asked to complete the social validity survey with a 5-point Likert-type scale. The results indicated that the caregivers felt that the participants' engagement in leisure activities improved ($M = 4.47$, range = 4–5), that their visual schedule use also improved ($M = 4.35$, range = 4–5), that it was easy for them to use the iPad2 ($M = 4.24$, range = 3–5), that use of the iPod Touch or iPad2 was beneficial for the participants ($M = 4.52$, range = 4–5), that their incidents of maladaptive behaviors decreased ($M = 4.00$, range = 3–5), and that the iPad2 promoted participants' engagement in various leisure activities ($M = 4.47$, range = 3–5). In addition, the raters responded with an average of 4.41 (range = 3–5) for a question related to stigma (i.e., "Do you believe the participants stand out less in the community by using the iPad2 for leisure activities compared to other materials (picture books, puzzles, etc.)"?) and with an average of 4.00

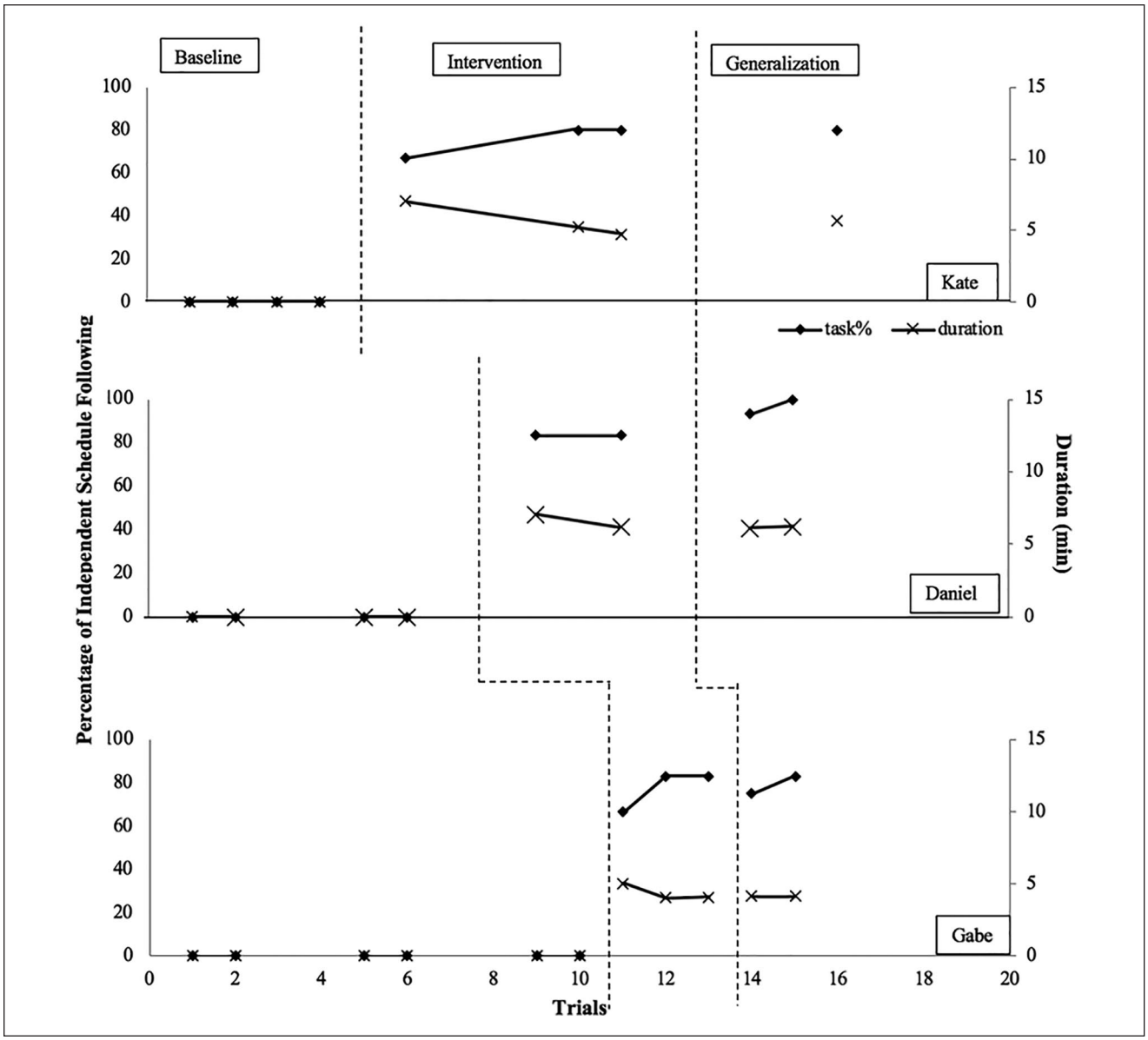

Figure 4. Percentage of independent schedule following and the duration of leisure activity engagement with the iPad 2® for Kate, Daniel, and Gabe during baseline, intervention, and generalization.

(range = 3–5) to the question, "Do you feel the participants are accepted more by others in the community by the use of the iPad2?"

Discussion

The first research question addressed the effects of a teaching package that included most-to-least prompting on improving independent leisure engagement and duration of engagement of adults with ASD and ID. Results of the current study support the effectiveness of the teaching package to teach leisure skills to individuals with ASD, consistent with previous findings in the literature (Cengher et al., 2016; Jerome et al., 2007; Vuran, 2008). As depicted in Figures 1 and 2, all participants' level of independence in engaging in leisure activities and their duration of engagement in leisure activities improved with the intervention. In addition, all participants continued to show high levels of independence during the generalization sessions.

The second research question addressed the effects of a visual schedule on the duration of leisure engagement and the level of independence in transitioning between activities of adults with ASD and ID. The results suggested that a visual activity schedule was effective in increasing

independent schedule following for all participants, which was also consistent with previous findings in the literature (Chan et al., 2014; Knight et al., 2015; Pierce et al., 2013). As depicted in Figures 3 and 4, the level of independence for all participants improved only after the intervention was implemented. The tablet-based visual schedule was effective for only two out of six participants as they acquired the skill of navigating the iPad2 to check their visual schedule app and then close the visual schedule app to go to each leisure app. It was observed that four participants kept, mistakenly, pressing the icon within visual schedule app attempting to access leisure apps. Unfortunately, the icons within the visual schedule app could not be linked with icons within the home screen. Therefore, participants could not always refer to the app-based visual schedule while they were engaging leisure activities and the printed-out visual schedule was necessary for these participants.

In addition, results of the social validity survey related to the third research question suggested that caregivers reported desirable effects of the use of the iPad2 on the participants. The caregivers indicated that the participants' leisure engagement and their level of independence improved with the intervention. They also felt the use of iPad2 would lessen the likelihood of participants' standing out in the community based on their disability. These results are consistent with previous research which suggests commonly available high-tech devices could potentially reduce stigma associated with the use of traditional and specialized systems (Conley, 2012; Parette & Scherer, 2004; Shinohara & Wobbrock, 2011; Van Laarhoven et al., 2009). Furthermore, given they were not able to answer questions on the social validity survey, it was anecdotally observed that the participants displayed vocal and nonvocal behaviors to request the activities on the iPad2. These behaviors as well as their demeanor (e.g., smiling) during sessions suggested that all participants enjoyed engaging in activities on the iPad2. Even though a formal QOL score was not assessed in the current study, the results of the social validity survey and the participants' behaviors indicated that their leisure engagement had a desirable impact on their affect and independent activity level that could potentially influence QOL, as is supported by previous research (Patterson & Pegg, 2009).

Study Limitations

Given results of the study suggesting that the intervention was beneficial for all six participants, there are limitations that require attention. First, the materials used in the preference assessment prior to the study were items such as a puzzle made out of paper, a printed-out word search, or CDs that were different from the actual stimuli used during the study in which all activities were programed on the iPad2. As a result, the preferences of participants as reflected in the preference assessments were not always reflective of their actual preferences with leisure apps on the iPad2. For example, Kate struggled to access music on the iPad2 and did not want to listen to music on it. After her music on the iPad2, she requested a radio to listen to music. This limitation could be addressed in future research by finding apps that are more closely aligned to user preferences, or that are more user-friendly for people with ASD and ID. In the case of an individual such as Kate who prefers to listen to music, this could mean evaluating her user preference among different music apps or streaming music services to determine which ones are most closely aligned to her preferences and user abilities.

Second, given the duration of leisure engagement significantly improved for all the participants when both interventions were implemented, duration of activity engagement might not be the best measure to assess their progress. The length of each activity varied depending on the leisure app, which naturally affected participants' duration of engagement. For example, an app with a game that could be completed in a few minutes limited participants' engagement compared with a game that took longer to finish. Alternatively, future research could address this limitation by allowing participants to play the same game multiple times. In addition, when the participants became more fluent with navigation of an activity, they completed the activity more quickly than at an earlier stage of the intervention.

Third, previous research suggests that barriers related to social attitudes and exclusion, policy and governmental support, and education and training inhibit technology and internet access of people with ID (Chadwick et al., 2013). While the current study addressed one of these areas, education and training, if other barriers remain (e.g., lack of access to portable electronic devices, apps, appropriate internet connections), individuals will still not experience technology-based leisure access at comparable levels to people without disabilities.

Finally, while results of the study showed how adults with ASD and ID can acquire greater independence in leisure activities on the iPad2, the study did not address the appropriate amount of time that individuals should use screen-based devices for leisure on a daily basis. Previous research has shown that daily screen times exceeding recommended durations are associated with negative outcomes, such as obesity (Banks et al., 2011). Therefore, future research should consider recommendations regarding optimal amounts of screen time in the design of interventions to promote independent leisure with technology. Related to this, while the generalization data showed that participants independently followed an activity schedule to engage in leisure activities, we did not clearly provide participants with a choice to not engage in leisure activities during these sessions, or measure their engagement

when given choices of different leisure, work, or other activities. Therefore, future research should seek to explore the role of choice in recreation and leisure for people with ASD and ID.

Future Research

The existing devices and apps had significant limitations, as discussed above. For example, some apps were easier than others to manipulate, given variations in participants' manual dexterity, and the scheduling app was not compatible with the leisure apps for most participants. This warrants further development and evaluation of apps that are designed to specifically accommodate individuals of various abilities, including those with ASD and ID. An interdisciplinary approach involving collaboration among gaming and information technology experts, and special education researchers, will be necessary for this future research. In addition, while the current study addressed generalization of independent leisure within the naturalistic setting, future research should also include measures of skill maintenance in conditions identical to baseline.

Finally, this study did not address additional related research questions related to mobile device-based leisure, which include: When is it appropriate to play mobile games and how do we teach this to people with disabilities? Can caregivers learn how to teach individuals to play games and provide greater access to the technology? What is the optimal amount of time to engage in leisure activities? How do people with ASD and ID show "enjoyment" of leisure activities through measures of facial affect or engagement in those activities when given a choice?

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References

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). American Psychiatric Publishing.

Banks, E., Jorm, L., Rogers, K., Clements, M., & Bauman, A. (2011). Screen-time, obesity, ageing and disability: Findings from 91 266 participants in the 45 and Up Study. *Public Health Nutrition*, *14*(1), 34–43.

Beadle-Brown, J., Leigh, J., Whelton, B., Richardson, L., Beecham, J., Baumker, T., & Bradshaw, J. (2016). Quality of life and quality of support for people with severe intellectual disability and complex needs. *Journal of Applied Research in Intellectual Disabilities*, *29*(5), 409–421.

Bouck, E. C., Savage, M., Meyer, N. K., Taber-Doughty, T., & Hunley, M. (2014). High-tech or low-tech? Comparing self-monitoring systems to increase task independence for students with autism. *Focus on Autism and Other Developmental Disabilities*, *29*(3), 156–167.

Bureau of Labor Statistics. (2015). *American Time Use Survey*. Washington, DC: Bureau of Labor Statistics.

Burgess, A. F., & Gutstein, S. E. (2007). Quality of life for people with autism: Raising the standard for evaluating successful outcomes. *Child and Adolescent Mental Health*, *12*(2), 80–86.

Cengher, M., Shamoun, K., Moss, P., Roll, D., Feliciano, G., & Fienup, D. M. (2016). A comparison of the effects of two prompt-fading strategies on skill acquisition in children with autism spectrum disorders. *Behavior Analysis in Practice*, *9*(2), 115–125.

Chadwick, D., Wesson, C., & Fullwood, C. (2013). Internet access by people with intellectual disabilities: Inequalities and opportunities. *Future Internet*, *5*(3), 376–397.

Chan, J. M., Lambdin, L., Graham, K., Fragale, C., & Davis, T. (2014). A picture-based activity schedule intervention to teach adults with mild intellectual disability to use an iPad during a leisure activity. *Journal of Behavioral Education*, *23*(2), 247–257.

Conley, J. (2012). Can the iPad address the needs of students with cognitive impairments by meeting IEP goals? In P. Resta (Ed.), *Society for Information Technology and Teacher Education International Conference* (pp. 3986–3990). Association for the Advancement of Computing in Education.

DeLeon, I. G., & Iwata, B. A. (1996). Evaluation of a multiple-stimulus presentation format for assessing reinforcer preference. *Journal of Applied Behavior Analysis*, *29*, 519–533.

Fisher, W., Piazza, C., Bowman, L. G., & Amari, A. (1996). Integrating caregiver report with a systematic choice assessment. *American Journal on Mental Retardation*, *101*, 15–25.

Fox, S. (2011). *Americans living with disability and their technology profile*. Pew Research Center's Internet; American Life Project. https://www.pewresearch.org/internet/2011/01/21/americans-living-with-disability-and-their-technology-profile/

Ibrahim, Z., & Alias, M. (2018). A review on using assistive technology to enhance social skills competence among children with autism spectrum disorder (ASD). *Advanced Science Letters*, *24*(6), 4250–4254.

Jansen, K. (2019, February 13). *Survey: The "gamer" demographic has shifted, creating more opportunities for developers*. https://blog.applovin.com/mobile-gaming-survey

Jerome, J., Frantino, E. P., & Sturmey, P. (2007). The effects of errorless learning and backward chaining on the acquisition of internet skills in adults with developmental disabilities. *Journal of Applied Behavior Analysis*, *40*(1), 185–189.

Kane, S. K., Jayant, C., Wobbrock, J. O., & Ladner, R. E. (2009, October). Freedom to roam: A study of mobile device adoption

and accessibility for people with visual and motor disabilities. In *Proceedings of the 11th International ACM SIGACCESS Conference on Computers and Accessibility* (pp. 115–122). Association for Computing Machinery.

Knight, V., Sartini, E., & Spriggs, A. D. (2015). Evaluating visual activity schedules as evidence-based practice for individuals with autism spectrum disorders. *Journal of Autism and Developmental Disorders*, *45*(1), 157–178.

Nepo, K., Tincani, M., Axelrod, S., & Meszaros, L. (2017). iPod touch to increase functional communication of adults with autism spectrum disorder and significant intellectual disability. *Focus on Autism and Other Developmental Disabilities*, *32*(3), 209–217.

O'Reilly, M. F., Lancioni, G. E., & Kierans, I. (2000). Teaching leisure social skills to adults with moderate mental retardation: An analysis of acquisition, generalization, and maintenance. *Education and Training in Mental Retardation and Developmental Disabilities*, *35*, 250–258.

Orsmond, G. I., Krauss, M. W., & Seltzer, M. M. (2004). Peer relationships and social and recreational activities among adolescents and adults with autism. *Journal of Autism and Developmental Disorders*, *34*(3), 245–256.

Parette, P., & Scherer, M. (2004). Assistive technology use and stigma. *Education and Training in Developmental Disabilities*, *39*(3), 217–226.

Parker, R. I., & Vannest, K. (2009). An improved effect size for single-case research: Nonoverlap of all pairs. *Behavior Therapy*, *40*(4), 357–367.

Parker, R. I., Vannest, K. J., Davis, J. L., & Sauber, S. B. (2011). Combining nonoverlap and trend for single-case research: Tau-U. *Behavior Therapy*, *42*, 284–299.

Patterson, I., & Pegg, S. (2009). Serious leisure and people with intellectual disabilities: Benefits and opportunities. *Leisure Studies*, *28*(4), 387–402.

Persson, B. (2000). Brief report: A longitudinal study of quality of life and independence among adult men with Autism. *Journal of Autism and Developmental Disorders*, *301*(1), 61–66.

PEW Research Center for Internet & Technology. (2019). *Mobile fact sheet*. https://www.pewresearch.org/internet/fact-sheet/mobile/

Pierce, J. M., Spriggs, A. D., Gast, D. L., & Luscre, D. (2013). Effects of visual activity schedules on independent classroom transition for students with autism. *International Journal of Disability, Development and Education*, *60*, 253–269.

Schalock, R. L., & Parmenter, T. (2000). Preface in quality of life: Its conceptualization, measurement and application. In M. Rapley (Ed.), *Quality of life research: A critical introduction* (pp. 11–16). SAGE.

Shinohara, K., & Wobbrock, J. O. (2011). In the shadow of misperception: Assistive technology use and social interactions. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 705–714). ACM Press.

Spriggs, A. D., Lane, J., & Gast, D. L. (2014). Visual representation of data. In D. L. Gast (Ed.), *Single case research methodology: Application s in special education and behavioral science* (pp. 154–175). Francis & Tayler/Routledge.

Van Laarhoven, T., Johnson, J. W., Van Laarhoven-Myers, T., Grider, K. L., & Grider, K. M. (2009). The effectiveness of using a video iPod as a prompting device in employment settings. *Journal of Behavioral Education*, *18*(2), 119–141.

Vuran, S. (2008). Empowering leisure skills in adults with autism: An experimental investigation through the most to least prompting procedure. *International Journal of Special Education*, *23*(1), 174–181.

Yalon-Chamovitz, S., & Weiss, P. L. T. (2008). Virtual reality as a leisure activity for young adults with physical and intellectual disabilities. *Research in Developmental Disabilities*, *29*(3), 273–287.