Use of an iPhone to Enhance Interpersonal Daily Living Skills in the Community for Adolescents with Autism Spectrum Disorder

Abstract

This study examined the use of an iPhone and the List Recorder Application to teach three adolescents with autism spectrum disorder to acquire, maintain, and generalize interpersonal Daily Living Skills (DLS) in a community setting. A multiple probe design across participants was used to teach participants to use interpersonal DLS to order and purchase coffee and a snack. All three participants demonstrated an increase in their use of interpersonal skills in the community. Participants were able to maintain these skills once the intervention was removed during follow-up and to generalize these skills to a novel community setting. Results indicate that the use of mobile technology can effectively be used to teach DLS, inclusive of interpersonal skills, entirely in a community setting.

Keywords: Autism Spectrum Disorder, daily living skills, community living, iPhone, smart device

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A number of supports and interventions have proven effective in promoting the development of social skills and increased abilities to navigate different social environments, yet there is minimal focus on teaching and promoting social skill routines required in various community settings (Wood et al., 2014). Individuals with ASD often require explicit instruction to improve the interpersonal decision making and communication skills necessary to successfully navigate society. Social skills training has been an area of investigation for years, with a number of different interventions demonstrated as effective, including (a) story-based interventions to improve social communication (Bucholz et al., 2008; Sansosti & Powell-Smith, 2008), (b) peer modeling to enhance social interaction (Harper et al., 2008; Hundert & Houghton, 1992), (c) incidental teaching to enhance age appropriate social phrasing (McGee & Daly, 2007; Schreibman et al., 2015), and (d) visual cuing systems used to teach conversational speech skills (Charlop-Christy & Kelso, 2003; Ganz & Flores, 2010). This body of work has yielded predominantly positive outcomes and supports the notion that training can increase social skills and routines (Yakubova & Taber-Doughty, 2013).

As the population of individuals with autism spectrum disorder (ASD) ages, the dynamics of their social world changes, as socialization, peer relationships, and interpersonal skills require ever-increasing social abilities. Adolescence and adulthood necessitates different social and interpersonal skills to navigate environments that often require single (e.g., seeking assistance in a store to purchase an item) and multiple (e.g., maintaining a relationship with a family member or friend) encounters with known and unknown individuals. Teaching interpersonal skills in the context of day-to-day activities may be beneficial for individuals with

ASD transitioning to adulthood, especially as they participate in inclusive environments, and many of these interpersonal skills also serve as daily living skills.

For example, Brolin (1997) developed a comprehensive framework, the Life Centered Career Education curriculum (LCCE) (Council for Exceptional Children, 2010), that details life skills in three critical domains: (a) interpersonal Daily Living Skills (DLS), (b) self-determination and interpersonal skills, and (c) employment skills. Adolescents are often faced with social situations far different from their younger peers. For example, adolescents must navigate a more complicated social world and engage in interpersonal daily living skills with strangers to obtain goods, services, and other life opportunities (e.g., employment). The LCCE includes a number of school and community daily living skills that adolescents and adults can use to navigate the tasks associated with increased age (e.g., demonstrating appropriate behavior in public settings). This is particularly important for adolescents with ASD who frequently have difficulty generalizing social skills to inclusive environments, when those skills have been learned solely in classroom or clinical settings (Barry et al., 2003). By providing targeted instruction in multiple school or community settings, an individual with ASD may improve interpersonal skills and develop independence with DLS. Although this instruction can be delivered in a number of different ways, the use of technology provides viable options for efficient and effective teaching, which may also enhance the generalization potential (by programming common stimuli) to inclusive environments.

Use of Technology to Improve DLS

According to the National Autism Center (n.d.), technology-based interventions for children with ASD have proven to have beneficial effects. Many forms of technology have been used in these interventions, including laptops, tablets, and other handheld devices (Ayres et al., 2013; Cihak et al., 2007; Yukabova & Taber-Doughty, 2013). As the research base on smart devices evolves, the technology may prove to be an integral component of effective interventions. For example, training may be easier, there may be greater applicability to inclusive settings real-life, and individuals with ASD might generalize their newly-learned skills to other people and settings. All of these issues have been identified as a need in previous research on mobile technology with people with autism (Aljehany & Bennett, 2019). Smartphones, tablets and other forms of mobile technology blend into many community settings and allow teachers to deliver effective, but covert interventions. Adolescents also might benefit from smart mobile technology when used to promote interpersonal daily living tasks in community settings (Cavkaytar et al., 2017; Douglas et al., 2015). For example, Walser et al. (2012) used an iPhone and a video modeling procedure to teach photography skills to a group of high school-aged students with moderate intellectual disability (ID), a popular activity for many adolescents.

Enhancing Interpersonal DLS in the Community

The use of technology is also emerging as a viable approach to support adolescents and adults with disabilities to navigate common day-to-day activities in typical community environments (Aljehany & Bennett, 2019). For example, Alcantara (1994) embedded social skills into video-based instruction of a purchasing task. With minimal instruction, the children in this study learned to use appropriate greetings, provide social responses to the cashier, purchase items, and say *thank you* following the task. Similarly, Yakubova and Taber-Doughty (2013) used an iPad and video modeling to teach social skills through purchasing activities in a grocery store to three junior high school students with ASD and ID, and found similar improvements.

Past studies (Alcantara, 1994; Yakubova & Taber-Doughty, 2013) demonstrate the potential of using a smart device to teach the interpersonal skills needed in a variety of scenarios;

however, it is an area that needs further investigation. This is particularly so in typical community settings, and with adolescents with ASD as they transition to the adult world. These studies and others identify the need for future research to include generalization outcomes as well. The research to date suggests that using efficient, effective technology could enable these adolescents to improve their social skills in a community context, by embedding these interpersonal skills into other community tasks.

The purpose of this study was to investigate the use of a mobile technology intervention that included an iPhone and List Recorder application on the interpersonal DLS of adolescents with ASD in a community setting. We posed three questions:

1. Will the use of a mobile technology intervention increase interpersonal DLS in a community setting?
2. To what extent will these skills maintain following the removal of the mobile technology intervention?
3. Will the use of a mobile technology intervention promote generalization of interpersonal DLS to another community setting?

Method

Participants

Three adolescents were recruited from a network of families known to the investigators. Pseudonyms were used throughout to mask the participants' identities. Selection criteria included: (a) a current diagnosis of ASD from a psychological or educational assessments documented in school records, (b) parent expressed need for social skills instruction, (c) absence of food allergies, (d) absence of maladaptive behavior, (e) willingness to follow directions and interact with an unfamiliar person, (f) ability to operate an iPhone 6s, and (g) ability to read simple directions. Participation was voluntary; parents gave consent for participation and all participants assented to study procedures. The study was approved by the university Institutional Review Board before implementing any activities. Prior to enrolling potential participants, the first author administered three screening procedures created for this study. Screening included (a) a *Parent Rating Scale*, (b) a *Parent Interview*, and (c) an *iPhone Screening Tool*. The three screening instruments were developed using a develop-pilot-revise protocol by the research team. The first three individuals to meet the inclusion criteria from these instruments were selected for the study.

Parents completed the *Parent Rating Scale* to assess their adolescents on two domains based on the LCCE curriculum (Brolin, 1997): (a) DLS (with one competency) and (b) Self-Determination and Interpersonal Skills (with eight competencies). Examples of competencies included (a) buying, preparing, and consuming food; (b) communicating with others; (c) developing interpersonal skills; and (d) developing social awareness. This instrument required that parents determine on a 3-point Likert-type scale whether skills are completed independently, with prompts, or not at all. The second screening protocol, *Parent Interview*, was used to help the researchers identify social and behavioral concerns that might manifest in community settings. This was a nine-question oral interview. Four of the questions were open ended (e.g., “Does your child have trouble waiting his/her turn?”); four of the questions required forced choice responses (e.g., “Has your child shown any of the following behaviors:_____? Yes / No”). A final question concerned the frequency of mobile device use. Finally, the *iPhone Screening Tool* assessed adolescents’ iPhone 6s use and experience. There were six-items for this instrument (e.g., “Turn iPhone on” and “Find and open the app”). Potential participants were assessed during a 5- to 7-minute pre-screening session using a least-to-most prompting system. Each participant was given verbal directions for each of six skills being assessed, and prompts were delivered only if the adolescents needed them to complete the step. For this study, participants were required to use the iPhone 6s independently or with minimal verbal or gestural prompts to participate. (Further information and copies of the instruments are available from the first author.) Information from the three parent screening instruments and the students' IEPs was used for the purpose of summarizing participants' characteristics.

Participant Characteristics

Sadie was a 16-year-old White Jewish female with ASD and a Language Impairment. She showed strengths in her social initiations and non-verbal communication. Her areas of social weaknesses were in social reciprocity, terminating social interactions, social cognition, perspective taking, and self-awareness. Sadie demonstrated appropriate behavior in public settings, and she did not display any maladaptive behavior in the community. She regularly followed instructions and was able to complete a purchasing task with prompts. Sadie required prompting to understand subtleties of communication and others' motives. Her parents indicated that she had experience with a mobile device. She was rated as independent on the mobile phone skills assessment and was proficient in texting and email applications. Based on the *iPhone Screening Tool*, Sadie used the device independently.

Zach was a 14-year-old White male with ASD, Traumatic Brain Injury, and a Language Impairment. Zach had strengths in non-verbal communication, perspective taking, and social awareness. He had social weaknesses with social initiations, reciprocity, terminating interactions, and social cognition. He also experienced social anxiety and withdrawal. Zach typically demonstrated appropriate behavior in public settings and did not display any maladaptive behavior in the community. He required prompting to recognize authority, follow directions, and to understand the motives of others. His parent indicated that he did not understand communication subtleties (e.g., making eye contact and maintaining personal space). Zach frequently used a mobile device, texted, and used email. Based on the *iPhone Screening Tool*, Zach scored independent on 50% of the skills, and required either a verbal or gestural prompt on the other skills.

Brian was a 16-year-old White male with ASD and ID, with strengths in non-verbal communication. He displayed social weaknesses with social initiations, reciprocity, terminating interactions, social cognition, perspective taking, and self-awareness. He also experienced social anxiety and withdrawal. Brian demonstrated appropriate behavior in most public settings, and did not display any maladaptive behavior in the community. He was able to follow instructions regularly and understand others' motives; however, he required prompts to respond to others. He was unable to communicate effectively and assertively, or to understand communication subtleties. Brian was able to make purchases when prompted. He frequently used a mobile device and sometimes used texting applications. On the *iPhone Screening Tool*, Brian completed 67% of the skills independently, but needed verbal or gestural prompts for the remaining skills.

Setting

The study was conducted at four community locations including one Dunkin Donuts (training site), and three Starbucks (generalization sites). The Dunkin Donuts location was a small store with limited menu items, and employees were accessible at the counter. Dunkin Donuts had a designated area to wait in line, a counter with two registers to complete the purchasing task, and a food pickup counter adjacent to the ordering counter. Each Starbucks site was located within three miles of Dunkin Donuts. Employees at these locations were accessible at the counter. Each participant was expected to use the designated area to wait in line, order at the counter, and pick up their items at the specified pick up counter.

Materials

An Apple iPhone 6s equipped with the List Recorder application (app), created by Sixth Mode Solutions (n.d.), was used for the study. The List Recorder app allowed a variety of audio functions, including recording, pausing, three-way recording, and transferrable options for audio files. Lesoom wireless earbuds (model X1T Mini with V4.2 stereo sound) were used by the participants when the audio recording was accessed. Earbuds had Bluetooth capability allowing up to 30 feet in range from the iPhone 6s. A single iPhone was shared across all participants, however all participants had their own sets of earbuds.

Prior to the study, information was collected from parents and participants on participants' food and beverage preferences based on the menus available at Dunkin Donuts and Starbucks. Information also was collected on any food restrictions the participants might have (no participants had food restrictions). Based on these results, each participant identified a range of beverage and snack selections they would select, and were provided with a gift card to make purchases. One Dunkin Donuts gift card worth $100 was used for intervention, and several Starbucks gift cards worth $5 were used for generalization. The gift cards were distributed to participants prior to each session and collected afterwards.

Three scripts were created for the study, to increase the probability of fidelity of implementation. The Script for *Baseline, Generalization, and Follow-Up* was used for non-training study procedures; two other scripts, *Script for Training I* and *Script for Training II* were used for training study procedures. The first intervention script, *Script for Training I*, was developed to provide richer, more extensive instructions to the participant; the second intervention script, *Script for Training II*, was designed to serve as a prompt to initiate the task, without extensive verbal instructions. (Copies of all scripts are available from the first author.)

Behavioral Measures

A task analysis was developed to promote participants' abilities to purchase and pay for coffee and a snack (see Table 1). Performance was measured by counting the steps delineated in the task analysis. *Performance steps* were coded as (a) correct without supports, (b) correct with supports, (c) incorrect with supports, or (d) incorrect without supports. *Correct without support* was coded if the participant performed the step without accessing the List Recorder app on the iPhone when attempting that step. If the participant used the List Recorder app and completed the step correctly, then *correct with support* was coded. If the participant accessed the List Recorder app and was unable to complete the step correctly, then *incorrect with support* was coded. If the participant was unable to perform the task correctly, and did not access the List Recorder app, then an *incorrect without support* was recorded for that step.

Three types of errors were recorded: (a) out of sequence errors, (b) latency errors, and (c) performance errors. *Out of sequence errors* occurred if a participant completed or attempted to complete a step out of the order listed (e.g., if a participant handed the store worker a gift card prior to ordering). *Latency errors* included a lack of movement or verbalization from the participant within 5 seconds after beginning the chain of behaviours (e.g., if a participant did not respond within 5 seconds when a server asked what he or she would like to order). *Performance errors* were coded when participants completed a step incorrectly (e.g., if a participant received the purchased item and walked away without saying "Thank you" or "Have a nice day").

Data Collection

Data were collected by two trained observers. Observers coded *performance steps*: (a) correct without support, (b) correct with support, (c) incorrect with support, or (d) incorrect without support, and *errors*: (a) out of sequence errors, (b) latency errors, and (c) performance errors.

The nature of the purchasing task required three coding exceptions. First, the second step (i.e., greet the store worker) was omitted if store workers greeted participants *before* they had the opportunity to greet the employee. Also, the sixth step (i.e., move to the pickup area and pick up the order) was omitted if a participant did not need to move to another area of the store to obtain the item. (This occurred if the employee handed the order to the participant as he or she paid for it.) The third exception involved data that were collected during a single trial of the 7-step task in each session. During baseline, generalization, and follow-up sessions, participants completed a single trial. During intervention sessions, participants were asked to complete two trials. After completing the first trial, the participant and investigator exited the store. After 2 minutes, the second trial was initiated. This allowed participants to have two opportunities to practice the skill during the intervention condition. To avoid skewing the intervention data, only data collected from the *first trial* were used to assess performance (and appear on the graph).

Interobserver Agreement

Observers were trained to collect data prior to the study by reviewing videos and definitions, and practicing coding. Observers reached at least 85% agreement on each variable before the study was initiated. During the study, an investigator used a small hand-held video recording device to record the session for interobserver agreement scoring at a later time. A secondary observer watched the videos of participants as they performed the purchasing task, and compared those observations to the primary observer's live recording.

Observer agreement was calculated by dividing the number of agreements by the number of agreements plus disagreements, then multiplying those results by 100%. Observer agreement checks were completed on 36% of all observations, distributed across each condition, for each participant. This yielded an overall agreement of 94% across the three participants. For Sadie and Zack, agreement was assessed on 30% of each of their sessions, yielding 100% and 87% agreement, respectively. For Brian, agreement was assessed on 48% of his sessions, yielding 95% agreement.

Data Analysis

The data were analyzed for each participant by examining (a) level, (b) trend, (c) variability, (d) immediacy of effect, (e) overlap, and (f) consistency of data patterns across conditions (Kratochwill et al., 2010). Additionally, Tau-U calculations were completed for each participant for baseline-to-intervention (A-B contrasts) to establish individual effect sizes. These data were then combined to determine an omnibus effect size for all A-B contrasts. Tau-*U* is a nonparametric index used to measure the extent of data overlap between conditions of a study; it also controls for baseline trends (Parker et al., 2011).

Experimental Procedures

Baseline

Prior to each baseline session an investigator met with each participant outside of Dunkin Donuts to discuss the task. The investigator followed the *Script for Baseline, Generalization, and Follow-Up* to increase the probability of the fidelity of implementation. Following the script, the investigator gave the participant an iPhone 6s, with earbuds and a gift card to pay for the menu items. The iPhone 6s was powered on and set to the home screen where the List Recorder app was present could be accessed. The participants' phone was swiped to open to the List Recorder app. (No suggestion was made to the students to access this or any other app.) This ensured that the iPhone was in the correct mode for use, but still required participants to visually discriminate between apps and choose the List Recorder app if they intended to use it. Next, the investigator instructed the participant to make a purchase in the store, and then accompanied the participant into the store. If the participant was unable to order or pay, the investigator completed the step without the participant watching or listening. This prevented the participant's ability to learn the steps via live modeling. After exiting the store, the investigator collected the iPhone, earbud, and gift card, and the participant consumed the coffee and snack.

Intervention

The intervention package consisted of the List Recorder app paired with the iPhone 6s. Similar to baseline, the investigator met with each participant outside of Dunkin Donuts prior to each intervention session. Before each intervention session, the investigator tested the ear bud to adjust sound quality and level. Next, the investigator gave the participant the iPhone 6s powered on, with the home screen displayed. Participants were informed that they could purchase one beverage and one food item of choice. Participants were then asked to access the List Recorder App. The List Recorder app provided visual and/or audio support to complete each step of the task. For example, the participant could access the List Recorder app and see the step 'Pay', and hear the audio reminder 'Pay by using the gift card'.

The intervention (training) was delivered using two scripts. Each script was used to increase the probability of fidelity of implementation. Initially, the *Script for Training I* was used until the participant completed at least 60% of the steps correctly without support over two consecutive sessions. During this portion of training, each list step was reviewed systematically by the participant where the researcher would check for understanding following all steps.

Participants were instructed to click on each step in the task and listen to the audio recording of the step. After listening to each step, the investigator paused and asked, "Do you have any questions?" Questions were answered, if posed, and then the investigator asked the participant to begin the task.

The investigator followed the participant into the store and stood behind the participant to collect data while the participant performed the task. Once the task was completed, the participant and investigator exited the store, and the investigator took the iPhone 6s back. After 2 minutes, the investigator initiated a second training trial by returning the iPhone 6s to the participant and delivering a request to the participant to begin the second trial. The same intervention procedure was followed during this trial. After the task was completed, the investigator and participant exited the store and the investigator collected the iPhone 6s.

Once participants completed 60% of the steps correctly and without support over two consecutive sessions, the investigator discontinued using the *Script for Training I* and used the *Script for Training II*. This second script was abbreviated, and provided a brief greeting and review of the task (i.e., reminder to access the iPhone and List Recorder app as needed, order from the menu, and pay with the gift card), but did not require participants to listen to each step. The abbreviated second script was used as a means to promote independent use of the List Recorder app.

An *error correction procedure* was implemented during intervention sessions if a participant performed a step incorrectly, or was unable to complete the task based on a multiple-opportunity probe procedure. If a participant committed an initial error on a step, the investigator delivered a prompt by saying *"Please look at step __ and press play."* The participant then activated the app to view and listen to the step being modeled correctly. If the participant committed a second error on the same step, the investigator again prompted the participant using the same scripted message. If a third error was committed, the investigator said, *"Let me show you how to complete step # __. Step # __ says to __",* and then modeled the step for the participant and store worker.

An *additional prompt* or 'booster' was added to the intervention for Brian when he did not show a steady and increasing trend in accuracy. The additional prompt entailed incorporating a starter sentences ("Please look at step # ___, and press play") to steps #3, 4, and 7 in the task analysis. This was implemented when Brian hit a plateau.

Follow-up

When participants achieved 100% accuracy over five consecutive intervention sessions, the intervention was discontinued. During these follow-up sessions, no training or error correction procedures were provided. As in baseline, the investigator followed procedures outlined in the *Script for Baseline, Generalization, and Follow-up* to increase the probability of procedural fidelity with the follow-up protocol. Two follow-up probes were conducted for each participant at the training site to determine whether the skill maintained after training was removed, and a third follow-up probe was conducted at the generalization site.

Generalization

Generalization probes were conducted at three different community Starbucks during sessions that corresponded with baseline, intervention, and follow-up conditions. No training or error correction procedures were provided during any of the generalization sessions. As in baseline, the investigator followed procedures outlined in the *Script for Baseline, Generalization, and Follow-up* to increase the probability of fidelity with the generalization protocol. Generalization probes occurred approximately once a week.

Experimental Design

A multiple probe design across participants was used to determine the effectiveness of the intervention package (i.e., iPhone 6s, *List Recorder App*, and training) on the participants' acquisition, generalization, and maintenance of interpersonal DLS (Horner & Baer, 1978). For two of the participants, follow-up probes were conducted in the training setting at 1 and 3 weeks following the removal of the intervention to evaluate whether each participant would maintain the skills. For the third participant, follow-up probes in the training setting were made at 7 and 67 days. The final follow-up probe was conducted after one participant was unavailable for an extended period due to absences. Finally, at least one generalization probe was conducted in novel settings during baseline, intervention, and follow-up conditions.

Social Validity

A post-study questionnaire was given to parents approximately 7 days after the study to learn more about their knowledge and understanding of the intervention and the impact of the intervention on their children. The questionnaire contained eight items assessing parents' perception of the following: (a) importance of the target skills, (b) parents' understanding of the steps used in the intervention, and (c) parents' ability to implement the intervention. These items were rated using a 5-point Likert scale in which 1 = Strongly Disagree and 5 = Strongly Agree. In addition, two open-ended questions were posed so the parents could provide an optional narrative of their perceptions. An investigator informed the parents of the study procedures via discussion and a written handout. The parents did not observe or participate in any of the sessions.

Results

Figure 1 displays the percent of task steps correct (closed circle), percent of task steps where participants used the mobile device (open circles), and generalization probes (triangles) along the y-axis. Follow-up data are also presented along the y-axis. Sessions are presented on the x-axis (see Figure 1). Participants emitted low levels of the targeted skills during baseline. Moreover, none of the participants accessed the mobile device as a prompting system during this condition, although it was available. Following the introduction of the intervention, all participants increased their interpersonal DLS and made use of the mobile device as a prompting system. Generalization of effects were observed, and participants' behaviors maintained following intervention.

Research Question #1

In response to the first research question (whether the intervention will increase interpersonal DLS in a community setting), each participant showed skill mastery (i.e., 100% task steps correct over five consecutive trials) after receiving the intervention. Sadie's baseline accuracy was relatively stable and averaged 57%. She achieved mastery after seven intervention sessions, with an overall intervention mean of 95%. Sadie's immediacy of the effect is apparent by comparing her last three baseline data points (50%, 66%, and 60%) to her first three intervention data points (80%, 83%, and 100%). There was a short but ascending trend on Sadie's total steps correct immediately after beginning the intervention; simultaneously, there was a slower decreasing trend in the use of the device throughout the intervention condition. Sadie did not show any overlap in data between baseline and intervention, nor between baseline and the follow-up condition.

Zach also showed stability during baseline, averaging 40% accuracy. Zach achieved mastery after nine intervention sessions with an intervention mean of 93%. His immediacy of effect is shown by his last three baseline data points (50%, 33%, and 40%) and his first three intervention data points (83%, 83%, and 80%). Overall, there was an ascending trend throughout the intervention condition with the total steps correct. There was also a descending trend related to the use of the device; however, these data remained variable thoughout the condition. There was no overlap in Zach's data between baseline and intervention, nor between baseline and the follow-up condition.

Brian's baseline also showed stability with four of six sessions at 0%, and a mean accuracy of 6%. Brian achieved mastery after 17 intervention sessions. During his initial intervention sessions, Brian's performance showed considerable variability ranging from 40-83% accuracy (M = 72%). Brian's performance plateaued at his ninth intervention session with four consecutive scores of 80%; thus, an additional prompt was administered during his 11th intervention session. For two subsequent sessions, Brian remained at 80% accuracy until he achieved mastery at 100% of the task steps completed correctly. Brian's intervention did show an immediacy of the effect when comparing his last three baseline data points (20%, 17%, and 0%) to his first three intervention data points (40%, 40%, and 60%). However, Brian's slower overall learning curve showed that he required an additional prompt prior to achieving mastery. Brian did not show any overlap in data between baseline and intervention, nor between baseline and the follow-up condition.

Research Question #2

In response to the second research question (whether interpersonal daily living skills would maintain when the intervention ended), each participant continued to perform the skill accurately after the intervention was removed. Sadie's follow-up probes at the training site were conducted at 10 and 23 days following removal of the intervention. During these observations, Sadie completed the tasks accurately and was able to access the iPhone and List App at her discretion. She did not use the iPhone and App during the session; however, she did look at and listen to the steps prior to entering the store. Zach also maintained 100% mastery of the skills at the training site after 7 and 21 days post intervention. Like Sadie, Zach used the audio component to review the steps on the mobile device prior to entering the store, but did not access the support when performing the task. Finally, Brian's first follow-up probe at the training site was conducted 7 days after the intervention ended; his skill performance was 83% correct. His second follow-up probe was held 67 days after the intervention, and he scored 100% correct.

Research Question #3

In response to the third research question (whether the interpersonal DLS would generalize to novel settings), each participant emitted the new skill with accuracy in novel stores in which they did not receive training. During sessions that corresponded to baseline, a generalization probe was conducted for Sadie, and she completed the task with 40% accuracy. During generalization probes that corresponded to intervention, Sadie increased her accuracy on the task steps to 83% and 100%. During the follow-up condition, Sadie was administered a generalization probe 14 days after the intervention, and she remained at 100% accuracy.

When generalization probes were conducted for Zach, his accuracy was 50% in baseline and increased to 83% accuracy during both intervention generalization probes. During a follow-up generalization probe 14 days after the intervention, Zach showed 100% accuracy in the novel setting. Brian's accuracy during the generalization probe in baseline was 20%. During three generalization probes during the intervention condition, he scored 50%, 83%, and 100%, respectively. When administered a generalization probe during the follow-up condition, 10 days after the intervention, he scored 100% accuracy emitting the task steps.

Effect Size Results

A post-hoc analysis of task steps completed correctly was conducted using the Tau-*U* non-overlap index (Parker et al., 2011). The benchmarks used to interpret Tau-*U* effect sizes are: questionable effect = 0-0.65, effective = 0.66-0.92, and very effective = 0.93 and greater (Rakap, 2015). The baseline to intervention Tau-*U* score for Sadie was 0.89, and this demonstrates that the intervention was effective for her. Zach's baseline to intervention Tau-*U* score was 1.0, indicating the intervention was very effective for him. The Tau-U score for Brian was 0.97; this shows the intervention was very effective for him. Finally, the omnibus Tau-*U* score for all participants was 0.96, which suggests that the intervention was very effective when combining each participant's Tau-*U* scores.

Social Validity Findings

Each parent gave the highest rating of "strongly agree" for all questions asked. This indicated that parents (a) believed the intervention targeted an important skill, (b) obtained a sufficient understanding of the intervention, and (c) believed they could implement this intervention. Sadie's parent provided comments. Her parent noted that after a few weeks of the intervention, Sadie began using the script spontaneously at other stores, talking with the cashiers by greeting them, and waiting to hear their responses. Zach's parent reported that Zach showed much more confidence in the community, especially when greeting and ordering. Zach's parent reported that he planned to continue using the List Recorder app and iPhone for future tasks. Brian's parent reported that Brian began to take initiative in new situations following the intervention. His parent believed that Brian will continue to use the List Recorder app in familiar situations.

Discussion

The purpose of this study was to examine the effects of mobile technology on the acquisition, generalization, and maintenance of interpersonal daily living skills among adolescents with ASD. To date, there has been little research conducted on teaching interpersonal DLS to individuals with disabilities entirely in the community. In this study, all participants demonstrated an increase in such skills through the use of mobile technology. These findings add to the literature related to the use of mobile technology to improve DLS among participants with disabilities in general, and with people with ASD in particular (Alcantara, 1994; Ayres et al., 2013; Cihak et al., 2007; Cihak et al., 2008; Walser et al., 2012; Yakubova & Taber-Doughty, 2013). These findings also support the limited research on the use of mobile technology to increase interpersonal DLS in the community (Yakubova & Taber-Doughty, 2013). For this study, young adults were able to navigate a community environment with assistance from mobile technology, thus expanding opportunities to take part in more diverse social activities and increase inclusion.

The results from the current investigation suggest adolescents can effectively generalize skills to other settings in the community. Acquiring, and ultimately generalizing skills across community environments bodes well for promoting greater community inclusion. Often, skill acquisition is isolated to school and other environments that lack the authenticity of the community, where young adults with disabilities are expected to, and should, live their lives. Sadie, Zach, and Brian showed minimal use of social exchanges in the generalization settings during baseline (scoring 40%, 50%, and 20%, respectively). Following the introduction of the intervention, however, the participants displayed significant gains. These generalization results maintained for each participant, as well. Notably, Sadie and Zach accessed the supports during intervention; however, they did not use the List Recorder app during the generalization probe in follow-up. Brian, however, accessed the support during two generalization follow-up probes with 50% and 83% accuracy. Thus, participants were able to access and use the supports provided on the mobile device *as needed*.

Based on the results from this study, all participants maintained interpersonal DLS after being taught to use the List Recorder app in the community. Sadie and Zach were able to maintain these skills with 100% accuracy when the intervention was removed. They no longer used the List Recorder app in the same way to make the purchases. During the follow-up condition, Sadie and Zach looked at and listened to the audio component prior to entering the community location; however, they did not access the support during the *in-store* follow-up sessions. This suggests that, for these two participants, that the List Recorder app played a strong *instructional* role, and limited the *compensatory* role to one of priming. This is not the case for Brian. Although Brian acquired and maintained the skill in the original training setting (i.e., Dunkin Donuts), and showed evidence of generalization in the second setting (i.e., Starbucks), he needed the List Recorder app to emit the skill while in the store to make purchases. Therefore, for Brian, the app appears to have taken on a *compensatory* role along with the instructional support it provided.

Limitations and Future Research

The results of the study should be considered in the context of its limitations. First, the wireless earbuds were useful; however, during the task, the earbuds occasionally fell out of the participants' ears. In some cases, the participants chose to forego the earbuds and just used the audio feature without earbuds, and this leads to questions as to which components of the intervention or features of the technology are more or less responsible for behavior change. It is possible that adolescents do not need to use earbuds once they learn to use the visual cues provided by the app. Thus, we recommend that future researchers consider component or parametric analyses of this intervention package. Second, the food item obtained following the completion of the task analysis was a strong reinforcer for the participants, and the results of this study might be best understood in this context. It is unknown if results would be similar if less motivating items were the product of task completion (e.g., purchasing a toothbrush). Therefore, we encourage additional research that examines these procedures where the goal is purchasing items that might not be obvious reinforcers. Third, treatment fidelity data were not collected; consequently, this could limit the internal validity of the study. One factor that might mitigate this issue somewhat is that the investigators used an implementation protocol to deliver the intervention. The intervention was delivered to each participant by the same researcher (the first author), using a pre-established script for all intervention sessions. We believe this protocol likely increased the fidelity of the intervention. Nevertheless, an objective observation of treatment integrity would have strengthened the results of this study. Fourth, although the parents provided very strong positive comments regarding the social validity of these efforts, we did not request social validity input directly from the participants. Clearly, seeking the opinions of participants about the study would contribute to our understanding of this intervention. Finally, there was not a final baseline probe in the session immediately prior to introducing the intervention to Brian. When using a multiple probe design, it is ideal if such a probe is conducted. However, Brian’s previous baseline data were low (at or near zero), with no obvious indication that his data were on the verge of any spontaneous increase. Given this data path during baseline, concerns regarding any threat to experimental control seem minor.

Conclusion

This study demonstrated that community-based training is viable using easily accessible mobile technology. In spite of little previous research, adolescents with ASD learned to participate in interpersonal DLS, entirely in the community. This study demonstrates that socially significant skills can be taught in authentic environments, a finding with numerous benefits toward social inclusion.

References

Alcantara, P. R. (1994). Effects of videotape instructional package on purchasing skills of children with autism. *Exceptional Children, 61*, 40–55.

Aljehany, M. S., & Bennett, K. D. (2019). Meta-analysis of video prompting to teach daily living skills to individuals with autism spectrum disorder. *Journal of Special Education Technology*. 34(1), 17-26. doi: 10.1177/0162643418780495

Ayres, K., Mechling, L., & Sansosti, F. (2013). The use of mobile technologies to assist with life skills/independence of students with moderate/severe intellectual disability and/or autism spectrum disorders: Considerations for the future of school psychology. *Psychology in the Schools, 50*, 259–271.

Barry, T. D., Kilinger, L. G., Lee, J. M., Palardy, N., Gilmore, T., & Bodin, S. D. (2003). Examining the effectiveness of an outpatient clinic based social skills group for high functioning children with autism. *Journal of Autism and Developmental Disorders, 33*, 685–701.

Brolin, D. E. (1997). *Life-centered career education: A competency-based approach*. Reston, VA: Council for Exceptional Children.

Bucholz, J. L., Brady, M. P., Duffy, M. L., Scott, J., & Kontosh, L. (2008). Using literacy based behaviour interventions and social stories to improve work behaviour in employees with developmental disabilities. *Education and Training in Developmental Disabilities, 43*, 486–501.

Cavkaytar, A., Acungil, A. T., & Tomris, G. (2017). Effectiveness of teaching café waitering to adults with intellectual disability through audio-visual technologies. *Education and Treatment in Autism and Developmental Disabilities, 52*, 77-90.

Charlop-Christy, M. H., & Kelso, S. E. (2003). Teaching children with autism conversational speech using a cue card/written script program. *Education and Treatment of Children*, *26*, 108–127.

Cihak, D. F., Kessler, K., & Alberto, P. A. (2007). Generalized use of a handheld prompting system. *Research in Developmental Disabilities*, *28*, 397–408.

Cihak, D. F., Kessler, K., & Alberto, P. A. (2008). Use of a handheld prompting system to transition independently through vocational tasks for students with moderate and severe intellectual disabilities. *Education and Training in Developmental Disabilities*, *43*, 102–110.

Council for Exceptional Children. (2010). *Life centered education (LCCE) transition curriculum*. Retrieved from https://www.cec.sped.org/Publications/LCE-Transition-Curriculum.

Douglas, K. H., Ayres, K. M., & Langone, J. (2015). Comparing self-management strategies delivered via an iPhone to promote grocery shopping and literacy. *Education and Training in Autism and Developmental Disabilities*, *50*, 446–465.

Ganz, J. B., & Flores, M. M. (2010). Implementing visual cues for young children with Autism Spectrum Disorders and their classmates. *Young Children*, *65*, 78–83.

Harper, C. B., Symon, J. B. G., & Frea, W. D. (2008). Recess is time-in: Using peers to improve social skills of children with autism. *Journal of Autism and Developmental Disorders*, *38*, 815–826.

Horner, R. D., & Baer, D. M. (1978). Multiple-probe technique: A variation of the multiple baseline. *Journal of Applied Behavior Analysis*, *11, 189-196.*

Hundert, J., & Houghton, A. (1992). Promoting special interaction of children with disabilities in integrated preschools: A failure to generalize. *Exceptional Children*, *58*, 311–320.

Kratochwill, T. R., Hitchcock, J., Horner, R. H., Levin, J. R., Odom, S. L., Rindskopf, D. M., & Shadish, W. R. (2010). *Single-case designs technical documentation*. Retrieved from http://ies.ed.gov/ncee/wwc/pdf/wwc_scd.pdf

McGee, G. C., & Daly, T. (2007). Incidental teaching of age appropriate social phrases to children with autism. *Research and Practice for Persons with Severe Disabilities, 32,* 112–123.

National Autism Center. (n.d). *Autism A-Z: Beyond the puzzle*. Retrieved from http://www.nationalautismcenter.org/

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

Rakap, S. (2015). Effect sizes as a result interpretation aids in single-subject experimental research: Description and application of four nonoverlap methods. *British Journal of Special Education, 42*(1), 12–33.

Sansosti, F. J., & Powell-Smith, K. A. (2008). Using computer-presented social stories and video models to increase the social communication skills of children with high-functioning autism spectrum disorders. *Journal of Positive Behaviour Interventions, 1*(3), 162–178.

Schreibman, L., Dawon, G., Stahmer, A. C., Landa, R., Rogers, S.J., McGee, G. G., & Halladay, A. (2015). Naturalistic developmental behavioural interventions: Empirically validated treatments for autism spectrum disorder. *Journal of Autism and Developmental Disorders, 45*, 2411–2428.

Sixth Mode Solutions. (n.d.). *List recorder: The best eyes-free list organizer on the iPhone*. Retrieved from http://sixthmode.com/

Walser, K., Ayres, K. M., & Foote, E. (2012). Effects of a video model to teach students with moderate intellectual disabilities to use key features of an iPhone. *Education and Training in Autism and Developmental Disabilities*, *47,* 319–331.

Wood, J. J., McLeod, B. D., Klebanpff, S., & Brookman-Frazee, L. (2014). Toward the implementation of evidence-based interventions for youth with Autism Spectrum Disorders in schools and community agencies. *Behaviour Therapy*, *46*(1), 83-95.

Yakubova, G., & Taber-Doughty, T. (2013). Effects of video modeling and verbal prompting on social skills embedded within a purchasing activity for students with special education. *Journal of Special Education Technology*, *28*(1), 35–47.