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The Use of iPad and eBooks to Perform Daily-Living Skills among Adolescents with Autism Spectrum Disorder and Intellectual Disability

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Abstract:	In the current study, three adolescents with autism spectrum disorder (ASD) and moderate intellectual disability (ID), were first taught to independently use an iPad to access instructional material (i.e., video models) via electronic books or eBooks. After iPad training, participants were required to apply their newly acquired skills to independently operate the iPad and eBooks to learn and perform other novel daily living tasks. The study employed a single case, nonconcurrent multiple baseline design across participants during the iPad training phase and across tasks for each participant during the application phase. Results based on visual analysis indicated that all participants learned to independently operate the iPad and access instructional materials presented via eBooks. Furthermore, they applied these skills to learn and independently perform other novel daily living tasks. Effect size estimates using between case standardized mean difference (BC-SMD) showed improvements in responding subsequent to iPad training.

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Abstract

In the current study, three adolescents with autism spectrum disorder (ASD) and moderate intellectual disability (ID), were first taught to independently use an iPad to access instructional material (i.e., video models) via electronic books or eBooks. After iPad training, participants were required to apply their newly acquired skills to independently operate the iPad and eBooks to learn and perform other novel daily living tasks. The study employed a single case, nonconcurrent multiple baseline design across participants during the iPad training phase and across tasks for each participant during the application phase. Results based on visual analysis indicated that all participants learned to independently operate the iPad and access instructional materials presented via eBooks. Furthermore, they applied these skills to learn and independently perform other novel daily living tasks. Effect size estimates using between case standardized mean difference (BC-SMD) showed improvements in responding subsequent to iPad training.

Key words: Autism Spectrum Disorder, Intellectual Disability, Mobile Devices, Video Applications.

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The Use of iPad and eBooks to Perform Daily Living Skills among Adolescents with Autism Spectrum Disorder and Intellectual Disability

Introduction

Autism spectrum disorder (ASD) is a neurodevelopmental disorder that is characterized by persistent deficits in verbal and nonverbal communication and social interactions, and restricted/repetitive patterns of behaviors (Allen et al., 2010) that could affect the lives of individuals with ASD and their primary caregivers (Hendricks & Wehman, 2009). The provision of care is usually higher for individuals with comorbid ASD and intellectual disability (ID) that experience greater limitations in the area of functional living (Cannella-Malone et al., 2011). Functional living encompasses a wide range of activities (e.g., self-care, domestic care, community participation, socialization, leisure, etc.) that allows an individual to actively participate in their environment.

To provide adequate support to individuals with ASD and ID, parents, teachers and/or other primary care providers often opt for additional interventions and environmental provisions. These provisions could come in the form of varying levels of structural supports, prompts and physical guidance to help individuals with ASD and ID perform various tasks. Griangreco and Broer (2005) surveyed 700 school personnel and found that individuals with ASD and other developmental disabilities (e.g., ID) spend 86% of their day in close proximity (i.e., within three feet) to a paraeducator or caregiver. The reliance on primary care providers (e.g., parents, special educators, teaching assistants, therapists, etc.) was particularly underscored when individuals with ASD and ID experienced greater difficulties across various environmental settings in the absence of these external agents (Hume et al., 2009; Van Laarhoven et al., 2018). Therefore,

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given this context, the necessity to develop instructional tools that fosters greater functional independence across a wide range of activities for individuals with ASD and ID is vital.

Tapping on the strengths of individuals with ASD, research has suggested that using visually cued instructions have been increasingly effective as an intervention modality as individuals with ASD seem to perform well, respond better and successfully complete tasks that involve visual stimuli (Shipley-Benamou et al., 2002). Video-based Instruction (VBI) is a form of visual, non-static, instructional material that has been found to be effective in teaching individuals with ASD (Bereznak et al., 2012). Commonly used VBI include video prompting (VP) or video modeling (VM); both of which are instructional, behavioral techniques that involve the use of videos for individuals to engage in observational learning of targeted behaviors (Hammond et al., 2010).

In VP, the individual watches a video of each specific step of a task chain and performs that step before moving on to the next video of the next step (Cihak et al., 2006). The number of video clips necessary in video prompted instructions, therefore, matches the number of steps required for each complex skill. For example, a task of 10 steps would require the creation of 10 video clips. This could prove to be less taxing on the individual watching the clips, as they are short, allowing for fewer demands on one's attention and memory (Cannella-Malone et al., 2011). However, VP could also prove to be more resource intensive as it requires the filming of different videos clips or editing a single video clip to illustrate the different steps as opposed to the production of a single video clip of the entire process. Research on VP as an instructional method has shown effectiveness in teaching various functional skills such as leisure activities (Edrisinha et al., 2011), vocational skills (Bereznak et al., 2012), and domestic skills (Johnson et al., 2013) across individuals with ASD and/or ID.

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In VM, the individual is primarily tasked to watch a video of a desired set of skills, before he or she is required to replicate and engage in the task itself (Van Laarhoven et al., 2009). This means that a VM instruction of the same task of 10 steps, for example, would only require the creation of one video. The length of this video clip in VM, as compared to the short videos of each step in VP, would be longer, and would require more attention and memory from the individual. However, the amount of resources, in terms of time and costs, necessary to produce one video clip, would be less. Hence, the creation of electronically mediated instructional material using VM would be perceived to be more practically convenient for educators and parents (Cannella-Malone et al., 2006). Additionally, VM has a strong research base demonstrating its effectiveness as an instructional tool for individuals with developmental disabilities (e.g., ASD; McCoy & Hermansen, 2007). Based on a systematic review conducted by Wong and colleagues (2015), VM is considered evidence-based practice for children with ASD and/or ID across various domains such as learning functional math skills (Burton et al., 2013), social initiation and communication (Cihak et al., 2012; Horn et al., 2021), reciprocal play (Nikopoulos & Keenan, 2007), and daily living skills (Shipley-Benamou et al., 2002).

Considering the emphasis of technological advancements on digital literacy among individuals with developmental disabilities, many research studies have reported the effectiveness of using handheld devices such as laptops, the iPad (Spriggs et al., 2015), the iPod, or the iPhone (Bereznak et al., 2012) as a successful platform to present videos. This could be because these devices are commonly used across both school and home settings. Additionally, more applications have been increasingly available to host videos, using host applications such as YouTube or Wisteria, or applications that allow you to customize videos, books or presentations with the inclusion of videos (e.g., Book Creator, StoryBuddy2, Story Creator, etc).

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A standout feature of the use of VBI is the ability to increase independence, whereby individuals are able to seek various tools to help them complete and engage in a desired task (Ayres et al., 2013). For this to happen, however, it is important for individuals with ASD and ID to first learn how to use various digital platforms, tools and handheld devices to access video models on executing various tasks (Jimenez & Alamer, 2018). For instance, Hammond and colleagues (2010), examined the effects of video modeling delivered via computer on accurate and independent use of an iPod by three participants with moderate intellectual disability (ID). All three participants learned to watch a movie, listen to music, and look at photos on an iPod. Results indicated that participants acquired skills following VM and could independently use the iPod across the various tasks.

Although previous research on VBI has illustrated benefits in developing skills across various functional domains, it remains unclear if prior training in operating a handheld device such as an iPad (e.g., unlocking the device, choosing the relevant instructional materials, swiping pages, etc.) could facilitate greater functional independence for individuals with ASD and ID. Previous research using video models primarily focused on participants accessing videos on a handheld device with the assistance of the researcher to learn target skills (e.g., Burton et al., 2013; Cihak et al., 2012; Edrisinha et al., 2011). Specifically, the researcher would operate the device for participants to view various video models to complete assigned tasks. In some studies, although a training phase on utilizing the handheld device was conducted, specifics on procedures and/or data collected on participant independence levels to operate the device to access videos were not included (e.g., Bereznak, et al., 2012; Van Laarhoven, et al., 2009). In other studies, using VBI, participants had previous histories of managing a handheld device to view videos (e.g., Burton et al., 2013).

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Considering the benefits of VBI documented in the behavioral literature for individuals with ASD and ID as well as the procedural gaps in the studies reviewed, the current study aims to answer the following research questions - a) Do participants learn to independently operate a handheld device such as an iPad to access the eBooks after the iPad training phase? and b) Do participants apply these newly learned skills of operating the iPad and eBooks to perform other novel daily living tasks with minimal support from external agents during the application phase?

Methods

Participants

At the time of the study, all three participants were studying in a special education school that catered to children with ASD and moderate to severe levels of ID. This school follows the Treatment and Education of Autistic and related Communications Handicapped Children (TEACCH) approach to achieve adapted curriculum goals geared towards building skills in functional academics, socialization, personal hygiene and self-care, communication, leisure activities, community participation, and vocational education. The participants were placed in classrooms where the teacher-student ratio was one is to three with a total class-size of seven to nine students. Additionally, the participants were diagnosed with ASD and moderate levels of ID based on psychological assessments conducted by registered psychologists. These psychological assessments consisted of test batteries that evaluated the participants' cognitive and adaptive skills, and the presence of ASD symptoms. Participant information was obtained from school records, parent and teacher reports.

Participants were invited to enroll in the study based on the following inclusion criteria reported by teachers - a) showed a preference for videos, b) demonstrated skills to attend to

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visual instruction, c) demonstrated simple fine and gross motor abilities, d) could match pictures (i.e., print and digital stimuli) to an object, and e) could imitate simple one step actions.

Two females and one male participated in the study. Kristine and Rebecca of Chinese ethnicity were aged 12 and 13 years respectively while Daniel of Indian descent was 12 years. All participants communicated their needs vocally using words and short phrases. They followed simple one to two step directions. They were independent with personal hygiene and self-care skills and could perform tasks involving simple fine and gross motor skills (i.e., opening/closing containers, carrying objects, transferring items between containers, etc.). They experienced inattention issues due to which redirection to maintain on-task behaviors was required. Their individualized education plans suggested goals towards expanding their functional repertoire to gain independence with daily living tasks in their home/domestic domain. In terms of familiar daily living tasks, Kristine and Rebecca could independently make jam sandwiches while Daniel could water plants and clean/wipe a table. Based on teacher report, all participants had limited knowledge and independent skills with operating an iPad and accessing eBooks on any handheld device. Specifically, when engaging with handheld devices, their teachers and/or parents would manage the device for them.

Setting, Tasks and Materials

All sessions were conducted in a one-to-one setting during school hours, at the school. Initial baseline sessions for the iPad training phase (i.e., the first three to four sessions) across participants were conducted in a separate room, also known as the therapy room, which consisted of a table and six chairs. However, due to venue constraints, as the therapy room was inconsistently available, the remaining baseline and intervention sessions across the two phases of the study were conducted in the participants' classroom. The classroom included a large,

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kidney-shaped table, three work carrels, a long white board, visual schedule board, and other teaching materials and tools. Sessions in the classroom were conducted when other students were engaged in other out of class activities (such as physical education, arts/crafts, home economics, etc.)

Five different tasks were selected for this study. These tasks were divided across two phases of the study- the iPad training phase, and the application phase. During the iPad training phase, participants performed one of the two familiar daily living tasks, such as making a sandwich or cleaning the table while learning to operate the iPad and eBooks. During the application phase, participants applied their newly acquired skills of using the iPad to three unfamiliar novel tasks, such as setting the table, folding clothes, and making cup noodles. The specific steps involved in performing these tasks were broken down into eight steps each. Table 1 shows the materials used for the familiar and novel daily living tasks respectively. Table 2 shows the task analysis of the novel daily living tasks.

<Insert Tables 1 and 2 here>

To provide an instructional base, eBooks were used to combine all instructional materials necessary for the participants to encourage independence with performing steps of the various tasks. The use of the eBooks also allowed for visual differentiation in the cover pages to assist the participants to distinguish and subsequently select the different instructional eBooks associated with the different tasks. An eBook for each task was created using the Book Creator application (Red Jumper Limited) and the Apple iMovie application (Apple Inc.). Each eBook comprised of visual cues (photographs and icons), textual cues (words), audio cues/messages (voice recordings), video models via point of view video recordings, and was published offline into the iBook application on the iPad (2nd generation) for easy accessibility. All photographs

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and videos in each eBook were filmed with either an Apple iPhone 6 and/or a 13" MacBook Air, and were edited using the iMovie application to include voice recordings and text instructions of each step. For additional details on the layout and graphics of the eBooks, please refer to Appendix 1 and 2 respectively available as a supplementary file to this article.

Design

A single case experimental design employing a nonconcurrent multiple baseline design (Ledford & Gast, 2018) was used across participants in the iPad training phase (Phase 1), and across novel daily living tasks for each participant in the application phase (Phase 2) of the study. In the iPad training phase, a nonconcurrent multiple baseline design was used as participants entered the study at different time points. In the application phase, a nonconcurrent multiple baseline design across the three tasks was used as each participant was required to gain 100% independence in implementing all steps for a specific novel daily living task for at least seven consecutive sessions before moving onto the next task. This was decided by the research team to help avoid confusion in learning and performance of steps across the three novel tasks for all participants. These decisions were based on factors such as increased complexity of task demands in the application phase (i.e., independently use the eBooks with embedded video models to learn steps to implement novel tasks and subsequently perform the steps of the various novel tasks), participant skill levels, and the results of the iPad training phase. Additionally, varying baseline lengths for each participant across the iPad training phase and the three novel daily living tasks in the application phase were collected prior to initiation of iPad training to prevent threats to internal validity that could occur due to exposure to the training materials, as this could potentially affect intervention effects (Harvey et al., 2004).

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Response Measures

Dependent Variable

Each session comprised of independently completing steps within an activity chain (i.e., operating the iPad and novel daily living tasks). For the iPad training phase, a response was recorded as independent when the participant completed one of the 13 steps to operate the iPad, with or without a verbal prompt and in the absence of any gestural and physical prompts from the researcher. Similarly, for the application phase, a response was recorded as independent when the participant completed one of the eight steps to perform the novel daily living task, with or without a verbal prompt and in the absence of any gestural and physical prompts from the researcher. Event recording was used to track the number of independent responses performed by each participant across both phases of the study. Occurrence data for each session was then calculated by summing up the total number of independent responses demonstrated by the participant, dividing it by the total number of steps in the activity chain, and multiplying it by 100 to provide a percentage of independent steps completed across both phases of the study.

Inter-observer Agreement (IOA)

All sessions were recorded using a 13" MacBook Air, and were reviewed subsequently to check for accuracies in recorded data. All data collectors were graduate students in a Master's program for applied psychology, and were trained in collecting behavioral data in their respective organizations. The primary observer/data collector was the lead researcher, and first author of the study. The secondary data collector was blind to the conditions (i.e., baseline vs. intervention) and phases of the recorded sessions randomly selected to calculate IOA. IOA was calculated using a frequency ratio to calculate a percentage of total agreement (i.e., interscorer reliability), and was derived by dividing the number of agreements, by the total number of both

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agreements and disagreements, before multiplying it by 100 (Ledford & Gast, 2018). The average IOA for all three participants across 30% of sessions randomly chosen for each of the phases was 98% (range = 91.7%-100%). The IOA scores averaged at 98.5% (range = 98.4%-99%), 99.2% (range = 97.6%-100%), and 96.3% (91.7%-100%) for Kristine, Rebecca, and Daniel respectively.

Treatment Integrity (TI)

A treatment integrity checklist was used to ensure that the procedures for the iPad training and application phases were carried out in a standardized format across all sessions by the researcher. TI for the iPad training phase included steps conducted by the researcher primarily on setting up materials for the daily living task, the most to least graduated prompting sequence and provision of reinforcement to teach the participants the 13 steps involved in operating the iPad and eBooks. TI for the application phase involved procedures conducted by the researcher to facilitate participants' application of previously learned skills on operating the iPad and eBooks to implementing the 8 steps of three novel daily living tasks. Therefore, procedures followed by the researcher in this phase focused on setting up materials for the novel tasks, the absence of using the graduated prompting sequence and redirection to the activity. TI was derived and calculated by dividing the number of accurately performed steps by the total number of steps, before multiplying it by 100. Data for TI were collected by graduate students in a master's program for applied psychology who were trained in collecting behavioral data. The TI scores for Kristine averaged at 99.2% (range = 97.6%-100%) for 30% of all sessions in each phase. Both Rebecca and Daniel achieved an average of 100% for 30% of their sessions randomly selected for each phase of the study.

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Procedures

The procedures for this study consisted of two phases: the iPad training phase, and the application phase. The iPad training phase consisted of baseline and iPad training sessions. Similarly, the application phase consisted of baseline and application sessions. Across all phases and participants, sessions were conducted twice a week, for approximately 30 to 45 minutes, with each session lasting for approximately 6 to 7 minutes, depending on the responsiveness of each participant.

iPad Training Phase

The purpose for Phase 1- the iPad training phase, was to teach participants to independently operate the iPad and access the preinstalled instructional eBooks with embedded video models on daily living tasks. In this phase, participants were coached through researcher delivered prompts (i.e., the least to most graduated prompting sequence) to execute 13 steps involved in operating the iPad and accessing the eBook to perform a familiar daily living task. Table 3 shows the task analysis of the 13 steps to operate the iPad and installed eBook. This phase consisted of baseline and training sessions. Across all baseline and training sessions, the familiar daily living task used in this phase was making a sandwich for Kristine and Rebecca, and cleaning the table for Daniel. All necessary materials required for the tasks and the iPad installed with the eBooks (i.e., familiar and novel tasks) were placed on the table in front of the participant. For each session, participants were asked to engage in the tasks, using the instruction "Use the iPad to make a sandwich" for Kristine and Rebecca or "Use the iPad to clean the table" for Daniel across all sessions in this phase. All participants were provided with at least 2 minutes of break in between each session. All sessions were terminated after 3 minutes, following the

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participants' lack of engagement in the steps necessary for completing the task, and/or in the event of task completion.

<Insert Table 3 here>

During baseline, no researcher interaction in the form of prompts was provided, with the exception of redirecting the participants' attention back to the task, and/or providing praise for completion of a step. During iPad training, researcher interaction in the form of prompts was delivered. Each participant was provided with a least-to-most prompting sequence to aid with completion of each step in the task chain. The prompting sequence included a verbal prompt (least), gestural prompt, and a physical prompt (most) for each step of the task chain. A verbal prompt involved telling the participant the step to operate the iPad (e.g., unlock the iPad, open the eBook application etc.). A gestural prompt involved pointing to the items to be selected on the iPad. A physical prompt involved moving the participants' hands to the relevant buttons and/or holding their hands to perform the task steps.

The iPad training session started with instructing the participant to first take the iPad laid on the table, unlock the iPad, open the 'iBook' application, followed by selecting the appropriate eBook pertaining to the familiar task at hand. Subsequently, the participant was instructed to flip the eBook open (i.e., the cover page) by tapping or swiping the screen. On reaching page 2, the participant was asked to press play to hear the audio message pertaining to instructions of the task at hand and then flip to the next page by tapping or swiping the screen. On reaching page 3, the participant was asked to press play to hear the audio message pertaining to materials required to complete the tasks and then flip to the next page. On reaching page 4, the participant was asked to press play to view the video model pertaining to all eight steps required to complete the task at hand. After viewing the video, the participant was instructed to flip to page and press play

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to hear the audio message pertaining the starting the steps involved in completing the task at hand (i.e., "Let's try it"). A session was deemed complete when the participant performed all 13 steps required to operate the iPad and completed the steps of the familiar task. The same set of 13 steps to operate the iPad and eBooks across the various familiar and novel tasks in the iPad training and application phases were standardized.

During the initial sessions of training, Kristine and Rebecca were provided with a tangible reinforcer after all 13 steps of the task were completed. However, due to low levels of responding, the research team decided that the reinforcer should be provided after every step of the activity chain to facilitate learning of the steps to operate the iPad. This modification was initiated in session 10 for Kristine, and session 11 for Rebecca. For Daniel, who joined the study at a later time, the modification started from the first iPad training session. Based on interviews with the participants' respective teachers and/or parents using the Reinforcement Assessment for Individuals with Severe Disabilities (RAISD; Fisher et al., 1996), Kristine's potential reinforcers were M&Ms, corn snacks, chips, raisins, cereals, and oreos. Rebecca's potential reinforcers were oreos, cereals, and juice, while Daniel's preferred items were chips, oreos, mamee noodle snacks, and gummy sweets. The iPad training phase was deemed complete when the three participants achieved 100% independence with implementing all 13 steps to operate the device and access the eBook, for at least two consecutive sessions.

Application Phase

The purpose for Phase 2 – the application phase, was to examine if participants could apply their newly learned skills of operating the iPad to perform other novel/unfamiliar daily living tasks via the corresponding instructional eBooks (with embedded video models) installed in the iPad. To achieve this goal, participants learned to implement the eight steps involved in

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completing each of the three unfamiliar novel tasks, such as setting the table, folding clothes, and making cup noodles, using the iPad installed eBooks in the absence of researcher delivered gestural and physical prompts. This phase consisted of baseline and application sessions. Across all sessions, necessary tools required for each of novel daily living tasks and an iPad with the installed eBook (i.e., familiar and novel tasks) were placed on the table in front of each participant. Participants were asked to engage in the task, beginning with the setting the table task, followed by the folding clothes task and the making a cup of noodles task. Due to time constraints related to the end of the school year, Daniel could not complete the last novel task on making a cup of noodles. For each session, participants were asked to engage in the tasks, using the instruction "Use the iPad to set the table", "Use the iPad to fold clothes" or "Use the iPad to make a cup of noodles". All participants were provided with at least 2 minutes of break in between each session. All sessions were terminated after three minutes, following the participants' lack of engagement in the steps necessary to complete the task, and/or in the event of task completion.

During the application phase, as the focus was to evaluate the participant's use of skills to independently operate the iPad to learn and implement novel tasks via the corresponding eBooks installed in the device, researcher interaction during baseline and application sessions of this phase was limited to selection of appropriate eBooks for each novel task (if needed), redirection of participants' attention back to the task, and provision of praises and/or reinforcement after every step of the task chain. The researcher did not follow the least to most graduated prompting sequence. Verbal, gestural and physical prompts for completion of each step in the task chain were not provided during this phase of the study. To avoid confusion in learning the various tasks, all participants were required to reach 100% independence in

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performing all eight steps of one task for seven consecutive sessions before moving to the next task.

Data Analysis

Behavior data involved in conducting a nonconcurrent multiple baseline design were analyzed by visual inspection of graphs to determine the functional relations between the variables. The quality and rigor of the multiple baseline design was evaluated using criteria delineated by What Works Clearinghouse (WWC) single-case design standards (WWC, 2020). Specifically, the study involved systematic manipulation of the independent variables during the assessment phase, using strictly controlled standardized procedures. The dependent variable was operationally defined in observable terms of the steps completed in the activity chain and was systematically measured over time using specific data recording procedures. The study also involved more than one researcher in data collection, and IOA checks were conducted to ensure accuracy of data collected. IOA checks were conducted for at least 30% of the data collected in the both phases of the study for all participants. The results of the manipulations were analyzed in terms of visual analysis of trends, levels and variability of the dependent variable to determine when the independent variable conditions/phases could be changed within the study design. Furthermore, intervention effects were demonstrated over at least three different time points across both phases of the study.

Effect sizes were also calculated using a hierarchical linear model that accounted for the nested structure for data in the present study. This calculation results in an effect size that is comparable to effect sizes of other studies using quantitative designs. Here, the effect size is between case standardized mean difference (BC-SMD). The calculation was carried out using R-Studio with ShinyApps (Pustejovsky et al., 2020). Two effect sizes were estimated separately.

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The first effect size was estimated for the iPad training phase to evaluate improvements in learning to independently use the iPad across all participants. The second effect size was estimated for the application phase to assess improvements in participants' application of their newly acquired skills of operating the iPad to independently perform steps across the three novel daily living tasks.

Results

Results for Phase 1 – iPad Training Phase

The results for iPad training are provided in Figure 1 across all three participants. Baseline results for iPad training indicated low levels of responding with stable trends. Participants achieved at most two out of 13 steps across all three participants (M = 11.65%, range = 0% - 15%). These results confirm that the participants had limited skills and knowledge to operate the iPad and installed eBooks. During intervention, in the first five sessions for Kristine, and four sessions for Rebecca, reinforcement was provided after the completion of all 13 steps. During these sessions, both participants continued to show stable trends with low levels of responding, and no immediate change in responding as a result of the intervention. Kristine performed a maximum of two steps (M = 9.4%, range = 8% - 15%) and Rebecca completed three of the 13 steps in the task chain (M = 17%, range =15% - 23%).

Following the implementation of reinforcement at the completion of every step of the task chain during intervention, an accelerating but variable trend was observed across all three participants. An immediate change in responding as a result of the intervention was observed with Rebecca between the last baseline session (i.e., session 10) and the first intervention session (i.e., session 11). This was not observed for Kristine and Daniel as there was overlap in data points between baseline and intervention results for the first three sessions of intervention.

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Kristine took 27 sessions to independently perform all 13 steps (*M* = 64%, range = 15% - 100%). Rebecca took the most number of training sessions, requiring 31 training sessions (*M* = 67%, range = 38% - 100%). Daniel took the least number of sessions, requiring 22 sessions to independently perform all 13 steps (*M* = 72, range = 8% - 100%). The participants performed all 13 steps for at least two consecutive sessions before moving onto the application phase of the study with a BC-SMD of 8.84 and a 95% confidence interval ranging from 3.52 to 14.15 during the iPad training phase.

<Insert Figure 1 here>

Results for Phase 2 – Application Phase

Results for the application phase for Kristine, Rebecca and Daniel are presented in Figures 2, 3, and 4 respectively. Kristine results during baseline revealed low yet variable levels of responding across the three tasks. She did not perform any of the steps in baseline (*M* = 0%) for the first novel task, two out of eight steps (*M* = 11%, range = 0% -25%) for the second novel task, and none of the steps (*M* = 0%) for the last novel task. After receiving training to independently operate the iPad in the iPad training phase, Kristine's results during the application phase showed an overall stable accelerating trend with an immediate change in responding from baseline across all three tasks. She performed all eight steps (*M* = 92%, range = 38% - 100%) of the first novel task in the second session, requiring a total of eight sessions to master this task. For the second novel task, she performed all eight steps independently on the third session (*M* = 86%, range = 38% - 100%), taking nine sessions in total. For the third novel task, she performed all eight steps independently on the fourth session (*M* = 87%, range = 50% - 100%), taking 10 sessions in total.

<Insert Figure 2 here>

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Rebecca results during baseline revealed stable and low levels of responding for the first novel task, low yet variable levels of responding for the second novel task, and a decelerating trend in responding for the third novel task. She performed none of the steps during the baseline phase for the first novel task (M = 0%), one out of eight steps (M = 7%, range = 0% - 13%) for the second novel task, and two out of eight steps (M = 4%, range = 0% - 25%) for the third novel task. After receiving training to independently operate the iPad in the iPad training phase, like Kristine, Rebecca's results during the application phase showed an overall stable accelerating trend with an immediate change in responding from baseline across all three tasks. She immediately and independently performed all eight steps for the first novel task (M = 100%), requiring a total of eight sessions to master this task. For the second novel task, she performed all eight steps independently on the sixth session (M = 82%, range = 38% - 100%), taking 12 sessions in total. For the last novel task, she performed all eight steps independently on the fifth session (M = 89%, range = 63% - 100%), taking 11 sessions in total.

<Insert Figure 3 here>

Due to time constraints, Daniel was only tasked to learn two of the three selected novel daily living tasks. At baseline, Daniel's results indicated low yet variable level of responding across the three novel tasks. He independently performed two out of eight steps for both the first (M = 5%, range = 0% - 25%) and second novel tasks (M = 9%, range = 0% - 25%). After the iPad training phase, like Kristine and Rebecca, Daniel results in the application phase showed an overall stable accelerating trend with an immediate change in responding from baseline. He immediately performed all eight steps independently (i.e., session 6) for the first novel task, but his responding drastically decreased in the subsequent session (i.e., session 7). Follow-up interviews with his class teachers revealed that he was unwell on the day that session was

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conducted, and he performed similarly below his usual standards in class as well. This could potentially account for the decrease in responding. He subsequently performed all eight steps independently in the fourth session (M = 91%, range = 38% - 100%) for the first and second novel task (M = 91%, range = 50% - 100%), taking a total of 10 sessions across both tasks. Results for overlap in data between baseline and intervention for all participants via the hierarchical linear model estimated a significant increase in performance across all participants with a BC-SMD of 5.22 and a 95% confidence interval ranging from 4.23 to 6.20 during the application phase.

<Insert Figure 4 here>

Discussion

Pertinent Findings

This study aimed to answer two pertinent questions. Firstly, it aimed to determine if participants with ASD and ID could learn skills necessary to independently operate an iPad to access instructional materials via eBooks with embedded video models preinstalled in the device. The findings of this study based on visual inspection of graphs indicated that all participants learned to independently use the handheld device following iPad training which employed the least to most graduated prompting sequence and reinforcement delivered by the researcher. Additionally, statistical analysis using hierarchical linear model estimated a mean increase in responding of about nine times from baseline across all participants as a result of iPad training. Secondly, the study aimed to determine if the participants could use their newly acquired skills of manipulating the iPad and eBook to independently perform novel or unfamiliar daily living tasks. The results from the application phase of the study indicated that all participants could independently execute preselected novel daily living tasks primarily using the iPad and eBooks

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with minimal assistance (i.e., verbal redirection) from the researcher. Minimal assistance by the researcher was provided, in terms of the selection of appropriate eBooks for each novel task (if required), redirection of participants' attention back to the task, and provision of praises and/or reinforcement after every step of the task chain. A prompting sequence was not used by the researcher to assist the participants to access the iPad and/or eBooks and/or performing the novel tasks. It is important to note that all participants during the application phase showed immediate increments in the number of steps independently performed. They required fewer sessions to autonomously execute all steps of the novel tasks using the iPad in the application phase when compared to the responding in the training sessions of iPad training phase. Additionally, effect size estimates calculated using a hierarchical linear model during the application phase specified an average increase in independent performance across all participants of approximately five times in response to using the iPad and eBooks for performing novel daily living tasks.

The results obtained from this study support existing research on teaching participants with ASD and ID to independently employ mobile/handheld devices such as an iPad to access electronically mediated instructional materials to support their learning needs in daily living skills (Cullen et al., 2017; Hammond et al., 2010; Horn et al., 2020). Independent use of the iPad allowed participants greater flexibility in retrieving instructional materials provided to them via the eBooks and learning at their own pace. Due to the interface of the Book Creator application and the iBooks application in the iPad, the published eBook provided ease with reviewing materials by flipping the book pages, forwards and backwards, on multiple occasions. The video models in each eBook could be paused, rewound and re-watched whenever participants deemed it necessary. For example, Daniel was found, on several occasions, to flip pages in the eBook and replay some instructions before moving onto the subsequent steps of the activity chain.

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Furthermore, the findings are in line with previous research that supports the use of VM as an effective instructional tool to teach daily living skills to individuals with ASD and ID (Burton et al., 2013; Cihak et al., 2012; Nikopoulos & Keenan, 2007; Shipley-Benamou et al., 2002).

Benefits of Using VM with Mobile Technology as an Instructional Tool

There are several additional benefits to using VM as a teaching tool via mobile applications as evidenced by this study's results. Similar to participants in this study, children with ASD have shown an inclination towards learning from technology, through visual mediums such as videos or computer games (Mineo et al., 2009). This preference for electronic screen media (Shane and Albert, 2008), thereby acts as a natural reinforcer for the learning of targeted behaviors for children with ASD (Nikopoulos & Kennan, 2007; Spriggs et al., 2015). The use of VM via mobile applications helps to reduce attentional requirements necessary in a learning process by allowing for the creation of instructional materials that are specific and relevant to a student's learning situation (McCoy & Hermansen, 2007). Specific cues or behaviors could be highlighted via video models by featuring them strongly in videos, without other irrelevant stimuli. For instance, function keys and materials to be selected for the completion of steps in task-chain were highlighted. This helped our participants to increase focus on the main stimuli required for observational learning and enhanced the instructional value of the teaching materials used.

Additionally, the use of printed visual materials in the classroom often comes with face-to-face interactions with teachers, trainers, parents or caregivers; a situation that is often difficult for most individuals with ASD (Charlop-Christy et al., 2000). Unpredictable attention from primary care providers that is usually necessary in traditional, static interventions could be reduced when students learn to independently use handheld devices to access instructional

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material (Charlop-Christy et al., 2000). At the same time, training individuals to independently learn through the use of available technological tools could increase their ability to learn and cope when presented with novel tasks (Smith et al., 2016). The availability of technological teaching tools therefore helps to reduce the challenge of prompt dependence, helps increase self-sufficiency in learning (Van Laarhoven et al., 2009), and allows the student to play an active role in their learning process (Knight et al., 2013). Finally, sharing of video materials via mobile applications also allows for consistency in intervention implementation between various settings. While caregivers and teachers may change over time, the use of consistent and standardized visual learning aids and tools, therefore helps to increase the predictability of the learning material to the individual (Ploog, 2010). This in turn, allows targeted skills to be better applied across various environmental settings.

Limitations and Future Directions

There were a few limitations and future directions for research that could be considered in this study. Adopting VM via mobile applications comes with the reduction of stigmatization faced by individuals with ASD and ID. With technology and handheld devices commonly embraced in today's society, video watching has been commonly linked to leisure or recreational activities. In fact, the use of self-instruction on technological devices is a tool commonly employed by individuals with or without disability (Smith et al., 2016). Given this premise, more information regarding the social acceptability of the use of iPad and eBooks as teaching tools by teachers and practitioners is necessary to determine the feasibility and integration of this instructional approach into a classroom setting. Hence, social validity or treatment acceptability, although not assessed in the current study, could be further explored in future studies.

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Furthermore, a small sample size of three cannot be considered representative of children with ASD and ID to generalize this study's findings on whether this target population can learn to independently operate an iPad and further apply these skills to learn and autonomously perform other novel daily living tasks. More research with a larger sample size would be required to extend the external validity of this study.

Maintenance data or follow up data on the continued performance of the participants on these tasks was not collected in the current study. Such evidence is necessary to determine if participants can sustain this novel learning over time. Similarly, no data was collected for the fading or removal of the iPad, and it is unknown if the participants would be able to translate this learning without the continued use of visual prompts (i.e., the iPad/eBook).

Conclusion

Findings of this study suggest that individuals with ASD and ID can be taught to independently use an iPad and eBooks which could be consequently applied to other learning contexts/tasks to master and perform target skills. More importantly, this study demonstrates the possibility of teaching these individuals to be independent, and active agents in their own learning via the use of VBI and digital literacy skills. This could, in turn, decrease the reliance on external agents and existing manpower. Teaching digital literacy skills and employing VBI as an instructional tool could be extended to multiple applied settings (e.g., home, vocational settings etc.) and learning domains (e.g., functional academics, adaptive functional/vocational skills etc.) to determine its practical social viability. If proven effective, more can be done to ensure that teachers, practitioners, primary care providers and future employers are suitably trained to use these resources when supporting individuals with developmental disabilities.

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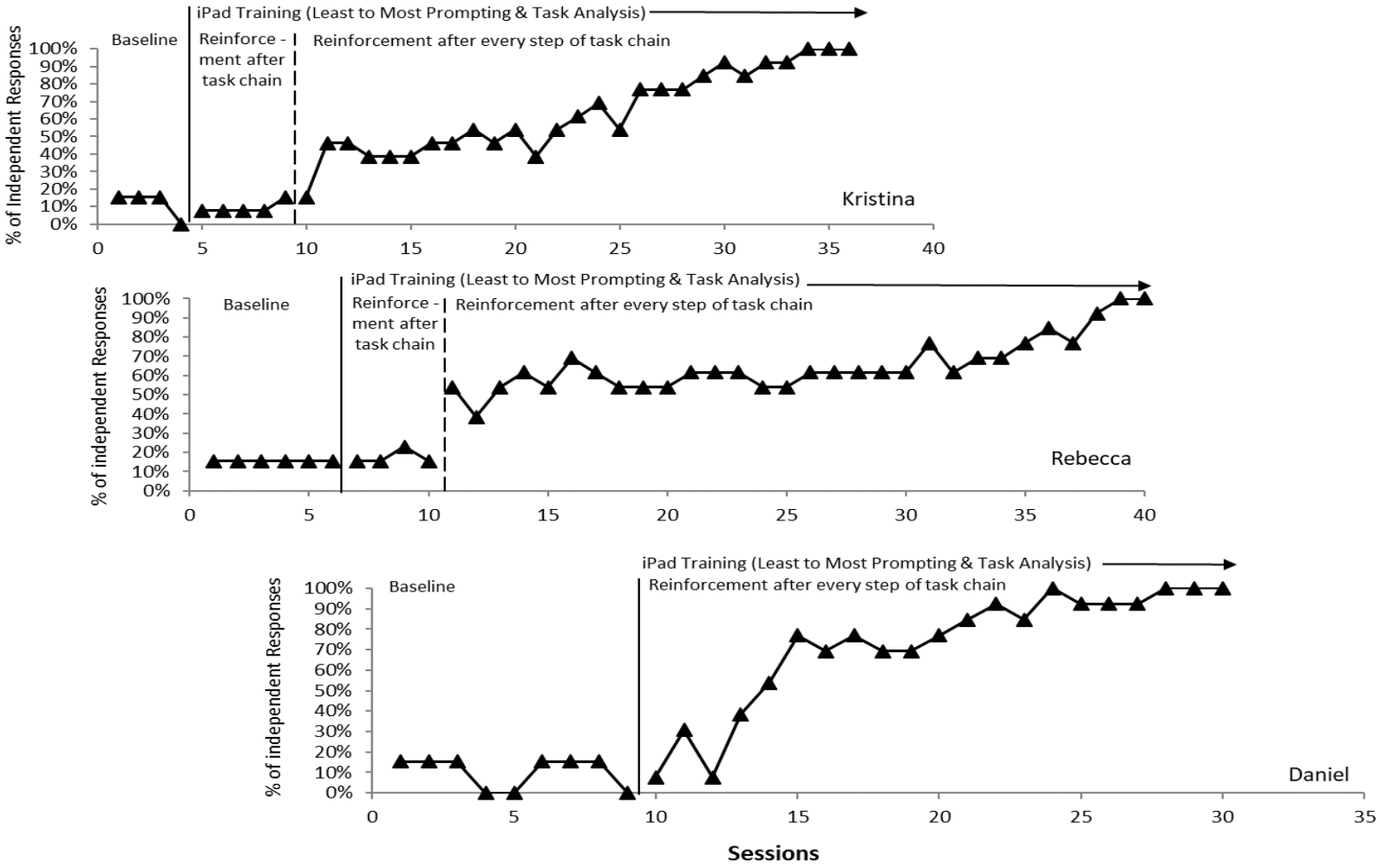
IPAD/EBOOK USE TO LEARN DAILY LIVING SKILLS FOR MID & ASD

Figure 1

iPad Training for Familiar Daily Living Tasks Across Participants Using a Nonconcurrent Multiple Baseline Design (Phase 1)



IPAD/EBOOK USE TO LEARN DAILY LIVING SKILLS FOR MID & ASD

Figure 2

Kristine's Application of iPad Training Across Novel Daily Living Tasks Using a Nonconcurrent Multiple Baseline Design (Phase 2)

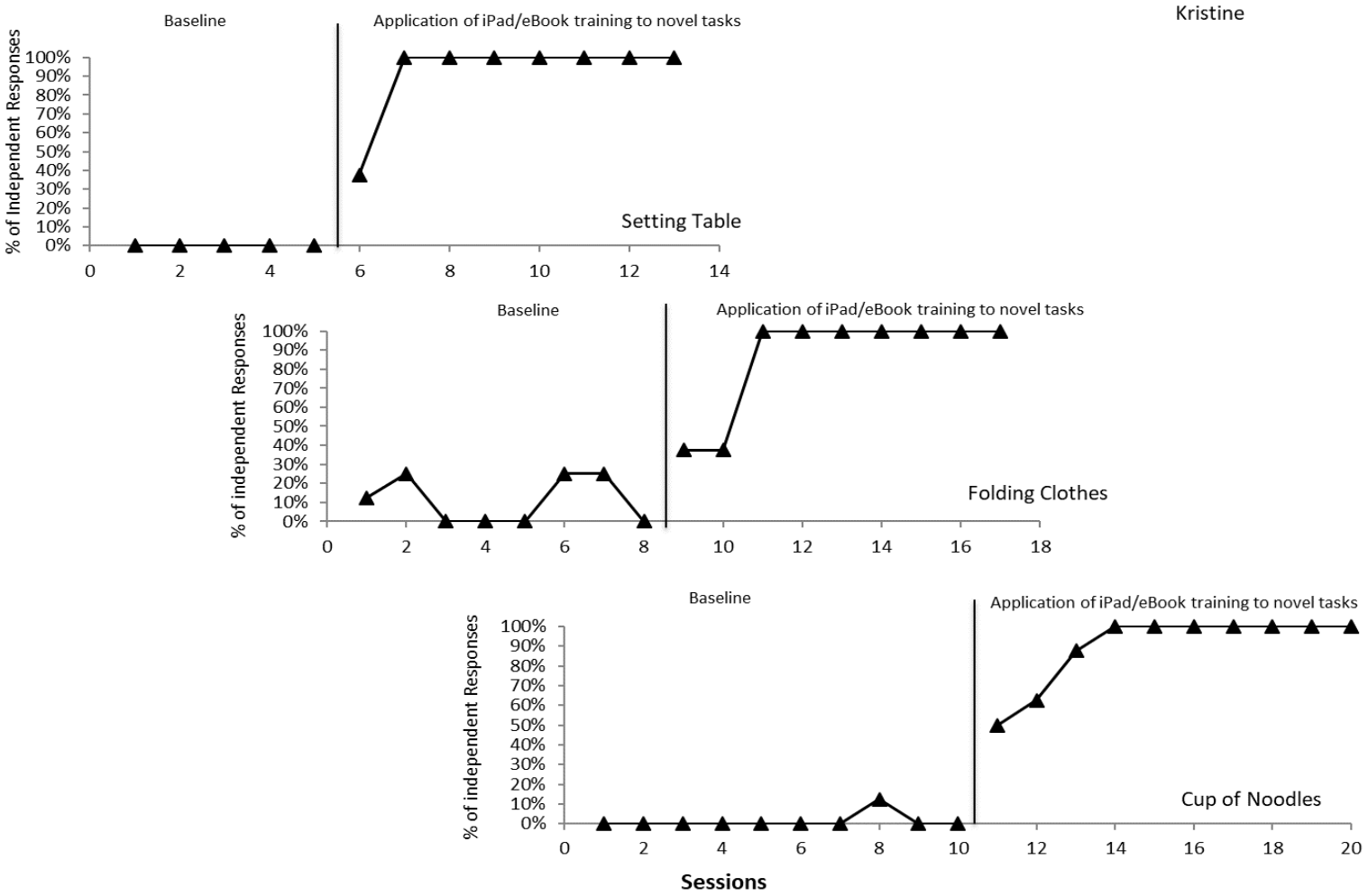


Figure 3

Rebecca's Application of iPad Training Across Novel Daily Living Tasks Using a Nonconcurrent Multiple Baseline Design (Phase 2)

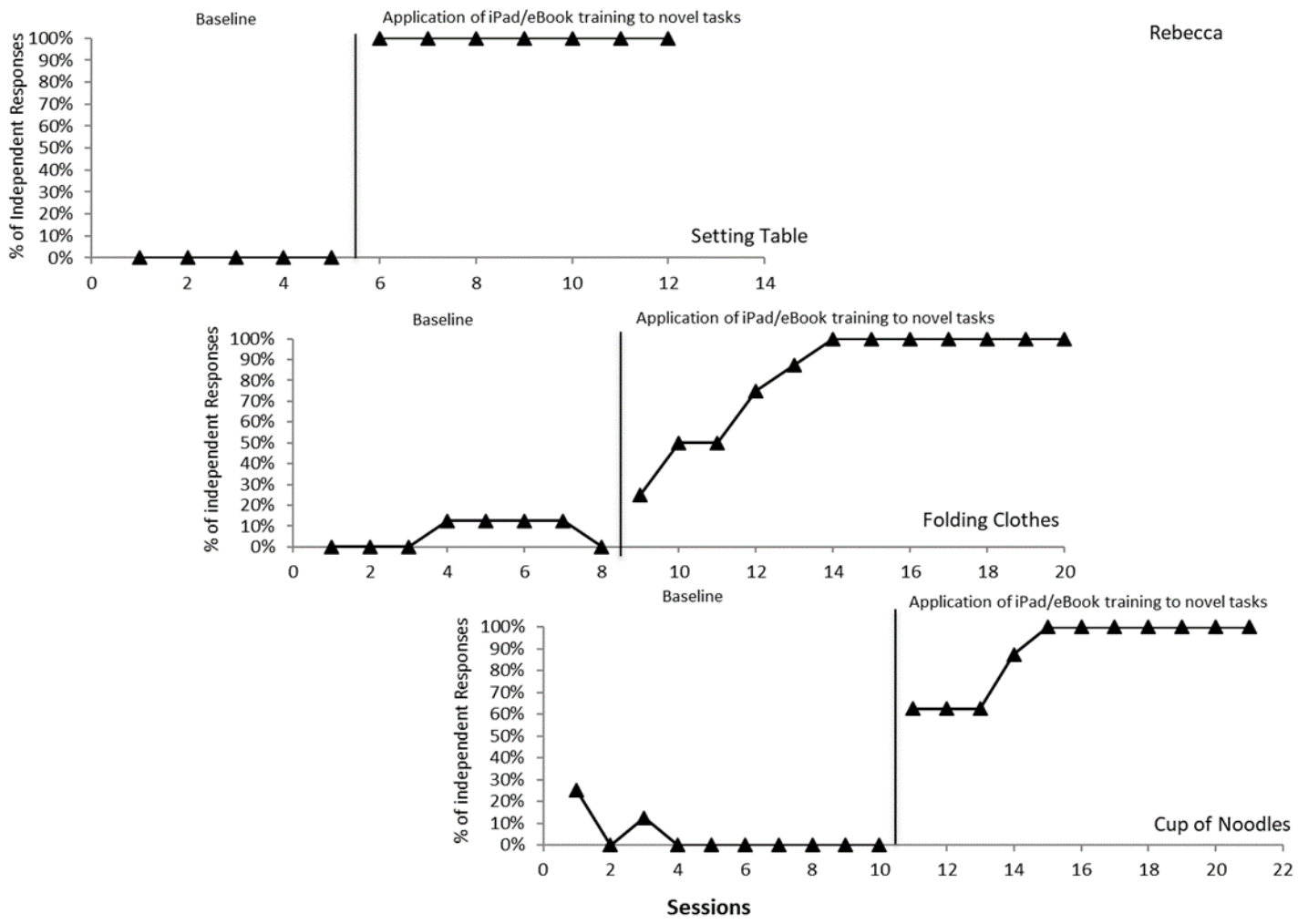


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Figure 4

Daniel's Application of iPad Training Across Novel Daily Living Tasks Using a Nonconcurrent Multiple Baseline Design (Phase 2)

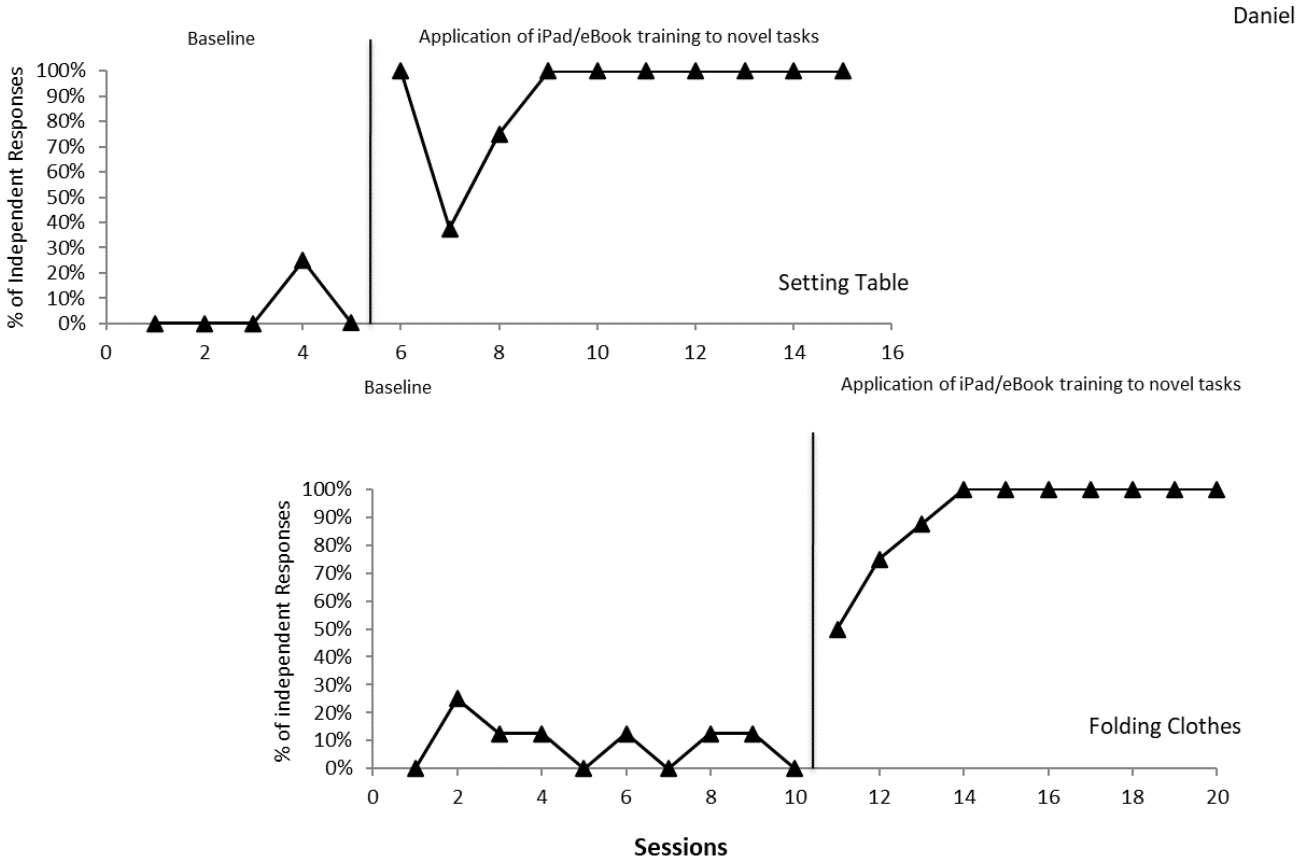

Table 1

Materials Used for Performing Each Familiar and Novel Daily Living Task

Tasks	Materials used
Making a sandwich (iPad training)	Jam, bread, plate, and a child-friendly (plastic) knife
Wiping the table (iPad training)	Basin of water, tablecloth and a table
Setting the table	A basket with a plastic table mat template, a child-friendly (plastic) spoon and a child-friendly (plastic) fork
Folding clothes	A basket with a t-shirt, and a blue folding clothes board
Making cup noodles	A cup of cup noodles, a double-insulated thermos flask of water, and a timer set to three minutes

Table 2

Task Analysis for Novel Daily Living Tasks for the Application Phase

Setting the table	Folding clothes	Making cup noodles
1. Take table mat	1. Take folding board	1. Take cup noodles
2. Place mat on the table	2. Open board	2. Open lid of cup noodles
3. Take plate	3. Open shirt	3. Take out plastic fork
4. Place plate on table mat	4. Place shirt in the middle of board	4. Take out plastic sachets
5. Take spoon	5. Fold first side	5. Pour contents of sachets into cup
6. Place spoon on table mat	6. Fold second side	6. Pour hot water
7. Take fork	7. Fold third side	7. Cover lid of cup
8. Place fork on table mat	8. Take shirt	8. Press timer for 3 minutes

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Table 3

Task Analysis for Operating the iPad/eBook in the iPad Training Phase

iPad training
1. Take iPad
2. Unlock iPad
3. Open 'iBooks' app
4. Select electronic book *(Cover Page)*
5. Flip book open (tap screen)
6. Press play (audio) *(Page 2)*
7. Flip page (swipe screen/tap)
8. Press play (for all audio segments) *(Page 3)*
9. Flip page (swipe screen)
10. Press play (for video) *(Page 4)*
11. Flip page (swipe screen)
12. Press play (audio) *(Page 5)*
13. Engage in presented task

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Appendices/Supplementary File

Appendix 1

Layout for All eBooks

Page number	Description
Cover page	A cartoon image of each task to be completed, together with the words, "Learning to make a sandwich" (iPad training), "Learning to clean the table" (iPad training), "Learning to fold my clothes" (generalization phase), "Learning to set the table" (generalization phase) or "Learning to make cup noodles" (generalization phase).
Page 2	A header with both textual and audio cues for "Things you need", together with a photograph of all materials necessary for each task. Each tool or material used in the photograph were also named.
Page 3	A basket with a plastic table mat template, a child-friendly (A header with both textual and audio cues for "Things you need", together with textual and audio cues for each item required for the task.
Page 4	A header of the task (i.e. "Making a sandwich" [iPad training], "Cleaning the table" [iPad training], "Setting the table" [generalization phase], "Folding my clothes" [generalization phase], or "Making cup noodles" [generalization phase]), together with a video of the task.
Page 5	Textual and audio cues saying "Let's try it" to prompt the child to commence starting the activity.

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Appendix 2

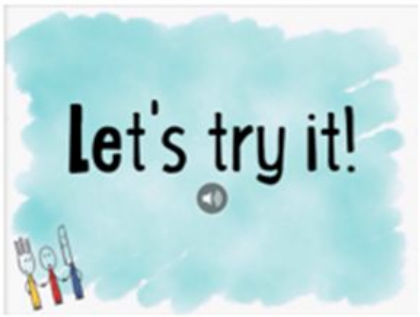
Layout of the Pages of the one of the Novel Tasks - 'Setting the Table' in the eBook

Cover page

2

3

4



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