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An Evaluation of the Acquisition of Receptive Labels using Traditional Materials versus the iPad

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by

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Abstract

The use of the iPad has become a popular intervention tool in many intervention programs. Although the iPad can be found in most intervention programs and classrooms, little research exists on the effectiveness of the iPad as a teaching and intervention accessory. The purpose of this study was to compare the acquisition rate of receptive labels with the iPad and traditional materials. The results indicated that traditional condition was more efficient for learning receptive labels. Not only did the traditional condition result in fewer trials to criteria, overall response errors were lower during the traditional condition then the iPad condition.

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Chapter I: Introduction and Literature Review

The use of computer technology in the field of autism treatment has rapidly expanded since the introduction of the iPad in 2010 (Neely, Rispoli, Camargo, Davis, & Boles, 2013). Although various forms of computer technology have long been available, using technology as part of a treatment plan did not expand rapidly as an intervention until the iPad was available (Knight, McKissick, & Saunders, 2013). Currently, the use of the iPad for teaching academic tasks has been widely reported in mainstream media as a method that can renovate and revolutionize instruction for individuals with autism (Knight et al., 2013). Shah (2011) suggested that the rapid increase in the use of iPads/iPods may be due to the devices ease of portability, simplicity to individualize programs, and the wide number of educational and leisure apps that are available. Additionally, the iPad or iPod has the ability to perform multiple tasks simultaneously such as, playing music while reading, GPS ability that can be sent to another device for location assistance, or having multiple applications running with the ability to switch between them. The iPad or iPod can also allow for storage of a large amount of data and encompasses multiple devices in one (O'Malley, Lewis, Donehower, & Stone, 2014). For example, the iPad and iPod allow for pictures or videos to be taken, can function as an auditory prompt with alarms or timers, and has many more features all within the same device. Before the iPad and iPod, individuals required several different devices, with each device only being able to complete one task.

The accessibility of the iPad and the unlimited number of educational, leisure, and communication applications has propelled the iPad to become a key component in many intervention programs. Furthermore, Kagohara et al. (2013) suggested that the affordability of the iPad and the potential of the iPad to be less stigmatizing than other forms of interventions and assistive technology have contributed to the iPad being widely used as an intervention or communication tool. van der Meer et al. (2012) found that when preference of intervention was assessed for speech generating devices (SGD) or picture-exchange (PE) a preference was shown for using SGD over PE. Lee et al. (2013) found similar results across academic tasks. When participants were allowed to select the presentation of instruction, they consistently chose the iPad-assisted condition compared to the therapist only condition. Although further replication is needed, preliminary results have begun to establish the iPad as an effective option not only for augmentative communication but also for academic teaching.

Several studies have been conducted on the use of the iPad as a communication device as well as comparing the iPad with non-electronic communication systems (Ganz, Hong, Goodwyn, Kite, & Gilliland, 2015). Lorah et al. (2013) reported that the use of the iPad as a communication device resulted in faster acquisition rates among three of five children and that four of five children showed a preference for the speech-generating device (SGD). Although a large body of research is readily accessible on the use of the iPad for communication, there is limited research on the use of the iPad to teach academic skills to individuals with autism or a developmental disability (Kagohara, Sigafoos, Achmadi, O'Reilly, & Lancioni, 2012; Lorah, Parnell, & Speight, 2014; van der Meer et al., 2015). This body of research is starting to grow; however, more studies need to be conducted to evaluate and assess the use of the iPad as an intervention tool for individuals with autism or a developmental disability. First, I will provide a historical perspective of technology-based interventions followed by a discussion of computer-assisted intervention (CAI) and, finally, a review of recent studies on the use of the iPad as part of an intervention.

Computer-Based Interventions

Colby (1973) conducted one of the first studies that used technology for teaching academic skills to individuals with autism over 40 years ago. Colby used a computer-based program to teach individuals names and sounds of letters. The intervention consisted of the participants playing a variety of computer-based games in which the participant interacted with the symbol (e.g., letter) and was in control of the game. Once the student pressed a letter on the keyboard a variety of different sounds of letter names could appear on the screen depending on what game the student was playing. When the study concluded, 13 of the 17 participants demonstrated an increase in involuntary speech and appeared to have a greater enjoyment of letters (Knight et al., 2013). This study set an early precedent in researching technology-based interventions.

Computer-based interventions have also been used to teach individuals a variety of self-help and independence skills. Mechling, Pridgen, and Cronin (2005) used computer-based video instruction to successfully teach three participants with an intellectual disability how to vocally respond to common questions when making a purchase at a fast food restaurant. A task analysis was used to break the skill down into smaller component steps. For each task on the task analysis a corresponding video was made that demonstrated the skills. Participants were taught how to greet a restaurant worker, order food items by name and size, pay for the meal, and gather required materials to eat their food (Mechling et al., 2005). Each participant was able to maintain skills across generalized restaurant locations.

A more recent study by Chang, Kang, and Liu (2014) assessed the use of a computer-based game to train three adult participants with a cognitive impairment to independently sort several different recycling materials. Individuals were presented with 16 different items that could be sorted into four kinds of recycling bins. The computer had the ability to identify correct and incorrect responding, provide on screen prompting to categorize errors, and provide auditory feedback. During the study and at a four-week follow up all of the participants were able to correctly identify and sort all 16 items. Chang et al. (2014) demonstrated that computer-based games, instruction, and feedback could be used to teach individuals with developmental delays job readiness skills.

Research on the use of computer-based instruction has demonstrated that CAI and assistive technology such as augmentative devices may effectively teach individuals with autism and other developmental disabilities a variety of different skills. CAI has been shown to be effective for teaching academic skills, communication, employment skills, leisure, and self-management skills (Burke, Anderson, Bowen, Howard, & Allen, 2010; Cihak, Write, & Ayres, 2010; Knight et al., 2013; Mechling & Ortega-Hurnden, 2007; Mechling et al., 2005; Pennington, 2010). Higgins and Boone (1996) stated that an additional benefit of using computer-based instruction is that the student can experience an increase in autonomy. Panyan (1984) also found that individuals who used computer-based instruction engaged in lower levels of stereotypic behavior and appeared to have an increase in motivation to complete tasks. The use of CAI has widely been researched and there is a large body of evidence supporting the use of CAI instruction (Knight et al., 2013; Mechling, 2011).

As technology evolved and the use of electronics became more easily accessible and readily available (e.g., iPad) several studies emerged showing promising results that the iPad is successful in teaching academic skills, decreasing challenging and stereotypic behaviors, and can be used to provided research-based interventions (Jowett, Moore & Anderson, 2012; Lee et al., 2013; Neely et al., 2013; O'Malley et al., 2014).

Teaching Skills on the iPad

Teaching academic skills to individuals with autism is often a focus in many intervention programs. Many times, individuals with autism require additional explanation, require that the skill be broken down into smaller components, and need additional time for repeated practice (Green 2001; Grow & LeBlanc, 2013). Cihak and Bowlin (2009) stated that the use of technology can provide increased learning outcomes and provide additional opportunities to individuals with disabilities to gain access to curriculum. Joewett et al. (2012) successfully taught a five-year-old boy with autism to discriminate numbers 1-7, write, and comprehend quantities for each target number. The participant was presented with a video clip that demonstrated counting a specific quantity, the correct writing formation of the number, and the number name. All clips included embedded reinforcement of *Angry Birds. Angry Birds* were counted at the start of each clip and each video clip ended with the sound of the *Angry Birds* cheering (Joewett et al., 2012). The participant learned to identify, write, and count quantities for each of the target number. The skill generalized across new environments and stimuli. Additionally, as the intervention continued, the participant required fewer presentations of the video to master the target behaviors.

Video self-modeling on the iPad was effective in increasing accuracy of math answers for four junior high individuals with autism and intellectual disability (Burton, Anderson, Prater, & Dyches, 2013). Burton et al. (2013) reported that students who watched themselves perform a task by watching a video model of themselves, performed better than students who did not watch themselves. During the intervention, each student was given an iPad with a video of the student correctly completing a math question. Students were allowed to watch the video multiple times, pause, or rewind the video as needed to solve the same question on paper (Burton et al., 2013). This procedure was the same for all of the five target math questions.

During post-intervention, a fading procedure was introduced to systematically fade the number of video models that were provided to each student (Burton et al., 2013). The post-intervention consisted of six different phases. During the first phase, each participant was provided four video models to complete four of the five math questions. Participants were then required to complete the fifth math question independently. This continued until Phase 5, where the participant completed all five math questions without a video model. During the final phase, participants were presented with all five math questions previously targeted. The goal of this phase was to assess if the participants could answer all of the math questions previously learned following a lapse in time (Burton et al., 2013). All of the four participants demonstrated an increase in correct responding across all five-math questions. All of the participants were able to answer some or all of the math questions correctly during Phase 6 and at three weekly follow up probes (Burton et al., 2013).

The use of the iPad as a SGD has proven to be effective for increasing communication skills for individuals with developmental disabilities (Lorah et al., 2014). Recent studies have emerged using a SGD such as *Proloquo2go®* a popular app, to teach individuals additional academic skills such as sentence discrimination and word to picture matching to aid in developing academic knowledge and conversation skills (Lorah et al., 2014; van der Meer et al., 2015). van der Meer et al. (2015) were able to successfully teach one child with autism to successfully match word to picture, picture to picture, picture to word, and word to word using *Proloquo2go®* on the iPad. The participant was able to maintain high levels of accurate responding during follow up trials (van der Meer et al., 2015). Additionally, several other literacy tasks could be taught using the iPad such as, reading comprehension, numeracy tasks, and writing (van der Meer et al., 2015).

Lorah et al. (2014) successfully taught three preschool children diagnosed with autism or developmental disabilities to accurately discriminate sentence frames ‘I have’ and ‘I see.’ Sentence fames and target objects were presented on the iPad using *Proloquo2go®*. Participants were first taught each target sentence frame in isolation. Once the sentence frames were mastered, discrimination training occurred. Each participant was systematically taught to discriminate the sentence frames in random rotation. All of the participants were able to correctly discriminate between the two frames to answer the target questions ‘What do you have?’ or ‘What do you see?’ During follow up, all of the participants maintained the skill and one participant started to vocally discriminate between the two target questions (van der Meer et al., 2015).

There is a strong link between time on task and learning success, making the ability to stay engaged with a task a critical component of skill acquisition (Flower, 2014). Flower (2014) and O’Mally et al. (2014) demonstrated increased academic engagement in a classroom by using the iPad. Flower (2014) conducted a study on the use of the iPad to increase on-task engagement during independent study. Three children diagnosed with emotional and behavioral disorders participated in the study. The intervention took place in the children's classroom during independent study. Each participant was provided with an iPad and the iPad was loaded with several educational applications that focused on phonics skills, math skills, listening, and reading comprehension (Flower, 2014). An alternating treatments design was used to evaluate on task engagement comparing the iPad-assisted condition to traditional materials (paper and pencil) during independent work periods. All three participants demonstrated higher rates of on task engagement during the iPad-assisted condition compared to traditional materials.

One limitation to the current study is only male participants were included, future research should evaluate the use of the iPad within the classroom across a variety of students. Furthermore, only individuals who had a diagnosis of emotional and behavioral disorders participated. This limits the findings to individuals who display similar characteristics to the studies participants. More research is required to assess the generality of using the iPad to increase independent on-task performance in the classroom (Flower, 2014). Further research should also evaluate the novelty of the iPad as an intervention. Prior to the study the iPad was not available in the classroom, this may have established an EO for working on the iPad. The introduction of the iPad may have correlated with an increase in on-task responding due to the presence of an EO. Future research should evaluate the use of the iPad over time to see if an increased rate of on-task behavior continues as the novelty of the iPad decreases.

O'Mally et al., (2014) investigated the use of the iPad in a classroom to increase academic task completion. Seven adolescents diagnosed with autism and moderate to severe developmental disabilities participated in the study. An ABAB design was used to compare the number of math tasks that were completed independently using the iPad versus using traditional instruction. With the traditional only condition, the participants completed a variety of different math tasks such as counting, matching, one-to-one correspondence, and number identification. During the iPad condition, the app "My First Numbers" by Grasshopper Apps was used. During this condition the participants engaged in a matching game. O'Mally et al. (2014) measured accuracy in responding across traditional instruction and the iPad, to assess if the iPad intervention improved math skills. Improvement in math skills using the iPad had mixed results across participants. However, during the iPad only condition a decrease in challenging behavior and improvement in independent task completion was observed across participants. Additionally, during the iPad only condition decreased levels of prompts was observed, indicating that the participants were completing more math questions independently than during traditional instruction condition. Similar to Flower (2014), O'Mally et al. (2014) reported that teachers described the intervention as positive and found it to be an effective intervention.

Challenging behavior can disrupt a classroom and impede learning. Neely et al. (2013) evaluated the effects of an iPad to decrease challenging behaviors during academic instruction within a classroom and family home. Two children diagnosed with Asperger's Disorder or PDD-NOS participated in the study. An ABAB design was used to measure rates of challenging behavior during a traditional materials and iPad condition. The traditional materials condition consisted of using paper and pencils versus the iPad condition where all instructions and responses were completed on the iPad. The same academic task was presented during both conditions. Both children demonstrated a decrease in challenging behavior and an increase in academic engagement during the iPad only condition. Higher rates of challenging behavior and a decrease in academic engagement were observed during the traditional material condition (Neely et al., 2013). During both conditions the participant was able to escape the demand if he engaged in a challenging behavior such as elopement, aggression, or throwing of materials (Neely et al., 2013). Decreased rates of problem behavior during the iPad condition indicate that the iPad may function as a motivating operation (MO) altering the reinforcing value of the task and decreasing the averseness of the demand (Neely et al., 2013).

The use of the iPad compared to traditional materials decreased problem behavior for two children (Neely et al., 2013). However, replicating these results with other children with disabilities is needed to further evaluate the use of the iPad during academic tasks to reduce problem behavior. Neely et al. (2013) also suggested that the use of the iPad could function as a MO that alters the reinforcing value of the task. Future research should evaluate if using the iPad during academic task functions as an EO to increase responding and student engagement. Many academic tasks do not use the iPad regularly or at all, which could establish an EO for using the iPad to complete academic tasks. Additionally, future research should also evaluate if regular use of the iPad for academic work functions as an AO for engagement and responding. Although Neely et al. demonstrated the effectiveness of the iPad- assisted instructions to decrease challenging behaviors. Little research has been conducted on the efficiency of the iPad to teach academic skills compared to traditional instruction (Neely et al., 2013). Future research should investigate the efficiency of the iPad to teach academic skills to individuals comparing the acquisition rate to traditional instruction.

Lee et al. (2013) reported similar results as Neely et al. (2013) on the rates of challenging behavior during academic instruction. Lee et al. assessed the rate of challenging behavior and on-task engagement of two children diagnosed with autism during a therapist-implemented condition and iPad-assisted condition in a university autism clinic. Lee et al. (2013) used an alternating treatments design to evaluate the effects of the different conditions. Results were mixed. One participant did not demonstrate a mean difference in responding or challenging behavior during either condition (Lee et al., 2013). The second participant demonstrated higher rates of on task responding and a decrease in challenging behavior during the iPad condition when compared to the therapist only condition (Lee et al., 2013). Lee et al. included a preference measure of choice across the intervention conditions using an ABAB design. Children were able to choose between the iPad-assisted or the therapist only condition. Both participants reliably choose the iPad- assisted condition over the therapist only condition (Lee et al., 2013). Choice of condition was correlated with a slight increase in on task engagement and decrease in challenging behavior (Lee et al., 2013).

A limitation of the study is that no baseline or maintenance measures were included. This limits the results of the study, as baseline measures were not included on the child's current level of independent responding prior to the intervention. Lee et al. (2013) reported mixed results for the two children involved; including a baseline measure may have assisted with further analysis of the procedures effectiveness. A strength of the current study is the inclusion of choice of the intervention conditions. Both children selected the iPad condition over the therapist condition. Future research should investigate if a choice of intervention reduces challenging behavior.

Teaching listener responding (receptive labeling) using an iPad application *Language Builder*™ was evaluated by Lorah and Karnes (2015). Two children participated in the study at a university autism clinic. Prior to starting the study each participant was assessed using the VB-MAPP (Sundberg 2008). The assessment scores for each participate indicated their level of listening responding was suitable for the study (Lorah & Karnes, 2015). Treatment consisted of presenting a target stimulus in a field of five on an iPad mini using the Language Builder™ application. All instructions, corrective feedback, and reinforcement where presented on the iPad. For example, if a participant selected the incorrect picture a within stimulus prompt was presented, by fading the brightness of distractor pictures (Lorah & Karnes, 2015). Prompts were systematically provided by the iPad until the student answered correctly. Additionally, once a prompt had been provided the application systematically faded the prompts, until the student was responding correctly at the independent level. If the student correctly responded, verbal praise was provided by the iPad and the target stimuli position moved on the screen.

The study results demonstrated that each participant was able to correctly learn listener discriminations for all target stimuli (Lorah & Karnes, 2015). Both participants were able to learn discriminations within two training sessions. During maintenance probes both participants continued to correctly discriminate stimuli with a high level of accuracy. Generalization probes were also conducted following mastery of each target. Generalization probes consisted of presenting two-dimensional flashcards in a field of five (Lorah & Karnes, 2015). All participants were able to correctly respond during generalization probes. These results indicate using iPad applications that follow behavioral principles can be effective at teaching children with autism (Lorah & Karnes, 2015).

Although the results of this study are significant, additional research is required to replicate this study across more individuals as well as with individuals who have a diagnosis of a developmental disabilities. Lorah and Karnes (2015) also suggested replicating these results in a home or school setting where additional variables may not be as easily controlled compared to a clinical setting. Another limitation to the study is one of the participants baseline scores demonstrated an ascending trend with the last data point at a 100%. Using a multiple baseline across responses may have resulted in overexposure to the target prior to starting the intervention (Lorah & Karnes, 2015). Future research should evaluate the Language Builder™ application using a multiple probe design to help limit exposure to target stimuli overtime. Additional research is also needed to evaluate maintenance of listener discrimination over longer periods of times (e.g., 1 month, 3 months, 5 months) when listener responding is taught using the iPad. This will help future practitioners evaluate the effectiveness of using the iPad to teach listener responding compared to other more traditional methods.

Teaching Receptive Labeling

Many early intervention programs focus on teaching receptive language. Kodak and Grow (2011) described receptive language as teaching auditory-visual conditional discriminations. Receptive labeling programs include the presentation of an auditory stimulus (e.g., ‘Point to___’, ‘Touch_____’) in the company of a picture or item that the student is required to respond to (Kodak & Grow, 2011). Two main teaching procedures used to teach receptive labels within early intervention programs are the simple-conditional and conditional only method. The simple-conditional method consists of teaching relations sequentially (Grow, Kodak, & Carr, 2014). The simple-conditional method consists of an antecedent stimulus, a response, and consequence (Green, 2001). Reinforcement occurs when the target response occurs only when the corresponding antecedent was presented for the target item (Green, 2001). For example, the antecedent ‘Point to dog’ is presented and the student points to the dog. Reinforcement will follow the correct response of pointing to the picture of the dog. Reinforcement will not occur if the student does not point to the dog. Different from the simple conditional method, the conditional only method consists of presenting instructions simultaneously across different stimuli (Grow et al., 2014). The conditional only method will teach more than one target concurrently (Grow et al., 2014). Green (2001) described the conditional only method as involving four components as opposed to three components that are involved in the simple-conditional method. The four contingencies consist of: conditional stimulus, antecedent stimuli, a response, and consequence (Green, 2001). Green recommended teaching receptive skills using the conditional only method as the conditional only method reduces the probability of faulty stimulus control.

Faulty stimulus control can occur during the simple conditional condition as learners are taught to identify stimuli in isolation. When targets are taught in isolation discrimination across other stimuli will not occur during the instructional period (Green, 2001). When teaching a discrimination of stimuli within a small field size, two or less, the possibility of chance selection of the target stimuli is greater than when discriminations are taught using a larger field (Green, 2001). Although faulty stimulus control can occur during conditional discrimination training, the possibility is reduced because discriminations across multiple stimuli, typically three or more, are taught simultaneously (Grow, Carr, Kodak, Jostad, & Kisamore, 2011). Teaching multiple stimuli simultaneously helps to ensure that the learner is attending to the relevant stimulus properties. Conditional discrimination training improves discrimination accuracy, as the learner is required to discriminate the stimuli from the start (Grow et al., 2011). During the conditional only condition the learner has to attend to all stimuli and engage in differential responding across the sample and comparison stimuli (Grow et al., 2011). Grow et al. (2011) also stated that conditional only reduces the likelihood of repeated errors as the presentation of multiple discriminations thin the reinforcement schedule for engaging in a response pattern.

Several studies have compared the simple conditional and conditional only methods across receptive labeling. Grow et al. (2011) and Grow et al. (2014) found the conditional only method resulted in faster acquisition rates across all participants. Grow et al. (2011) and Grow et al. (2014) also found that participants were more likely to engage in a consistent error pattern during the simple conditional training that required the implementation of additional interventions to teach the target discriminations. Error patterns observed during the simple conditional method resulted in slower acquisition rates and required additional teaching methods for the learner to acquire the skill. Grow et al. (2011) and Grow et al. (2014) found that teaching discriminations simultaneously resulted better maintenance of the skills.

Auditory instructions. Teaching receptive labels involves the presentation of an auditory instruction or antecedents to signal the learner to respond when stimuli are presented. Green (2001) and Grow and LeBlanc (2013) suggested that only relevant information be presented at the start of each trial. The use and presentation of irrelevant information as part of an antecedent may contribute to discrimination errors (Green, 2011; Grow & LeBlanc, 2013). Presenting instructions that include ‘Point to______’ or ‘Give me________’ may inhibit the discrimination across the target stimuli as the learner may have a difficult time discerning the relevant information within the antecedent or the learner may be confused as antecedents sound similar (Green, 2001). Including only the relevant information such as “Dog” when the learner is required to touch or point to a dog can increase accuracy in responding. Additionally, using only the relevant information helps to increase the likelihood that the learner is attending to the important auditory stimuli and not irrelevant information (Green, 2001; Grow & LeBlanc, 2013).

Prompting. Teaching new skills to learners often involves the use of prompts to assist with acquiring the new skill. MacDuff, Krantz, and McClannahan (2001) described prompts as an addition to a trial where the occurring stimulus does not have stimulus control over the response. The use of prompts has been proven to teach discrimination in which the discriminative stimulus comes to have stimulus control over the response. There are two categories of prompts that can be used to assist with teaching a new skill, stimulus prompts and response prompts (MacDuff et al., 2001). Stimulus prompts involve adding or changing the target stimulus to facilitate a correct response whereas a response prompt is when the behavior of the instructor is changed to provide additional support to the student to respond correctly.

Several considerations should be evaluated before selecting a prompting procedure based on the learner’s history and current repertoire. Generally speaking, stimulus prompts should not be used for learners who have demonstrated error patterns that include attending to irrelevant stimuli and or have a history of engaging in over responding (Grow & LeBlanc, 2013). The use of stimulus prompts for learners who have demonstrated these error patterns could contribute to increased errors among responding and faulty stimulus control. Additionally, response prompts should not be used with learners who have sensitivity to touch as this may increase the likelihood of inappropriate behavior (Grow & LeBlanc, 2013). Evaluation of the learner and the learner’s history of reinforcement should be reviewed before selecting a prompting procedure (Grow & LeBlanc, 2013).

The use of prompts has proven to be effective at increasing correct responding (MacDuff et al., 2001). Several different prompting procedures have been widely reviewed within the literature. Errorless teaching is a method of prompting using most to least prompts. Due to the widely-reported success on errorless teaching, Green (2001) suggested that errorless teaching be used for teaching conditional discriminations. MacDuff et al. (2001) also stated that errors have been shown to interfere with the acquisition of learning and also hinder generalization and maintenance of the skill. The use of ineffective prompting procedures results in slower learning (Grow & Le Blanc, 2013). Errorless teaching strategies that result in fewer errors have been shown to be the most effective from the onset of teaching (MacDuff et al., 2001).

Differential reinforcement. In addition to using prompts and prompt fading procedures, differential reinforcement should also be used as part of the teaching method (Grow & LeBlanc, 2013; MacDuff et al., 2001). Most often, when teaching a new skill, prompted trials should result in reinforcement to help create stimulus control over the response. As the response becomes more fluent and established within the learner's repertoire, prompts should be faded along with reinforcement. The use of differential reinforcement is important to reduce prompt dependency and establish stimulus control for independent responses (Grow & LeBlanc, 2013; MacDuff et al., 2001). Once the learner has experienced prompts with reinforcement, the reinforcement should be thinned and prompts faded. Higher levels of reinforcement should be provided for independent responses while providing no or very little reinforcement for prompted trials (Grow & LeBlanc, 2013).

Conclusion

The use of the iPad as part of an intervention combined with effective and empirically proven teaching methods can assist with teaching new skills. Resent research into the use of the iPad-assisted instruction (IAI) has found IAI to effectively decrease problem behavior, increase on-task responding, and teach new academic concepts (references). Additionally, when students were presented with a choice of instruction, the iPad was selected more often than other instructional materials (Lee et al., 2013; Neely et al., 2013). Often, a struggle in many classrooms and intervention programs is teaching individuals to work independently. Flower (2014) and O'Malley et al. (2014) found that the iPad not only increased correct responding, but also increased independent on task completion. Flower (2014) and O'Malley et al (2014) also reported that teachers who used the iPad during the study described positive results and found the iPad to be acceptable and effective. The preliminary research of the effectiveness of the iPad holds promise. See Appendix B, Table 1, for a Literature Review Summary.

Research Proposal

The use of the iPad to teach academic skills to individuals diagnosed with autism is an emerging tool. Recent research found the iPad to be an effective intervention in teaching numeracy and math skills to individuals diagnosed with autism and intellectual disabilities (Burton et al., 2013; Joewett et al., 2012). Both Burton et al. (2013) and Jowett et al. (2012) used video modeling on the iPad to teach math skills and number identification. Additionally, Burton et al. (2013) found the iPad to be a successful intervention to use within a classroom setting across multiple participants. O'Mally et al. (2014) also assessed the use of the iPad to teach math skills within the classroom and found the iPad to be an effective intervention to increase independent task completion across an entire class.

The emerging research for using the iPad to teach academic tasks shows potential for teaching skills to individuals with autism. Research by Neely et al. (2013), Larabee, Burns, & McComas (2014), and Lee et al. (2013) compared traditional teaching methods such as paper, pencils, and flashcards to using the iPad to teach academic tasks. Neely et al. (2013), Larabee et al. (2014), and Lee et al. (2013) all observed a decrease in challenging behavior and an increase in task engagement when the task was presented on the iPad versus the traditional teaching method, across all participants. Furthermore, Lee et al. (2013) found that when presented with a choice of the iPad vs. traditional materials, participants consistently selected the iPad condition. The iPad-assisted research holds promise for students who engage in challenging behavior to escape academic tasks and interventions.

The iPad has shown to increase academic engagement, accuracy in responding, and to decrease challenging behavior (Burton et al., 2013; Flower 2014; Lee et al., 2013; Jowett et al., 2012; Neely et al., 2013). Although, some research supports the use of the iPad for teaching skills, I am aware of no research to date to evaluate if the iPad results in more efficient teaching of receptive labels compared to traditional methods. Therefore, the purpose of this study is to compare traditional versus the iPad for teaching receptive labeling to individuals diagnosed with autism.

Chapter II: Method

Participants, Setting, and Materials

Two children and one adolescent with a diagnosis of Autism Spectrum Disorder (ASD) participated in the study. All participants were part of an intensive home-based ABA program. Mike was a 4½-year-old boy with a diagnosis of ASD. He received a diagnosis of ASD 1 month prior to participating in this study and had just begun home sessions. Mike used simple two three-word sentences to communicate his daily needs and was able to independently complete daily living skills such as dressing, toileting, and eating. Mike scored within the Level 3 (30-48 months) range for the *Verbal Behavior Milestones Assessment and Placement Program* (VB-MAPP). All domains tact, mand, listener responding, independent play, visual performance, match-to-sample, social, and echoic behavior scored within Level 3. At the time of the study, Mike had an extensive repertoire of receptive labels and was able to phonetically sound out Grades 1 and 2 sight words. Mike had been exposed to discrete trial methods within his home program. He received approximately four hours of one-to-one ABA instruction at his family home. Program instruction focused on self-management, academic, leisure, and daily living skills. Sessions were conducted in his tutoring room at his teaching table located on the main floor of his families' home in which he received his regular home instruction. The author served as the experimenter for all sessions with Mike.

Evan was a 12-year-old adolescent with a diagnosis of ASD who had been part of an ABA intensive home program since 2008. Evan communicated using simple sentences (e.g., 'Can I go to the bathroom please') and was able to vocally communicate his daily needs with his family, teachers, and interventionist. He was able to independently complete daily living skills such as dressing, toileting, and eating. Evan attended a local elementary school in his neighborhood. At school, Evan received one-to-one support to participate in school activities, and academic tasks. Evan also received approximately 15 hours of one-to-one ABA instruction at his family home each week. Program instruction focused on daily living skills, community access, academic, and self-management skills. Evan could discriminate over 100 sight words and had been exposed to discrete trial methods within his home program. Sessions were conducted in his tutoring room at his teaching table located in the basement of his families' home in which he received his regular home instruction. The author served as the experimenter for all sessions with Evan.

Tim was a 5-year-old boy with a diagnosis of ASD who had been part of an ABA intensive home program since he received a diagnosis at the age of three. Tim communicated using three- to four-word sentences and was able to vocally communicate his daily needs with his family, teachers, and interventionist. Tim scored within Level 3 (30 - 48 months) VB-MAPP. Tact, mand, listener responding, independent play, visual performance, match-to-sample, social, and echoic behavior domains scored within Level 3. Tim attended a local elementary school in his neighborhood and received one-to-one support to participate in class activities and academic tasks. Tim received approximately four hours a week of one-to-one ABA instruction at his family home and two hours a week of one-to-one ABA instruction in the community. Program instruction focused on self-management, academic, and leisure skills. Tim could discriminate 200 receptive labels and approximately 75 sight words and had been exposed to discrete trial methods within his home program. Sessions where conducted in the living room of his families' home in which he received his regular home instruction. The author served as the experimenter for all sessions with Tim.

The criterion for inclusion in the study was that participants were able to identify targets by pointing and were part of an ABA home program. All participants were required to learn receptive labels as part of their current home program goals and displayed little or no challenging behavior. Participants were not excluded from the study if they had previous experience with and/or had receptive labeling in their repertoire.

All sessions were conducted in the participant's typical 'therapy room.' During instructional trials, the participants were required to sit in a chair at their teaching table. Materials consisted of traditional flashcards and the iPad application *See Touch Learn* by Brain Parade®. In addition to teaching materials, the room also contained a token board and back up reinforcers. The experimenter used a pen and paper to record dependent measures. A *Go-Pro* camera was placed in the therapy room at the start of all sessions to record all trials. Location of camera varied as needed to record the participant's observing response and selection of targets. All 2D flashcards were 5 inches long by 3 inches wide and all target sight words were printed in Calibri front size 48. With the exception of flashcards for Tim's that had a front size of 30 to allow for the target word to fit on the card. Target words presented on the iPad were entered into the application *See Touch Learn* and words were automatically sized to fit the flashcard and all flashcards measured 2½ inches by 2 inches.

Response Definitions, Measurement, and Interobserver Agreement

An independent correct response was defined as the participant selecting the correct item by pointing to or touching the requested item within 3 seconds of the S^D being presented. An incorrect response was defined as pointing to or touching the incorrect item following the presentation of the S^D, or engaging in non-responding for a period of 3 seconds or greater. All prompted responses were scored as an incorrect response in the data totals. Self-correction where the participant first touched an incorrect stimulus, followed by touching the correct stimulus were considered incorrect responses. Data were collected using paper and pen to score correct, incorrect, and prompted responses during the instructional session. In addition to correct and incorrect responses, the instructor and observers scored an observing response (Grow et al., 2011). An observing response was defined as the participant's eyes directed towards the stimulus or instructor prior to the presentation of the vocal S^D being presented. The purpose of this was to help rule out non-attending as the purpose of an incorrect response (Grow et al., 2011).

The dependent variable in the study was the number of sessions and trials that were required for the participant to achieve mastery criterion. All trials consisted of presenting the stimuli in a field of three. Mastery criterion for each phase was two sessions at 80% or higher of independent responses.

Interobsever Agreement

All sessions were video recorded to allow a second independent observer to record each participant's responses. For each trial, an agreement was scored if both the primary and secondary observer recorded (a) a correct response, (b) incorrect response, (c) a prompted response, and (d) the non-occurrence or occurrence of an observing response. A disagreement was scored if the primary and or secondary observers score differed. Interobserver agreement was scored for 30% of all sessions for each participant. Interobserver agreement was calculated by dividing the number of agreements by the total number of agreements and disagreements per session. Interobserver agreement for Mike, Set 1 was 98.8% (8 –100%) and Set 2 was 100%. Interobserver agreement for Evan, Set 1 was 96.7% (77–100%) and Set 2 was 100%. Interobserver agreement for Tim, Set 1 was 99.0% (88–100%).

Design

An adapted alternating treatments design was used to evaluate the acquisition rate of traditional versus iPad condition (Sindelar, Rosenberg, & Wilson, 1985).

Procedure

Preference assessment. A brief multiple stimulus-without-replacement (MSWO) was conducted prior to the implementation of the intervention (Carr, Nicolson, Higbee, 2000). Items were selected that had been identified by the participant's caregivers, BCBA, and current team members. Six to ten items were presented during the MSWO in a signal array spaced 5 cm apart. The participant was asked to select an item from the array. A selection was scored if the participant selected or touched one item. If a participant touched more than one item, the first item touched by the participant was scored as the selected item. Following the selection of the item the participant was allowed 30-seconds access to the item. If the selected item was an edible the participant was allowed to consume the item. All remaining items were rotated by moving the item on the left end, to the right end of the line. This process continued until all items had been selected or the participant did not select an item for 30 seconds or more. A hierarchy of preferred items was generated by calculating the percentage of times each item was selected over the number of times it was presented in the field. At the start of each session, the participant was presented with two or three of his choices and asked to select a preferred stimulus for that trial. This was repeated at the start of each trial or anytime throughout the session if the participant appeared to be satiated on the item.

Baseline. Baseline sessions were conducted for all target stimuli prior to the start of the intervention. Each baseline session consisted of presenting the target stimulus in a field of three. The auditory stimulus consisted of presenting only the relevant information required for a correct response (e.g., “balloon’). Once the auditory stimulus was presented the participant had up to 3 seconds to correctly point to or touch the requested target stimulus. Reinforcement was provided on a variable ratio schedule of three (VR3) for compliance and good working. No prompts were provided during baseline. Correct and incorrect responses were scored as defined above. The position and presentation order of the target stimuli varied across each trial (Green, 2001). Baseline was conducted across all training sets for both the traditional and iPad conditions. Each target stimulus was presented a total of three times during baseline. Evan and Mike both needed a total of five baseline sessions before targets for Set 1 were selected, whereas Tim needed three baseline sessions. For Set 2, Evan required three baseline sessions and Mike required five sessions. For each training set, a total of six labels were selected and divided into two functionally equivalent learning sets based on experimenter judgment, word similarity, and difficulty. A total of 12 labels were selected for Evan and Mike and six labels for Tim.

Teaching procedure. Both the traditional and iPad condition used the conditional only method to teach the labels. During the traditional and iPad conditions, three target stimuli were presented in a balanced three-choice match to sample procedure as described by Green (2001). Each target stimulus was the correct response three times during one session. Following each trial, the stimuli were rotated within the field and the position changed. The same target stimulus was not asked for more than two times in a row or in the same position for more than two successive trials (See Appendix A, Figures 1 and 2) (Green, 2001; Grow et al., 2011; Grow et al., 2014). Each session consisted of nine trials for each condition. Sessions were run three to five days a week with a minimum of one session per day. Similar to baseline, stimuli were presented for both presentation methods in a counterbalanced manner, with no more than two sessions of the same condition run back to back (Grow et al., 2011; Grow et al., 2014).

Each trial consisted of traditional components of a discrete trial teaching procedure. A trial consisted of an auditory stimulus, scripted prompt, response, consequence, and intertrial interval (Smith, 2001). Following correct responses, a consequence was provided to the participant. For all participants, social praise was provided on a continuous schedule of reinforcement and tokens were provided on a variable ratio (VR2) schedule following a correct response with a backup reinforcer provided once the token board was completed. Backup reinforcers were selected for each participant based on the results of the MSWO. Mike often selected chocolate chips, iPad, or tag, Tim selected toy figurines, iPad, or chips, and Evan selected iPad, or seaweed. In addition to backup reinforcers, Tim earned tokens for self-management behaviors to exchange for larger reinforcers such as trips to a restaurant, aquarium, or toy store. This was included during each session under the guideline of Tim's BCBA and in accordance to how reinforcement was currently provided in his home tutoring sessions.

If the participant engaged in an incorrect response or a non-response, a correction procedure was followed. The correction procedure consisted of representing the auditory stimulus and providing a prompt for the participant to engage in the correct response following the presentation of the auditory stimulus. No reinforcement was provided during the correction procedure.

A point prompt and progressive prompt delay were used to transfer stimulus control from the prompt to the appropriate antecedent stimulus. Initial trials for the traditional and iPad condition consisted of providing a 0-second prompt delay to point to the correct stimuli. During all 0-second prompt delay trials, a point prompt was provided for the student to correctly respond to the auditory S^D. Following two consecutive sessions at a 0-second prompt delay, the prompt delay was increased by 1-second increments up to 3 seconds. Each participant had to achieve 80% or higher across two different presentations before the prompt delay was increased. During the 1-second prompt delay a decrease in independent responses or variable responding was observed during the iPad condition, all participants were moved onto a 3-second prompt delay without achieving mastery criterion at a 1-second prompt delay. Evan achieved mastery during the 1-second prompt delay for traditional condition only. The decision to move each participant on from a 1-second prompt delay to a 3-second prompt delay without achieving mastery was made on an individual basis when the participant started to display prompt dependency or a decrease in independent responding. Mike and Evan achieved mastery of all targets at a 3-second prompt delay, however, for Tim, the prompt delay was increased to 5 seconds. This change was made to provide Tim with additional time to respond, as he was slower to respond.

All independent and prompted correct responses resulted in praise and tokens on a VR2 schedule. The presentation of the vocal antecedent followed the guidelines identified by Green (2001). Only the word of the target sight word was presented (e.g., “copy”). All other instructions such as 'Point to____', 'Show me____', or 'Give me___' were not presented with the vocal antecedent.

Selection of training sets. Training sets consisted of six different sight words divided into two functionally equivalent training sets for a total of 12 sight words. Each participant was assigned a total of four training sets with the exception of Tim, who was only assigned two training sets (six sight words). Targets were selected based on the baseline results. All targets were assessed during baseline to ensure the selected items were unknown. Parents and the BCBA identified sight words for each participant as unknown. All sight words selected were functionally appropriate for the participant, based on the participants' current intervention goals and were recommended and approved by each participant's BCBA. The experimenter grouped sight words according to the length of the word, the sound of the word, and difficulty of the word (see Appendix B, Table 2). For Mike, words were grouped together based on their similarity in sound, length, and look. This was to help prevent false mastery, as Mike was able to phonetically decode words that sounded and appeared different for each other (e.g., exit, stop, and play).

Maintenance. Maintenance probes were conducted at two-week and four-week follow-up sessions. Maintenance probes were conducted using baseline procedures.

Generalization probes. Generalization probes were conducted at the two-week follow up. Generalization probes consisted of presenting two-dimensional stimuli for all targets taught on the iPad and presenting targets on the iPad that were taught using two-dimensional stimuli. For example, if dog, car, and boat were taught using the iPad, the generalization probe consisted of two-dimensional flashcards. Similarly, if cup, hat, and pen were taught using two-dimensional materials, these targets were presented on the iPad. Generalization probes were conducted following baseline procedures.

Chapter III: Results

Mike

Set 1. Figure 3 (Appendix A) displays the percentage correct for each session for the traditional and iPad conditions. Mike reached mastery criterion for all 6 sight words in the iPad and traditional conditions. He required a total of 99 iPad condition trials and 72 traditional condition trials to achieve mastery (See Appendix B, Table 2). Maintenance probe at two weeks for the iPad condition resulted in a score of 78% accuracy, whereas, traditional condition resulted in 100% accuracy. Mike responded incorrectly to two of the three presentations of ‘nest’ during the maintenance probe. During acquisition sessions, Mike responded incorrectly during 51.5% of the trials to ‘nest.’ The maintenance probe at four weeks for the iPad condition resulted in a score of 89% accuracy. Mike incorrectly responded once, selecting the incorrect word for ‘nuts’. Maintenance probe at four weeks for the traditional condition resulted in a score of 77% accuracy. Errors during maintenance probes were due to over selection of ‘bank’ for back and bake.

Generalization probe at two weeks for the iPad condition resulted in a score of 55% accuracy, whereas, the traditional condition resulted in 100% accuracy. Mike incorrectly responded four times during the iPad generalization probe for ‘nuts’ and ‘nest’, incorrectly selecting the incorrect word twice for ‘nuts’ and ‘nest.’ In short, Mike required fewer trials to master target sight words in the traditional condition versus the iPad condition. Additionally, during maintenance and generalization probes, traditional was superior to the iPad. During maintenance and generalization probes, Mike continued to engage in similar error patterns that had been observed during acquisition trials, such as, continuing to respond incorrectly more often when ‘nest’ was the requested target than the other two targets.

Set 2. Figure 4 (Appendix A) displays the percentage correct for each session for the iPad and traditional conditions. Mike reached mastery criterion for all 6 sight words in the iPad and traditional conditions. He required a total of 54 iPad trials and 99 traditional trials to achieve mastery. Although mastery was achieved in the iPad condition with fewer trials than the traditional condition, the traditional condition resulted in a mean of fewer errors per trial across targets than the iPad condition (See Appendix B, Table 2). Maintenance probes at two weeks resulted in a score of 88% accuracy for both the traditional and iPad conditions. Generalization probes at two weeks for the iPad and traditional targets resulted in 100% accuracy. Maintenance probes at four weeks resulted in 100% accuracy for both the traditional and iPad conditions.

Evan

Set 1. Figure 5 (Appendix A) displays the percentage correct for each session for traditional and iPad conditions. Evan reached mastery criterion for all 6 sight words in the iPad and traditional conditions. A total of 180 iPad condition trials and 54 traditional trials were required for Evan to achieve mastery of Set 1 targets. During 2-week maintenance probes of iPad targets Evan responded with a score of 88% accuracy, whereas, with traditional targets, Evan responded with 100% accuracy. Even responded with 100% accuracy during the 4-week maintenance probes for both the iPad and traditional condition. Two-week generalization probes resulted in a score of 78% accuracy for iPad targets and 100% accuracy for traditional targets. Similar to Mike’s results, Set 1 traditional condition was superior to the iPad condition in acquisition, maintenance, and generalization. Furthermore, Evan did not engage in any errors during traditional sessions, whereas errors during the iPad condition were significantly higher.

Set 2. Figure 6 (Appendix A) displays the percentage correct for each session for iPad and traditional conditions. Evan reached mastery criterion of all six sight words selected for Set 2. A total of 63 iPad condition trials were required for Evan to achieve mastery of iPad targets and 54 trials for traditional condition targets. Similar to Set 1, errors during the traditional condition remained lower than the iPad condition. Errors during the iPad condition where lower then Set 1, however, Evan did engage in more errors in the iPad condition. Evan correctly responded 100% of the time for two of the three targets in the traditional condition.

Maintenance probes at two and four weeks resulted in 100% accuracy for the iPad and traditional conditions. Generalization probes for the iPad condition resulted in a score of 88% accuracy and the traditional condition resulted in 100% accuracy. Evan incorrectly responded once during the generalization probe, selecting the incorrect word for ‘your.’

Tim

Set 1. Figure 7 (Appendix A) displays the percentage correct for each session for iPad and traditional conditions. Mastery criterion was not achieved for either the iPad or traditional conditions. Sessions were stopped before mastery criterion was achieved due to infrequency of sessions. Tim’s schedule changed at the start of the school year and he was no longer available for two or three sessions a week. The last five data points for the traditional and iPad conditions were run across three weeks. Response patterns for the iPad condition became more variable, while traditional responses displayed no trend. We decided to stop sessions with Tim, as he was no longer able to have frequent sessions. The data also indicated that infrequent exposure to the targets was interfering with Tim's ability to learn the targets. A total of 23 iPad sessions and 21 traditional sessions were run. Although mastery was not achieved it appeared that the iPad targets may have been superior to the traditional targets. For one of the iPad sessions Tim scored 88%, which was in the mastery criteria range. During all traditional sessions, Tim never responded within range of mastery criteria. In addition, errors were lower per target for the iPad condition than the traditional (See Appendix B, Table 4).

Chapter IV: Discussion

The purpose of this study was to compare the acquisition rate for teaching receptive skills on the iPad and with traditional materials. Both the iPad and traditional conditions were effective in teaching Mike and Evan all selected targets, however, the traditional condition was superior then the iPad in acquisition, maintenance, and generalization. All targets maintained during 2 and 4-week maintenance probes as well as generalized to new stimuli at two-week generalization probes. Tim did not achieve mastery of selected targets due to changes in his schedule that limited his availability for sessions.

Mike required the least amount of sessions to reach mastery for all six targets. He required a total of 34 sessions while Evan required 39 sessions to reach mastery of all targets. Overall, Evan performed better during the traditional condition than the iPad condition. Evan only required a total of 12 sessions, 6 sessions for Set 1 and 6 sessions for Set 2, to reach mastery for all traditional targets. A total of 27 sessions, 20 sessions for Set 1 and 7 sessions for Set 2, were required for mastery to be reached for all iPad targets. Mike required fewer sessions in Set 1 to reach mastery for traditional targets than iPad targets. During Set 1, Mike required a total of 8 traditional sessions and 10 iPad sessions for mastery to be achieved, whereas, in Set 2 a total of 10 traditional sessions and 6 iPad sessions were required before mastery was reached.

The efficiency of teaching is not merely based on the number of trials required to learn, but also the numbers of errors that occurred while teaching. The iPad condition for Mike resulted in the highest numbers of errors during Set 1 targets and Set 2 targets resulted in the highest percentage of errors. For Evan, the iPad condition resulted in the highest number of errors for all targets. Although Mike required fewer sessions for Set 2 iPad targets, percentage of errors for the iPad targets was still greater than the traditional targets. For Evan, targets presented on the iPad resulted in the highest number of errors for all targets. It is important to consider the frequency of errors when teaching as increased errors may result in additional trials for mastery or may produce undesirable emotional responses (Green, 2001).

In depth within session error analysis was completed for each participant. Error analysis for Mike, Evan, and Tim demonstrated that over selection and non-responding were the two errors that occurred across targets. Future research should evaluate error patterns while teaching on the iPad to assess if error patterns are more or less likely to occur on iPad. This will be particularly helpful as not all iPad applications allow for systematic customization of materials, displays, and prompts. Evaluating error patterns may lead to more efficient teaching procedures for the iPad and selection of applications.

Neely et at. (2013) reported that the iPad can be effective in reducing challenging behavior and increasing academic engagement. During Set 1, Mike initially responded more accurately during the traditional condition, resulting in fewer trials for mastery to be reached. However, during Set 2, Mike required more trials in the traditional condition than the iPad condition for mastery to be achieved. The increase in the number of trials during the traditional condition may have been due to an increase in non-compliance and off task behavior that was observed during traditional condition sessions. During traditional condition sessions Mike started to engage in off-task behaviors, such as, attempting to leave the worktable, head spinning (repeatedly moving his head in a circle motion), and vocal stereotypy. None of these behaviors were observed during the iPad condition. These off-task behaviors anecdotally appeared to interfere with Mike's ability to respond correctly.

One limitation of this study is that all participants had previous experience learning receptive labels with traditional materials. Additionally, all participants were concurrently receiving one to one home-based instructions that utilized traditional materials for learning a variety of skills (categories, functions, reading, etc.) A history of reinforcement had previously been established with traditional materials, prior to the onset of this study. Although the experimenter attempted to control for this by selecting unknown targets for the iPad and traditional materials and by keeping target difficulty similar, previous history of reinforcement for traditional materials may have contributed to lower errors and more efficient acquisition of targets. Mike did require fewer sessions to reach mastery for Set 2 iPad targets, however, this only occurred after Set 1 targets had been mastered establishing a history of reinforcement with the iPad. However, this effect was not observed with Evan. Future research should evaluate if the iPad can perform more efficiently or just as efficiently as traditional materials once a history of reinforcement has been established for learning on the iPad.

Traditional targets not only resulted in fewer errors per trial, but also showed greater generalization than iPad targets. Set 1 iPad targets for Mike generalized with 55% accuracy and 100% accuracy for Set 2. Set 1 iPad targets for Evan generalized with 78% accuracy and 88% accuracy for Set 2. In comparison, traditional targets for Sets 1 and 2 for Mike and Evan generalized with 100% accuracy. Generalization of iPad skills is especially important, as individuals with ASD are more likely to come into contact with stimuli not on the iPad across educational, home, and community settings.

Similar to generalization results, traditional targets had few errors during maintenance probes. Maintenance probes for Mike on Set 1 targets resulted in two errors occurring during the iPad condition while no errors occurred with traditional targets at the two-week probe. During iPad maintenance probes Mike incorrectly responded to ‘nest’ during two of the three presentations. During four-week probes, a decrease in traditional targets occurred. Mike responded incorrectly twice to one of the three presentations of bake and back. During four-week probes, Mike engaged in one error with iPad targets, responding incorrectly during one of the three presentations of ‘nuts’. Increased errors with traditional targets during the four-week maintenance probes anecdotally corresponded with an increase in off-task behaviors. Off task behaviors continued to occur during Set 2 traditional targets.

Mike and Evan were able to learn all selected targets for the traditional and iPad condition. Traditional targets overall were learned more efficiently than iPad targets, had a lower percentage of errors, and generalized and maintained more accurately. Both Mike and Evan had previous experience with the iPad and often used the iPad during leisure times to play different apps and games. Neither Mike nor Evan had previous experience with learning receptive skills on the iPad. Future research is needed to determine what prerequisite skills are required for individuals to learn using the iPad. This information would help establish an assessment for evaluating prerequisite skills and possibly identifying what type of learner would benefit the most from the iPad. Additionally, determining prerequisite criteria would also help to establish what skills are required before learning on the iPad can occur.

One limitation of the study is that Tim did not master targets for traditional or the iPad condition. Although every attempt was made to continue to run sessions with Tim, schedule changes that occurred with the onset of school prevented sessions from continuing until mastery was achieved. Future research is needed to evaluate if the iPad is as efficient at teaching receptive labels across additional participants, targets, and academic subjects.

Another limitation of this study is that all participants did not achieve mastery at the 1-second prompt delay. This resulted in modifications of the teaching procedure for all participants. A progressive prompt delay was used to teach selected targets to each participant. The progressive prompt delay followed errorless teaching principles. Each participant received two sessions at a 0-second prompt delay. Following two sessions at 0 seconds, the prompt delay was increased to a 1-second prompt delay. Once mastery had been reached at 1 second, the prompt delay was to be increased to three seconds. Mike and Tim did not reach mastery at the one-second prompt delay. Evan also did not reach mastery for the iPad condition targets at a one-second prompt delay. Data for all participants demonstrated prompt dependency at the one-second prompt delay. Initially, each participant was attempting to respond independently, however, as sessions conditioned a one-second prompt delay a decrease in independent responding was observed. When the prompt delay was increased from 1 second to 3 seconds, Mike and Evan achieved mastery of all targets in the iPad and traditional conditions. The prompt delay for Tim was increased from 1 second to 5 seconds, and an increase in independent correct responses was observed following the increase.

All participants had a previous learning history with errorless teaching. Each participant within their typical home session is provided a minimum of 40 trials at a specific prompt level prior to decreasing the prompt. In this study, participants were provided with 18 trials before the prompt level was decreased. Furthermore, within the home session for all participants, the prompt delay is increased from 0 second to 3 seconds. Providing additional prompting at one-second prompt delay may have resulted in some confusion leading to prompt dependency. An immediate increase in independent responding was observed across all participants following the increase in time. Additionally, mastery was achieved within five sessions of the iPad condition for Mike and Evan and only two sessions were required for the traditional condition to reach mastery for Mike following the increase from 1-second to 3-second prompt delay.

Results of this study demonstrated that the iPad can be used to teach receptive skills, however, traditional materials were more efficient, produced fewer errors, and generalized more accurately. Lee et al. (2013) and Lorah and Karnes (2015) reported that the iPad can be successful for teaching individuals with ASD if the application can be programmed to follow research-based interventions. The present study contributes to previous research in that the iPad can be used to teach skills to individuals with ASD following behavioral principles. Furthermore, the study demonstrated that traditional methods were more efficient in teaching receptive skills. Future research is needed across additional academic skills to fully evaluate if traditional materials are more proficient.

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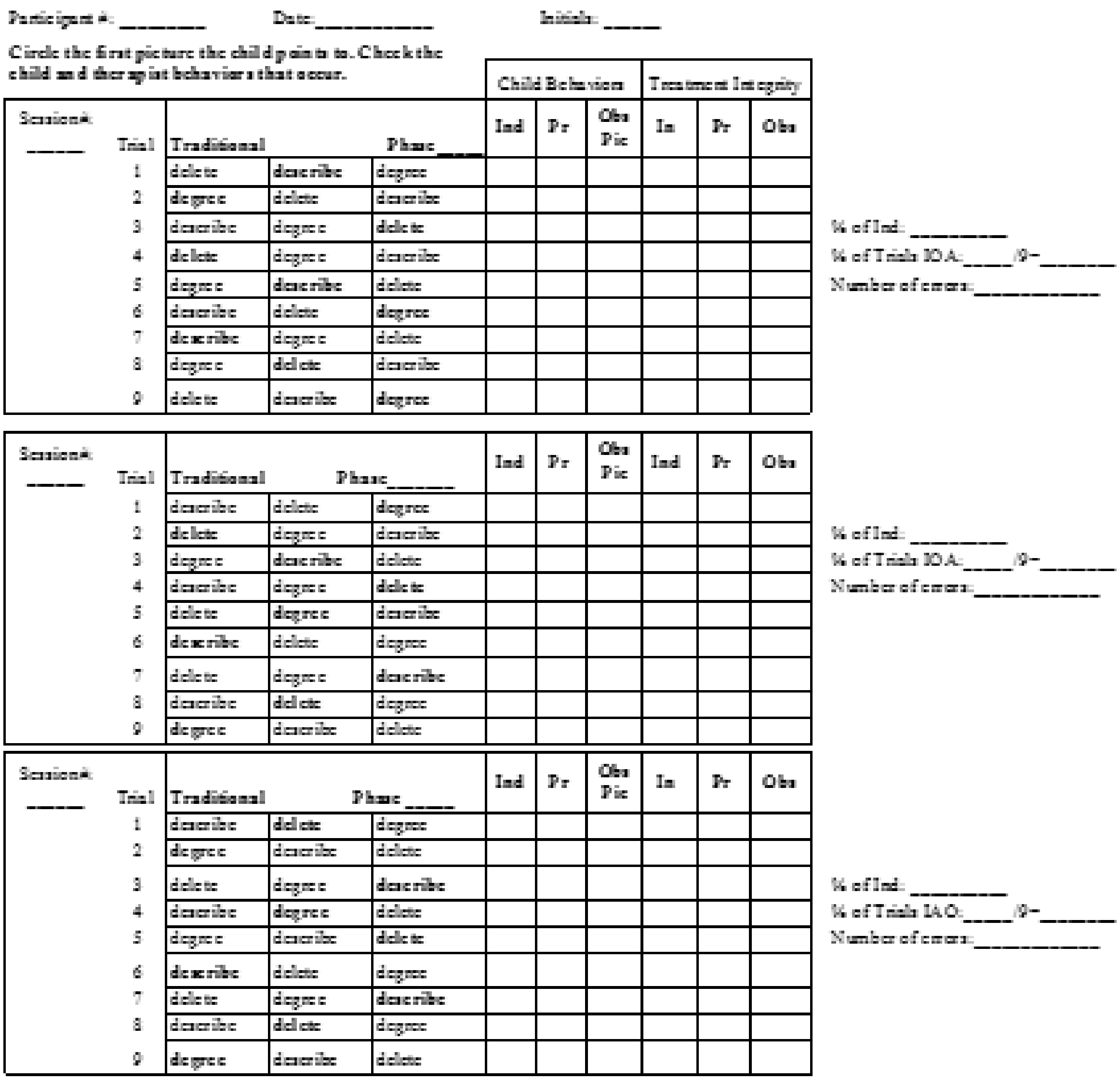
Appendix A: Figures 1 Through 7



Participant #: _______ Date:__________ Initials: _____

Circle the first picture the child points to. Check the child and therapist behaviors that occur.

Session#: _____ Trial	Traditional		Phase____	Child Behaviors Ind	Pr	Obs Pic	Treatment Integrity In	Pr	Obs
1	delete	describe	degree						
2	degree	delete	describe						
3	describe	degree	delete						
4	delete	degree	describe						
5	degree	describe	delete						
6	describe	delete	degree						
7	describe	degree	delete						
8	degree	delete	describe						
9	delete	describe	degree						

% of Ind: ________
% of Trials IOA:____/9=______
Number of errors:__________

Session#: _____ Trial	Traditional		Phase______	Ind	Pr	Obs Pic	Ind	Pr	Obs
1	describe	delete	degree						
2	delete	degree	describe						
3	degree	describe	delete						
4	describe	degree	delete						
5	delete	degree	describe						
6	describe	delete	degree						
7	delete	degree	describe						
8	describe	delete	degree						
9	degree	describe	delete						

% of Ind: ________
% of Trials IOA:____/9=______
Number of errors:__________

Session#: _____ Trial	Traditional		Phase_____	Ind	Pr	Obs Pic	In	Pr	Obs
1	describe	delete	degree						
2	degree	describe	delete						
3	delete	degree	describe						
4	describe	degree	delete						
5	degree	describe	delete						
6	describe	delete	degree						
7	delete	degree	describe						
8	describe	delete	degree						
9	degree	describe	delete						

% of Ind: ________
% of Trials IAO:____/9=______
Number of errors:__________

Figure 1. Data Sheet for traditional Condition. Bold targets represent the target that as asked for during the trial. Percentage of independent responses and errors wre recorded each session.

Participant #: ________ Date:___________ Initials: ____ Circle: Prim/Seco

Circle the first picture the child points to. Check the child and therapist behaviors that occur.

					Child Behaviors			Treatment Integrity		
Session#: ______	Trial	**iPad**		**Phase ____**	**Ind**	**PR**	**Obs Pic**	**Ind**	**Pr**	**Obs**
	1	challenge	**channel**	character						
	2	channel	character	**challenge**						
	3	**character**	challenge	channel						
	4	challenge	character	**channel**						
	5	channel	**challenge**	character						
	6	**channel**	character	challenge						
	7	challenge	**character**	channel						
	8	channel	character	**challenge**						
	9	**character**	challenge	channel						

% of Ind: _________
% of Trials IOA:_____/9=_______
Number of errors:___________

Session#: ______	Trial	**iPad**		**Phase ____**	**Ind**	**Pr**	**Obs Pic**	**Ind**	**Pr**	**Obs**
	1	channel	challenge	**character**						
	2	**challenge**	character	channel						
	3	character	**channel**	challenge						
	4	channel	character	**challenge**						
	5	**channel**	challenge	character						
	6	challenge	**character**	channel						
	7	**character**	channel	challenge						
	8	channel	**challenge**	character						
	9	challenge	character	**channel**						

% of Ind: _________
% of Trials IOA:_____/9=_______
Number of errors:___________

Session#: ______	Trial	**iPad**		**Phase ____**	**Ind**	**Pr**	**Obs Pic**	**Ind**	**Pr**	**Obs**
	1	**challenge**	character	channel						
	2	character	**channel**	challenge						
	3	channel	challenge	**character**						
	4	channel	**character**	challenge						
	5	character	challenge	**channel**						
	6	**challenge**	channel	character						
	7	channel	character	**challenge**						
	8	**character**	challenge	channel						
	9	channel	**character**	challenge						

% of Ind: _________
% of Trials IOA:_____/9=_______
Number of errors:___________

Figure 2. Data sheet for iPad condition. Bold targets represent the target that was asked for during the trial. Percentage of independent responses and errors were recorded each session

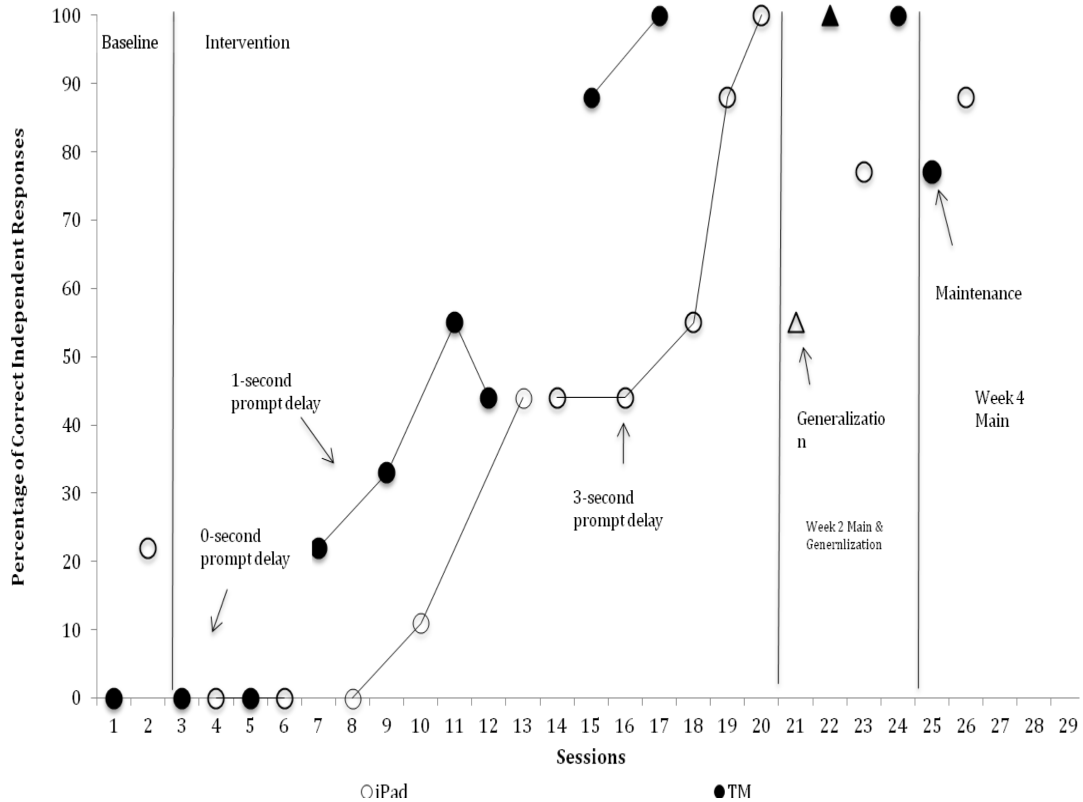


Figure 3. Percentage of correct response for Mike per session for Set 1 targets. The graph shows maintenance probes at two and four weeks and generalization probes at two weeks.

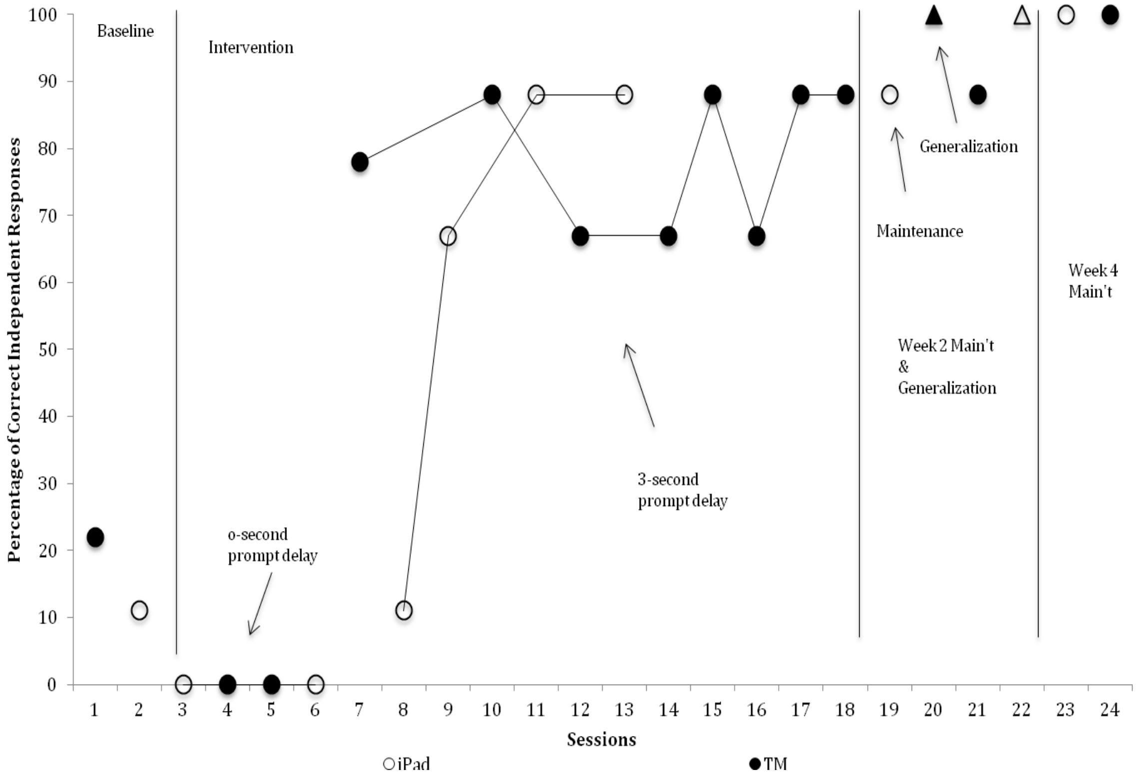


Figure 4. Percentage of correct response for Mike per session for Set 2 targets. The graph shows maintenance probes at two and four weeks and generalization probes at two weeks.

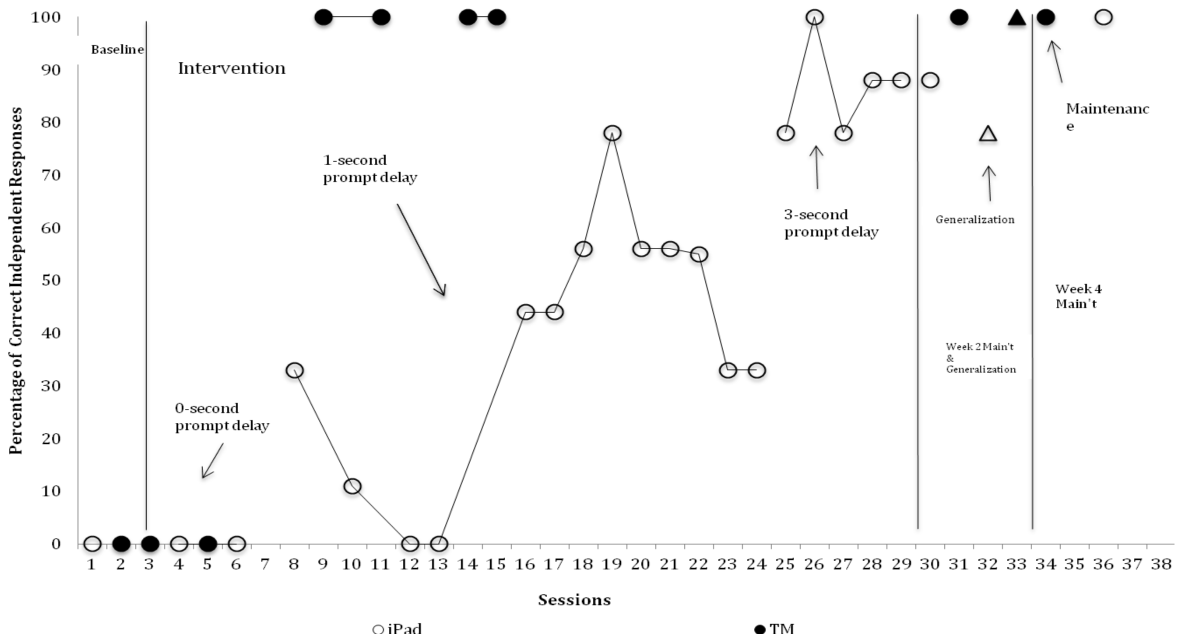


Figure 5. Percentage of correct response for Evan per session for Set 1 targets. The graph shows maintenance probes at two and four weeks and generalization probes at two weeks.

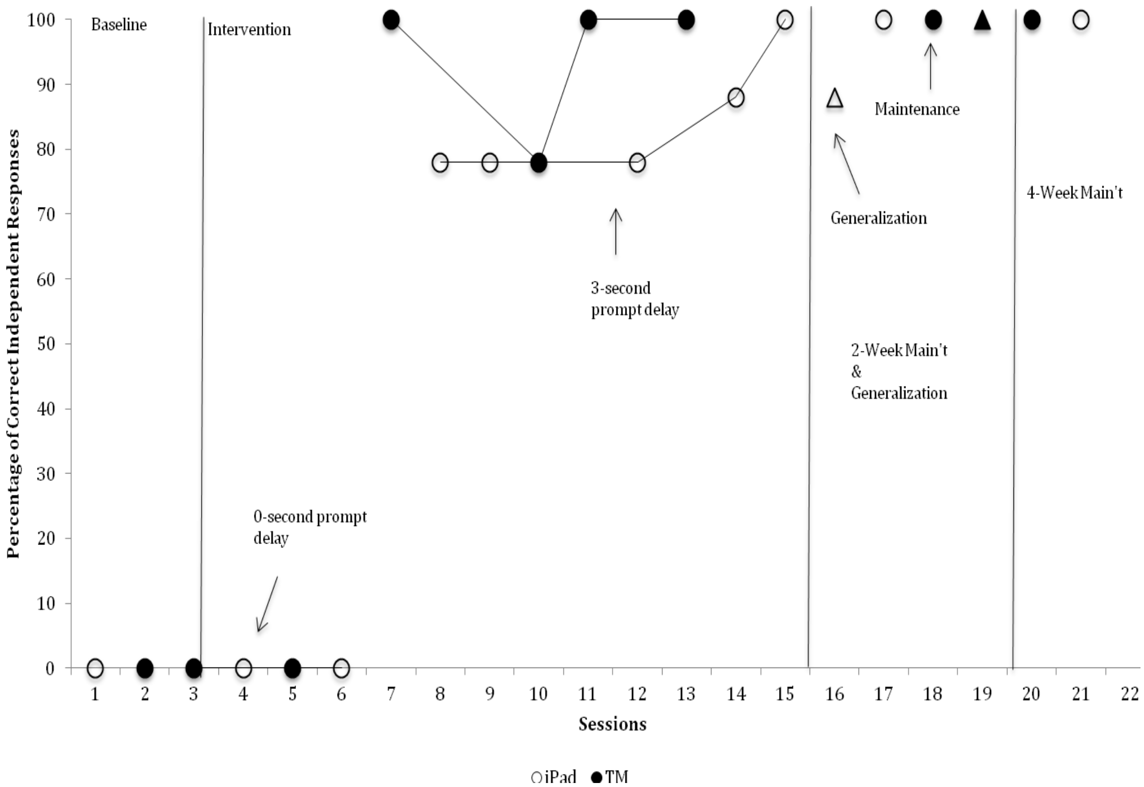


Figure 6. Percentage of correct response for Evan per session for Set 2 targets. The graph shows maintenance probes at two and four weeks and generalization probes at two weeks.

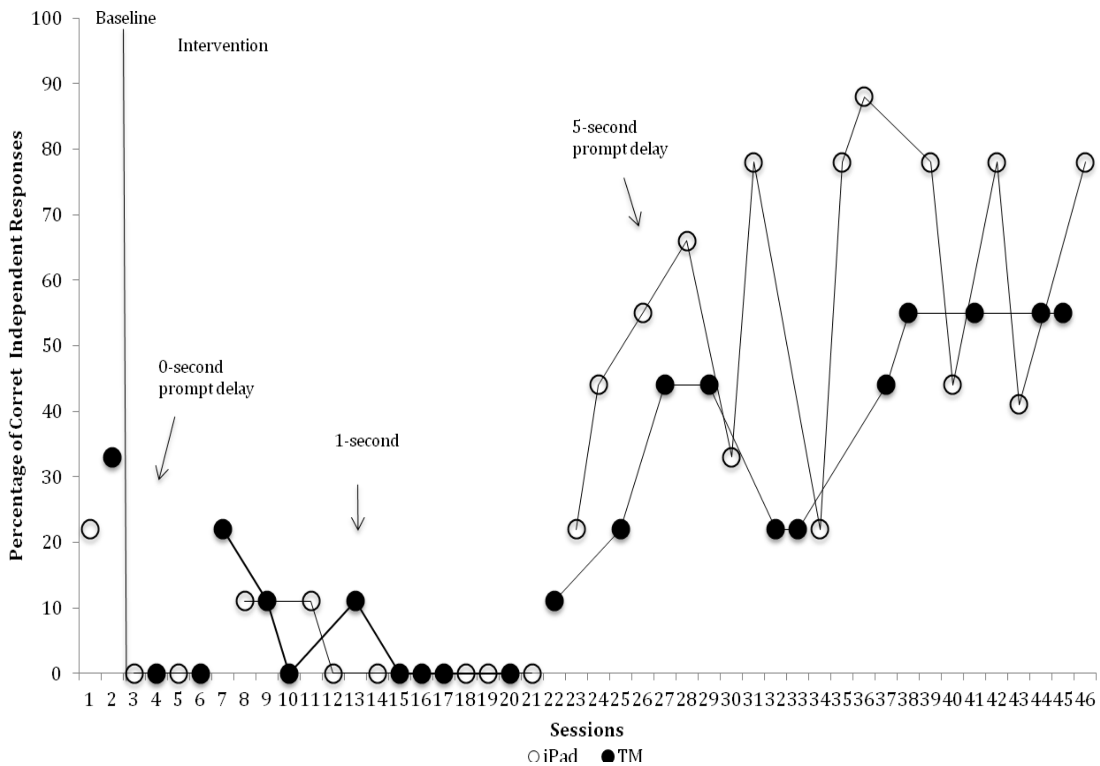


Figure 7. Percentage of correct response for Tim per session for Set 1 targets. A total of 23 iPad and 21 traditional sessions were run. Sessions were terminated after 44 sessions.

Appendix B: Tables 1 Through 4

Table 1

Literature Review Summary

Author	Participants	Independent Variable	Dependent Variable	Outcome
Lee et al. (2013)	Two male children. Aged 4 and 2 both diagnosed with autism.	Two intervention conditions were randomly evaluated using an alternating treatment design. One condition consisted of therapist-only condition, where a therapist presented all instructions. The second condition was the iPad-assisted condition. All stimuli were presented on the iPad. All stimuli remained the same during conditions.	• Percentage 10s whole interval of on task behavior • Percentage of 10s partial interval of challenging behavior. Challenging behavior was defined as stating lines from a movie repeatedly, screaming, grabbing instructional materials, and moving away more than 0.5mm from the instructional area. • Percentage of independent correct responses out of the total trials presented. A correct response was defined as the child sitting in their chair with their eyes orientated towards the instructional materials or instructor, engaged in active responding with the task materials, and the absence of challenging behavior. • Duration of sessions and intervention trials were also recorded.	Results for one of the participants (Michael) indicated no consistent difference between the therapist condition vs. the iPad-assisted condition. During the iPad-assisted intervention, data for the second participant (Aaron), indicted that Aaron was more engaged during the iPad-assisted intervention, compared to the therapist only condition. Aaron also demonstrated more correct responses during the iPad-assisted intervention. As well as less challenging behavior occurred during the iPad condition. Both participants consistently selected the iPad condition when presented with a choice.
Neely et al. 2013	Two male participants, aged 7 and 3 participated in the study. Elton was seven-years-old and had a diagnosis of Asperger's disorder. Dan was three-years-old and had a diagnosis of PDD-NOS.	Two intervention conditions were evaluated using a reversal design. During the traditional material condition the participants completed all instructions using a paper and pencil (Elton) or flashcards (Dan). During the iPad condition both participants completed the same academic instruction using the iPad.	• Percentage of challenging behavior was recorded using 10s partial interval recording. • Challenging behavior consisted of vocal protest, aggression, and task avoidance for both participants.	Both of the participants challenging behavior decreased during the iPad only condition compared to the traditional materials condition. Both participants also demonstrated an increase in academic engagement during the iPad condition compared to the traditional materials condition.

Author	Participants	Independent Variable	Dependent Variable	Outcome
Jowett et al. (2012)	One male participant (Jack) five-years-old with a diagnosis of Autism Spectrum disorder and an intellectual disability.	A multiple-baseline across behaviors was used to evaluate the use of the video modeling on number identification, comprehension and writing skills. Videos were presented that consisted of using a voice over that said the target number, while drawing the number. Each video contained embedded reinforcement of a picture of an angry bird as well as the sound of the angry birds clapping. Prompts in the video were faded systematically.	Data was collected on Jack's ability to write, identify, and comprehend the quantity of numbers from 1 – 7. A changing criterion rubric was created to score correct and incorrect responses. Scores were provided according the following: 1. The written number was identifiable; 2. No additional prompts were provided following the presentation of the video; 3. The number written was the correct size (no more 3.5 cm in size); 4. The formation of the number during writing was correct; 5. All of the required components of the number were written; 6. The correct card displaying the correct quantity was selected. An incorrect response was scored if Jack did not meet the criterion within a category.	Jack was able to correctly identify, write, and comprehend numbers 1 – 7 at the end of the intervention and during a 6-week follow up. Generalization was also observed across settings, as Jack was able to identify numbers across a variety of materials.
Van der Meer et al. (2015)	One 10-year-old male (Harley) with a diagnosis of Autism Spectrum disorder participated in the study.	Harley was presented with a card and asked to select the corresponding word/picture on the iPad using Proloquo2go application. A multiple-probe across matching tasks was initially used. Due to concerns of generalization affecting the results the design was changed to an ABCD design that consisted of a baseline, intervention, follow-up, and random rotation.	Percentages correct across responses were calculated following each session. A correct response occurred when Harley independently selected a picture or word on the iPad with enough force to activate the voice output that corresponded with the picture or word card presented by the interventionist. An incorrect response was scored if Harley did not use the iPad to select the corresponding word or picture, selected an incorrect word or picture, or engaged in multiple toughing of the icon on the screen after	During baseline Harley was not able to correctly identify word-to-word, word to picture, picture to word, and picture-to-picture pairs. Following the intervention Harley mastered picture-to-picture matching, word to picture matching, picture to word matching, and word-to-word matching during the intervention and continued to demonstrate the skills at follow up.

Author	Participants	Independent Variable	Dependent Variable	Outcome
			the voice output had been generated.	
O' Malley et al. (2014)	All participants involved in the study were in a special education classroom for individuals with moderate to severe developmental disabilities. A total of 7 students participated in the study. Ages ranged from 11 – 13 with varying grade levels from 4 – 7. Five males and two female students participated.	An ABAB design was used to evaluate the effects of using an iPad to teach math skills verses traditional teaching methods for an entire classroom. Baseline consisted of traditional materials (paper and paper) and the intervention consisted of using the iPad (‘*My first Numbers’* application by Grasshopper Apps*)* for math skills.	Number of independently completed math questions per assignment and percentage of noncompliance behaviors were recorded. Noncompliance behavior was defined as passive responding, refusing to work, dropping to the ground, putting head down on desk, or getting up and moving away from the desk. Active noncompliant behavior was defined as engaging in aggression, self-injurious behavior, and or throwing of materials. During the fourth week assessment probes were completed for 4-5 of the sessions.	An increase in math skills was not observed across any of the participants during the study. However, an increase in independent task completion was observed across the entire class. During the iPad-assisted condition a decrease in non-compliance was observed class wide.
Lorah et al. (2014)	Three participants, one female, and two males with ages 4 – 6 years old. Two participants had a diagnosis of autism (Antonio & Mary) and Zach had a diagnosis of developmental delay and cerebellar hypoplasia.	A multiple-baseline across participants was used to evaluate discrimination training across two sentence frames ‘I see’, and ‘I have’. Each sentence frame was taught separately using the iPad. The iPad screen consisted of a sentence frame at the top with five pictures to select from on the lower part of the screen.	Correct and incorrect responses were scored on discrimination of sentence frames per session. A correct response was scored if the participant selected the correct picture symbol for the sentence frame (e.g.,‘I have’), selected the corresponding item picture (e.g., ‘ball’), and then pressed the sentence frame window with enough force to activate the voice output. An incorrect response was scored if the participant did not perform all of the above steps in order or selected an incorrect sentence frame or picture, and did not respond within 5s of the presentation of the stimulus.	All three participants were able to learn each sentence frame and discriminate the two target frames. Zach's data was variable throughout the intervention and discrimination training. One participant Mary, during the discrimination phrases started to vocally discriminate between the two target phrases.
Burton et al. (2013)	Four male participants aged 13 – 15 years old	A multiple-baseline across participants was	A task analysis was used to score the percentage	All participants were able to learn the target

Author	Participants	Independent Variable	Dependent Variable	Outcome
	participated. Three of the participants Joey, Will, and Ryan had a diagnosis of Autism spectrum disorder. Aaron was diagnosed with an intellectual disability.	used to evaluate the use of video self-modeling on the iPad to teach functional math skills (purchasing items).	of steps correctly completed.	behavior. These skills also maintained during follow-up for all participants.
Larabee et al. (2014)	Three participants aged six participated in the study. Two males and one female all with a diagnosis of English language learners (ELL).	Two interventions procedures were evaluated using a multielement design. Traditional materials verses the iPad for decoding words and on task engagement.	10s momentary time sample was used to evaluate the participant's time on task. Percentage of on-task behavior was calculated by dividing the number of correct and incorrect intervals. Correct and incorrect responses were scored for letter decoding. A correct response was defined as active or passive participation. On task was scored when the student was observed answering questions, talking about the word/sound that was currently being taught, looking towards or at the instructor, responding and following directions, and appropriate engagement with the instructional materials. An incorrect response was scored for off-task behavior. Off-task behavior was defined as engaging in a conversation about an unrelated topic, playing with instructional materials, not looking towards the instructor or the instructional materials, and laying head down on desk.	Decoding performances were variable across all participants with no clear differentiation between the traditional materials versus the iPad-assisted condition. However, all three participants did demonstrate higher task engagement when instructions were presented on the iPad vs. traditional materials.
Flower 2014	Three male students aged 7 – 10 participated in the study. All participants had an IEP (Individualized Education Program) and had a diagnosis of emotional /behavioral	Two interventions procedures were evaluated using an alternating treatment design. Traditional independent work conditions using paper and pencil were compared to an iPad condition	10s momentary time sampling was used to score on- task or off-task behaviors. Percentage of on-task intervals was calculated by dividing the total number of intervals on-task by the total number of	Levels of on task behavior were consistently higher across all three participants during the iPad condition.

Author	Participants	Independent Variable	Dependent Variable	Outcome
	disorder.	where all instruction were presented on the iPad. The iPad had several different educational applications installed that focused on reading, phonics comprehension, listening comprehension, and math skills. iPad tasks were similar to the questions and problems that were presented during the traditional material condition. The traditional material condition consisted of reading and other math tasks such as answering multiple choice questions, matching, and fill-in the blank questions.	intervals. On-task behavior was defined as the student's eyes being directed towards the worksheet or iPad and their fingers or pencil moving, without talking to other students. Additionally, on-task was scored if the student raised their hand to ask a question. If the student was not engaged in any of the above on-task behaviors, the interval was scored as off-task.	
Lorah et al. (2013)	Five male children with the mean age of 4.5 years participated in the study. All children had a diagnosis of autism.	An alternating treatment design was used to evaluate the use of PE (Picture Exchange) versus the use of a SGD (Speech Generating Device).	Percentage of independent and prompted mands across PE and SGD condition was calculated to evaluate the acquisition rate across conditions. PE was defined as the participant picking up the picture and placing the picture into the hand of the instructor independently. For SGD was defined as the participant touching a picture on the screen with enough pressure to activate the voice output.	The SGD (iPad) as a communication device resulted in faster acquisition rates among three of five participants and four of five participants showed a preference for the speech generating device (SGD).
Lorah and Karnes (2015)	Two children aged 3 and 4 with a diagnosis of autism participated in the study.	A multiple baseline across responses was used to assess the use of the iPad application *Language Builder*™ to teach listener responding (Receptive labeling).	Percentage correct was the dependent variable. Percentage correct was calculated by dividing the total correct responses by the total correct and incorrect responses. A correct response was defined as the participate touching the correct picture on the screen when the instruction 'touch(label)" (e.g., 'touch dog') was presented within five seconds.	The use of the iPad application *Language Builder*™ was effective at teaching both participants listener discriminations for three different target stimuli. Each participant met criterion within two sittings for all target stimuli. Maintenance and generalization probes were also conducted. Both participants were able to respond correctly during maintenance and generalization probes.

Author	Participants	Independent Variable	Dependent Variable	Outcome
			An incorrect response was defined as the participant not responding within 5-seconds of the presentation of the instruction or toughing the incorrect picture.	

Table 2

Number of Sessions and Trials Required to Achieve Mastery Criteria, Number of Errors, and Percentage of Errors Per Target in Each Condition for Mike.

Method / Set	No. of trials	No. of sessions	Total No. of errors	% of error per trial	2-week Maintenance probe % correct	4-week Maintenance probe % correct	2-Week Generalization probe % correct
Mike Set 1							
iPad - next	33	10	12	36.3	100	100	100
iPad - nest	33	10	17	51.5	33	100	33
iPad - nuts	33	10	13	39.3	100	66	33
TM - back	24	8	13	54.1	100	66	100
TM - bank	24	8	10	41.6	100	100	100
TM - bake	24	8	8	33.3	100	66	100
Set 2							
iPad – challenge	18	6	4	22.2	100	100	100
iPad – channel	18	6	2	11.1	100	100	100
iPad – character	18	6	6	33.3	66	100	100
TM - delete	33	10	8	24.2	100	100	100
TM - describe	33	10	2	6.0	66	100	100
TM - degree	33	10	5	15.1	100	100	100

Table 3

Number of Sessions and Trials Required to Achieve Mastery Criteria, Number of Errors, and Percentage of Errors Per Target in Each Condition for Evan.

Method / Set	No. of trials	No. of sessions	Total No. of errors	% of error per trials	2-week Maintenance probe % correct	4-week Maintenance probe % correct	2-Week Generalization probe % correct
Evan							
Set 1							
iPad - Something	60	20	38	63.3	66	100	66
iPad - important	60	20	17	28.3	100	100	66
iPad - beautiful	60	20	28	46.6	100	100	100
TM - better	18	6	0	0	100	100	100
TM - light	18	6	0	0	100	100	100
TM - thought	18	6	0	0	100	100	100
Set 2							
iPad – own	21	7	3	14.2	100	100	100
iPad – your	21	7	4	19.0	100	100	66
iPad – kind	21	7	0	0	100	100	100
TM - copy	18	6	2	11.1	100	100	100
TM - idea	18	6	0	0	100	100	100
TM - raise	18	6	0	0	100	100	100

Table 4

Number of Sessions and Trials Required to Achieve Mastery Criteria, Number of Errors, and Percentage of Errors Per Target in Each Condition for Tim.

Method / Set	No. of trials	No. of sessions	Total No. of errors	% of error per trials	2-week Maintenance probe % correct	4-week Maintenance probe % correct	2-Week Generalization probe % correct
Tim							
Set 1							
iPad - Sunday	69	23	28	44.4	NA	NA	NA
iPad - Thursday	69	23	47	74.6	NA	NA	NA
iPad - Friday	69	23	42	66.6	NA	NA	NA
TM - Tuesday	63	21	34	53.9	NA	NA	NA
TM - Wednesday	63	21	43	68.2	NA	NA	NA
TM - Monday	63	21	52	82.5	NA	NA	NA