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AN EVALUATION OF A STIMULUS PREFERENCE ASSESSMENT OF IPAD

APPLICATIONS FOR YOUNG CHILDREN WITH AUTISM

by

Lyndsay D. Nix

A thesis submitted in partial fulfillment
of the requirements for the degree

of

MASTER OF SCIENCE

in

Special Education

Approved:

Thomas Higbee, PhD Major Professor	Barbara Fiechtl, MS Committee Member
Robert Morgan, PhD Committee Member	Mark R. McLellan, PhD Vice President for Research and Dean of the School of Graduate Studies

UTAH STATE UNIVERSITY
Logan, Utah

2016

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ABSTRACT

An Evaluation of a Stimulus Preference Assessment of iPad

Applications for Young Children with Autism

by

Lyndsay D. Nix, Master of Science

Utah State University, 2016

Major Professor: Dr. Thomas S. Higbee
Department: Special Education and Rehabilitation

Previous researchers have conducted preference assessment studies using different types of stimuli (e.g., edibles, tangibles, music) to identify reinforcers for individuals with disabilities. This study investigates the ability of paired-stimulus preference assessment techniques to assess the potential reinforcing effectiveness of iPad applications (apps) on the academic behavior of preschoolers with autism. This study yielded a preference hierarchy for each participant among the iPad apps. Participants' responding increased upon implementation of the low-preferred app. When accessing the high-preferred app as reinforcement, participants generally engaged in a higher rate of responding. These results show that a paired-stimulus preference assessment can be used to rank preference of iPad apps, and therefore identify which apps are high-preferred and low-preferred. Findings also add to the research in showing that high-preferred stimuli are more effective because they increase rates of responding. This study provides many possibilities for conducting future research involving preference of technological stimuli.

(54 pages)

PUBLIC ABSTRACT

An Evaluation of a Stimulus Preference Assessment of iPad Applications for Young Children with Autism

by

Lyndsay D. Nix

The process researchers use to determine what children with disabilities like and dislike is called preference assessment. Studies have been conducted with preference assessments using different types of materials (e.g., food, toys, music). In this study, we used a preference assessment on the iPad for children with autism. The purpose was to see if iPad applications (apps) could be used to increase responding. The preference assessment ranked iPad apps for each participant in order of most-preferred to least-preferred. Participants' responding increased when they could receive the most-preferred iPad app for completing the task (i.e., stringing beads). These results show that the preference assessment can be used to rank preference of iPad apps and, therefore, show which apps are most-preferred and least-preferred. Findings also add to the research by showing that the apps the participants liked the most were generally more effective by increasing rates of responding. Teachers can use this information by using the apps their students like the most for completion of harder tasks.

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I would also like to thank my family and friends for their encouragement, moral support, and patience as I have worked through the process and finally "finished my thesis!"

Lyndsay D. Nix

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CHAPTER I

INTRODUCTION

Successful educational programs use positive reinforcement as the primary tool to teach children with autism to acquire new skills. The items used as reinforcers are most effective when they are based on each child's individual preference. Children with autism typically display restricted interests (American Psychiatric Association, 2013). That is, they generally do not interact with a wide variety of different items. This pattern is shown across various types of stimuli (e.g., food, toys, games). Because of their restricted interests and lack of communication skills, it is crucial to develop systematic methods to determine what items will be effective as reinforcers.

The process of identifying reinforcers requires a stimulus preference assessment (SPA) (Fisher et al., 1992; Pace, Ivancic, Edwards, Iwata, & Page, 1985) with multiple steps. Because the process for identifying reinforcers is perceived to be complex, teachers often resort to informal observation, staff guessing, and self-report (Mason, McGee, Farmer-Dougan, & Risley, 1989). Many researchers have conducted formal preference assessments with a variety of types of stimuli to determine effective reinforcers (Fisher et al., 1992; Horrocks & Higbee, 2008; Mason et al., 1989; Pace et al., 1985, Snyder, Higbee, & Dayton, 2012) and have shown positive results.

Preference assessment research, along with the type of stimuli used, has evolved and expanded throughout the years. Initially, the stimuli used in such assessments involved edibles or toys (Fisher et al., 1992; Pace et al., 1985). Recently, researchers have broadened the scope of SPAs to include social stimuli (Nuernberger, Smith, Czapar, & Klatt, 2012) and musical stimuli (Horrocks & Higbee, 2008). These studies found that various types of stimuli functioned as effective reinforcers. The findings of these studies are important because they allow children with autism to access typical events and activities that are readily-available in school environments (e.g., classrooms, lunch, recess). Delivering reinforcers already contained within a classroom or school may be less-stigmatizing and more-easily delivered than only using edibles and toys because the children with autism can receive similar reinforcers to typical children.

In fact, typical children in regular school settings today have access to an even greater array of stimuli than before that often serve to reinforce behavior. It is reasonable to assume that, in the general population, the most common class of stimuli now available to children are technological devices (Hoffmann, 2014). The prevalence of electronic devices, and more specifically, the iPad®, is revolutionizing the way teachers teach and students learn (Quam, 2012). Many schools have an iPad available in every classroom or even one iPad for every student (Rice, 2013). Because of the prevalence of iPads in classrooms, children with autism seem to show interest in them by often requesting access to these devices.

Apple® is continually developing applications (apps) and products for pre-K and younger students, many of which are applicable for children with autism (Quam, 2012). Some of these apps are interactive games that involve auditory and visual stimuli usable as reinforcers. Teachers who work with children with autism need more information about which apps could be potentially reinforcing for individual students. Thus, the development of a procedure to assess student preference for these apps seems warranted.

CHAPTER II

LITERATURE REVIEW

I searched multiple sources of articles relating to preference assessments, including EBSCO Host database (ERIC and Psych Info), Google Scholar, articles recommended by committee members, and reference sections from relevant articles. I decided to include the landmark study by Fisher et al. (1992) to discuss the evolving procedure of the paired-stimulus preference assessment. Next, I reviewed Snyder et al. (2012) to show how they used technology to present complex stimuli used in a SPA. Third, I reviewed Horrocks and Higbee (2008) because they incorporated auditory stimuli, and my study will be structured similarly. I also used Google to search the terms *iPad classroom prevalence*, *autism resources + iPad*, and *autism iPad usage*.

In a landmark article, Fisher et al. (1992) developed the paired SPA procedure in which two stimuli were presented simultaneously, and the researchers instructed the children to pick just one item. This “forced-choice” presentation format allowed for greater differentiation between preferred and nonpreferred stimuli; rather than just determining whether a stimulus was preferred as examined in the Pace et al. (1985) study. Fisher et al. predicted that the paired-stimulus assessment would better calculate which stimuli would result in higher levels of responding than in the Pace et al. procedure.

Fisher et al. (1992) selected four participants with disabilities ranging in ages from 2 to 10 years. In the first phase, the stimuli were compared using the single-item presentation format of the stimulus preference (SP) procedure developed by Pace et al. (1985) and the forced-choice method. In the forced-choice method, these same 16 stimuli were presented in pairs. In a randomized order, each stimulus was paired once with every other stimulus, which resulted in 120 stimulus-pair presentations. During each trial, the two stimuli were placed 0.7 m apart and about 0.7 m in front of the participant. When the participant approached one of the stimuli, he or she received access to it for 5 s, and the other stimulus was removed. The therapist blocked attempts to approach both stimuli. If a participant did not approach either stimulus within 5 s, the therapist prompted the participant to sample each stimulus for 5 s. After sampling, the two stimuli were represented for another 5 s. If the participant still did not approach either item within 5 s, both were removed and the next trial began. This comparison showed that all of the items identified as highly preferred by the forced-choice method were also considered so based on the single-item method. If data from the two assessments disagreed, the single-item method identified the stimuli as highly preferred, while the forced-choice method classified them low to moderate. This suggests that the single-item method tends to overestimate highly preferred items, perhaps because the stimuli are presented individually and other options are not available. Therefore, it can be suggested that the forced-choice method might be a useful extension of the Pace et al. (1985) procedure.

In a second phase, Fisher et al. (1992) compared high-high stimuli (i.e., approached on at least 80% of trials on both single-item and forced-choice assessments) to SP-high stimuli (i.e., approached on at least 80% of single-item trials and 60% or less of forced-choice trials). For all four participants, the duration of the behavior was significantly higher as compared to baseline when they could gain access to the high-high stimuli. Results varied with SP-high stimuli, however. Behavior was somewhat higher with one participant, while it was unchanged for two, and actually decreased with another. When both categories of stimuli were directly compared, the behavior was significantly higher when associated with the high-high stimuli than the SP-high stimuli. Because greater increases in responding occurred with the high-high stimuli, this indicates that the forced-choice method better predicted which stimuli would function as more potent reinforcers than the single-item method.

Snyder et al. (2012) conducted a preliminary study for children with autism to determine if presenting tangible stimuli via videos would produce preference hierarchies similar to those obtained using the tangible stimuli. Researchers ran two paired-stimulus assessments with each participant: one using videos and the other using the actual tangible items. Prior to the video assessment, the participants were each shown video clip that corresponded to the tangible item. While the clip was paused with a still image on the screen, participants were given 15 s to access the stimulus. For the assessment, clips of the stimuli played on two DVD players—first playing a video on the left and then on the right. After each clip, the DVD players were paused on a picture of the item. Participants were instructed to pick one and then given 15-s access to the stimulus. The procedures for the tangible items were similar to the video, except that toys were used instead of the DVD players.

The researchers evaluated the correspondence between the rankings generated by the two formats (i.e., video vs. tangible) for each item. The number of correspondences varied across participants, but the most-preferred stimulus matched in both assessments for five out of the six participants. This shows that, in general, the video assessment identified the same high-preference stimulus as the one conducted with the actual items. A reinforcer assessment was not included to confirm that the stimuli actually served as reinforcers for the participants, however research indicates that when tangible and pictorial SPA identify the same high-preferred stimulus, that the stimulus function as a reinforcer as tested by reinforcer assessments. This study is important because it was the first to show that SPA can be conducted via video format to identify potential reinforcers. It serves as a lead into conducting preference assessments with other complex stimuli through technology.

Most of the stimuli used in previous paired-stimulus studies consisted of edible and tangible items. Horrocks and Higbee (2008) were the first to investigate using auditory stimuli in preference assessments. They claimed that there were three advantages to using auditory stimulation as reinforcement. First, auditory stimuli can be easily delivered and controlled in many settings with the use of portable electronic devices. Second, auditory stimuli can be used without necessarily disrupting the natural environment through the use of headphones. Finally, auditory stimulation can be easily varied to ensure that satiation does not occur as often. Horrocks and Higbee (2008) used a paired-stimulus preference assessment, comparable to the procedures used by Fisher et al. (1992) to assess participant preference for these stimuli. They used this method because the single-item method tends to overestimate preference (Fisher et al., 1992) and the difficulty of presenting more than two auditory stimuli at the same time.

The participants consisted of six middle school students (ages 13 – 15) receiving special education services in a self-contained classroom. The researchers selected six music samples (i.e., songs) to use for each participant’s SPA. Two identical CD players played identical copies of each participant’s auditory stimuli. All stimuli were presented twice (i.e., once on the left and once on the right) to each participant during the SPA, for a total of 30 preference trials. Preceding each trial, the participant could listen to each auditory stimulus for 15 s each. Next, the two identical CD players were placed about 1 m apart and centered in front of the participant. After listening to each stimulus, the participant was instructed to “Touch the one you like the most.” The participant could then choose between the two selections by touching one of the CD players. After making a selection, the participant was given access to the stimulus for another 15 s. This process continued until each of the six participants completed all 30 preference trials. Because of the length of each assessment, it was completed in two sessions on consecutive days.

A percentage selection score was calculated for each stimulus by dividing the number of times it was selected by the number of times it was available during the SPA. The auditory stimuli were then ranked from most to least preferred based on this percentage. A reinforcer assessment was conducted to evaluate the effectiveness of the stimuli assessed. The item that ranked first for each participant was used as high-preferred, and the item ranked last was used as least-preferred.

Target responses for the reinforcer assessment were based on the participant’s Individualized Education Plan (IEP) and, according to the classroom data, they were performing the task at a low rate. Initially, several baseline sessions were conducted with each participant to determine levels of responding in the absence of consequences. Then, researchers used an alternating treatments (multi-element) design (Cooper, Heron, & Heward, 2007) in which baseline, high-preference, and low-preference stimuli conditions alternated in a semi-random fashion. At the beginning of each session, the experimenter presented a verbal instruction (e.g., “sort the candy”) to engage in the required response. After the participant completed the task according to the criteria, and the high-preferred, low-preferred, or no stimulus was provided. This sequence continued until stable data trends were visible for each condition.

During baseline sessions, the levels of responding for all participants remained low and stable throughout the study. For three participants, there was a clear separation in the data with high-preference stimuli producing higher rates of responding than low-preference stimuli or baseline. For the other three participants, the same separation was observed when the reinforcement schedule was increased. The low-preference stimuli used for all participants also produced consistently higher rates of responding than in baseline conditions. This indicated that the low preference stimuli still functioned as a reinforcer, even though they were not as effective as the high-preference stimuli. This study shows that auditory stimulation can function as an effective reinforcer for individuals with developmental disabilities. The findings also suggest that the reinforcing potency of auditory stimuli can be accurately predicted by a paired SPA. As indicated by the data, auditory stimuli can be used to increase rates of academic behavior. Because of the benefits of using auditory stimuli, future researchers should continue to investigate their effectiveness as reinforcers.

To date, there is very little research that uses electronic devices in preference assessments (Hoffmann, 2014). Applied practice suggests that technology use among individuals with disabilities has increased and more research is needed to show the reinforcing possibilities of such stimuli. It is necessary to evaluate preference for technological stimuli and then demonstrate their effects on responding when used as reinforcers.

As shown in the above literature review, preference assessments are of crucial importance in determining potent reinforcers for children with disabilities. Teachers need to be aware that as technology continues to advance at a rapid pace, our society is becoming increasingly digital (Angst & Malinowski, 2010). Teachers should consider the prevalence of iPad usage when incorporating reinforcement into a student's schedule.

Children with autism are interested in technology, and in applied practice, they often request such devices (i.e., iPads). Since there is a wide variety of apps (i.e., interactive games involving auditory/visual stimuli) available, it seems logical we need to identify which apps would be most motivating for students. Given the success of stimulus preference assessments for determining potentially reinforcing stimuli, we seek to use this technology to identify potentially reinforcing apps for children with autism.

Purpose and Research Questions

Therefore, the purpose of this study is to investigate whether a technology-based stimulus preference assessment can be used to create a preference hierarchy of iPad apps for preschool-aged children with autism and then to evaluate the effects on academic behavior of delivering access to iPad apps that are identified as high- or low-preference by the assessment contingent on correct responding. This study will follow a similar structure of that used in the Horrocks and Higbee (2008) article to address the following research questions:

1. Can SPA procedures be used to rank preference of iPad apps for three preschool-aged children with autism as measured by a technology-based paired-stimulus preference assessment?

2. What effects do high- and low-preferred iPad apps, as measured by a reinforcer assessment, have on the academic behavior of three preschool-aged children with autism?

CHAPTER III

METHOD

Participants and Preexperimental Observations

Participants included three preschoolers with autism in a university-based preschool setting: Harry, Kolby, and Roger. Harry and Roger were 3 years old, and Kolby was 4 years old. None of the participants had auditory or visual impairments. All participants had a prior history with an iPad or similar technological device with audio/visual stimuli. This information was based on caregiver report (see Appendix A) and observed interactions when presented with an iPad (i.e., touched applications to make a selection). Harry's parents reported that he typically used an iPad to access music, movies, interactive books, and basic alphabet games. Kolby's parents said that when given an iPad, Kolby would usually flip through pictures or watch movies. Roger's parents mentioned that he would typically play games, draw, or watch cartoons on his tablet. For the duration of the study, iPad access was restricted during school hours; participants only had access during research sessions. However, we did not ask parents to restrict it at home, nor did we measure the length of time each participant had access at home.

Setting and Materials

The research sessions were conducted in a research room adjacent to the participants' classroom. This room was about 2.5 m by 3 m and contained tables, chairs, filing cabinets, and bookcases. The preference assessments were conducted using an iPad with programmed apps. The subsequent reinforcer assessments also included the same iPad to deliver the selected apps contingent on correct academic responding. Items used in the reinforcer assessment included beads and string for Kolby and Roger, and a pegboard and pegs for Harry. Tangible items that were present during the reinforcer assessment were a book for Harry, a Bob the Builder figure for Kolby, and a glitter-stick for Roger. MotivAiders® and timers were used to measure the session times, and all sessions were recorded with a video camera.

Preference Assessment

Dependent Variables and Response Measurement

The dependent variable for the preference assessment was the selection of preferred apps. The selection response was defined as activating the app by touching its corresponding icon on the iPad. I calculated the percentage selection score for each app by dividing the number of times it was selected by the number of times it was available during the SPA and multiplying it by 100 (to produce a percentage). I graphed the percentage chosen for each stimuli used in the preference assessment.

Procedures

The purpose of the preference assessment was to rank five iPad apps in order of most- to least-preferred. The five apps for each participant were individually selected based on the caregiver/teacher report and observed interactions with the participants. Each app used in the study was free, and the participants could navigate each one independently. Prior to the SPA on the iPad, a brief preassessment (see Appendix B) was conducted to ensure that each participant could accurately discriminate between the five various apps used. Following the preassessment, I conducted a paired-stimulus preference assessment comparable to the procedures used by Fisher et al. (1992). Before beginning the SPA, participants were allowed to access each app for 30 s (i.e., preexposure). During the SPA, all apps were paired together twice, in a counterbalanced fashion, to control for potential sequence effects or side preferences (see Appendix C). Therefore, a total of 20 preference trials were conducted with each participant. The iPad displayed two available app icons and was placed approximately 0.2 m in front of the participant with the instruction, “Pick one.” Each participant was allowed to select one app by touching the corresponding icon to open the application. Following the selection response, the participant was given access to the selected app for 30 s. At the end of the 30 s, I said, “My turn,” (modified for Roger based on his responding—see Results section for more detail), closed out of the app, and removed the iPad. Then I rearranged the apps by dragging the icons off the screen, so that the next two available selections were shown on screen. This process continued until each participant completed all preference trials.

Reinforcer Assessment

Dependent Variables and Response Measurement

The dependent variables for the reinforcer assessment were each participant’s responding when the high-preferred (high-p) and low-preferred (low-p) apps were used as reinforcers. I expressed the participants’ responding as the total number of responses for the progressive ratio schedule sessions and response rate (i.e., responses per min) for the fixed ratio sessions. Target responses for the reinforcer assessment were identified based on each participant’s programming (i.e., determined individually for each participant) that consisted of discrete, observable, measurable responses that were free-operant in nature. Each participant had demonstrated the ability to complete his target task but at low-rates in the classroom. The target responses varied for each participant.

I selected stringing beads as the target responses for Kolby and Roger. A bucket of beads was presented with one string. The task was operationally defined as one bead on the string with string visible on both sides of the bead. Each bead was considered a separate response. Attempts to remove and re-string the same bead were physically blocked. I selected putting pegs in a foam board as the target response for Harry. The response requirement was that each peg must be completely in the board. A bucket of pegs and the foam board were the materials available to Harry during the reinforcer assessment sessions.

Experimental Design

I conducted baseline sessions with each participant to determine general levels of responding in the absence of programmed consequences and to determine initial reinforcement schedules. After initial baselines sessions, I used an alternating treatment (multi-element) design to analyze the reinforcing effectiveness of high- and low-preferred apps in comparison to baseline (Cooper et al. 2007). I chose this design because it allows comparison across all three conditions (i.e., baseline, low-preferred, and high-preferred), which serve as the independent variables. I also embedded the alternating treatment design within a nonconcurrent multiple baseline design to control for the potential occurrence that participants found all apps reinforcing.

Procedures

I conducted a reinforcer assessment to analyze the reinforcing effectiveness of the stimuli assessed in the paired-stimulus preference assessment. I used the items ranked first (high-preferred) and last (low-preferred) in the SPA for each participant. Each of the two sessions (i.e., high-preferred and low-preferred) were conducted daily in a randomized fashion (i.e., using the website random.org), with at least five min in between each session. Following the baseline sessions, I used a Progressive Ratio (PR) schedule and then a Fixed Ratio (FR) schedule to see how different schedule requirements would affect the participants' responding (Cooper et al., 2007). As previous pilot testing with other participants had shown undifferentiated results with the FR schedule, we began with a PR schedule to see if rapidly increasing the response requirement would produce differentiated responding. During the PR schedule, the response requirements for reinforcement were systematically increased throughout each session (see Appendix D). Examples of PR schedules that I used include +1 additive PR schedule (i.e., 1 response → reinforcement, 2 responses → reinforcement, 3 responses → reinforcement, and so on) and additive +2 PR schedule (i.e., 1 response → reinforcement, 3 responses → reinforcement, 5 responses → reinforcement, and so on). Because of lack of consistent results (see Results section), I switched to an FR schedule of reinforcement. During the FR sessions, the reinforcement was consistently delivered after a specific number of responses during each session (see Appendix E).

Tangible SPA. Prior to starting the reinforcer assessment, I conducted a paired-stimulus preference assessment with tangible items (Fisher et al., 1992) with each participant. I included items that were reported to be preferred but were seldom chosen or consistently chosen last in a multiple stimulus without replacement (MSWO) SPA that the participants' teachers conducted daily. During the tangible SPA, participants were given 15 s with each selected item. After ranking the 5-items, I selected the lowest preferred tangible item to be present during all of the reinforcer assessment sessions. The purpose of this item for was for each participant to have an alternative task available so that they did not simply engage in the response (i.e., stringing beads for Kolby and Roger, putting pegs in the board for Harry) because there was nothing else to do (Daly et al., 2009).

Baseline. At the beginning of each baseline session, I presented the vocal instruction to engage in the task (i.e., "You can (do task), play with the (tangible item), or do nothing."). No programmed consequences were provided, and each session lasted 5 min, or sessions were terminated after participants didn't engage in the target response for 1 min.

High-p and low-p sessions. Each of the high-p and low-p sessions began with the instruction, "This session you're working for (app)," while the iPad displayed the single available icon on the screen. I then stated the same instruction from baseline (i.e., "You can (do task), play with the (tangible item), or do nothing."), but I added the phrase "Sometimes when you (do task), you get to play (app)." Next, I included a presession exposure to the reinforcement contingency. I said "Like this," while physically prompting the participant to engage in the target response to meet the first schedule requirement. Following the prompted response, the participant was given 30 s with the corresponding app for the session. After the preexposure, as soon as the materials were presented, the session-time began. Each time the participant met the schedule requirement, I removed the task materials and provided the participant with the 30 s of the iPad app designated for that session. I stopped the session-clock while the participant had access to the iPad for reinforcement breaks. Therefore, there was 5 min of "in-session" time when the participant could respond to the task. Because of this, the total session length varied depending on how many times each participant accessed reinforcement. I used the same termination criteria from baseline (i.e., not engaging in the target response for 1 min), and I continued to run sessions until stable trends were evident for each condition.

Interobserver Agreement

The student researcher served as the primary data collector. A second data collector simultaneously collected data during 100% of the SPA sessions and during 35% of the reinforcer assessments (i.e., at least 30% of each condition) for the purpose of interobserver agreement (IOA). IOA was calculated by dividing the smaller of the counts by the larger count and then multiplying that number by 100% to yield a percentage score. I trained the data collectors prior to conducting sessions to ensure accurate data collection. Each data collector scored at least 90% during training before they could independently code the reinforcer assessment videos. The average agreement was 98.6% (range from 92.2% to 100%) for Harry, 98.4% (range from 91.7% to 100%) for Kolby, and 99.6% (range from 93.9% to 100%) for Roger.

Treatment Integrity

Treatment integrity was evaluated by an independent observer who recorded the occurrence of critical components in the preference and reinforcer assessments (see

Appendix F). The components for the SPA included (a) correct instruction provided during the session (i.e., “pick one” and “my turn”), (b) correct materials present during the session, (c) preexposure included access to each item, (d) items presented in the correct sequence and position, and (e) participant given 30 s with the chosen app. The same measures were used with the tangible SPA, but the participants had 15 s access with each item. The included components for the reinforcer assessment were (a) correct instruction provided at the beginning of the session, (b) correct materials present during session, (c) preexposure included correct prompt to engage in response (no prompt during baseline), (d) iPad app given for 25 – 35 s after schedule requirement met (no consequences during baseline), and (e) session terminated after 1 min of not responding to task or 5 min total of in-session time.

Observational data on treatment integrity was collected on 100% of the SPA sessions and 35% of the reinforcer assessment sessions. For each treatment integrity session, the number of correct implementation steps was divided by the total steps and multiplied by 100% to generate a percentage score. The agreement was 100% for each participant.

CHAPTER IV

RESULTS

Tangible SPA

The tangible SPA ranked each participant's tangible items from highest-preferred to lowest-preferred. The least selected item was chosen to be present during each participant's reinforcer assessment. Harry's lowest preferred item was a book; Kolby's was a Bob the Builder figure; and Roger's was a glitter-stick. These items were included in the session instruction "…you can play with the (item)…"

iPad SPA

The SPA conducted on the iPad yielded a preference hierarchy for each participant with a high-preference (i.e., highest percentage chosen) and a low-preference iPad app (i.e., lowest percentage chosen). Figure 1 depicts the results of each participant's iPad SPA. Harry's highest-preferred app was Food Flashcards, while his lowest-preferred was Alphabet Phonics. Because Alphabet Phonics and Thomas Activities were both chosen the least and the same number of times, a brief pair-wise SPA was conducted directly comparing the two apps. Since Thomas Activities was chosen more than Alphabet Phonics, Alphabet Phonics was used as the app in Harry's low-p sessions. Angry Birds was Kolby's highest-preferred app, and Food Flashcards was his lowest-preferred. Although he did not select it at all during the SPA, it was still selected as the lowest-preferred because all of the apps used in the assessment were considered preferred (e.g., based on teacher/caregiver report). A slight modification was made to Roger's SPA procedures. Since the phrase "my turn" while removing the iPad had frequently set the occasion for engaging in problem behavior, the phrase was eliminated during the SPA and all subsequent sessions. I simply closed out of the app and removed the iPad without proving any instruction. Roger's highest-preferred app was Thomas Activities, and his lowest-preferred app was Car Rush. When Car Rush was directly compared to Mad Frogger, he chose Mad Frogger more frequently, thus Car Rush was used as Roger's low-p app. Each of the participant's highest-preferred apps were used in their high-p sessions during the reinforcer assessment, while the lowest-preferred apps were used in the low-p sessions.

Reinforcer Assessment

Baseline

Harry did not engage in his target response (i.e., put pegs in the board) at all during baseline. Each session he dumped out the bucket of pegs, so all five sessions were terminated after 1 min of no responding. Kolby's responding during baseline was variable at first, then decreased to zero for two sessions. Responding spiked back up when he strung several beads during one session, but then dramatically decreased to between zero and one response the next few sessions. During his last three sessions of baseline, he did not string any beads at all, thus all of these sessions were terminated after 1 min of in-session time. Roger's responding during baseline was more variable than the other participants. He responded between one and 20 times across the baseline sessions, while 62% of sessions were terminated. His responding stabilized the last five sessions, where he engaged in the response an average of 7.2 times per session.

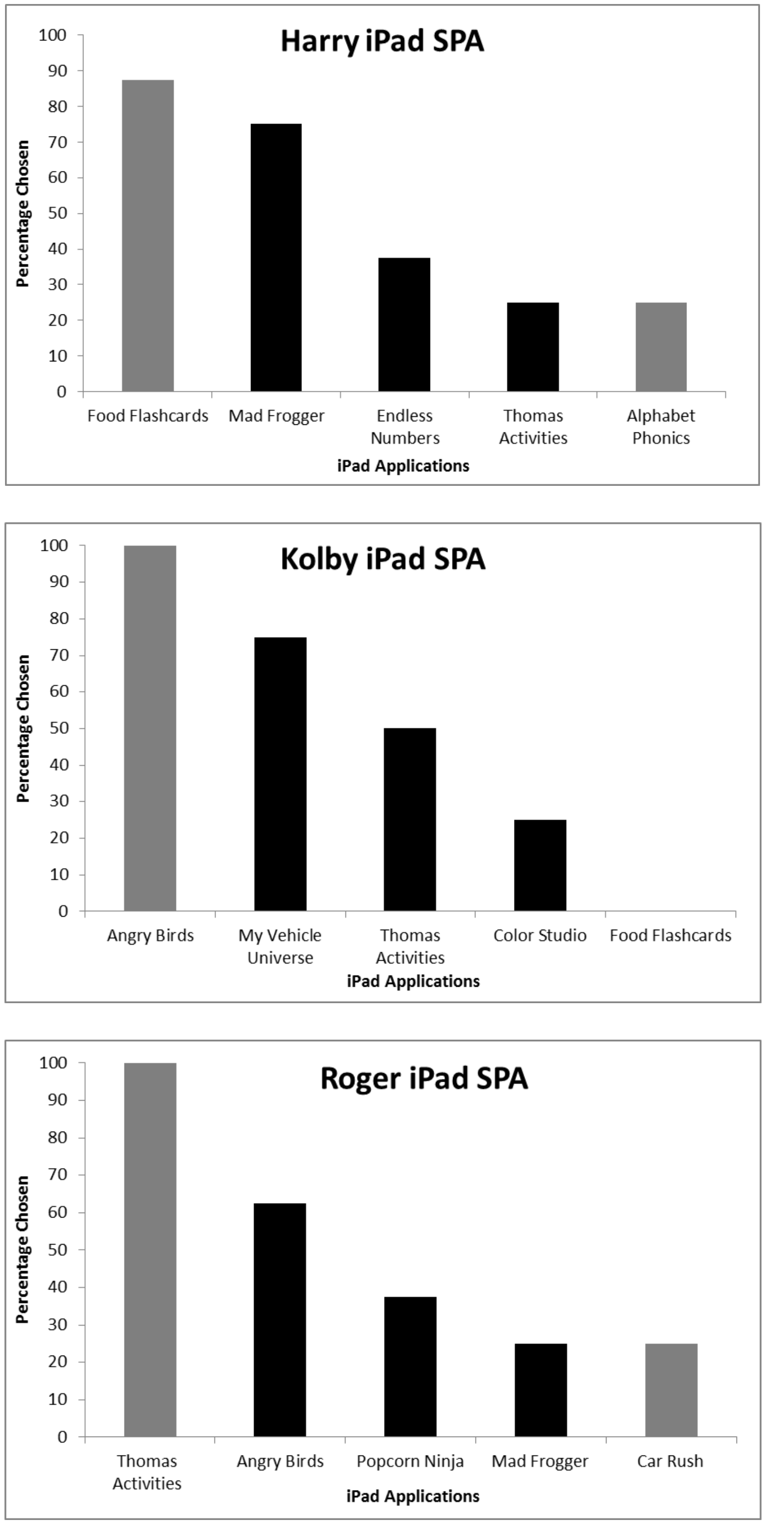

Figure 1. Results for the iPad SPA. The highest- and lowest-preferred apps are shaded gray. The highest-preferred app was used in the high-p sessions, while the lowest-preferred app was the reinforcement provided in the low-p sessions.

Progressive Ratio (PR) Schedule

The data for the PR reinforcer assessment are shown in Figure 2. The top panel shows how Harry responded in the PR schedule of reinforcement. Because Harry did not respond during baseline, I used a +1 additive PR schedule. During the first two series of low-p and high-p sessions, Harry still did not put any pegs in the board. Due to his lack of responding, I repeated the preexposure trials (i.e., prompted him to engage in the task) five times before starting his sessions (marked with an asterisk on the graph in Figure 2) for the next two series. The purpose of this repeated-exposure prompt was to frequently expose Harry to the reinforcement contingency of putting pegs in the board. As shown in Figure 2, Harry's responding slightly increased during the sessions with the repeated-exposure prompts, but it was inconsistent across sessions. He only met the first schedule requirement during two sessions, and the first two schedule requirements on the last repeated-exposure prompted session. I then returned to only prompting once in the preexposure, and he only met the first schedule requirement in all but one session. During one of the high-p sessions, he actually met the fourth schedule requirement (i.e., put 11 pegs in the board), but his responding decreased immediately after that session to only meeting the first schedule requirement (i.e., two responses). Due to this pattern of responding, I included a PR-exposure prompt to meet the first two PR schedule requirements during the presession exposure (i.e., prompted 1 response → reinforcement, prompted 2 responses → reinforcement, then began session) starting in session 20 (marked by an arrow on the graph in Figure 2). I continued this PR-exposure prompt in the for three series, but his responding remained constant as he continued to only meet the first schedule requirement (i.e., 1 response → reinforcement, 1 response → session terminated after 1 min). All of Harry's sessions during the PR schedule were terminated because he stopped responding to the target task.

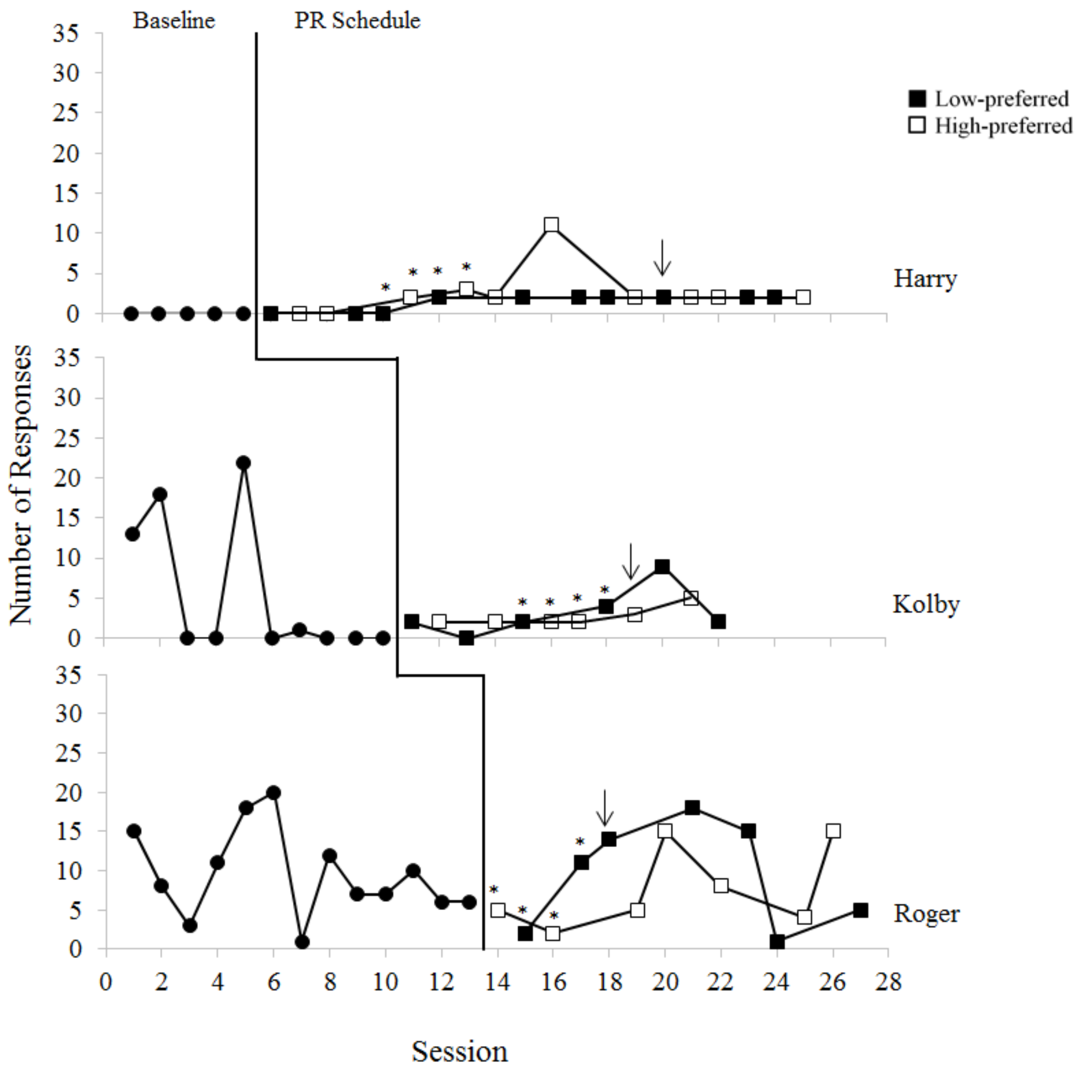

Figure 2. Results for the reinforcer assessment, with the progressive ratio (PR) schedule. The sessions marked with an asterisk included five repeated trials during the presession exposure (i.e., repeated-exposure prompt). The session marked with the arrow and all subsequent sessions included a prompt to meet the first two PR schedule requirements in the presession exposure (i.e., PR-exposure prompt).

The middle panel in Figure 2 shows Kolby's responding during the PR schedule. Due to Kolby's low rates of responding during baseline, I used a +1 additive PR schedule with him as well. Kolby had a similar pattern of responding, where he only met the first schedule requirement during the first two series, and one session he actually did not respond at all. Because of his low levels of responding, I repeated the preexposure trials five times before starting his sessions (marked with an asterisk on the graph in Figure 2) for the next two series. His responding increased slightly, but was inconsistent across sessions. I then included the same PR-exposure prompt I used with Harry, where I prompted him to meet the first two PR schedule requirements in the presession exposure (marked with an arrow on the graph in Figure 2). His responding slightly increased in the high-p sessions. It also increased initially in the low-p session, where he met the third schedule requirement (i.e., nine responses), but following this session, his responding returned to the previous level of two responses. All of Kolby's sessions during the PR schedule were terminated as well because he stopped stringing beads.

Roger's data for the PR schedule are shown in the bottom panel of Figure 2. Because Roger consistently responded more than the other participants and at a higher level, I used an additive +2 PR schedule with him. I started with the repeated presession exposure contingency five times before beginning his sessions during the first two series. His responding actually decreased in the high-p sessions, where he met the second (i.e., five responses) then first (i.e., two responses) schedule requirements. His responding increased in the low-p sessions; meeting the first (i.e., 2 responses) and then third (i.e., 11 responses) schedule requirements. For the rest of the PR sessions, I used the PR-exposure prompt (marked with an arrow on the graph in Figure 2) and prompted him to meet the first two schedule requirements in the preexposure. In his low-p sessions, Roger's responding increased up to stringing 18 beads (i.e., meeting the fourth schedule requirement) but then decreased to only meeting the first (i.e., one bead) and second (i.e., five beads) schedule requirements. During the high-p sessions, his responding increased to meet the third schedule requirement (i.e., 15 responses) twice, but it was never consistent or a stable trend. Although he responded more than the other participants, it was still variable and inconsistent across all series. Fifty-seven percent of Roger's PR sessions were terminated because he stopped responding.

Fixed Ratio (FR) Schedule

Because the participants did not appear to come under the control of the PR schedule, I switched to a fixed ratio (FR) schedule of reinforcement to see if they would respond more to a consistent schedule requirement. The data for the FR reinforcer assessment are shown in Figure 3. The top panel in Figure 3 shows how Harry responded to the FR schedule of reinforcement. I started with an FR1 schedule, where each correct response was reinforced. Initially, clear separation was observed with high-p app producing higher rates of responding (i.e., about 7 responses per min) than the low-p app (i.e., about 4.5 responses per min), but then the data paths crossed. Responding during the low-p sessions increased, while responding during the high-p sessions decreased. This resulted in less separation between the two conditions. Because the data were variable for the next few series, I decided to increase the schedule requirement to FR2, where every two correct responses were reinforced. Harry only engaged in the task once each session, and then stopped responding, thus all FR2 sessions were terminated. Because of this, I returned to an FR1 schedule, where Harry's responding was variable for the first two series (i.e., low-p increased while high-p decreased). Responding with the low-p app stabilized for the last three sessions (i.e., about four responses per min). Harry's responding during the high-p sessions had a wider range (i.e., 6.5 – 9.8 responses per min), but his level of responding was consistently higher than with the low-p app for three consecutive sessions**.** Eighty-one percent of Harry's sessions were terminated (i.e., 77% of low-p sessions and 85% of high-p sessions) early because he stopped responding.

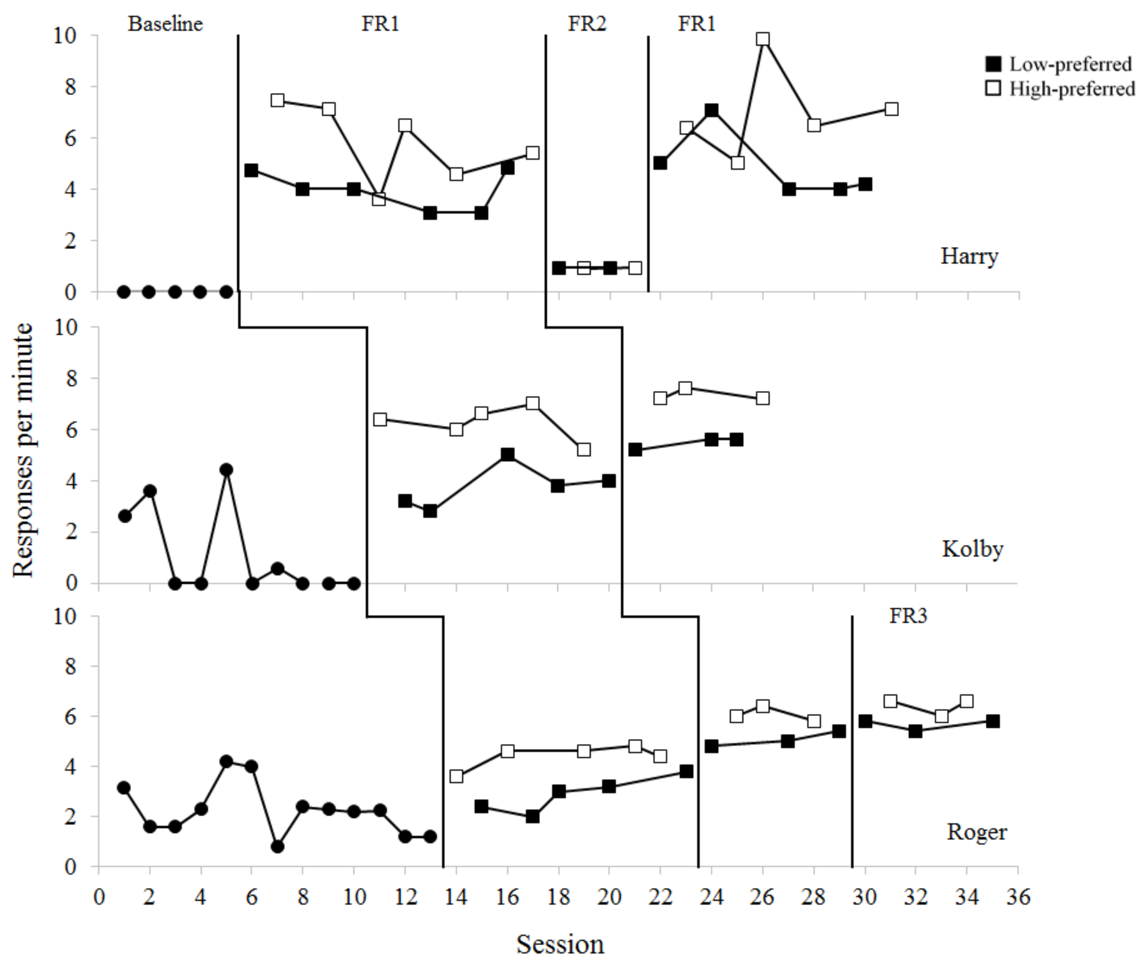

Figure 3. Results for the reinforcer assessment, with the fixed ratio (FR) schedule.

The data for the FR reinforcer assessment for Kolby are presented in the middle panel of Figure 3. I started with an FR1 schedule for Kolby as well. There was initially great separation between the low-p (i.e., three responses per min) and high-p (i.e., six responses per min) data paths. Although Kolby's responding during the high-p sessions was conssistently higher than the low-p sessions, the separation between the two conditions decreased over time. I increased his response requirement to an FR2 schedule to see if more separation would occur. I ran three series with Kolby in the FR2 condition, and his responding stabilized while he consistently responded quicker in the high-p sessions (i.e., 7.2 – 7.6 responses per min) when compared to the low-p sessions (i.e., 5.2 – 5.6 responses per min). Each of Kolby's FR sessions were five min in length, thus none of them were terminated early due to nonresponding.

The bottom panel in Figure 3 depicts how Roger responded in the FR schedules. Due to the inconsistency in Roger's responding, I again started with an FR1 schedule. Like Kolby, Roger engaged in the response more in all of the high-p sessions, but the separation between his responding decreased over time (i.e., low-p increased from stringing two to almost four beads per min, while the high-p sessions only slightly increased from three to four beads per min). I increased the schedule to an FR2 to see how that would affect his rate of responding. The separation initially increased, but then decreased again (i.e., six responses per min during high-p and five responses per min during low-p sessions). I changed the response requirement to an FR3 schedule, and his responding stabilized in each of the high-p and low-p sessions (i.e., same separation ratio throughout three series). He consistently responded more in the high-p sessions when compared to the low-p sessions. Like Kolby, none of Roger's FR sessions were terminated early due to nonresponding, and were each five min in length.

For all participants, separation occurred in the data paths, with the high-p apps typically producing higher response rates than low-p apps. The low-p apps also produced consistently higher rates of responding than baseline, which indicated that the low-p apps still function as reinforcers, although not as effectively as the high-p apps. I concluded running sessions with each participant when there were three data points in each condition that showed consistent separation between low-p and high-p series.

CHAPTER V

DISCUSSION

Given the results, this preliminary study suggests that a paired-stimulus preference assessment can be used to rank preference of iPad apps, and therefore identify which apps are high-preferred and low-preferred. The results from the reinforcer assessment illustrate that high-p apps can be more effective as reinforcers because they increased each participants' responding to a higher level than with the low-p app. The low-p apps still generally resulted in increased levels of responding as compared to baseline, but they were not as effective as the high-p app. The results during the FR schedule of reinforcement evaluation suggest that iPad apps involving auditory/visual stimuli can function as effective reinforcers for children with autism. They also show that a technology-based paired-stimulus preference assessment can accurately predict the reinforcing potency of iPad apps.

Using iPad apps as reinforcers in applied settings can be a valuable tool to increase rates of responding in academic tasks. Because satiation effects could cause these rates to drop if the same app is repeatedly used to reinforce every response, it is important to evaluate each individual's preference hierarchy. This way, therapists can use the moderately-preferred apps for general tasks, while saving high-preferred apps to reinforce new or more difficult tasks. Lower-ranked apps can then be used for easier skills that do not require as much reinforcement. It is important to use the corresponding preference rank so that reinforcement can be as efficient as possible.

One limitation of this study was that participants potentially satiated on the iPad, and it possibly lost its reinforcing effectiveness within the session. For example, Harry was observed to engage in the response quickly for 1 – 2 min of the session, and then slow down to eventually stop responding, thus resulting in 81% of his sessions being terminated. Future research should be conducted to investigate the satiating effects. Possible options to limit satiation of apps could include shortening the duration of access or pairing with a token system to control for less frequent access to the apps.

Because we evaluated a wide variety of different apps, it is possible that different types of apps could be more reinforcing. We did not restrict the apps to a particular category, but future researchers could do so by focusing the type of apps to puzzles, games, or academic apps. Another possible limitation of this study is that high-p iPad apps were not compared to other types of stimuli. Therefore, there may be more effective stimuli which could increase responding. Researchers could address this issue by incorporating other high-p stimuli in these assessments and comparing the results.

Another item to consider is that while separation between the high-p and low-p sessions occurred in all participants, the difference in response rates varied and was not consistent. Future research should look at this to determine if this pattern of responding was due to similar preference levels between the apps or if the iPad itself served as a reinforcer. Also, the fact that the participants experienced two different reinforcer assessments is a potential limitation to this study. Because each of the participants were exposed to the PR schedule of reinforcement first, this probably affected their responding to the FR schedule. Future research could address this limitation by examining these effects and expanding the literature using PR schedules for children with autism.

Future research could also examine the use of iPad apps as reinforcers with other populations, such as different age groups or disabilities. Additionally, researchers could look at comparing different SPA procedures (e.g., allowing access to reinforcers while conducting the SPA). Finally, investigators could examine the effects of the reinforcer duration (e.g., 30 s vs. 15 s) on the rate of responding.

In conclusion, the data suggest that iPad apps can be used to increase rates of responding and that SPA methods can accurately predict the reinforcing potency of these apps. Because this a preliminary study, these findings need to be validated by further research and replication. Future research should continue to investigate methods for using the iPad as a more effective reinforcer.

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APPENDICES

Appendix A

Caregiver Report

Caregiver Report

Student: _________________________ Parent(s): _________________________________

Please complete the questionnaire about your child to the best of your ability.

- Has your child ever used an iPad (or similar electronic device)?

- Can he/she independently select apps?

- What does your child usually do on the iPad?
  - e.g., play games, draw, watch movies, etc...

- List all of the apps your child interacts with in order of preference (#1 = most preferred):
  - i.e., apps defined as interactive games involving auditory/visual stimuli

  1.
  2.
  3.
  4.
  5.
  6.
  7.
  8.
  9.
  10.

- Are there any apps that your child doesn't like?

- Is there anything else we should know about how your child uses an iPad?

Appendix B

Pre-Assessment Data Sheet

Pre-Assessment Data Sheet

Pre-Assessment:

1. Ask child to touch an iPad icon
    - only icon on the screen – in five different locations *(see 5 various screen shots below)*

a.

b.

c.

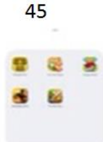
d.

e.

2. Ask child to touch each of the specific apps when in array of 4 other apps being used in SPA
    - 5 trials for each app → Criteria: 100% of trials *(see 5 various screen shots below)*

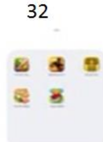
a.

123
45



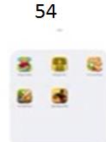
b.

541
32



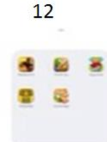
c.

312
54



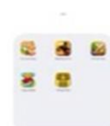
d.

453
12



e.

245
31



Appendix C

SPA Data Sheet

SPA Data Sheet

Stimulus items:	% Calculation	Overall rank
1.	1. ___ / ___ X 100 = ___%	
2.	2. ___ / ___ X 100 = ___%	
3.	3. ___ / ___ X 100 = ___%	
4.	4. ___ / ___ X 100 = ___%	
5.	5. ___ / ___ X 100 = ___%	

Record item with corresponding item number:		Circle item selected:					
1.	2.	1	2	3	4	5	N
5.	4.	1	2	3	4	5	N
3.	1.	1	2	3	4	5	N
2.	4.	1	2	3	4	5	N
4.	5.	1	2	3	4	5	N
3.	2.	1	2	3	4	5	N
1.	5.	1	2	3	4	5	N
3.	4.	1	2	3	4	5	N
5.	1.	1	2	3	4	5	N
1.	4.	1	2	3	4	5	N
2.	3.	1	2	3	4	5	N
3.	5.	1	2	3	4	5	N
4.	2.	1	2	3	4	5	N
5.	2.	1	2	3	4	5	N
4.	3.	1	2	3	4	5	N
2.	5.	1	2	3	4	5	N
1.	3.	1	2	3	4	5	N
4.	1.	1	2	3	4	5	N
5.	3.	1	2	3	4	5	N
2.	1.	1	2	3	4	5	N
	Times selected:						

Appendix D

PR Schedule Data Sheet

PR Schedule Data Sheet

Participant:

Date:

Session:

Condition:

Time:

+1 PR Schedule	Response Requirement
1	1
2	1 - 2
3	1 - 2 - 3
4	1 - 2 - 3 - 4
5	1 - 2 - 3 - 4 - 5
6	1 - 2 - 3 - 4 - 5 - 6

Participant:

Date:

Session:

Condition:

Time:

+2 PR Schedule	Response Requirement
1	1
3	1 - 2 - 3
5	1 - 2 - 3 - 4 - 5
7	1 - 2 - 3 - 4 - 5 - 6 - 7
9	1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9
11	1 - 2 - 3 - 4 - 5 - 6 - 7 - 8 - 9 - 10 - 11

Appendix E

FR Schedule Data Sheet

FR Schedule Data Sheet

*Participant: *Date:

Session/Condition: ___________________ FR ________

Total Session Length: ___________

Total Number of Responses: __________

Number of Reinforcers Delivered: ____________________________= ______ total

Notes:

Appendix F

Treatment Integrity Data Sheets

Treatment Integrity Data Sheets

TREATMENT INTEGRITY CHECK: iPad SPA	***Yes/No?***
1. Correct instruction provided during session (“pick one”/“my turn”	
2. Correct materials (apps) present during session	
3. Pre-exposure included correct access to each app	
4. Apps presented in correct sequence & position	
5. Participants given 30 s with each item after selection	

TREATMENT INTEGRITY CHECK: Tangible SPA	***Yes/No?***
1. Correct instruction provided during session (“pick one”/“my turn”	
2. Correct materials (items) present during session	
3. Pre-exposure included correct access to each item	
4. Items presented in correct sequence & position	
5. Participants given 15 s with each item after selection	

TREATMENT INTEGRITY CHECK: Baseline Sessions	***Yes/No?***
1. Correct instruction provided at beginning of session	
2. Correct materials present during session	
3. No pre-session exposure prompted during baseline	
4. No programmed consequences during baseline	
5. Session terminated after 1-minute of not responding to task or 5-minute total of in-session time	

TREATMENT INTEGRITY CHECK: High-P/Low-P Sessions	***Yes/No?***
1. Correct instruction provided at beginning of session	
2. Correct materials present during session	
3. Pre-exposure included correct prompt to engage in response	
4. iPad app given (for 25-35 sec) after schedule requirement met	
5. Session terminated after 1-minute of not responding to task or 5-minute total of in-session time	