Implementing the Speakall! iPad App and Intervention Protocol with a Child with Autism: A Pilot Study

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ABSTRACT

The ability to communicate is essential for children with developing language systems, and ultimately to being successful academically and eventually vocationally. In a world where communication is vital, children with autism spectrum disorder (ASD) are at a disadvantage and require additional options to express themselves; augmentative and alternative communication (AAC) technologies have presented promising options for helping these children communicate. One technology option that has proven to be of particular interest to families of children with ASD involves the use AAC iPad apps. Research has been conducted in AAC, ASD, and music, but there is limited research to date, which integrates these three areas.

This investigation was designed to address the lack of evidence-based AAC app interventions specifically designed to meet the communication needs of children with ASD. This pilot study will serve to further the evidence available to date indicating that SpeakAll! can be effectively implementing in 1:1 interventions using food reinforcers. This intervention adapts the SpeakAll! intervention protocol in a classroom setting with natural music activities to aid in functional communication.
DEDICATION

For Tyler, thank you for your love and encouragement. Without you none of this would have been possible.
ACKNOWLEDGEMENTS

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CHAPTER I: LITERATURE REVIEW

The ability to communicate is essential for children to learn language, and ultimately to be successful academically and in future careers. In a world where multi-modal communication is vital, children with autism spectrum disorder (ASD) need more options to be able to express their wants, needs, thoughts, and emotions. Research has been conducted on augmentative and alternative communication (AAC) and music activities for children with ASD, but there is limited research investigating the use of AAC by children with ASD during music activities. Research conducted to date in these individual areas has yielded promising outcomes for children with ASD, so implementing an AAC intervention in a music context appears to hold particular promise.

Autism Spectrum Disorders

Autism spectrum disorder (ASD) is a developmental disability that affects an individual’s social, behavioral, and communicative abilities and is different for each individual, ranging from mild to severe (Centers for Disease Control and Prevention, 2014). Classifications of the severity of autism are based on multiple factors such as overall language impairment, social communication impairment, restricted and repetitive behaviors, aggressive behaviors, age, and cognitive ability (Reszka, Boyd, McBee, Hume, & Odom, 2014). ASD is now the second most frequently occurring developmental disability in the United States, and the overall prevalence rate in the United States is 1 in 68 children (Centers for Disease Control and Prevention, 2014). The CDC reports ASD is five times more common in boys (1 in 54), than girls (1 in 252). ASD manifests before the age of three and lasts throughout a person’s life, but symptoms may
improve over time (Centers for Disease Control and Prevention, 2014). The diagnostic criteria for ASD, as specified by the American Psychiatric Association (2013), state that individuals with ASD have persistent deficits in language, restricted and repetitive behavior patterns, and social communication and interaction in multiple contexts. For example, a nonverbal child with ASD who does not spontaneously communicate or initiate interaction may need verbal or physical prompting to do so. These individuals may also have poor eye contact, body language, and gestures that magnify their inability to be efficient communicators.

According to Autism Speaks (2014), approximately 25 percent of individuals with ASD are nonverbal and lack functional communication skills. This lack of functional communication can prohibit these individuals from communicating their own wants/needs with their teachers, peers, family, or friends and therefore delay their development academically and socially. Augmentative and alternative communication (AAC) was created to present varying options to facilitate communication for individuals who are unable to independently communicate using natural speech alone.

**Augmentative and Alternative Communication Devices**

Augmentative and alternative communication (AAC) is a term used to describe a group of communication approaches used to assist with communication for those who are unable to communicate efficiently and independently via natural speech. AAC devices offer options to replace or supplement non-functional speech through the use of pictures or symbols (American Speech-Language-Hearing Association, 2015). There are numerous AAC devices that are extremely beneficial in aiding the communication of children who are nonverbal. AAC
interventions for children with development disabilities are not typically designed to replace natural speech; rather, they are designed to provide alternative communication modes to facilitate ongoing language development while natural speech skills continue to develop. For those who never develop speech, AAC devices can assist them in communicating throughout their lifetime.

There are aided and unaided forms of AAC. Unaided forms of AAC include signs, gestures, sign language, or other body language used as a form of communication. Aided forms require more than just the child’s body to communicate and there are both low-tech and high-tech forms. Low-tech forms of aided AAC include picture boards such as the Picture Exchange Communication System (PECS), which allows the child to point to or exchange photo or line drawing symbols to communicate. PECS is a prominent intervention for teaching functional communication skills, which has been particularly popular for implementation with children with ASD (Boesch, Wendt, Subramanian, & Hsu, 2013; Lancioni et al., 2007). The PECS protocol contains six phases including: (1) how to communicate by exchanging a picture symbol to request, (2) learned persistence and generalization, (3) discrimination between pictures, (4) sentence structuring to support requesting, and (5) answering questions when asked “What do you want?” and 6) responding to questions requiring the child to learn each behavior before progressing to the next. High-tech forms of aided AAC include speech generating devices (SGDs) such as iPads with specialized communication apps and other dedicated SGDs manufactured by such companies as Dynavox Technologies, Prentke Romich Company, and Saltillo. High-tech SGDs are engaging for individuals with ASD because of their visual appeal,
and therefore may be effective in supporting functional communication skills (Pennington, 2010). With the use of SGDs, individuals with disabilities can increase functional communication through words and sentences (Schepis, Reid, Behrman, & Sutton, 1998). High-tech SGDs have been noted to increase quality of life for both children and adolescents (Hamm & Mirenda, 2006).

One specific type of SGD that has enjoyed increasing popularity with the ASD population is AAC iPad apps. iPads exploded onto the market and have exponentially grown in popularity over the past decade. Further, multiple studies, as evaluated in a systematic review (Kagohara et al., 2013) have confirmed the success of using iPad’s in implementing interventions in individuals with developmental disabilities. Another observational study concluded that iPads have been used appropriately in the schools to support communication in individuals with ASD (King et al., 2014). The iPad has been discussed to have many benefits to contributing to its popularity including: cost effectiveness in comparison to other dedicated SGDs, easy accessibility, ease of operation, small and lightweight design, social acceptance, and flexibility in downloading multiple academic applications to fit the specific needs of individual children (Mcnaughton & Light, 2013; Dolic, Pibernik, & Bota, 2012).

Contrary to the abundance of positive feedback about AAC devices, some suggest they prevent the individual from producing speech verbally. To continue to challenge this allegation, an application for the iPad, SpeakAll! was designed to help nonverbal individuals with ASD with their speech and language skills.
**SpeakAll! Communication Application**

One specific app, which was designed specifically for implementation with children with ASD, is *SpeakAll!* (SPEAK MODalities, 2014). *SpeakAll!* was created to help individuals who are non-verbal learn to construct simple sentences using an early symbol lexicon and eventually produce speech. *SpeakAll!* was designed based on the PECS protocol and to facilitate transition from a low-tech PECS approach to a high-tech SGD.

A study conducted by the SPEAK Modalities development team at Purdue University provided support for the hypothesis that AAC can have facilitative effects on natural speech development and refuted the myth that AAC prevents speech (Wendt, 2014). A series of three experiments were conducted with four participants, each of whom had severe ASD according to the Childhood Autism Rating Scale (CARS) and the Autism Diagnostic Observation Schedule (ADOS). The participants had limited vocalizations and speech, but used a few gestures, excessive echolalia, or jargon. The research team reported results indicating that the *SpeakAll!* application and protocol were effective in facilitating functional communication. The most positive advances were found for a child with echolalia, because this child was able to request in spoken sentences after the iPad was faded out. The other participants varied in their production of speech, and the research team reported that augmented input might enhance both expressive and receptive communication development (SPEAK MODalities, 2014). Aided augmented input in this case is described as providing verbal input while selecting the corresponding symbol on an AAC device to teach symbol meaning while modeling language (Dada & Alant, 2009).
These results suggest *SpeakAll!* may be a promising intervention approach for enhancing communication abilities in children with ASD. Since iPad’s and iPad applications offer new and preferred method for supporting communication for children with ASD, additional research is needed to more fully explore potential outcomes. The addition of music implemented with iPad apps could be a potential new context to explore because of the popularity of these two approaches and motivation for children with ASD.

**Music and Autism**

AAC devices can significantly aid in the development of communication of a child with ASD. When paired with a music context, these communicative abilities could be enhanced and give these children a way to be heard. AAC devices make it possible for students who are nonverbal to have a speaking voice and participate in a variety of contexts, including music, by using synthesized speech (Humpal & Dimmick, 1995). Musical elements and activities have been discussed to be motivating and beneficial in increasing communicative attempts in children with ASD. In a systematic review by Hajjar & McCarthy (2014), they found that treatment approaches using musical elements resulted in considerable improvement across all 15 studies. More specifically, improvement from these studies consisted of an increase in the number of words produced by patients, naming, and repetition (Hajjar & McCarthy, 2014).

In addition, music has also been discovered to be preferred over verbal stimuli in intervention. Buday (1995) found that children with ASD learned more signs and symbols when paired with music and speech than with only speech. Overall, music activities provide a way for individuals to be able to freely express themselves in a positive and enjoyable way thus provide
more positive results in making communicative attempts. The enjoyment these children get from music could potentially result in more meaningful responses than would be received in a normal classroom or therapy context.

Because of the success of music in increasing communication attempts and speech of children with ASD, it could also be useful when combined with an AAC device. This would give nonverbal children with ASD opportunities to communicate by making a song choice or choosing an instrument to engage with. To date, there has been minimal research conducted on the implementation of AAC iPad applications specifically designed for children with ASD to increase communication, speech and/or language abilities in a music setting. The lack of research in the area of AAC devices used during music activities, paired with the successful findings of the impact of music elements on a child with ASD’s development, lends to the need for a study where these elements are combined.

Research Objectives

This investigation will serve to contribute information on the effectiveness of using the *SpeakAll!* iPad application and protocol to develop the communicative competence of children with ASD in a music education context. Specifically, this investigation will examine the effects of using the *SpeakAll!* app and an adapted intervention protocol in a classroom context with musical instrument activities and reinforcers on the aided communicative requests of a young child with ASD expressed via the *SpeakAll!* app. The adapted intervention protocol will involve Phase 1 and Phase 2 as published in the original *SpeakAll!* manual (Wendt, 2014). It will represent the first independent adaptation and evaluation of *SpeakAll!*.
CHAPTER II: METHODOLOGY

Research Design

This investigation was conducted as a pilot study, examining the use of *SpeakAll!* for a child with ASD in a music education context. Pilot studies are used to examine the feasibility of an approach that is intended for use in a future larger study (Leon, Davis, & Kraemer, 2011). An A-B case study design was employed. The independent variables were Phase 1 and Phase 2 of the *SpeakAll!* training protocol as adapted for a music education context. The dependent variable was the number of one-symbol requests made by the participant using the *SpeakAll!* app.

Participant Selection

One school-aged child enrolled in a charter school for children with ASD in the Central Florida area was selected to participate in the study. The participant met the following additional subject selection criteria: (a) primary diagnosis of ASD as indicated by school records and parent/educator report, (b) identified by the classroom teacher to have natural speech insufficient to meet all communication needs in the classroom context and therefore be in need of AAC for functional communication, (c) exhibited some experience using low-tech AAC during at least the current school year based on teacher report, (d) exhibited successful selecting and dragging skills as indicated within 10 trials of touch and dragging of icons on an iPad puzzle application, and (e) receptive language ability at least at an 18 month old developmental level (i.e., at or above the 25th percentile) on the MacArthur-Bates Development Inventories (CDI) parent-informant assessment (Fenson, Marchman, Thal, Dale, Reznick, & Bates, 2007). A case history form was
sent home with the child’s parent to collect data regarding family demographic information and the child’s diagnostic history including types of therapy received, challenging behaviors, personality traits, communication skills, preferred items, current or previous communication devices, and fine and gross motor skills.

**Participant Demographics**

The participant was a 4-year-old Mexican American male with a primary diagnosis of autism (Pseudonym = Antonio). Antonio was enrolled in a Preschool program at a charter school for children with ASD. The student/teacher ratio in his classroom was 1:4. Antonio’s vision and hearing were reported by his parent and teacher to be within normal limits. At school, Antonio received speech therapy daily, occupational therapy weekly, and music therapy weekly in his classroom. At the time of enrollment in the study, Antonio used a communication book to make requests for food choices, toys, and music during music therapy and in the classroom. He also used the communication book to identify common objects during speech therapy. According to his speech therapist, he could accurately select items out of a field of 12 or more and could easily follow one-step directions. Antonio demonstrated the ability to recognize letters and sight words, but did not use traditional orthography for functional communication purposes. During classroom activities, Antonio’s attention span was reported to be in the 5-10 minute range for activities of interest; Antonio was not reported to have difficulty with transitioning between activities or environments. Antonio was not observed to make spontaneous attempts to interact with others or to make eye contact without visual and verbal prompting. Antonio required hand over hand prompting to complete writing activities in class as a result of his limited attention
span. Antonio was reported by his teachers and observed to be ‘laid back’ and to exhibit minimal challenging behaviors. At the time of participation in this investigation, Antonio was receiving private behavioral therapy on a weekly basis. According to the MacArthur Bates CDI assessment, Antonio exhibited receptive language well below expectations for his chronological age. From the report, his receptive language was right at the 25th percentile at an 18th month level and his expressive language was well below that around the 10th percentile.

Materials

The SpeakAll! AAC application on an iPad was used during each session. The iPad and SpeakAll! application were obtained from the Florida Alliance for Assistive Services and Technology Center (FAAST) at the University of Central Florida. Vocabulary folders were created within the SpeakAll! application for all musical stimuli. A folder was created with 10 symbols corresponding with the musical instruments chosen for the preference assessment. Musical and visual instruments used during the sessions included maracas, a scarf, bells, a wooden clacker, a triangle, an egg shaker, a drum, a rhythm shaker, a tambourine, and cymbals and some were used as preferred items to engage with during a music clip. Seven songs were cut into 10-second sound clips and played while the child engaged with the instruments. The songs included Hot Potato, Wheels on the Bus, Old McDonald, Mary Had a Little Lamb, Row Your Boat, ABC song, and Itsy Bitsy Spider. These songs were selected based on parent input to be stimulating for the participant. The preference assessment checklist (Appendix C) recorded which items where chosen during the assessment.
Research has shown the CDI to be an adequate measure of the receptive language skills of children with ASD (Luyster, Qiu, Lopez, & Lord, 2007). The CDI: Words and Gestures form, is appropriate for children at the gestural and early word stage of language development (Fenson, Marchman, Thal, Dale, Reznick, & Bates, 2007). This form is divided into two major sections: Part I: Early Words and Part II: Actions and Gestures. Part I consists of four sections. Section A, First Signs of Understanding, contains three general questions about early comprehensions of familiar words and phrases. Section B, Phrases, is a set of 28 phrases examining the comprehension of everyday phrases and routines. Section C, Starting to Talk, asks two questions focusing on imitation and labeling. Section D, Vocabulary Checklist, includes a 396-item Vocabulary Checklist for the parent to report the child’s understanding and use of words. Part II: Actions and Gestures contains five sections. Section A, First Communicative Gestures, is a set of 12 items used to assess nonverbal communication attempts (pointing, reaching, touching, etc.). Section B, Games and Routines, is a set of 6 yes-no items related to typical routines or games children may participate in. Section C, Actions With Objects, is a set of 17 yes-no items if the child completes these activities. Section D, Pretending to be a Parent, is a set of 13 yes-no items relating to pretend play with a doll or stuffed animal. Section E, Imitating Other Adult Actions, is a set of 15 yes-no items relating to actions typically produced by adults. For inclusion in the study, the participant must score at or above the 25th percentile on the CDI.

The SpeakAll! Phase 1 and 2 Training protocol (Appendix B) were the independent variables. Wendt (2014) empirically validated the SpeakAll! protocol with his colleagues to yield increased communicative turn-taking of children with ASD. The MacArthur-Bates Development
Inventories (CDI) (Fenson, Marchman, Thal, Dale, Reznick, & Bates, 2007) was first used to screen the participant’s receptive language to determine eligibility. Phase 1 of the training protocol focused on teaching one-symbol requests and Phase 2 focused on expanding the spontaneity of these requests. The *SpeakAll!* manual describes the appropriate steps to take to implement this phase and the context for implementing the steps. Mastery criterion is listed for Phase 1 for an individual to advance to Phase 2.

In Phase 1, Trainer 1 places the iPad on the table in front of the child and entices the child with the item from across the table. If the child tried to grab the item, Trainer 2 would provide hand over hand prompting to drag the correct symbol to the sentence strip on the app. If the child independently requested the item with the *SpeakAll!* app, it was recorded as a correct response on the Event Recording Form. When the item was requested, the child had 8-10 seconds to engage with the item during a music clip. The criterion for this phase was three communicative requests across two communicative partners.

In Phase 2, Trainer 2 placed the iPad on the table and Trainer 1 stood halfway across the room and enticed the child with the item. If the child tried to grab the item, Trainer 2 used a prompt fading approach to help the child pick up the iPad, walk it over to Trainer 1, and use hand over hand prompting to make a request with the app. If the child could successfully and independently pick up the iPad, walk it over to Trainer 1, and request the item, then it was counted as a correct response on the Event Recording Form. The child was then given 8-10 seconds to engage with the item during a music clip. Criterion for the first part of Phase 2 was to make three consecutive requests.
A Treatment Integrity Checklist (Appendix E) and Event Recording Form (Appendix D) were used to collect data during each session. The Treatment Integrity Checklist was used to record if the trainer accurately executed each component of the intervention necessary for the observation including physical prompting, prompt fading, and refraining from communicating verbally or nonverbally with the participant outside of the intervention protocol. There were checklists for both Trainer 1 and Trainer 2 for Phase 1 and Phase 2. A second independent rater completed the Treatment Integrity Checklist for 20% of sessions in all phases of the investigation. Treatment integrity was calculated to be 100%. The Event Recording Form documented the participant’s one-symbol requests using the *SpeakAll!* app during each session to obtain the total number of requests during each trial. The same second independent rater completed Event Recording Forms for the dependent variable (aided independent requests) for 20% of all sessions, and data reliability was calculated to be 100%.

**Procedure**

Before the study was conducted, IRB approval (Appendix A) was obtained from the University of Central Florida. The *SpeakAll!* intervention was conducted in a classroom twice daily - once in the morning and once in the afternoon for 8-10 minutes each session for 2 weeks. There were 10 trials per session. Phase 1 was implemented with the participant with the purpose of teaching the participant to make one-symbol requests using the *SpeakAll!* application. Phase 2 was implemented with the participant with the purpose of increasing spontaneity by having the participant make one-symbol requests from a distance. This investigation included the following
two phases: baseline and instruction. During the investigation, all sessions were performed in a classroom context with music and all sessions were video recorded using a Sony DCR-SX45 video recorder and tripod.

Pre-Baseline Phase

A preference assessment was conducted with the participant to select musical instruments of interest using the Preference Assessment cheat sheet (Appendix B) as a guide. The preference assessment was critical for the intervention because it identified which items were motivating to the child, so the training environment could be manipulated using the items the participant preferred. The researcher (Trainer 1) held up 2 preferred items and had the participant chose one. If the child did not choose an item, the next set was presented. The selected items were used in the trials until the next preference assessment. The participant was not able to select the same object more than 2 times in a row. If the participant did select the same object twice, 2 new objects were presented at the next preference assessment. Items that were selected 80% (4-5 items) of the time were used in the following trials.

Phase 1 -Baseline Phase

During the baseline phase, measures of the dependent variable were taken to determine the child’s performance before intervention was introduced. During these sessions, the investigator performed 10 trials of activities. The researcher (Trainer 1) was the communicative partner during all communicative interactions and presented all reinforcers and responded to the participant’s communicative requests. Trainer 1 placed the iPad in close proximity to the participant for the participant to make spontaneous requests to use it, but the child was not
prompted to use it. The iPad displayed all items used in the baseline trials from the preference assessment. Trainer 1 enticed the participant with the preferred item and waited 5-10 seconds for a request. If the participant reached for the item instead of using the iPad, no prompting was given and it was counted as an incorrect response and the child was presented the item with a verbal label. If the child did not reach for the item, the next item was presented. If the participant requested the item using the iPad, Trainer 1 gave the participant the preferred item paired with a label (e.g., giving the participant a blue maraca and saying “blue maraca” aloud) and it was counted as a correct response on the Event Recording Form.

**Phase 1 - Intervention Phase**

A stable baseline was established with the child (defined as three stable baseline points, or 30 trials, with no evident rising trend), therefore the instructional program was implemented with the participant. Phase 1 of the *SpeakAll!* training protocol was used to guide the intervention phase. An undergraduate student (Trainer 2), with experience in working with children with ASD, was trained to prompt the participant to communicate during interactions and use backwards chaining to correct the participant following the prescribed protocol procedures. Another trained student volunteer held the task of recording the number of one-symbol requests using Event Recoding Form and playing the audio clips. The participant was observed for any one-symbol requests to play with preferred instruments while listening to a music clip.

Trainer 1 placed the iPad in front of the participant with the preferred graphic symbol displayed for each item. Each preferred item had a separate folder so only one item was displayed at a time. Trainer 1 enticed the child with the preferred item from across the table. If
the participant reached for the item, Trainer 2 used hand over hand prompting to help the participant drag the picture of the preferred music item on the iPad to the sentence bar to make a request until he could request independently. Trainer 2 discontinued physical prompts over time, but still remained in the room to provide additional support as needed. When the participant activated the sentence strip, Trainer 1 said the item name and gave the preferred item to the participant and counted the response as correct on the Event Recording Form. The criterion for advancing from Phase 1 to Phase 2 was at 80% mastery across all trials for 2 consecutive sessions, across 2 communicative partners and 3 reinforcers. If the participant could not achieve this criterion across five consecutive sessions at 50% below mastery, modifications were made specific to the participant. For example, providing more physical prompting and verbal cues to the child and fading out prompts/cues at a slower pace.

**Phase 2 - Baseline Phase**

During the baseline phase for Phase 2, measures of the dependent variable were taken to determine the child’s performance before intervention was introduced. The investigator performed 10 trials of activities for one baseline point. The baseline was conducted over three baseline points as long as it was stable. The iPad was placed on the table for the child to pick up and carry over to Trainer 1 to spontaneously request, but the participant was not prompted to use it. Trainer 1 stood halfway across the room and enticed the participant with the preferred item while Trainer 2 and the participant stood at the table. If the participant carried the item over to Trainer 1 and activated the sentence strip with the corresponding item, it was counted as a
correct request and the child was given the item with a verbal label. This would require the child to independently pick up the iPad, walk the iPad to Trainer 1, and make an independent requests using SpeakAll! for the preferred music item. If the child did not activate the strip but did reach for the item, it would be counted as an incorrect response on the Event Recording Form and the item would be given to the child with a verbal label and a music clip was played. If the child did not come to the item, the next trial would begin. The baseline phase included 30 trials.

Phase 2 - Intervention

After a stable baseline was achieved for Phase 2, intervention was implemented with the child. The purpose of Phase 2 was to expand communicative spontaneity and teach the child to walk to the communicative partner to make an independent request. The first part of Phase 2 required the participant to travel halfway across the room to Trainer 1. The iPad was placed on the table with the corresponding symbol for each trial. Each preferred item had a separate folder so only one item was displayed at a time. Trainer 1 stood halfway across the room and enticed the participant with the item while Trainer 2 stood at the table with the participant and the iPad. The iPad was placed in front of the child for the child to make spontaneous requests. If the child picked up the iPad and walked it over to Trainer 1 making a request, it was counted as correct on the Event Recording Form and the item was given to the child with a verbal label to engage with during a music clip. If the child did nothing or tried to walk towards the item, Trainer 2 stepped in and used hand over hand physical prompting to help the participant pick up the iPad and travel to Trainer 1 to make the request. Trainer 1 would give the item to the child with a verbal label to engage with during a music clip. This response would be counted as incorrect on the Event
Recording Form. Prompting was faded out over time. For example, at first Trainer 2 would help the participant pick up the iPad and walk it over, but eventually Trainer 2 would just help the participant pick up the iPad and let him independently walk it to Trainer 1. Mastery for the first part of Phase 2 was that the child must independently take the iPad to Trainer 1 and activate it two times in a row.

**Measures**

The independent variables of this study were the *SpeakAll!* iPad app and the *SpeakAll!* Training protocol (Phase 1 and 2). The protocol was used as a guide throughout the study. The dependent variable was the number of one-symbol requests within 10 seconds. The dependent variable was recorded using the Event Recording Form.

**Data Collection and Coding**

All sessions were videotaped during baseline and intervention phases and took place in a classroom. All sessions were video recorded using a Sony DCR-SX45 video camera and tripod during the baseline and intervention sessions. When video recording, the volunteer remained at a distance comfortable for the participant to avoid distracting the participant. Following each daily session, data was collected from the video recordings and recorded onto the Event Recording form and coded by a trained student volunteer. Once a session was finished, the student volunteer coded the dependent measures by reviewing the video recordings and completing the Treatment Fidelity Checklist and the Event Recording Form. Treatment fidelity analyzed how reliable the researcher was at implementing the therapy and following the protocol. The coder
also recorded the number of one-symbol requests on the Event Recording form. Coding reliability was used to measure the consistency in coding the dependent variable. The researcher coded 20% of the video recordings (2 minute samples) as well to determine a measure of inter-rater reliability for all participant requests. The total number of agreements, disagreements, and omissions for each session was divided by the total number of agreements to determine reliability. A reliability of 80% or greater was considered to be acceptable.

Data Analysis

The Percentage of Nonoverlapping Data (PND) (Scruggs, Mastropieri, Cook, & Escobar, 1986) has been previously used to show treatment efficacy in studies that use a single-subject design and will be used to evaluate the effectiveness of the intervention. The PND was calculated by counting the number of data points during the intervention phase that exceeded the highest baseline point. For example, if 8 out of 12 data points in the intervention stage were higher than the highest baseline point, the percentage would be 67%. According to previously researched PND ranges (Scruggs & Mastropieri, 1998), 70% and up classify the treatment to be fairly effective to highly effective. Below 50% shows that the treatment was unreliable and between 50-70% the effectiveness of the treatment is questionable. Visual inspection principles also were implemented (Horner et al., 2005) to quantify change over time, including level, variability, trend, immediacy of effect, and error analyses for the Intervention Phase.
CHAPTER III. RESULTS

Pre-Intervention – Phase 1 Baseline Probe

After the preference assessment was conducted and 5 items were chosen, a Phase 1 baseline probe was implemented. When the Phase 1 Baseline Probe was conducted, the participant met the 80% correct or above criterion for Phase 1. The participant was successfully able to independently make one-symbol requests using the SpeakAll! app for the preferred musical instrument for 8 out of 10 trials. A decision was then made to move onto Phase 2 immediately in light of the limited two-week pre-determined intervention time period.

Pre-Intervention - Phase 2 Baseline

Phase 2 Baseline probes were conducted over 3 sessions (i.e., 30 trials) since the participant consistently performed below the criterion achievement level. The participant was unable to pick up the iPad, walk it over to Trainer 2, and make the request independently during these baseline sessions. With no one-symbol requests made during baseline, all sessions were at 0% performance level with no rising trend. The average percent accuracy for this baseline level was also at 0%. Because there were three consistent baseline points with no rising trend, Phase 2 Intervention could be initiated.

Phase 2 Intervention Results

Phase 2 Intervention was conducted over 12 sessions, or 120 trials. There were brief preference assessments done intermittently between probe sets for the purpose of renewing the interest of the child in the musical instruments. Immediacy of effect was not evidenced for this participant and no evidence of independent one-symbol requests was shown until Session 9 of
intervention. A sharp rising trend was evidenced across the final 4 intervention sessions: 40%, 30%, 50%, and 70%. Figure 1 shows the percent of independent aided one-symbol requests for this participant across all sessions. When calculating the data using PND, the results were 33% indicating that the treatment was unreliable. These results indicated that the participant was unable to meet Phase 2 criterion accuracy levels within the pre-determined two-week intervention time frame.

*Error Analysis*

Although the participant did not meet criterion performance level for Phase 2 Intervention, error analyses revealed a progression in the percentage of prompting level required each session. Figure 2 illustrates that there was a decreasing trend in the frequency of required prompts over time. Prompts that were initiated by Trainer 2 in Phase 2 intervention include hand-over-hand prompting to pick up the iPad, escorted walking with the iPad over to Trainer 1, and hand-over-hand prompting to make the request with *SpeakAll!*. Prompting to make the one-symbol request was faded out early, and prompts were only needed to pick up the iPad and walk it over to Trainer 1 for the first 4 sessions. For the next 4 sessions, prompting to walk the iPad over to Trainer 1 was faded out; in these sessions, only prompting to pick up the iPad was necessary. For the last 4 sessions, the participant was able to independently make one-symbol requests with the *SpeakAll!* app across an increasing number of trials.
Figure 1. Percent Accuracy: Independent Requests
Figure 2. Phase 2 Intervention Error Analysis: Percentage of Prompting Level Required by Session
CHAPTER IV. DISCUSSION

Intervention Effectiveness

Overall, a package intervention approach was implemented. Although the participant did not meet the criterion for Phase 2 Intervention and the PND suggested that treatment was unreliable, the rising trend during the end of Phase 2 Intervention along with error analysis suggests that with an extended period of time, the participant could have potentially reached Phase 2 Intervention criterion within a reasonable period of time. Immediate results were unexpected because of the variability in language and learning patterns reported in previous research for children with ASD. However, the error analysis indicated that the prompt fading approach was successful in eliciting independent one-symbol requests during this intervention. More specifically, error analyses demonstrated that after approximately every 4th session, (i.e., 40 trials), the participant required fewer prompts during the intervention phase.

Clinical Implications

The findings from this investigation show that this type of intervention could be effective if done in an appropriate time-span. The SpeakAll! application was simple for the participant to use as evidenced by his progression throughout each phase of the investigation. In Phase 1 Baseline, the participant understood that he needed to request via the app instead of reaching straight for the object and was therefore met criterion to move on to the next phase. For Phase 2, close examination of the errors yielding the scores over time is critical to gain a clear understanding of the participant’s progress over time. Without the fading out of the prompts, the participant may have been unable to make independent requests successfully in Phase 2. Unlike
Phase 1, the participant required prompting to be able to make one-symbol requests at a distance and it took some time for the participant to understand what he was being inquired to do. The progress made in fading out the frequency of prompts suggests that this method could be successful when completing the rest of Phase 2 where the participant would have to request at the full distance of the room instead of half. The participant’s progress demonstrated in this investigation also suggests that musical instruments can be sufficiently appealing and motivating to yield promise as more appropriate reinforcers than food in a music classroom context. The participant demonstrated active engagement and enjoyment from the musical instruments combined with played music clips. The current investigation makes a contribution to the dearth of research on iPad-specific applications in a musically stimulated classroom context.

Limitations of the Study

The main limitation of this study is the limited sample size. Since this investigation was designed as a pilot study for a planned future experimentally controlled study, there was only one participant. Even though this participant did make progress, an investigation of this protocol in a naturalistic setting like music class across different participants could contribute to the literature on the use of the SpeakAll! app in intervention. Additionally, implementing this study within a pre-determined, and relatively limited, two week time period precluded full examination of the effects of the entirety of Phase 2 Intervention. Multiple participants are also beneficial to have because of the variability of learning patterns for the ASD population. With more time, the results suggest that the participant could have reached criterion for Phase. The behavior of the participant was another obstacle during this study. With this participant, morning sessions were
more successful and afternoon sessions were more difficult to conduct because of his short attention span later in the day; the participant required more prompting to use the iPad in the afternoons because of his limited capacity for attention. This idiosyncrasy could have affected the overall results of this investigation. The case that the iPad was in was another limitation to this study. During Phase 2 baseline, we began to notice that the iPad was too heavy to pick up after watching the participant attempt to pick it up. Modifications were made and the iAdapter case was removed during Session 5 and the participant was then able to quickly progress to pick up the iPad.

**Future Research**

Future research with this application requires a more extended intervention period to fully assess the potential of classroom-based intervention in promoting independent communication skills in children with ASD. Implementation of a single subject, multiple baseline design could be beneficial because of the success of this design in intervention for heterogeneous populations such as individuals with ASD. The *SpeakAll!* protocol also measured social communication and verbalizations/vocalizations in previous studies. These variables could be measured in future investigations in this type of naturalistic intervention context to see if there is a difference in those components when given music reinforcers versus food reinforcers. Also, it would be helpful to implement a generalization phase to further validate the results of the study.

**Conclusion**

To conclude, this was the first independently conducted evaluation of the *SpeakAll!* application and protocol in this type of naturalistic intervention environment. The investigation
provides encouraging results on the effects of the SpeakAll! application on the independent requesting skills of children with ASD. The results suggest that when implementing the SpeakAll! protocol and the prompt fading approach in intervention, the child would be able to gradually increase independent requests spontaneously over time. Results from this study are notable in contemporary intervention literature, which is lacking in evidence-based interventions for children with ASD in more naturalistic contexts.
APPENDIX A: IRB APPROVAL LETTER
Approval of Human Research

From: UCF Institutional Review Board #1
FWA0000351, IRB00001138
To: Jennifer E. Kent Walsh and Co-PIs Jamie R. Schwartz, Olivia Downes
Date: October 03, 2014

Dear Researcher:

On 10/2/2014, the IRB approved the following human participant research until 10/02/2015 inclusive:

Type of Review: UCF Initial Review Submission Form
Project Title: Effects of SpeakAP! (iPad App and Training) Protocol Use on the Communicative Turn of Children with Autism Spectrum Disorders
Investigator: Jennifer E. Kent Walsh
IRB Number: SBE-14-10586
Funding Agency: N/A
Research ID: N/A

The scientific merit of the research was considered during the IRB review. The Continuing Review Application must be submitted 30 days prior to the expiration date for studies that were previously expedited, and 60 days prior to the expiration date for research that was previously reviewed at a convened meeting. Do not make changes to the study (i.e., protocol, methodology, consent form, personnel, site, etc.) before obtaining IRB approval. A Modification form cannot be used to extend the approved period of a study. All forms may be completed and submitted online at https://irbresearch.ucf.edu.

If continuing review approval is not granted before the expiration date of 10/02/2015, approved of this research expires on that date. When you have completed your research, please submit a Study Closure request in IRIS so that IRB records will be accurate.

Use of the approved, stamped consent document(s) is required. The new form supersedes all previous versions, which are now invalid for further use. Only approved investigators (or other approved key study personnel) may obtain consent for research participation. Participants or their representatives must receive a copy of the consent form(s).

All data, including signed consent forms if applicable, must be retained and secured per protocol for a minimum of five years (six if HIPAA applies) past the completion of this research. Any links to the identification of participants should be maintained and secured per protocol. Additional requirements may be imposed by your funding agency, your department, or other entities. Access to data is limited to authorized individuals listed as key study personnel.

In the conduct of this research, you are responsible to follow the requirements of the Investigator Manual.

On behalf of Sophia Drzgielewski, Ph.D., L.C.S.W., UCF IRB Chair, this letter is signed by:

Page 1 of 2
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iPad Instructions – Preference Assessment Cheat Sheet

1. Hold up two items and allow the child to select one. The child should consume the item.

2. Do several of these presentations until each item has been presented 5 times in different combinations.

3. Those items that are selected 80% of the time will be used for training.

4. In the end we want to identify about 4-5 items that are the most motivating.
iPad Instructions - Phase 1 Cheat Sheet

**Purpose:** Teach one-symbol requests.

**Setting:** Trainer 1 will be sitting across a table from the child and Trainer 2 will be standing directly behind the child.

1. Conduct a preference assessment. Repeat this every 5 trials.

2. Put a bag of the preferred snack item on the table and have the corresponding graphic symbol displayed in SPEAKall!

3. **Trainer 1** place iPad in front of the child and entice with the preferred item.

4. **Trainer 2** provide prompting for dragging and dropping graphic symbol onto sentence strip. Fade out over time.

5. **Trainer 1** once sentence strip is activated, give desired item to child and say the item name.

6. Give the child time to consume the snack item or play with the preferred toy.

7. **Trainer 1** press “return cards” button to start a new trial. Begin to entice with the desired item again.

8. Switch communication partners. Make sure child can request at least 3 different items before moving on to the next phase.
Phase 2 Cheat Sheet

Purpose: The child will learn to activate the iPad from a distance and to walk to the communication partner.

Setting: An open room with multiple surfaces on which to place the iPad.

1. Conduct a preference assessment. Repeat this every 5 trials.

2. **Trainer 2**: Stand with the child at one end of the room. Place iPad in front of the child.

3. **Trainer 1**: Stand halfway across the room and entice with the preferred item.

4. **Trainer 2**: Assist the child to travel with the iPad to Trainer 1 if necessary. Help activate the graphic symbol. Fade out prompting in following trials.

Mastery: The child independently takes the iPad to Trainer 1 and activates it two times in a row.

5. **Trainer 1**: Increase distance between you and the child to the full size of the room.
<table>
<thead>
<tr>
<th>Instrument</th>
<th>Times Chosen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drums</td>
<td></td>
</tr>
<tr>
<td>Green Bells</td>
<td></td>
</tr>
<tr>
<td>Yellow Bells</td>
<td></td>
</tr>
<tr>
<td>Egg Shaker</td>
<td></td>
</tr>
<tr>
<td>Yellow Maraca</td>
<td></td>
</tr>
<tr>
<td>Red Maraca</td>
<td></td>
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<tr>
<td>Tambourine</td>
<td></td>
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<tr>
<td>Triangle</td>
<td></td>
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<tr>
<td>Sticks</td>
<td></td>
</tr>
<tr>
<td>Scarf</td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX D: EVENT RECORDING FORM
### Behavior Definition (in specific, observable, measurable terms):

**DV1- Request**

Requesting (one symbol), only record during baseline; within 10 s, picking up a graphic symbol card that corresponds with the presented or desired item, placing that card into the hand of the trainer, or activating corresponding graphic symbol on iPad by dragging onto iPad sentence strip.

<table>
<thead>
<tr>
<th>Target behaviors</th>
<th>Trials</th>
<th>Total number of behavior occurred</th>
</tr>
</thead>
<tbody>
<tr>
<td>Session 1</td>
<td></td>
<td></td>
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<tr>
<td>Session 2</td>
<td></td>
<td></td>
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<tr>
<td>Session 3</td>
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<td>Session 4</td>
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<td>Session 5</td>
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<td>Session 6</td>
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<td>Session 7</td>
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<td>Session 8</td>
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<td>Session 9</td>
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<td>Session 10</td>
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<td>Session 11</td>
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<td>Session 12</td>
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<td>Session 13</td>
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<td>Session 14</td>
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<td>Session 15</td>
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<td>Session 16</td>
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<td>Session 17</td>
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<tr>
<td>Session 18</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX E: TREATMENT INTEGRITY FORMS
### iPad Phase 1 (trainer 1) – Treatment Integrity Checklist

#### Rater: ______________       Today’s Date: _______________       Participant:________________

Session: ____________      Session Date:                    ______    Trainer 1:  ________________

<table>
<thead>
<tr>
<th>COMPONENT</th>
<th>Set 1</th>
<th>Set 2</th>
<th>Set 3</th>
<th>Set 4</th>
<th>Integrity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Trainer places the iPad within reach with only one symbol on iPad display</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Trainer rearranges position of symbol on iPad display with every new trial</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Trainer refrains from verbal prompts</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Trainer entices child with reinforcer</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Trainer gives reinforcer to child within 3 seconds</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Trainer provides verbal model</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

***Mark [X] if component is performed, mark [---] if component is not performed during direct observation.***

***If a component is to be faded, and is currently not applicable for this session mark [NA]***

---

### iPad Phase 1 (trainer 2) – Treatment Integrity Checklist

#### Rater: ______________       Trainer 2: ________________

<table>
<thead>
<tr>
<th>COMPONENT</th>
<th>Set 1</th>
<th>Set 2</th>
<th>Set 3</th>
<th>Set 4</th>
<th>Integrity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Trainer waits for child to reach for item</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Trainer physically prompts the child</td>
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<td></td>
</tr>
<tr>
<td>3. Trainer is gradually faded out</td>
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</tr>
<tr>
<td>4. Trainer prevents the child from engaging in unwanted behaviors</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>5. Trainer refrains from verbally or nonverbally communicating with child</td>
<td></td>
<td></td>
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</tbody>
</table>

***Mark [X] if component is performed, mark [---] if component is not performed during direct observation.***

***If a component is to be faded, and is currently not applicable for this session mark [NA]***
**iPad Phase 2 (trainer 1) – Treatment Integrity Checklist**

Rater: _______________  Today’s Date: _______________  Participant: _______________  Session: _______________  Session Date: ___________

**Trainer 1: _______________**

**COMPONENT**

***Mark [X] if component is fulfilled***

1. Interventionist is offering at least two, and if possible more, reinforcing items during each session ______
2. Any reinforcing item is not used more than ten times ______

**COMPONENT**

<table>
<thead>
<tr>
<th>COMPONENT</th>
<th>Set 1</th>
<th>Set 2</th>
<th>Set 3</th>
<th>Set 4</th>
<th>Integrity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Preference assessment is performed</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Trainer places iPad with symbol in front of child</td>
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<tr>
<td>3. Trainer or child rearrange position of symbol on iPad display</td>
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<tr>
<td>with every new trial</td>
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<tr>
<td>4. Trainer refrains from verbal prompts</td>
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<tr>
<td>5. Trainer entices child with reinforcer</td>
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<tr>
<td>6. Trainer provides verbal model</td>
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</tr>
</tbody>
</table>

**Integrity**

***Mark [X] if component is performed, mark [---] if component is not performed during direct observation.***

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<table>
<thead>
<tr>
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<th>Set 1</th>
<th>Set 2</th>
<th>Set 3</th>
<th>Set 4</th>
<th>Integrity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Trainer waits for child to reach/walk for item/toward trainer 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Trainer uses backwards chaining</td>
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<tr>
<td>3. Trainer physically prompts the child to pick up iPad</td>
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<tr>
<td>4. Trainer provides physical assistance to take iPad to Trainer 1</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>5. Trainer provides physical assistance to activate iPad with Trainer 1</td>
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</tr>
<tr>
<td>6. Trainer prevents the child from engaging in unwanted behaviors</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>7. Trainer refrains from verbally or nonverbally communicating with child</td>
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</tr>
</tbody>
</table>

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***If a component is to be faded, and is currently not applicable for this session mark [NA]***
REFERENCES


