Using mobile technology to improve phonological awareness and letter recognition in preschoolers.

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Abstract.

This study explored the efficacy of using mobile technology to help preschoolers develop early literacy skills. An existing iPad application Учубука was used in a single subject study design to determine the effect of daily sessions using the application on phonological awareness and letter recognition. The subject was trained on the use of the application via a peer-to-peer tutoring model, and the efficacy of the training were also studied. Standard Celeration Charts were used to conclude that peer to peer tutoring has a significant effect on treatment compliance in preschool subjects. The authors further concluded that daily treatment sessions with an application designed to improve literacy increased letter recognition and phonetic awareness in preschoolers, which indicates that mobile technology can be used within the guidelines established by the American Academy of Pediatrics to effectively develop early literacy skills in preschool-age children. Due to the single subject study design, further research is necessary to generalize the results to other populations. The study is published as a white paper.

The purpose of this exploratory study is to examine the efficacy of using mobile technology to help preschoolers develop early literacy skills. Specifically, an iPad application Учубука (MobileUp, 2012) was utilized to train and test the development of phonological awareness and letter recognition of the Cyrillic alphabet. Phonological awareness (PA) is defined as the ability to hear sounds that make up words in spoken language, which includes deciding whether words begin or end with the same sounds, understanding that sounds can be manipulated to create new words, and separating words into their individual sounds (Stanovich, Cunningham & Cramer, 1984). It is specifically concerned with measuring the participant's ability to recognize verbal input. Letter recognition (LR) is defined as the ability to recognize and name the letters of the alphabet based on visual cues (Longcamp, Zerbato-Poudoub & Velay, 2005).

Literature Review.

Mobile Technology and Early Literacy.

The American Academy of Pediatrics (AAP) recommends that children between two and five are limited to two hours on screen-time daily, with screen-time defined as time spent on the computer, television or mobile devices (Committee on Public Education, 2001). Unfortunately, these recommendations are rarely followed, and the average screen-time often exceeds four hours a day (Tandon, Zhou, Lozano, & Christakis, 2011). Since this study made use of a mobile application designed for preschoolers, following AAP recommendations is an integral part of the study design.

The use of technology to promote early literacy skills has been widely researched. In a 1996 study, Kaminsky and Good tested the efficacy of three novel computer applications on thirty-seven kindergarteners and forty-one first-graders. One of the applications was designed to assist the participants with phonological awareness, and fluency in letter naming by sounding out a letter and asking the participants to select it from a list of four letters (Kaminsky & Good, 1996). A statistical analysis of the results determined that the measures displayed adequate psychometric properties for kindergarten children who were not yet reading (Kaminsky & Good, 1996). Specifically, phonological awareness improvement was significantly more pronounced in preliterate kindergarteners than in first-graders, who had better early literacy skills prior to the administration of the treatment (Kaminsky & Good, 1996).

In a 2008 study, Revelle, Reardon, Green, Betancourt and Kotler developed a mobile-phone based intervention that would encourage parents to engage their children in daily literacy-learning activities. Though the primary subject of this study was the effect the technology had on the time parents spent teaching their children early literacy skills, the authors found that mobile delivery made it significantly easier to incorporate literacy activities into the children's daily routines (Revelle, Reardon, Green, Betancourt & Kotler, 2008).

The use of mobile device applications to assist in the development of literacy skills was further examined by Lan, Sung and Chang in a 2007 study. This study focused on the effect of a mobile application designed to improve phonological awareness in elementary school English/foreign language (EFL) learners on collaborative learning (Lan, Sung & Chang, 2007). The authors found that the use of mobile technology significantly improved learning outcomes (Lan, Sung & Chang, 2007).

Peer Tutoring and Treatment Compliance.

One of the major difficulties of working with children under five is treatment compliance. When a toddler refuses to participate in treatment, a researcher's options are limited. Research has shown that working in groups and peer-to-peer tutoring improves both compliance and educational outcomes.

In a 1986 study, Piggot, Fantuzzo, and Clement evaluated the effects of peer-to-peer tutoring on twelve underperforming fifth-grade subjects. Over the course of twelve weeks, daily

peer tutoring sessions with higher-achieving classmates improved the educational outcomes for the experimental group to levels indistinguishable from their peers (Piggot, Fantuzzo & Clement, 1984). These results have been widely replicated in a variety of study designs with subjects that belong to different age groups. Cross-age tutoring programs have been especially successful.

Cross-age tutoring involves a tutor that is a few years older than the tutee (Libby, 2016). A pilot program launched at a Canadian elementary school paired eighteen underperforming second graders with high-achieving fourth graders in weekly online tutoring sessions (Libby, 2016). The program was found to improve academic performance for both groups and promote responsibility and empowerment (Libby, 2016). Peer-to-peer tutoring and collaborative play have also been found to improve classroom behavior and compliance.

In a 2015 study, Yaoying Xu randomly assigned seventy-five English second language learning (ELL) preschoolers to an experimental and control groups, with the experimental group receiving daily peer-tutoring in the form of social interactions with native English speaking peers. The author found that the experimental group demonstrated significant improvement when compared to the control group in positive social interaction behavior, receptive language, and classroom compliance (Xu, 2015).

The Application.

The study was conducted using an existing iPad application Учубука created by MobileUp in 2012 specifically to help preschoolers develop early literacy skills. To the best of this author's knowledge, the efficacy of the application has never previously been tested.

The application has several use-cases for different ages, including animal recognition, letter recognition, word recognition and spelling (MobileUp, 2012). For this study, we concentrated on the single use case of letter recognition, both verbal and visual.

There are two distinct modes of use, "hint" mode and "test" mode. In hint mode, the subject is presented with a screen on which a letter is flashed

Figure 1. Учубука Screen 1.

and the application provides a verbal hint – "This is the letter И (the application pronounces the sound the letter makes)" (See Figure 1). The flashing letter utilizes visual short-term memory (VSTM) to improve letter recognition and phonological awareness. This technique has been shown to be more effective than pure phonetic techniques, where the letter is only sounded (Ehri & Wilce, 1985).

On the next screen the subject is presented with multiple letters

Figure 2. Учубука Screen 2.

and verbal instructions to find the letter "И" are given (See Figure 2). The subject then uses the touchscreen to pick a letter from the six choices provided.

If the wrong letter is chosen, it falls off the screen

Figure 3. Учубука Screen 3.

and the subject is given a verbal instruction to try again (See Figure 3). If the correct letter is chosen, the application presents one of a variety of "Good Job" screens

Figure 4. Учубука Screen 4.

followed by the next problem (See Figure 4).

In test mode, the application does not provide a verbal or visual hint. The choices are presented immediately and the subject is asked to pick the letter that is sounded out. There is no report feature and the results are recorded for analysis.

Methods.

The study was conducted using a single subject design. Its purpose was to determine the efficacy of Учубука, an app designed to improve phonological awareness and letter recognition in pre-literate preschoolers. A peer-tutoring model was utilized for the initial training of the subject on the use of the application.

After an initial round of testing, a two-and-a-half-year-old male subject (S) was provided with seven tutoring sessions (PTPT) with a four-and-half-year-old peer tutor (T). The tutoring sessions were self-paced, their length was recorded, and the results were analyzed for statistically significant differences. The null hypothesis was that:

1. Peer tutoring sessions (PTPT) sessions will have no effect on the number of incidents of non-compliance (NC).

Upon completion of training, the subject was administered treatment in the form of daily sessions using the application in "hint" mode for a period of eight weeks. The sessions were self-paced. These were followed with weekly sessions in "test" mode, during which data on session length, compliance, number of questions answered correctly and number of incorrect responses were recorded. Each test session consisted of twenty-five questions and the results were compared to test the following null hypotheses:

2. There will be no differences in phonological awareness (PA) and letter recognition (LR) following the eight-week treatment period.

The single subject study design prohibits us from using most statistical research methods. However, there are established practices for single subject reporting in the behavior analysis community, specifically in the field of Applied Behavior Analysis (ABA). One of these is the Standard Celeration Chart which was used for data analysis. It measures celeration (C), the change in the rate of responding per unit of time (Sarafino, 2012, p. 43).

Results.

The results of the first test administration revealed a non-compliance (NC) rate of 21/25. An incident of non-compliance (NC) was defined as either:

- Turning off the application

- Walking away from the application
- Repeatedly hitting the iPad

Thus, a baseline rate of NC was established and NC was tracked during each peer tutoring (PTPT) treatment session. Finally, NC was measured in a session with PTPT removed to determine if progress was made. The results were processed in Excel and the resulting Standard Celeration Graph is presented below (See Figure 5).

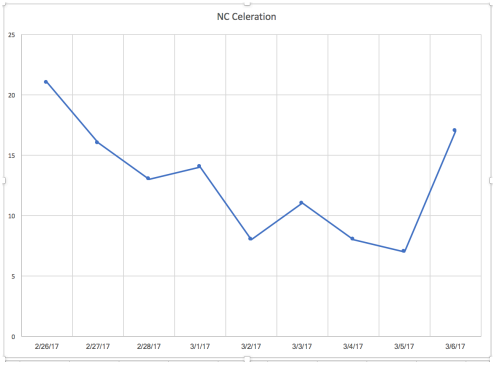

Figure 5. NC Celeration during training period.

As you can see, there was a steady decrease in the frequency of NC across the PTPT treatment sessions, with a spike in the final session during which no treatment was administered. This is a common phenomenon known as an extinction spike, which occurs when the reinforcing stimulus is removed (Piggot, Fantuzzo & Clement, 1984). Following the spike, the NC celeration rate dropped to a manageable level of under 10 instances per session (See Figure 6).

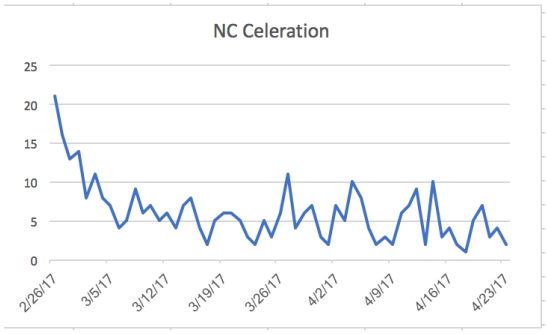

Figure 6. NC Celeration across sessions.

Celeration charts were also used to measure letter recognition (LR) and phonological awareness (PA). First, we tracked first try responses (FTR), which are the number of questions answered correctly on the first try (See Figure 7).

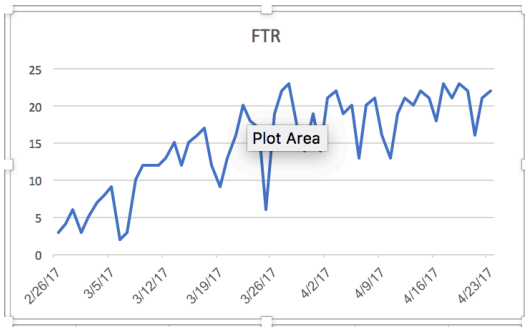

Figure 7. FTR Celeration across sessions.

As you can see, there is a clearly defined trend, with the number of FTR responses steadily increasing to an average of 20.2 per session. The improvement is even more pronounced when we look at the average number of tries before the correct answer is found (ANT) (See Figure 8).

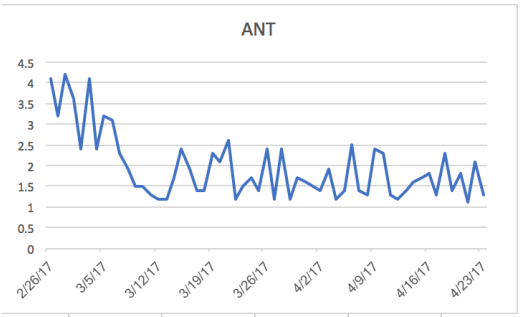

Figure 8. ANT Celeration across sessions.

ANT dropped from an average of 3.6 during the peer tutoring period to an average of 1.46 during the last four weeks of treatment.

Conclusion.

Due to the observable decrease in non-compliance null hypothesis #1 is rejected. Thus, we conclude that peer to peer tutoring has a significant effect on treatment compliance in preschool subjects. That effect follows a predictable pattern of a steady decrease in behavior instances, followed by

an extinction spike, and a further decrease until the level of non-compliance plateaus.

Null hypothesis #2 is also rejected due to an observable increase in FTR and an observable decrease in ANT across sessions. Thus, we conclude that daily treatment sessions with an application designed to improve literacy increase letter recognition and phonetic awareness in preschoolers. These findings indicate that mobile technology can be used within the guidelines established by the American Academy of Pediatrics to effectively develop early literacy skills in preschool-age children.

Limitations.

Note that due to the nature of the single subject design, we were not able to separate the treatment effects on PA and LR. In order to accomplish this task, further studies using a between-groups design would need to be conducted.

The current study design also makes it difficult to generalize results to other populations. Thus, this study must be viewed as explorative in its nature, and its results must be replicated with other subjects to support the claims presented.

Due to the tremendous difficulties of obtaining IRB approval for studies involving children we did not seek IRB approval. Unfortunately, this precluded the study from being published in peer reviewed journals and submission to conferences. The study is published as a White Paper.

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