

Software to Improve Verbal Communication in Children

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Autism-assistive apps offer therapists and caregivers new approaches for educating and assisting individuals with autism spectrum disorder (ASD), mainly in social interaction. Even though these apps are deemed effective, they are not. These autism-assistive apps are not highly customizable, which limits their usefulness.

Keywords: autism spectrum disorder ; apps ; intervention ; verbal communication

1. Introduction

Autism was classified as a developmental disorder by Leo Kanner in 1948. Since then, researchers have shown an interest in autism, resulting in continuous changes in the diagnostic criteria of autism ^[1]. In May 2013, the American Psychiatric Association released the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5), which included predominant changes to the criteria that are used to diagnose autism. These new criteria have two impairment domains: (1) social interaction and social communication; and (2) restricted interests and repetitive behaviors. Additionally, Autistic Disorder, Asperger's Disorder, and Pervasive Developmental Disorder—Not Otherwise Specified (PDD-NOS) are categorized into one umbrella term: "Autism Spectrum Disorder, ASD" ^[2].

The symptoms of autism spectrum disorder (ASD) usually present in the early developmental period. Individuals with ASD commonly struggle to communicate, such that they experience difficulty initiating conversations socially. They also have difficulty responding to communicative bids of others and engaging in reciprocal exchange ^[3]. Approximately 25 to 61% of children with ASD have little or no functional speech ^[4], while around 25 to 50% still have not developed language even by reaching 10 to 13 years old ^[5]. Learning basic communication skills is crucial as communication is an essential part of everyday life; communication is needed to exchange messages, thoughts, feelings, and information with other people. Generally, communication is comprised of speech, vocalizations such as sounds and shouts, body languages such as facial expressions and posture, sign language or the exchange of pictures, the use of communication devices, and writing ^[6].

In this modern era, individuals with ASD benefit from technology. Researchers are convinced that technology could help individuals with ASD improve their quality of life ^{[7][8][9][10]}. Several review papers have discussed the effectiveness of using technology-based intervention to improve communication skills for individuals with ASD. Digennaro, Hyman and Hirst focused on studies that used technology for social skills intervention and suggest that technology is helpful to teach social skills for children with ASD ^[11]. Ramdoss et al. reviewed the use of computer-based interventions (CBI) to teach communication skills to children with ASD ^[12]. They concluded that integration of technology in intervention is a promising practice for improving vocal and non-vocal communication. Wainer and Ingersoll claimed that an innovative multimedia program could be a good strategy for delivering the direct intervention to teach language, emotion recognition, or social skills to children and adults with ASD ^[13]. Kagohara et al. concluded that handheld devices, such as iPods, iPhones, and iPads can be used within educational programs that are targeting academic, communication, employment, and leisure skills for individuals with ASD ^[14]. A systematic review by Still et al. suggested that high-tech devices (e.g., smartphone technology) could be applied as augmentative and alternative communication (AAC) devices for individuals with ASD ^[15]. In their review, Kristy, Teresa, and David echo these findings by stating that the AAC interventions are helpful to assist children with ASD to communicate, particularly to request preferred items and activities ^[16]. Heath et al. proposed that technology could alleviate the treatment cost while allowing more significant support for individuals that are interested in the treatments ^[17]. In addition, the positive effect of the technology-based intervention on children with ASD is prolonged. Post-intervention analysis showed that the language and social communication skills of children with ASD were maintained for at least a year after ceasing the technology-based intervention ^[18].

The critical factor that makes technology successful is the application software ('apps') installed. Designers must ensure that the apps have high interactivity and be of good quality, meet users' needs, and have an effective learning framework ^{[19][20]}. It is challenging to find one that is suitable for ASD intervention ^{[21][22]}. From the literature, it can be said that no

comprehensive intervention apps for individuals with ASD are available. All related publications used the AAC, speech generating device (SGD), or educational apps as the tools to deliver the intervention. This is due to the fact that ASD is a spectrum, and the needs of individuals vary. An intervention app should be designed as completely as possible, covering lessons from the lowest to the highest difficulty levels while allowing caregivers or therapists to select the lesson plan or add new activities. Considering the availability of multi-superior programming languages today, designers can easily design apps with such features. This paper focuses on the software application that is used to encourage verbal communication in the intervention for children with ASD. The aim is to determine the minimum requirements that a verbal communication intervention app should have to satisfy children with ASD while also being helpful to caregivers and therapists in terms of monitoring purposes.

2. Current Insights

The apps used in the fifteen selected studies were not explicitly developed for the verbal communication intervention. The Proloquo2Go, My Choice Board, GoTalk NOW, Sonoflex, Pick A Word, and iCan apps were designed to function as the AAC or SGD. These apps on their own were unable to encourage the user to initiate verbal communication. Instead, the apps talk on their behalf. On the other hand, the Turkish sequencing game, SIGUEME, Find Me (Autism), HER, iMovie-VMIT, Symbol matching, and Picture-based computer apps were developed as cognitive or social educational tools. Similarly, these apps will not encourage verbal communication if used in their original design.

The readymade apps (Proloquo2Go, My Choice Board, GoTalk NOW, Sonoflex, Pick A Word, HER, iMovie-VMIT, Symbol matching, and Picture-based computer) contain adequate tools or exercises, thus work reasonably well for their specific purposes only. On the contrary, the custom-made apps (iCAN, Turkish sequencing game, SIGUEME, and Find Me (Autism)) contain inadequate tools or lessons. Due to these limitations, the readymade and custom-made apps used in the studies could not effectively perform as verbal communication intervention tools. The researchers had to apply additional procedures when using the apps to deliver the interventions in their studies. The approaches that were taken by the researchers were analyzed to deduce the features of a satisfying verbal communication intervention app. Detailed analysis reveals that the intervention apps should be designed with the following characteristics:

- Attractive and engaging to the children with ASD;
- Able to identify the child's capability and suggest appropriate lesson activities;
- Encompass specific learning outcomes with multilevel lesson strategies;
- Use systematic evidence-based intervention procedures in the activities;
- Are able to evaluate the child's learning progress;
- Allow the caregivers or therapists to keep track of the application usage and performance.

Most of the participants in the selected studies showed high levels of interest in the apps during the intervention. They showed a preference for electronic devices compared to traditional materials like books and cards. The high level of interest in electronic devices could motivate children with ASD to stay engaged in learning. No challenging behaviors were observed upon the introduction of the apps during the intervention. However, the features and contents of the apps, particularly how interesting the tasks were to the children and the novelty of the tasks, influenced children's motivation to communicate verbally ^[23]. If the software application did not respond as expected, the children would react by making sounds to express their annoyance.

Children with ASD process icons and images faster than texts ^[24], and they respond to exciting pictures that are displayed on the apps. An additional feature like voice output can help to increase children's attention and convey the message. The voice output could motivate the children to 'voice over' (or speak out loud), especially those individuals with little control over their vocalizations ^[25]. Imitating the voice from the device is the first big step for the children to initiate speech and learn verbal communication skills. Unfortunately, finding an app that 'speaks' their mother-tongue language is often challenging ^[26]. In addition, the apps could be further enhanced by integrating the speech processing techniques for detecting correct verbal responses to encourage verbal communication ^[27].

A good intervention app should be equipped with a preliminary assessment section to identify the child's capability and suggest practical lesson activities accordingly ^{[28][29]}. It would be helpful if the apps could indicate the specific competencies that the child should have to begin. A multilevel lesson strategy for each learning outcome should be

provided as individuals with ASD have different learning abilities. Some intelligent procedural modifications should be in place, in which the implemented instructional procedures can be individualized to suit the learning characteristics of every child with ASD.

Interventionists' systematic evidence-based intervention procedures should be adapted into the software application as they were proven effective [30]. For example, the adaptation of the ABA concept by Doenyas et al. was proven to improve the children's expressive language and social communication behaviors [31]. The researchers also suggested that implementing MLT procedures could help promote independence and correct requesting during the intervention [32][33]. Parsons suggested that the 3T (theory, technology, and thoughts) design approach should be taken as a framework for designing and developing future ASD-specific technology apps [34]. Fletcher-Watson et al. stated that it is essential to include evidence-based intervention procedures in the apps that are designed for individuals with ASD [28].

According to the professionals within the ASD community, the intervention apps should have a system to evaluate the child's learning progress and a reporting system for the caregivers and therapists [35][36]. It will be an added value if the application software is interactive. For instance, it sends progress notifications, allows users to add their voices, is intelligent enough to allow sufficient time to carry out the learning activities, and monitors and assesses the proposed activities. The apps, aided with intelligent algorithms, could adjust the learning strategy depending on the child's performance.

The above findings were deduced by analyzing each intervention approach in the fifteen selected studies. It can be observed that the researchers had taken additional measures in the intervention process due to the limitations of the apps. In all studies, the researchers concluded that the apps were contributing positively to the target participants. However, most studies used a small sample size, consisting of one to ten children with ASD. Only three studies had more than ten participants. All studies did not systematically analyze the intervention duration, but they emphasized that the frequency and duration of intervention play a significant contribution. In accordance, this paper has excluded the intervention frequency and duration as factors to be stressed when examining the studies. We believe a systematic and comprehensive analysis should be conducted using proper intervention apps to get the optimum intervention frequency and duration.

3. Conclusions

This technology could enhance the intervention quality as it enables correct responses to be easily prompted without fatigue. Technology that is paired with human interventionists could contribute to better reinforcement which facilitates learning and motivates verbal communication even in low-functioning children with ASD. With a proper schedule, the use of technology can make the parent-delivered interventions at home more focused and systematic. The continuous use of interventions in a home environment contributes to longer treatment times that would improve the child's ability to communicate. Additionally, the application software with technology devices (i.e., iPad, tablet, computer) could be cheaper than augmentative and alternative communication (AAC) devices and they could be useful and powerful instruments for intervention. Finally, the use of technology in intervention does provide benefits to children with ASD. However, it should never replace the interventions that are provided by qualified therapists.

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