

# *Mobile Technology for Children with Autism Spectrum Disorder: Major Trends and Issues*

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*Abstract*— Mobile devices had gained popularity among the special needs community. These mobile devices are the new and cool gadgets to be seen with, unlike the ‘old’, complex and ‘I-am-not-normal-looking’ assistive devices. These mobile devices were said to serve as a communication device in the pocket, a learning device on the go and even a lifesaver for some. Among the features are its flexible multimedia content and storage, portability, mobility and affordability. The touch screen interface makes it appealing and simple to use, particularly for those who have weak fine motor skills. It offers practical communication solutions for autistic persons in relating to their families and others in the community. The flexibility and the advanced capabilities of mobile technology are opening new opportunities for further research in the area of computer-based intervention for children with ASD. Several anecdotal reports gave an early indication of the immense possibilities of how these devices could play a significant role in enhancing the quality of life of the children with ASD and their families. There is definitely lack of published research studies on the use of mobile technology with children with ASD. Due to the growing popularity of adopting mobile devices as assistive devices, more in depth research in warranted.

*Keywords*—autism; computer technology, mobile technology; assistive technology; trends

## I. INTRODUCTION

Children with Autism Spectrum Disorder (ASD) is said to have qualitative impairments in verbal and non-verbal communication that severely affects their relationship with their families and others around them. It is also reported that 50% of individuals diagnosed with ASD do not speak but are highly visual-oriented [1] with the presence of strong visual-spatial skills [2]. This is supported by research studies that found persons with ASD responded better to visual based stimuli compared to auditory-based stimuli [e.g. 3, 4, 5, 6].

The flexibility and capability of the computer to store, use and retrieve high volume of still and moving visuals makes the machine rather engaging for children with ASD. It seems like a perfect match between computer technology and children with ASD. Computers are emotionally and socially neutral and this addresses the anxiety that children with ASD typically experience when trying to communicate with other people in person or in unpredictable social environments [7].

## II. COMPUTER TECHNOLOGY AS ASSISTIVE TECHNOLOGY WITH CHILDREN WITH AUTISM SPECTRUM DISORDER

Capitalizing on this strength, many professionals and schools utilizes computer technology as assistive technology to support children with ASD. Assistive technology is defined as “any item, piece of equipment, or product system, whether acquired commercially, off the shelf, modified, or customized, that is used to increase, maintain, or improve the functional capabilities of children with disabilities” [8]. In general, assistive technology can be any tool that is used daily to improve or increase the functional abilities, be it educational, social, behavioral or physical, of children with disabilities [9].

The idea of using computer technology as assistive technology with children, including those with ASD, is not new. For example, Goldenberg [10] reviewed the uses of the computer for communication for those with serious communication problems (e.g. deafness, autism or severe physical handicaps) and reported a pilot research work with 10 multiply handicapped children (5 – 16 years old). He viewed that computers are as prosthesis to these special children that can radically improve their quality of life, stating, “if you can control a computer, you have a powerful tool for communication and access to vast range of valuable educational, vocational and recreational activities” [10, p. 5]. Goldenberg also highlighted early research works of other researchers [e.g. 11; 12] that confirm the ability of the computer as a mediator to human communication as well as a stimulus for spontaneous and voluntary speech and communication among children with ASD.

### A. Major Trends and Issues

There seems to be a sharp increase in the research articles published on the use of computer technology with children with ASD in the past ten years as compared to the 1990s and 1980s combined (see Figure 1). It is found that majority of the computer-based interventions address the core issues faced by children with ASD, such as communication skills, literacy and academic skills, social skills, and emotion recognition. Other skills include functional life skills e.g. using activity schedules,

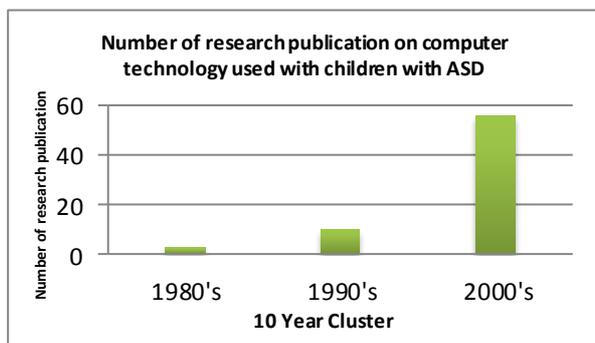


Figure 1. Number of research publication

independent task completion, increased attention, understanding of virtual environments, symbolism and imagination, sense of presence, decreasing problem behaviors and pretend play.

### 1) Communication skills

One of the significant characteristics of children with ASD is the difficulty in communicating, be it verbal or non-verbal. It is not surprising that a notable amount of research focuses on developing interventions to address this core issue [e.g. 13]. Due to the fact that traditional communication interventions require highly complex procedures both in training and implementation as well as time consuming [14], computer technology has been utilized to provide intervention and instruction. Using computer-based intervention, the specific communication skills that were targeted are increasing vocal imitation [15, 16]; learning and increasing new vocabulary words [17, 18, 19, 20, 21]; increasing spoken utterances [15, 17, 20, 22, 23]; and functional language [17, 22]. Most of these studies were carried out in a school classroom while the rest were either carried out at a computer room in the school or the university-based laboratory.

### 2) Social emotional skills

What heightens the impairment of communication skills in individuals with ASD is the inability to display appropriate social etiquette. Children with ASD often lack social understanding, awareness, empathy as well as failing to recognize others' emotions and facial expressions [24, 25]. These impairments ultimately lead to difficulties in creating and sustaining meaningful, positive relationships (Bellini, 2006). Therefore, many computer-based programs has been designed and developed to train and teach social understanding and awareness [25, 27, 28, 29, 30] as well as emotion identification and recognition [31, 32, 33, 34].

### 3) Functional life skills

One of the important goals for children with Autism is to attain functional life skills that would advance self-determination, greater independence and autonomy. Several researchers have used computer-based interventions to instill these functional like skills. For example, Kimball, Kinney, Taylor and Stromer [35] developed and tested a computer-mediated activity schedule with a young child with ASD and found that he was able to generalize the activities. Another group of researchers worked with several children, age 7-9,

using a software program that simulated real-life activities such as setting the table, making soup and making a sandwich [36]. The program required the student to manipulate images on the screen that stimulated the natural environment. The researchers found that each child mastered all the skills they were taught via the computer and generalized to the natural environment and the skills maintained after a two-week follow up. Teaching older children with ASD to complete a task independently via computer based instruction such as cooking with recipes [37] and pushing a 'request to stop bus signal' and exit a city bus in response to target landmarks [38] also yield positive results.

Various computer technologies were used as the delivery system in the many research studies mentioned above. Among the most commonly used system is computer-assisted instruction. Computer-assisted instruction usually utilizes a desktop computer or a laptop loaded with either commercial softwares (Microsoft Power Point and Hyperstudio), specialized software programs made specifically for children with ASD and other developmental disabilities (Keytalk, Alpha, Delta, Speech Viewer, Emotion Trainer, Baldi/Timo, I Can Word It Too, TeachTown: Basics, Mind Reading, Junior Detective Program, I Can!-Daily Living and Community Skills, Book Builder, Let's Face It!, FaceSay), and other programs developed by researchers. Other technology such as virtual environments and virtual tools are also gaining some popularity. Some researchers have also explored the use of robots as well as smart-board technology.

## III. COMPUTER TECHNOLOGY TO MOBILE TECHNOLOGY: MOVING FORWARD

Recent advancement in computer technology in mobile devices has opened up immense possibilities for children with ASD. Mobile devices serve as an augmentative and alternative communication (AAC) in the pocket and had since gained popularity because of its flexible multimedia content and storage, portability, mobility and affordability. The touch screen interface makes it appealing and simple to use as well. Below cites several case studies and recent reports on how some of the intervention techniques can be assimilated with mobile technology where "high" technology strategies can be implemented with more flexibility, mobility, and portability; and at a relatively lower cost.

### A. Case Studies and Anecdotal Reports

#### 1) Picture Exchange Communication System (PECS) in smartphones.

Researchers Dr. Gonyer Leroy and Dr. Gianluca De Leo shared their development of the PECS system to be used in smartphones. Citing the traditional low tech PECS to be cumbersome, time-consuming and inefficient, the researchers developed software that emulates the system of PECS that addresses the limitations of paper pictures. In their smartphone solution, the software system is able to first, allow the child to move the images around to form sentences simply by touching the mobile device screen as well as track the number of times each image is being used by the child to form messages. Second practical solution to enhance the PECS system is the ability to easily customize the images based on the needs,

interests and preferences of each child as compared to the tediousness of creating personalized picture cards [39]. An online report of this research project claims “initial trials of the application involving children with moderate to severe autism have yielded encouraging feedback about its advantages over traditional laminated paper cards” [40].

### 2) *Mobile communication tools for children with special needs.*

Another notable report is on prototypes of mobile communication tools for children with special needs called Mocoto. Researchers Monibi and Hayes discovered, through interviews and observations, the need for extreme flexibility and customization in these visual communication tools. Recognizing children with special needs possessing only crude motor skills, they explored new technologies, such as the “capacitive screens on many small touch-screen devices” which could provide fresh path for interaction [41, p.122]. Their first prototype Mocoto is operated on portable device, a Nokia N800 cell phone. The touch screen capabilities allow for easy interactions with a comprehensive library of cards which come preinstalled with the Mocoto. The system has the flexibility for users to add customized images such as digital photographs, scanned materials or created digital images. These images can be easily managed and categorized with the customizable meta-data for future searches.

### 3) *iPod, therefore I can.*

In another research carried out by Dr Genee Marks and Jay Milne in a special developmental school in Victoria, Australia, the use of iPod suggested improvement and progress in the participating students. The main aim of the study was to explore the educational potential of emerging technologies, particularly, the iPod. The majority of the participants of this study were located on the autistic spectrum. In this study, contents such as “photos for personal self-esteem and social cognition; movies featuring the student as social scripts to demonstrate and reinforce appropriate behaviours; the use of pictorial symbols for coin recognition, days of the week, and daily activities (such as timetabling); and pictorial symbols, photos and videos to improve cognitive skills, such as classifying and categorising” were placed in the devices to be used with/by students in the classroom under the supervision of teachers [42, p. 173].

### 4) *Augmentative and Alternative Communication (AAC) in the pocket.*

In other recent reports, applications such as iConverse (<http://www.converseapp.com/>) and Prologue2go (<http://www.proloquo2go.com/>) are showing favourable success in aiding persons with communication disabilities. These applications are specifically developed for persons with impairment in communication and language. iConverse was specifically designed for young children especially those which communication difficulties and disabilities. In their website, creators of iConverse are optimistic that as an educational tool, it could assist in communication just as any high tech AAC but in a less bulky and inexpensive way. There are 6 basic icons representing a person’s most basic needs. These icons are activated when touched, giving both visual and auditory representation. Important features of iConverse are the My

Buttons’s features which includes: ability to make custom icons with pictures; add text to the pictures to enable text to audio; visual display of custom icons with scrolling ability; audible sentence stating the icon that was touched.

Another application that is gaining popularity is Prologue2go. Doctoral student Samuel Sennott stated that Prologue2go was created to provide a cheaper and easier way to convert text to speech. Though there is no empirical data to support its effectiveness, recent feedbacks from parents with autistic children are shouting its usefulness and practicality. One parent exclaimed that the application has changed her son’s life. “He is actually communicating,” she says. “It’s nice to see what’s going on in his head” [43]. The website also reported that “special educators, speech language pathologists, occupational therapists have found Proloquo2Go a proven communication solution for children and adults”. Some of its key features are: full communication solution with a default VocaSpace vocabulary of over 7000 items; built-in natural sounding text-to-speech voices; supports picture and/or text-based communication; close to 8000 built-in symbols, automatic conjugation of verbs, automatic plurals and possessives for nouns; extensive customization options: item size, color, interactivity, restrictions, speech; one-button addition of new vocabulary items and categories; easy cut, copy and paste of items; quick access to recently spoken items for the last 15 minutes, last hour, all the way up to one week back; and typing view for typing full paragraphs.

### 5) *The life changing experience of the iPad.*

In yet another recent report, a mother shares her experience of how an iPad change the life of her son, Leo [44]. Leo is a 9-year-old boy with Autism with the typical issues associated with Autism such as verbal communication and aggressive and violent behavior. After spending time using the iPad, his mother, Shannon, notice signs of independence in Leo. He was able to draw in ways he previously could not while his violent outbursts were quell with the help of the iPad. Shannon is all praise for this new technology and how it has helped her son.

In a separate report on CNN.com, Seshadri’s report entitled “iPad gives voice to kids with autism” highlights how the iPad has revolutionized communication yet again. In the case of Sharia, a two year old girl with Autism, it has given her a voice. It was reported that even after speech, occupational and behaviour therapies, Sharia still struggled with communication. With the iPad, she is now able to “speak in broken sentences and is aware of the world around her”. The significant of the presence of the device was so great that the father of the child was reported to say “I think of it as Sharia before the iPad and Sharia after the iPad” [45].

## IV. FUTURE RESEARCH

Though tablet computers and other mobile devices are not made specifically to be an assistive device, parents are adopting and adapting it to support their child with ASD. As yet, there is still no published research in peer-reviewed journals on the use of mobile technology with children with ASD. Though a small number of conference and anecdotal reports were found, there is obviously a dearth of research studies in this area. Obviously, these conference and anecdotal

reports cannot be generalized and taken as research evidence as you would with other empirical studies. However, it does give an early indication of the immense possibilities of where these emerging technologies could bring us. It offers promising development as well as practical communication solution for autistic persons as well as for their families. The flexibility and the advanced capabilities of mobile technology are opening new opportunities for further research in the area of mobile-based intervention. These emerging technologies has so far elevated and enhanced the quality of life for children with communication impairments and their families albeit anecdotal reports. Further empirical and well-designed research is warranted to substantiate these findings.

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