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High technological design and application for autistic children: An analysis of digitalized therapeutic technologies

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***Abstract*---**The data from the survey include information on individuals of varied ages and levels of ability. We found that the pattern of access and use was consistent across age groups; however, a higher level of reading and language ability was connected with the utilization of a greater number of devices and interfaces. The ability to capture variation in the ways in which autistic children use commercial technologies influences future learning and helps in the invention of new technologies. There was a correlation found between the stated fear of technology and the amount of time spent using various forms of technology. According to the findings, in order for technologies to be engaging to people, they may need to achieve a high level of design quality. These technologies were developed with therapeutic goals in mind. Children and adolescents who have autism make great use of common forms of technology for a diverse range of recreational pursuits.

***Keywords*---**autistic children, commercial application, therapeutic technology.

Introduction

Less well-documented is the use of technology by autistic people who find standard surveys inaccessible, such as young children or those with learning difficulties. Digital gadgets with touchscreen, tactile, or whole-body interfaces are commonly available, making technology more accessible (Adusumalli, 2016a). Autistic people utilize technology for fun and school. They use technology extensively (apps, software, and online materials accessible via digital devices) (Sharma et al., 2021). Asking parents how their autistic children use devices and

for what activities can reveal technology use in a diverse autistic population, including younger children and those with learning difficulties.

Parent surveys can also be used to study the link between technology and parental perspectives. The majority of research has focused on self-reporting by autistic teenagers and adults (Hedges et al., 2017; Adusumalli, 2019; Mazurek & Engelhardt, 2013), although a recent investigation of parent attitudes in a small sample indicated that parents were enthusiastic but lacked understanding about their children's autism (Adusumalli, 2017a; Heidary et al., 2021). In addition to external effects, parents' opinions on technology may be influenced by their children's use. Anand and Krosnick (2005) say parental education and marital status affect the media children consume. Concerns of parents of autistic children may be heightened. Due to autism's social dynamics, especially isolation, parents may worry that technology may replace "real-life" communication with their children (Adusumalli, 2016b; Abdollahi et al., 2022). The presence of limited and repetitive activities may indicate that parents are concerned about their child's use of technology, as technology usage is restricted by professionals (Fadziso & Adusumalli, 2020).

Digital technology may help autism-related learning and development, such as communication, social skills, emotion recognition, and academic ability (Ramdoss et al., 2010). A recent meta-analysis indicated that there are just a few well-controlled research on technology usage among autistic people, despite the data base being typically high quality (Chisty & Adusumalli, 2022). For example, commercial technology innovation outpaces university research production by a wide margin. A systematic mismatch exists between technologies with independent effectiveness evaluations and commercially available technology (Adusumalli, 2022). The highest-quality technologies aren't usually the ones buyers can get straight from producers. It's important to know what technologies autistic children and teens use at home. Knowing this is a crucial first step in developing a solid evidence base for the future use of technology to benefit autistic persons.

The present research tries to bridge knowledge gaps about autism and technology and gives statistics on technology usage since the iPad and other mobile touchscreen technologies became popular (Ahmed et al., 2020). How do autistic children use home technology? We can collect information from parents about their children's devices, interface types, software, and functions, as well as time spent on technology-mediated activities, to answer specific questions regarding their children's use of technology. Do children with autism frequently utilize autism-specific technology, such as augmented or alternative communication devices and technologies built specifically for autistic users? Second, what is the relationship between parental opinions on technology, their child's reported usage, and the sample demographics?

Autism-specific design is another unresolved question in autism technology. In recent years, research has reported on best practices in designing with and for autistic persons (Fletcher-Watson et al., 2016), but little clearly ties design aspects with user experience or results. Commercially available apps for mobile touchscreen devices that are specifically advertised for autism exist (Fletcher-

Watson et al., 2016), however only a handful have scientific evidence to support their use. It's unknown if autistic people use autism-specific technologies or if they're just as—or more—engaged with mainstream technology. Since there has been much discussion about making technology accessible to users with motor and learning difficulties and creating content appealing to a broad spectrum of users, including those with developmental delays (Adusumalli et al., 2022), it is interesting to investigate whether and how commercial technologies can achieve these goals.

Methods

Procedure

The parents of children diagnosed with autism were asked to answer questions regarding their child's use of technology at home via an online survey that was distributed to them. The poll could be accessed online for around ten days. Once the survey was finished, the data were saved as a.csv file and analyzed using once the survey was finished, the data were saved as a.csv file.

Participants

A survey in English was constructed to gather parent demographics, kid characteristics, technology usage at home, and opinions toward technology use. Parents were asked "can your youngster read?" and could pick "yes," "learning to read," or "no." As part of the assessment, parents choose their child's most difficult level of language from a list that included babbling, word approximations, single words, two-word phrases, short phrases, multi-part sentences, wh-questions, complex grammar, pronoun use, and fluent, adult-like speech. Autism parents were polled online. We included data from children waiting for a diagnosis and those with secondary diagnoses such Fragile X Syndrome. Final sample (n=100) included Californians. Participants were divided into five age groups: preschoolers (5 and under), children (6-12), teens (13-17), young people (18-25), and adults (26 and over).

Analysis Methods

The survey included forced-choice responses (such as "select all the interface types your child is familiar with"), 5-point rating scales (such as "rate how strongly agree/disagree with the statement "I am concerned about how much time my child spends using technology"), and free-text sections (such as "list the top five apps/software/online platforms your child uses"). The data was separated by age: "preschool children" between 5 and 6, "children" between 6 and 12, "teenagers" between 13 and 17, "young adults" between 18 and 25, and "adults." To refine our findings, we split the sample by reading ability (fluent vs. learner vs. non-reader) and parent-reported learning disability. To make things easier, verbal aptitude was separated into two categories: "babbling, word approximations, single words, and two-word sentences" and "fluent adult-like speaking". Because these groupings aren't based on age (e.g. "individuals with/without learning disability"), we use "person."

Linear regression and Chi-Square testing were used to analyze technology use and demographic variables. When there are data gaps, case-by-case analyses are undertaken (including demographic information, information about technology access, etc.). Researchers asked them to name their children's five favorite apps, platforms, or software. The most frequently cited applications were ranked. We tallied up the answers identifying individual apps in that category to produce an overall frequency figure for all apps.

Parents used a series of closed-ended time-windows to describe their child's daily use of various technologies (such as a tablet or a games console). Using a 30-minute time window, data were converted to numbers and added to estimate daily technology use. These statistics were also used to estimate how much time each age group spent using a given device. The estimates differ because the number of responders with each device varies.

The poll included ten questions about how parents felt about their kids' use of technology. The replies were coded from 1 to 5, with higher scores indicating a more positive attitude toward technology. When charting the data, there were three answer groups (agree, neutral, disagree) with "strongly" collapsing at either extreme. Five relevant questionnaire questions were combined to create a 'attitude score' that assessed attitudes toward technology rather than (for example) available money for new technologies. "I worry about how much time my child spends using technology," "I've had problems with my child being obsessed with technology," and "Technology prevents my child from interacting with others" were added together, and a regression was used to examine the relationship between attitude score and participant demographics. Calculated final attitude score.

Results

Devices

Table 1 outlines the tech items children can use at home and independently. Technology access was not timed, but technology use was requested on each given day. Tablets and PCs/laptops were the most common all-ages electronics. Access to devices varied by age, learning difficulty, language competence, and reading level (fluent vs. learning vs. non-reader). An analysis of variance showed that age groups used different numbers of gadgets. The average number of gadgets used by those with and without disabilities was similar. More linguistically fluent people utilize more devices (4.45 vs. 3.25) It indicated that skilled readers (mean = 4.01) varied from learners (mean = 3.71) and non-readers. Researchers looked at how many devices people who were learning to read or couldn't read owned.

Table 1: Technology available to children in their homes

Device (%)	Adults ($n = 22$)	Teenagers ($n = 18$)	Children ($n = 140$)	Preschool ($n = 124$)
Nintendo DS	11 (28.57%)	7 (36.84%)	68 (48.75%)	51 (38.06%)
Wii	11 (28.57%)	8 (42.11%)	74 (52.5%)	42 (38.81%)

Apple Mac	5(14.29%)	2 (13.16%)	18 (17.5%)	6 (11.94%)
PC	25 (57.14%)	15 (62.79%)	109 (74.38%)	81 (67.91%)
Smartphone	14 (35.71%)	8 (31.58%)	51 (38.12%)	34 (32.84%)
iPhone	7 (19.05%)	6 (34.21%)	47 (35.63%)	24 (25.37%)
Tablet	13 (33.33%)	5(23.68%)	45 (34.48%)	44 (40.3%)
iPad	19 (42.86%)	8 (47.37%)	88 (61.25%)	58 (50.75%)

Commonly Used Software

When we refer to the "purpose" of a piece of technology, we are referring to the explanation that parents give for why their child uses it. The survey presented the parents with a number of predetermined options from which they may select only those that pertained to their particular child. Reading, playing video games, listening to music, navigating the internet, and engaging in a variety of other activities were all choices, in addition to the general category of "other" (Nayeem, 2015). According to frequency counts done by device type for both children and adults, the applications of technology that were the most popular were listening to music, watching videos on YouTube, and playing video games. According to the findings of this study, there are no discernible differences between the ages of participants in their use of technology.

Technological Approaches to Autism

The following list details the applications that were mentioned the most frequently by survey participants.

Endless Reader

Endless Reader introduces "sight words" to beginning readers and autistic youngsters with learning and speaking difficulties. "Sight words" are often used in school and children's books, making them "must know" vocabulary to read fluently. Endless Reader teaches kids hard-to-spell and pictureless words. Endless Reader features an interactive app where a flashcard is within a monster's mouth and students can choose which word to study. Then a sentence with the selected word appears, and students can tap the words to hear them pronounced. A little monster then scatters the sentence's words. The learner must reassemble the words to complete the original statement. Each movement is animated and repeated. More than two hundred words are included in each of the first two levels of the school edition (Level 1 for PreK-K, Level 2 for K-2, and Level 3 for grades 2-3). At the level 3 of Endless Reader, there are 118 additional words. There is also a new version available for teachers, in which pupils can additionally spell out the word that has been selected. It offers cute animations to make the learning process more entertaining, word puzzles to help with spelling and sentence formation, and the ability to interact with the software at a student's pace. This app is educational, not stressful.

Otsimo

Zafer Elcik co-founded Otsimo, an autistic app with AAC and games. AAC helps people with speech impairments and ASD communicate. Otsimo offers premium

and free learning packages with no commercials, 100+ games, analytics, daily reports, recommendations, video modeling, and speech therapy skills. With premium, kids may play voice-based games to help parents improve their vocal and communication abilities. Amazon Echo can play speech therapy games. Elcik built Otsimo to support his 2-year-old sibling who has severe autism. Elcik's younger brother had trouble learning, but his attention span grew 10 times when he used smart devices. Elcik gave his brother an iPad because of this. Elcik was committed to design a safe and functional autism software without damaging adverts.

Proloquo2Go

AAC software Proloquo2Go uses symbols. It's iOS-compatible. AssistiveWare designed it in April 2009. "Not being able to speak isn't the same as having nothing to say," software creators say. The app is for persons with severe cognitive difficulties to minor issues. Autism, Down syndrome, cerebral palsy, and other special needs diagnoses are its target audience. It helps with apraxia and dysarthria. The app is used by adults and children, but it didn't have a child's voice before. In 2012, AssistiveWare altered that. About 60% of AssistiveWare's users are under 12, so offering real children's voices made sense, said CEO David Niemeijer. No more plans are planned for the software, although AssistiveWare explains why. Niemeijer: "We'd rather create the best product on one platform than several ones." 70% of iPad buyers bought it for the app, he said.

Language Therapy for Kids

Language Therapy for Kids - MITA is a method of teaching that has been scientifically proven to be very effective in methods of teaching: in a three year study of 6,454 children affected with autism, those who trained with MITA scored an average of 2.2 times higher on a final test than those who did not study with MITA. Language Therapy for Kids - MITA was developed by researchers at the University of California at Los Angeles. There are a variety of activities, such as color identification, time prepositions, subject/object, writing and reading, and arithmetic, included in this program. No Wi-Fi connection required, and No ads there. In addition to English, it is also available in 11 other languages: Portuguese; Russian; German; Dutch; Spanish; Italian; Persian; Arabic; Farsi; Korean; Chinese. MITA boosts imagination and language skills. The app's activities will get harder with time, such assigning two chores instead of one (ex. define the color and size). As a child masters a subject, the problems get harder. MITA is for kids and daily use. Engaging elements help kids focus. This software is for children with language delay, SD, PDD, IDD, Down syndrome, autism, and other diseases that hinder communication.

LetMeTalk

LetMeTalk by Appnotize UG is a free AAC app designed to give everyone a voice. The program uses over 9,000 photos from its database to produce messages in the form of sentences. It also lets users take photos to use in the app, allowing for customization and familiarity. The app doesn't require internet or a cell contract, so it can be used practically everywhere. The AAC platform aids people with

disabilities like autism, speech apraxia, Down syndrome, and other speech-impaired conditions. It has several helpful features. It's available in English, Spanish, French, and Italian. This helps users communicate with individuals worldwide. It also supports voice support for images and words, enhancing non-verbal communication. Instant messaging allows users to communicate online. 18 languages are significant because they allow users to break both the language and speech barriers. Few "verbal" persons can converse with people around the world. LetMeTalk's simple and comprehensible platform actually helps anyone converse.

Time Spent in APP Activities

According to table 2, tablet computers are used for significantly longer lengths of time than the vast majority of other types of technology. Tablets are used for more than an hour every day, on average. iPads (mean usage time across groups: 80 minutes), other tablet brands (mean: 42 minutes), and personal computers (mean: 61 minutes) were the devices that were used the most frequently across all age groups. It appeared that children, adolescents, and young adults were more likely than people of other age groups to use gaming devices, and they were also more likely to use these devices for a longer period of time than people of other age groups.

Table 2: The average amount of time spent engaging in activities mediated by technology, broken down by device

Mean time* (*n* with access)	Adults (*n* = 42)	Teenagers (*n* = 18)	Children (*n* = 140)	Preschool (*n* = 124)
Kinect	0 (4)	3.33 (3)	0 (11)	10 (8)
Apple Mac	24.3 (12)	18 (16)	69.6 (28)	26 (16)
PC	38.3 (24)	118.4 (25)	80.9 (119)	56.2 (91)
Smartphone	16 (15)	40.8 (12)	32.2 (61)	10.5 (44)
iPhone	37.5 (8)	103.8 (13)	64.3 (57)	11.7 (34)
Tablet	82.3 (14)	67.7 (9)	48.1 (55)	38.1 (54)
iPad	65 (18)	93.8 (18)	80.1 (98)	70.8 (68)

Each participant's daily time spent utilizing technology was calculated. An individual's age, learning impairment, language ability, reading skill, and number of gadgets were all analyzed to establish their influence on the total amount of time the individual reported spending with technology (Dan et al., 2021). Literacy level and number of gadgets in the home were the most important predictors of technology usage; higher levels predicted longer use. Age, learning disability, and language competency didn't predict technology use.

Parent attitudes

Parents were asked if they were concerned about their child's technology use on a 5-point scale. This was compared to parents' overall tech use. Parents' fear was linked to their child's screen time. Parents who were more concerned about their child's technology use said their youngster used it more. The poll asked parents 10 questions about their kids' tech use. To measure attitudes toward technology,

the researchers constructed a scale comprising three items: "I'm worried about how much time my child spends on technology," and "I've had issues with my child getting obsessed with technology." The median attitude score was 9, with 3 signifying the most negative/worried attitude and 15 the most positive/relaxing. We were able to determine whether parent factors (parents' age and age at which they left school) and child factors (child age, presence of learning disability, reading and language level, number of devices they accessed at home) were associated with how much time people reported spending with technology. Higher reading levels were connected with more time spent using technology when predicting parent attitudes toward technology.

Discussion

This article's objective is to explore how children with autism use digital technology in their homes, as recounted by their parents, and to incorporate data from the adult offspring of these autistic children. We looked into the different kinds of technologies, interfaces, and software that were utilized, as well as the total amount of time that was spent participating in activities that were mediated by technology. We questioned precisely whether or not parents would report high levels of use of technology that was designed specifically for autism, as well as whether or not they would report high levels of use of technology in general. In addition to this, we investigated the perspectives of parents with regard to the use of technology by their children, in addition to the factors that may contribute to variation in these attitudes.

Using Technology

The usage of newer mobile and touchscreen technologies by children of all ages, as well as adults with varying levels of language and reading ability, is consistent with previous research (Adusumalli, 2017b). Those with better reading and language skills had access to more devices, used interfaces more independently, and spent more time with technology. Persons with learning difficulties could use more technological interfaces independently than people without learning problems (Urdziková et al., 2016). This was an unexpected conclusion, considering persons with learning disabilities have fewer gadgets and spend less time using technology. When their children have trouble utilizing the keyboard and mouse, parents may explore for alternate interfaces. Parents of children with these qualities may have been more engaged in teaching and encouraging their child's use of these interfaces, as reported by parents. Compared to adults, kids utilize more interfaces alone. This may be because adults still use the same technology they had as youngsters and haven't expanded their interface options (Adusumalli, 2018). Given that we expect autistic adults to reside at home with their families, our adult group may contain more persons with learning difficulties and other complex needs. These findings also imply a delicate interplay between parental attitude, kid abilities, age, and technology use, which will require observational techniques and additional qualitative study.

We continue to believe that design, especially for children with autism, has benefits (Fletcher-Watson et al., 2016), including the capacity to empower children through the design process (Frauenberger et al., 2013). Recent research

shows that technological products are crucial to the well-being of autistic people. Establishing a solid proof base for current autism technologies is an important future research subject. Digital gaming, YouTube, listening to music, and taking photos were often reported uses of technology. Such events aren't just for fun, though. According to other studies, children with autism may be better able to talk and play together while using technology (Farr et al., 2010). Our qualitative survey data and observational data will need a more in-depth examination to see how our category definition of use manifests itself. A study should also include how non-functional technology may be important to the person being studied. Some electronic elements might be comforting, while others provide vital cultural information for peer social relationships (Linderoth, 2012).

Parents' Perspectives

Parents who worried about their child's screen time gave higher estimations. This finding is difficult to interpret due to parent-report data. Parental concerns over "screen time" may overstate or understate their children's reported time spent on devices. Only a child's reading ability predicted parents' tech attitudes. No parent or child factor predicted technological attitudes. Better readers may be able to access more online or digital materials and be more autonomous, causing parents concern. This study has multiple flaws, the most major being that all findings are based on parent reports of their children's technology use. For example, the media has recently discussed the issue of "screen time" and how it affects children. Without a deeper look at cross-cultural differences in employment and socioeconomic position, these results are confusing. Although we did not compare our groups based on their residences or demographics, we believe we have a good representation of varied socioeconomic and demographic backgrounds across the sample.

We couldn’t compare technology use across weekdays. On weekends, children with and without autism have increased access to electronics. We also didn’t compare autistic and non-autistic people’s technology usage, despite past research showing no difference between these groups, especially in a large and representative sample. Our findings about the home technology utilized by autistic people have implications for design and future research. First, new technologies for autistic persons must be competitive with or at least equal to existing technologies and applications, which autistic people habitually utilize. The patterns of technology use revealed by parents of children with autism in this study are similar to those expected of non-autistic children. The most common uses of technology are gaming, listening to music, watching movies, and performing schoolwork. Autism-specific apps are rarely used. Parents are concerned about their children’s use of technology, specifically the amount of time they spend on gadgets and its societal repercussions. Future research may employ qualitative and observational methods to investigate these concerns.

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