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A preliminary investigation assessing the basic digital capabilities of minimally verbal children on the autism spectrum with intellectual disability.

Journal of Enabling Technology

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Abstract

Purpose: Children with Autism Spectrum Disorder (ASD) can demonstrate a preference for using digital technologies which can represent a relative strength within the autism community. Such a strength would have implications for digitally-mediated interventions and support for autism. However, research to date has not developed a methodology for assessing the capabilities of minimally verbal children on the autism spectrum with intellectual disability (ID) to use digital technology. Methodology: Six minimally verbal children with ASD and ID undertook an accessible assessment that identified what capabilities for interacting with a digital tablet device they could and could not demonstrate. 12 brief assessments were demonstrated, including turning on the device, adjusting the volume, operating the camera, touching, tilting and rotating the screen. Findings: Participants could be assessed on their digital capabilities. In this study, participants could largely touch and swipe the screen effectively and leave the app, but could not tilt and rotate the screen nor turn on the digital tablet device. Research limitations/ implications: Whilst the numbers were small, the findings indicate that the digital capabilities of this group can usefully be assessed. Future research can use such assessments to highlight how intervention effectiveness and support can be enhanced by matching the digital capacities of minimally verbal children with ASD and ID to technological support. This is a preliminary study and a greater understanding of children's prior experiences with technology will better inform how and which digital capabilities develop. Originality/ value: This is the first study to assess a range of basic capabilities for using digital tablet devices in minimally verbal children with ASD and ID.

Keywords: Autism, minimally verbal, intellectual disability, digital technology.

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder characterised by the combination of persistent deficits in social communication and social interaction and restricted, repetitive patterns of behaviour, interests or activities, that cause significant impairment in normal functioning and have been present since the early developmental period (APA, 2013). The prevalence rate of ASD in America, Europe and Asia has been estimated at between 1% and 2% (CDC. 2014), with the majority (70%) of those diagnosed with autism having at least one other co-morbid psychiatric condition - 41% having two or more (Simonoff et al., 2008). One common co-morbid condition is intellectual disability (ID). ID is characterised by an Intelligence Quotient (IQ) of 70 or below, as well as deficits in adaptive functioning (APA, 2013). Adaptive functioning refers to communication, social and other skills needed to live an independent life. ID has been estimated to affect from 56% to 73% of individuals with ASD, depending on the diagnostic criteria, and may include individuals in the 'borderline' IQ range (71-84: Baird et al., 2006; CDC, 2014). However, this large portion of individuals with ASD is severely underrepresented in current research (Pellicano, Dinsmore & Charman, 2013), which focuses mainly on those without ID. Further, around 30% of individuals with ASD are minimally verbal (Brignell et al., 2018; Tager-Flusberg & Kasari, 2013) and are also under-researched and have been referred to as the "neglected end of the spectrum" (Tager-Flusberg & Kasari, 2013). Although some research has suggested that IQ of minimally verbal children is often underestimated (Munson et al., 2008), a large portion of minimally verbal children with ASD are also diagnosed with ID.

Individuals with ASD have also shown preference for being delivered intervention and support through digital tablet devices, compared to non-digital formats, such as pen and paper (Bouck, Savage, Meyer, Taber-Doughty & Hunley, 2014; Hourcade, Bullock-Rest & Hansen, 2011; Whalen et al., 2010; Williams, Wright, Callaghan & Coughlan, 2002). The development of touchscreens has supported children with ASD, ID and both ASD and ID to use tablet devices and engage comparably in the development of digital technology to support their needs (Brosnan et al., 2016; 2017; Constantin et al., 2017; Kagohara et al., 2013; see also Parsons et al., 2019). However, a higher than usual prevalence of deficits in both gross and fine motor function has also been identified in those with ASD (Bo, Lee, Colbert & Shen, 2016; Bhat, Landa & Galloway, 2011; Jansiewicz et al., 2006; Lloyd, Macdonald & Lord, 2011; see also Arthur et al., 2019), which may impact on how effectively touchscreen tablet devices can be used.

A survey of family members identified that 83% of children (aged 1-17) with ID use digital devices (Palmer et al., 2012). Individuals with ID mostly used digital devices for recreation (78%) as, within schools, students with ID are often unable to use educational technologies as very few devices have been designed to ensure access and utilisation for this population (see Ayres et al., 2013; Palmer et al., 2012; Wehmeyer et al., 2004; 2008). Teaching those with ASD and ID who are minimally verbal presents additional challenges as they do not have the verbal abilities to learn through usual methods (see McIlvane et al., 2016; Serret et al., 2017). Serret et al. propose that such challenges can be overcome by using digital technology to support relative visual-spatial strengths in minimally verbal children with ASD’s learning. Tager-Flusberg and Kasari (2013) call for a better understanding of how digital technologies such as tablets might be used most effectively and what the limits might be for this population. This preliminary study sought to identify whether the digital capabilities of this population could be assessed through the ‘SMART-ASD’ app.

Method

Participants

The participants were six minimally verbal children with ASD and ID, consisting of three males and three females with a mean age of 10.67 years (range 7-13; SD=2.88). Participants all attended a specialist centre for children with special educational needs. All participants had received a formal diagnosis of both ASD and ID from a clinician using internationally agreed standards (WHO, 2018). Whilst the presence of these diagnoses was confirmed by centre staff, the diagnoses were not made available to the researchers (see below). Nine participants with ASD were initially included, but two dropped out due to an illness and one withdrew due to leaving for a treatment.

Ethics were obtained from the University of [ANONYMISED] Psychology Department Ethics Committee. Parents and teachers provided written consent and assent was sought from each child. If the child demonstrated any sign of distress, the assessment would cease, but this did not occur.

Procedure

Classroom staff (teachers/ teaching assistants) were asked the child’s sex, age and estimate the number of days per week (0 to 5) the child used a digital tablet at school. Staff were then asked to indicate the child’s level of impairment (none, mild moderate, severe) on the following dimensions: Level of Autism; Level of General

Cognitive Ability (intellectual functioning, IQ); Level of Expressive Language skills; Level of Receptive Language skills; Level of Reading skills; and Level of problematic behaviour (Smith et al., 2020). These staff assessments of children's level of impairment are subjective and relate to the perceived levels of support the child needs from the DSM5 criteria (needs no support; needs support; needs substantial support; needs very substantial support; Smith et al., 2020). Whilst the methods by which teachers, clinicians and researchers operationalize severity largely depend on individual preference, background, and training (Weitlauf, Gotham, Vehorn, & Warren, 2014), class teachers rating have been found to correlate well with formal assessments of the diagnostic criteria for autism (Azad, Reisinger, Xie, & Mandell, 2016).

A Samsung Galaxy Tab S 8.4" was used with the SMART-ASD app (which is free and available for the iPad[1], which assesses 12 key skills for using tablet devices (such as touching the screen, swiping), see Table 2, column 1, for a list of all 12 tasks and Figure 1 (and SMART-ASD.EU[2] for details about the overall project). The demonstrator starts with a blank screen. The screen illuminates and a task is demonstrated, as described in Figure 1. The app detects when this is completed. The screen goes blank with an image of an adult passing a tablet to a child and the tablet is passed to the child. The child repeats the task that has been demonstrated. Success is automatically recorded. The screen then goes blank with an image of a child passing a tablet to an adult. If the task has not been repeated successfully after

[1] https://apps.apple.com/us/app/smart-asd/id1225962755
[2] https://eur01.safelinks.protection.outlook.com/?url=www.smart-asd.eu&data=02%7C01%7Cpssmjb%40bath.ac.uk%7C72639e56619245c8722108d7cc50804c%7C377e3d224ea1422db0ad8fcc89406b9e%7C0%7C0%7C637202518434594148&sdata=AZ3GgcnDXCQyWCBjUgV39BKYcnpr%2Ffw6G8Qrct66nmM%3D&reserved=0

10 seconds a verbal prompt is provided (e.g. ‘touch’) by the demonstrator. If the task has not been successfully completed after 20 seconds the verbal prompt is repeated with a motor prompt (mimicking the movement that needs to be undertaken). If the task has not been repeated after 30 seconds, the screen goes blank with an image of a child passing a tablet to an adult. This is repeated for each task.

Figure 1 about here

Procedure

The centre identified children who had a formal clinical diagnosis of ASD and ID who were minimally verbal. Parental consent was obtained as was child assent prior to assessment. Classroom staff brought each child individually to a quiet room in the centre that the children were familiar with, and were able to provide any reassurance to the child if required (but no child became distressed). The researcher (first author) sat side by side with the child at a table and demonstrated the 12 tasks in turn, vocalising what they were doing during the demonstration. After each demonstration, the tablet device was then passed to the child who was invited to do the same as the researcher had just done. If required, verbal prompts (single words such as ‘touch’) were provided after 10 seconds and visual prompts (such as mimicking touching the button) were provided after 20 seconds. If the target behaviour occurred within 30 seconds, this was recorded as successful by the system. The 12 tasks are listed in Table 2 (column 1) and Figure 1.

Results

The assessments from classroom staff are reported in Table 1 for each child and were consistent with the formal clinical diagnoses. The children were perceived to be severely autistic, with severe ID (moderate in one child) and not expressing any words verbally. Most children were thought to comprehend single words and be unable to read any words, mostly with moderate to low levels of problematic behavior. Most children used a tablet device everyday.

TABLE 1 ABOUT HERE

All the participants were able to be assessed using the SMART-ASD pp. Table 1 highlights a high degree of variability in the number of tasks that could be completed (1 to 9), with a mean of just under 5 (out of 12). Table 2 shows which tasks were completed by each participant.

TABLE 2 ABOUT HERE

The only task accomplished by all participants was Touching Big Button, whereas none of the participants managed to Switch On the tablet device or navigate a route through a Labyrinth with their finger. Five participants managed to Touch the Screen Anywhere and Slide their finger across the screen. Four participants completed the Touch Little Button task and were able to Leave the App using home button. Tilting the Tablet, Orienting the Screen horizontally and vertically, Controlling the Volume, Navigating the Desktop and using the Camera were all completed once.

Discussion

This preliminary study sought to identify if the digital capabilities of minimally verbal children on the autism spectrum with ID could be assessed. The finding that all the participants could complete some tasks (to varying degrees) indicates that the SMART-ASD app is appropriate for identifying digital capabilities in this group. The minimally verbal end of the autism spectrum has been termed the “neglected end of the spectrum” (Tager-Flusberg & Kasari, 2013) due to the challenges with working with these children and recruiting samples that would allow meaningful comparisons. Therefore, before discussing the results further, it is important to note the small sample size in this study which may not be fully representative of the minimally verbal population with ASD and ID and the absence of a comparison group. However, digital technologies (tablet devices, smartphones) offer great potential for supporting this group of children in the development of independence and learning skills and such interventions will be most effective when the child’s digital capabilities enable them to interact with the technology. As there are no standardized assessments of basic accessibility to digital tablet devices for minimally verbal children with ASD and ID, SMART-ASD can be considered an *ad hoc* solution for such a diverse population with so many co-morbidities, where standard tests have little to contribute.

The types of tasks completed by each participant, shown in Table 2 and Figure 1, could potentially be useful when designing and delivering app-based support and interventions for minimally verbal children with ASD and ID, as there appear to be certain tasks these children find more difficult and some they find easier to complete. For example, there appears to be a need for those supporting minimally verbal children with ASD and ID to switch their tablet devices on, as none of the participants managed to complete this task. However, most participants were able to use the home button to exit the app, which may be useful for informing at what point the children could be left alone to interact with an app. Overall participants were able to accurately touch objects on the screen (both small and large) and enact a slide action on the screen. This was successfully achieved when the screen was in the orientation presented to the participants. Overall, participants were not skilled at adjusting the orientation of the screen, such as tilting the screen, or rotating it 90 degrees (from vertical to horizontal orientation). Accessing features such as the camera or volume control were only achieved by one participant. Serret et al. (2017) propose that relative visual-spatial strengths in this population can be developed to address challenges associated with being minimally verbal. This study suggests that the visual-spatial skills of touching specific areas of the screen and swiping (slide action) are capabilities that should be built upon for this purpose.

It has been argued that the autism community may particularly benefit from digital interventions and support (Bouck, Savage, Meyer, Taber-Doughty & Hunley, 2014; Hourcade, Bullock-Rest & Hansen, 2011; Whalen et al., 2010; Williams, Wright, Callaghan & Coughlan, 2002), although this is not based upon minimally verbal children and those with ID. Without a comparison group, the present study cannot confirm that this is the case for this population, though all participants could use the digital tablet device to some degree. Verbal children with ASD can have a propensity to engage with digital technology (Frauenberger, 2015; Mazurek, et al., 2012), and this affinity may extend to those who are minimally verbal with ID. The autistic mind has also been characterised as having relative strengths in areas related to technology (Baron-Cohen, 2012), which again may extend to minimally verbal children with ASD and ID and needs to be explored through future research (see Serret et al., 2017). There have been calls for the autism community to be actively engaged within the research process (see Fletcher-Watson et al., 2019a,b; Parsons et al., 2019) and this research suggests that including those who also have ID and are minimally verbal has potential for co-developing digital interventions and support.

There are a number of limitations to this study. For this study it would not have been appropriate to clinically reassess the participants for autism or ID and the confirmation of their formal clinical diagnoses were dependent upon subjective reports from classroom staff, rather than re-administered by clinicians. Such reports have been found to be effective and class teachers ratings have been found to correlate well with formal assessments of the diagnostic criteria for autism (see Azad et al., 2016; Smith et al., 2020; Weitlauf et al., 2014). Furthermore, assessing intelligence via traditional IQ tests has been shown to be inaccurate in those with ID (Sansone et al., 2014), with evidence showing that the IQ of minimally verbal children is often underestimated (Kasari, et al., 2013).

Crucially however, this study is limited in that it demonstrates that digital capabilities can be assessed for this group, not how or why these capabilities have developed or can be developed in the future. It may be that the tasks that largely were achieved were conceptually the simplest or required simpler motor co-ordination (Bo, Lee, Colbert & Shen, 2016; Bhat, Landa & Galloway, 2011; Jansiewicz et al., 2006; Lloyd, Macdonald & Lord, 2011; see also Arthur et al., 2019). Future research can identify why children on the autism spectrum with ID who are minimally verbal are able to perform some tasks, and not others. Knowing this can help inform the development of interventions for this population (see Brosnan et al., 2016; 2017; Constantin et al., 2017; Kagohara et al., 2013; see also Parsons et al., 2019) and the targeting of specific skills if they are required. In addition, Centre staff reported that most of the participants did use a tablet on a daily basis prior to this study. It was not possible to reliably identify the nature or extent of this prior experience. The literature would suggest that this use is largely recreational rather than educational (see Ayres et al., 2013; Palmer et al., 2012; Wehmeyer et al., 2004; 2008). Again, this study highlights that digital capabilities can be assessed rather than the role of experience in developing these capabilities. Future research can develop methods for reliably assessing the quality and quantity of prior tablet experience upon the assessment of digital capabilities.

Thus, how the tablet devices are being used beyond the study would be a useful addition for future research, and a limitation of the present study is not knowing how else tablets were used. The sample size was small, and even so, there was great variability in the extent to which participants could use tablet devices. Importantly, the study does not support the use of tablets for this population *per se*, rather serves to highlight that, whilst severely autistic minimally verbal children with severe ID can actively use tablet devices, there are easily identifiable differences within this population. A better understanding of how technologies such as tablets might be used most effectively and what the limits might be for this population will be useful for identifying appropriate interventions and support for this population (Tager-Flusberg & Kasari, 2013).

Conflicts of interest:

The authors have no conflicts of interest to declare.

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Figure 1. The 12 tasks in SMART-ASD app.

Task	Child successful if…	Image
Switch On	Presses the on button.	
Tilt the Tablet	Tilts screen so that balls roll around the screen.	
Touch the Screen	Touches one (or more) of the balls on the screen.	
Touch Big Button	Touches a single large button on the screen.	
Touch Little Button	Touches a small button on the screen.	
Swipe	Swipes a slider from left to right.	
Screen Orientation	A moving train image shifts orientation by 90 degrees, the screen is rotated so the image is the right way up.	
Volume Control	Music is played, volume is adjusted by touching a large volume symbol to increase volume or a small volume symbol to decrease volume. (Both are demonstrated, either indicates success).	
Desktop Navigation	A specific musical note icon is selected from an array of (other non-functioning) icons to play music.	

Move finger round Labyrinth	A finger is moved from the beginning to the end of a simple labyrinth	
Camera	The camera mode is activated on the tablet and a photo taken.	
Leave the app	The app is exited and then re-entered (by selecting the app icon from an array of icons).	

Table 1.

Demographic data for each participant

Participant	ASD1	ASD2	ASD3	ASD4	ASD5	ASD6
Sex	Male	Male	Female	Male	Female	Female
Age	13	12	12	7	13	7
ASD Severity	Severe	Severe	Severe	Severe	Severe	Severe
ID Severity	Severe	Severe	Severe	Severe	Severe	Moderate
E.L.S.	Non-Verbal	Non-Verbal	Non-Verbal	Non-Verbal	Non-Verbal	Non-Verbal
R.L.S.	None	Single words	Single words	Single words	Single words	Short sentences
Reading ability	None	None	None	None	None	None
Problematic behaviour	None	Moderate	Low	Moderate	Moderate	Low
Tasks Completed	9	5	4	1	5	5

Note. E.L.S. = Expressive Language Skills. R.L.S. = Receptive Language Skills

Table 2.
Tasks Completed by each participant

	ASD1	ASD2	ASD3	ASD4	ASD5	ASD6
Switch On						
Tilt the Tablet	✓					
Touch the Screen	✓	✓	✓		✓	✓
Touch Big Button	✓	✓	✓	✓	✓	✓
Touch Little Button	✓	✓			✓	✓
Slide	✓	✓	✓		✓	✓
Screen Orientation	✓					
Volume Control	✓					
Desktop Navigation						✓
Move finger round Labyrinth						
Camera	✓					
Leave the App	✓	✓	✓		✓	