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Tablets for two: How dual tablets can facilitate other-awareness and communication in learning disabled children with autism

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ABSTRACT

Learning-disabled children with autism (LDA) are impaired in other-awareness, joint attention and imitation, with a poor prognosis for developing language competence. However, better joint attention and imitation skills are predictors of increased language ability. Our study demonstrates that a collaborative activity delivered on a novel dual-tablet configuration (two wifi-linked tablets) facilitates active other-awareness, incorporating imitation and communicative behaviour, in 8 LDA boys with limited or no language, aged 5–12 years. LDA children did a picture-sequencing activity using single and linked dual tablets, partnered by an adult or by an LDA peer. Overall, the dual-tablet configuration generated significantly more active other-awareness than children sharing a single tablet. Active other-awareness was observed in LDA peer partnerships using dual tablets, behaviour absent when peer partnerships shared a single tablet. Dual tablets facilitated more communicative behaviour in adult–child partnerships than single tablets. Hence, supporting collaborative activities in LDA children can facilitate other-awareness and communicative behaviour and adult and peer partnerships make different, but essential contributions to social-cognitive development through the collaborative process.

1. Introduction

Autism is a Spectrum Disorder, highlighting the fact that the level of impairment experienced by people affected by the condition can vary greatly. Intellectual disability (ID) is very commonly associated with autism, with approximately 70% of individuals diagnosed with autism also having ID. An individual is considered to have an ID with an IQ < 70 and ID can be separated into three groups; mild ID, IQ 55–69, moderate ID, IQ 40–54 and severe ID < 40 [1]. Of the 70% of individuals diagnosed with autism and ID, about one third will have a mild to moderate ID and another third severe to profound [2–4].

The long-term outcome of individuals diagnosed with autism and ID is very poor, with only a small minority of individuals with IQs less than 50 achieving a high level of independent functioning by adulthood and the majority remaining dependent on their families and the state [5]. The long-term outcome for adults with ASD is estimated to cost the UK economy approximately £25 billion annually (Knapp, Romeo, & Beecham, 2009). Therefore, it is crucial to determine how to help learning disabled children with autism (LDA) attain more independent levels of functioning by adulthood.

Technological interventions for children with autism have been popular across levels of age and IQ [6]. However, Parsons [7] notes the need for careful reflection in such design. Parsons and Cobb [8] propose a three-layered design approach of Theory, Technology and Thoughts (3T). They suggest that the top 'Theory' layer should drive design to address the fundamental impairments of interaction and communication found in children with autism. The 'Technology' layer is represented by the 'learner-centred design' of technology to offer affordances designed with specific learning or interaction goals in mind. The base, 'Thoughts' layer should influence the design from the bottom up by incorporating the views and experiences of teachers, parents and children with autism and designing the technology appropriately for the environment where it will be used and hence designed with both the context and the end user in mind [7].

This paper presents the on-going development and evaluation process of a novel computer application (app) designed as a technological intervention to support other-awareness and collaboration in LDA children. Following the 3T approach, we first, introduce the developmental theory underpinning the authors' focus of designing technology to support other-awareness and collaboration in LDA children. Secondly, we illustrate how the design of the technology was learner-centred and informed by the

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collaborative design framework proposed by Yuill and Rogers [9], with the specific goal of facilitating collaboration. Thirdly, we illustrate how the design drew on end-users in a specific context through incorporating the views of teaching staff familiar with the participants during the design process and testing the app in the special school environment.

By their very diagnosis LDA children are impaired in communication and so it is challenging to obtain their views in traditional ways, meaning that these views are not always reflected in design. Some researchers have demonstrated ways of including the views of the autism community during the design process. For example, Parsons and Cobb [10] used workshops, discussions groups and paper and high fidelity prototypes as methods for participatory design and commented that testing the high fidelity prototype in school with the teachers and end users "was important to ensure that technology design was informed by user needs and abilities so that the final product was fit for use in school-based learning" (ibid, p. 5). Frauenberger et al. [11] described a participatory design process that took into account children's feedback using annotator tools for a touch screen computer interface, including smiley and sad faces. The children with autism could indicate the aspects of the digital environment they liked or disliked and the researcher used these external representations of the children's thoughts to initiate discussions. These are good examples of how to include children with autism in a participatory design process where children have some verbal communication abilities.

We propose here two important means of incorporating the views of LDA children with autism who have limited or no verbal ability. Firstly, LDA children can be given contrasting versions of a high fidelity prototype technological intervention to test in the environment in which it will be used and secondly the method of analysis used to assess the effectiveness of the prototype should reflect the fundamental impairment of interaction and communication that the software is aiming to address, and should assess in detail children's behavioural responses to the different software environments. Accordingly, this paper reports on the testing of a prototype technological intervention with LDA children in a special school environment. The main theme of this paper is the comprehensive analysis of LDA children's interactive behaviour compared across two similar technological aids in order to determine what aspects of the environment are more effective for engaging the LDA children and promoting the target behaviours. Fine-grained analysis of LDA children's behavioural responses can be used as a means of gauging their views and reactions. Such analysis of LDA children's responses to technology is both appropriate for testing effectiveness of design to elicit the target interaction goals and also helpful for incorporating the views of LDA children who would be disadvantaged by approaches requiring explicit reflection and verbal skills.

1.1. Theory: the development of other-awareness and collaboration

In typically-developing (TD) children other-awareness emerges early in development and can be observed in the face-to-face interactions of mothers and infants from around one month of age [12]. Early social abilities in TD children, such as joint attention and imitation are thought to be intimately related to the development of self and other awareness. From around six months of age a TD child will develop the capacity to include objects in self and other referential cognitions and in social interactions based on joint attention [13]. Joint attention involves the capacity of children to coordinate their attention to include another person and an object. These are complex behaviours that include *responses* to gaze and gestures from another person seeking to share attention to an object or event, and using gaze and gesture to *initiate* the sharing of attention to an object or event with another person [14]. Imitating the actions of another person is a common behaviour that suggests an awareness of the other. Evidence from Killen and Uzgiris [15] suggests that in TD children this may emerge from around $7\frac{1}{2}$ months of age and that imitation is an early emerging social skill used to initiate and maintain social interaction [16]. Eckerman and Didow [17] also found that TD children were more likely to communicate with a peer partner when engaged in coordinated action dominated by imitative behaviour. Therefore, in typical development, other-awareness, joint attention and imitation are found to be the earliest forms of behaviour that support social interaction and communication.

However, children with autism are shown to have impairments in imitation [18,19] and joint attention [20,21]. These impairments are considered fundamental in affecting their long-term outcome, since, in children with autism, better joint attention and imitation skills are robustly associated prospectively with superior language development [22–25,19]. Furthermore, the fundamental abilities of joint attention and imitation are seen as prerequisites for participation in collaborative activities [26] and hence a possible reason for deficits in the capacity of children with autism to cooperate [27]. Moll and Tomasello [28] draw on Bratman's definition of cooperation to advocate the Vygotskian intelligence hypothesis (VIH), that cooperative interaction is the driving force of social cognition. Through cooperative interactions Moll and Tomasello [28] propose a child develops an awareness of the other person and this other-awareness facilitates language, learning and social development. Moll and Tomasello [28] propose that other-awareness emerges from children firstly being able to recognise the sharing of a 'joint' focus of attention with another person, and then, from this triadic awareness, to develop an understanding that another person can have a different perspective of a shared experience. This understanding that others have individual thoughts, beliefs, emotions and intentions is believed to be a critical aspect of social cognition and a primary impairment in autism [29–31]. Therefore, the aim of the design of the app reported in this paper is to facilitate collaboration in order to support the development of other-awareness, joint attention and imitation and ultimately the communication skills of LDA children.

We use the term collaboration as defined by Roschelle and Teasley [32] to describe "a coordinated, synchronous activity that is the result of a continued attempt to construct and maintain a shared conception of a problem" (ibid, 1995, p. 70). In contrast, these authors defined cooperation as a "division of labour among participants, as an activity where each person is responsible for a portion of the problem solving" (ibid, 1995, p. 70). These authors define collaboration as activities that bring about the 'mutual engagement' of participants to solve a problem together, in contrast to those that give participants individual problems to solve. This distinction of working on the same problem together compared to having different roles with the ultimate aim of achieving the same goal is consistent with descriptions by Hord [33] and Paulus [34]. The technological design and the activities reported in this paper were designed so that two players have identical tasks to solve, with actions interlinked in a way that necessitates the generation of corresponding representations during the problem solving process, in order to reach a shared solution. We therefore characterise the tasks reported in this paper as collaborative, rather than cooperative.

It is generally accepted that children with autism find computer technology motivating and beneficial to their learning [35–39]. Taking this into account researchers have turned their attention to investigating how shareable computer technology can help support collaboration and the social interactional skills of children with autism. However, there are two general limitations of this literature. First, much of this work relies on the very general assumption that technology is motivating. While this might be