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Designing for young children with autism spectrum disorder: A case study of an iPad app

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ABSTRACT

Individuals with autism spectrum disorders often benefit from technology-based intervention. Technologies being marketed to the autism community, and relevant published research, are proliferating. However, in the context of research in health and education, the requirement for an effective design process is not necessarily recognised. Understanding this process is necessary to facilitate recommendations about best practice in technology design and implementation where the end result is being applied in a health or education context. This report describes the development of an iPad app designed for very young children with autism. We describe methods for user-centred design with relevant stakeholders, expert evaluation and pilot testing of demo versions of the app, and their consequences for the finished game. In a final evaluation with 41 pre-schoolers with autism, average game play over a 2 month period was 11 minutes per day, with no evidence of obsessive behaviour. We discuss how this approach permits individual studies to inform the design of multiple technologies, contributing to dissemination of high standards in how therapeutic and educational technologies for specific populations are designed, pilot-tested and reported.

1. Introduction

Autism spectrum disorder (ASD) is a blanket term which describes a range of individuals having atypical behaviours in two diagnostic domains: social communication and restricted or repetitive behaviours [1]. ASD is also associated with language delays and intellectual disability in a large proportion of cases [2]. Atypicalities in social interaction may manifest as difficulty in understanding non-verbal behaviour [3], in understanding the thoughts, beliefs and intentions of others [4], and in peer relationships [5]. Specific impairments in communication include problems with conversational rules, or in interpretation of idiomatic expressions [6,7]. The restricted and repetitive behaviours domain can manifest as a need for sameness and routine, or as an inability to generalise information [8]. These challenges may require consideration during the design process when creating technologies specifically for individuals on the spectrum.

In health and education services, there is a significant focus on early intervention for ASD [9,10]. The fundamentals of social communication, including 'joint attention', have been identified as pivotal skills in development, and key targets for early autism intervention [11]. Joint attention at its most complex involves coordinated attention between a child, another person and an object, cued by eye-gaze, gestures such as pointing, and verbal cues (e.g. "look at that!") [12]. This complex process is built on developmental precursors including looking at other people, and following their cues — looking where they are looking or pointing [13]. These behaviours are often not spontaneously apparent in young children with autism [14,15]. Targeting intervention at such basic components of social attention may provide a foundation of skills for subsequent, more complex social communication [16].

A number of reviews report how technology-based education and therapy has been employed to help people with ASD across the life span ([17–24]). Such approaches have been used successfully to teach literacy [25–27], emotion recognition [28,29] and social skills in general [30,31].

Few, if any, technological interventions have been applied to very young children (under 6 years) with autism. This is likely to be

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because, until relatively recently, interaction with a commercially-available computer required comprehension of the function and use of a mouse or keyboard, which is beyond the average pre-schooler. There is evidence from studies, even with older children with ASD, of the necessity of a learning phase in which the child develops their computer skills before they can begin to access the intervention (e.g. [32]).

In the research described here, we aimed to harness the accessibility of touchscreens and the advantages of technological interventions for ASD, applying these to targeting pivotal social communication skills in young children [11]. The target user is a child with autism, with a developmental and a chronological age in the range from 18 months to 6 years, and a diagnosis of 'core' autism (according to the Autism Diagnostic Observation Schedule—2; [33]). There is evidence for beneficial effects of social communication intervention in this population, which extend beyond the immediate target [34,35]. This paper focuses on creation of an app which provides a motivating learning environment for the target user—interaction with the app being a clear pre-requisite for any learning to occur. The potential of the app to have a therapeutic impact on social communication, which was subsequently evaluated in a randomised controlled trial, is reported elsewhere [36].

2. Previous research: design for autism

The rise of toddler-friendly touch screen technology, as embodied in the iPad, has begun to influence educational approaches to autism [37]. Evidence suggests that children with ASD can access iPad and other touchscreen technologies [38,39], and have been observed to be more engaged and verbal during their use [40,41]. As a result there are now hundreds of iPad apps being marketed specifically for use by children (and, to a lesser extent, adults) with ASD [42]. However this proliferation leaves very little room for quality control and the large majority of apps lack any foundation in theory or research evaluation [43].

2.1. The design approach

Designers do not occupy the same world as children with autism. In order to better design for them, designers need to learn more about the child's understanding, perspective and needs, and determine the ways in which technology needs to be designed to accommodate these [44,45]. Frauenberger et al. [46] argue for the benefits of Participatory Design, including being "*more likely to lead to an outcome which is more user-focused and user-oriented than non-participatory methods*" (p. 39), and for participation being an enriching and empowering experience for children. However, they also note that there are challenges, particularly salient for individuals with autism, including working in unfamiliar settings, with unfamiliar researchers with whom they have no previous relationship.

Frauenberger, Good and Alcorn [47] describe different styles of participation in design with children with disabilities, based on the Ladder of Citizen Participation [48] and drawing on Druin's proposals for the roles of children in the design process [49]. They suggest 3 categories of approach:

1. Non-participatory approaches: informed by theory, best practice or prior experience but having no direct involvement of, for example, children with autism.
2. Participation via proxy: those with intimate knowledge of the user population, such as parents and teachers, represent the needs of the children.
3. Full participation: defined as "*any form of involvement that allows children with disabilities to have direct impact on the outcome*" [47, p. 2].

In this research, we adopt an approach somewhere between Participation by Proxy and Full Participation since we involve both children with autism and expert representatives. In addition, the roles that children play in the various design activities change: primarily informants and testers, but at times closer to design partners.

2.2. Specific challenges of designing with and for children with autism

While children are increasingly being involved in the design process, as users, testers, informants and design partners [50,51], including children with additional needs [52] the use of such design methodology remains less common in designing for children with ASD [53]. Existing frameworks that do address this include [54], who proposes a four stage iterative model of Research–Inspire–Listen–Develop. She discusses methods that may (e.g. simple mock ups), and may not (e.g. brainstorming), be suitable for use with children with ASD. van Rijn and Stappers [55,56] used context mapping techniques in the LINKX project, supporting children with autism and their parents in the design process and increasing users' feelings of ownership. Benton [57] developed IDEAS (Interface Design Experience for the Autistic Spectrum) as a method for involving (higher functioning) children with ASD as design partners.

Specific challenges in participating in design may arise from the difficulties experienced by children with autism [46]. For example, impaired social cognitive skills may result in a lack of consideration for, or awareness of, the contributions of others. Suggestions from children with ASD may be presented as a monologue, without apparent understanding of the perspective of others. Design activities which lack structure may cause anxiety. Thus there is a balance to be struck between empowerment of children with ASD through full co-design, and its feasibility and appropriateness. In cases where co-design with children with ASD ('Full participation', cf. Frauenberger, Good and Alcorn [47]) is not possible then Participation by Proxy may be employed. As well as working with parents and professionals, including older and more able children as proxies takes advantage of their ability to explain the rationale for their ideas, empathise with others, use flexible thinking and avoid conventional biases [58].

2.3. The current research

This paper outlines three phases of design and development of an iPad app, for the use of children with ASD under the age of 6 years, with many having concurrent intellectual disability. The goal of the app is to provide an opportunity to rehearse key social communication skills in a highly motivating environment. The phases were informed by: the literature; knowledge and prior experience of the research team; and input from stakeholders. The latter participated in a number of studies, at pre-design, design, formative evaluation and summative evaluation stages. This paper focuses on design to formative evaluation. The summative evaluation is described in [36].

Phase 1 was a design phase incorporating a number of data collection methods and participant groups. In Phase 2, we describe the initial app creation. In Phase 3, we report on the formative evaluation phase, again working with a range of methods and participant groups.

The Discussion describes the finished app, provides initial data on how the app was used by participants, evaluates the benefits and pitfalls of the process, and describes next steps in evaluating and commercialising the app. An overview of the design and testing process is illustrated in Fig. 1.

This research was reviewed and approved by the ethics committee of the School of Education at the University of (removed