An inclusive design approach for developing video games for children with Autism Spectrum Disorder

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ARTICLE INFO

ABSTRACT

The efficacy of therapeutic treatments for Autism Spectrum Disorder is mainly associated with the treatment's intensity in terms of weekly hours. This has led mental health professionals to explore the use of video games to complement traditional treatments. However, major weaknesses have been found due to poor game design, which has failed to fulfill therapeutic objectives or to properly engage children. These weaknesses are typically characterized by the poor integration of knowledge from mental health experts, children's interests and designers' expertise. Starting from this necessity, we propose an inclusive design approach to develop therapeutic games. The method presents strategies to integrate the expertise of clinicians, contributions of children and experience of designers through a set of elicitation and merging techniques. The goal of this method is to design games that are effective in terms of therapeutic objectives and that are enjoyable for children. To describe this method, we present its application in the design and development of a Kinect-based game for high-functioning children with ASD called "Pico's Adventures". This game aims at promoting social initiation in young children with autism. Findings from a first exploratory study with 10 children with ASD showed the effectiveness of the game in eliciting social initiation behaviors. This provides a first validation of the method. An essential aspect of the game's success was the use of elements and mechanics that were appealing for the children. As a result, we have identified effective design concepts and paths for further research on games for children with ASD.

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1. Introduction

Autism Spectrum Disorders (ASD) are neurodevelopmental disorders characterized by impairments in verbal and non-verbal social communication and by restrictive interests and sensory abnormalities (according to the Diagnostic and Statistical Manual of Mental Disorders, DSM-5,[1] by the American Psychiatric Association, 2013). Considering the significant individual variability within the broad spectrum of the Autistic condition, research and therapy tend to focus on specific sub-groups, based on the functionality related to cognitive abilities and social adaptation. For the purpose of this study we focused on high-functioning ASD children (as defined by the ADOS diagnostic tool, module 3 level 4 and a minimum IQ of 70; for further details see Section 4.2.2). This sub-group reports normal scores in non-verbal IQ measurement (IQ > 70), however social communication impairment may represent the most important deficit (Roeyers, 1995) and improved social functioning is considered one of the most important intervention outcomes (Rogers, 2000).

Consequently, a range of treatments have been designed, evaluated and published in autism literature. However, the effectiveness of the treatments is mainly associated with their continuity and intensity in terms of weekly hours (Boyd et al., 2014). Requirements related to the intensive nature of treatments led mental health professionals to explore the use of digital games and gamified therapeutic interventions to complement traditional treatment methods (Goh, Ang, & Tan, 2008). This approach is based on the

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[1] Although the current ruling Diagnostic and Statistical Manual of Mental Disorders is DSM-5, at the time of the definition of the Project, the reference manual was still DSM-IV.

interest that children show in digital games and the capacity of games to foster motivation and engagement (Prensky, 2003; Resnick, 2002), and produce behavioral changes (Deterding & Dixon, 2011). Moreover, game-based interventions with children within the Autistic Spectrum Disorder (ASD) have been proven to accelerate learning processes (Charlton, Williams, & McLaughlin, 2005) by reducing the need for supplementary rewards and by increasing the willingness to complete the required tasks (Hoque, Lane, El Kaliouby, Goodwin, & Picard, 2009). These findings have lead to a widespread proliferation of digital games for children with ASD. Within this context, different approaches have been employed. These range from gamifying therapeutic interventions to fully developed games. This tendency toward applying games elements is consistent with the increased use of gamification in different fields, such as healthcare, business or education (Burke, 2012). However, as Burke (2012) highlights, this surge of gamified applications has lead to a peak of inflated expectations. According to the author about 80% of gamified solutions will fail in reaching their objectives due to a lack of understanding of game design and inefficient player engagement strategies. Although this analysis is mainly oriented toward business strategies, a similar concern on the fundamental role of appropriate design methods has also been expressed in research concerning the development of psychotherapeutic gaming interventions (Goh et al., 2008). In this latter context, the main design pitfalls are related to shortcomings in reaching the therapeutic goals and to difficulties in designing an experience that can be truly engaging and motivating for children. A possible reason behind these pitfalls can be found in the shortage of inclusive design approaches, which are capable of integrating the knowledge of mental health experts with the interests of children and the experience of designers. Despite an increasing effort to define multidisciplinary teams for designing therapeutic gaming interventions, in many cases game elements are simply inserted into an already existing experience for embellishment (Whalen et al., 2010; Yan, 2011), instead of being properly integrated into an overall playful experience. Other significant shortcomings are related to the lack of consideration of children's contributions, interests and motivations as pointed out by Benton, Johnson, Ashwin, Brosnan, and Grawemeyer (2012) and Frauenberger, Good, Alcorn, and Pain (2012).

To address these necessities, we propose an inclusive design method for developing therapeutic gaming interventions for children with ASD. The method is based on defining a model to integrate the expertise of clinicians, contributions of children and experience of designers through a set of elicitation and merging techniques. The goal of this method is to design playful experiences that are effective in terms of therapeutic objectives and are enjoyable and engaging for children. At the same time the proposed method addresses the ethical concern related to designing for and with a population with special needs by including them in the design process.

In the following sections we will contextualize, describe and justify the proposed approach and the results we have achieved. In Section 2 we will provide an overview of relevant work related to the aspects of using IT for skills acquisition in ASD and to design methods of games for children with ASD. In Section 3 we then formalize the inclusive model that we propose. Section 4 then goes on to describe how we applied the model to the design of a fully developed videogame, based on the Kinect technology, with the goal of eliciting social initiation behaviors. In particular, we will describe our approach to elicit requirements from experts and children and a model to merge these contributions. We describe the Participatory Design workshops we undertook with four children with ASD as part of the inclusive model. We close this section with a detailed description of the design decisions that took us to define

each of the four sessions which the game is composed of. In Section 5 we describe the preliminary study we undertook with ten children with ASD (4–6 years old) in order to evaluate issues such as their acceptance of the game, their behaviors with respect to the game mechanics, etc. Finally, in Section 6 we discuss the encouraging results achieved in the study that suggest the effectiveness of our approach for designing therapeutic games. Specifically, we provide insight on the effectiveness of the game in eliciting several behaviors related to social initiation and how these provide a promising context for further controlled studies. This leads us to propose four design guidelines and methodological techniques that should be useful in the design of new games for children with ASD.

2. Related work

We have divided this analysis of related work into two sections, specifically those related to the two main topics that affect our study. The first concerns work related to interactive systems that address acquisition of social skills. The second analyzes work done related to the design methods for developing games for children with ASD.

2.1. IT systems and social skills acquisition

Impairments in social skills represent a central feature of Autistic Spectrum Disorder, and different methods and interventions have been designed to facilitate behavioral changes in this area. Traditional approaches are related to cognitive-behavioral therapies, social stories, programs for learning social skills, play based interventions and relation development interventions (Fuentes-biggi et al., 2006).

In the last decades a growing attention has been focused on the potential of using IT systems to complement traditional treatments for social skill acquisition. In this context we identified the following three main trends which we describe in the next subsections: 1) Gamification of exercises in traditional treatments; 2) Simulations of social situations in virtual environments or with robotic agents; 3) Co-located collaborative games.

2.1.1. Gamification of exercises in traditional treatments

Within the first group, several systems have been developed according to the classic paradigm of gamification, which is understood as the use of game elements in non-game contexts (Deterding and Dixon, 2011).

Examples of these can be found in projects such as: "A SUNNY DAY: Ann and Ron's World" (Yan, 2011), "TeachTown: Basics" (Whalen et al., 2010) and "LIFEisGAME" (Abirached et al., 2011). The game "A SUNNY DAY" is an iPad application where traditional training methods are gamified through the inclusion of a system of levels and rewards (Yan, 2011). Similarly "TeachTown: Basics" mixes exercises from a traditional treatment, called Applied Behavior Analysis, with game elements as rewards (Whalen et al., 2010). The gamification approach is mainly based on inserting game elements into traditional therapeutic exercises. From a research perspective positive results have been found (Whalen et al., 2010), suggesting the importance of embedding traditional therapeutic methods in game design.

However, major shortcomings are related to oversimplification of game design principles, since often game design is reduced only to merely using a reward system. As a consequence game elements and therapeutic techniques are only juxtaposed but not integrated into a coherent experience. This lack is aligned with the identified risk of poorly applying game design principles in a number gamification approaches (Burke, 2012) and is consistent with the concerns about the lack of appeal and engagement of several gamified