Full length article

Designing computer-based rewards with and for children with Autism Spectrum Disorder and/or Intellectual Disability

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ARTICLE INFO

ABSTRACT

Children with Autism Spectrum Disorder (ASD) tend to have an affinity for digital technologies, often preferring computer-assisted learning to human-assisted learning. Many children with ASD are also diagnosed with Intellectual Disabilities (ID), yet design studies involving children with ASD and ID are scarce. Rewards can have a positive impact on children's learning and motivation, but little is known about the nature and impact of rewards for children with ASD, and/or ID. Digital technologies are well placed to provide task-based rewards, and in combination with a better understanding of the reward preferences of children with ASD and/or ID this has significant potential to enhance learning. This paper presents two robust participatory design (PD) studies involving children with: i) ASD; ii) ID; and iii) both ASD and ID. The studies aimed to identify: i) the reward preferences of children with ASD and/or ID (RQ1) and ii) how rewards might develop throughout a task as the child progresses (RQ2). Results revealed a number of reward categories that were common to all children, as well as children's preferences for how rewards could develop as they progress through computer-based tasks, for the first time. Original implications for designing computer-based rewards embedded within digital intervention/educational technologies for children with ASD and/or ID, are discussed.

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1. Introduction

The relationship between rewards, motivation, engagement and performance is complex and continues to spark controversy and debate (Cerasoli, Nicklin, & Ford, 2014). Historically, Deci (1971) has categorized motivation as either: a) *extrinsic* (driven by an external reward, e.g. a certificate); or b) *intrinsic* (driven by enjoyment and personal interest). While intrinsic motivation is considered to be "an important construct, reflecting the natural human propensity to learn and assimilate" (Ryan & Deci, 2000, p. 54), there is also evidence that extrinsic motivation brings benefits, particularly for children with neurological differences (Johnson & Picard, 2016; Mancil & Pearl, 2008). External rewards have been shown to stimulate participation and enhance task performance (Eisenberger & Cameron, 1996; Lai, 2011). They can also increase the enjoyment of the task, particularly if the reward promotes a sense of competence after doing a 'good job' (Myers, 2007). Whilst the effect of rewards on intrinsic motivation has been controversial, one interesting finding is that participants often report that extrinsic rewards are useful for keeping them engaged (Wolters & Benzon, 2013).

Digital technology has been shown to be an ideal medium for providing extrinsic rewards (Cramer, Hirano, Tentori, Yeganyan, & Hayes, 2011; Fletcher-Watson, Pain, Hammond, Humphry, & McConachie, 2016; Humphry, 2011). Digital reward systems are commonly used within computer games to provide positive feedback and enhance user engagement (e.g. Cruz, Hanus, & Fox, 2015; Goh, Pe-Than, & Lee, 2017). These systems typically involve players accumulating points or badges in recognition of certain actions, achievements or task completion. Whilst some theories (e.g. self-determination theory) suggest that extrinsic rewards might harm players' intrinsic motivation there is also research suggesting that such systems can actually be intrinsically motivating and may also provide additional benefits such as boosting self-esteem (see Cruz et al., 2015). Moon, Jahng, and Kim (2011) lend credibility to the

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use of game reward systems in learning programs to promote self-regulated learning. The authors examined different reward systems of digital games and investigated the possibility of using similar reward systems in the context of learning systems to promote motivation. Within educational settings digital reward systems enable greater consistency and immediate notification of the child's achievement compared to paper-based reward systems (Cramer et al., 2011).

The research on rewards reported in this paper is being conducted within the context of creating technologies to deliver behavior/perspective change interventions to children with autism and/or ID. Currently few technological solutions to these interventions exist, and consequently teachers rely on the medium of paper for the interventions and their associated rewards, for example using sticker charts. In many classrooms, especially larger ones, a paper-based system requires significant teaching effort to monitor and maintain. Thus, the provision of rewards can be inconsistent both within classrooms and also across teaching professionals. A computer-based reward system can help avoid such inconsistencies and subjectivity. Also, it can take time for the teacher to perceive the achievement and administer the reward and delays between activities and rewards can diminish the effectiveness (Cramer et al., 2011). Well-designed, in-built systems of reward within digital technology have the potential to be more effective by overcoming such delays. Additionally, a computer-based reward system can offer an extensive choice of rewards, which can be personalized to the child's needs and interests, and enhanced by adding features, such as animations or sound.

Given their well-documented affinity with technology and their special interests, children with Autism Spectrum Disorder (ASD) may be particularly receptive to digital rewards embedded within software. ASD is defined by persistent deficits in social communication and interaction, combined with restricted and repetitive behaviors and interests (APA, 2013). Computers can act as an interface between the individual with ASD and other people, ameliorating social communication and interaction deficits (Brosnan & Gavin, 2015) and reducing social anxiety (Cobb et al., 2002; Moore, Cheng, McGrath, & Powell, 2005; Williams, Wright, Callaghan, & Coughlan, 2002). Computers also offer the opportunity to modify the environment, for example by eliminating or reducing information that might distract attention from the main task, and allowing children to work at their own pace (Williams et al., 2002). Additionally, computers, including multi-touch tablets (Hourcade, Bullock-Rest, & Hansen, 2012; Sampath, Indurkhya, & Sivaswany, 2012), have been found to be appealing for children with ASD, resulting in benefits such as increased motivation, attention and learning compared with traditional methods (Bosseler & Massaro, 2003; Goldsmith & LeBlanc, 2004).

In addition to an apparent affinity for digital technology, extrinsic rewards can also have a positive impact on motivation and task performance for children with ASD (Humphry, 2011; Johnson & Picard, 2016; Koegel & Egel, 1979; Mancil & Pearl, 2008; O'Dell, Dunlap, & Koegel, 1983). Rewards are especially important for individuals with ASD since they are more prone to failure than typically developing children, due to their social communication and interaction deficits (Clark & Rutter, 1979). It has also been suggested that intrinsic motivation may not be sufficient to overcome sensory demands and environmental distractions required for learning and task completion, and therefore extrinsic rewards are necessary (Johnson & Picard, 2016). Such rewards have been found to be particularly motivating when related to the individual's restricted interests (Mancil & Pearl, 2008). Humphry (2011) argues that a computer-based intervention needs to reward appropriate behavior in order to maintain the learner's interest and that planning a reward strategy is crucial for any intervention with children

with ASD. Despite this, studies within this area are scarce (Humphry, 2011; South, Ozonoff, & McMahon, 2005).

In a small study with three children with ASD Humphry (2011) found that the children displayed the highest level of motivation, focus and accuracy when their favorite reward type was presented. She also found a high degree of variability regarding the children's reward preferences highlighting the need for a variety of choices in order to meet the diverse range of interests of the individuals with ASD. Despite these individual preferences, there are preferred topics popular with people with ASD. In a study involving 19 individuals with Asperger Syndrome (AS), and 21 with high-functioning autism (HFA), aged 8–20 years, South et al. (2005) found that the topics of major interest were consistently similar in both groups. The most popular topics were: Japanese animation (e.g. Pokemon), Gadgets/devices, Dinosaurs, Space/Physics, Natural disasters, Historical events, Power rangers/Ninja Turtles, Encyclopedias/fact books, and Playing videogames. Thus, whilst there is variety in preference for reward instances in people with ASD, there is consistency in the topic categories from which the reward instances originate. Whilst this research identified the most popular topics for rewards to be drawn from, there is a lack of research in supporting children in designing their own rewards, and in identifying whether and how rewards should change with progress for children with ASD.

Technology is well-suited to both personalizing the topic of the reward and reward adaptivity. However, there appears to be an absence of literature on the latter aspect, which may be crucial to continued motivation to engage with the technology, learning and task performance. In addition, technology is well placed to satisfy the need for a variety of choices of rewards. As a preference for sameness can be characteristic of the restricted and repetitive behaviors and interests that define ASD, how rewards might adapt as a task progresses is particularly pertinent for this group.

Finally, much of the design research to date has been undertaken with highly able people with ASD (e.g. Fabri, Andrews, & Pukki, 2016; McAllister & Sloan, 2016; South et al., 2005). However, 44–52% of children diagnosed with ASD also have developmental deficits in intellectual and adaptive functioning - Intellectual Disabilities (ID) (APA, 2013; NAS., 2016). Hence it is important to understand the requirements of children with and without ID when developing digital rewards for children with ASD. Although children with ASD have social communication and interaction deficits, they are able to effectively participate in the design of digital technologies, when the participatory design sessions are structured appropriately (Benton, Johnson, Brosnan, Ashwin, & Grawemeyer, 2011, 2012). Similarly, though challenging, children with ASD and ID can contribute to participatory design (PD) sessions (Börjesson, Barendregt, Eriksson, & Torgersson, 2015; Hourcade et al., 2012; Keay-Bright & Howarth, 2011; Keay-Bright, 2012).

The underlying context for the studies reported in this paper relate to our main research goal: to develop, in collaboration with children with ASD, software to support the delivery of Social Stories[1] (Gray, 2010) as a perspective taking/behavioral intervention. The system will be used by children, their teachers and parents and will, if required, enable personalized and potentially adaptive/progressive rewards to be tailored to individual children. The development of the system affords the opportunity to consider: i) if, and how rewards enhance engagement, motivation and learning by children with ASD and/or ID, and ii) if rewards that adapt to learning or other progression are of benefit to a population with a

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[1] Social Story is a short story with a specific style and format that describes a situation, a social skill or a concept in a meaningful way for individuals with ASD.