Facilitating Pretend Play in Autistic Children: Results from an Augmented Reality App Evaluation

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Mihaela Dragomir
School of Informatics
University of Edinburgh
m.dragomir@sms.ed.ac.uk

Andrew Manches
School of Education
University of Edinburgh
a.manches@ed.ac.uk

Sue Fletcher-Watson
Edinburgh Medical School
University of Edinburgh
sue.fletcher-watson@ed.ac.uk

Helen Pain
School of Informatics
University of Edinburgh
helen@inf.ed.ac.uk

ABSTRACT
Autistic children find pretend play difficult. Previous work suggests Augmented Reality (AR) has potential in eliciting pretend play in children with autism. This paper presents the evaluation of an Augmented Reality app to help autistic children engage in solitary pretend play. We followed a user-centred design process, involving various techniques and stakeholders. Results from a pre-post study design suggest the AR system is promising in facilitating quantitative aspects of pretend play in autistic children.

Author Keywords
Autism; Children; Practitioners; Pretend Play; Software Design.

ACM Classification Keywords
Human-Centred Computing →User Studies, User Centered Design, Mixed/Augmented Reality, Field Studies; [Personal Computing]: General – Games.

INTRODUCTION
Pretend play can be thought of as an arena where young children develop and practise a variety of social and communication skills, learn to self-regulate their behaviour and emotions, and acquire the building blocks of abstract thought [1]. However, spontaneous engagement with, and production of, pretend play is one of the most affected areas of development in children with autism [2].

Research suggests technology may have educational and therapeutic potential for this population [3]. A number of studies indicate a significant positive effect of technology use on the social and communication skills of individuals with autism [4]. However, technology-based support for pretend play is scarce. Augmented Reality (AR) technology has recently received attention for its potential in eliciting pretend play in children with autism as it can dynamically link multiple representations: a tangible (a tangible object or element of the real environment) to a digital identity (a pretend object/element) [5]. However, very little is known about 1) how to design AR technology-enhanced supports for both practitioners and autistic children, in order to develop and practise pretend play in current practice, and; 2) the effects of using such AR systems on autistic children's pretend play, if any.

In this paper, we focus on the second point: the evaluation of an AR system designed, following a user-centred approach, to help autistic children develop pretend play in school contexts. We conducted a pre-post study with 7 autistic child-practitioner dyads over a 5-week period. Quantitative analysis of pretend play suggest that overall the participating children spent more time in, and engaged in more acts of, pretend play with toys in the post-session compared to the pre-session.

THE AUGMENTED REALITY SYSTEM

Figure 1. Example snapshots of story (left), tangible objects (centre) and augmented world (right)

Approach to Design
A user-centred approach to design was adopted with experienced practitioners, human-computer interaction experts and typically developing children taking part at different stages of the project.

System Description
The AR system design makes use of narrative to provide children with opportunities for pretence. The system has three stories. For example, the first story introduces a small hungry dragon who needs to be fed. The story is read out loud, and illustrated for the child to see. The child is encouraged to pretend to feed or give a drink to the dragon by using tangible objects which are placed between them and the screen. The child is told that the objects can change into food or drinks. The objects have markers attached that enable it to be changed on the screen into something else (e.g. the image of a fruit that the child has chosen from a menu). The child is given the choice to decide in what to change the tangible object from a list of available options.

EVALUATION

The AR system was evaluated through an empirical study exploring the effects of its use by practitioners and autistic children in a school context. Participants were six experienced practitioners and seven children with an existing autism diagnosis. The children were 6 male and 1 female, aged 8-14 years old, with an autism severity rated as between moderate and severe, based on Childhood Autism Rating Scale scoring [6]. A pre-post study design was followed with children taking part in 5 play sessions over a period of 5 weeks. For all play sessions, the child was joined by a familiar practitioner they were confident in interacting with. The pre/first and post/last sessions involved the child playing with a predefined set of toys, on their own for 3 minutes (unstructured play) and with a practitioner for another 5 minutes (structured play). During the middle 3 sessions the child and practitioner played with the AR system for up to 10 minutes, or less time if the child preferred. All sessions were video recorded for subsequent analysis.

MEASURES. To determine the duration of play by category a moment-by-moment analysis (10-second intervals) was conducted on the video data collected from the pre-post sessions, for each child-practitioner dyad. A coding scheme adapted from relevant literature was used to label cognitive play categories, presented bellow in terms of increasing levels of cognitive complexity [8, 9, 10, 11, 12].

No play – no engagement with toys or others, transitions;

Sensorimotor play – engagement in repetitive interactions with an object with no clear purpose besides sensory and motor stimulation (e.g. touching, biting, tasting).

Relational play – interacting with two or more objects in a way that does not indicate functional or symbolic play (e.g. piling or stacking objects up);

Functional play – using an object as its function designates *with an intended, reality-based outcome* (e.g. colouring with crayons, putting a peg in a hole);

Pretend play comprising two behaviour types:

Functional play with pretence – using an object (actual or miniature) in the manner it was *intended but without the reality-based outcome* (e.g. placing a miniature cake pan in a miniature oven does not result in an *actual* cake);

Symbolic play, itself made up of three behaviour types:

Object Substitution – the use of an object as if it were a different object (e.g. using a block as a car);

Assigning Absent Attributes – assigning dramatic roles or emotions to the self, others or inanimate objects (e.g. saying the stuffed animal is sick).

Imagining Absent Objects (IAO) – performing an action as if an object was present *in the object's absence* (e.g. moving fist around a pan as if stirring with a spoon).

The play categories were discussed and agree with a second coder until an agreement was achieved. The percentage of time a child spent in a play category was measured as the sum of 10-seconds intervals that category of play was recorded divided by the total play time. If the child showed more than one type of play over the 10-second interval, the highest cognitive level of play was chosen if shown for at least 3 seconds. The frequency of pretend play was measured as the number of pretend play acts shown by the child in one minute.

RESULTS AND DISCUSSION

Results of pre and post-test measures of mean percentage of time spent in play categories are illustrated in Figure 1.

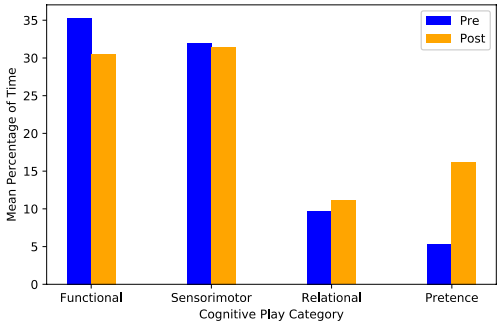

Figure 2. Distribution of mean percentage of time spent in each play category across children

The percentage of time spent in each category of play and the mean frequency of pretend play are normally distributed according the Shapiro-Wilk normality test. We conducted a paired t-test and report a significant increase (203.18%) in the percentage of time spent in pretend play (t-value=-2.23, $p < 0.05$). Also, the measure of mean frequency of pretend play acts suggests a significant increase from the pre to the post-session (t-value=-1.98, $p < .05$).

Five out of the seven participating children provided feedback on system interaction. Four of the five liked all the AR system design and interaction elements that feedback was requested on. All five children reported liking the stories and were reported by practitioners to have spontaneously commented on their interaction with the AR system, in the classroom. In follow up, practitioners requested continued use of the tool in the classroom, outside of the research study.

The quantitative measures of pretence and the feedback provided by children and practitioners suggest the AR system has potential in facilitating pretend play in autistic children, in a school context. Besides, adopting a user-centred approach by including practitioners and children at different stages of the design process ensured the system is easy to use, accessible, and enjoyable. This study is not without limitations, the small sample size and no control group suggest the results should be interpreted with caution. Next steps will focus on exploring qualitative aspects of children's play and pretence over the five sessions as well as the role of adult and AR scaffolding.

REFERENCES

1. Vygotsky, L., 1933. Play and its role in the mental development of the child. In J. Bruner, A. Jolly, & K. Sylva (Eds.), Play: Its role in development and evolution (pp. 461–463). New York, NY: Penguin.
2. Charman, T., Swettenham, J., Baron-Cohen, S., Cox, A., Baird, G. and Drew, A., 1997. Infants with autism: An investigation of empathy, pretend play, joint attention, and imitation. *Developmental psychology*, *33*(5), p.781.
3. Fletcher-Watson, S., 2014. A targeted review of computer-assisted learning for people with autism spectrum disorder: Towards a consistent methodology. *Review Journal of Autism and Developmental Disorders*, *1*(2), pp.87-100.
4. Wong, C., Odom, S.L., Hume, K.A., Cox, A.W., Fettig, A., Kucharczyk, S., Brock, M.E., Plavnick, J.B., Fleury, V.P. and Schultz, T.R., 2015. Evidence-based practices for children, youth, and young adults with autism spectrum disorder: A comprehensive review. *Journal of Autism and Developmental Disorders*, *45*(7), pp.1951-1966.
5. Bai, Z., Blackwell, A.F. and Coulouris, G., 2015. Using augmented reality to elicit pretend play for children with autism. *IEEE transactions on visualization and computer graphics*, *21*(5), pp.598-610.
6. Schopler, E., Reichler, R.J., DeVellis, R.F. and Daly, K., 1980. Toward objective classification of childhood autism: Childhood Autism Rating Scale (CARS). *Journal of autism and developmental disorders*, *10*(1), pp.91-103.
7. Gotham, K., Pickles, A. and Lord, C., 2009. Standardizing ADOS scores for a measure of severity in autism spectrum disorders. *Journal of autism and developmental disorders*, *39*(5), pp.693-705.
8. Baranek, G. T., Barnett, C. R., Adams, E. M., Wolcott, N. A., Watson, L. R., & Crais, E. R., 2005. Object Play in Infants with Autism: Methodological Issues in Retrospective Video Analysis. *American Journal of Occupational Therapy, 59(1).*
9. Dominguez, A., Ziviani, J., & Rodger, S., 2006. Play behaviours and play object preferences of young children with autistic disorder in a clinical play environment. *Autism, 10(1),* 53–69.
10. Kasari, C., Freeman, S., & Paparella, T., 2006. Joint attention and symbolic play in young children with autism: A randomized controlled intervention study. *Journal of Child Psychology and Psychiatry and Allied Disciplines, 47(6*), 611–620.
11. Williams, E., Reddy, V., & Costall, A., 2001. Taking a Closer Look at Functional Play in Children with Autism. *Journal of Autism and Developmental Disorders, 31(1),* 67–77.
12. Wolfberg, P. J., & Schuler, A. L., 1993. Integrated Play Groups: A Model for Promoting the Social and Cognitive Dimensions of Play in Children with Autism 1. *Journal of Autism and Developmental Disorders, 23(3).*
13. Murphy, J. and Cameron, L., 2008. The effectiveness of Talking Mats® with people with intellectual disability. *British Journal of Learning Disabilities*, *36*(4), pp.232-241.