Design for social interaction through physical play : proceedings of the 1st workshop, October 22, 2008, Eindhoven

Proceedings of the 1st workshop on

Design for Social Interaction through Physical Play

October 22, 2008 – TU Eindhoven, Eindhoven, The Netherlands

In conjunction with

fun and games

October 20-21, Eindhoven, The Netherlands
International conference on Fun and Games

Edited by:

Janienke Sturm
Tilde Bekker
Emilia Barakova

Front cover designed by Iris Soute

A catalogue record is available from the Eindhoven University of Technology Library
ISBN: 978-90-386-1458-8

Programme Committee

Nadia Berthouze - *University College London, UK*

Adrian David Cheok - *National University of Singapore*

Kerstin Dautenhahn - *University of Hertfordshire, UK*

Berry Eggen - *TU/e, The Netherlands*

Loe Feijs - *TU/e, The Netherlands*

Newton Fernando - *National University of Singapore, Singapore*

Ole Sejer Iversen - *University of Aarhus, Denmark*

Florian ‘Floyd’ Mueller - *University of Melbourne*

Narcis Pares - *Universitat Pompeu Fabra, Spain*

Matthias Rauterberg - *TU/e, The Netherlands*

Ben Robins - *University of Hertfordshire, UK*

Table of Contents

Design for social interaction through physical play

Tilde Bekker, Janienke Sturm, Emilia Barakova

TU Eindhoven, Department of Industrial Design
P.O. Box 513, 5600 MB Eindhoven
The Netherlands
{m.m.bekker, j.sturm, e.i.barakova@tue.nl}

Nine very interesting position papers were submitted to our workshop on Design for Social Interaction and Physical Play. The papers, presented in these proceedings, cover design concepts for very diverse user groups and contexts of use. Creating novel concepts is often done using theories about human behaviour as an inspiration source. This introduction describes the content of our workshop along three dimensions: user groups, context of use and related theories.

1 User groups

A number of papers focus on designing interactive products for children, sometimes combined with other user groups such as elderly. **Abeele and De Schutter** describe a design project of an intergenerational game controlled with the Wiimote is designed for children and elderly users. Both **Wainer et al.** and **Barakova** describe projects in which robots are used to stimulate interaction between autistic children. In the paper by Wainer at al. autistic children receive classes about programming Lego robots where they are motivated to collaborate while creating their Lego programs. In the paper by Barakova autistic children are motivated to collaborate by jointly having to interact with a life-size controller that interacts with a robot in a storytelling context.

The work by **Sturm** et al. focuses on designing open-ended intelligent play objects for children that are stimulated to social interaction through the negotiation of game rules and goals created by the children themselves. The paper by **Leal Panados** et al. describes the design process of an intelligent cuddly toy. Children have to care for their toy through diverse physical and social interactions and are rewarded for good behaviour by the toy staying healthy. **Novoa** draws a link between challenges of children on the one hand and design students on the other hand in participating in social and physical (design) activities. He discusses how both groups can be supported in their inquisitive process without being hindered by the limitations of products they interact with and which lack meaning and place.

Other papers describe projects for adult users. For example, the work by **Decortis** describes how the use of low-tech camera-like tools are used to stimulate people to explore their environment both through creating photos but also through a discussion about the artifacts created with the pinhole cameras. The work by **Ludvigsen** et al. on iSport explores how to apply technology to enhance various sport-related activities, such as training of professional athletes, game experience of spectators and sport education in schools. The work by **Visser and Vastenburg** explores mechanisms for social interaction and introduces the concept of Social Nudge to describe persuasive concepts that stimulate social interaction between for example parents and children that just moved out house or between elderly.

2 Context of use

Technological developments such as miniaturization of technology, and sensor and actuator networks provide new opportunities for creating playful experiences in the context of social and physical play. In addition, designing dedicated games will stimulate social interaction through collaboration or competition. The technologies that are covered in the projects in the workshop are fairly diverse and cover a large part of the topics that we included in our workshop description.

Diverse research areas look into aspects of social interaction and physical play. In *sport-like contexts* Mueller et al. [10] have designed various networked sport-like games to stimulate social bonding. They use ideas about designing for social interaction to make physical activities more appealing. They explore whether collaborative and competitive aspects of the design contribute to the enjoyment of the games. The project by **Abeele and De Schutter** is based on Wiimote controlled computer games which clearly falls in the area of exertion interfaces.

Social and physical interaction is also a theme that plays in role in the relatively new area of *tangible interaction*. The framework by Hornecker and Buur [7], which consists of four themes, which are tangible manipulation, spatial interaction, embodied facilitation and expressive representation, nicely illustrates this. Embodied facilitation and spatial interaction are the two themes most related to our workshop topic because they are related to social and often also to physical interaction. The projects by **Sturm** et al. and by **Leal Penados** et al. explore mobile solutions based on sensor actuator technology for intelligent play objects.

Pervasive games, such as Uncle Roy All Around You [1] also combine social interaction and physical play. These games are often based on existing computer games, but are enhanced by adding a physical and networked dimension. For example, the mixed-reality game Uncle Roy all around you integrates aspects of the physical world (a city) and a virtual game world: street players and online players must work together using web cams, audio and text messages to find a secret destination. We received no submissions related to pervasive games.

Social play also plays an important role in the field of *robotics*. Keepon [6] is a small robot designed to perform emotive and attentive exchange with human interactants (especially children) in the simplest and most comprehensive way. Keepon is used to study the underlying mechanisms of social communication. Its simple appearance and actions make it possible for infants and children to interact with it as well as adults. The projects by **Barakova** and by **Wainer** et al. are placed in the context of programming and interacting with robots.

Some of the other submissions are harder to relate to a particular research area. **Decortis** applies low-tech camera tools for exploring the environment. Some of the other papers were not yet specific about the type of technology that would be applied to create social and physical play concepts.

3 Related theories

One workshop goal is to share information and experiences among researchers in the area of social interaction through physical play. The work covered in the workshop is inspired by theories from diverse areas. A number of references are made to theories about social interaction and collaboration. For example, Parten's [11] theory about the development of social play in early childhood, describes how children develop from playing in a solitary manner, through parallel play to being able to play in a collaborative manner. The theory by Broadhead [3] about early play and learning describes how children's communication also develops from non-reciprocal to more reciprocal actions and language when being able to play in a more collaborative manner. Other relevant concepts that were mentioned were for example turn-taking, imitation, joint attention, shared gaze and helping activities as being indicators of social communication.

The papers also provide theories related to physical interaction. The work by Lackoff and Johnson [8] is used to understand how our bodies are the basis for how we build up our experiences and interactions with our environment. Ideas about kinesthetic empathy by Fogtmann [6] and kinesiology (the science or study of (human) movement) are used as input to look into how people can learn and explore through their movements. The work by Bruner [4] and his ideas about enactive knowledge (which is knowledge stored in the form of motor responses and acquired by the act of "doing") is also mentioned in the context of thinking about physical interaction. The theory can help to explore different types of physical interaction styles.

4 Conclusion

Social and physical interactions have been explored in very diverse components of everyday life. In addition, there is an increase in the number of persons with social impairments. The papers presented in the proceedings explore the opportunities that new technologies offer not for individual entertainment, but rather for social and physical interaction in order to fight this isolation and to enhance the benefits that the social engagements have brought to human society. They describe a wide diversity in terms of the technologies applied, such as robots, computer games, cuddly toys and low-tech camera tools to enhance activities such as exploring the environment, participating in sports activities, education, playing physical computer games and being connected to other people.

References

1. Benford, S., Flintham, M., Drozd, A., Anastasi, R, Rowland, D., Tandavanitj, N., Adams, M., Row Farr, J., Oldroyd, A., Sutton, J. (2004). Uncle Roy All Around You: Implicating the City in a Location-Based Performance. *Proceedings Advanced Computer Entertainment (ACE 2004)*.
2. Billard, A., Robins, B., Dautenhahn, K., Nadel, J. (2006). Building Robota, a Mini-Humanoid Robot for the Rehabilitation of Children with Autism. *RESNA Assistive Technology Journal,* 19.
3. Broadhead, P. (2004). *Early years play and learning : developing social skills and cooperation*, London : RoutledgeFalmer.
4. Bruner, J. (1968). *Processes of cognitive growth: Infancy*. Worcester, MA: Clark University Press.
5. Enactive Network. (12-07-2008). www.enactivenetwork.org
6. Fogtmann, M. H. (2007) Kinesthetic Empathy Interaction – Exploring the Possibilities of Psychomotor Abilities in Interaction Design. In *Proceedings of the Second International Workshop on Physicality*, Lancaster.
7. Hornecker, E., Buur, J. (2006). Getting a grip on tangible interaction: a framework on physical space and social interaction. *Proc. of CHI '06*. ACM, N.Y., pp. 437–446.
8. Lakoff, G., and Johnson, M. (1999). *Philosophy In The Flesh*, Basic Books, New York.
9. Michalowski, M.P., Kozima, H. (2008). Rhythm in human-robot social interaction. *IEEE Intelligent Systems*, 23(2), pp. 78-80.
10. Mueller, F., Agamanolis, S., Picard, R. (2003). Exertion Interfaces: Sports over a Distance for Social Bonding and Fun. *CHI '03*, ACM Press.
11. Parten, M. (1932). Social participation among preschool children. *Journal of Abnormal and Social Psychology*, 27, 242-269.
12. http://www.wii.com

Designing Intergenerational Play through Physical Action

Vero vanden Abeele[1] and Bob De Schutter[1]

[1]eMedia, GROUP T - International University College Leuven (Association KULeuven)
Vesaliusstraat 13,
3000 Leuven, Belgium,
{vero.vanden.abeele, bob.de.schutter}@groept.be

Abstract. We report on the design process of a physical game to be played by seniors and youngsters. We first assess the need for intergenerational game play, then we introduce the constructs enactive interaction and competition and how they relate to physical gaming and social interaction. Next, we elaborate on our benchmarking and user evaluation of existing physical minigames. We argue that competition within physical minigames is facilitated by ease-of-use, equality-in-ease-of-use and visibility of physical actions. Finally, we discuss the design of our own physical minigame based upon these drivers and conclude with the results of our user testing and the lessons learned.

Keywords: intergenerational play, social interaction, competition, seniors, youngsters, physical gaming, enactive interaction

1 Introduction: A User-Centered Design and Development of a Computer Game for Seniors and Youngsters

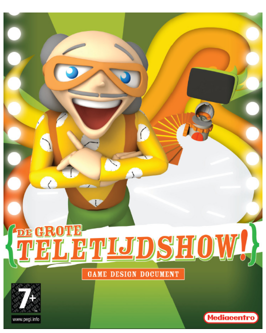


Fig.1-The Great Tele-time Show

The e-Treasure research project (fig.1) aims at developing a computer game[1] via a user-centered design process. The main aim of the game is to foster intergenerational play, and to create a knowledge transfer between youngsters (seven to ten years old) and seniors (sixty five years or older). The e-Treasure project therefore included seniors and youngsters from the beginning until the end. By means of ethnographically inspired research methods and participatory design processes, the e-Treasure game took the shape of a Nintendo Wii game. The game is designed to be played in a living room by four players, each playing for him/her self. In this paper we discuss one specific part of the research project, namely the design

[1]e-Treasure is funded by IWT-Vlaanderen (IWT-nr.:60135 start:1/01/200 end:1/01/2009)

process behind one of these *physical trials*, included as minigames in 'De Grote Teletijdshow![2]'. As the team had no experience in designing for interaction with a WiiMote[3], nor for 'intergenerational play', we deemed it important to understand better how the specific sensor technology (i.e. infrared sensors and motion sensors) within the WiiMote afford physical action. How does physical action influence the way seniors play games, and how does is this different from the influence that physical action has on the way youngster play games? Finally, how can physical action stimulate intergenerational interaction?

To answer these questions, we first assert the necessity for games for elderly. Then we explain why we aim for competition rather than social interaction. Next, we relate physical action to enactive interaction. After introducing these constructs, we elaborate on our benchmarking exercise of existing physical minigames, and the corresponding user evaluation of four selected minigames. We argue that the main drivers for competition within physical minigames are ease-of-use, equality-in-ease-of-use and visibility of physical actions. Finally, we discuss the design of our own physical minigame based upon these drivers and user testing.

2 A Need for Intergenerational Play

Elderly users are a growing population; today between 15 and 25%[4] of the European population is sixty years or older [1]. Unfortunately, these statistics are not reflected in the number of games that are designed for an elder population. In the past decades, research on digital games for elderly was mostly placed under the umbrella of 'gerontechnology' [2]. This unfortunate view of senior life as 'frail' does not correspond to the huge group of seniors that still live active and healthy lives, independently. In 'Digital Games for the Elderly', Ijsselsteijn et al. [3] argue that besides being used for therapeutic means, digital games also offer the benefit of connecting different age groups while playing, especially grandparents and grandchildren. De Schutter & Abeele [4] provide a model of meaningful play in elderly life that stipulates that in order to attract a senior audience games should first and foremost stimulate connectedness. Similarly, Tarling [5] claims that being able to play with the grandchildren is an important incentive for seniors to play a computer game. However, digital games that focus on intergenerational play are rare. We are only aware of two other research projects that had similar ambition of connecting grand parents and grandchildren via game playing. Curball [6] is a prototype of a distributed bowling game for older people, to be played with the grandchildren over the internet. Age Invaders [7] is

[2] 'De Grote Teletijdshow!' was the result of the e-Treasure project. The game facilitates meaningful play and intergenerational knowledge transfer via quiz rounds and physical trials.

[3] The Nintendo WiiMote allows users to interact with items on a screen via movement and pointing. This is done through the use of accelerometers and optical sensor technology

[4] The exact percentage is depending on the specific country. In Italy, 25% of the population is over sixty years of age. In the Netherlands, 18% of the population is over sixty years of age.

a physical game which allows elderly to play together with children in the same physical space, via an interactive floor. Interesting as they are, the research papers only describe the motivations and the technical implementation. Guidelines or 'lessons learned' are lacking.

How can we foster intergenerational interaction via physical gaming? Lucas and Sherry [8] stress the importance of studying the interpersonal dynamics among players during game play, and rely on Schutz's [9] fundamental interpersonal relationship orientation (FIRO) theory to do so. FIRO theory states that all people are oriented by three interpersonal needs: inclusion, affection, and control. Inclusion points towards being part of a group, affection points towards the closeness or warmth within the relationship. Control finally expresses the need to have influence over the actions of others and has to do with being on top or on the bottom. Control relates well to the gratification of competition within games, while inclusion and affection correspond with the social interaction gratification. When reviewing literature on game gratifications, it is indeed striking that the social interaction motive strongly correlates to the competition [10, 11, 12] motive. Similarly, our own research [13] stipulates that co-located competition within competition is linked to and even a precursor of social interaction. Therefore within the physical trials, we decided to focus mainly on competition, as a means to exert control over the other game players but also experience inclusion and express affection.
When designing for competition via physical game play, the needs of both youngsters and seniors need to be balanced carefully. Youngsters have had far more exposure to digital technology. For seniors, the lack in digital competences can be problematic when lacking correct mental models on how to deal with digital appliances [3]. Furthermore, elderly players might have a decline in memory, visual functions or motor ability. Therefore, our physical minigame should be able to deal with sensory, motor or cognitive limitations of elderly users. Anecdotic accounts of care homes where the WiiMote is causing residents to become avid players [14] do suggest that physical game play might have its merits. Yet, there is little scientifically validated information on how physical interaction can and should be designed for elderly.
We might understand the benefits of physical game play better when discussing enactive interaction. Enactive knowledge, first coined by psychologist Bruner [15], is *"knowledge stored in the form of motor responses and acquired by the act of doing."[16]*. Enactive interfaces are then capable of conveying and understanding these motor responses or gestures of the user, in order to provide an adequate response in perceptual terms. According to this definition, most Wii games provide 'enactive interaction'. However, it is important to understand that the quality of enactive interaction cannot just be analyzed by the type of physical action that is required, but also by 'what is fed into the perceptual system'. What we see, hear and feel will shape our action, [17] and vice versa we perceive the environment by the actions it affords to us. That environment can be natural or exist out of man-made, artificial worlds. Indeed, Wii games rely heavily on the artificial game world to make the player understand which actions he or she should make. The exact meaning of the WiiMote (being a tennis racket or a golf club) is mainly addressed by the

representation within the artificial game environment. Therefore, analyzing enactive interaction is not just a matter of analyzing the physical actions of the player but involves the representation in the game world as well and more specifically how tight the relationship is between a player's physical actions and the game's representation. Furthermore, enactive interaction relies on previous experience of motor acts within real life.

3 Benchmarking Minigames

We chose to analyze the minigames included within Mario Party 8 because of the similarity with our project. Mario Party 8 can also be played with up to four players and it includes over 65 minigames that contain a variety of interaction styles and game mechanics. Similar to our aim, most minigames last one or two minutes, aim to foster social interaction (as a 'party game') and require physical action with the WiiMote.

3.1 Providing enactive interaction in the minigames.

When analyzing the enactive interaction within the minigames, we roughly divided the games into three different groups of *physical action*. Not surprisingly, they correspond with the different sensor systems. First Mario Party 8 features games that mainly use the 'pointing', via the optical sensor system. Because of the sensor bar's limited detection region, the pointing mechanism favors directed and well-controlled physical actions. The pointing mechanism works fine if players stay perfectly still in front of the television. In fact, pointing works best when one can sit down and support the pointing arm, thus in fact limiting physical action. We noted that when playing with four players in less ideal setups, from time to time, the players positioned on left and right side 'fell off' the screen. Therefore, the pointing mechanism is fragile for physical gaming within a multiplayer context.

Second, Mario Party 8 also hosts games that sense the gross movements provided by the acceleration sensors. Movement via the acceleration sensors seems to hold the highest promise for physical action. One can truly swing, shake, hammer, etc. Unfortunately, we noted that these games often lack good synchronization between physical action and on screen representation; consequently this hampered enactive interaction[5]. The design team felt that true enactive interaction was only achieved in those games where the physical action exists out of simple discrete actions.

[5] This problem is commonly known: the current acceleration sensors in the WiiMote do not allow for a true 1:1 response in game play. Nintendo just announced that it will release the Wii MotionPlus to resolve this issue.

Finally, a large portion of the minigames in Mario Party 8 rely primarily on 'button pressing' and use physical action as a gimmick[6], e.g. one game requires the player to tilt the WiiMote in order to change camera view. However, the main interaction is done via the buttons. According to the design team, this type of games does not afford enactive interaction and was excluded.
We also noted that games that scored highest on enactive interaction were those games that represent a clear tool-directed activity such as 'swinging a baseball bat', 'hammering a nail', 'painting a fence'. It is no coincidence that all these games make use of our *prior enactive knowledge* and provide *clear digital affordances*.

3.2 Fostering competition in the minigames

We then explicitly looked at how competition was stimulated within the game environment. We noticed that some games allowed the players to be in the same world, where others offered a split screen. The design team stipulated that interaction in the virtual world might enhance opportunities for competition in the real world as well. Furthermore we noted that some games allow players *to influence each other directly* during the game, e.g. actions of one player benefit or hamper the other player directly e.g. trying to shoot at each other' or bumping each other out of the way. Consequently, we conceptualized that if both a common game screen was present and if players could directly influence each other's actions, competition and consequently social interaction between seniors and youngsters would be highest.

4 User evaluation of selected physical minigames

After benchmarking the minigames, we selected four minigames that struck us as exemplary according to the dimensions of enactive interaction (presence of physical actions, digital affordances and prior enactive knowledge) and the dimensions of competition (being in the same screen and the possibility to influence each other during game play).

[6] Mario Party 8 is the most recent version from a succession of Mario Party games, first released in 1998 for the Nintendo 64. As such many of the minigames, that are still included in the latest version, were originally not designed to make use of the physical action afforded by the WiiMote.

4.1 The selection of physical minigames.

Breakneck Building was high in enactive interaction because of the strong focus on physical action and prior experience (hammering, sawing and painting) and offered clear digital affordances. Without any explanation, the design team knew how to play the game. We wondered if this would also be true for our seniors. Although high in enactive interaction, it scored actually low on the dimensions of competition since the game does not offer players to influence each other directly. *Lob to Rob* was a pointing (shooting) game that also scored high on enactive interaction. However, we wondered how seniors and youngsters would feel about a 'pointing mechanic'. Again, it did not score high on competition.

Table 1 - An listing of the four selected minigames, enactive interaction and competition.

			Enactive Interaction			Competition	
	Sensors	Desc.	Physical action	Digital affordances	Prior enac. knowledge	Same screen	Direct influence
Breakneck Building	Acceleration sensors	Sawing, painting, etc.	High	High	High	None	None
Lob to Rob	Pointing sensors	Shooting (by pointing)	Low	High	High	None	None
Surf's Way Up	Acceleration sensors	Rolling and pitching	Average	Average	Low	High	High
Frozen Assets	Directional pad and buttons	Collect, kick & jump	None	None	None	High	High

Surf's Way Up, although not as high in enactive interactive (holding the WiiMote as the surfboard you could steer), scored high on the competition dimensions. Being in one world, one can and should bump each other out of the way to compete for the balloons filled with points. *Frozen Assets* was a typical console game that entirely relies on buttons to navigate and combinations of two other buttons to kick, jump and punch. We expected seniors to be disadvantaged when playing this game. Yet, again it provided many opportunities for competition, being in the same world and being able to push and kick each other while competing for diamonds.

4.2 The observations of seniors and youngsters playing the selected minigames

After the benchmarking exercise, we asked five pairs consisting of a senior and a youngster to play all four games twice. We wanted to observe how seniors and youngsters played the games and how and when they competed with each other. We wondered if our seniors would encounter many difficulties or whether it would be straightforward to play the games. After playing the games we asked them to rate the games from most favorite to least favorite. More than providing an absolute ranking we were interesting in their reasons for choosing one game over another. Particularly, we wondered if we would find a great difference in ratings between seniors and youngsters.

Breakneck Building was the favorite of most players, including both seniors and youngsters. As stipulated, this game was high in enactive interaction and consequently easy to use. The game did not rely on digital competences or necessary mental models of how to operate digital appliances. In addition, we also noticed 'equality-in-ease-of-use', meaning that we did not encounter a difference in the ability to play the game between seniors and youngsters. Although at an older age one might experience a decline in perceptual-motor functions, this did not seem to influence the game play. We observed an immediate, fun competition between the players, while laughing about the physical gestures of the partner and themselves. This was contrary to our expectation. While we believed competition to be low for this game, this was actually quite the opposite. During the game players were keeping an eye on each other and saying things like "*How are you doing that?",* "*Oh, no, you are ahead of me*" or "*Yes, I'm the master"*. It seemed that although the game did not provide the dimensions we assumed to foster competition, the high visibility of physical actions, the ease-of-use, and the equality-in-ease-of-use did foster social interaction and competition. While we also expected seniors to be more reserved, we did notice a difference in the expression of game play between seniors and youngsters.

Lob to Rob was also favored by our players. Seniors had no problem using the pointing mechanism and did not encounter major problems. However, youngsters were clearly better at this game; the pointing mechanism does place higher demands on the perceptual-motor mechanism. We noted ease-of-use but not equality-in-ease-of-use. We also noted that this game play was more contained; during the game players were not commenting on each other. Only after the game was over, players compared scores. Might this be attributed to pointing gestures that are less visible for the other player than the gross motor movements that *Breakneck Building* provided?

Contrary to our expectation, *Surf's Way Up* was not liked at all by both seniors and youngsters. This was mostly due to the synchronization problem described earlier and the lack of clear enactive knowledge. The players expressed discomfort when playing the game, uttering sentences like: "*What are you supposed to do here? Is this how it goes? I don't understand!*" Both seniors and youngsters experienced these difficulties. As a consequence there was really no meaningful play and no competition.

Finally, *Frozen Assets* did yield an interesting result. As expected, seniors expressed a greater dislike for this game than their younger counterparts, as they had greater difficulties to master the game, due to a lack of experience with game controllers. Most seniors did not manage to play this game well. There was little competition possible, although the dimensions for competitions were present within the game. Again, the lack in 'equality-in-ease-of-use' hampered competition. However, in one instance, the grand son actually managed explaining how it worked to the other partner. When the grand mother mastered this game mechanic we noticed hard fun [18] or 'fiero' kicking in, the proudness of overcoming a challenge. The youngster as well was proud of his pupil mastering the game as well. This team listed Frozen Assets at the top of their list.

			Enactive Interaction			Competition
	Sensors	Description	Ease-of-use	Equality-in-ease-of-use	Visibility actions	
Breakneck Building	Acceleration sensors	Sawing, painting, etc.	High	High	High	High
Lob to Rob	Pointing sensors	Shooting (by pointing)	High	Average	Low	Average
Surf's Way Up	Acceleration sensors	Rolling and pitching	Low for both	Not applicable	Not applicable	Low
Frozen Assets	Directional pad and buttons	Collect, kick & jump	Easy (Y) Hard (S)	Low	None	Low except for one team

Table 2 – A summary of the findings.

From this exercise we concluded that our dimensions of competition had to be reconsidered. Game mechanics such as being present in the same screen or the ability to directly influence each other seem to be less important than ensuring good enactive interaction, which in turn ensured ease-of-use, equality-in-ease-of-use and visibility of physical actions.

5 Designing and testing our own minigame

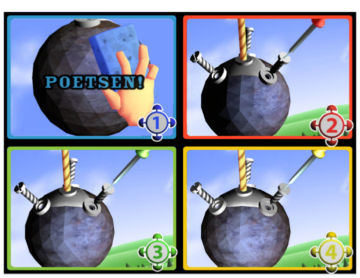


Figure 2 - The atomium minigame

Strengthened by this information, we designed our own minigame (fig.2) in which players help to restore the Atomium[7]. Playing the game is done solely with the WiiMote acceleration sensors, no button pressing or pointing is necessary. Players have to screw nails in (by rotating the WiiMote as a screwdriver), rub of some dirty spots (by rubbing in the air with the WiiMote) and put one of these balls in the right place by swingeling a crank. Whoever finishes first, is the winner. Similar to Breakneck Building, this game aims to provide high

[7] The Atomium was build for the national world trade fair in 1958 and still functions as a symbolic building for many Belgians.

enactive interaction, relies on prior enactive knowledge, requires physical action and offers clear digital affordances. Furthermore players cannot directly influence each others scores.

Fig.3 Seniors & youngsters playing.

User evaluation of our minigame. Finally, we tested our minigame with our audience (fig.3); four seniors and four youngsters played the game twice. As a first observation, we noted that they immediately knew how to play the game; seniors as well as youngsters engaged in the physical action. We therefore managed to provide 'ease-of-use' and 'equality-in-ease-of-use' and 'visibility of physical actions'. We also noticed that both seniors and youngsters immersed themselves into the activity and forgot about the cameras in the research lab. Comments during the game play made clear that the players were tracking each others progress and that competition was fierce: "*What, you are faster? How are you doing that?*" One of the seniors even triumphed when finishing first, shouting to the other (younger) players *"you didn't expect that, did you",* a behavior we did anticipate from our youngsters but not our seniors. From these observations we concluded that our aim of creating a game that was high in enactive interaction succeeded, as well as our aim to provide a competition between all game players, both seniors and youngsters.

6 Lessons Learned

Via the making of this minigame we argue that it is not physical action per se but rather enactive interaction that ensures ease-of-use for seniors and youngsters. Both target groups can start playing right away. The use of enactive knowledge avoids relying on digital competences and/or mental models of how to operate digital appliances which would favor youngsters. The decline in perceptual-motor functions, associated with older age, did not seem to influence the game play of our seniors when making movements. Therefore, enactive interaction also implies 'equality-of-ease-of-use', seniors and youngsters are equally good in playing the game which promotes competition between both generations. Finally, physical action also relates to visibility of actions, this allows for monitoring other players and for laughing with others, again promoting competition and social interaction. We acknowledge that these specific drivers uncovered in this design research study are preliminary insights, explored on a limited scale, with a limited number of users. We therefore put them forward as hypotheses needing further validation with confirmatory research modes.

Acknowledgments. This research project would not be possible without game developer Jelle Husson, usability specialists Gerrit Vos en Rogier Vermaut, digital artists David Molenberghs and David Dils and our project coordinator Stef Desmet.

7 References

1. de Jong Gierveld, J.: Ouderen in Europa. Centraal Bureau voor de Statistiek, No.5 (2001)
2. De Schutter, B.: Never Too Old to Play: The Appeal of Digital Games to an Older Audience, Games and Culture: A Journal of Interactive Media, CA: Sage (2008)
3. Ijsselsteijn, W., Nap, H. H., de Kort, Y., and Poels, K.: Digital game design for elderly users. In Proceedings of the 2007 Conference on Future Play, Toronto (2007)
4. De Schutter, B. & Abeele, V. Vanden : Meaningful play in Elderly life. Proc. of ICA 2008, Communication for social impact., Montreal, (22/26-06-2008)
5. Tarling, A. Older Peoples social and leisure time, hobbies & games. Univ. of Sussex, (2005)
6. Kern, D., et al., Cur-Ball a Prototype Ubigame for Older People. http://www.cogs.susx.ac.uk /interact/projects/Equator/curball.htm
7. Khoo, E. T., Lee, S. P., Cheok, A. D., Kodagoda, S., Zhou, Y., and Toh, G. S.:Age invaders: social and physical inter-generational family entertainment. In CHI '06 Ext. Abstr. (2006)
8. Lucas, K., Sherry, J. Sex Differences in Video Game Play: A Communication-Based Explanation. Communication Research, Sage Pub Vol. 31 No. 5, (2004) 499-523,.
9. Schutz, W. C.: FIRO, A three-dimensional theory of interpersonal behavior. New York: Rinehart and Company (1958)
10. Jansz, J., & Tanis, M.: Online games: de relaties tussen de motivatie van gamers en hun spelkeuze. Presentation at Etmaal van de Communicatiewetenschap. (2007)
11. Sherry, J. L., Lucas, K., Greenberg, B.S. and Lachlan, K.: Video Game Uses and Gratifications as Predicators of Use and Game Preference. In P. Vorderer and J. Bryant (eds.), Playing video games: Motives, responses, consequences. LE Ass. (2006)
12. De Schutter, B: Never too old to play: the appeal of digital games to an old audience. Games & Culture (Under review)
13. Abeele, V. Vanden, De Schutter, B. A means end analysis of game gratifications and game attributes. Proceedings for ICA (Under review)
14. Borland,S.:Elderly 'addicted' to Nintendo Wii at care home http://www.telegraph.co.uk/news/uknews/1563076/ (17 Sep 2007)
15. Bruner, J.: Processes of cognitive growth: Infancy. Worcester, MA: Clark Uni.Press (1968).
16. Enactive Network. www.enactivenetwork.org (12-07-2008).
17. Gibson, J. J.:The Theory of Affordances. Hillsdale, NJ: LE Associates, Inc. (1977).
18. Lazzaro, N.: Forget Usability: What Makes it Fun? Player Experience Design of Affect in Games. CHI 2006 User Centered Design for Games Workshop. (2006)

Emotion recognition in robots in a social game for autistic children

Emilia I. Barakova

Eindhoven University of Technology P.O.Box 513 5600MB Eindhoven, The Netherlands, e.i.barakova@tue.nl

Abstract. This paper provides a framework for a social game that has as a goal improving the social interaction skills through associative play. It describes the design of the game platform and an ongoing study on the perception of emotional expression from motion cues for communication and social coordination. Especially, children with autism spectrum disorders are targeted, since they will benefit most from behavioral training that may improve their social skills. The promising results from two stages of this work are shown.

1 Introduction

The ability to recognize a behaviour within a social context is the foundation of social interaction. The nonverbal ways for conveying socially relevant information include facial expressions and body movements [4][13]. Neurological studies suggest that understanding nonverbal communication of facial expressions and body movements involves the mirror neuron system. However, Montgomery and Haxby [11] showed that these two forms of nonverbal social communication have distinct representations within that system, so it is plausible to study them separately. We focus on body movement as means of conveying social information.

The aim of this work is teaching of socially relevant behaviours to children through games. Simple and most obvious value of games is enjoyment and the sharing of social experiences with others [8]. In addition, play is widely used as a preferred educational activity for younger children. Especially, we target autistic children, since they are marked by delays in social development [4] and will benefit most of such training.

More specifically, there is evidence that individuals with autistic spectrum disorders do not interpret social messages that motion conveys as typical people do. Moore, Hobson, and Lee [12] found that 14- year-old individuals with autism have deficits in perceiving emotion related attitudes and subjective states, given the motion cues of a point-light-walker display [2][12]. This finding reveals a deficit in perceiving mental states based on motion cues. Klin [8] found autism specific differences in people's descriptions of the Heider and Simmel task [6]. Heider and Simmel [6] showed to subjects actions of simple geometric figures. The subjects were asked to narrate the perceived actions. The subjects reported to see that geometric figures had goals, desires, intentions and emotions. Klin [8] conducted an experiment with sixty participants with autism that were asked to provide narratives describing Heider and Simmel's animation. He found differences at interpreting social motion in autistic people, suggesting the important developmental question of whether people with autism would have typical precursors to this ability to perceive social information in motion cues.

In this paper, featuring several studies, we want to investigate the following question: even if autistic children can not recognize the social cues naturally, are we able to teach them socially relevant emotional expressions by motion cues through rule-based learning. Therefore we developed and tested a game that includes initial emotional behaviours on robots for training autistic children. The emotional robotic behaviors were additionally tested and optimized on a follow up study.

2 Game design

Play is the preferred activity of every child. In an investigation of social play behaviour Parten [14] distinguishes between several types of play, depending on the level of social involvement of the children, namely *solitary independent play, parallel activity, associative play, and cooperative or organized supplementary play.* These play behaviors were found typical for different age groups. Autistic children are most often observed to be engaged in *solitary independent play* and some in *parallel activity,* even when their age progresses.

In *solitary independent play* the child plays alone and independently with toys that are different from those used by the other children and s/he makes no effort to get close to other children. S/he pursues her/his own activity without reference to what others are doing. In *parallel activity* the child plays independently, but the activity chosen naturally brings him/her among other children. The child plays with toys that are like those which the other children are using, but does not try to influence/modify the activity of nearby children.

In *associative play* the child plays with other children. There is a greater level of awareness of the peers and there is a borrowing and loaning of play material; there is evident interaction, as for instance, following one another with trains or wagons; mild attempts to control which children may or may not play in the group are present as well.

Most autistic children stay within *solitary independent play* or *parallel activity* even when their age progresses. We aim to shift the autistic play from *solitary independent play* or *parallel activity* towards the mid ground between *parallel activity* and *associative play* through a game. Teaching all the elements of the *associative play* to autistic children is too ambitious goal. We aim to stimulate parallel play with elements of *associative play*. To narrow the scope and make the right design choices, a good overview of the existing literature was made, as well as observations and interviews with caretakers were performed. The following problems were identified: inability to share and socially interact, inability to understand expression of emotion and link them to context, preference to learn by teaching and logic rather than by trial and error.

To account for these problems, a combined approach of a game that will require negotiations and working towards a common goal, together with recognition of emotional states was made. The game uses a storyline that describes various situations involving different emotions. Recognizing the emotion will make the children command a robot, by their collective physical behavior. In response, the robot displays movements representing the emotions that the storyline refers to. In slightly different scenario the recognized emotion has to be changed. The bottom line of the game is that the children have to identify the correct emotion based on the story and movement. The teacher can use different by complexity storylines referring to an emotion, that will consequently be acted by the movement of the robot. With this multivalent approach we aimed at an integrated understanding of the acted emotion.

For the purpose of the game the following system was developed. A huge round disk that could accommodate several children was made (Figure 1). The disc can control the movement of a robot by being tilted in a certain direction. The robot in the game situations is drawn as a small green object near the platform. It resembles the shape and the size of the e-puck robot [5] that was used for this experiment. The e-puck is a two-wheel mobile robot that was originally developed at Swiss Federal Institute of Technology (EPFL). The robot is equipped with a dsPIC processor and can be controlled by blue tooth through the computer, or a very simple program can be uploaded on the dsPIC processor. We used computer-mediated control.

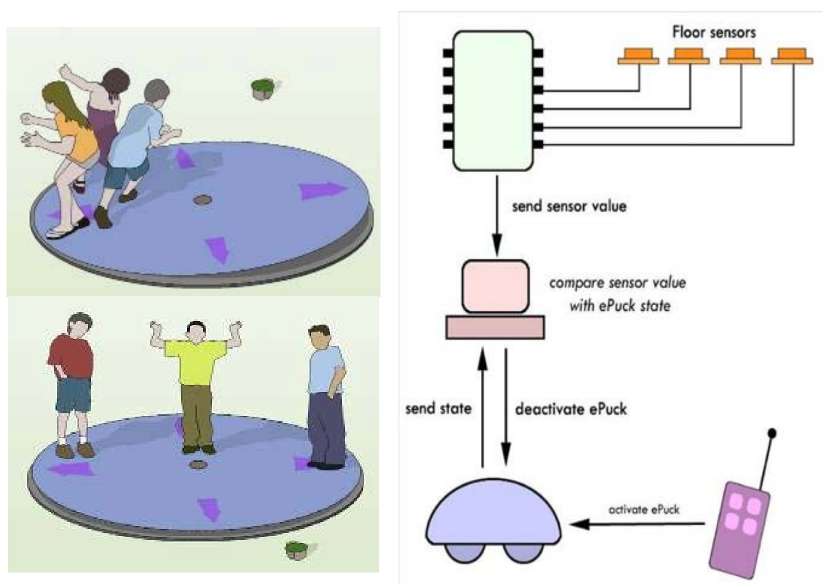


Figure 1 Game situations and flowchart of the game platform. The robot in the game situations is drawn as a small green object near the platform.

The children, standing on top of the platform, had to negotiate their positions since a single child could not tilt the disc. Once multiple children moved to the right position and the disc tilted at that direction, the corresponding behaviour of the robot was triggered. To change the robot emotional behavior, the children had to agree on their next position and move together. When conflicting views occur, it was an opportunity for the children to learn to negotiate and get aware that they need others' help.

3 Emotional behaviours in perspective

The emotional behaviours of the robot were central in this work. The aim of the designed game was not to create a framework in which autistic persons can directly recognize emotions, but rather an appealing platform and a game which can further be used to teach emotional behaviors. A study by Pierno and colleagues [15] concludes that visuomotor priming proceeds normally in children with autism when primed by a robot. This finding is consistent with other results demonstrating that people with autism perform at normal to superior levels at tasks presented in a repeatable and predictable formats established by a robot or a computer [16][17]. However, autistic children will most probably fail to recognise the emotional behaviors at first.

At the first stage of the project robot behaviours were created only based on observations of humans. As expected, the behaviours were not recognized by the autistic children during the user tests. The reasons for that could be either the lack of social understanding of autistic children, or the poor design of the behaviours. To clarify the reason for that, and improve the design of emotional behaviors so they can be used for teaching social skills, a follow-up study was conducted that focused on the construction of the emotional behaviours. To target this problem specifically, a control user group of 42 typically developing children was tested. The new behaviours were designed after an extensive literature review on dance [3] and Laban movement analysis, and on animation and deducting emotions from recorded human motion [1].

The outcome of the tests showed a good recognition of several basic emotions (Figure 2). It is important to mention that the children were not provided with a list of emotions to choose from. After the first user test there were occasions of decreased recognition for two behaviours. This chart shows the recognition rate in percents of better designed emotional behaviours of each test.

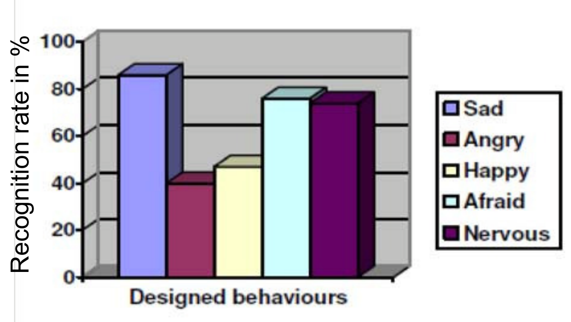


Figure 2 Recognition rate of basic emotions.

4 Discussion

A framework and the available results of an ongoing work on designing game for teaching emotional behaviours to autistic children with autonomous robots is presented. Two tasks, one of designing the game and the other of designing emotional behaviors were pursued. The second task is considerably more challenging, and its solution requires a multidisciplinary approach. Therefore the behaviors were redesigned several times based on the research findings from different disciplines related to movement analysis. Compared to related studies, we have reached a considerably better recognition rate on the 3 of 5 emotional behaviors, and we are currently working on further optimization the whole spectrum of behaviors. The final behaviors so far are tested on typically developing children of similar age as the autistic children, and further testing with autistic children and training is forthcoming.

5 Acknowledgements

I would like to thank SBO Palet Weert, especially Jolanda Hertogs and Noelia Cicilia, for their valuable feedback and for making possible the user tests. This work would not be possible without the active contributions to the both projects by my students Marc van Zee, Jeffrey Braun, Yixian Chen, Marco van Beers, Yening Jin, Anh Khoa Nguyen, and Joep Wijnands.

References

[1] Amaya, K., Emotion from motion, 1996 Graphics Interface.

[2] Blake R, Turner LM, Smoski MJ, Pozdol SL, Stone, WL (2003) , Visual recognition of biological motion is impaired in children with autism. *Psychol Sci* 14:151–157.

[3] Camurria, A.; Lagerl, I.; Volpe, G., Recognizing emotions from dance movements, 2003

[4] Diagnostic Criteria for Autistic Disorder, Indiana Resource Center for Autism, Indiana Institute on Disability and Community, Indiana University. Retrieved Feb. 27, 2007

[5] E-puck education robot, http://www.e-puck.org.

[6] Heider, F., & Simmel, M. (1944). An experimental study of apparent behavior. *American Journal of Psychology*, 57, 243–259.

[7] Hobson, P. (1993). Understanding persons: The role of affect. In S. Baron-Cohen, H. Tager-Flusberg, & D. J. Cohen (Eds.), *Understanding other minds: Perspectives from autism* (pp. 204–227). Oxford, UK: Oxford University Press.

[8] Klin, A. (2000). Attributing social meaning to ambiguous visual stimuli in higher-functioning autism and Asperger syndrome: The Social Attribution Task. *Journal of Child Psychology and Psychiatry and Allied Disciplines*, 41, 831–846.

[9] Melamed, L.., 'Games for Growth', *In Celebration of play,* Pg 162, London 180: Croom Helm Ltd.

[10] Michotte, A. (1963). *The perception of causality.* Oxford: Basic Books.

[11] Montgomery, K. J. and Haxby, J. V., Mirror Neuron System Differentially Activated by Facial Expressions and Social Hand Gestures: A Functional Magnetic Resonance Imaging Study, *Journal of Cognitive Neuroscience* 20:10, pp. 1–12.

[12] Moore, D., Hobson, R. P., & Lee, A. (1997). Components of person perception: An investigation with autistic, non-autistic retarded and typically developing children and adolescents. *British Journal of Developmental Psychology*, 15, 401-423.

[13] Parr, L. A., Waller, B. M., & Fugate, J. (2005). Emotional communication in primates: Implications for neurobiology. *Current Opinion in Neurobiology*, 15, 716–720.

[14] Parten, M. (1932). Social participation among preschool children. *Journal of Abnormal and Social Psychology*, 27, 242-269.

[15] Andrea C. Pierno, Morena Mari, Dean Lusher, Umberto Castiello, Robotic movement elicits visuomotor priming in children with autism, NeuropsychologiaVolume 46, Issue 2, , 2008, Pages 448-454.

[16] Robins, B., Dautenhahn, K., Dickerson, P., & Stribling, P. (2004). Robotmediated joint attention in children with autism. *Interaction Studies*, *5*, 161–198.

[17] Werry, I., Dautenhahn, K., Ogden, B., & Harwin, W. (2001). Can social interaction skills be taught by a social agent_ The role of a robotic mediator in autism therapy. In M. Beynon, C. L. Nehaniv, & K. Dautenhahn (Eds.), *Cognitive Technology: Instruments of Mind: 4th International Conference, CI 2001*, Warwick, UK, August 6–9, 2001,

A socio-cultural model for enhancing joint creative activities exploring spaces and places

Françoise Decortis

[1] FNRS-FRS
ÏKU, University of Liège
5, Bd du Rectorat, 4000 Liège, Belgium
francoise.decortis@ulg.ac.be

Abstract. We present NAMC++ a socio-cultural model of narrative and creative activity which includes a spiraling cycle of exploration, inspiration, production and sharing and is ideally suited to think of joint creative activities in space. We explore activities that allow participants, using very simple artifacts built by themselves, to build meanings relate to space. Exploring, be inspired, producing and sharing expressions about spaces foster fruitful interactions between children and adults coming from different socio-cultural backgrounds. It elicits reflection about the common environment and (re)connects participants to their local environment. This research helps to think about technological mediations to be introduced in creative activities seeking to foster social inclusion.

Keywords: socio-cultural model, joint creative activities, space, place, artifacts.

1 Introduction

The interest of the study of play makes it possible to grasp the ways in which the activities of play and narrative must be treated like vehicles of expressive imagination of the children and simultaneously like tools for control of reality [10], [11] . The play is regarded as a social, cultural and imaginative activity. The play is always a shared activity even when the child plays lonely. The roles and scenarios experienced by the play reveal the appropriation of the socio-cultural material. Vygotsky considers the centrality of the psychological processes of creativity and imagination in the educational process. For Vygotsky, imagination is present in all the aspects of the cultural life and makes possible the artistic, scientific and technical creativity. Imagination is not psychologically opposed to reality but intimately dependent. Reality and imagination are correlated according to Vygotsky by at least four relations: 1) Imagination is built starting from reality. The richer the experience, the more the individual will have materials to build his imagination. 2) The social practices and experiences exchange with our pairs. 3) Emotions, the feelings influence imagination and vice versa. 4) The crystallisation of imagination in external and shared objects. Moreover, Vygotsky identifies the mechanisms of imagination and creativity: the experience and the re-elaboration of experience through dissociation, association and mutation.

My objective is to show that the socio-cultural perspective makes it possible to define a sound and articulated vision that allow to consider specific social aspects nature of play and narrative activity including collective, intersubjective and also creative dimensions. All dimensions, I believe, which are not taken with sufficient attention in the majority of research and design of technology for children in the field of Child-Computer Interaction.

I will present NAMC++, a model of narrative and creative activity, which constitutes a theoretical basis to define recommendations to inform the design of new multi-media technologies. Then I will explore this model within the framework of joint creative activities exploring spaces and places using a low tech artifact. By joint creative activity, I mean activities that reunite participants from different generations and socio-cultural backgrounds where children, teenagers, adults and elders are invited to individually and collectively discover and tell stories about their living space.

2 Enhancing narrative and creative activity through technology : NAMC++

In our research we found empirical evidences that the cycle of creative imagination proposed by Vygotsky [10], [11] for children as a psychological process could be used to rethink and to inform the design of technology-enhanced learning [3]. The model, NAMC++, that emerges from this perspective has four phases namely, exploration, inspiration, production and sharing (figure 1). It describes how the child experiences the external world, elaborates the impressions received, assembles them in a novel way and shares this production with others.

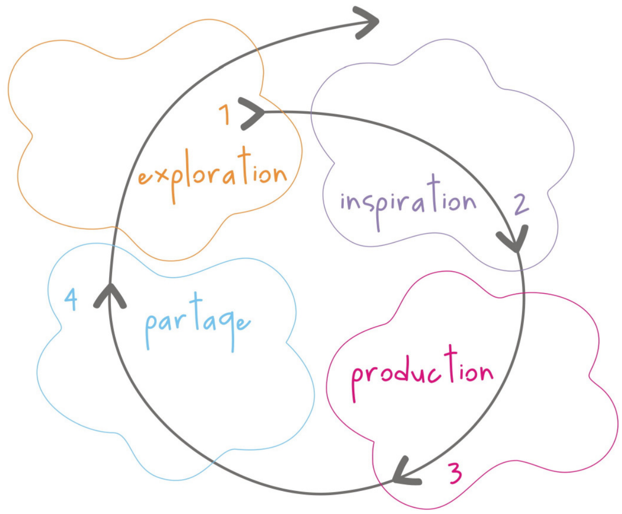


Fig. 1. NAMC++, a model of narrative and creative activity

Exploration consists of the interactions with the real world, which can be either direct or mediated by social relations. The sensory experiences constitute the starting point for the theme and for the ideas, what the child has seen, heard, touched or encountered in various experiences (museum, forest) or even in the classroom with the support of objects and people. At this stage, the child uses instruments appropriate for exploration (e.g. dip net, shovel, microscope, points of view, etc.) and handles various materials (e.g. earth, shells, sand, photos, objects, etc.).

Inspiration is a phase of reflection and analysis on the experience during the exploration. The child is encouraged to think about the previous experience, discuss it and sort out the elements they gathered. Individual writing, drawing or group discussion usually supports this phase.

Production corresponds to the recombination of the elements dissociated and transformed during the previous phase. It is the moment where children, based on selections and choices of elements, produce new content usually through a great variety of media. During this phase, the children mainly use their notebooks, pens and pencils for illustrations, cardboards, puppets, posters and bricolage sets.

Sharing. This is the phase in which children's externalized productions start to exist in their social world. Children present the result of their production and verify the effects of this production on the others (e.g., children, teachers, parents). Sharing can be supported by instruments such as notebook or it is a full-scale performance of groups of children or of the whole class.

The most important achievement of our research within POGO [5], [9] was the development of an educational tool that supports the entire cycle of creative imagination, letting it evolve as a never-ending creative process. POGO's challenge was to design innovative technologies for children that should be equally attractive, fun, long lasting and yet offering sound pedagogical learning opportunities to be seamlessly integrated in the current context of European schools.

We showed that the POGO tools allow for a rich sensorial interaction where physical and virtual elements of children's reality can be explored, analysed, decomposed, and recombined in new ways. The existing objects or the new one produced working with the different POGO tools can be captured by children and edited in real time. What a child builds or brings as a part of the personal experience can be combined with the products of other children in a continuous negotiation process where the evolution of transformations of the objects is recorded and the movement along this process of meaning construction can be used as a way to understand the other's points of view. Moreover the physical objects that are produced in this iterative and combinatory activity remain live features of the process and can be used as the physical address for the articulated production of future creative activity.

Regarding the cycle of creative imagination our results showed several interesting features [5] [9]. With regard to ***Exploration***, we found that it is crucial that any environment supports the transition from everyday life experiences to the fantastic world of narration by affording the collection of media such physical objects that are personally meaningful for children, and transforming them into virtual objects thus creating a rich repository of elements useful for the story. In particular tools which enables the user to import a virtual version of any sort of object, stimulates children to store an experience represented by the object itself. Concerning ***Inspiration***, the technology should be used to encourage children to rethink an experience, to analyze its constituent parts and to express it orally or by drawing. The tools support personal reflection, collective comparison and meaning negotiation. We showed that using POGO, the ***Production*** phase was one of the most surprising in terms of creative constructions made by the children. They made new connections among contents just by manipulating the tools. They explored the flexibility of the tools in representing and structuring the contents. Finally it was clear that POGO tools can be used to amplify and enhance collective ***Sharing*** of the children's production: both the creative process and the product of the narrative activity. This meta level of sharing stimulates meta-cognition and meaning construction and negotiation.

2 Exploring joint creative activities

A thorough analysis of the model [3] made it possible to specify for each phase some specific dimensions. In particular one dimension, which was not detailed in the first version of the model, is relating to the question of space and in particular the exploration of space and places. In a recent research, this dimension was analyzed within the framework of **joint creative activities** within a case study[1]. By joint creative activity, we mean activities that reunite participants from different

[1] This case study is about creative workshops organized for two years in our city which involved more than 400 participants. Exploring together the notions of **identity and territory** participants (including children, teenagers, migrants, displaced populations, local citizens) constructed and shared multifaceted artistic interpretations of common locations.

generations and socio-cultural backgrounds where children, teenagers, adults and elders are invited to individually and collectively discover and tell stories about their quarter, neighbourhood, habits, living space, cultural differences by producing pinhole images and narratives. Sorts of hands-on laboratory, these workshops let participants build their own artifacts, pinholes[2], from inexpensive and readily available materials. Through joint creative activities, we assume that people will explore their environments, feel entitled to speak, get to know their neighbours and neighbourhoods, and will engage in community development.
Figure 2 represents the different steps composing the joint creative activities. Participants are invited to build their camera, observe their environments, explore their ideas, shoot, develop the photographs and create narratives on the issue of Territory.

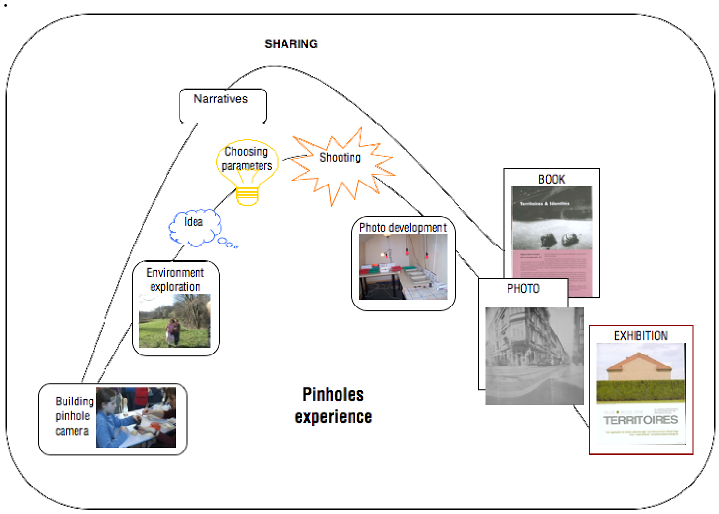


Fig. 2. Joint creative activities exploring spaces using pinholes

The pinhole is an "open" artifact: participants are physically involved in the different steps of the process leading from the camera to the photography. Present at every step of the process, the participants are made responsible for the result. Each step, to be successfully completed, requires that the participants involve themselves in the activity, and implies a reflection before to act.

Exploration. The first loop: from the building of the pinhole to the first picture obtained, act as an exploration phase. The participants discover their environment but also how the pinhole mediates their relationship to the environment. They appreciate its physical and sensorial properties and discover their surroundings. They figure out how the things they see can be transformed by the action of taking picture: they take a castle in picture but the photo obtained look like a firefly!

[2] **Pinholes** are rudimentary camera following the principle of a *camera obscura*: small boxes pierced by a very little hole that allows light to come inside, they capture the reality just like the eyes do. On the surface that is opposed to the hole, an inverted image of the subject is formed and captured by a photo-sensible paper (such as photographic paper).

Inspiration. Thanks to their first picture, they can reflect on, and share with other, the feelings and meanings related to this first experience. As participants explained, it is like if they had “new eyeglasses”.

The dissociation is mediated and facilitated by objects. The image, the photograph obtained, and the "ceremony" which surrounds the discovery of the image (developing photos in the darkroom, to put the photograph to be dried, act as many moments of exchanges with the others) makes it possible to reconsider the feelings, the impressions related to the use of the pinhole.

The **production** phase really arises through the iteration of the loop: Through multiple experiences of the environment and of the pictures obtained, they plan their production. They choose to use the pinhole differently (e.g. superposing images), and to express particular things through their photo (e.g. how I feel today).

The activity provides opportunities for the participants to express themselves and give value to their opinions and feelings. Moreover, we have observed that the shooting step could lead to rich interactions and collaborative behaviours.

Sharing. The moments when the photos are shared represent great opportunities to interact. Participants discuss about their respective pictures, give their opinion, congratulate each other, ask questions about how the picture was taken, where it was taken. It favours the improvement of the pinhole camera’s use and helps each participant to increase his/her knowledge of the pinhole technique. The pinhole, as an externalizable tool [2], favors learning because it provides external results that can be shared and discussed among the participants (figure 3).

Fig. 3. Participants express their satisfaction and are proud to show their photos to others. External results are concrete basis for discussions.

Sharing pictures are opportunities to appreciate each other's work. Positive comments made about the pictures inside the group, and the fact that the photos (as well as narratives) are considered as "oeuvres" that worth to be publicly exposed, brings to the participants a feeling of recognition of their work, and consequently, of their personal value. Confronting the external results to other's appreciation give pride and enhance the participants feeling of self-worth. Finally, externalizing such joint products into "oeuvres", that are shared in the group and then outside the group through a public exhibition, produce and sustain group solidarity and help making a community of mutual learners [2]. The final photographs and narratives were compiled in books and have been part of an exhibition in the frame of the city Photography Biennale (www.biennalephotoliege.be) under the title "*Territories and Identities*" (see figure 2). The oeuvres were exhibited for two months. Participants were empowered to exhibit their oeuvres side by side with recognized artists. The exhibition was designed in order for each of the participating groups to have a dedicated space. The photographs were also assembled into a collective fresco within the form of a tree in order to symbolize the relationships of men in their territory.

Fig. 4. Participants discovering their photos in the exhibition (a, b). Participants exploring the environment.

3 The role of artifact in the experiences of space and places

While the photography activity leads to walk around and rediscover the environment, the narratives activity leads to explore the relationship between places and identity. To elicit reflection on that theme, the animator individually asked the participants to think of "what is my territory?" The narratives based on the participants' answer to that question generally reflected personal experiences related to critical life issues, and associated to particular contexts and places.

As emphasized by the literature on places, "it is not simply the places themselves that are significant, but rather what we can call "experience-in-place" that create meaning" [8], p. 74. The workshops create opportunities for significant experiences. One interesting particularity of the workshops is that the photography activity (in particular the shooting step) is performed outside. Thus, the participants continually move from inside (indoor activities and developing the pictures) to outside (exploring the environment and taking pictures). The indoor space was generally spacious, though some workshops took place in small locals that didn't allow for many movements. Speaking of the photo laboratory, some participants stressed the feeling of oppression when developing their photos in this "*dark little room with no space to move freely*". However, as we have previously described, other participants appreciated this particular atmosphere, favouring collaborative, or complicity behaviours. It contrasts with the feeling associated with outside activities: The participants commonly perceived the workshops as an "*open space*", a "*space of freedom*", with great moments of environment exploration, that gave them a feeling of autonomy and liberty.

The workshops also give the opportunity to explore the public spaces [4]. It is a way for each participant to (re)discover the environment and (re)create an emotional relation to places, as they are associated with rich interactions, inclusion feelings (sharing together a pleasant experience, being part of a community), and personal development (personal growth, self-esteem) [1], [6], [7], [8].

More specifically, if we try to understand the role of the pinhole camera in the appreciation of places. It implies to physically move in the space, as participants search for something to take in picture (see figure 9). For instance, we could observe that the participants were always going further to take their pictures: "*we have walked for more than one hour away from the cultural centre, to find the perfect subjects for our pictures!*". Hence the pinholes encourage physical/geographical discovery of the environment.

But not only it allows to appreciate the familiar places/environment differently as participants, individually and collectively, rediscover their neighborhood [7]. Indeed, participants have to pay attention to the environment in order to choose the subject of their picture: "*We scan the environment, searching for something we really like before to take a picture, so we must carefully pay attention to what is around us*". Then, a new look on familiar environment can arise: "*We rediscover places that can be interesting though we see them every day without considering them. The train shelter, for instance, it has always been there, but we could look at it differently because we paid attention to it, searching for an angle, for something nice to take in picture; it is as if we have new eyeglasses*".

It elicits reflection about the common space. It allows to appreciate physical properties of the environment. As one of the photographers involved in the pinhole workshops confided: "*To take a good picture, you must pay attention to light, texture, colours, movement*". Because it implies to take into account the physical properties of the photographed subject, the pinhole mediates the sensorial relation to the environment and "reveals" its physical properties.

The participants are based on their spaces and environment to express themselves, to carry a new glance and to reconsider what surround them by seeing a certain beauty and poetry there.

4. Discussions

Compared to the themes of the workshop, that is "to explore the opportunities that technology- driven physical play offers for enhancing and stimulating real social interaction", the approach that I propose can be situated less on the perspective of the physical play but more on that of the play in space. And insofar as this last is carried out collectively, the question of social interaction, which emerges through play in space, is then central. From this point of view I am interested to explore how meaning related to space are built and how this construction confers to space a status of place. I have taken the option, even provisional, that the joint creative activities whose product are oral and visual narratives, are forms of play because, in the case study on which I rely, these activities are lived as such by the participants.

For the majority of young people, cyberspace becomes an integrated part of their experience of spatiality. However several studies underline the fracturing of physical and virtual spaces, and stress the fact that the children of today have more difficulty to get into contact with their physical local surrounding and spaces due to the decrease of opportunities of exchanges with them.

Though, involvement in the community space is a crucial way to develop social inclusion, particularly through fostering sense of community, i.e. the "sense that one is part of a readily available mutually supportive network of relationship". Feeling connected to the community space help defining oneself as active member of the community.

Our observations of the use of a very simple artifact, such as the pinhole, showed us the interest for participants to carry a glance on their space and places. Exploring, be inspired, producing and sharing expressions about their space and places enable them to express themselves and this expression is drawn on what surround them. But not only it :

1. Fosters fruitful interactions between diverse populations, which develop a better knowledge of each other and feeling of being part of the same community. It also promotes expression of each individual as equally valuable member of the community. It gives the same weight to all participants' opinion, and empowers them, as complete citizen fully able to take actively part in the community life.

2. Elicits reflection about the common environment and fosters new positive relationships to the community space. It (re) connects participants to their local environment, which is a first step for them to involve and feel included in the community life.

Our research helps us to think about technological mediations to be introduced in creative activities seeking to foster social inclusion and participation. Now that strong social interactions are rarely limited by distance, they should not contribute to dissipate the importance of our interaction with the environment and in particular with the significances which we give individually or collectively to the places where we live.

Acknowledgments. This research was partly conducted with the support of the European Commission – EACEA Agency under the framework of the Minerva action and the PUENTE project. I wish to thank my colleagues from the PUENTE project, and Laura Lentini at University of Liège who contribute to this research. I also thank Dorothée Luczak & Werner Moron, artistic directors of the photography biennale, organizers of the pinhole workshops, and all the participants who pleasurably involved in this experience.

References

1. Auburn, T., Barnes, R.: Producing place: A neo-Schutzian perspective on the "psychology of place". Journal of Environmental Psychology. *26*, 38-50 (2006)
2. Bruner, J.: The culture of education. Harvard University Press, Cambridge, MA. (1996)
3. Decortis, F. : L'activité narrative et les nouvelles technologies pour les enfants. Habilitation à diriger des recherches, Université de Paris 8, Paris, December, 175 pages. (2008)
4. Decortis, F., Ackermann, E., Barajas, M., Magli, R., Owen, M. & Toccafondi, G.: From "La Piazza" to "Puente": How place, people and technology make intergenerational learning. International Journal of Technology Enhanced learning, vol. 1. N1/2, pp. 144-155. (2008)
5. Decortis, F., Rizzo, A., Saudelli, B.: Mediating effects of active and distributed instruments on narrative activities. Interacting with Computers. 15, 6. (2003)
6. Hernandez, B., Hidalgo, M., Salazar-Laplce, M., & Hess, S.: Place attachment and place identity in natives and non-natives. Journal of Environmental Psychology*,* *27*, 310-319. (2007)
7. Mannarini, T., Tartaglia, S., Fedi, A., & Greganti, K.: Image of neighborhood, self-image and sense of community. Journal of Environmental Psychology*,* *26*(3), 202-214. (2006)
8. Manzo, L.C.: For better or worse: Exploring multiple dimensions of place meaning. Journal of Environmental Psychology*,* *25*(1), 67-86. (2005)
9. Rizzo, A., Marti, P., Decortis, F., Rutgers, J., Thursfield, P.: Building narratives experiences for children through real time media manipulation : POGOworld. In M.A. Blythe, A.F. Monk, K. Overbeeke & P.C. Wright (eds). Funology : from usability to enjoyment, chapter 15, 1-12, Kluwer Academic Publishers, Amsterdam. (2003)
10. Vygotsky, L.S.: Immaginazione e creatività nell'età infantile. Editori Riuniti. Paideia, Italy (1930/1983)
11. Vygotsky, L. S.: Imagination and creativity in childhood. In R. W. Rieber (Ed.), The Collected Works of L.S. Vygotsky. Plenum, New York (1998)

Get Up and Move: An Interactive Toy that Measures (In) Activity and Stimulates Physical Activity

Andrea Leal Penados[1,2], Mathieu Gielen[1], Pieter-Jan Stappers[1], Tinus Jongert[2]

[1]Delft University of Technology
[2]TNO Prevention and Healthcare
lealpenados@yahoo.fr, {m.a.gielen, p.j.stappers@tudelft.nl},tinus.jongert@tno.nl

Abstract. Health experts are worried about the increase in overweight and the decrease in activity levels, particularly amongst youngsters. This project explores the possibilities of using interactive toys and social interaction in encouraging children to reduce their sedentarism. The project consists of a stuffed puppet which has an accelerometer to record the child's (in)activity, and interactive elements. The puppet enables young children, aged 4 to 8, to care for it through their own physical actions. To arrive to the final concept a research was carried out on the barriers and motivators for children to engage in physically active play. On the basis of that knowledge four key elements were used to develop the product: fantasy, social interaction, surmounting physical and cultural barriers and inspirational factors. Two pairs of prototypes were tested. First limited tests indicated that the toys' key elements were appreciated and understood, and suggest that it is possible to use interactive toys and social interaction to change the physical activity behaviour.

Keywords: Interactive toy, physical activity, sedentary behaviour, social interaction, fantasy, obesity, health care.

1 Introduction

Recent studies show that the increase of overweight in children and adolescence in the last decade is significant, and at the same time children's level of physical activity and physical performance has declined [3, 4]. Some reports highlight the role of digital technologies (television, videogames and computers) in shifting children's play into sedentary experiences [2, 12].

However, media have recently been used to increase physical activity (PA), and have become promising in the prevention and treatment of obesity in youth. Examples are the success of Nintendo Wii®, DanceDanceRevolution® and Xerbike®.

The goal of the project was to develop a product that measures children's inactive time and motivates them, when needed, to reduce their sedentary behavior and increase their physical activity (for a detailed description of the project, see [15]).

2 Research

Literature research, interviews and generative session were used as research methods. There is vast documentation regarding (in)activity in children. Complementary interviews and generative sessions were carried out to gain empathy with the users. The main results of the research are:

2.1 Sedentary Behaviour and PA in children: The I-change model

A behaviour change is required to shift from sedentarism to activity. For that reason a behavioural change model was chosen to identify the motivational mechanism and the procedures necessary to promote change from sedentary behaviour to an active behaviour. The Integral model of change, I-change model, [19.23] originally used for reducing smoking in adolescents, was chosen (Figure 1).

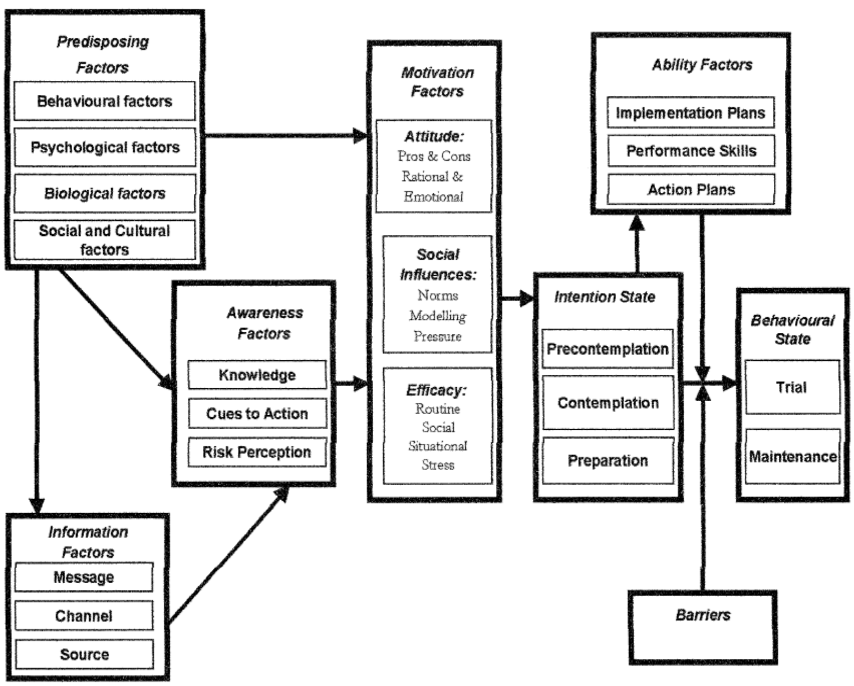


Figure 1. I-change model [23] shows which factors contribute to behaviour change.

All factors of the model related to sedentary behaviour and physical activity are relevant, but only the ones that turned out to influence the design decisions are described below; we will not explain information factors, awareness factors and ability factors.

Predisposing Factors. Gender is an important biological predisposing factor. Compared to boys, girls show higher levels of overweight and obesity, exhibit lower levels of physical activity [12, 22], and experience steeper declines of PA during adolescence [4, 8].

Sociodemographic factors like low income, ethnic minority, single parent and overweight parent are consistently related to TV viewing and overweight in children [1, 11, 24, 25].

Motivation Factors. For young children enjoyment could be the most important determinant of the attitude towards PA [6]. From the interviews it was concluded that children participated in a sport or played actively when they enjoyed doing it.

Social influence is primordial. Many reports show that parental support is consistently conductive to greater amounts of physical activity [10, 27], and that family exerts a tremendous influence on health-related behaviours such as exercise [6]. During the interviews it was noted that parents are the main influence factor in the duration and frequency of outdoor play, which is dependent on their parent's time and mood. Participating in sports and the regulation of some sedentary behaviour such as TV viewing and computer use is determined by parents. Friends are a second important stimulator to play outdoors, participate in sports or change from a media use activity to another type of play.

Barriers. Diverse environmental factors have an important role in the levels of physical activity in children. Among the negative factors are dog waste, high traffic and high rise buildings [8, 25].

Interviews revealed that young children can only play outside by themselves if they live in a house (or first level of an apartment), in a low or none traffic area and far away from canals (if the children could not swim). Even when living near playgrounds, many children living in areas considered unsafe by their parents, do not go to playgrounds often since they cannot go by themselves.

Cultural background also plays an important role. Some parents do no allow their children to go outside, since they are scared of bad influence from other children [1].

2.2 Relationship between Media use and Overweight

A study done for Jantje Beton [13] (Dutch association that stands up for the chance to play for all children in the Netherlands) by TNS NIPO (The Dutch Institute for Public Opinion and Market) says that 53% of children give as reason for not playing outside the TV or the Computer. All the interviewed parents mention that their children preferred to watch television to almost any other activity if they were allowed to.

Some researches [11, 12] show that television viewing and electronic game/computer use are somehow associated with adiposity.

Janz et al. [14] in a study relating television, physical activity and fatness in the adiposity rebound period (4 to 6 years), concluded children who on average watched 1 h or less of TV had 3% less body fat than those watching more than 3 h.

Several countries now recommend a maximum of two hours per day of electronic media use in children's physical activity guidelines.

2.3 Children's Play and interests

Piaget made a classification of play, based upon which type of play children execute at different stages [26]. Symbolic play (stories and roles) is the main type of play for children aged 2 to 5, and construction play for children aged 4 to 8. Parents affirmed that their children could play for hours at construction and fantasy play (symbolic play), independently of the type of child and gender. However, the girls' and boys' ways of playing can be very different [18].

2.4 Technology and children

As explained before, children are much attracted to technology products such as TV and computer games and use them on a daily basis. These are barriers to perform physical activity, but some of their aspects can be use to stimulate physical activity.

Crawford [5] gives several reasons why people play videogames. Fantasy is one of the main reasons. He believes that people need to escape from their daily routines and fantasize. He explains that through the fantasy people can overcome social restrictions and that video games also provide the means of proving oneself. Malone [16, 17] estimates that of all the features a computer game has, fantasy is the most important feature that can be usefully included in other user applications. In his diverse studies, he explains that there are four main factors that motivate the use of specific video games: fantasy, curiosity, control and challenge. Games are appealing by evoking the users' curiosity. Environments can evoke curiosity by being novel and surprising. Sounds and images are usually used to enhance the curiosity [5, 7, 20] and contribute to the players' immersion in the game and concentration by providing sensory "proof" of the game's reality. The challenge is determined by the relation between the players' abilities and the complexity of the task. Personal meaningful goals with uncertain outcomes are beneficial to the challenge.

3 Concept Development

3.1 Key Elements Considered for the Design

The research provided a number of key elements to apply to the product. One of the main factors was to surmount the environmental and cultural barriers. Since many children cannot freely play outdoors, their natural play area (inside their home) could be adapted to allow them to have more physical activity. Even if the solution was focused on inside play, the play should provide a motivation factor to be used outside as well, since outdoor play stimulates physical activity and some parents do not appreciate their children being active inside the house.

Social interaction was another main aspect to consider for the object, since parents and/or friends play a major role in a child's behaviour. In addition, it was decided to use fantasy as a central factor for the solution because fantasy games are often played by children, and it has proven to be effectively used to attract them to play video games or watch television. In this project, fantasy was used contrariwise to attract children to physical play, away from television and computer. Some video game aspects such as curiosity, control and challenge were decided to be used to support the fantasy.

3.2 Design Approach

To facilitate the exploration of possible concepts and develop the user's experience and the physical components for the product, prototyping was introduced early in the design process. Different concepts were created and parts of it were tested to learn from the users' reactions. Features that took into account the key elements were kept from each concept and further developed in the next one.

3.3 Technology

In order to reduce sedentary behaviour when needed, it was necessary to measure it. For that an accelerometer was used to measure (in)activity. RFID technology was used to have the toy react to different objects. The data was received in software Max/MSP which also controlled the sounds, vibration and/or lights, creating the toy's behaviour.

4 Final Design

The final design consists of a puppet called Gum. A Gum is small creature that needs to be taken care of by a child. The child's mission is to make his/her Gum healthier and happier by moving with it, feeding it and playing with it. A resume of its functions is given in figure 2. A Gum can pronounce words and emits sounds to ask for things or show its mood. It can also light up its ears and stomach and vibrate to communicate. Together with the Gum a child will obtain a group of objects (to feed and play with the Gum), a small story to learn about the Gums, a parents' guide and a charger.

A Gum is healthy and happy when it has a minimal amount of daily physical activity. Since a Gum cannot move by itself, the child needs to do it. The Gum is placed in a special pocket which is attached to the child's waist, in that way the Gum will sense the child's physical activity. For the child it is a type of baby carrier.

Gum's food has to be placed in different parts of the house by the children together with parents. A Gum wants to eat when the child has been inactive for a long period of time. It will tell the kid in a Gum language (similar to toddler's language) which food it wants to eat. The child will take the Gum to where the food is placed (See

Figure 3); it makes different noises depending on the food it is asking for or eating. The type of food a Gum eats changes over time.

As the Gum gets healthier, lighted stars will appear in its ears, until it reaches a maximum healthy state. To increase the number of stars, the child needs to progressively increase and later on maintain its physical activity level. This takes several days, and up to a month in the last levels.

Gums also react to the child's daily activity. The stars in the ears are brightly illuminated only if the child does the required PA (depending on Gum's level), and dim when the child does not do it. The Gum can get angry if it has not moved enough and happy if it has. Besides moving around with the child, the Gum needs to eat, drink, play with friends, etc.

Even though a Gum is similar to a Tamagotchi [21] or a Furby [9], Gums invite children to be more physically active and move through the house, inside and out. Tamagotchi is a nurturing personal digital interactive toy and Furbies are interactive pets that encourage children to talk to them.

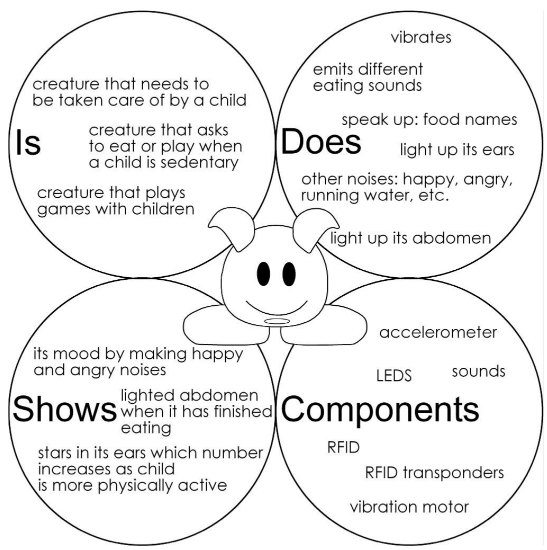


Figure 2. Gum's activities and components

Figure 3. Gum sensing a food object.

4.1 Social games with the toy

Gums like to play with their favourite toy (ball) and pet (spider). When the Gum touches the ball (or the spider) a sound is heard, after touching it for a number of times (depending on the level) the Gum will blink its ears and say “yuppi / yuhoo”. The games can be freely played by the child. A Gum can also ask to play a game, if it senses the child’s inactivity for a long period.

Due to the simplicity of this type of interaction many games can be played. With an added timer, some competitions can also be made. A game example is running from the ball/spider: the child runs to escape from the ball/spider that the parent or friend is carrying, when the parent/friend touches the Gum a number of times, he/she wins. If another child has a Gum, more games can be done, for example the fastest to touch the adversary’s Gum (with the ball or spider) a number of times wins.

Besides the previous game, there is another game that can only be played with two Gums and a set of toy eggs. Children race against each other to see who finds the eggs the fastest. The fantasy consists of the Gums wanting to kiss the eggs and wake up the birds inside the eggs. However birds are not always happy when woken up. The first Gum to make four birds happy wins. The child will either hear a happy or an angry bird sound when touching an egg with the Gum. The Gum who wins vibrates and says “yuhoo”.

4.2 Key elements used for the design

The four key elements derived from the research were applied in the final design as follows:

Fantasy. Children can get very attached to their own toys, especially to stuffed puppets which can be easily hugged, kissed or petted. A Gum is meant to be a special partner, almost like a pet. The chosen activities are similar to living creatures’ activities: eating, going to the toilet, getting cleaned, playing with friends and pets. The accompanying story helps children to get immersed in the fantasy.

Social interaction. Different ways are used to stimulate social interaction. First with a friend, a child will want to show how she/he has helped her/his Gum to become healthier, the number of stars in the ears will be displayed and comparisons can be made among friends. The kissing eggs game can only be done when a child is with someone else. Playing with the ball and the Gum is more exiting if more children are playing.

Parents will have a guide of the correspondences between the level of the Gum and the quantity of physical activity asked. In that way they will be aware of the PA their child does. They can motivate their children and even do some extra physical activities with them to make the Gum healthier, and the child happier.

Inspirational factors. The game was inspired by some video game qualities: goal, challenge, curiosity and control. These factors serve to support the fantasy. In this case the main goal is clear: make the Gum healthier and happier by being active. The challenge increases as the time passes by, first the Gum will rapidly increase stars without major effort, and progressively need more activity to change. Curiosity is engaged since the child is curious of what will happen: when is the Gum talking, when are the stars going to appear? The curiosity is supported by the sounds, vibration and lights. The child can have control over some actions by ignoring the Gum and by asking the Gum to play or eat.

Surmount cultural and environmental barriers. As explained before, these barriers are surmounted by allowing the child to use the Gum and do some physical activity at home, since many children cannot play freely outdoors. However, the game is not restricted to indoor play and can be played outside.

5 Testing

Two pairs of prototypes were made to test the concept, prototype 1 used sensors that needed USB connection to a PC, and prototype 2 allowed wireless communication to the computer. The final design is intended to function without an external computer.

5.1 Test set up

Testing the prototype was divided in two different test set ups. The first set up consisted of a series of short tests with eleven children aged 4 to 8, lasting two hours each. For technical reasons they were conducted with a Gum attached to a computer with a long wire. The second setup consisted of one longer test done with one seven year old boy one hour daily, during 10 days. This test was done with a wireless Gum. Before the actual tests were conducted, the story together with the parents' guide was sent to the family's house.

The first test's main purpose was to observe the reaction of the children and parents towards the whole concept and the understanding and appreciation of the key elements. Different parts of the interaction were tested: feeding, ball game and eggs game. The Gum's mood and evolution was not tested with children, only discussed with parents, since it was not possible for the toy to evolve or have a specific mood in a short time frame. The second test served to observe those elements that required longer time of use.

Both tests had some limitations. The novelty of the toy, the presence of the tester, having the Gum commanded by a computer and the small number of participants might have affected the results. Whenever possible, it was tried to verify observations and findings from children's sessions through interviews with the parents.

6 Test Results

Both children and parents showed a good appreciation and understanding of all key elements:

- Fantasy: it could be observed that children believed in it. After reading the story they all remembered it, most parents mentioned that their children were impatient to meet the Gum. Many children, especially girls, showed signs of affection to the puppet such as hugging and kissing. During the long test, the boy wanted to care for it. He was affected when the Gum was angry, and tried to please him. He demonstrated his love for him by playing with it, sleeping with it or talking to it. No participants expressed a dislike of the narrative or the character.

- Social interaction: children showed social interaction by sharing the fantasy with others. In the first test, children explained the story and the Gum to each other. They were animated while telling the story and explaining how everything worked. They showed good comprehension of the concept and remembered most of the details. During the long test the boy's brother was almost as happy as the testing boy when the Gum lit up a new star. Parents participated with children to place the food objects and by reading the story together.

Children were more excited when other children were also present. The more they were, the longer they played each game. They preferred the eggs game, which can only be done with two Gums. When many children were present, they teamed up to help each other find the eggs faster.

With the ball game, children had an active physical activity (See Figure 4) for more than 30 minutes, especially when more than two children participated in the game.

- Curiosity: it was observed that the sounds and vibration helped the children get immersed in the fantasy. All children responded to the Gum talking and wondered what the Gum would ask next. Most kids found the sounds funny and smiled or laughed after hearing them. Parents did not consider the sounds annoying.

- Control: during the second test, the tester showed wanting to have control of the Gum and the game. He often made the Gum want to eat, before the Gum would ask it. He had a table to mark every time the Gum asked for a new food. When watching television, in some occasions, he ignored the Gum once or twice and fed him when he thought that the TV show was almost over.

- Goal: the boy in the second test showed comprehension towards the goal of having many stars through physical activity. He asked everyday if the Gum had been informed about him swimming and eventually he would tell the Gum himself. He mentioned several times wanting to be active in order to have a Gum with many stars and eating more food.

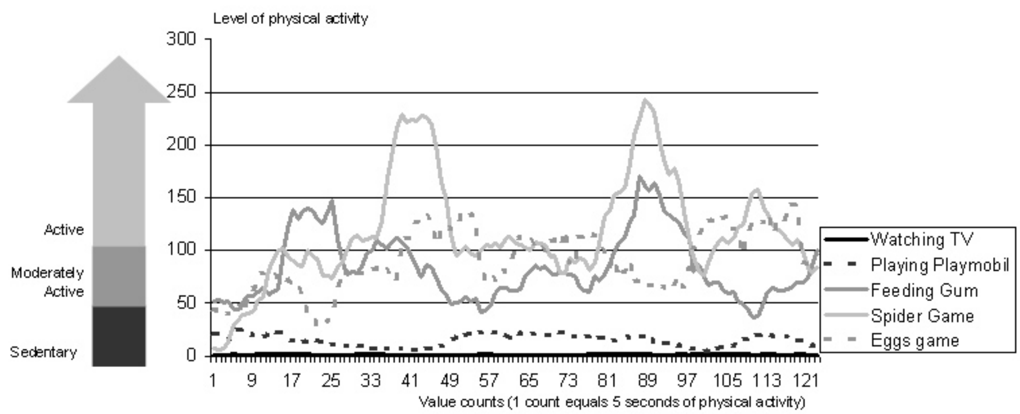


Figure 4. Comparison of the intensity of each activity done with a Gum to other types of play. Each value count corresponds to five seconds of activity. The activity level refers to the calculated velocity between accelerometer values.

- Reducing sedentary behaviour: It was observed that with the puppet it is possible to reduce sedentary behavior and increase PA, however physical activity is not necessarily prolonged after interacting with the toy. During the second test the boy always paid attention to the Gum when it asked for something. However, when it was during a television show, he would ask the Gum "Why do you want to eat now?" and get upset. During the first days of the test, he would always get up and feed the Gum, going back and forth from the television to the food. Then, he was told that he could ignore the Gum. He did it, but when the Gum got angry, he was very surprised and felt bad about making the Gum angry. He immediately got up and fed it.

- Increase PA: It was observed that children could be very active while playing with the Gum and that it is possible to increase PA by wanting to make it happy. Children were active when playing the different games, especially the ball game. The eggs game and feeding the Gum were observed to be moderately active activities (see figure 4).

During the second test, the child increased his physical activity inside the house, and mentioned that he was running in order to light more stars in the Gum's ears. He was emotionally expressive whenever the Gum lit up a star or asked for a new food. He showed this by singing and sharing the moment (see Figure 5).


Figure 5. Being happy when the first star appeared.

Most parents expressed that they appreciated the toy; only one thought that her boy would not use it for a long time. Most parents mentioned they thought that their children would be motivated to move more thanks to the star system. They think that it is also motivating for the child when the Gum makes happy or angry noises.

7 Discussion

It can be discussed that the enthusiasm shown by the children towards the toy was a first reaction to a new toy or influenced by wanting to satisfy the tester.

However some indications suggest that children are interested in the games aspects and not only on the novelty. During the tests many children asked to do the activities several times and not only once as planned. Most of them showed interest in the Gum after the tests. They asked to play again when all the accessories, Gum and computer were packed and the tester was ready to leave from the participant's home. Some weeks after the test, the majority of parents mentioned that their children continued asking for the Gum, and some of the kids named their own food after the Gum's food.

In the second test the attachment of the participant increased with time. As the days passed the boy showed more affection and had more interaction with the toy. However, it is possible that his reactions towards the toy and him increasing physical activity were influenced by the fact of knowing that he was testing the toy.

Preliminary tests which were limited in time and number of participants can not give final conclusions, but it was overall observed that children did understand and appreciate the key elements of the toy; that the toy motivates the child to play with it; and that playing with it led to more physically active behavior. Some indication was found that this continues in the mid-long term: even when not responding to the toys signals immediately, the test child did feel responsible to keep the Gum happy and therefore engage in Physical activity in the course of the day.

8 Conclusions

The project indicates that interactive toys can be an effective tool to reduce sedentary behaviour and motivate the increase of physical activity.

The key elements used in this toy were useful to get the children engaged in the different game aspects and due to their engagement change their physical activity behaviour. Being socially active with the toy was achieved, and at the same time, the toy allowed the increase of physical activity through social interaction, since children were more willing to play.

Some concern may arise about converse health implications to children with eating disorders. Thought food is part of the narrative, the toy/play does not encourage dieting or reducing food intake in any way; instead, it focuses on burning calories through physical play.

The project suggests that toys can to some extent compete with television and computer games and seduce children to leave these behind to engage in more physical and social play behaviour.

For the moment this is a concept that opens a possible research line, if its development is continued it will probably make a product with high play value. The next step could be to produce a large series of prototypes to use with children in a longer term and to integrate more social games.

To come to more definitive conclusions a large scale test is necessary to verify the findings so far and measure caloric expense through use of the day.

9 REFERENCES

1. Boere-Boonekamp, M., L'Hoir, M.Beltman, M.P., Bruil, J., Dijkstra, N., and Engelberts, A.: Overgewicht en obesitas bij jonge kinderen (0-4 jaar): gedrag en opvattingen van ouders. Ned Tijdschr Geneeskd. 9 februari;152(6) (2008)
2. V. d. Boogaard, C., de Vries, S., Simons, M. and Jongert, M.: Bewegen met computergames. TNO Prevention and Healthcare. The Netherlands. (2007)
3. Brettschneider, W.D. and Naul, R.: Study on young people's lifestyles and sedentariness and the role of sport in the context of education and as a means of restoring the balance. European Commission report. (2004)
4. Comission of the European Cominuties: Green Paper. Promoting healthy diets and physical activity: a European dimension for the prevention of overweight, obesity and chronic diseases. Brussels. (2005)
5. Crawford, C.: The Art of Computer Game Design Washington State University. REV.5.27.97 http://www.vancouver.wsu.edu/fac/peabody/game-book/Chapter1.html (1997)
6. DiLorenzo, T., Stucky-Ropp, R., Vander Wal, J., and Gotham. H.: Determinants of Exercise among Children. II. A Longitudinal Analysis. Prev Med 27, 470–477 (1998)
7. Druin, A., Bederson, B., Boltman, A., Miura, A., Knotts, D.and Collan, I.: Children as our technology design partners. In: Druin, The Design of Children's technology. Morgan Kaufmann publishers, Inc (1997)
8. Evenson, K., Scott, M., Cohen, D., and Voorhees, C.: Girls' Perception of Neighborhood Factors on Physical Activity, Sedentary Behavior, and BMI OBESITY Vol. 15 No. 2 February (2007)
9. Furby. http://www.mimitchi.com/html/furby.htm
10. Golan, M., Weizman, A., Apter, A., and Fainaru, M.: Parents as the exclusive agents of change in the treatment of childhood obesity. The American Journal of Clinical Noutrition 67:1130–5 (1998)

11. Gorely, T., Marshall, S. and Biddle, S.: Couch Kids: Correlates of Television Viewing Among Youth International Journal of Behavioural Medicine. 4, Vol 11, No. 3, 152-163 Lawrence Erlbaum Associates. Inc (2004)
12. Hesketh, K., Wake, M., Graham, M. and Waters, E.: Stability of television viewing and electronic game/computer use in a prospective cohort study of Australian children: relationship with body mass index. International Journal of Behavioral Nutrition and Physical Activity. 4:60 doi:10.1186/1479- 5868-4-60 (2007)
13. Jantje Beton http://www.sp.nl/nieuws/nwsoverz/div/030729jantjebeton.stm
14. Janz, K.F., Levy, S.M., Burns, T.L., Torner, J.C., Willing, M.C. and Warren ,J.J.: Fatness, Physical Activity, and Television Viewing in Children during the Adiposity Rebound Period: The Iowa Bone Development Study. Prev Med 35(6):563-71. (2002)
15. Leal Penados, A. Get Up and Move: Development of a sedentary measurement tool that stimulates physical activity. MSc Thesis, Delft University of Technology (2008).
16. Malone, T.W.: Heuristics for Designing Enjoyable User Interfaces lessons from Computer Games Xerox Pale Alto Research Center. Association For Computing Machinery. (1981)
17. Malone, T.W.: What makes things fun to learn? Heuristics for Designing Instructional Computer Games. Xerox Palo Alto Research Center. ACM 0-89791-024-9/80/0900-0162 (1980)
18. Owen Blakemore, J.E. and Centers R.E.: Characteristics of Boys' and Girls' Toys, Sex Roles Volume 53, Numbers 9-10 / Nov. (2005)
19. Schermers, P., Jongert, M.W.A. and Vries, S. de: Is de Healthcheck effectief als vorm van beweegstimulering bij VMBO-leerlingen? TNO Kwaliteit van Leven. Preventie en Zorg.
20. Sweetser, P. and Wyeth, P.: Game Flow: A Model for Evaluating Player Enjoyment in Games The University of Queensland, St Lucia, Australia. ACM Computers in Entertainment, Vol. 3, No. 3, July (2005)
21. Tamagotchi. http://www.tamagotchi.com/
22. Vandewater, E.A., Shim, M. and Caplovitz, A.G.: Linking obesity and activity level with children's television and video game use. J Adolesc 27(1):71-85 (2004)
23. Vries, H. De, Mudde, A., Leijs I., Charlton, A., Vartianen, E., & Buis, G.: The European Smoking prevention Framework Approach (EFSA): an example of integral prevention. Health Education Research, 18, 611-626. (2003)
24. De Vries, S. , Bakker, I., Van Overbeek,K. and Hopman-Rock,M.: Kinderen in prioriteitswijken: lichamelijke (in)activiteit en overgewicht TNO Prevention and Healthcare. The Netherlands. (2005)
25. De Vries, S., Bakker, I., Van Machelen,W. and Hopman-Rock, M.: Determinants of Activity-Friendly Neighboorhoods for Children: Results from the space study. American Jounal of Health Prevention. The Netherlands. (2007)
26. Xypas, C : Les stades du développement affectif selon Piaget L'Harmattan (2003)
27. Zabinski, M., Saelens, B., Stein R., Hayden-Wade H., and Wilfley E.: Overweight Children’s Barriers to and Support for Physical Activity OBESITY RESEARCH Vol. 11 No. 2 February pp 238- 246. (2003)

iSport: Varieties of Physical Interactions in Social Contexts

Martin Ludvigsen[1], Rune Veerasawmy Nielsen[2], Maiken Hillerup Fogtmann[1]

1 Aarhus School of Architecture, Norreport 20, 8000 Aarhus C, Denmark
2 Center for Interactive Spaces, University of Aarhus, Åbogade 34, 8200 Aarhus N, Denmark
martinl@interactivespaces.net, runevn@cs.au.dk, maikenhf@interactivespaces.net

Abstract. The iSport project is exploring the design and interaction potential of movement and physical interaction in social contexts. The project deals with three distinct areas of application all within the world of sports: elite athletes training, spectator experiences at sport events and physical education in schools. The goal of the project is to create interactive prototypes that will enhance and support the activities already at play in the three contexts and in that effort explore new ways of interacting with ubiquitous computing technology.

Keywords: Kinesthetic empathy interaction, elite sports, learning, social interaction, play, spectator experience, collective action, design research.

1 iSport

Today it is becoming a well-known and generally accepted thesis that human beings perceive, learn and experience through bodily movement to the same extent as through purely cognitive means [1]. George Lakoff and Mark Johnson state "Our sense of what is real begins with and depends crucially upon our bodies, especially our sensorimotor apparatus, which enables us to perceive, move and manipulate..."[ibid]. This means that our bodies are the foundation for the way we experience and interact with our surrounding.

The iSport project is focused on exploring the challenge of designing and using computers in ways that enhance and support physical and social capabilities and experiences. The project is divided in three areas of interest where the central notions of movement and sociality are essential to all three. As emphasized in the call for this workshop, there is a huge challenge in the field Human-Computer Interaction of designing a better relation between computational functionalities and the physical and social context that these are used in. Many of the activities we are engaged in as social beings are situated in physical space and almost all of our social skills are developed and connected to meeting people socially in physical space [2].

The three areas in the iSport project are all dedicated to exploring physical interaction in social context and how they are connected and can be supported. However, in each area the context, means and goals vary a great deal, even if they are all located in the world of sports. The domain of sports have been chosen since movement and physical interaction is already in focus here, making it an ideal context for working with applying tangible and physical interaction that goes beyond the facination of material qualities and start focusing on how to enrich the users bodily and socialy goal through interaction. Our job as designers and researchers is to introduce technologies and interaction forms that fit within the existing setting without becoming disruptive to the overall goals of the social contexts.

From the introduction of tangible and physical interaction [8] the research has been focused mostly on exploring the potential of these interaction forms themselves. Now there is a general move towards a utilization of the knowledge that has been uncovered in a range of application areas. The iSport project seeks to participate in this exploration with its focus on these three areas already devoted to physical interactions and movement by designing technologies that physical and social engage users.

The iSport project is engaging the issues of social and physical interaction on a broad front to investigate and develop new forms of interactions and novel technologies to support these interactions that will enable better results, better learning and better experiences.

1.1 Goals and means in the interaction

The goals of the three areas of application in the iSport project are very different, but they stem from the same core issue of exploring the potential of movement and physical interaction in social context.

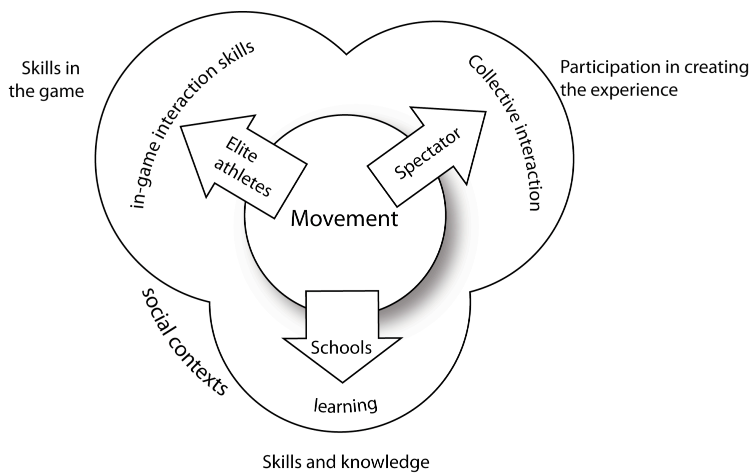


Figure 1. The iSport project is organized around exploring the potential of movement and physical interaction in various social contexts

Each part of the project explores this potential in a given social context and seeks to introduce digital technology in order to support the attainment of the purposes or goals already present in that context.

For the competitive sports-area the goal that our users are working towards is to achieve better results when playing the game against real live opponents. In the interactive sports – interactive in the sense that a player interacts directly with another person – the individual's ability to pass, trick or feint an opponent is central to success in the overall game. This skill needs to be integrated in the athlete's physical psychomotor skills through intense practice or real match experience. So the overall goal is to win the matches by enhancing in-game kinesthetic empathy interaction skills [3], and the mean to achieve this is physical training and physical interaction. The artifact we are designing must support this particular activity as a piece of training equipment that focus and isolates the social interaction of standing in front of an opponent and try to trick him in a game of skill.

For the spectator part of the project the goal of the users is to create the best possible support for their team, including dominating or out-cheering the visiting team's fans. This collective action is deeply based on the physical experience of being part of the crowd and the physical activity of the audience as a whole. Our challenge here is to design an artifact that presents interaction possibilities to spectators without limiting their range of expression.

In the school-area of the project the goal in the social context is, of course, to teach the pupils skills and give them knowledge of a particular subject matter. We seek to do this through exploring how physical education can be combined with other subjects in school like primary and secondary language, natural science or media.

2 Exercising Kinesthetic Empathy Interaction

The first part of the project is focused on developing a way for elite athletes to train their psychomotor skills through what we call kinesthetic empathy interaction [3] – basically the man-to-man situation where two persons compete opposed to each other often as part of a larger game. In a range of disciplines these types of skills are central to the overall success on the field. We focus on team handball and basketball as the sports where we want to develop a piece of interactive training equipment for honing the athletes' skills within this specific situation.

Everything an elite athlete does in training is done in order to train his or her skills at one particular aspect of the game. This aspect is isolated from the actual game activity and an exercise is made where the particular skill is worked on repeatedly. We have observed that the training sessions of a range of sports are organized in the same way; going from warm-up, over skill training, discovery learning to game/match. Our design space is located in the interplay between specific skill training, where the athlete repeats specific exercises to build muscles or speed, and discovery learning, where the athlete tries new running patterns, combinations, shots etc. Kinesthetic empathy interaction is not only a simple bodily skill that can be trained isolated like speed or power. Because it involves another human being as direct opponent, there is a continual aspect of discovery learning included in increasing the skill. From the start when we decided to focus on kinesthetic empathy interaction, we also decided to design a system that would require two or more users to test each other's skills and play in direct confrontation or collaboration, and not merely a system that simulated the opponent.

This furthermore provides an interesting design challenge, since it is difficult to make an objective measure of one participant's progression with this particular skill, when the skill is always trained in collaboration with another person. For the elite athletes it is very important that they have a clear understanding that an exercise will enhance their chances for overall success in the actual game.

In participatory design sessions we have had both coaches and athletes themselves give us their design proposals on exercises and training installations that could train kinesthetic empathy interaction. Groups of team handball players and other athletes collaboratively designed proposals for installations and exercises that could pitch two or more opponents in front of each other creating an motivating game-play that could be included in their normal training.

3 Spectator Participation

The second part of the project is focused on the experiences the rest of us have with elite sport, namely as spectators at sport events.

The fan culture around the bigger sports like team handball and football is highly engaging both as a physical and as a social activity. The participants of a fan group are highly devoted to the success of their team and engage in a wide range of coordinated and uncoordinated activities to express their support.

In the iSport project we are looking towards these activities as a place to explore collective action and communication, and as an area where we can work with integrating technological platforms that will support the social activities of the spectators. Today the technological support at sport events is focused on conveying athletic achievements and statistics from the game to the spectators. However, for the spectators there are more to the game than just passively watching it as it unfolds.

In our field research [4] we found that there are several different ways of being spectators to a sport event. However when we look at the highly engaged fans we see two main types of activities: First, they cheer in order to influence the game hoping their team performs better, scold the referee for bad calls or otherwise comment the game as it unfolds. The focus is on the game.

The other type of activity is focused on the other team's fans. There is an ongoing battle between the two groups of spectators supporting either side. The two groups are constantly trying to out-do the other in order to dominate the arena. This type of activities is much more focused on the group itself and entails an almost tribal battle for territory with colors, flags and singing and shouting. There is a high degree of self-representation involved in being a spectator. They dress in team t-shirts, they paint their faces, and in our research we often found "cheer-leaders" not watching the game, but fully focused on getting their fellow spectators to cheer more devoted. It seems, that the spectators is more engaged in the overall atmosphere than in the ongoing athletic activities on the court. That does not mean that the experience of spectating is separated from the athletic activities but rather that it is an integrated part of the sport event itself.

Both types of spectator activities are of course highly linked to the game and where it takes place. Our focus in this part of the iSport project is to develop a platform that will support the spectators' experiences of being at the game. Spectator activities are heavily dependant on the co-experience [5] of the involved participants, and when designing interactive technology for this setting it is important to support the participants in creating their experiences themselves [ibid.].

As opposed to the Elite-area in the iSport project, this spectator-area is not so much focused on sensing individual movement, tracking the human body and manipulating physical objects. However, spectators' activities are still highly physical and deeply connected to being present in the space where the sport is taking place. Spectators also use the physical environment to create the best possible support for their team by standing in the place where their song can be heard the best or jumping up and down on the stand to create a high thumping sound. It is activities such as these that our system should support and enhance without taking focus away from the actual social context and the event taking place.

4 Learning through physical and social interaction

The third and last leg of the project is focused on exercise and physical education in schools and other institutions for children. We are here working with developing new and more engaging ways of getting the kids to explore their physical capabilities and combine this with learning in other subjects in school like physics, chemistry, mathematics, own language, secondary language, media etc.

Howard Gardner's [6] concept of several different intelligences that can be utilized in learning is one of the central focus points in this part of the project. In the context of Danish schools there is a big move towards cross-subject teaching. This poses a challenge for creating new curricula that can contain several types of knowledge and new teaching materials that can support the crossover of two or three subjects. For physical education there is also the challenge of making new sports equipment that can elicit data or in other ways enable new perspectives on physical activities and connect it to other curricula.

The goal here is to connect kinesthetic intelligences with logic or creative intelligences in order to reach better performance in learning. The Center for Interactive Spaces has previously developed an interactive floor that is currently in use at a local school for teaching everything from language to mathematics at a range of age-levels [7].

In coming research activities we will involve pupils as well as teachers in developing ideas for applications and discovering potentials for design in the context, and also have these participant help in testing and improving the designed concepts as they are build.

5 Conclusion

The iSport project is an experimental design exploration of aspects of purposeful physical and social activities. The competitive sport-part of the project explores individual training of kinesthetic empathy interaction, which is a highly specific social sport-related competence. Through a future design of training equipment we enable elite athletes to train this competence and see their improvement over time. The spectator-part of the project is more focused on the social activity of being a spectator at sport events. Here we are faced with the challenge of designing a system that connects the intense physical activity and experience of the spectators to a meaningful interaction with a system that allows the spectators to co-create their experience. Lastly the school-part of the project is focused on designing a platform for utilizing physical skills and activities to learn other subjects in schools.

The core of all these explorations is to make a better connection with physical activities – socially and individually – to the computational capabilities that are offered through the technologies we design. The reason for doing this is that, in all three areas of the project, there are huge improvements to be made to the experience and outcome of the participants in the activity, be that learning in schools, achievements on the handball court or for the collective actions of the spectators on the stands at sport events.

Our overall goal in the iSport project is to explore how physical and social skills can better be integrated and utilized in the use of computational artifacts.

References

1. Lakoff, G., and Johnson, M., *Philosophy In The Flesh*, Basic Books, New York, (1999).
2. Goffman, E., *Behaviuor in Public Places, Notes on the Social Organisation of Gatherings*. New York, The Free Press, (1963).
3. Fogtmann, M. H., Kinesthetic Empathy Interaction – Exploring the Possibilities of Psychomotor Abilities in Interaction Design. In *Proceedings of the Second International Workshop on Physicality*. Lancaster, (2007).
4. Nielsen, R. V., Spectator Experience - are they watching the game at all?, in *Participation and Innovation, Proceedings of SIDeR 08,* eds. Matthews, B., Buur, J., Sønderborg, Denmark, (2008)
5. Battarbee, K. (2003). Defining co-experience. *Proceedings of the 2003 international conference on Designing pleasurable products and interfaces*. Pittsburgh, PA, USA ACM Press.
6. Gardner, H. *Frames of Mind: The Theory of Multiple Intelligences*. Basic Books, New York, 1983
7. Grønbæk, K., Iversen, O.S., Kortbek, K.J., Nielsen, K.R., Aagaard, L.: " iGameFloor - a Platform for Co-Located Collaborative Games". In proceedings of the International Conference on Advances in Computer Entertainment 2007, 13.-15. June, Salzburg, Austria, pp 64-71
8. Ullmer, B. and Ishii, H., "The metaDESK: Models and Prototypes for Tangible User Interfaces," *Proceedings of User Interface Software Technology (UIST '97*), ACM, Banff, October 1997, pp. 223-232.

Designing for social interaction through physical play, movement and learning

Mauricio Novoa

Industrial Design Department, School of Engineering, College of Health and Science, University of Western Sydney, Australia (UWS)

Abstract. This paper reports on two related but different developments in relation to designing for social interaction. It intends to compare and link together both a four years old international collaborative industrial design and manufacturing studio project between three universities, and a users' observational research of pre-school children for five years in a community based toy library located in one of most cosmopolitan suburbs in the state of New South Wales. It has surfaced there are similar cultural and social constrains influencing child development as well as the designing of products directed towards social interaction through physical play, movement and learning.

Keywords: Social interaction, physical play, learning, industrial design, design process, action research, ethnographic research, globalization.

1 Introduction

This paper compares and evaluates spatial tangible usage and interaction by comparing observation and findings at a community toy library on one hand and the role of lecturing on creativity and innovation at university level on the other. At local level, a number of discoveries have become clear through usage of artifacts by children with innate ability and attitude, and their parents influence. In the other, design teams have created new designs and carried out testing and application in a local and international mix of a global design studio and manufacturing project at university. Each actor, small, young and old, has participated with his/her own combination of perception, feelings and experience. It is clear now that circumstances program how people see things and respond. As Reilly (1997) says, "people operate by recognizing patterns; and then because they have become quite expert within applying their own "program", they respond in ways based on historical conditioning and many times are blind to the other possibilities" [1]. That assertion brings about a number of questions that are at the centre of this paper. What are those conditions that determine and influence both, children in their path of discovery and students in their endeavour to understand knowledge patterns? In addition, how can designers open up users to new opportunities and innovation? The proposition of this paper is that there are determining factors affecting early childhood development, education, and design.

Design has the significant role of acting as the link between creativity and innovation by breaking conventional patterns enough to allow renewal. Tertiary design education plays an important part for both the profession and industry by preparing students for their future working life in our local, national and global market. The international project directed by the author intends that from a third year design studio unit at UWS. Currently supported and funded by a special PVC Learning and Tea-ching Action Grant, the project has benchmarked Australian students with counterparts in Canada (Alberta University) and Chile (University of Technology). Thanks to using latest design, communication, and prototyping technologies, it focuses on

- Education challenge to achieve excellence within a global market
- University as gatekeeper of technology and professional standards
- Research on teaching and learning, new design methodologies and process
- Development of new dynamics of work and production through distributed means.

The project is immersed in and influenced by the intake of local students with uncertain and uneven backgrounds, degree of English language proficiency, mathematical and literacy skills. Current discussion in favor and against a unified curriculum for the Australian school system intending to overcome the apparent "dumbing down" syndrome referred to education in high schools and increasingly to university as well [2]. Furthermore, the interest to improve standards appears to succumb to political confrontation concerning issues of federal and state control of education and budget. Universities seem to be slow in recognizing the impact of changes in demography, background, experience, skills and industry demands in recent times. These concerns seem to be contributing factors to problems of attrition of students and retention [3].

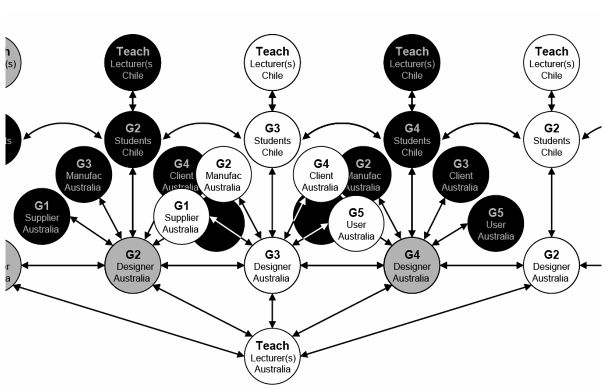
New studies in Australia focus on the above mentioned factors as a matter of current status, trends in community integration, relationship between social capital and various economic and social phenomena that have their start in early stages of life. [4]. They run along the lines of Putnam's research in USA suggesting important linkages with and impact of social capital on the breakdown of family life, the atomization of society into nuclear families, from description of people born in 1920s as the last real participatory generation to recent progressively passive ones that are affected by the use of modern technology (i.e. television) [5].Important similarities and differences with the American case are starting to appear locally. Studies such as an ongoing longitudinal research of over 10,000 children and families started in 2004 [6] are showing unique results in the local scenario with concern about today's children developing with growing rates of obesity, internalizing and externalizing experiences and behaviors, depression, communication and peer relationships issues [7]. Also there is now the recognition of deficit in human computer/technology interaction skills across individuals and socioeconomic groups which shows social and psychological gaps and need to be addressed at very early ages. It is little known about the effect of using computers by very young children. However findings indicate to their impact on their cognitive (knowledge, understanding of meaning, purpose, etc) and non-cognitive (emotional symptoms, peer problems, isolation, etc) skills in relation to parental background, family composition, neighborhood, community, etc [8]. There is, however, a departure from classic sociological approaches like 'ghettoes of hope' by the American Herbert Gans (1967) [9], the Australian case has been implemented with more egalitarian policies. Nevertheless, people from ethnically diverse localities in Australia do not pull together because just similar struggle in a new country; it has been found that currently social networks are poor and civic participation is low. [10, 11]. It is in this context that design can contribute with practical solutions to opening up minds and bodies, and bringing together children, parents and communities.

2 Methods

Data gathering and evaluation in the community based toy library has been carried out by first running unobtrusive observational research with children and parents with the intention to draw together their views and desires with no interference. Then, participatory action research when some parents and children become more familiar with the toy library. Children have been named advisors and testers of toys and activities. Findings have also had two different characters. First, qualitative by the way of gathering use, task and value related views and perceptions from children and parents. Second, quantitative by the way of measuring membership numbers, provenance, preference according to borrowing cost, space, packaging, transport, access, etc.

The international distributed design project runs as a design agency/studio and production environment with standard constrains and processes concerning time, cost, negotiation, tendering, costing, development, manufacturing and implementation. The theme of the assignments is focussed on Exercise/Learning/Movement (equipment for development and maintenance of gross motor skills). The target market is early childhood 3 – 6 years old and senior citizens. Students must fit to constrains of: play and entertainment, high tech manufacture – low tech application, social innovation, and sustainability. They are given a feel of professional life with access to industrial experts and political authorities on both continents, use of state of the art rapid prototyping and modelling facilities, videoconferencing, Skype, blogs, etc. The project pursues the creation of a ‘sociotechnical virtual collaboration’ brought about by concepts of ‘working together apart’, ‘role playing’, ‘authorship’, ‘ownership’ and ‘intellectual capital’ based on group and self evaluation and marking. Students work is tailor made to fit each group own brief according to a criterion referenced approach with moderation, assessment and feedback by peer, blind, group, lecturers, etc. The ultimate goal pursued is for students to take full responsibility and ownership, develop and test their critical judgment. Qualitative findings are achieved through the application of action research methods in design teams and users. Rigorous quantitative data is gathered by keeping record on process (gantt charts, minutes, etc). Ultimately, the intention is to understand the processes followed by different local and international participants and then assess which singular or combined solution is the most appropriate now [12].

Fig. 1. Action research group role playing model for the unit and international project



3 Results

Over the last five years, the community based toy library has had an average membership of more than 105 families and 3 children per household. The membership is formed by a diverse group with different backgrounds ranging from low skilled refugees to professionals, either from first to third generation migrants and also members of Anglo Celtic ascendance with community interest. There is a rising component of senior citizens raising grand children. The ethnic breakdown is mainly divided and characterized by:

- 37% Asian. Their children tend to be individualistic and show to be most attracted by puzzles and toys that promote brain activities (i.e. mathematics)
- 18% Indo Asian. Their children tend to share and collaborate with an interest on puzzles and domestic toys.
- 14% Anglo Celtic. Their children appear gregarious and individualistic with interest on transport and dressing up.
- 13% MiddleEast. Their children favor group activities, a hierarchical structure with boys preferring big toys and girls having special interest for literacy aids and toys.
- 10% Mediterranean and Latin. Their children have especial interest for fine motor skills toys, manual and hand crafting, toys with sound and musical instruments.
- 08% African and Pacific Islands background and others. Their children have especial interest for musical and rhythmic instruments and toys.

Generally, boys are mostly attracted to transport toys as their first choice and then house shores (ie. vacuum cleaners, lawn mowers, stove, etc). Surprisingly, the latter development had been considered peculiar to recent residential conditions as those things previously were thought as girls activities. In contrast, girls are attracted to dolls first and increasingly to social, literacy and language related activities with pretend play and preschool aids and toys. Building and construction games are equally attractive to both males and females. However, their demand has diminished together with the interest for three dimensional block play toys directed to developing spatial awareness. In contrast there is an increased borrowing of computer toys that develop numeracy, literacy and virtual 3D skills (vTech, CD Rom games, etc).

Parents have shown a different attitude according to the number of children they have. With the first child, they look for advice from the coordinator or other parents and they decide on behalf of their small children. With subsequent children, they seem to give more freedom to them to choose toys to a point that, in the Arabic community, older brothers take the responsibility to choose toys for their younger siblings. Furthermore, parents generally tend to spend less on borrowing toys when families increase in numbers and they also ultimately decide against toys that are large, with too many pieces or loud. Smaller dwellings seem to dictate and constrain the possibilities to use toys that are still attractive to both parents and children; however they cannot longer use them due to lack of space and more expensive everyday life. Somehow those circumstances delay their children mental development, three dimensional awareness, associative and relational skills, gross and fine motor skills, etc. Similar to other places in Australia, children appear to have gained weight while The Wiggles are favorites with dancing on the spot sing-alongs.

Findings of this observational research echo literature describing how children cognitive ability does not only depend on environmental context [13], they often feel transparent when toys lack appealing identity [14] or there is not a place they can call their own [15]. Consequently, students design projects have developed towards playground and scenario building for restricted areas (coffee table space), toys and games where traditional physical games are re-valued and computers blend together, complement, substitute or add value to them. No longer are interface and human computer interaction circumscribed to traditional QWERTY format. Instead technology is seen as inbuilt and responsive to the activity, invisible otherwise and even wearable.

It has meant a learning curve for the Australian students who seem to have a tendency to games and play in isolation, great focus on manufacture of objects and implementation due to the need to fit to programmed timelines, outcomes and cost. In contrast, their American counterparts seemed to have a more collective approach and a great deal of time is devoted to conceptualization of design, experimentation and argumentum. A number of positive outcomes have resulted in students expanding their network from a local scenario, interpersonal skills, and improvement of design outcomes, self reliance and critical judgment. On one hand students have been offered to exhibit with final year Honours graduating students and dealt with offers of commercialization of their products. On the other, some have voluntarily failed and decided consciously to come back to the unit again since they believed they have not met their own expectations. This has been a first time experience at UWS.

4 Discussion

Findings at both extremes of toy and games designed products, users and designers, indicate there are similar constrains and influences related to environment, community, time, resources, location, etc. They affect childhood and students learning development, creativity and innovation. On one side, children have their innate inquisitiveness shortened by artifacts that delay or deprive them from further progress. On the other, design students either have formulaic patterns inbuilt into them by the time of reaching university or must abandon any prefixed schemata that prevent them from designing creatively because the need to fit to designated patterns. The comparison of both parallel studies has brought to surface the notion of appropriate products when they have a social and cultural purpose and inappropriate objects when they lack meaning and place. There is the need to re-situate both infant brain development and design education in terms of a matrix of cultural practices and pre-occupations. It contends that infant brains function in conjunction with the marketing promises of developmental toy manufacturers - as a form of 'ritual magic'[16].

Within these circumstances there is a risk, the object focus of industrial design education may become burdensome for a heterogeneous student base with diverse backgrounds, experiences and lack of understanding concerning their place and role in this changing era. Objects and technology alone many times have no innovation input when their contextual meaning is missing. If they lack real value, function and place; objects soon may lose their attractiveness and do not reach stage of significance and transcendence for students and users alike. However, in a society dominated by assembled images and artifacts, they are still treated as fetishist commodities traded with phantom objectivity and taking on autonomous, rational relations between things with a false sense of consciousness. Consequently, many times students may be rendered unable to internalize learning and creative research as real experience and progressively construct their own knowledge wares [17].

Acknowledgments. Many thanks for their participation to Mrs Eliana Madrid, Coordinator Sunny Corner Toy Library, Professor Steven Riley, Dr. Hector Torres, Associate Professor Robert Lederer, Ms Alejandra Mery, lecturers, tutors and students on both sides of the Pacific.

References

1. Reilly, J: Using the methods of Fernando Flores , Center for Quality for Management Journal, USA, Spring 1997
2. Donnelly, K. 2006: Dumbing Down. Harie Grant Trade Books. Australia
3. Long, M. 2006: Stay, play or give it away? Students continuing, changing or leaving university in first year. Centre for the Economics of Education and Training. Monash University, ACER
4. Johnson, D. 2005: No. 26 Communities, social capital and public policy. The Melbourne Institute of Applied Economic and Social Research Policy Research.
5. Putnam, R 2000, Bowling alone: the collapse and revival of American community, Simon & Schuster, New York.
6. The Australian Institute of Family Studies, 2008: Growing Up in Australia: the Longitudinal Study of Australian Children (LSAC). Commonwealth of Australia
7. Smart, D: 2007. Do today's Australian children have more problems than they did 20 years ago? University of Melbourne, LSAC Conference, December 2007
8. Fiorini, M: 2007. The effect of home computer on children's cognitive and non-cognitive skills. University of Technology, LSAC Conference, December 2007
9. Gans, H 1967, The Levittowners: ways of life and politics in a new suburban community, Pantheon Books, New York.
10. Holmes, D, Hughes, K Julian, R, 2007: Australian Sociology, A changing society. Pearsons Australia Group.
11. Alesina, A & La Ferrara, E 2000, 'Participation in heterogeneous communities',The Quarterly Journal of Economics, August, pp. 847–904.
12. Novoa, M: 2008: Preparing Designers for the New Economies. International conference on Engineering and Product Design Education, E&PDE 2008, Universitat Politecnica de Catalunya, Barcelona, Spain
13. Rushton, P, 2005: Thirty years of research on race differences in cognitive ability. Psychology, Public Policy and Law. The American Psychology Association, vol 11, 235-294
14. Compton, C. 2006: Identity, childhood culture, and literacy learning. Journal of Early Childhood Literacy. Sage Publications London, vol 6(1) 57-76, 2006
15. Wardle, F, 1998: Meeting the needs of multiracial and multiethnic children in early childhood settings. Early Childood Education journal, vol 26 No 1, 1998
16. Holmer, M, 2002: Engineering the entrepreneurial infant: brain science, infant development toys, and governmentality. Cultural Studies, vol16(3), 401-432, 2002
17. Lukacs, G. 1971: History and class consciousness: Studies on Marxist dialectics, trans. Rodney Livingstone, London, Merlin Press

Playful interactions: Social interaction through open-ended physical play

Janienke Sturm, Tilde Bekker, Berry Eggen

Industrial Design, Eindhoven University of Technology
P.O.Box 513, 5600MB Eindhoven, The Netherlands
{J.Sturm, M.M.Bekker, J.H.Eggen}@tue.nl

Abstract. We outline our vision on how to stimulate children to play together and be physically active. We develop intelligent interactive play objects using as an inspiration source both ideas from game design and opportunities of new technologies, such as sensors and actuators. We explain our open-ended play philosophy and describe research projects focusing on various aspects of open-ended play and its effect on social interaction.

Keywords: design, interactive objects, social interaction, physical play, exertion interfaces.

1 Introduction

Television and computer have caused people to lead increasingly inactive lives. Many children, for example, spend large amounts of their free time playing computer games rather than playing outside. This sedentary lifestyle has serious consequences for people's health. To stimulate children (and adults) to be more physically active instead of watching television or playing computer games, a new type of products are being developed that require some form of exercise or exertion such as the Nintendo Wii-interface and dance-mat controlled games. These exertion interfaces, or exergames, have also been studied in several research projects, for example Ishii and colleagues [8] have designed an enhanced version of ping pong, called PingPongPlus. Mueller and colleagues [11] have designed various applications to play sports at a distance and Rogers and Muller [13] have designed an adventure game for children, which requires physical interaction. In our own research we also addressed a number of questions in sports-related contexts for children, such as how can practicing sport skills be made more appealing and how can technology contribute to creating a more fun sporting experience for children? For example, we have run design projects in the context of playgrounds, football, basketball, skating, running and hiking [4, 3, 15].

Unfortunately, the increasing amount of time spent playing computer games not only brings along health risks, but it influences children and adult's social skills and social life as well, as nowadays a lot of communication takes place in the virtual world. In our current research we aim to address not only health issues but also the social issues by enriching outdoor physical play in a way that appeals to children, thus making the outdoor playground a more attractive alternative to computer and television. To meet this goal, we make interactive, mobile play objects that use digital technology such as sensors and actuators. In this way, the play objects can measure the behavior of their user and use this information to provide meaningful motivating feedback or to adapt the games to the level of the children. We especially aim to enable children to play games in groups. In this way our interactive play objects stimulate and motivate the children to move and play together.

In previous work [17] we presented a research agenda covering five key issues for the design of intelligent play objects: social interaction, simplicity, open-endedness, goals, challenge and feedback. These issues are addressed in various projects carried out by our students and by ourselves often in cooperation with (design) companies. In this paper we describe recent explorations of the issue of open-ended play and its effect on social interaction. Facilitating open-ended play means providing opportunities to play, for example by showing interactive behavior, without pre-defining specific game rules and goals [10]. Open-ended play objects enable children to freely explore the possibilities of the object and create their own games.

After an overview of work in related fields, we will discuss several of our own projects aimed at investigating the effects of open-ended play.

2 Related Work

Our work on social and physical games is closely related to research on other types of games. Apart from the exertion interfaces that were already discussed in the introduction we would like to mention for example pervasive games and social games. Pervasive (or location-aware or augmented reality) games bring the gaming experience from the world of computers and the internet towards the physical environment of the game player, by wireless and location-based technologies [9]. An example of a pervasive game for adults is Can You See Me Now, which is played both online in a virtual city and on the streets of an actual city [5]. An example of a game for children is the Ambient Wood project, which is a pervasive educational game. In this game children could explore a technology-enhanced wood [12]. A new genre of pervasive games is Head Up Games [15]: technology enhanced games that do not require screen-based interaction and therefore allow for rich social interaction. Camelot [18] is an example of such a mixed reality outdoor game in which children collaboratively create physical castles.

Various games focus on social interaction between children. The mixed reality table top game aMAZEd [1] is a maze game where teams of children, have to reach various locations in the maze to get to the next phase of the game. Age Invaders is an inter-generational mixed-reality game in which children, parents and their grand-parents play a socio-physical game [6]. Active players move about on an electronic game board and can trigger rockets and bombs, while online players can help the active players.

A couple of research projects have addressed the open-ended issue. For example, Morels are soft cylindrical objects that allow their users to remotely launch other Morels in the vicinity [7]. While other Morels are nearby, a player can 'charge them up' by squeezing his/her Morel. If the charging player lets go and squeezes the Morel once again, charged Morels will launch themselves. The Morels do not contain rules for specific games, and players are encouraged to either play known games with it or improvise their own. The Interactive Pathway is another example of an intelligent play object with an open-ended structure [14]. When a child walks or runs through the interactive pathway, motors that are attached to the pathway start spinning one-by-one, accompanying the child on a short journey across the path. The simple design of the interactive pathway enables open-ended play patterns. As a result, children may use the pathway for everything from simple running to playing choo-choo trains.

3 Stimulating open-ended physical play

Play objects may either have predefined goals or allow more open-ended behavior in which players can create their own (emerging) goals [10]. In general goals have been shown to be very important for the design of (computer) games: providing goals contributes to the appeal of games, and to the intrinsic motivation of users. However, we believe that an intelligent play object does not necessarily have a predefined goal and fixed game rules; instead, it may leave room for exploration and encourage creativity. It may let the children discover what the effect of a certain action is and let them develop their own games with their own targets.

Only a few related projects and products apply an open-ended play philosophy. Moreover, only limited research was found on how children play open-ended games. We assume that open-ended play will be fun and stimulate social interaction, and that it will provide opportunities for diverse play patterns: e.g. different types of play such as physically active play, fantasy play, and games with rules. However, there is a risk that children will not enjoy creating their own games, nor like playing with open-ended play objects. Therefore, before continuing implementing open-ended play in our design approach we decided to conduct a series of studies to examine whether children will enjoy creating their own games and whether open-ended play does support social interaction.

We have applied an open-ended play approach in a number of design projects. Some projects focus on play objects for children, while others are intended for adults. So far, the interactive functionality provided by the objects has been fairly simple in most projects: using single sensors as a source for providing one type of coloured LED feedback. In a recent project we are extending the interactivity of the objects to provide richer opportunities for play. By varying the use contexts of the designs we intend to increase our understanding of the relationship between design variables and user behaviour.

Together with a design company (http://www.creativeconversionfactory.com) we developed a simple prototype play object to examine whether children have fun when playing with open-ended intelligent objects. The LEDball (see Fig. 1) is a cylindrical object that emits red, green or blue light. The LEDballs change color depending on the children’s behavior. One variant changes color when shaken, another one when rolled. For a pre-determined period of time, the LEDballs stay the same color; then they switch off again. Because no specific game rules or goals have been implemented, the LEDballs facilitate open-ended, exploratory play.

Figure 1 The LEDball prototype and children playing with it
(Photograph courtesy of Rik Wesselink)

Children between 7 and 11 years old were asked to play with the objects in a free-play and pre-set game session. They were observed during the play sessions, and afterwards they filled in a questionnaire and were interviewed. The study shows that children create a wide variety of games and practice many social skills when negotiating the rules of various games [2]. Overall, children felt that playing with the objects in the free-play sessions was more fun than in the pre-set sessions. No significant differences were found in terms of their perceptions of social interaction in the free-play or the pre-set game sessions. These insights will be used to design the next version of our play concept.

Another example of our work on open-ended play is the soccer training system “SmartGoals”, developed in an Industrial Design Master-project. This system consists of six SmartGoals that can recognize when a ball passes through and that can communicate whether it is active or not using lights in the top of the cones of each SmartGoal (see Figure 2). The goals can communicate with each other wirelessly. After a ball has been passed through a goal, one or two other goals will light up, indicating where the ball has to be played. This enables players to train their soccer skills.

Figure 2 The SmartGoals prototype and players during a soccer training
(Photograph courtesy of Chris Heger)

A first user study has been done with the SmartGoals system in the context of adult indoor soccer training. This study addresses the effects of open-endedness on play, in terms of use of strategies, communication between players as well as game experience and enjoyment. Open-endedness is approached in this study by providing participants with two situations: Situation 1) One SmartGoal is active at a time to score a goal through (no choice situation) Situation 2) Two SmartGoals are active at a time to score a goal through (choice situation). The evaluation showed that participants like the designed system and have no problem using and interacting with it. First impressions suggest that participants use more different strategies alternately in situation 2. Communication in situation 1 seems to be more informative, whereas communication in situation 2 seems to be more focused on negotiation. Participants indicated that they needed to communicate more in situation 2. There is no clear preference of the participants for either one of the situations. Participants indicate that they feel situation 1 is better suitable as a training exercise for endurance and skill training, whereas they feel that situation 2 is better suitable as a training exercise for cooperation and communication.

Another Industrial Design Master student designed several open-ended play objects that can not only change color, but also communicate with each other using colored light. Using these objects we will investigate how the possibility to communicate through the objects influences the game play and the interaction between the children.

Our studies provide preliminary indications that open-ended play is a viable design philosophy for interactive play objects. While the influence of a number of design options, such as communication between objects and complexity of functionality and feedback still have to be explored further, we think that our insights can be translated into valuable design guidelines that may help other design researchers and designers to make good choices when designing open-ended play solutions.

In future studies we will also examine longer term use and fun of intelligent play objects. Some of the research questions to be addressed are: How will simple communication functionality between the prototypes influence the kinds of games and challenges that children create? Will they create more complex games when playing with the prototypes longer? How would this contribute to the perceived challenge of the concept?

4 Conclusion

Interactive play solutions can create motivating contexts for children to play together and be physically active. Digital technologies, such as sensors and actuators can contribute to creating rich, appealing and surprising play opportunities. Allowing children to create their own games and negotiate how they want to play with the objects (open-ended play) provides many opportunities for social interaction.

References

1. Al Mahmud, A., Mubin, O., Octavia, J. R., Shahid, S., Yeo, L., Markopoulos, P., and Martens, J. (2007) aMAZEd: designing an affective social game for children. In *Proceedings of the 6th international Conference on interaction Design and Children (IDC'07).*
2. Bekker, T., Sturm, J., Groenendaal, B., Wesselink, R. and Eggen, B. (2008) Interactive Play Objects and the effects of open-ended play on social interaction and fun. To appear in *Proceedings of International Conference on Advances in Entertainment Computing (ACE) 2008*, Japan.
3. Bekker, T. and Eggen, B., (2008) Designing for Children's Physical Play. In *CHI 08 extended abstracts on Human factors in computing systems*, Florence, Italy.
4. Bekker, M., van den Hoven, E., Peters, P. and Klein Hemmink, B. (2007) Stimulating Children's Physical Play through Interactive Games: Two Exploratory Case Studies. In *Proceedings of Interaction Design and children (IDC'07)*, June 6-8, Aalborg, Denmark, 163-164.
5. Benford, S., Crabtree, A., Flintham, M., Drozd, A., Anastasi, R., Paxton, M., Tandavanitj, N., Adams, M., and Row-Farr, J. (2006) Can you see me now?. *ACM Transactions on Computer-Human Interaction*, 13 (1) (Mar. 2006), 100-133.
6. Cheok, A. D., Lee, S.P., Kodagoda, S., Tat, K.E. and Thang, L.N. (2005) A Social and Physical Inter-Generational Computer Game for the Elderly and Children: Age Invaders. In *Proceedings of the Ninth IEEE International Symposium on Wearable Computers (ISWC'05)*, 202-203.
7. Iguchi, K. and Inakage, M. (2006) Morel: remotely launchable outdoor playthings. In *Proceedings of the 2006 ACM SIGCHI international Conference on Advances in Computer Entertainment Technology (ACE '06).*
8. Ishii H., Wisneski C., Orbanes J., Chun B., and Paradiso J. (1999) PingPongPlus: design of an athletic-tangible interface for computer-supported cooperative play. In *Proceedings of CHI '99*, ACM Press (1999) 394–401.
9. Magerkurth, C., Cheok, A. D., Mandryk, R. L., and Nilsen, T. (2005) Pervasive games: bringing computer entertainment back to the real world. *Computers in Entertainment*, 3 (3) (Jul. 2005), 4-4.
10. Malone, T.W. and Lepper, M.R. (1987) Making learning fun: a taxonomy of intrinsic motivations for learning. In *Aptitude, Learning and Interaction III Cognitive and Affective Process Analysis*, R.E. Snow and M.J. Farr (Eds.), Lawrence Erlbaum, Hillsdale, NJ, USA.
11. Mueller, F., Stevens, G., Thorogood, A., O'Brien, S., Wulf, V. (2006) Sports over a Distance. *Journal of Personal and Ubiquitous Computing*, 2006, 633-645.
12. Rogers, Y. and Price, S. (2004) Extending and augmenting scientific enquiry through pervasive learning environments. *Children, Youth and Environments*, 14(2), pp. 67-83.
13. Rogers, Y. and Muller, H. (2006) A framework for designing sensor-based interactions to promote exploration and reflection in play. *Int. J. of Human-Computer Studies*, 64 (1), 1-14.
14. Seitinger, S., Sylvan, E., Zuckerman, O., Popovic, M., and Zuckerman, O. (2006) A new playground experience: going digital?. In *Adjunct Proceedings of Extended Abstracts on Human Factors in Computing Systems (CHI '06).* ACM Press, New York, 303 - 308,
15. Soute, I., Markopoulos, P. (2007) Head Up Games: The Games of the Future Will Look More Like the Games of the Past. In *Proceedings Interact 2007*, 404-407.
16. Stienstra, J., Hopma, E. and Bekker, M. (2006) 'Move it'- A persuasive game for 11-year old children. In *Adjunct proc. Persuasive 06*, 21-25.

17. Sturm, J., Bekker, T., Wesselink, R., Groenendaal, B., and Eggen, B. (2008) Key issues for the successful design of an intelligent interactive playground. In *Proceedings of Interaction Design and Children (IDC'08)*, June 11 - 13, Chicago (USA).
18. Verhaegh, J., Soute, I., Kessels, A., and Markopoulos, P. (2006) On the design of Camelot, an outdoor game for children. In *Proceeding of the 2006 Conference on interaction Design and Children (IDC '06)*. ACM Press, New York, NY, 9-16.

Social Nudge:
A Mechanism for Stimulating Social Interaction

Thomas Visser and Martijn H. Vastenburg

ID-StudioLab, Faculty of Industrial Design Engineering, Delft University of Technology,
Landbergstraat 15, 2628 CE Delft, The Netherlands
{t.visser, m.h.vastenburg}@tudelft.nl

Abstract. In this paper the concept of *social nudge* is introduced to describe a particular persuasive mechanism for stimulating social interaction. A social nudge reveals opportunities and provokes people into social interaction. To provide a social nudge at the right moment and in the right presentation form, an intelligent system would need to be able to assess the value of social nudges in relation to the context of use. This paper is the first step in the process of developing a conceptual framework that describes the properties of social nudges in relation to the context of use. The framework is aimed at supporting designers and system developers in creating systems that are more effective in increasing the quantity and quality of social interaction. Section 1 discusses related work in the area of stimulating social interaction. Section 2 outlines the conceptual framework. The paper concludes by presenting an overview of future challenges in designing social nudges.

Keywords: Social Nudge; Social Interaction; Persuasive Technology

1 Introduction

In recent years, there has been a growing interest in persuasion by means of technology. The body of work in this domain focuses on Internet marketing applications (e.g., [2]), on improving health by stimulating healthy food and physical exercise and non-smoking (e.g., [3]). The framework developed by Fogg [1] provides persuasive tools that can be exploited by means of technology. Two tools are most applicable for the context of this paper. The first is *tailoring*: provide information that is relevant to the individual. The second is *suggestion*: intervening at the right time.

At the same time, in social sciences, interest emerged into the improvement of social well-being. Recent models explicitly distinguish between physical and social well-being [4], rather than approaching well-being as a single, inseparable entity. The amount of social interaction and the size of a social network have been found to be primary factors of social well-being [5]. Both social interaction and maintaining a social network are found to have a positive effect on social well-being. As social well-being was found to be a reliable predictor for symptoms of depression [6], also the medical world shows more interest into monitoring social well-being [7].

In the Human-Computer Interaction (HCI) domain, several examples can be found of designs and evaluations of prototypes that inspire social-interaction. The *ASTRA awareness system* [8] enables people to exchange messages about their current experiences, to support interpersonal relationships. Users can collect images when away from home, and send them to a home-display, one-way only. The *Family Pictures* [9] project enables remote monitoring of elderly to generate comfort and remove worries that the children might have. Rather than stimulating social interaction, the family pictures provide a feeling of connectedness [10]. More recent work has focused on remotely displaying the activities of elderly to their children [11] by the *Daily Activities Diarist*. This project deliberately aims to improve feelings of connectedness by communicating the activities of the elderly to their social intimates. However, most of these projects are focused on communicating functional information, such as activities. Social issues are generally not addressed.

A design that is less content-oriented, and more focused on the peripheral context is the *Gustbowl* [12]. The design enables adolescents who have left their elderly home to communicate daily affairs to their parents in an unobtrusive way; the design shifts communication from a conscious level to a –more or less- unconscious level. Placing objects in a bowl at a child's house triggers a photograph of that bowl to show up in the bowl of the parents' house. Even though the communication tends to blend in with the home environment, the presentation of the message (the photograph in this case) is not dynamically adapted to the (social) context of the receiver of the message, which might have an effect on the effectiveness of the message.

These examples show that a lot of work is done on both context-aware systems (*Family Pictures* and *Daily Activities Diarist*) as well as connectedness projects (*ASTRA* and *Gustbowl*). However, in these projects, the presentation of messages is non-adaptive to the social and physical context of the receiver. Additionally, these projects do not specifically aim for triggering social interaction, but are rather designed for generating and supporting feelings of being connected and feelings of not being worried about the social contact.

Context-aware systems might be used to trigger social interaction and thereby improve overall well-being. The current paper introduces a mechanism called *social nudge*, which aims to improve the quality of social interaction between the people. A *social nudge* is triggered by a situation, and generated automatically by a context-aware system. A successful nudge can be described as a stimulus that contributes to increasing the quality of the social interaction between two people. To achieve this, an understanding is needed of the parameters underlying social nudges, and the relationship between these parameters.

2 Social Nudge

The term *Nudge* has been coined before in relation to persuasive systems [13]. However, social aspects were not taken in account in this description. Therefore we introduce the term *Social Nudge* by first giving two scenarios of use. Thereafter, the definition of *social nudge* –as used for our studies– is presented.

2.1 Scenarios

Making Coffee: *On Sunday morning Marianne (75 years) gets up. Today, she is a little later than usual. After she has taken a shower, she walks into the kitchen in her bathrobe to make coffee. She turns on the coffee machine and gets the beans. That very moment, the coffee machine shows her that her grandson, Sam, is also having a coffee at home. This is shown to Marianne by the small digital picture frame on the fridge: it now shows a picture of Sam. Marianne's attention is drawn to the change of the picture; it reminds her of her grandson, and she decides to call him.*

Basketball: *Tim has been playing basketball with his friends on the neighborhood court. They have been shooting 3-pointers. Tim set a very high score of 8-out-of-10. His friend Joshua enters the court the next day. As soon as Joshua scores the first 3-pointer, the display above the rim shows a movie Tim scoring his last 3-pointer the day before. Joshua realizes that he has not played Tim for a while. "He is playing way better then he used to!" he thinks, and calls him to arrange a game.*

In both scenarios, the *social nudge* contributes to increasing social interaction. In the first scenario it is the digital photo frame. In the second scenario it is the movie. Because the presentation of the information is subtle and context related, the receiver does not feel forced to get involved in more interaction, but rather he/she is tempted.

2.2 Definition

We define a *social nudge* as: a technology mediated stimulus that aims for an improved social interaction. The stimulus is initiated by one or more persons (senders), and should be embedded in the receivers' physical and social context.
This definition has three implications:

1. Because the stimulus is to be embedded in the receivers' context, a system generating social nudges should be able to sense the user context. It should take those contextual aspects in account in order to improve effectiveness [14].
2. In order to be able to evaluate the success of a system generating social nudges, quality and quantity of social interactions need to be measured.
3. The initiator of the stimulus does not necessarily have to be aware of the nudge. Routine activities of the initiator could serve as trigger, without interfering with the initiators' behavior.

2.3 Conceptual Framework

Towards creating systems that can generate *social nudges* at the right time and in the right form, a conceptual framework representing the factors underlying *social nudges* is currently under development. We present a preliminary view on what such a framework might look like. This is not an attempt to capture the full dynamics of social interaction; rather it is a condensed view on interaction that is stimulated by a *social nudge*. The framework is set up around the interaction between initiator, system, and receiver of the nudge (an example can be seen in Figure 2.1). In the diagram, relevant variables are mapped on the three entities that contribute to the effect of a social nudge. These aspects could be related to the effectiveness (persuasive power) and the domain in which the social nudge is to be applied.

Fogg [1] has shown that the persuasive tools *tailoring* and *suggestion* increase the persuasive power of the stimulus. To be able to apply those tools it is important to include contextual factors, such as the social (network, relationships), behavioral (habits, rituals, activities), physical (presentation, location, abilities and activity) and temporal (time and timing) aspects in the framework.

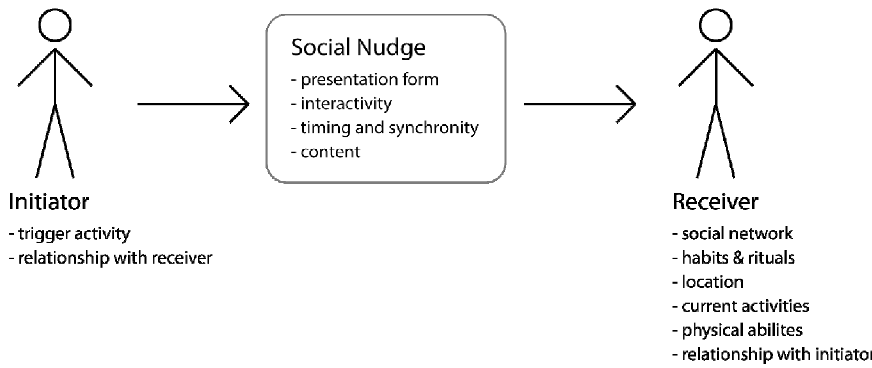


Figure 2.1. Factors assumed relevant for successful social nudges.

2.4 Application Domain

The social nudge mechanism is especially suitable for application domains in which people need to be externally stimulated towards improving social interaction. These are typically domains in which at least one party is intrinsically motivated to interact. In such contexts, people often feel morally obliged, but are not really willing to start social interaction with each other. A *social nudge* might trigger and facilitate social interaction at moments and in contexts where the peers are willing to communicate.
Two example application domains:

Empty nesters. Parents whose children have just moved out are so-called empty nesters. These people feel strongly connected to their children. Although the parents feel the need to know all about their children's whereabouts, the children usually do not feel motivated to have social interaction as much as is expected by the parents. Research into social nudge might show opportunities for improving this social interaction and social well-being.

Elderly. This group of users is in a phase of life where the size of the social network tends to decline and personal mobility tends to decrease. Also, these users often expect others to communicate towards them, instead of the other way around. Social nudges might result in a larger quantity of social interactions, and eventually contribute to the social well-being of these elderly. For our research, this user group will be the focus of studies in the next three years.

3 Challenges

In developing a framework, we have identified three main challenges for future research. These challenges cover contextual, technology, and methodology aspects.

Framework Development. Figure 2.1 shows an… outline of aspects that could be included in a framework. Such a framework could help designer in increasing effectiveness of *social nudges*. The framework should focus on the factors of the nudge itself and on the context of the initiator and the receiver. Future work should concentrate on exploring the relationships between the factors that were introduced.

Context-Aware Technology. A system should be aware of the social, behavioral, physical and temporal context. Also, the system should be able to use that contextual information to increase the persuasive power.

In recent years, there have been substantial developments in context-aware technologies. Even though current state-of-the-art sensors are able to detect many low-level environmental cues, it still is difficult to detect high-level variables such as *user activities*. Consequently, the current state-of-the-art systems are not yet capable of providing the right persuasive cues to people at the right time. In order to bridge this gap, more understanding is needed on what the technology should be able to measure and when it should intervene. The conceptual framework will guide the process of selecting and developing context-aware technology.

Methodology. Social nudges aim to improve the quantity and quality of social interactions. Quantity of interactions can be measured by monitoring the objective frequency and duration of communications, e.g., the amount of phone calls and e-mails one receives and sends. However, no reliable instrument is currently available for measuring the quality of interactions. This would be the main challenge, regarding methodology.

As Romero et al. [8] have found in their work, it is difficult to apply self-report methodology in field studies; as interactions are frequent and diverse, and users had too much work in reporting on each interaction. A tool should therefore influence the usual behavior of people as little as possible. The focus should be on developing instruments that can be used with the participants in a matter of seconds.

3.1 Future work

In our future studies, we will use controlled studies to gain insight in the relationships between the factors described in the framework. Our current focus is therefore on developing an applicable context-aware system and a usable measurement instrument.

By developing the framework, technologies and methods for designing and evaluating *social nudges*, designers and system developers will be able to nudge people in a natural way.

References

1. Fogg, B.J.: Persuasive Technology: Using Computers to Change What We Think and Do. Morgan Kaufman, San Francisco (2003)
2. Weiksener, G.M., Fogg, B.J., Liu, X.: Six Patterns for Persuasion in Online Social Networks. In: Oinas-Kukkonen, H. et al. (Eds.) PERSUASIVE 2008. LNCS, vol. 5033, pp. 151—163. Springer-Verlag, Berlin Heidelberg (2008)
3. Khaled, R., Fischer, R., Noble, J., Biddle, R.: A Qualitative Study of Culture and Persuasion in a Smoking Cessation Game. In: Oinas-Kukkonen, H. et al. (Eds.) PERSUASIVE 2008. LNCS, vol. 5033, pp. 151—163. Springer-Verlag, Berlin Heidelberg (2008)
4. Ormel, J., Lindenberg, S., Steverink, N., Vonkorff, M.: Quality of life and social production functions: a framework for understanding health effects. Soc. Sci. Med. 45 (7), 1051—1063 (1997)
5. Greenglass, E., Fiksenbaum, L., Eaton, J.: The relationship between coping, social support, functional disability and depression in the elderly. Anxiety, Stress and Coping 19 (1), 15—31 (2006)
6. Demura, S., Sato, S.: Relationships between depression, lifestyle and quality of life in the community dwelling elderly: A comparison between gender and age groups. Journal of Physiological Anthropology and Applied Human Science 22 (3), 159—166 (2003)
7. Allison, P.J., Locker, D., Feine, J.S.: Quality of life: a dynamic construct. Soc. Sci. Med. 45 (2), 221—230 (1997)
8. Romero, N., Markopoulos, P., Baren, B., de Ruyter, B., IJsselsteijn, B., Farshchian, B.: Connecting the family with awareness systems. Pers. Ubiquit. Comput. 11 (4), 299—312 (2007)
9. Rowan, J., Mynatt, E.D.: Digital Family Portrait field trial: Support for aging in place. In: CHI 2005, pp. 521—530. ACM Press (2005)
10. Bel, D., IJsselsteijn, W., Kort, Y.: Interpersonal connectedness: conceptualization and directions for a measurement instrument. In: CHI '08 extended abstracts on Human factors in computing systems, pp. 3129—3134. ACM Press (2008)
11. Metaxas, G., Metin, B., Schneider, J., Markopoulos, P., de Ruyter, B.: Daily activities diarist: Supporting aging in place with semantically enriched narratives. In: Baranauskas, C. et al. (Eds.): INTERACT 2007, LNCS 4663, Part II, pp. 390—403. Springer-Verlag, Berlin Heidelberg (2007)
12. Keller, I., van der Hoog, W., Stappers, P.J.: Gust of me: reconnecting mother and son. Pervasive Computing 3 (1), 22-27 (2005)
13. Thaler, R.H., Sunstein, C.R.: Nudge: Improving Decisions About Health, Wealth, and Happiness. Yale University Press, New Haven (2008)
14. Vastenburg, M.H., Keyson, D.V., de Ridder, H.: Considerate Home Notification Systems: a Field Study of Acceptability of Notifications in the Home. Pers. Ubiquit. Comput. 12 (8, 555-566 (2007)

Using robots to foster collaboration among groups of children with autism in an after-school class setting: An exploratory study

Joshua Wainer, Kerstin Dautenhahn, and Ben Robins

University of Hertfordshire, School of Computer Science, Adaptive Systems Research Group, Hatfield, Hertfordshire, England

Abstract. This article describes an exploratory study involving the design of a robotics class for groups of children with autism. The material was used in an after-school class with children at the higher-functioning end of the autistic spectrum. The aim of the study was to foster collaboration among the children in the context of a class where they programme Lego robots under guidance by an experimenter. The class took place once a week over several months and used many different measures to assess the children's collaborative behaviours. Despite limitations of the study, e.g. the very open design of the class and the fact that participation was completely voluntary, results from observational data as well as feedback from the parents/carers suggest a strong, positive relationship between the amount of fun the children had during the classes and the number of potentially collaborative behaviours they exhibited during them. In addition, many of the children in the class either found their experiences in class to be helpful in other social interactions or expected them to be.

1 Introduction

Human social behaviour can appear subtle, elaborate, and sometimes random for people with autism. As such, children with this disorder often find it very difficult to socially interact or communicate with their peers, leading to many difficulties later in life. Because it is known that children with autism enjoy playing with robots and other mechanical devices, one of our laboratory's projects, Aurora, seeks to use robotic toys as therapeutic and educational aids to teach these children skills that will help them to communicate and interact with others, such as turn-taking and imitation [1]. So far, the project has seen great progress and discovered much about how children with autism interact differently with robots than with other people as well as how robots can sucessfully mediate interactions among children with autism. [2] [11] [12] .

Others have followed a similar route and used children with autism's stereotyped interests to teach them how to socially interact with their peers [28] [29]. Specifically, LeGoff (2004) found that children who participated in structured, group-based Lego therapy displayed positive social behaviours significantly more and negative social behaviours significantly less after the set of therapy sessions concluded [24]. Later, in a longitudinal study spanning three years, LeGoff and Sherman (2006) found that children who attended a set of Lego therapy play sessions performed significantly better on standard social behavior tests than children who attended more traditional autism therapy sessions for the same period of time [25], although other researchers have found Lego therapy to be only slightly more effective than traditional therapy [26].

Our study used designs similar to those used in LeGoff's Lego therapy sessions, inasmuch as the children in both studies learned positive social interaction skills by cooperatively playing with a single toy or set of toys with other children in a group setting. However, our study focused on the children programming robots that were previously constructed from Lego Mindstorm kits, as children with autism have a natural fascination with computers and electronic devices [21] [22] [23]. Furthermore, while LeGoff's Lego therapy sessions focused on children building structures, children in our study made their robots perform specific tasks and learned how their interactions with the robot changed its behavior. In this way, the robot became an independent agent with its own goals that the children learned to play with. Furthermore, in addition to collaborating with other members of their own group, children in our study also learned to collaborate with children from other groups when they made all the robots play together to accomplish goals, while LeGoff does not mention having done this. As part of the abovementioned Aurora project, this exploratory study reports on the collaboration observed among the children during this class.

2 Autism, Robots, and Group Learning

Autism is a lifelong developmental disability that affects 0.34% to 0.6% of the population of any given country [6]. It appears in many possible forms and degrees of severity, making people with autism a very heterogeneous group. The defining characteristics, known as the triad of impairment, are impaired social imagination, impaired social interaction, and impaired social communication [7]. Among children, manifestations of these impairments include initiating joint attention using pointing (the selection and focus of gaze on the same object as someone else) far less than other children [8], finding it difficult to initiate and sustain social play [9], and spontaneously displaying helpful behaviours far less than other children, even those with other developmental disabilities[10].

Robots have proven to be useful devices for studying and helping children with autism, as the robots often elicit responses from the children like few people can. In addition to the abovementioned projects, Fasel et al (2002) used simulated systems and robotic ones to study normal and abnormal development of joint attention in infants with and without autism [14]. Later, Kozima, Nakagawa, and others (2005) developed a simple robot, Keepon, capable of establishing triadic interactions between itself, an infant with autism, and another individual, whether another child or the infant's parent / caregiver [13]. Michaud and Théberge-Turmel (2002) also studied many small robotic designs (an elephant, a spherical robotic 'ball', etc) to see which one best engaged children with autism in playful interactions that helped them develop social skills [18].

Teams of children in robotics classes have been shown to learn about technology as well as social interaction. Puntambekar et al (1997) found that intragroup communication in a mobile robotics course focused more on details of models, while intergroup communication focused more on justifying the roles and methods each group's robot used in gathering scientific data [3]. Denis and Hubert (2001) found that children in robot design groups chose specific, distinct roles for themselves and that a group's discussions on why their robot behaved a certain way were always beneficial to the robot's design [4]. Järvinen (1998) observed that given the chance, children in robotics groups were able to correctly learn about robotic technologies for themselves as well as from their teammates, and only asked the teacher's advice when they needed it [5]. Nourbakhsh, Hamner, et al (2004) found that while groups of students in a summer robotics course reported the most trouble with technical issues, they reported breakthroughs with these issues as well as non-technical ones, such as teamwork and problem solving [19].

Table 1. Descriptions of the children who attended nine or more classes. NOTE: detailed diagnostic information was not available for all of the children

Name	Age	Sex	Diagnosis
R	10	Male	Some form of autism
O	8	Male	High functioning autism and severe ADHD
M	9	Male	Borderline Asperger's Syndrome
Sh	8	Male	Some form of autism
C	14	Male	Asperger's Symdrome
S	11	Male	Asperger's Syndrome, developmental language disorder, fine motor dyspraxia, and hyperactivity
B	9	Male	Asperger's Syndrome

3 Method

Working with the St. Nicholas Academy for Autism Project (SNAAP), an after-school computer club for children with autistic spectrum disorder (ASD) who live in the London borough of Barnet, we recruited children to participate in our weekly robotics classes on a volunteer basis from the end of February to the middle of July (see Table 1). During this time period, fourteen weekly classes were taught. We designed the classes such that the experimenter would teach a new robotics lesson in the first 15 minutes, and groups of 2-3 children would program and play with the robots to demonstrate what they learned in the remaining 45 minutes. During the first few classes, up to four such groups of children would play in the same classroom at the same time, but in last few classes, one to two groups of children would play in the same classroom. These groups were organized by the heads of SNAAP who knew the children well. Although the children in each group were matched for temperaments, capabilities, and placements on the autistic spectrum as closely as possible, compromises were made depending on which children attended a given day of class. At these classes, each group of participants played with one of three Lego NXT robots, which were assembled as mobile, differentially driven units, and programmed it using NXT-G, the graphic-based programming environment provided with Lego's Mindstorm NXT robot kits (see Figure 1). The three robots were designed to easily sense and interact with their environments, including other robots. These robots were always used in a 6 foot x 6 foot (128.88 cm x 128.88 cm) wooden arena which we also designed. The arena had RFID and IR range sensors that would make LEDs flash and sounds play from a laptop computer when the robots performed certain actions, although the specifics of how this happened changed according to the requirements of each day's lesson plan.

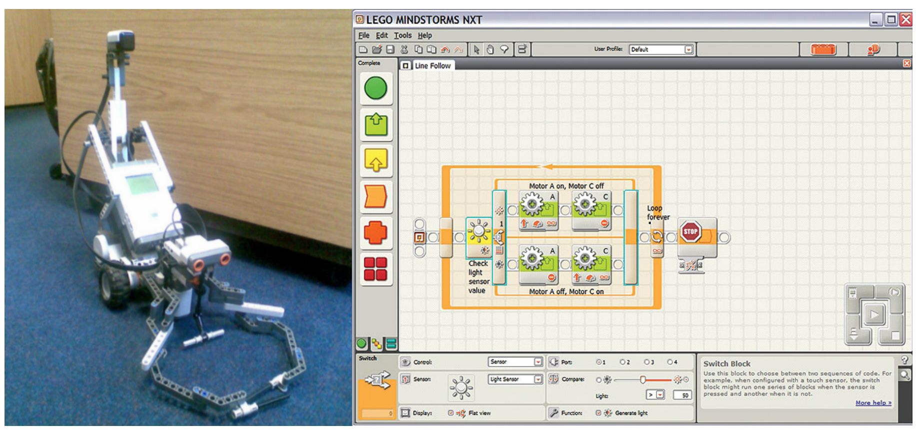


Fig. 1. Left: one of the LEGO NXT robots that the children played with. Right: The NXT-G graphical environment with which the children programmed the robots

Because the children had difficulties sharing or taking turns with their groupmates while playing with their group's robot and because visual devices are commonly used to inform autistic children about social behaviours and proper social etiquette [20], we designed simple "turn taking wheels" to show how each group member should play with the robot, much like how a "Wheel of fortune" shows how much money each player can win during a round (see Figure 2). The wheel was successfully used for classes 4 through 11, inclusively. For classes 12 through 14, when the children were told that the wheels would no longer be used, the children in remaining groups were successfully able take turns playing with their robots.

Fig. 2. Left: The “turn-taking wheel” the children used. Right: The children play with the robots and interact with each other during class

We used camcorders to record the children’s interactions during class time and asked them and their parents / carers to fill out short questionnaires when class was over (see appendix). From the video footage, we observed many behaviours among the children that Bauminger described earlier in her studies on social interaction among children with autism [15]. We chose to code five of Bauminger’s behaviours that we observed in our video footage and felt were essential or necessary for collaboration:

1. **group proxemics**, when groupmates stood within 120 cm, or what Hall describes as the limit of “personal distance” in conversational interaction, of each other [16]
2. **shared gaze**, when groupmates looked at the same object or at each other;
3. **helping -** how many times help was solicited or offered for working with the robots to either the experimenter or groupmates
4. **pointing behaviour**, or initiating joint attention by indicating the robots or computers to either the experimenter or groupmates through pointing at them
5. **shared positive affect**, how many times the children would laugh or smile with groupmates.

The last three behaviours were only coded if they occurred while the child in question’s groupmates were “close while sharing gaze” (within “personal distance” of each other as well sharing the same gaze). This was done because when group members are not in close proximity to each other and do not have face-to-face communication, they will have a difficult time collaborating [17]. Therefore, because we wanted to see whether the robots could foster collaboration among the children, the last three behaviours were only coded if they were considered potentially collaborative.

4 Results

We looked at the above data for four different classes for each of the seven children that attended over 60% of the classes: their first class, their last class (because of the voluntary nature of the classes, the last day of class was not necessarily the same day for each child), and, according to the questionnaires they filled out, each child's self-reported most fun class and least fun class. In order to get as much data as possible, we specifically did not allow the most or least fun classes to overlap with the first or last classes; this was feasible since the children whose most or least fun classes overlapped with the first or last ones had multiple classes that they reported as being the most or least fun, so we simply selected another, intermediary class as being their most/least fun.

We used Wilcoxon's signed-rank tests to determine the significance of differences in social behaviours on different days; because our paired sets of data were neither random nor normally distributed, we could not use paired t-tests.

Table 2. The behaviours of the children who attended nine or more classes. †- statistically insignificant, * - marginally statistically signficant, ** - statistically significant

Increase in ...	From first to last classes	From least to most fun classes
Proportion of class time spent "close while sharing gaze"	Z = -1.527, p = 0.127†	Z = -1.863, p = 0.063*
Helping behaviours	Z = -1.859, p = 0.063*	Z = -2.371, p = 0.018**
Pointing behaviours	Z = -0.420, p = 0.674†	Z = -2.023, p = 0.043**
Freq. of helping behaviours	Z = -2.197, p = 0.028**	Z = -2.366, p = 0.018**
Displays of positive affect	Z = -1.581, p = 0.114†	Z = -2.214, p = 0.027**

As can be seen in Table 2, the children spent a marginally greater proportion of class time "close while sharing gaze" during their most fun classes than during their least fun classes. The children also exhibited marginally more helping behaviours during their last classes than during their first class, and significantly more helping behaviours during their most fun classes than during their least fun classes. The children exhibited significantly more pointing behaviour as well as shared displays of positive affect with their groupmates during their most fun classes than during their least fun classes (see Figure 4:left).. The children also exhibited a significantly higher rate of displaying helping behaviours during their last classes than during their first class, as well as during their most fun classes than during their least fun classes(see Figure 4:right). In fact, when the total number of helping behaviours was graphed against the proportion of time spent "close while sharing gaze" for all four days, the data fit a quadratic curve best with a correlation coefficient of $r = 0.81$ (see Figure 3). This shows that the children exhibited helping behaviours more frequently as they spent more time together.

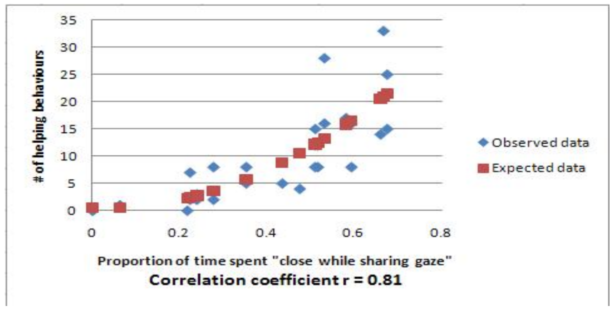


Fig. 3. The quadratic trend indicates that the children had higher rates of displaying helping behaviours on days that they spent more class time around their groupmates

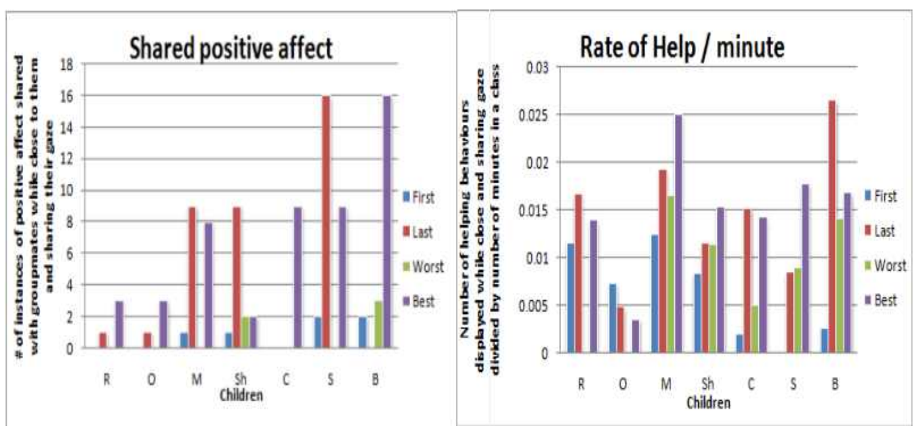


Fig. 4. Left: Our data on how often the children displayed "shared positive affect". Right: Our data on the children's rates of helping behaviours displayed per minute.

After the penultimate class was concluded, we conducted private interviews with the children's parents to hear what they felt about the robotics classes. From this anecdotal evidence, we found that three of the parents felt that the turn taking wheel was a very successful and helpful tool. In addition, four of the parents felt that the experiences and knowledge from the robotics classes help their children in current social situations or could help them in future social situations; the first said that when her child becomes anxious with children at school, they could be reminded of the behaviour and coping mechanisms used during the robotics classes to help get them through; the second said that her child is now confident enough to approach and help out other children with their programming when they go to Legoland; the third said that the robotics classes have given her child more “normal” topics with which to start conversations when meeting new people; the fourth said that her child has learned about how to take turns and talk with others through programming problems instead of directly taking control of the computer and fixing it without talking.

5 Discussion

While we have determined that certain behaviours are related to certain conditions as well as other behaviours, it is difficult to determine whether one causes the other. For example, children reported more enjoyment during classes that showed them exhibiting significantly more potentially cooperative behaviours. While it is possible that the children exhibited these behaviours because they were enjoying a class, it is also possible that they enjoyed a class more because they were exhibiting potentially cooperative behaviours, which they may find difficult to perform under normal circumstances. Additionally, the few children who attended the last class freely agreed to play socially with each other instead of playing alone with their own robots. While it is possible that they were purely motivated by the elaborate sensory rewards they could receive if they played together, the fact that many children reported the last few classes to be more fun than the first few suggests that the children may have learned to enjoy playing together and collaborating. However, it may also be that the children who would attend so many classes that emphasized teamwork and collaboration would also be inherently more willing and able to play cooperatively, and therefore attend more classes, than those that were not; the exit interviews with some parents of the children who attended fewer than nine classes seem to confirm this final hypothesis.

6 Conclusions and Future Work

This paper shows our findings from a voluntary after-school class on robotics for groups of children with autism. The results from this exploratory study suggest that the amount of enjoyment a child had at a given class was more strongly related to the amount of potentially cooperative behaviours they exhibited than was the amount of time a child spent with a given group. In addition, children displayed helping behaviours more frequently as they spent more time close to groupmates while sharing their gaze, and many of the children’s parents felt that attending the class helped or would help their children in social situations. We feel that future studies could explain the dynamics behind these results, and that the following improvements to the experimental design would help to do so: a larger pool of participants for greater statistical significance, control and experimental conditions to determine whether a robotics class yields different results than another group-based class, using sensory rewards in the classes as much as possible to better keep the children interested, fewer pairs of children playing during a given session instead of many groups of three children to make it easier for the children to concentrate, as well as replacing anecdotal evidence with pre-study and follow-up testing for more reliable data.

7 Acknowledgements

The authors would like to thank the organizers of SNAAP, Christine Haugh, Matt Connoly, and Steph Moriarty, for granting us the use of their facilities, as well as all the parents, carers, and children of SNAAP for attending our classes. We would also like to thank Scott Watson and Dr. Ester Ferrari for their psychological expertise in capturing and analyzing data, advice, and endless patience.

APPENDIX : Questionnaires for class participants

Most items on the questionnaires used seven degree Likert scales for responses and had appropriate verbal descriptions near every question's first, fourth, and seventh Likert boxes. To illustrate how the Likert scale worked, both questionnaires also contained one example question each. This example question used an already-filled scale along with an explanation of how such a response would be interpreted. Below are both the items on the questionnaires as well as the text below the first, fourth, and seventh boxes on the Likert scales. Questions without Likert text are open-ended questions.

Parents' weekly questionnaire

1. How much do you think your child enjoyed this week's robotics class?
   1st: Did not like it **4th:** Thought it was average **7th:** Really enjoyed it
2. How frequently did your child collaborate with other children during this week's class?
   1st: Never **4th:** Occasionally **7th:** All the time
3. How well do you think they collaborated with other children during this week's class?
   1st: Not very well **4th:** About average **7th:** Very well
4. In terms of social behaviour, how would you describe your child's behaviour outside of SNAAP during this past week?
   1st: Very unsociable **4th:** Neutral **7th:** Very sociable
5. Do you think your child learned something from this week's class? If so, what?
6. Was any of your child's behaviour unusual or unexpected during this week's class? If so, how?

Children's weekly questionnaire

1. What did you think of this week's robotics class?
   1st: It was not fun **4th:** It was okay **7th:** It was a lot of fun
2. How often did you work with other children during today's robotics class?
   1st: Never **4th:** Sometimes **7th:** All the time
3. How easy was it to work with other children during today's robotics class?
   1st: Very hard **4th:** So-so **7th:** Very easy
4. Did something unusual happen during today's class? If so, what was it? If you can think of anything, please write your answer on the lines below!

References

1. AURORA, URL: http://www.aurora-project.com/ last accessed 2/9/08, 2008
2. I. Werry, K. Dautenhahn, B. Ogden, and W. Harwin, "Can Social Interaction Skills Be Taught by a Social Agent? The Role of a Robotic Mediator in Autism Therapy," in Proc. *CT2001, The Fourth International Conference on Cognitive Technology: Instruments of Mind, LNAI 2117*, M. Beynon, C. L. Nehaniv, and K. Dautenhahn, Eds. Berlin Heidelberg: Springer-Verlag, 2001, pp. 57-74.
3. Puntambekar, S., Nagel, K., Hübscher, R., Guzdial, M., & Kolodner, J.: "Intra-group and intergroup: An exploration of learning with complementary collaboration tools"; Proc. 2 nd International Conference on Computer Supported Collaborative Learning (CSCL'97), University of Toronto, Toronto (1997), 207214.
4. B. Denis and S. Hubert, Collaborative learning in an educational robotics environment, *Computers in Human Behaviour* 17 (2001), pp. 465-480.
5. Järvinen, E-M.: 1998, 'Lego/logo Learning Environment in Technology Education an Experiment in a Finnish Context', *Journal of Technology Education* 9(2), 47-59.
6. Fombonne, E. The prevalence of autism, *The Journal of the American Medical Association*, Vol. 289, pp. 87-89, 2003
7. Wing, L. *The autistic spectrum.* Constable Press, London, 1996.
8. Frith, U. *Autism: Explaining the Enigma*, Blackwell 1989.
9. Jordan, R. (2003). Social play and autism spectrum disorders. *Autism, 7*, 347-360.
10. Liebal, K. Colombi, C. Rogers, S. J. Warneken, F. Tomasello, M. "Helping and Cooperation in Children with Autism"; *Journal of Autism and Developmental Disorders*, 2008, VOL 38; NUMBER 2, pages 224-238.
11. B. Robins, K. Dautenhahn, R. te Boekhorst, and A. Billard, *Robotic assistants in therapy and education of children with autism: Can a small humanoid robot help encourage social interaction skills?* Universal Access in the Information Society (UAIS), 2005.
12. Robins, B., and Dautenhahn, K. The role of the experimenter in HRI research - A case study evaluation of children with autism interacting with a robotic toy. In *Proceedings of the 15th IEEE International Symposium on Robot and Human Interactive Communication* (Hatfield, England, September 6-8, 2006). Piscataway, NJ: IEEE, 2006, 646-651.
13. H. Kozima, C. Nakagawa, and Y. Yasuda, "Interactive robots for communication-care: A case-study in autism therapy," in *Proc. Of the IEEE International Workshop on Robot and Human Interactive Communication*, 2005, pp. 341-346.
14. I. Fasel, G.O. Deak, J. Triesch, and J. Movellan, "Combining Embodied Models and Empirical research for Understanding the Development of Shared Attention," *Proc. The 2nd International Conference on Development and Learning*, 2002.

15. Bauminger, N. (2002). The facilitation of social-emotional understanding and social interaction in high-functioning children with autism: Intervention outcomes. Journal of Autism and Developmental Disorders, 32, 283-298.
16. Hall, Edward T. *The Hidden Dimension.* Anchor Books, 1966.
17. Kiesler, S and Cummings J.N. (2002) What do we know about proximity and distance in work groups? A legacy of research. In Distributed Work (Hinds, P and Kiesler S, Eds), pp. 57-80, The MIT Press, Cambridge, MA.
18. F. Michaud and F. Théberge-Turmel. Mobile robotic toys and autism. In K. Dautenhahn, A. Bond, L. Canamero, and B. Edmonds, editors, Socially Intelligent Agents - Creating Relationships with Computers and Robots, pages 125132. Kluwer Academic Publishers, 2002.
19. I. R. Nourbakhsh, E. Hamner, K. Crowley, and K. Wilkinson, "Formal measures of learning in a secondary school mobile robotics course," Proc. IEEE International Conference on Robotics and Automation, vol. 2, pp. 1831-1836, 2004.
20. Bondy, A. S., & Frost, L. A. (1994). The picture exchange communication system: Training manual. Cherry Hill, NJ: Pyramid.
21. Colby K, Smith D (1971) Computers in the treatment of non speaking autistic children, Current Psychiatric Therapy 11:1-17.
22. Moor D (1998) Computers and people with autism. Communication 20-21.
23. Powell S (1996) The use of computers in teaching people with autism. Autism on the agenda: papers from a National Autistic Society Conference, London.
24. LeGoff, D. B. (2004). Use of LEGO as a therapeutic medium for improving social cCompetence. *Journal of Autism and Developmental Disorders, 34*(5), 557571.
25. LeGoff, D. B., & Sherman, M. (2006). Long-term outcome of social skills intervention based on interactive LEGO©play. *Autism, 10*(4), 317329.
26. Owens G, Granader Y, Humphrey A, Baron-Cohen S. (2008) LEGO ®Therapy and the Social Use of Language Programme: An Evaluation of Two Social Skills Interventions for Children with High Functioning Autism and Asperger Syndrome. Journal of Autism and Developmental Disorders, [Epub ahead of print] Jun 20 2008.
27. Papert, S. (1980). *Mindstorms: Children, computers, and powerful ideas.* New York: Basic Books.
28. Attwood, A. J. (1998). *Aspergers syndrome: A guide for parents and professionals.* London,UK: Jessica Kingsley Publishers.
29. Greenspan, S. I., & Wieder, S. (1998). *The child with special needs: Encouraging intellectual and emotional growth.* Reading, MA: Perseus Books.