Swinxsbee: A Shared Interactive Play Object to Stimulate Children's Social Play Behaviour and Physical Exercise

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Abstract. This paper describes a study on the influence of personal and shared play objects on the amount of social interaction. The study makes use of Swinxs, a commercially available game console that uses the strength of digital games to facilitate physically active games that can be played indoor or outdoor. A Frisbee-like object called Swinxsbee has been designed to support new game possibilities for Swinxs and stimulate social interaction. The results of a user evaluation show that children playing with shared objects engage in more social interaction than children playing with personal objects. Furthermore we observed that when games require much physical activity, this might have a negative influence on the level of social interaction, while games demanding creativity might have a positive influence.

Keywords: intelligent play objects, head-up play, social play behaviour.

1 Introduction

The popularity of digital games amongst children is huge. Digital games are engaging through their stimulating audiovisual effects and adaptability [1]. Despite the high score in engagement, most computer games do not stimulate social interaction and physical exercise. Nintendo Wii [2] and Sony Playstation's EyeToy [3] are recent attempts to make games more physical. Unfortunately these examples still keep the children in a setting that is not optimal for social interaction: play in front of a screen.

Traditional games like tag or soccer are both physical and social. The outdoor environment allows for freedom of movement and the children are playing with each other instead of with a computer. Pervasive gaming is a movement of digital gaming towards outdoor play. This genre blends real and virtual game elements to create new exciting game experiences [4]. Head-up play is a variation to pervasive gaming [5]. Where pervasive games still require children to pay attention to the technology, head-up play strives for games where children keep their 'head up' to stimulate social interaction. Swinxs [6] is a commercially available game console that supports a form of head-up play. It uses the strength of digital games to facilitate (physically) active games that can be played indoor or outdoor. This project has emerged from an interest in Swinxs as a platform for research on intelligent play and the request of the company

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that has developed Swinxs to design a new play object for new game possibilities. In particular we are interested in the influence of the designed object in stimulating social interaction, because of the crucial role it plays in child development.

This paper describes the design of a new play object for Swinxs and the investigation of the influence of this design on social interaction. Our aim is to find specific game elements positively influencing social interaction as guidelines for game designers and researchers.

2 Background

Swinxs is a new game console for children aged 4 to 12. It facilitates physically active games that can be played indoor or outdoor. The most important technical features of Swinxs are the RFID-reader, speakers and USB-port. Swinxs comes with coloured armbands called XS-tags. Each XS-tag contains an RFID-tag for recognition of players. The range of the RFID-reader is approximately five centimeters above Swinxs, which requires the XS-tags to be really close to Swinxs for detection. The speakers are used for playing music and talking to the children by playing a set of professionally recorded sound samples. Swinxs explains the games, encourages the players and gives feedback on their achievement. This capability to talk enables Swinxs to communicate with the children without an attention-drawing screen. New games and supporting sound samples can be uploaded when connecting it to the computer via the USB-connection.

Fig. 1. The Swinxs game console and the XS-armbands

Swinxs games have a physical, creative or educational objective. Most Swinxs games are modern versions of traditional games like tag, hide and seek and musical chairs. The new version of musical chairs is called SwinxsCircle. The children are asked to run or dance in a circle on two meters distance of Swinxs while the music is playing. When the music stops, the children need to scan their XS at Swinxs. The player that first scans his XS wins the game.

One benefit of Swinxs over traditional games is that Swinxs acts as an objective referee. This can avoid arguments about the rules and about the score. Swinxs also encourages the children and gives positive feedback about each achievement. Swinxs

can also play music during physical exercise, which leads to an increase positive affect and reduces perceived exertion [7].

2.1 Related Work

The interest in social gaming is quite recent. Researchers in interaction design have been creating several experimental social games for children. An example is aMAZEd, a tangible tabletop game [8]. The players have to go through a projected maze to rescue a princess. There are hurdles in the maze that force team members to meet somewhere in the maze and move together toward a certain location on the maze. The designers of the game have approached the stimulation of social interaction through cooperation. A quite similar approach has been applied in the development of Ely the Explorer [9], a game supporting a multi-user tangible interface. An Ely is a doll and an on-screen character. The children learn about different cultures through sending their Ely all over the world through a teleporter. The children are asked to help the Elys with documenting their travel. In the end the documentation of the children is combined as a common outcome. Another project is Camelot, a head-up game for outdoor play explores the potential of tangible interfaces [10]. In Camelot, two teams have to finish building a castle as fast as possible. Virtual resources need to be collected to earn parts of a physical castle.

All previously mentioned projects provide games to support social interaction, however they do not explicitly address the relationship between play objects and social interaction. This project hopes to find approaches how to positively influence social play behaviour through carefully designing game dynamics. This topic is also issued in current game design literature [11].

2.2 Theories

This subsection describes theories related to social interaction and player interaction patterns that inspired our work.

There are several theories that contribute to the field of social play behaviour. Parten defined the degree of participation in six sequential social participation categories: unoccupied behaviour, solitary play, onlooker behaviour, parallel play, associative play and cooperative play [12]. However this degree of participation does not describe in which way the children behave socially. Broadhead has created a methodology called the Social Play Continuum [13]. Here social play behaviour is measured by the level of reciprocity in language and action. The method describes four social domains: associative play, social play, highly social domain and cooperative play. The Social Play Continuum is a method to describe the level of social interaction.

Social interaction can be provoked by a game, but always requires other players. The type of relation between the players can influence the type of social interaction that will occur. The structure of interaction between a player, the game and other players is the so-called player interaction pattern [14]. Figure 2 shows the different player interaction patterns. A high level of social interaction can be provoked by the player interaction patterns cooperative play or team competition.

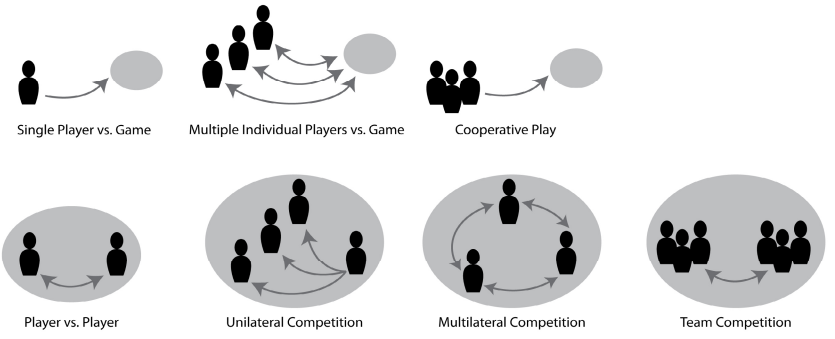


Fig. 2. The different player interaction patterns (based on Fullerton et al., p.52 [14])

3 Design Case

The project has been approached through a design research process. In such a project, the design process and the research process run parallel to each other. We designed a play object for the purpose of addressing a research question about social play behaviour. The duration of the project was eight weeks.

3.1 Design of a New Swinxs Object

An analysis of Swinxs has shown that current Swinxs games do not include the player interaction patterns collaborative play or team play. Both patterns require collaboration, which can lead to a high degree of social interaction. To design a play object that requires collaboration is an opportunity for Swinxs to stimulate a high level of social play behaviour.

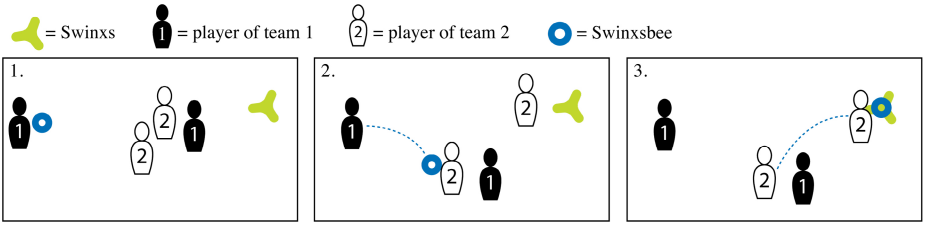
After several design iterations the concept Swinxsbee was created. Swinxsbee is a Frisbee that contains an RFID-tag (fig. 3). The fundamental difference between Swinxsbee and the existing armbands is that the armbands are *personal* objects and Swinxsbee is a *shared* object. Players are able to exchange Swinxsbee, because it is

Fig. 3. Swinxsbee, an interactive Frisbee for Swinxs

unattached, light in weight and floats on air. Handling a Frisbee is not easy; it requires skill of throwing and catching and a good sense of timing. Improving these skills is a very challenging activity and is a reason why it can remain fun on a long term.

Two Swinxsbee games have been developed for this study: Ultimate Swinxsbee and Multibee. For the design of the games the limited sensitivity of Swinxs' RFID-reader was kept in mind. It requires the players to hold the Swinxsbee close to Swinxs (approximately 5 cm) to scan Swinxsbee.

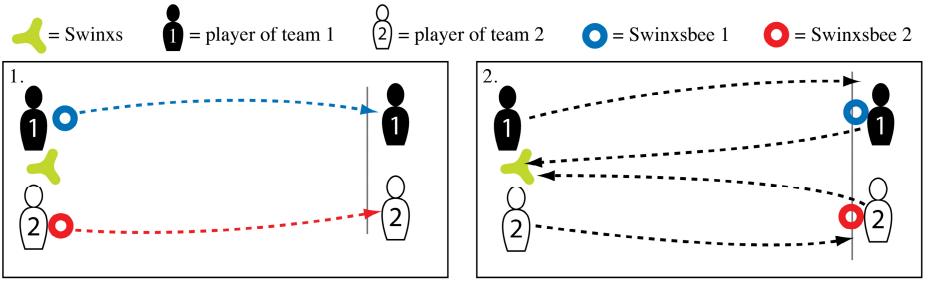
Ultimate Swinxsbee. This game is based on a Frisbee game called Ultimate Frisbee. It requires a Swinxs, a Swinxsbee and an even number of players (at least four players). Swinxs divides the group into two teams using the colors of the bracelets. The rules in this game are quite simple. The team that possesses the Frisbee can try to score a point by scanning the Frisbee at Swinxs. But the player holding Swinxsbee is not allowed to run or walk and has to throw Swinxsbee within ten seconds to his team member. The other team has to try to intercept the Swinxsbee by defending the free player. If they do so, they can try to score a point themselves. To recognize which team has scored, the XS-tags should be scanned after scanning Swinxsbee. After a point is scored, the scoring team throws the Frisbee away as far as possible to determine the location the other team can start from. The team with the most points after 3 minutes wins.



1 - The player holding Swinxsbee is not allowed to walk or run and has to throw Swinxsbee within 10 seconds. Team 2 defends the free player of team 1.
2 - Team 2 intercepts Swinxsbee and is able to attack.
3 - Swinxsbee is thrown to the free player of team 2, who scans Swinxsbee at Swinxs and scores a point.

Fig. 4. Scenario of Ultimate Swinxsbee

Multibee. The group is divided into teams of two players and each team has a Swinxsbee. The players have to draw a line of 10 meters long at about 15 meters from Swinxs. Each team has a thrower and a catcher. The thrower stands next to Swinxs and the catcher on the line. On Swinxs' signal the game starts and the player next to Swinxs throws Swinxsbee towards the catcher, but the Frisbee has to be thrown further than the line. The catcher should get Swinxsbee and run to Swinxs to scan Swinxsbee for scoring a point. On the same time the thrower runs to the line. The catcher becomes the thrower and the thrower becomes the catcher and this continues until the game ends after 3 minutes. The team with the highest score wins.



1. - Throw Swinxsbee to your team member
2. - The catcher runs with Swinxsbee to Swinxs and the thrower runs to the line

Fig. 5. Scenario of Multibee

4 Study

The study examines whether children playing with Swinxsbee engage in higher levels of social interaction than children playing with the bracelets. The game console Swinxs encourages physical play for children, but the current play objects especially stimulate play without collaboration. In contrast, the newly designed object Swinxsbee stimulates collaborative play. Using Swinxsbee we will examine our hypothesis: Playing with a shared object enhances social interaction as compared to playing with a personal object. Two conditions will be compared: play with a personal object versus play with a shared object.

4.1 Set-Up

The experiment is executed at a primary school in Eindhoven. In total 32 children between 8 and 12 years of age were asked to join the play sessions, of which 17 girls and 15 boys. In preparation for the experiment, the parents of the children have been informed and asked for permission to film and take pictures of the sessions.

The study exists of eight sessions with groups of four children. To decrease the influence of a specific game on social interaction, two games per condition will be played. All games should have a physical goal. The Swinxsbee games are Ultimate Swinsxbee and Multibee. The games for the XS-armbands are SwinxsCircle (explained in section 2) and Far and Away. In the game Far and Away Swinxs plays a music sample with a random length. The first time this sample is played, the children have to count and remember the duration of the sample. The second time the sample plays, the children have to run as far away as possible, but scan their XS-tag at Swinxs before the sample stops playing.

For this study we used a within subject design. Furthermore, both the order of playing with the shared and personal objects as the order of the games within both conditions was varied to reduce the chance of order effects.

4.2 Methodology and Analysis

This study approaches the analysis of social interaction in two ways: through video analysis and a questionnaire. The video is analysed using an observation scheme and the questionnaire provides data about the children's view on their social behaviour.

Video Analysis. Methodological research for evaluating children's interactive products is a relatively young field. Examples of observation methods for analyzing social behaviour are the earlier mentioned Social Play Continuum, the Play Observation Scale (POS) [15] and the Outdoor Play Observation Scale (OPOS) [16].

POS is not appropriate for this study, because it uses a too detailed scheme for our purposes. It also tries to examine the kind of play, which is not in the interest of this study as the kind of play is already given. OPOS aims at analyzing outdoor play. The social interaction module of OPOS codes the number of functional and non-functional interactions, but does not distinguish levels of social interaction. Therefore OPOS is not suitable for this study. The Social Play Continuum describes the level of social interaction through observing the reciprocity of actions and communication. However the Social Play Continuum is complex and not always clear about the boundaries between the domains. Therefore a new coding scheme is created for this study, which is intended for coding social interaction of players using intelligent play objects.

The coding scheme is based on the Social Play Continuum. The development of the observation scheme has gone through an iterative process of testing, evaluating and redefining the parameters. This process has eventually led to specific parameters (table 1) the observer should look at.

Table 1. Parameters of the observation scheme

Parameters	Values
Playing alone/together	Alone, parallel, teamwork
Communication	None, one-sided, reciprocal
Action	None, for own goal, for shared goal, constant reactive
Focus on game or other players	None, temporarily, constant

The values of the parameters form a basis for the interpretation of the children's play behavior. The coding scheme is shown in table 2.

Table 2. The observation scheme

Level of social interaction	Characteristics
Level 1 (low)	Alone, no focus on game or other children
Level 2 (mediocre)	Parallel/teamwork, one-sided communication/action
Level 3 (high)	Parallel/teamwork, reciprocal communication/action
Level 4 (rich)	Parallel/teamwork, cluster of reciprocal communication/action
Other	Children not in sight or intervention of the researcher

For the assessment of social play behaviour, the behaviour of each child needs to be coded separately. Providing an overall group score takes less time, but the observer's attention might be drawn to the active players. To give a realistic score of social interaction, the less active children have to be taken into account as well.

The procedure of coding is similar to the procedure of POS. Each child is observed while playing the four games. To get familiar with the behaviour of the target child and context, the observer watches the target child for 30 seconds before recording

behaviours. Subsequently the target child is observed during intervals of 10 seconds. When the video is paused, the observer has to checkmark the appropriate level of social interaction within the next 5 to 10 seconds.

For each game the number of occurrences for each of the four social interaction levels is calculated. Because not all games have an equal duration, the numbers will be represented by percentages of the total play time of a game minus the play time coded as "other".

Because of time constraints only four play sessions with a total of 16 children have been analysed. The four groups have been chosen based on quality of the video. The first author has coded the play sessions.

Fig. 6. Ultimate Swinxsbee – the right girl tries to throw Swinxsbee to the left girl. The two middle girls try to defend the left girl.

Questionnaire. The questionnaire is used to find the children's perspective of their social play behaviour. It consists of 15 statements about social play behaviour during the play sessions. All 32 children have filled out the questionnaire twice, once after playing the bracelet games and once after playing the Swinxsbee games. The children were asked to give their opinion on how much they agree with the statements on a 5-point scale (not at all, slightly, moderately, fairly and extremely). The statements are derived from the social interaction module of the Kids Game Experience Questionnaire [17] extended by statements based on social interaction theories of Broadhead. The questionnaire has been written in a child friendly format and wording. Some examples of statements used are: "I was looking at others while playing", "We were mainly playing together" and "I was mimicking others while playing".

The mean differences between both conditions are calculated for all questions. To get an indication of how players perceive the social interaction, an average over all questions is calculated. A Wilcoxon signed rank test is used to test whether a significant difference between the two conditions exists.

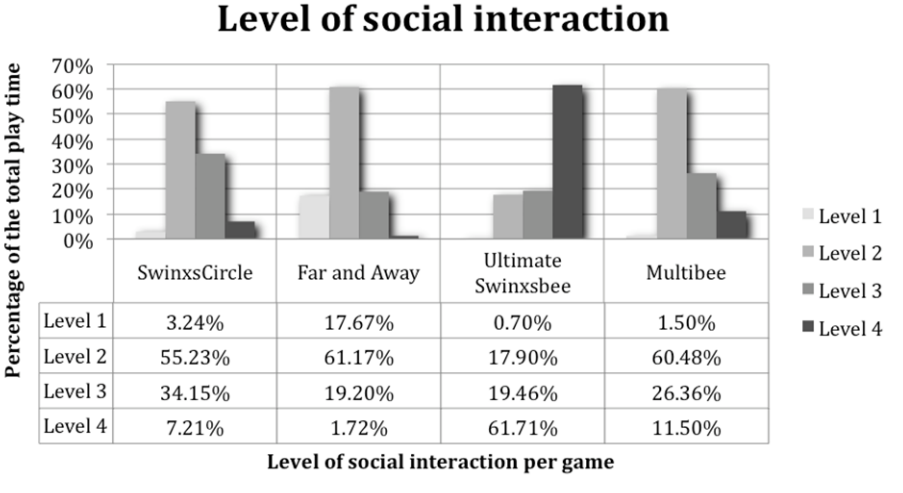
5 Results

We will describe our findings on how the personal and the shared objects influenced the children's play behaviour. We will first present the social interaction scores from

the video analysis, and then we will provide a more descriptive account of the children's behaviour. Secondly we will present the outcome of the questionnaire data.

A paired t-test was conducted on the average total social interaction scores for the two games with the bracelets versus the two games with the Swinxsbee. The total social interaction score was based on an average of the scores for social interaction levels 1 to 4. The paired t-test showed that children playing with the Swinxsbee had a significantly higher social interaction (average = 2.9, s.d. = 0.01) than children playing with the bracelets (average = 2.2, s.d. = 0.03) ($n=16$, $p < 0.001$). The average scores for social interaction for the two bracelet games are very similar, 2.4 (s.d. = 0.35) for SwinxsCircle and 2,1 (s.d. = 0.21) for Far and Away. The average scores for social interactions for the two Swinxsbee games were much more diverse: 3.4 (s.d. = 0.27) for Ultimate Swinxsbee and 2.5 for Multibee (s.d. = 0.21).

Figure 7 shows the average scores per social interaction level in percentages of all four games. The data of Ultimate Swinxsbee shows a peak for social interaction level 4. The videos of this game show that the children have a constant focus on each other and communicate both verbally and non-verbally. The ability to exchange the Swinxsbee leads to a high level of social behaviour. The players can actively ask for the Swinxsbee and carefully look at each other to defend the attackers or to make sure the defenders do not intercept the Swinxsbee. Remarkably, Multibee has scored on a similar level as a game played with personal objects, SwinxsCircle. The big difference between Multibee and the other games is the amount of physical exercise. Multibee demands all children to keep running for three minutes. The game clearly exhausted the children. This has had a big influence on the social interaction; in the end, the children were simply too exhausted to communicate and keep focus on each other and the game. The bracelet game SwinxsCircle has a higher percentage of social interaction level 3 than Multibee. The children are asked to run or dance in a circle around Swinxs. The silly tone of the music provoked funny dance moves. This creativity and humour in the game has regularly led to a high level of social interaction.



	SwinxsCircle	Far and Away	Ultimate Swinxsbee	Multibee
Level 1	3.24%	17.67%	0.70%	1.50%
Level 2	55.23%	61.17%	17.90%	60.48%
Level 3	34.15%	19.20%	19.46%	26.36%
Level 4	7.21%	1.72%	61.71%	11.50%

Fig. 7. Overview of the average scores for each level of social interaction of all four games

In total 32 children have filled out the questionnaire for both conditions. The mean differences show a few outliers. The statement "We helped each other while playing" scores much better for the Swinxsbee games (average c1 = 2.4, average c2 = 4.1). This is probably an effect of team play. The same reason counts the statement: "We played mainly together" (average c1 = 3.0, average c2 = 3.7). Another positive outlier is: "During the game we talked with each other about the game" (average c1 = 2.1, average c2 = 2.7). A negative outlier is: "We played mainly close to each other" (average c1 = 3.4, average c2 = 2.7). The negative result is likely an effect of one of the Swinxsbee games, Multibee. During this game children from the same team are separated and need to throw the Swinxsbee to each other.

The analysis of the questionnaire data has shown a higher total average score for the shared object games (average = 2.6, s.d. = 0.56) than the scores of personal objects for the shared (average = 2.1, s.d. = 0.49). The result of the Wilcoxon Signed Ranks Test shows a significant difference in social interaction of all groups ($p = 0.039$) where children felt they had more interaction during Swinxsbee games than during bracelet games.

6 Conclusions and Discussion

The current Swinxs games lack opportunities for cooperative play. A new play object called Swinxsbee, was created to support cooperative play and stimulate social interaction. Swinxsbee is a shared object and has the ability to be exchanged between players. This makes it likely that a higher level of social interaction occurs while playing with a shared play object than with a personal play object. The goal of this study was to examine the effect of shared and personal play objects on social interaction.

The data of both the video observation and questionnaire support the finding that playing with Swinxsbee leads to more social interaction than playing with the bracelet games. Even though the hypothesis was accepted; the differences in the video analysis data between the two Swinxsbee games have led us to a post-hoc examination of the other factors that influence social interaction. Our conclusion of this study is that collaboration is needed to achieve a high level of social interaction in a game. A shared object like Swinxsbee is able to evoke cooperation, but should be supported by the right game objectives and rules. Games for Swinxsbee are intended for physical play, but they can also be too focused on the physical objective. The amount of physical exercise in the game Multibee has led to a lower level of social interaction than the other Swinxsbee game. A balance between physical exercise and moments of rest might influence social interaction in a positive way. The game SwinxsCircle showed another game aspect that evoked social interaction. The children are asked to dance and the children use their creativity to dance in a funny way and leads to mimicking and laughing with other players. These game dynamics are aspects that influence social play behaviour and can be used as guidelines for the design of social games. Future research needs to examine the interaction between diverse design decisions such as game rules and other object properties and the amount of social interaction.

For the analysis of social interaction an observation scheme has been constructed. This scheme is based on social interaction theory and other observation methods. The next step is to determine the inter-coder reliability.

The newly designed object and the insights from the study were presented at the client company. They were surprised by the strength of such a simple concept like Swinxsbee. Looking at Swinxs from a player interaction pattern perspective has given them a different approach to design new games for Swinxs. Furthermore they were happy to see that in general Swinxs games scored well on social interaction.

Overall, the study has shown that using the theory of interaction patterns as an inspiration source for the design of play objects can lead to promising extensions to existing designs in terms of influencing levels of social interactions.

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