aMAZEd: Designing an Affective Social Game for Children

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ABSTRACT

This paper discusses a design case, which explores the potential of psychophysiological measures as an input technique for social gaming applications intended for children. aMAZEd is an example of a tabletop mixed reality game that supports social interaction between players through and around the game. It is clear that sensing technology used to obtain psychophysiological measures needs to be improved and there is still a range of solutions that need to be explored. However, our experience shows that psychophysiological input appeals to children and can be a fun element of games supporting social interaction among players.

Keywords

Tabletop augmented reality, children, social gaming, psychophysiological input.

ACM Classification Keywords

H.5.2 [**Information Interfaces and Presentation**]: User Interfaces– *prototyping, user-centered design.*

INTRODUCTION

This paper presents an interaction design exploration into the use of psychophysiological measures as an input technology in social games for children.

Psychophysiological measures pertain to the measurement of physical processes on the human body such as heartbeat, sweating, muscular activity, etc., that can be linked to psychological processes, e.g., stress, engagement, etc. Psychophysiological measures are an essential component of affective computing, defined as computing that relates to, arises from, or influences emotions [9].

Affective computing is a relatively new field, and there is a growing interest in developing novel applications and enabling technologies. This paper explores the potential of affective social gaming applications for children. With the term *social gaming*, we refer to gaming that encourages social interaction spontaneously as part of the game or around the game. Social gaming is attracting a lot of interest as it becomes increasingly clear that a major element of fun for games is social interaction with other players and also because of frequently voiced concerns regarding the negative impact of computer gaming upon the social development of children.

The interest in social gaming is quite recent; companies like Sony release games they describe as "social gaming technologies". Researchers in interaction design have been creating experimental social games for children, e.g., Ely the Explorer [1], Camelot [12], and the Scorpiodrome [6]. Understanding the kinds of social interaction that arises through and around gaming, and how to influence these through game mechanics is a very current question for game design literature, e.g., see Salen and Zimmerman [11, chapter 28].

aMAZEd is a tangible tabletop augmented reality game for children aged 7-11 years: it combines a projected display on a tabletop surface and input through the manipulation of physical objects. There have been earlier attempts to design social tabletop games, e.g., pOwerball [2] which aimed to enhance the social interaction among children with mixed abilities through a mixed reality pinball. In aMAZEd, we aimed to assess the potential and the downsides of psychophysiological measures as an added input modality.

There are relatively few examples of using psychophysiological input in gaming, e.g., [4]. More often such technology is used to measure mental effort, stress, etc. [13, 14]. Psychophysiological data has been used to evaluate fun in game play [5] or even the level of engagement of a child using an educational game [3]. Most applications of psychophysiological measurement are intended for adults; the domain of computer games for children which incorporate real-time psychophysiological feedback is still under-explored.

GAME DESIGN

The game was designed iteratively; numerous game-workshops were set up, in which several children participated. Written consent was acquired from the parents of the children beforehand. We started from existing games,

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gradually introducing and refining game elements that we were considering to include in our game. Play sessions were conducted at one of the children's homes and in coordinating each session 4-5 researchers were involved. Each game session lasted for about 30 minutes and was followed by a short discussion with the children. The main points explored are discussed below.

- **Bluff/Deception.** We assessed how children take bluff on two occasions. First, 20 children aged 7-8 years participated in a session organized at their school, where they played 'Liar's Dice'. Second, two children aged 7 and 8, participated in a session at their home. They played a variation of the popular 'snakes and ladders' board game; here players could bluff regarding their throw of dice. Children enjoyed bluffing and catching each other's bluff and penalties added to the enthrallment. In the second case, bluffing appeared even more attractive than the core of the game, but this is probably because 'snakes and ladders' is more appropriate for slightly younger children.

- **Cooperation/Competition.** Variants of 'PacMan3D' [8] involving competition and cooperation were played with 4 children (7-9 years) who evaluated the game at the home of one of the children. We noticed that the combination of competition and a fast-paced game, lead the children to stop conversing with each other as well as preventing them from getting absorbed in the play. One child even mentioned that playing in different rooms would have felt the same. In the variant involving cooperation, many more social interactions took place: apologizing to teammate for failures, discussing tactics, warning each other etc. Several verbalizations during the game in first plural form, e.g., "we have to win this time", demonstrated their team spirit.

- **Psychophysiological measures.** The 'Journey to Wild Divine' [15] was played with the same two children who evaluated snakes and ladders. The game was based on heart rate measured via sensors attached to the fingertips. The first thing the children said when they played the game was that: "its magic!". The interaction mechanism of breathing to control the game was something different, unique and interesting for them.

Two game concepts were developed based on the afore-mentioned experimentations. One was a variant of 'Ludo' adapted to incorporate bluff and movement inside a home. The other was 'Save the Princess' where the children had to cooperate and find the princess. The two concepts were evaluated on another day that lasted for three hours with the same four children as in the session of PacMan3D. After the play session, we asked children to sort cards depicting the elements of the game, related to fun [10] (see Figure 1). The cards were utilized to direct the flow of the interview and ensure that the children remain focused. The cards illustrated various aspects of the game: cooperation, competition, bluff, the ghost and resources. For Ludo, bluff was ranked as the most enthralling where as a need was expressed for more uncertainty in Save the Princess.

Figure 1. aMAZEd conceptual design game board (left) and interviewing by picture card sorting (right)

A new game was composed by combining elements from Ludo and Save the Princess; this game was again evaluated in another session with the same four children mentioned previously. Apart from evaluating the new game concept, we aimed to evaluate the manner in which psychophysiological measurements could be accessed during the play: a player could obtain the opponent's psychophysiological data by a "ping", i.e. by invoking a single momentary reading for it.

The same four children participated in the next three iterations to finalize the game concept that was called aMAZEd; the board used in these cases is shown in Figure 1. These repeated iterations and testing were aimed at finding the right level of challenge and complexity in terms of the game structure and game rules.

THE aMAZEd GAME and IMLEMENTATION

In the aMAZEd game, the game board is an interactive tabletop, relying on a tangible user interface and the projected display of a maze. The game is played by 4 children, in teams of 2. Players throw a dice and hide it after the throw. They read out the digit on the dice and they may choose to bluff about the number thrown. The Galvanic Skin Response (GSR) and the heart rate of players are measured during the game. An opponent can challenge a throw; players caught bluffing is given a penalty. To help in deciding whether a player is bluffing or not, an opponent can 'ping' this player, obtaining feedback regarding his/her level of arousal estimated from the skin conductivity or the heart rate.

The game itself has three main stages. In the first stage, each player has to reach a specific point on the maze represented by a particular graphic (e.g., a river or a mountain). There are hurdles in the maze; to overcome them both players from a team have to meet somewhere on the maze and then move towards the common resource target. This was the case in the second stage where the teams had to find a palace. The last stage of the game was reaching a specific location on the maze where the princess was shown to be located. The first team to find the princess was the winner. The idea was to enable a particular stage and display the next target resource only if the previous stage was successfully conquered.

The game was implemented on the Visual Interaction Platform (VIP), a tabletop augmented reality platform. VIP

Figure 2. Three levels of Pinocchio

supports interaction through tangible checkers that are tracked in 2D by an infrared vision based system. The game engine was visualized in OpenGL (see www.opengl.org) and C++ on the Visual Studio.NET IDE. Animated 2D/3D sounds and audio feedback were implemented using OpenAL (see http://www.openal.org/).

For measuring the GSR and heart rate, we used the Mobi system [7] (see Figure 3). This is a multi-channel device for obtaining signals such as ECG, EEG, EMG, temperature, force, movements, etc. For viewing and processing of data captured by the Mobi system, we used the Portilab software. We applied different low pass and high pass filters for GSR and heart rate separately. Communication between the Mobi system and Portilab software was executed using a Bluetooth connection. Once the data was processed by the Portilab, it was transmitted to the game engine database.

Psychophysiological output was generated only if there was a ping by a player for heart rate or GSR. In practice, this amounts to an estimation (via thresholds of the heart rate and GSR) of whether a player is lying or not. The confidence in such estimation is shown in just 3 discrete levels, depicted as the character of a Pinocchio with a correspondingly sized nose (see Figure 2).

EVALUATION of THE aMAZEd GAME

An evaluation was set up to answer the following questions:

- Is psychophysiological input used as part of the game or is it ignored?
- Does psychophysiological feedback add to the fun of playing the game?
- Do bluff and psychophysiological feedback encourage social interaction between players?
- How do children react to psychophysiological measurement?

Method

The evaluation involved observation of the play and interviews after the game session. Two researchers acted as observers and two others, ran the interviews and facilitated the game sessions.

Participants

Two play sessions were conducted on two separate days, each involving four children from a school in our region. Written consent was acquired from the parents prior and they remained in the vicinity of the children during the free play session. Children were first interviewed as a group and then individually. The interview involved a card sorting exercise; children ranked the elements of the game with regards to fun (see [10]).

Procedure

Each evaluation comprised of two test sessions. The first session comprised of testing the aMAZEd game without the psychophysiological element. The session started with the introduction of the general game rules. After that, the children were given a free play session on the game board itself to ensure that they understood the game rules and could play without any assistance from the facilitator.

The second session started with an introduction of the second version of the aMAZEd game that incorporated psychophysiological feedback. The children were shown how to inspect if other players were bluffing (via pinging) by using a trackable square block and placing it on an appropriate button/icon on the game board. Heart rate, skin conductivity and the bluff estimation were iconically presented on the game board by a bigger heart, more droplets of sweat and varying nose sizes of Pinocchio respectively. Baseline measurement for heart rate and skin conductivity was taken for all players before they started the trial session of the game.

Findings

The children enjoyed catching others bluffing and escaping from being caught after bluffing. They pointed out that bluff was good because they could defeat their opponents. After a few rounds in the first game-play session, the children developed their own tactics to detect bluff. For instance, a throw was deemed a bluff if, the opponent would take too long to read the dice or if he/she would squirm when observed/stared at, etc. For instance, when one player bluffed the opponent said, “You have a look on your face that makes it obvious”.

From our observations and interviews, it was evident that children had no problem in interpreting the presentation of the psychophysiological output. They mentioned that they understood the cartoon like representations. Overall, during the card sorting, six children ranked pinging (the card that showed Pinocchio with the longest nose) in the top three fun elements. One player commented, “It’s really magic, I was not sure that Feddrick was lying or not even after looking into his eyes but the long Pinocchio nose helped in guessing and it worked.”

Social interaction occurred in the form of cooperation and competition within and between the teams respectively. Sometimes due to their partner’s erroneous judgment the children would lose a turn, yet they still enjoyed playing together and cooperating. From our observation, it was determined that the children supported each other as a team while searching for resources, finding the shortest way to reach their target, etc.

Children complained regarding the ergonomics of the Mobi device. They found the tethered heart-rate earplug heavy and even painful on their ears (see Figure 3).

Figure 3. Snapshot from a play session (left) and the Mobi system (right)

The children had mixed opinions regarding the accuracy of the Mobi system. Some suggested that psychophysiological measurement should not be totally accurate. When the Mobi system was working more or less flawlessly one child said, "sometimes it was too good and I won continuously three times." Another child said "Its better that it does not always work, I will not use it if it is 100% accurate". Another child did not use the system for checking bluff even after several tries; rather he preferred to look at his opponent in the eyes. In addition, children had the feeling that their opponent could cheat and fake the Mobi system and consequently did not always trust the reading from the device. However, further into the game play, some children built up a dependency to the system. For instance, one child said, "Where is the thing (the square block used for 'pinging'?) I think I need the thing".

A positive aspect of the entire game play process was the uncertainty. Suspense was rendered via various factors such as, imprecision in the psychophysiological readings (just three levels), uncertainty of the appearance of resources on the game board and uncertainty of the hidden resources in the environment.

DISCUSSION

From the evaluation results, it is clear that bluff and psychophysiological readings were experienced as fun, and that they enhanced the social interaction between players. While turn taking inherent in various board games can be boring as players have to wait for their turn, this was not the case in aMAZEd, where players were engaged even when it was not their own turn.

Psychophysiological measurement is promising but a lot more experience needs to be gained for learning how to use it in games and to find which measurements should be used and when. In the context of gaming, future research should focus on the design of appropriate visualizations of psychophysiological data and reaching the right balance between the accuracy and precision of the displayed values. Finally, more unobtrusive and children-appropriate hardware needs to be developed.

CONCLUSION

We have presented the design of an affective tabletop game for small groups of children. The study is a first exploration of psychophysiological feedback as an element in games for children. It shows some promise for this technology combined within the context of social gaming and sets some challenges for future research in this domain.

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