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## **Exploring User Experience in Game Using Heart Rate Device**

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### **ABSTRACT**

*In this paper we describe our experience using psycho physiological techniques to explore user experience in playing games. We used heart rate devices to measure the user experience during a simulation game play called The Sims™ 3. This study does not emphasize the measurement of data, but focuses mainly on experiences in applying a psycho physiological method to capture user experience while playing games. We measured selected participants' heart rates using a heart rate detector while playing a game. The majority of participants had an average of 60-90 bmp heart rates (HR). Our analysis revealed that there was no difference in HR between novice and non-novice players, but that HR had mostly similar patterns amongst the players throughout the game-playing experiment. HR was higher during the interesting or fun activities or tasks. We end by discussing lessons learnt and issues identified in the experiment which are useful for future enhancement.*

*Keywords: user experience, game play, human-computer interaction, heart rate device.*

### **1. INTRODUCTION**

Evaluation of user experience has been addressed recently in several publications and workshops (Gajadhar et al., 2008; Vaataja & Roto, 2009; Vermeeren et al., 2010; Korhonen et al., 2010; Takatalo et al., 2011). However, the measuring of game experiences is not like evaluating applications in business and software industry. Productivity and gaming applications clearly have very different goals and it is not sufficient to focus exclusively on usability-related metrics (IJsselsteijn et al., 2007). Since games are played for the experience, they are hard to study and understand with traditional usability methods that are typically applied in the field of human-computer interaction (HCI) (Takatalo et al., 2011).

Recently, psycho physiological measures have gained some attention in digital game research and have been used to measure player experience in game genres (Kivikangas et al., 2010; Gualeni et al., 2012). Nacke et al. (2011) claims there has been increased commercial interest in using physiological input in digital games, not only for biofeedback training, but also to enhance immersion and engagement for players. Using physiological sensors such as heart rate (HR), galvanic skin response (GSR), cardiovascular measures, and electromyography (EMG), as a replacement for the game controller have been used to measure user emotion during interactions with gaming systems (Nacke et al., 2011). Psychophysiological methods have become more popular in game research as reliable measures of players' affective experience, emotions and cognition (Drachen et al., 2010). The cardiovascular system offers a variety of measuring options to determine valence or arousal, including Heart Rate (HR). Measurements of

electrodermal activity (EDA) and heart rate (HR) allow us to make inferences about player arousal (i.e., excitement) and are easy to deploy (Drachen et al., 2010).

In this paper we describe our experience using psycho physiological techniques for exploring user experience in playing games. In the experiments reported, we used heart rate to measure user experience while playing the simulation game called *The Sims™ 3*. We also discuss related work and prior research which used psycho physiological measurements to measure player experience in game genres including the use of heart rate devices.

## **2. LITERATURE REVIEW**

A review of the use of psycho physiological methods in game research (Kivikangas et al., 2010) explains the theory behind the method and presents the most useful measures. From their review, Kivikangas et al. (2010) concluded that the use of psycho physiological measurements provides an objective, continuous, real-time, non-invasive, precise, and sensitive way to assess the game experience, but for best results it requires carefully controlled experiments, large participant samples and specialized equipment.

Prior research has been carried out on capturing entertainment through heart rate (Yannakakis et al., 2006, 2008; Yannakakis & Hallam, 2007; Nenonen et al., 2007; Drachen et al., 2010; Gualeni et al., 2012). Previous work by Yannakakis et al. (2008) used children's heart rate (HR) signals for capturing and modelling individual entertainment ("fun") implemented on an interactive physical playground inspired by computer games. The statistical analysis shows that the children's reported entertainment preferences correlate well with specific features of the HR signal. Nenonen et al. (2007) used real-time heart rate information to control a physically interactive biathlon (skiing and shooting) computer game. They presented a prototype of a computer game that uses a novel heart rate interaction method. The results showed that heart rate interaction is fun and usable.

More recently Gualeni et al. (2012) used heart rate to measure the relative stress level provoked by casual games. They claimed that an increase in players' heart rate caused a higher stress experience while playing the game. Drachen et al. (2010) reported a case study on HR correlations with subjective gameplay experience in the context of commercial game development. They claimed that the measurements of heart rate (HR) allow making inferences about player arousal (i.e., excitement) and are easy to deploy. Their results indicated that physiological measures correlate with gameplay experience components (Drachen et al., 2010).

Instead of heart rate (HR), physiological sensors such as galvanic skin response (GSR), electromyography (EMG), electrocardiography (EKG), respiration (RESP) and temperature sensor (TEMP) have also been used to sense the physiological response from users. Electromyography (EMG) describes the measurement of electrical activation of muscle tissue. While facial EMG is used in emotion detection, EMG has also been used to sense muscle activation as a more direct form of input (Nacke et al., 2011). Electrodermal activity (EDA) or galvanic skin response (GSR) is a common psycho physiological measurement with easy applications. GSR is associated with emotional arousal (Kivikangas et al., 2010) and has also been proposed for potential entertainment augmentation in computer games (Tognetti 2010). According to Kivikangas et al., (2010), EDA data can be analysed as skin conductance level (SCL), an aggregate over a certain period of time, or number or amplitude of discrete skin conductance responses (SCR) to a specific phase or event. Electrodermal responses are slow (delay of one to

four seconds), but in general, EDA is less sensitive to noise and less ambiguous than facial muscle and heart activity.

Using psycho physiological data to understand users' interaction with systems is still quite new and a lot more needs to be done in terms of determining what combinations of psycho physiological data of a user imply what type/level of engagement or usability. Mapping between users' biological response and user-interface features is an ambitious goal but as more and more researchers explore different ways to experiment and interpret the data, it is expected to become a significant clue and instrument to measure the value of designed interfaces.\

### 3. USER EXPERIMENT

The objective for the experiment is to use a heart rate device to explore user experience while playing games. We observed participant's reactions while playing The Sims 3 computer game. The Sims 3 is a type of 'simulation' game or 'real life' game genre and its main purposes is creating and controlling virtual characters in a virtual world (Albrechtslund, 2007).

#### Participants

Thirty five (22 female, 13 male) computer science and multimedia students were recruited from the Faculty of Information Science and Technology, Universiti Kebangsaan Malaysia. The average age was 22, ranging from 20 to 28 years old. All participants were frequent computer users.

#### Procedure and Measurement

All participants filled out a background questionnaire, which was used to gather information on their computer use, general computer experience with The Sims game, and demographic data such as age and gender. After the experiment, the instrument asked about what they liked about the game and their experience with the game, including player satisfaction and overall comment about the game experiment. Participants were divided into novice and non-novice according to the demographic background and experiences in playing the game. In this experiment, the Sims 3 game options were chosen (e.g. 'free will' option was turned off) so that the participant could play in the same environment (see Figure 1 for a screen shot).



FIGURE 1: Screen shot of The Sims™ 3

All participants were introduced to The Sims game and a short tutorial was given before the experiment started. During the experiment, they were given an information sheet about the game and a list of controls. We provided three experiment tasks: 1) create a Sims character (e.g. set personality, gender etc.); 2) decorate the house (e.g. design and buy furniture); and 3) fulfill and monitor the Sims basic needs (e.g. hunger, bladder, energy etc.). The participants created their own Sims character and built the Sims' virtual house.



FIGURE 2: Garmin Forerunner 610 Heart Rate Monitor Watch

The experiment took place in a silent room where only one participant and one researcher were present. For the physiological measures, the Garmin Forerunner 610 sports watch with HR monitor, and a touch screen GPS-enabled watch that supports customizable data screens was used (see Figure 2). The Garmin device measures HR by means of a wireless heart-rate monitor strapped around the chest of the test subject. Participants had to wear the Garmin device before they started playing the game. Participants were given 45 minutes to play the game. In addition to the physiological measurements, the participants and the computer screen were video-recorded for analysis. The video footage during the experiment captured participants' facial expressions while Camtasia Studio software was used to record their interaction with the screen. Figure 3 shows one participant during the experiment.



FIGURE 3: (Left) Screen capture of current game activities, (Middle) player's face reaction and (Right) Biometric results using heart rate device.

#### 4. RESULTS AND DISCUSSION

The ethnicity of the participants was primarily Malay (63%), followed by Chinese (30%), Indian (3%) and others from Indonesia and the Middle East (14%). All participants had some prior experience in playing computer games. The average time participants had spent playing computer games ranged from one to two times a year (29%), once a month (34%), once a week (20%) and everyday (17%). Only eight participants reported experience playing The Sims game. Most of them had no prior experience with The Sims (77% novice, 23% non-novice). The details of demographic information are shown in Table 1.

TABLE 1: Demographic profile.

<i>Demographic profile</i>	<i>Men (n = 13)</i>	<i>Women (n = 22)</i>	<i>Total (n = 35)</i>
<b>Age</b>			
20-24	9 (69.23)	19 (86.36)	28 (80.0)
25 above	4 (30.77)	3 (13.64)	7 (20.0)
<b>Race</b>			
Malay	4 (30.77)	18 (81.82)	22 (62.86)
Chinese	4 (30.77)	2 (9.09)	6 (17.14)
Indian	1 (7.69)	1 (4.55)	2 (5.71)
Others	4 (30.77)	1 (4.55)	5 (14.29)
<b>Frequency of Playing PC Game</b>			
Everyday	4 (30.77)	2 (9.09)	6 (17.14)
Once a week	7 (53.85)	2 (9.09)	9 (25.71)
Once a month	2 (15.38)	8 (36.36)	10 (28.57)
1-2 a year	1 (7.69)	9 (40.91)	10 (28.57)
<b>The Sims game experience</b>			
Non-Novice	5 (38.46)	3 (13.64)	8 (22.86)
Novice	8 (61.54)	19 (86.36)	27 (77.14)

Figure 3 shows the results of participants' own assessments on the task performed during the experiment.

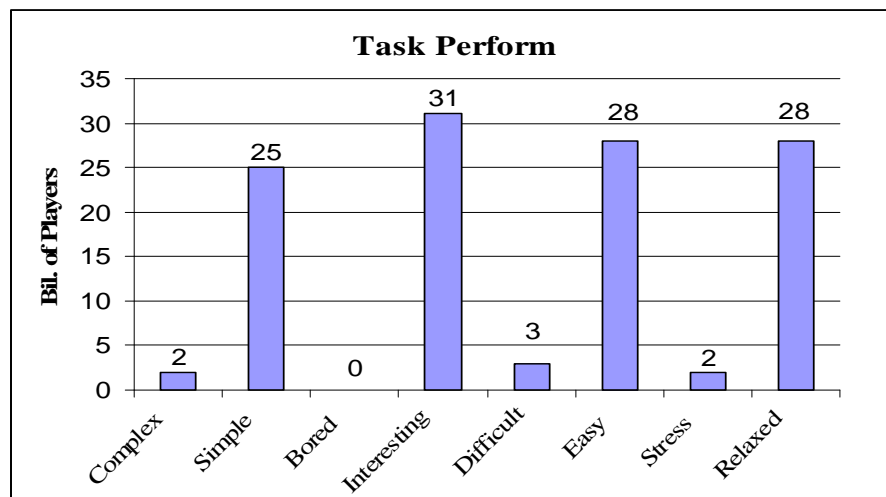


FIGURE 3: Results for performed task



Most of the participants (89%, n= 31) felt that the game was interesting and they enjoyed the task given. 80% (n=28) of participants felt relaxed while playing the game. Only a few participants perceived that the task was complex, difficult and stressful. None of them felt bored.

Due to some limitations in the use of the heart rate detector as described in Section 3, we only managed to measure the heart rates of selected participants (7 females and 12 males) out of the total thirty five participants. A majority of participants recorded an average heart rate (HR) of 60-90bpm. Our analysis revealed that there was no difference in HR between novice and non-novice players, but that HR had mostly similar patterns amongst the players throughout the game playing. For example, HR was higher during interesting or fun activities as identified by the researcher. Mandryk & Inkpen (2005) claim that a positive play experience will generate higher heart rates.

From the results, we discovered that players have a higher HR at the beginning of the game which might indicate their excitement to start the game (see Figure 4). In order to understand further the individual differences of HR, we analysed the current stage of the game each user was engaged in relation to the HR. The HR pattern for each participant seems similar to each other, but their current game activity stages were different. Participants enjoyed playing the game in different ways. For example, there were participants who really enjoyed the game during Task 1 (i.e. create a Sims character), some of them enjoyed Task 2 (i.e. decorate the house) and some of them enjoyed Task 3 (i.e. interact with the Sims; fulfill the Sims' basic needs). From observation, a majority of novice users liked to spend more time on Task 1 and 2, and less time on Task 3. Novice users tended to decorate and construct items for the house. Flanagan's (2003) work on feminization and The Sims game culture noticed that most new Sims players spent hours (and usually days) in creating a Sims's character and decorating the house.

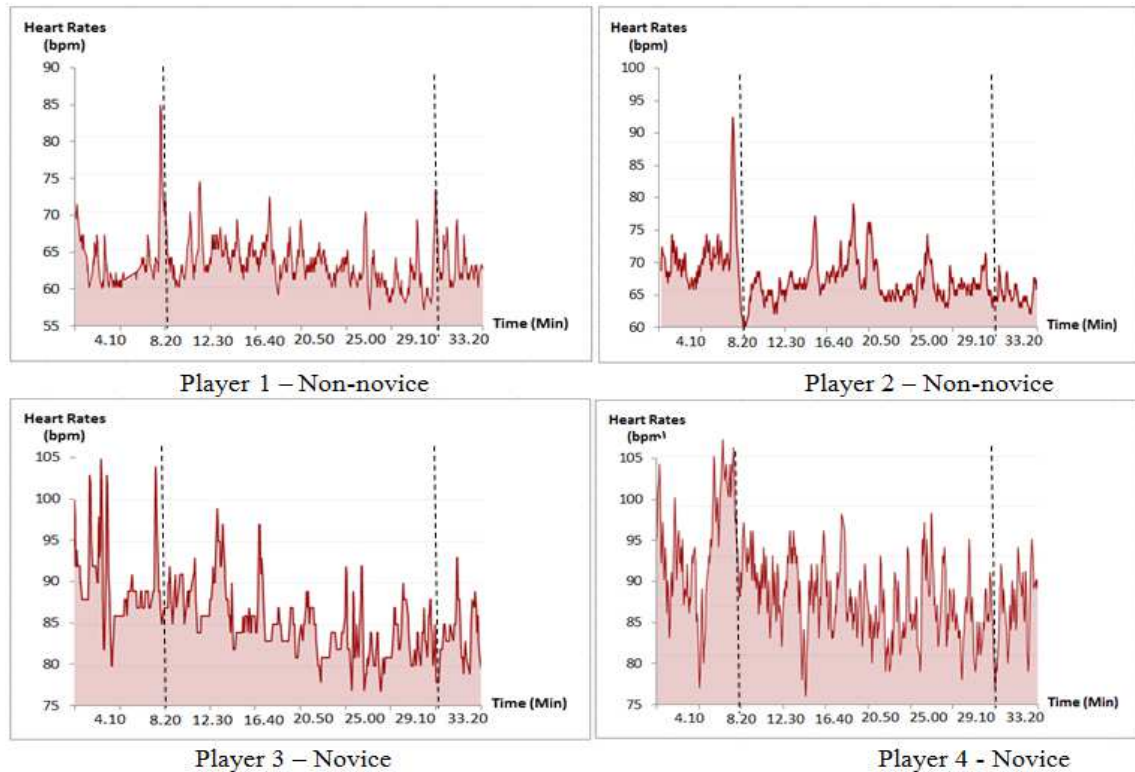


FIGURE 4: Heart rate split by different players (non-novice/novice players)

However despite these psycho physiological results, there were a number of issues that might have influenced the results in this experiment. Ganglbauer et al. (2009) mentioned in their study that implementing psycho physiological methods in measuring user experience needs to be done carefully due to the many factors that can affect the results. They claim that the temperature and humidity of the room, individual user differences, differences in gender (women even differ depending on the menstrual cycle), age, time of the day, consumed stimulants such as coffee or energy drinks, medications, drugs, etc. can cause different reactions in people thus in the sensor data obtained from them. We particularly noticed that the HR (bpm) patterns showed bigger differences among those from the Middle East and Malaysian players. We further investigated and noticed that these participants with higher bpm were smokers. However, there are many other factors that might have affected individual HR (bpm) patterns.

The results reported in this section did not cover all participants as we introduced the device to random participants (7 females 12 males). Not all participants used the device especially females as it had to be worn inside their clothes. Thus, we could not measure the metrics accurately. Our intent was to explore the use of devices in measuring user experience. Issues such as heart rate measures, recruiting people to wear the device and in accurate reading data should be carefully considered in future work. We need better and more robust measuring systems or equipment.

## 5. CONCLUSION

We used a device to measure the heart rate during our experiment to explore user experiences while playing a digital game. Based on our initial experience we believe that psycho physiological methods are as applicable in the gaming and entertainment industry, as during gameplay. We attempted to explore how the game players' heart rate and their subjective assessments relate to the overall experiences of playing the games. This shows that using psycho physiology device could be helpful in identifying specific states of user interaction in any experiment. We will further explore the relations between game players' experiences and their psycho physiological responses from larger sample sizes and perform more in-depth analysis on different types of data using a more robust measuring system.

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