

PLAY EXPERIENCE ENHANCEMENT USING EMOTIONAL FEEDBACK

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ABSTRACT

Abstract less than or equal to 1 page one page stating what the thesis is about highlight the contributions of the thesis

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LIST OF ABBREVIATIONS

TT	Thought Technology
GSR	Galvanic Skin Response
EMG	Electromyography
HR	Heart Rate
BVP	Blood Volume Pulse
EDA	Electrodermal Activity
HCI	Human Computer Interaction
AV	Arousal/Valence
NPC	Non-Player Character
Mod	Modification
CSV	Camma Separated Values

CHAPTER 1

INTRODUCTION

Since computers are playing a significant role in our daily life, the need for a more friendly and natural communication interface between human and computer has continuously increased. Making computers capable of perceiving the situation in terms of most human specific factors and responding dependent to this perception is of major steps to acquire this goal. If computers could recognize the situation the same way as human does, they would be much more natural to communicate. Emotions are of important and mysterious human attributes that have a great effect on people's day to day behavior. Researchs from neuroscience, psychology, and cognitive science, suggests that emotion plays critical roles in rational and intelligent behavior [16]. Apparently, emotion interacts with thinking in ways that are nonobvious but important for intelligent functioning [16]. Scientists have amassed evidence that emotional skills are a basic component of intelligence, especially for learning preferences and adapting to what is important [13, 8] People used to express their emotions through facial expressions, body movement, gestures and tone of voice and expect others understand and answer to their affective state. But sometimes there is a distinction between inner emotional experiences and the outward emotional expressions [15]. Some emotions can be hard to recognise by humans, and inner emotional experiences may not be expressed outwardly [9]. Recent extensive investigations of physiological signals for emotion detection have been providing encouraging results where affective states are directly related to change in inner bodily signals [9]. However whether we can use physiological patterns to recognise distinct emotions is still a question [16, 4].

Although the study of affective computing has increased considerably during the last years, few have applied their research to play technologies [22]. Emotional component of human computer interaction in video games is surprisingly important. Game players frequently turn to the console in their search for an emotional experience [18]. There are numerous benefits such technology could bring video game experience, like: The ability to generate game content dynamically with respect to the affective state of the player, the ability to communicate the affective state of the game player to third parties and adoption of new game mechanics based on the affective state of the player [22]. This work concentrates on developing a real-time emotion recognition system for play technologies which can quantify player instant emotional state during a play experience The rest of the paper is organized as follows: in Section 2 we outline different emotion recognition theories with an overview of physiology sensors. In Section 3 we demonstrate some implementation details of the system. We then describe the experimental setup in Section 4 before giving

our results in Section 5. Finally, we give conclusions in Section 6.

CHAPTER 2

HUMAN AND PLAY TECHNOLOGIES

2.1 Affect and Emotion

Using emotional responses to increase the level of users interaction with a real-time play technology requires an effective technique to identifying specific emotion states within an emotional space. Major existing emotion models in the psychology literature includes: basic emotion theory [6, 7], dimensional emotion theory [10, 19] and models from appraisal theory (e.g., [17]) [24]

Basic emotion theory identifies anger, disgust, fear, happiness, sadness, and surprise [14] as the concise set of primary emotions. These are actually the least six universal categories researchers agreed upon [23]. It also claims these primary emotions are distinguishable from each other and other affective phenomena [5]. On the other hand dimensional emotion theory argues that all emotional states reside in a two-dimensional space, defined by arousal and valence.

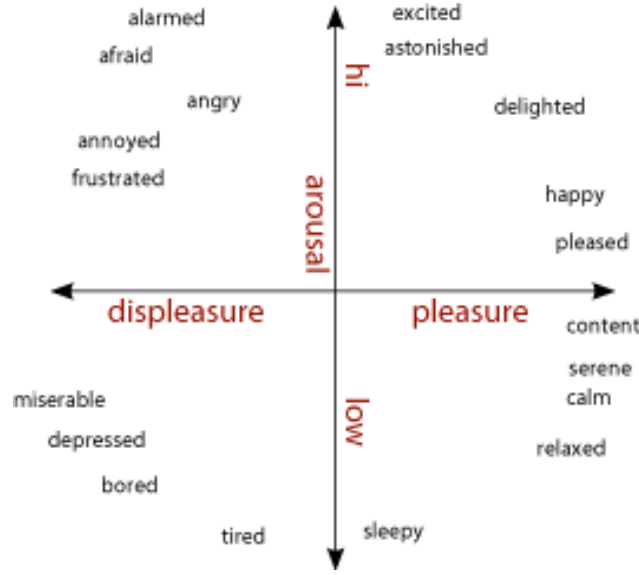
While there are various opinions on identifying emotional states, classification into discrete emotions [5], or locating emotions along multiple axes [20, 10], both had limited success in using physiology to identify emotional states [3].

Lang used a 2-D space defined by arousal and valence (pleasure) (AV space) to classify emotions [10]. Valence can be described as a subjective feeling of pleasantness or unpleasantness while arousal is the subjective state feeling activated or deactivated [1]. Using an arousal-valence space to create the Affect Grid, Russell believed that arousal and valence are cognitive dimensions of individual emotion states. Affect is a broad definition that includes feelings, moods, sentiments etc. and is commonly used to define the concept of emotion [15]. Russell's model has two "axes" that might be labeled as displeasure/pleasure (horizontal axis) and low/high arousal (vertical axis) It is not easy to map affective states into distinctive emotional states, However these models can provide a mapping between predefined states and the level of arousal and valence [23], Figure 2.1.

Both mentioned models for identifying emotions convey some practical issues in emotion measurement. In a HCI context, the stimuli for potential emotions may vary less than in human-human interaction (e.g., participant verbal expressions and body language) [24] and also the combination of evoked emotions [14]. However with help of physiological signals and the fuzzy logic in the model we are going to use, such issues

¹Photo credit: <http://imagine-it.org/gamesurvey/>

Figure 2.1: Russell’s circumplex model with two axes of arousal and valence ¹.



with our dimensional emotion models would be minimized. Though it is anticipated to observe different range of evoked emotions while interacting with play technologies compared to interacting with other humans in daily life. [24]. However our dimensional emotion models suffers some other problems. One problems is that arousal and valence are not independent and one can impact the other [12]. Continuously capturing emotional experiences in this applied setting is of its other hallmarks. Subjective measures based on dimensional emotion theory, such as the Affect Grid [20] and the Self-Assessment Manikin [2], allow for quick assessments of user emotional experiences but they may aggregate responses over the course of many events [24]. This work uses Mandryk et al. version of AV space [12].

2.2 Measuring Affect

2.3 Affect and Play Technologies

2.4 Real Time Game Adaptation

Playing video games as a kind of entertainment would help people to have new internal experiences. The virtual world of video games let adults to play as new rolls and enjoy filling their heads with new thoughts and emotions. Some people value the sensation

Games are opportunities for development and design of environments therefore the player can interactively experience various emotions and mental conditions. This interactive experience in contrast to cinema and other major types of entertainment is what makes them exceptional

CHAPTER 3

CUSTOMIZING PLAY EXPERIENCE IN REAL-TIME

3.1 Adaptive Game Design

3.1.1 Player

3.1.2 NPCs

3.1.3 Environment

3.2 Physiological Signals

3.2.1 Heart Rate

3.2.2 Galvanic Skin Response

3.2.3 Facial Electromyography

3.3 Real-Time Affect Engine

3.3.1 Fuzzy Logic for Space Transformation

3.3.2 Physiological Signals to Arousal and Valence

CHAPTER 4

IMPLEMENTATION AND INTEGRATION

4.1 Recognizing Emotion

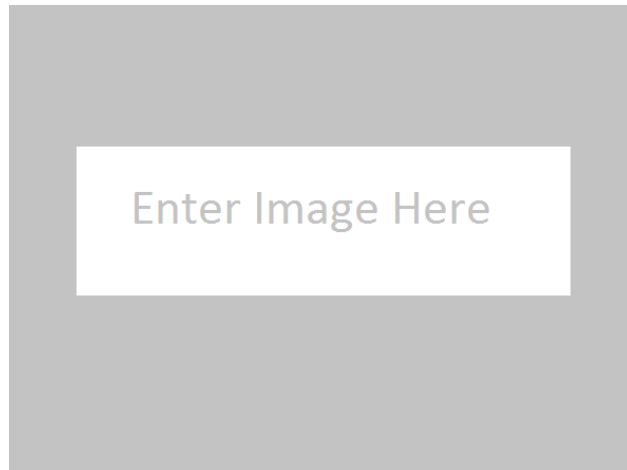
Heart rate (HR), blood pressure, respiration, electrodermal activity (EDA) and galvanic skin response (GSR), as well as facial EMG (Electromyography) are of physiological variables correlated with various emotions most. Interpreting physiological measures into emotion state can be difficult, due to noisy and inaccurate signals, however recent on-going studies in this area by Mandryk and Atkins [12] presented a method to continuously identifying emotional states of the user while playing a computer game. Using the dimensional emotion model and the fuzzy logic, based on a set of physiological measures, in its first phase, their fuzzy model transforms GSR, HR, facial EMG (for frowning and smiling) into arousal and valence variables. In the second phase another fuzzy logic model is used to transform arousal and valence variables into five basic emotion states including: boredom, challenge, excitement, frustration and fun. Their study successfully revealed self-reported emotion states for fun, boredom and excitement are following the trends generated by their fuzzy transformation. The advantage of continuously and quantitatively assessing user's emotional state during an entire play by their fuzzy logic model is what makes their model perfect to be incorporated with real-time play technologies. Therefore exposing user's emotional state as a new class of unconscious inputs to the play technology.

4.2 Affect Engine

Affect Engine is the software unit developed to transform collected physiological data to their equivalent emotional state in real-time. While it is generally agreed that emotions comprise three components: subjective experience (e.g. feeling joyous), expressive behavior (e.g. smiling), and physiological activation (e.g. arousal) [21], Affect Engine provides a framework for transformation of physiological activations and some expressive behaviors. Affect Engine consists of four major components (Sensor Module, Fuzzification Module, Administration Panel and Engine Proxies), Figure ?? is a schematic view of these components working together.

At the following a brief description on these components is provided.

Figure 4.1: Affect Engine



4.2.1 Sensor Module

The sensor module consists of a Thought Technology ProComp Infinity encoder [11] Figure 4.2, connected to PC with a USB cable, SensorLib as the basic application programming interface (API) receives raw physiological inputs from the encoder driver and provides functionalities to apply different filters such as low-pass, high-pass, smoothing and shifting to the signal.

Figure 4.2: Thought Technology ProComp Infinity encoder



4.2.2 Fuzzification Module

Then filtered signals are fuzzified by the use of a set of fuzzy rules in the first phase of transformation. Then generated arousal and valence values are transformed into emotion values using another set of fuzzy rules in the second pass [12]. A sample set for fuzzy rules used in the first and the second phase can be found in Appendix A and B. Applications such as games can easily integrate the system where emotion recognition can offer adaptive control to maintain user interest and engagement. Once connected via sensors to the emotion recognition system, the affective state of the user can be captured continuously and in real-time and it can be monitored on a displayed 2-dimensional graph of valence and arousal, Figure 1.

4.2.3 Administration Panel

Figure 4.3: Administration Panel



4.2.4 Engine Proxies

4.3 Sensors

Currently the system uses Blood Volume Pulse (BVP), Galvanic Skin Response (GSR) and Electromyography (EMG; for frowning and smiling), to classify human affective states in 2-dimensional valence/arousal space, Figure 2. The system has three modules, Figure 4:

The Blood Volume Pulse (BVP) signal is a relative measure of the amount of blood flowing in a vessel. From BVP we calculated heart rate and heart rate variability. The heart rate is known to reflect emotional activity and has been used to differentiate between both negative and positive emotions as well as different arousal levels [11] The Galvanic Skin Response (GSR) sensor to measure the skin's conductance (between two electrodes and is a function of sweat gland activity and the skin's pore size). As a person becomes more or less stressed, the skin's conductance increases or decreases proportionally [15].

4.3.1 Heart Rate

4.3.2 Galvanic Skin Response

4.3.3 Facial Electromyography

4.4 Inegration with Valve Source Engine

4.4.1 Level Design

4.4.2 The Director

CHAPTER 5

EXPERIMENTATION

5.1 Introduction

5.2 Experiment

5.3 Participants

Data were recorded from 15 male and 1 female University students, aged between 18 and 32 ($M = 25.00$, $SD = 3.875$). As part of the experiment procedure demographic data were collected with special respect to the suggestions made by [?]. Of the participants 94.1% were right-handed. 41.2% of participants rated their computer skills as Advanced while the rest of 58.8% rated their skills as Intermediate. 35.3% of participants have described themselves playing video games every day, while 41.2% of them described themselves playing video games a few times per week and 17% have been playing video games a few times per month and the rest of 5.9% have been playing video games a few times per year. All participants have used PC as gaming system while 76.48% of them also have used at least one of the four popular console platforms (XBox360, PS3, PS2, Wii) for gaming. All of participants had at least some experience with 3D shooting games like First Person Shooters. 47.1% have described themselves playing 3D shooting games many times, while another 41.2% described themselves as experts in 3D shooting games; Only a total of 11.8% had limited or intermediate experience with 3D shooting games. Among the participants only 5.9% had intermediate experience in using mouse in games, 35.3% of them declared using mouse in games for many times and other 58.8% of them described themselves as experts in doing that.

5.4 Design

A four condition (standard, player, NPC, environment) play session was employed to evaluate performance and excitement as dependent variables. The order 4 Latin square used to permute conditions between participants was as the following:

a b c d
b c d a

c d a b
d a b c

at the start of the play session, they were required to press one of the four buttons on the entrance ramp labeled 1 to 4, and when any one of these buttons were pressed, the Affect engine started calibrating players signals for 60 seconds, during the calibration mode, no adjustment to any of game parameters is applied, no matter which condition is being played. After the one minute of calibration the system decides the standard range of signal for player's excitement value. After that except for the condition number 1 which is the no adaptation mode, the captured excitement value is normalized in the calibrated player range of excitement into a value between 0 and 1, and this value is then used to adjust the game parameters, this process of capturing, adjusting and applying the signal value would continue for 3 minutes until the next cycle of calibrating and adjustment starts. The player is required to play every condition for at least 5 minutes to ensure capturing of a complete cycle of calibrating and adjustment. After playing each condition, the player is asked to rest for 7 minutes, during this time the player is asked to fill out between condition questionnaires, which tries to ask the participant to self-estimate his affect level. The Player Mode is labeled as condition number 2, the NPC mode is labeled as condition number 3 and the Environment mode is labeled as condition number 4. From the 17 participants in this study, one has been lacking adequate level of expertise and therefore was unable to continue doing the required tasks at the expected level and therefore his results was not usable for this study. The image of signal values for this participant is depicted at the following:

5.5 Procedure

The experiment was piloted with six participants (2 female). Pilot participants were selected from the Interaction Lab at the University of Saskatchewan, their comments on different mechanisms and online questionnaires of the experiment were reviewed to make participant more comfortable and less intervened during the experiment. Also pilot participants physiological data was recorded to confirm the functionality of the system during the experiment.

All experiments were conducted on weekdays, with the first slot beginning at 11:00h and the last ending at 18:30h. Participants were contacted to choose their preferred time slots while general time for one experimental session was 1:30 hours with setup and cleanup. Participants were invited to a laboratory, after a brief introduction of the experimental procedure, and becoming aware of the data being collected during the session, they were asked to fill out and sign informed consent form, this was the only paper form used during the experiment. Then the GSR sensors were attached to participant's hand.

Attached GSR sensors wired to the signal decoder brings limitations for participants while moving and using their hand. To diminish noisy signals and make participants feel comfortable under these limitations, the GSR sensors were attached to the hand that was handling the mouse during the game. While fingers dealing with mouse were quite steady compared to the other hand handling the keyboard, those fingers used

to press the left and right mouse buttons were usually most comfortable ones for attaching GSR sensors. Some participants used index and middle fingers to press mouse buttons and others used index and ring fingers to do that 5.1.

Figure 5.1: GSR sensors attached to index and middle finger of participant’s right hand



Having GSR sensors attached, participants were seated in a comfortable office chair, which was adjusted according to their individual height. They were then led to fill out the initial game demographic questionnaire. To keep GSR sensors attached during the experiment, all questionnaires after attaching GSR sensors were filled out using mouse and the same computer system. After the demographic questionnaire, participants were asked to self-assess their arousal, valence and dominance level using the self assessment manikin (SAM) questionnaire [?]. Filling initial questionnaires after attaching GSR sensors was meant to give enough time (approximately 5 minutes) to the participant to get used to the sensors before playing the game. Participants then have been taken to a tour in the game. Different game mechanics were shown to them, and they were given about 1 minute, dependent to their experience, to make themselves comfortable with it. Some participants didn’t need this time due to prior experience and asked to skip that. Then, participants played four different game conditions described before. Participants were not told about the differences between conditions. Each game condition was set to take 5 minutes. After each condition, participants were asked to write their comments about particular changes they noticed under that condition and its effect on their gameplay. Then they were asked to filled out the intrinsic motivation inventory (IMI) questionnaire, the player experience of need satisfaction (PENS) questionnaire and the game engagement questionnaire (GEQ) to rate their experience. Filling the questionnaires between conditions was done during the minimum 7 minutes of resting time before the next condition begins. The resting time was meant to restore players baseline signals. GSR sensors were recording players signals during both the play and the resting sessions from the beginning of the first condition to the ending of the last condition. After completion of the experiment, sensors were removed. Participants were debriefed and compensated \$15 Canadian dollars and escorted out of the lab.

5.6 Materials and Measures

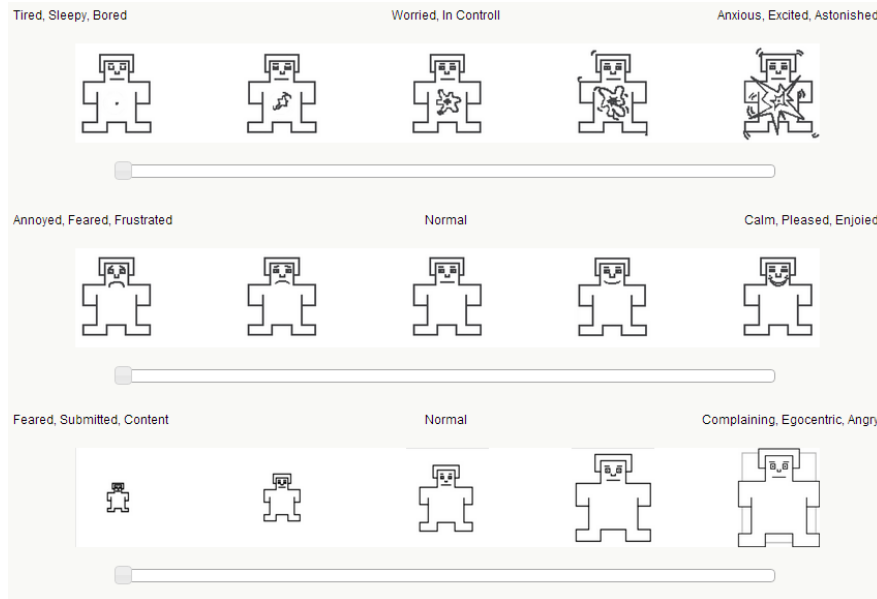
5.6.1 GSR

5.6.2 Subjective Measurements

Participants were assessing their experience under different conditions, using four online questionnaires. FluidSurveys was used to host the questionnaires.

Self-Assessment Manikin After each condition participants were asked to rate the condition using 5-point Self-Assessment Manikin (SAM) [2] scale for arousal, valence and dominance. @FluidSurveys Multiple Choice widget was modified to include the SAM scales. Figure 5.2 shows the arousal, valence and dominance scales used.

Figure 5.2: Self-assessment manikin for arousal, valence and dominance used after each condition and before the first condition



Intrinsic Motivation Inventory Different components of game experience were measured using the Intrinsic Motivation Inventory questionnaire [?]. It combines several game-related subjective measurement dimensions: interest/enjoyment, perceived competence, effort and felt pressure and tension while playing the game. Each one of these components consists of ?? question items (e.g., “While playing, I was thinking about how much I enjoyed it” is a interest/enjoyment component item). Question items were shown in a randomized order every time the page was viewed. Each question item consists of a statement on a five-point scale ranging from 1 (strongly disagreeing with the statement) to 5 (strongly agreeing with the statement). The questionnaire was developed based on survey studies [?].

Player Experience of Need Satisfaction

Game Engagement Questionnaire An image of a regular participant signal values is depicted at the following. In this image from left to right the light blue line shows different conditions being played, and when the light blue line is declining towards its base value, that is the period that participant is asked to stop playing and instead relaxing and filling out the questionnaires. The blue line is the normalized GSR signal value of the participants which is used as an estimation of his excitement level. The yellow green and pink lines are showing the three different modes of Player, NPC and Environment parameters being adapted

Following image is the GSR signal of players playing different conditions from 1 to 4. From left to right the conditions are the Default, Player, NPC and the Environment mode. This signals are all based to an initial start value of 100, during the play experience, some of them had gone bellow the start point and some other had risen above that. Also the start time for each different condition is shifted 500 seconds times the number of condition, from 0.

The following image is the average of GSR values for players in four different conditions from left to right: Default, Player, NPC and Environment modes

5.7 Results

CHAPTER 6

DISCUSSION

5 to 10 pages talk for the discussion State what you've done and what you've found Summarize contributions (achievements and impact) Outline open issues/directions for future work

REFERENCES

- [1] Lisa Feldman Barrett. Discrete emotions or dimensions? the role of valence focus and arousal focus. *Cognition & Emotion*, 12(4):579–599, 1998.
- [2] Margaret M Bradley and Peter J Lang. Measuring emotion: the self-assessment manikin and the semantic differential. *Journal of behavior therapy and experimental psychiatry*, 25(1):49–59, 1994.
- [3] John T Cacioppo, Gary G Berntson, Jeff T Larsen, Kirsten M Poehlmann, Tiffany A Ito, et al. The psychophysiology of emotion. *Handbook of emotions*, 2:173–191, 2000.
- [4] John T Cacioppo, Louis G Tassinary, et al. Inferring psychological significance from physiological signals. *American Psychologist*, 45(1):16–28, 1990.
- [5] Tim Dalgleish, Michael J Power, and John Wiley. *Handbook of cognition and emotion*. Wiley Online Library, 1999.
- [6] Paul Ekman. An argument for basic emotions. *Cognition & Emotion*, 6(3-4):169–200, 1992.
- [7] Paul Ekman et al. Are there basic emotions. *Psychological review*, 99(3):550–553, 1992.
- [8] Daniel Goleman. *Emotional intelligence: ; why it can matter more than IQ*. Bantam, 2006.
- [9] Christian Martyn Jones and Tommy Troen. Biometric valence and arousal recognition. In *Proceedings of the 19th Australasian conference on Computer-Human Interaction: Entertaining User Interfaces*, pages 191–194. ACM, 2007.
- [10] Peter J Lang. The emotion probe. *American psychologist*, 50(5):372–385, 1995.
- [11] Thought Technology Ltd. Procomp Infinity Hardware Manual. <http://www.thoughttechnology.com/manual.htm/>, 2013. [Online; accessed 20-April-2013].
- [12] Regan L Mandryk and M Stella Atkins. A fuzzy physiological approach for continuously modeling emotion during interaction with play technologies. *International Journal of Human-Computer Studies*, 65(4):329–347, 2007.
- [13] John D Mayer and Peter Salovey. The intelligence of emotional intelligence. *Intelligence*, 17(4):433–442, 1993.
- [14] Christian Peter and Antje Herbon. Emotion representation and physiology assignments in digital systems. *Interacting with Computers*, 18(2):139–170, 2006.
- [15] Rosalind W Picard. Affective computing: challenges. *International Journal of Human-Computer Studies*, 59(1):55–64, 2003.
- [16] Rosalind W. Picard, Elias Vyzas, and Jennifer Healey. Toward machine emotional intelligence: Analysis of affective physiological state. *Pattern Analysis and Machine Intelligence, IEEE Transactions on*, 23(10):1175–1191, 2001.
- [17] Ira J Roseman. A model of appraisal in the emotion system: Integrating theory, research, and applications. 2001.

- [18] Richard Rouse III and Steve Ogden. *Game design: Theory and practice*. Jones & Bartlett Publishers, 2010.
- [19] James A Russell. A circumplex model of affect. *Journal of personality and social psychology*, 39(6):1161–1178, 1980.
- [20] James A Russell, Anna Weiss, and Gerald A Mendelsohn. Affect grid: A single-item scale of pleasure and arousal. *Journal of Personality and Social psychology*, 57(3):493–502, 1989.
- [21] Klaus R Scherer. Neuroscience projections to current debates in emotion psychology. *Cognition & Emotion*, 7(1):1–41, 1993.
- [22] Jonathan Sykes and Simon Brown. Affective gaming: measuring emotion through the gamepad. In *CHI'03 extended abstracts on Human factors in computing systems*, pages 732–733. ACM, 2003.
- [23] Nelson Zagalo, Anthony Barker, and Vasco Branco. Story reaction structures to emotion detection. In *Proceedings of the 1st ACM workshop on Story representation, mechanism and context*, pages 33–38. ACM, 2004.
- [24] Tao Zhang, David B Kaber, Biwen Zhu, Manida Swangnetr, Prithima Mosaly, and Lashanda Hodge. Service robot feature design effects on user perceptions and emotional responses. *Intelligent Service Robotics*, 3(2):73–88, 2010.

APPENDIX A

TRANSFORMING PHYSIOLOGICAL VARIABLES INTO AROUSAL- VALENCE SPACE

The following 22 rules were used as described in Section 4.2.2 to transform physiological variables into arousal-valence space:

1. If (GSR is high) then (arousal is high)
2. If (GSR is mid-high) then (arousal is mid-high)
3. If (GSR is mid-low) then (arousal is mid-low)
4. If (GSR is low) then (arousal is low)
5. If (HR is low) then (arousal is low)
6. If (HR is high) then (arousal is high)
7. If (GSR is low) and (HR is high) then (arousal is midlow)
8. If (GSR is high) and (HR is low) then (arousal is midhigh)
9. If (EMGfrown is high) then (valence is very low)
10. If (EMGfrown is mid) then (valence is low)
11. If (EMGsmile is mid) then (valence is high)
12. If (EMGsmile is high) then (valence is very high)
13. If (EMGsmile is low) and (EMGfrown is low) then (valence is neutral)
14. If (EMGsmile is high) and (EMGfrown is low) then (valence is very high)
15. If (EMGsmile is high) and (EMGfrown is mid) then (valence is high)
16. If (EMGsmile is low) and (EMGfrown is high) then (valence is very low)
17. If (EMGsmile is mid) and (EMGfrown is high) then (valence is low)
18. If (EMGsmile is low) and (EMGfrown is low) and (HR is low) then (valence is low)
19. If (EMGsmile is low) and (EMGfrown is low) and (HR is high) then (valence is high)
20. If (GSR is high) and (HR is mid) then (arousal is high)
21. If (GSR is mid-high) and (HR is mid) then (arousal is mid-high)
22. If (GSR is mid-low) and (HR is mid) then (arousal is mid-low)

APPENDIX B

TRANSFORMING AROUSAL-VALENCE SPACE INTO EMOTIONAL STATES

The following 67 rules were used as described in Section 4.2.2 to convert arousal and valence into boredom, challenge, excitement, frustration, and fun:

1. If (arousal is not veryLow) and (valence is midHigh) then (fun is low)
2. If (arousal is not low) and (valence is midHigh) then (fun is low)
3. If (arousal is not veryLow) and (valence is high) then (fun is medium)
4. If (valence is veryHigh) then (fun is high)
5. If (arousal is midHigh) and (valence is midLow) then (challenge is low)
6. If (arousal is midHigh) and (valence is midHigh) then (challenge is low)
7. If (arousal is high) and (valence is midLow) then (challenge is medium)
8. If (arousal is high) and (valence is midHigh) then (challenge is medium)
9. If (arousal is veryHigh) and (valence is midLow) then (challenge is high)
10. If (arousal is veryHigh) and (valence is midHigh) then (challenge is high)
11. If (arousal is midLow) and (valence is midLow) then (boredom is low)
12. If (arousal is midLow) and (valence is low) then (boredom is medium)
13. If (arousal is low) and (valence is low) then (boredom is medium)
14. If (arousal is low) and (valence is midLow) then (boredom is medium)
15. If (arousal is midLow) and (valence is veryLow) then (boredom is high)
16. If (arousal is low) and (valence is veryLow) then (boredom is high)
17. If (arousal is veryLow) and (valence is veryLow) then (boredom is high)
18. If (arousal is veryLow) and (valence is low) then (boredom is high)
19. If (arousal is veryLow) and (valence is midLow) then (boredom is high)
20. If (arousal is midHigh) and (valence is midLow) then (frustration is low)
21. If (arousal is midHigh) and (valence is low) then (frustration is medium)
22. If (arousal is high) and (valence is low) then (frustration is medium)
23. If (arousal is high) and (valence is midLow) then (frustration is medium)
24. If (arousal is midHigh) and (valence is veryLow) then (frustration is high)
25. If (arousal is high) and (valence is veryLow) then (frustration is high)
26. If (arousal is veryHigh) and (valence is veryLow) then (frustration is high)

27. If (arousal is veryHigh) and (valence is low) then (frustration is high)
28. If (arousal is veryHigh) and (valence is midLow) then (frustration is high)
29. If (valence is veryLow) then (fun is veryLow)(challenge is veryLow)
30. If (valence is low) then (fun is veryLow)(challenge is veryLow)
31. If (valence is high) then (challenge is veryLow)(boredom is veryLow)(frustration is veryLow)
32. If (valence is veryHigh) then (challenge is veryLow) (boredom is veryLow)(frustration is veryLow)
33. If (valence is midHigh) then (boredom is veryLow) (frustration is veryLow)
34. If (arousal is veryLow) then (challenge is veryLow) (frustration is veryLow)
35. If (arousal is low) then (challenge is veryLow)(frustration is veryLow)
36. If (arousal is midLow) then (challenge is veryLow) (frustration is veryLow)
37. If (arousal is midHigh) then (boredom is veryLow)
38. If (arousal is high) then (boredom is veryLow)
39. If (arousal is veryHigh) then (boredom is veryLow)
40. If (arousal is veryLow) and (valence is midHigh) then (fun is veryLow)
41. If (arousal is low) and (valence is midHigh) then (fun is veryLow)
42. If (arousal is veryLow) and (valence is high) then (fun is low)
43. If (valence is midLow) then (fun is veryLow)
44. If (arousal is veryLow) and (valence is high) then (boredom is low)
45. If (arousal is low) and (valence is midHigh) then (boredom is low)
46. If (arousal is veryLow) and (valence is midHigh) then (boredom is medium)
47. If (arousal is veryHigh) and (valence is veryLow) then (challenge is medium)
48. If (arousal is veryHigh) and (valence is veryHigh) then (challenge is medium)
49. If (arousal is high) and (valence is low) then (challenge is low)
50. If (arousal is high) and (valence is high) then (challenge is low)
51. If (arousal is veryHigh) and (valence is low) then (challenge is high)
52. If (arousal is veryHigh) and (valence is high) then (challenge is high)
53. If (arousal is midHigh) and (valence is midHigh) then (excitement is low)
54. If (arousal is high) and (valence is midHigh) then (excitement is medium)
55. If (arousal is high) and (valence is high) then (excitement is medium)
56. If (arousal is midHigh) and (valence is high) then (excitement is medium)
57. If (arousal is veryHigh) and (valence is midHigh) then (excitement is high)
58. If (arousal is veryHigh) and (valence is high) then (excitement is high)
59. If (arousal is veryHigh) and (valence is veryHigh) then (excitement is high)

- 60. If (arousal is high) and (valence is veryHigh) then (excitement is high)
- 61. If (arousal is midHigh) and (valence is veryHigh) then (excitement is high)
- 62. If (arousal is midLow) then (excitement is veryLow)
- 63. If (arousal is low) then (excitement is veryLow)
- 64. If (arousal is veryLow) then (excitement is veryLow)
- 65. If (valence is veryLow) then (excitement is veryLow)
- 66. If (valence is low) then (excitement is veryLow)
- 67. If (valence is midLow) then (excitement is veryLow)

APPENDIX C

DEMOGRAPHICS QUESTIONNAIRE

Questionnaires

14%

Demographics

Basic demographic information

Age

Sex

☐ Male

☐ Female

Handedness

☐ Right handedness

☐ Left handedness

General computer expertise

☐ Basic

☐ Intermediate

☐ Advanced

Area of study

Play Experience

How often do you play computer or video games?

- ☐ every day
- ☐ a few times per week
- ☐ a few times per month
- ☐ a few times per year
- ☐ less than a few times per year

What systems have you used? (Please check all that apply)

- ☐ Xbox 360
- ☐ Playstation 3
- ☐ Playstation 2
- ☐ Nintendo Wii
- ☐ Computer
- ☐ Tablet (Apple, Android, Surface, etc)
- ☐ Smartphone (Apple, Android, Windows, etc)
- ☐ Dedicated mobile system (Sony PSP, Nintendo DS, etc)
- ☐ Other, please specify...

Specify your game experience by rating the followings.

	I've never done that				I'm an expert
2D shooting gallery games	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
3D shooting games (e.g., first-person shooters)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Using mouse in games

☐☐☐☐☐

Using touchscreens in games

☐☐☐☐☐

Play Style

Which mode of playing do you prefer?

- ☐ Single player alone
- ☐ Single player with other people helping or controller passing
- ☐ Multiplayer in the same room
- ☐ Multiplayer over the Internet
- ☐ Team/Cooperative play or clan play over the Internet
- ☐ I don't play

Rate each of these videogame experiences listed.

Choose from a scale between "I love it!" for experiences you enjoy through "It's okay" to "I hate it!" for experiences you would rather avoid.

	I love it	I like it	It's okay	I dislike it	I hate it
Exploring to see what you can find.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Frantically escaping from a terrifying foe.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Working out how to crack a challenging puzzle.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The struggle to defeat a difficult boss.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Playing in a group, online, or in the same room.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Responding quickly to an exciting situation.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Picking up every single collectible in an area.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Looking around just to enjoy the scenery.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Being in control at high speed.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Devising a promising strategy when deciding what to try next.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Feeling relief when you escape to a safe area.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Taking on a strong opponent when playing against a human player in a match.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Talking with other players, online or in the same room.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Finding what you need to complete a collection.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Hanging from a high ledge.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Wondering what's behind a locked door.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Feeling scared, terrified, or disturbed.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Working out what to do on your own.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Completing a punishing challenge after failing many times.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Cooperating with strangers.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Getting 100% (completing everything in a game).	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Rate the following statements.

Choose the highest number for the most preferred statement to the lowest number for the least preferred. Please choose each number only once.

	1	2	3	4	5	6	7
A moment of jaw-dropping wonder or beauty.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
An experience of primeval terror that blows your mind.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
A moment of breathtaking speed or vertigo.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The moment when the solution to a difficult puzzle clicks in your mind.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
A moment of hard-fought victory.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
A moment when you feel an intense sense of unity with another player.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
A moment of completeness that you have strived for.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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APPENDIX D

CONDITION QUESTIONNAIRE

Questionnaires

28%

Condition

Choose the button number you pressed for the condition you just played.

- ☐ 1
- ☐ 2
- ☐ 3
- ☐ 4

What particular changes did you notice in the game under this condition and what was its effect on your gameplay?

Did anything related to your gameplay was changed, and do you think you performed better with these changes or not.

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APPENDIX E

SELF-ASSESSMENT-MANIKIN AROUSAL SCALES QUESTIONNAIRE

Questionnaires

42%

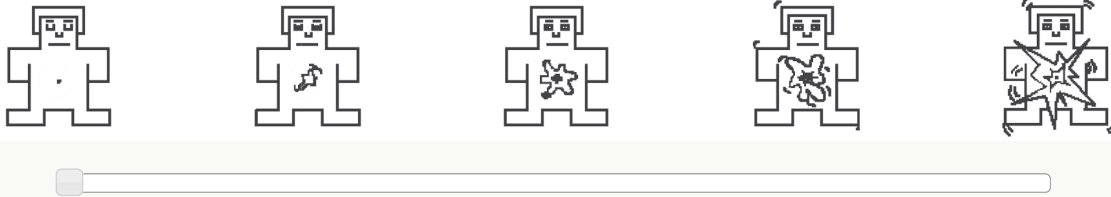
Self-Assessment-Manikin Arousal Scales

Scale your **arousal** level using the images at the following

Tired, Sleepy, Bored

Worried, In Control

Anxious, Excited, Astonished



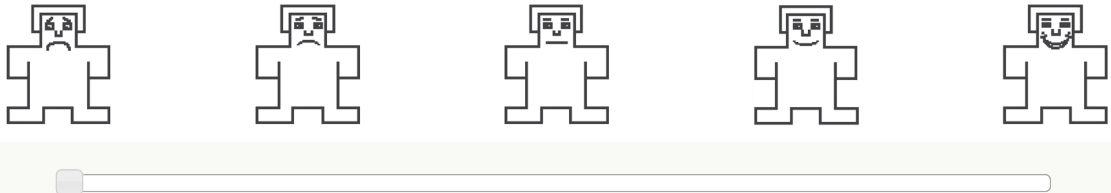
Self-Assessment-Manikin Valence Scales

Scale your **valence** level using the images at the following

Annoyed, Feared, Frustrated

Normal

Calm, Pleased, Enjoyed



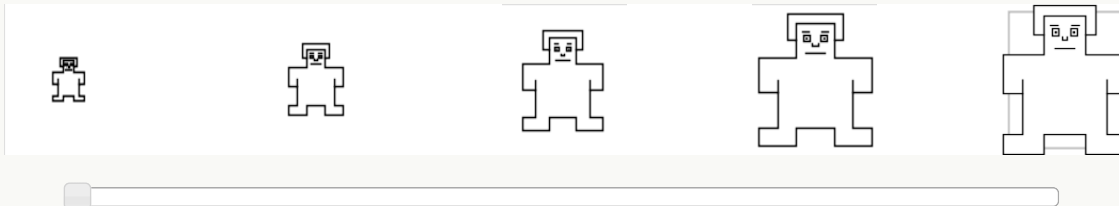
Self-Assessment-Manikin Dominance Scales

Scale your **dominance** level using the images at the following

Feared, Submitted, Content

Normal

Complaining, Egocentric, Angry



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APPENDIX F

INTRINSIC MOTIVATION INVENTORY QUESTIONNAIRE

Questionnaires

57%

Intrinsic Motivation Inventory

Indicate how you thought during the game. Do not spend too much time on any one statement. Remember, give the answer which seems to describe how you thought during the test.

	strongly disagree	disagree	neutral	agree	strongly agree
Playing the game was fun	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I put a lot of effort into this game	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I felt tense while playing the game	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
While playing, I was thinking about how much I enjoyed it	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I was anxious while playing the game	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I was very relaxed while playing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
This game did not hold my attention	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I felt pressured while playing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I tried very hard while playing the game	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I enjoyed the game very much	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
It was important to me to do well at this game	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I would describe this game as very interesting	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I didn't try very hard at playing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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APPENDIX G

PLAYER EXPERIENCE OF NEED SATISFACTION QUESTIONNAIRE

Questionnaires

71%

Player Experience of Need Satisfaction

Reflect on your play experience and rate your agreement with the following statements:

	strongly disagree	disagree	neutral	agree	strongly agree
I experienced a lot of freedom in the game	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When moving through the game world I felt as if I am actually there	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Learning the game controls was easy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I felt competent at the game	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I didn't feel close to other players	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The game provides me with interesting options and choices	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I had reactions to events and characters in the game as if they were real	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I found the relationships in this game important	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When I wanted to do something in the game, it was easy to remember the corresponding control	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Exploring the game world felt like taking an actual trip to a new place	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The game lets you do interesting things	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I was not impacted emotionally by events in the game	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I felt very capable and effective when playing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When playing the game, I felt transported to another time and place	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When playing the game I felt as if I was part of the story	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The game was emotionally engaging	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
When I accomplished something in the game I experienced genuine pride	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My ability to play the game was well matched with the game's challenges	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I experienced feelings as deeply in the game as I have in real life	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The game controls are intuitive	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I found the relationships I form in this game important	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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APPENDIX H

GAME ENGAGEMENT QUESTIONNAIRE



Questionnaires

85%

Game Engagement Questionnaire

For each question, mark the response that best describes how you USUALLY felt while you were playing.

	No	Sort of	Yes
I felt spaced out while I was playing, sometimes.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I felt different	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I really got into the game	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My thoughts went fast	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The game feels real	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Things seemed to happen automatically	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
If someone was talking to me, I couldn't hear them	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I lost track of where I was	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I couldn't answer when someone talked to me	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I couldn't tell that I'm getting tired	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I got wound up	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I played longer than I meant to	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Playing made me feel calm	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I lost track of time	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I felt scared	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Playing seemed automatic	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I played without thinking about how to play	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Time seemed to be kind of standstill or stoped	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I felt like I just couldn't stop playing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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Submit