Pressure at Play: Measuring Player Approach and Avoidance Behaviour through the Keyboard

Wouter M. van den Hoogen
School of Communication, Media & IT
Hanze University of Applied Sciences
P.O. Box 70030, ZP11
9704 AA Groningen, The Netherlands
w.m.van.den.hoogen@pl.hanze.nl

Eelco P. Braad
School of Communication, Media & IT
Hanze University of Applied Sciences
P.O. Box 70030, ZP11
9704 AA Groningen, The Netherlands
e.p.braad@pl.hanze.nl

Wijnand A. IJsselsteijn
Human-Technology Interaction
Eindhoven University of Technology
P.O. Box 513, IPO 1.22
5600 MB, The Netherlands
W.A. IJsselsteijn@tue.nl

ABSTRACT

With the increased adoption of real-time objective measurements of player experience, advances have been made in characterising the dynamically changing aspects of the player experience during gameplay itself. A direct coupling to player action, however, is not without challenges. Many physiological responses, for instance, have an inherent delay, and often take some time to return to a baseline, providing challenges of interpretation when analysing rapidly changing gameplay on a micro level of interaction. The development of event-related, or phasic, measurements directly coupled to player actions provides additional insights, for instance through player modelling, but also through the use of behavioural characteristics of the human computer interaction itself. In this study, we focused on the latter, and measured keyboard pressure in a number of different, fast-paced action games. In this particular case, we related specific functional game actions (keyboard presses) to experiential player behaviour. We found keyboard pressure to be higher for avoidance as compared to approach-oriented actions. Additionally, the difference between avoidance and approach keyboard pressure related to levels of arousal. The findings illustrate the application potential of qualifying players' functional actions at play (navigating in a game) and interpret player experience related to these actions through players' real world behavioural characteristics like interface pressure.

Proceedings of DiGRA 2014: <Verb that ends in 'ing'> the <noun> of Game <plural noun>.

© 2014 Authors & Digital Games Research Association DiGRA. Personal and educational classroom use of this paper is allowed, commercial use requires specific permission from the author.

Keywords
player experience, interface pressure, approach/avoidance behaviour.

INTRODUCTION
In the past decade, much attention has been given to the measurement and analysis of the player experience in digital games. In many studies, objective psychophysiological measurements have been combined with subjective self-reports, questionnaires and think-aloud protocols (Mandryk and Atkins 2007; IJsselsteijn et al. 2007; Kivikangas et al. 2010). In many cases, the player experience has been studied using a combination of measurements during play and those shortly after play. Such combinations of measurements, e.g. using both live physiological data and retrospective continuous self-reports (e.g. (Van den Hoogen et al. 2012)), aid the understanding of player experience by addressing the interpretation through the use of multiple measurement techniques. These developments echo well with the inherent changing nature of player experience. The player experience is dynamically changing during play and as such is a complex, multi-dimensional and multi-layered concept relating to various affective, cognitive and behavioural aspects of the state of mind of the player (Poels, De Kort, and IJsselsteijn 2007). Distinguishing between short-term (immediately after play) and long-term (after three weeks), Poels and colleagues (2012) found that while pleasure during play predicted playing time and game preferences on the short term, it was arousal that predicted game preference in the longer term. In a study on the experience of immersion in games, (Jennett et al. 2008) have included measurements at specific times during gameplay to address this temporal aspect of player experience. Since the experience of playing a game is a result of an on-going real-time interaction with the game, it is expected that the mere process of playing modulates the player experience. The effects are created through the process of playing and hence it is insufficient to focus only on the outcome of play (Mandryk, Atkins, and Inkpen 2006).

An increased understanding of the player experience can be used to improve the effectiveness of game design by including player experience factors in game design patterns, adaptive game design, and player modelling (Bjork and Holopainen 2005; Yannakakis and Hallam 2009). In addition to understanding and tracking general changes in the player experience, there is a need for measurements that provide high detail in the temporal domain, and can be related to specific player actions as well. Particularly in fast-paced action games, such as first-person shooters and racing games where actions follow each other in rapid succession multiple phasic (i.e., event-based) measures, in addition to tonic measures, may be used to further zoom in on the detailed, and dynamically changing aspects of the player experience (Nacke, Grimshaw, and Lindley 2010). One approach to analysing the player experience using phasic measures is the study of physical player behaviour itself. The way in which players behave during gameplay may provide further insight on how to interpret and qualify their in-game actions (e.g. see Canossa, Drachen and Møller Sørensen, 2011; and Drachen and Canossa, 2011). Such an approach is useful for game designers and researchers, particularly with developments in innovative input devices, such as the Wii Balance Board, Microsoft Kinect and, more recently, the Leap Motion Controller and the Oculus Rift VR, becoming commercially available to consumers. In player experience studies, many of these interface devices require the detection of user input through behaviour tracking. With it the detection of characteristics of user interface behaviour and connecting these to the user's experience is becoming an ever more relevant research direction.

In this paper we explore the value of behavioural indicators for connecting player experiences to specific functional aspects of gameplay. We conceptualise behaviour as the actions a person physically performs (e.g. pressing a button on an interface device) and distinguish between behaviour as a functional part of the user interaction (e.g. steering to the left or right) and behaviour as one of the channels that inform us about the players' affective, and experiential state (e.g., having fun, being aroused, feeling challenged) of the behaviour. While the former is more often used in player modelling as a measure of tracking the player's objective progress, actions and choices during the game, the latter has received only limited attention. However, the characteristics with which players perform the functional actions may provide further insight into the player experience. Where many physiological measures, such as skin conductance, have an inherent delay in measured response and require a minimum time until the measure returns to baseline, behavioural characteristics of functional actions themselves are uniquely tied to that action. It is therefore a candidate for an experiential measure confined to the action itself. In this paper we present the results from a study in which the keyboard pressure players exert while playing fast-paced action games was recorded and related to approach and avoidance behaviours in the game. One may further distinguish between player behaviour in the real world and player-controlled behaviour of the agent in the game world. In this paper we focus on the real world behaviour.

BACKGROUND

The physical behaviour of players during play has shown potential for providing qualitative aspects of the dynamically changing player experience. For example, players were found to tilt their controller in synchrony with the track layout in race games (Van den Hoogen, IJsselsteijn, and De Kort 2009). Moreover, behavioural indicators have been shown to be valuable indices of people's emotions and experiences in performance oriented settings (Mentis and Gay 2002; Park et al. 2005), and in understanding emotional expression in human communication (Wallbott 1998; Weisfeld and Beresford 1982). Posture, as measured through a pressure-sensitive chair, has been used to automate the detection of frustrations in learners using a digital learning system (Kapoor, Burleson, and Picard 2007) and similarly, keyboard pressure has been related to the level of difficulty in a game, and related experiences of frustration and boredom in games as well (Tijs, Brokken, and IJsselsteijn 2008; Van den Hoogen, IJsselsteijn, and De Kort 2008). In addition to quantifying the emotional states of players using psychophysiological measures (Mandryk and Atkins 2007), behavioural measures provide information not only on the functional actions people perform during the game-play, but are likely to signal affective aspects of the player experience as well.

In order to interpret player behaviour in terms of gameplay and game events, we require a closer analysis of the gameplay itself. Challenge is widely recognized as one of the key constituents of engaging gameplay (Malone 1982) with the tension between challenge provided by the game and the levels of skill of the player creating a tension at the heart of gameplay. The optimal balance between skill and challenge has been characterized as bringing about a state of flow in the player (Csikszentmihalyi 2000) under the condition that the player is in full control and actively pursuing a clear goal (Sweetser and Wyeth 2005; Keller and Bless 2008). However, players' need not be in control all the time to experience enjoyment. Players may, for instance, respond positively to negative events in terms of the game objectives, such as the event of dying in a game (Ravaja et al. 2006; Ravaja et al. 2008). Indeed, the struggle of a player to keep in control is one of the factors resulting in game enjoyment (Klimmt, Hartmann, and Frey 2007; Klimmt, Hefner, and Vorderer 2009). In fact, negative affect has its use in computer-based systems in general, and particularly in games in specific. While ‘at game’ frustration relating to the interface outside the locus of control of the player and a persistent state of frustration is something to be avoided, in gameplay, a balanced variation between 'in-control' and 'out-of-control' situations is key in increasing player enjoyment and optimising the player experience (Gilleade and Dix 2004). It is important, however, to keep a healthy balance. With too many repeated experiences of being over-challenged the fun of struggling for control may become feedback of a players’ inability to gain control. For instance, with repeated death events initial indications of enjoyment were reduced suggesting players started to feel incapable of proceeding in the game, losing the fun in the game (Van den Hoogen et al. 2012).

When players experience increased levels of difficulty while playing, the pressure with which gamepad buttons are pressed increases (Sykes and Brown 2003). In the same study it was suggested that increased arousal in the player might explain this relation, which was shown to be plausible by correlating arousal to interface pressure (Van den Hoogen, IJsselsteijn, and De Kort 2008). Additionally, behavioural cues extracted from measuring touchpad pressure can be used as indicators of negative effect, when related to phasic critical incidents (Mentis and Gay 2002). In general, across a large range of psychological phenomena, it has been found that bad is stronger than good (Baumeister et al. 2001): bad emotions and negative feedback have more impact than their positive counterparts and bad information is processed more thoroughly than good information. We can use these observations in behavioural analysis of player experience by looking at in-game player actions. In an 'in-control' situation, players predominantly initiate actions to pursue the in-game goals. For example, in a first-person shooter game, a player may choose to steer the controlled character to approach desirable (sub-)goals such as triggers, health packs, ammunition, etc. In an 'out-of-control' situation, players predominantly respond to the, possibly sudden, changes in the game. For example, the appearance of a fierce enemy may cause the player to quickly backtrack and avoid the confrontation. This behaviour of exercising control to fulfil goals can be partly described along a dimension of approach and avoidance. Where approach motivation is the process of directing behaviour towards positively valued stimuli (e.g. objects, events, etc.), avoidance motivation is the process of directing behaviour away from negative stimuli (Elliot 2006).

HYPOTHESIS

The extent to which a player feels in control (i.e. effectance) is of great importance to the enjoyment of the game. Fun can arise from being in control, but also from a struggle to gain control creating challenge within the game. Enticing suspense and emotional relieve, respectively, enjoyment is built on various affective aspects (Klimmt, Hartmann, and Frey 2007). In many games, challenge is established by motivating players to pursue desirable goals while trying to avoid undesirable goals. In doing so, players adopt 'in control' (or approach-like) and out of control (or avoidance-like) behaviours to execute their intents. The avoidance of undesirable goals is expressed more strongly than the approach to desirable goals, as evidenced in increased arousal and motor activity. This physical aspect of behaviour can be measured through the amount of pressure exerted in expressing experiential, in-game, intents through real-world, physical, button presses.

We hypothesize that avoiding an undesirable situation will coincide with increased intensity in expressing such behaviour. More precisely, we expect increased analog intensity in keyboard pressure to occur with in-game evasive or avoidance actions. In an experiment, we let players play a number of fast-paced action games (first-person shooters and racing games) and measured the pressure exerted on the keyboard while controlling the game. Using this behavioural measure in the temporal domain during play, we analyse the player experience in terms of approach and avoidance behaviours.

METHOD

Participants

The data presented in this study was recorded as part of a larger study focussing on the relation between player emotions and digital game preferences and playing time (Poels et al. 2012). In the study, nineteen participants (7 females and 12 males, aged 18 to 42), M=23.47, SD=7.24) played the games in a 90-minute lab session, for which they received compensation of €15,-. The frequency with which participants usually play games ranged from ‘‘a couple of times a year’’ (n = 4), ‘‘monthly’’ (n = 4), ‘‘weekly’’ (n = 5) to ‘‘daily’’ (n = 6).

Procedure

Participants played a total of four PC games; two first-person shooter games and two racing games. Specifically; Battlefield 1942 (Digital Illusions 2002), Hitman Contracts (IO Interactive 2004), Colin McRae Rally (Codemasters 2003) and Trackmania (Nadeo 2004) were played. Each of the games was played for 10 minutes in a counterbalanced order. Prior to playing the games they were given a brief introduction of the game, and instructions on how to play the game. After each play session, participants rated their experiences on the Self-Assessment Manikin scale (SAM-scale), a visual, 9 point, self-report scale based on the pleasure, arousal, dominance dimensions of Mehrabian and Russell (1974) and includes three nine-point visual scales on which participants have to indicate how much pleasure, dominance, and arousal they felt while playing the computer game (Bradley and Lang 1994). The SAM-scale is frequently used to measure emotions in general emotion studies, and in consumer and gaming research.

Game Controls

All four games made use of two simple, and commonly used, control schemes. For the first-person shooters the controls used were setup as WSAD, where the W and S keys control forward and backward movement, respectively, and the A and D keys control left and right turning. In the racing games the arrow keys were used as the control scheme to accelerate, brake and turn the car to navigate the track. Here, acceleration (arrow up) may be characterised as an in-control, approach event while braking (arrow down) may be characterised as an out-of-control, avoid event. Both schemes typically involve the player utilizing their middle finger to alternate between the keys used for forward and backward movement.

Behavioural measures

During gameplay all keyboard strokes and the corresponding force on the keyboard was recorded. Keystrokes were recorded as onset and offset times accompanying the key that was pressed. The force was measured using four flexi-force force (Tekscan) sensors placed under the four corners of the keyboard collected with a sample frequency of 100Hz. Force values from the sensors were, prior to further analyses, range corrected to correct for individual differences. That is, for each individual, the pressure values were divided by the maximum pressure values measures for that individual. This procedure is advised for the use of galvanic skin response (GSR) data (Lykken & Venables 1971), which has properties and dependencies on individual differences similar to our automatically captured behavioural measures, and allows comparisons across individuals

Before analyses, these two datasets were joined to provide one dataset indicating the force with which each of the keys was depressed. In total four keys were used to calculate the interface force of forwards and backward movement. Within the FPS and Race games the ‘W’ and the ‘Arrow Up’ are used to move forward and accelerate, whereas the ‘S’ and the ‘Arrow Down’ keys were used to move backward or brake respectively. Using the onset and offset times of key presses, windows were created in which these keys were pressed. Within these windows the mean force on the keyboard was calculated. These mean forces for each key press were subsequently averaged into a mean interface force for forward (accelerate / forward movement) and backward (brake) movement for each of the four games. This resulted in a mean interface pressure for each game for forward oriented movement and backwards oriented movement providing eight variables (2 for each game). Using these pairs of variables a difference score was calculated for each of the game. This difference score was calculated by, per participant, subtracting the mean backward movement pressure from the mean forward movement pressure. Positive numbers on this resulting scale indicate that backwards movement pressure was higher than forward movement pressure.

Results

Descriptive statistics

We first provide a general overview of the descriptive statistics for the three SAM dimensions and interface force values (see Table 1). Although Trackmania was, on average, most liked, there was considerable variation between participants. Importantly, none of the four games was disliked.

	Self-report		**Mean Interface Pressure**		
	Pleasure	**Arousal**	**Average**	**Forward**	**Backward**
Battlefield	6,00 (1,89)	4,63 (2,43)	0.151 (0.161)	0.151 (0.161)	0.164 (0.173)
Hitman	5,26 (2,66)	4,88 (2,01)	0.154 (0.171)	0.153 (0.170)	0.168 (0.182)
Colin McRae	5,37 (1,5)	4,42 (1,5)	0.165 (0.187)	0.160 (0.185)	0.183 (0.197)
Trackmania	7,26 (1,41)	5,84 (1,92)	0.167 (0.168)	0.166 (0.168)	0.191 (0.164)

Table 1: Descriptive statistics of Self-Report and Interface Pressure per Game

Note: numbers in the table display mean values with standard deviations in brackets. Scale for the self-report measure runs from 1-9, with higher values indicating higher pleasure or higher arousal. The scale for the Interface pressure runs from 0-1 with higher scores indicating higher pressure.

Analysis

A repeated Measure ANOVA was performed using Game (one of the four games), and Direction (forward vs. backward movement) as within subject factors with interface force as the dependent variable. This analysis tests for the hypothesized relation between the forward and backward movement (approach vs. avoidance) and interface pressure, in an event related, phasic fashion. The results showed a significant main effect of Direction ($F(1,16)=14.06$, $p=.002$ on interface force with higher average force for the backward movement (M=.17, SE=.04) than forward movement (M=.15, SE=.04). The main effect of Game on interface force was found to be marginally significant $F(3,14)=2.62$, $p=.09$) providing limited indication that the interface pressure, on average, differed between the games. As can be seen in Table 1, pressure was higher for the race games as compared to the FPS games. The interaction between Direction and Game was not significant providing no indication that the effect of Direction was dependent on the Game played.

A second analysis was performed to test the relation between arousal and the difference in interface force dependent on the direction of movement a Linear Mixed Models (LMM) analysis was performed on the restructured data. In order to perform this analysis the original data was restructured in such a way that the scores for the different games were treated as separate cases, creating four rows of data for each participant. Since our data were now ''nested within participants,'' we included participant number as a random factor in our analyses, allowing us to control for differences in variance that solely reside at the level of participants. In the LMM the SAM Arousal scores were entered as fixed factor, participant number was entered as random factor and the difference score between forward and backward keyboard pressure was used as the dependent variable. The results show a significant main effect of SAM Arousal on the difference score of keyboard pressure ($F(1,66.18)=5.73$, $p=.02$). The positive sign of the parameter estimate (parameter estimate 0.0044) shows that increased levels of arousal are related with greater difference between forwards and backward oriented keyboard pressure. Since positive numbers on the difference score for keyboard pressure signal higher mean pressure for backward movement as compared to forward movement, the result can be interpreted as indicating arousal to relate to comparatively higher pressure for keyboard pressure related to backward (avoidance) movement as compared to forward (approach) movement.

DISCUSSION

In this paper we have explored the utilization of behavioural characteristics of player actions – interface pressure coupled to functional game actions – as an indicator of player experience. We demonstrated the utility of player behaviour as a qualitative measure of player experience. In particular, by qualifying in-game actions in terms of their role in the gameplay situations – approach or avoidance - we have approached behavioural measures in a truly phasic, time-conscious way, qualifying the player experience at a micro level. This approach of analysing behaviour tied to specific actions extents previous research on behavioural measures as an indicator of player experience (e.g. Van den Hoogen, IJsselsteijn, and de Kort 2008; Van den Hoogen, IJsselsteijn, and De Kort 2009). In the study we included four fast paced action games (two FPS games, and two race games) and measured both the functional actions people performed through the keyboard scheme, and the force with which they pressed the buttons.

Throughout the study we have distinguished between forward movements (navigating forward or accelerating) as approach-events, and backward movements (navigating backward or braking) as avoidance-events. Additionally, we related differences between forward movement pressure and backward movement pressure to general levels of arousal. We hypothesized that avoiding an undesirable situation will coincide with increased intensity in expressing such behaviour, and expected increased intensity in keyboard pressure to occur with in-game evasive or avoidance actions.

The results were clear; keys corresponding to avoidance actions were pressed with significantly more force than those corresponding to approach actions. Furthermore, the difference between the interface force for approach and avoidance actions related to self-reported levels of arousal experienced throughout each of the games. As suggested by previous findings where interface pressure was analysed as an average across a level (Van den Hoogen, IJsselsteijn, and de Kort 2008; Van den Hoogen, IJsselsteijn, and De Kort 2009), the intensity with which players perform their actions these findings again indicate a relation with experienced levels of arousal. Importantly, suggestions have been made that this relation is not limited to player behaviour but could be a more general relation between arousal levels in the autonomic nervous system and levels of motor activity (Gershon, 1998 in Pentland, 2008, p13). When aiming to increase our repertoire of measures of player experience and connect these to the general dimensions of player emotions of valence and arousal, a fine grained understanding of the characteristics of people's naturally occurring behaviour appears as a promising candidate.

In this study we have only examined the mean pressure during individual button presses. As such, we have explored the use of phasic measurements that may provide insight into the temporal domain of the player experience. Future studies should also consider additional characteristics of player action behaviour beyond mean pressure during button presses. Further analysis may include additional aspects of pressure in keystrokes, such as attack, decay and sustain of the presses, allowing further micro-level analysis. Such detailed analysis in the temporal domain may provide additional qualifications of the player's behaviour as well as help gain insight in the classification of the events along the player experience spectrum.

Although the results are clear, we have made several assumptions that should be considered in future studies as well. Most notably, we have assumed that approach actions are mostly related to in-control game situations, in which the player intently initiates the action. Conversely, we have assumed that avoidance actions are mostly related to out-of-control game situations, in which the player generally reacts to a sudden change within the game. While we have argued how this may hold in general, expert players may use such behaviours in different, perhaps more advanced ways. As found by Elliot (2006), behaviours may be adopted in the context of goal-orientation in an anticipating way. In gameplay, a player may move forward as an avoidance action, running away from an enemy. Likewise, expert racers may brake before a corner to maximise exit speed, and do so in a controlled manner. While we did include measures of player expertise and game literacy the number of participants in the current study is insufficient to include these factors as additional, between-subjects, variables. Future research may distinguish in more detail between the level of experience and expressing in control and out of control behaviour through interface force or other characteristics of player behaviour.

In sum, in this paper we have reported on the development of event-related, or phasic, measurements directly coupled to player actions based on behavioural characteristics of the interaction itself. In this study, we measured keyboard pressure in a number of different, fast-paced action games. We related specific functional game actions (keyboard presses) to experiential player behaviour and found keyboard pressure to be higher for avoidance as compared to approach-oriented actions. Additionally, the difference between avoidance and approach keyboard pressure proved, consistent with suggestions from previous research using intensity of behaviour as an indicator of player experience, to be related to levels of arousal. The findings from the study presented in this paper illustrates the application potential of qualifying players' functional actions at play (navigating in a game) and interpret player experience related to these actions through players' real world behavioural characteristics like interface pressure. While this study is a first indication of how the combination of phasic analysis with behavioural measurements may be used to qualify players' functional actions, further research is required to gain a broader and more detailed set of measures that allow the temporal domain of the player experience to be analysed.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge financial support from the European Commission's Framework 6 IST program. In particular, the work reported here has been supported by the FUGA project (part of the IST–New and Emerging Science and Technology program).

Bibliography & Ludology

Bjork, Staffan, and Jussi Holopainen. 2005. *Patterns in Game Design*. Cengage Learning.

Bradley, Margaret M., and Peter J. Lang. 1994. "Measuring Emotion: The Self-Assessment Manikin and the Semantic Differential." *Journal of Behavior Therapy and Experimental Psychiatry* 25, no. 1: 49–59. doi:10.1016/0005-7916(94)90063-9.

Canossa, A., Drachen, A., and Sørensen, J.R.M. 2011. "Arrrgghh!!!: Blending Quantitative and Qualitative Methods to Detect Player Frustration." Proceedings of the 6th International Conference on Foundations of Digital Games, 61-68. New York: ACM. doi: 10.1145/2159365.2159374.

Codemasters. 2003. "Colin McRae Rally."

Csikszentmihalyi, Mihaly. 2000. *Beyond Boredom and Anxiety: Experiencing Flow in Work and Play*. San Francisco: Jossey-Bass.

Digital Illusions. 2002. "Battlefield 1942". Electronic Arts.

Drachen, A., and Canossa, A. 2011. "Evaluating Motion: Spatial User Behaviour in Virtual Environments." International Journal of Arts and Technology 4 (3): 294. doi: 10.1504/IJART.2011.041483.

Elliot, Andrew J. 2006. "The Hierarchical Model of Approach-Avoidance Motivation." *Motivation and Emotion* 30, no. 2: 111–116. doi:10.1007/s11031-006-9028-7.

Gilleade, Kiel M., and Alan Dix. 2004. "Using Frustration in the Design of Adaptive Videogames." In *Proceedings of the 2004 ACM SIGCHI International Conference on Advances in Computer Entertainment Technology*, 228–232. Singapore: ACM. doi:10.1145/1067343.1067372.

IJsselsteijn, Wijnand A., Yvonne A.W. De Kort, Karolien Poels, Audrius Jurgelionis, and Francesco Belotti. 2007. "Characterising and Measuring User Experiences." In *Proceedings of the ACE 2007 International Conference on Advances in Computer Entertainment Technology*.

IO Interactive. 2004. “Hitman Contracts”. Eidos Interactive.

Jennett, Charlene, Anna L. Cox, Paul Cairns, Samira Dhoparee, Andrew Epps, Tim Tijs, and Alison Walton. 2008. “Measuring and Defining the Experience of Immersion in Games.” *International Journal of Human-Computer Studies* 66, no. 9: 641–661. doi:10.1016/j.ijhcs.2008.04.004.

Kapoor, Ashish, Winslow Burleson, and Rosalind W. Picard. 2007. “Automatic Prediction of Frustration.” *International Journal of Human-Computer Studies* 65, no. 8: 724–736. doi:10.1016/j.ijhcs.2007.02.003.

Keller, Johannes, and Herbert Bless. 2008. “Flow and Regulatory Compatibility: An Experimental Approach to the Flow Model of Intrinsic Motivation.” *Personality and Social Psychology Bulletin* 34, no. 2: 196–209. doi:10.1177/0146167207310026.

Kivikangas, J. Matias, Inger Ekman, Guillaume Chanel, Simo Järvelä, Mikko Salminen, Ben Cowley, Pentti Henttonen, and Niklas Ravaja. 2010. “Review on Psychophysiological Methods in Game Research.” In *Proceedings of the 1st Nordic DiGRA*.

Klimmt, Christoph, Tilo Hartmann, and Andreas Frey. 2007. “Effectance and Control as Determinants of Video Game Enjoyment.” *Cyberpsychology & Behavior* 10, no. 6: 845–848. doi:10.1089/cpb.2007.9942.

Klimmt, Christoph, Dorothée Hefner, and Peter Vorderer. 2009. “The Video Game Experience as ‘True’ Identification: A Theory of Enjoyable Alterations of Players’ Self-Perception.” *Communication Theory* 19, no. 4: 351–373. doi:10.1111/j.1468-2885.2009.01347.x.

Malone, Thomas W. 1982. “What Makes Computer Games Fun?” In Vol. 13. ACM.

Mandryk, Regan L., M. Stella Atkins, and K.M. Inkpen. 2006. “A Continuous and Objective Evaluation of Emotional Experience with Interactive Play Environments.” In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (CHI 2006)*.

Mandryk, Regan L., and M. Stella Atkins. 2007. “A Fuzzy Physiological Approach for Continuously Modeling Emotion during Interaction with Play Technologies.” *International Journal of Human-Computer Studies* 65, no. 4: 329–347. doi:10.1016/j.ijhcs.2006.11.011.

Mehrabian, Albert, and James A. Russell. 1974. *An Approach to Environmental Psychology*. Cambridge, MA: The MIT Press.

Mentis, Helena M., and Geri K. Gay. 2002. “Using TouchPad Pressure to Detect Negative Affect.” In *Proceedings of the 4th IEEE International Conference on Multimodal Interfaces*, 406–410. IEEE Computer Society. doi:10.1109/ICMI.2002.1167029.

Nacke, Lennart E., Mark N. Grimshaw, and Craig a. Lindley. 2010. "More than a Feeling: Measurement of Sonic User Experience and Psychophysiology in a First-Person Shooter Game." *Interacting with Computers* 22, no. 5: 336–343. doi:10.1016/j.intcom.2010.04.005.

Nadeo. 2004. "Trackmania". Steam.

Park, Namkee, Weirong Zhu, Younbo Jung, Margaret McLaughlin, and S. Jin. 2005. "Utility of Haptic Data in Recognition of User State." In *Proceedings of HCI International*. Vol. 11.

Pentland, Alex. 2008. *Honest Signals: How They Shape Our World*. Cambridge, Mass.; London: MIT Press.

Poels, Karolien, Yvonne A.W. De Kort, and Wijnand A. IJsselsteijn. 2007. "It Is Always a Lot of Fun!: Exploring Dimensions of Digital Game Experience Using Focus Group Methodology." In *Proceedings of the 2007 Conference on Future Play*, 83–89. ACM.

Poels, Karolien, Wouter M. van den Hoogen, Wijnand A. IJsselsteijn, and Yvonne A.W. De Kort. 2012. "Pleasure to Play, Arousal to Stay: The Effect of Player Emotions on Digital Game Preferences and Playing Time." *Cyberpsychology, Behavior, and Social Networking* 15, no. 1: 1–6. doi:10.1089/cyber.2010.0040.

Ravaja, Niklas, Timo Saari, Mikko Salminen, Jari Laarni, and Kari Kallinen. 2006. "Phasic Emotional Reactions to Video Game Events: A Psychophysiological Investigation." *Media Psychology* 8, no. 4: 343–367. doi:10.1207/s1532785xmep0804_2.

Ravaja, Niklas, Marko Turpeinen, Timo Saari, Sampsa Puttonen, and Liisa Keltikangas-Järvinen. 2008. "The Psychophysiology of James Bond: Phasic Emotional Responses to Violent Video Game Events." *Emotion* 8, no. 1: 114–120.

Sweetser, Penelope, and Peta Wyeth. 2005. "GameFlow: A Model for Evaluating Player Enjoyment in Games." *ACM Computers in Entertainment* 3, no. 3.

Sykes, Jonathan, and Simon Brown. 2003. "Affective Gaming: Measuring Emotion through the Gamepad." In *CHI '03 Extended Abstracts on Human Factors in Computing Systems*, 732–733. ACM.

Tijs, Tim, Dirk Brokken, and Wijnand A. IJsselsteijn. 2008. "Creating an Emotionally Adaptive Game." In *Proceedings of ICEC 2008*, edited by S.M. Stevens and S. Saldamarco, 122–133.

Van den Hoogen, Wouter M., Wijnand A. IJsselsteijn, and Yvonne A.W. De Kort. 2008. "Exploring Behavioral Expressions of Player Experience in Digital Games." In *Facial and Bodily Expressions for Control and Adaptation of Games (ECAG 2008)*, edited by Anton Nijholt and R. Poppe, 11–19. Enschede: Centre for Telematics and Information Technology University of Twente.

Van den Hoogen, Wouter M., Wijnand A. IJsselsteijn, and Yvonne A.W. De Kort. 2009. “Effects of Sensory Immersion on Behavioural Indicators of Player Experience: Movement Synchrony and Controller Pressure.” In *Proceedings of the 2009 Digital Games Research Association Conference*, edited by Barry Atkins, Helen Kennedy, and Tanya Krzywinska, 1–6. London: Brunel University. http://www.digra.org/dl/db/09287.18127.pdf.

Van den Hoogen, Wouter M., Karolien Poels, Wijnand A. IJsselsteijn, and Yvonne A.W. De Kort. 2012. “Between Challenge and Defeat: Repeated Player-Death and Game Enjoyment.” *Media Psychology* 15, no. 4: 443–459. doi:10.1080/15213269.2012.723117.

Wallbott, Harald G. 1998. “Bodily Expression of Emotion.” *European Journal of Social Psychology* 28, no. 6: 879–896. ftp://ftp.infomus.org/pub/PPM/Publications/Wallbott, 1998, bodiliy espression of emotion.pdf.

Weisfeld, Glenn E., and Jody M. Beresford. 1982. “Erectness of Posture as an Indicator of Dominance or Success in Humans.” *Motivation and Emotion* 6, no. 2: 113–131. doi:10.1007/BF00992459.

Yannakakis, Georgios N., and John Hallam. 2009. “Real-Time Game Adaptation for Optimizing Player Satisfaction.” *IEEE Transactions on Computational Intelligence and AI in Games* 1, no. 2: 121–133. doi:10.1109/TCIAIG.2009.2024533.