Towards real-time behavioral indicators of player experiences: Pressure patterns and postural responses

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Introduction

The current paper sets out to describe a first exploration of behavioral expressions that could serve as real-time indicators of experiences related to playing digital games. In this paper, we focus primarily on pressure patterns exerted on a physical control device, and postural responses. Based on this exploration, we present our progress in developing a set of behavior-based measures of such player experiences and their validation through an experimental study.

Behavioral indicators of flow, frustration and boredom

Enjoyment is arguably the single most important motivation for people to play digital games. It is a factor that game developers would like to understand more fully in order to optimize game design [6]. In his pioneering work, Csikszentmihalyi [1,2] found that many elements of enjoyment are universal. During optimal experiences, people are completely absorbed by an activity, losing track of time and a preoccupation with self. Through striking the balance between a person's skills and the challenges an activity offers, that person may arrive in a psychological state known as *flow*. Although Csikszentmihalyi's work on flow suggests it is quite a rare experience, it certainly is a state that rings familiar to players of digital games. Flow may gradually increase over the course of the game in a homeostatic positive feedback loop, until either the challenge becomes too great (resulting in frustration) or the player's skill outpaces the challenges the game can offer (leading to boredom). Being able to measure in real-time when a game is becoming unacceptably boring or frustrating is likely to contribute to a more optimal player experience, as such information can be provided directly to the game engine, allowing it to adjust the game dynamically to the player's psychological state.

Behavioral responses exhibited during gameplay, such as postural movements, gestures, facial expressions, or pressure exerted on interface devices, constitute a potentially promising class of measures in this regard. Mota and Picard [4] have, for instance, demonstrated that postural patterns can be indicative of learner interest. They developed a system to recognize postural patterns and associated affective states in real time, in an unobtrusive way, from a set of pressure sensors on a chair showing that the dynamics of postures can distinguish with significant reliability between affective states of high interest, low interest and boredom, each relevant to a gaming situation as well.

Research by Mentis and Gay [3] and Park, Zhu, McLaughlin and Jin [5] provides evidence that the force people apply to interface devices can be interpreted as an indicator of negative arousal. Indeed, Park et al. [5] showed a correlation between higher pressure patterns and facial expressions showing negative affect, thereby providing converging evidence that pressure exerted may be related to frustration. In the domain of digital games, Sykes and Brown [7] found that the mean pressure exerted by players on a gamepad's button increases with the difficulty level of a game. However, their results are ambiguous in that higher pressure may be associated with either a positive emotion (more excitement) or a negative one (more frustration), both of which can plausibly occur at higher difficulty levels. In sum, the literature provides tentative evidence that behavioral responses to game events may be fruitfully explored as real-time measures of player experience, in particular interest, boredom and frustration.

Construct validity study

In order to test the utility and validity of behavioral indicators of player experiences, we carried out an experiment in which thirty-two participants played 3 customized levels of a first-person shooter (Half Life 2). The levels varied in difficulty with the aim to induce boredom (easy level), enjoyment (moderate level), and frustration (hard level). The experiment had a within-subjects design, counterbalancing the order in which the levels were played. Dependent measures included several real time behavior measurement systems, including a pressure-sensitive chair, inspired on the work of Mota and Picard [6], and a pressure sensitive mouse and keyboard (see Figure 1). The chair was designed such that changes in forward-backward and sideways movement can be sensed. Complementing these systems we also employed a 3-axis Phidgets accelerometer measuring tilt and acceleration of participants' upper body in both the frontal and lateral plane. In addition, observational coding of sitting position was done, based on video recordings of each participant. Moreover, several self-report measures were applied (GEQ; SAM; FlowGrid) in order to ensure that the behavioral data could be sensibly interpreted, and to check convergent validity of the behavioral indicators with such self-report data.

The results show a consistent pattern between self report, observed behavioral indicators and automatically captured measurements. The self report measures indicate frustration for the hard level, balanced play for the moderate level, and less engagement at the easy level. In line with literature and our hypotheses, behavioral measures for movement (e.g. accelerometer data and observational coding of movement) and force (e.g. on the mouse) appeared to be indicative of frustration in the hard level. More specifically, mean accelerometer data was highest in the hard level indicating stronger movement. Similarly, data from both the automatic chair and observational coding show the range in forward-backward movement to be significantly higher in the hard level as compared to the other two levels. The force measurements of the mouse show that participants applied more force on the mouse buttons (both maximum and mean over the level) in the hard level, an effect consistent with previous findings [7]. Our findings further show maximum force on the mouse and range in sitting position to be correlated with the self-report measurement of frustration, providing additional, convergent validity for the measurement of frustration through these behaviors.

To conclude, the first analysis of our results bode well for the applicability of behavioral indicators to measuring player experiences in relation to digital games. However, our pressure and posture measures appear to be particularly sensitive to frustration but not so much to boredom. This may be due to our manipulation strength, the sensitivity of our set

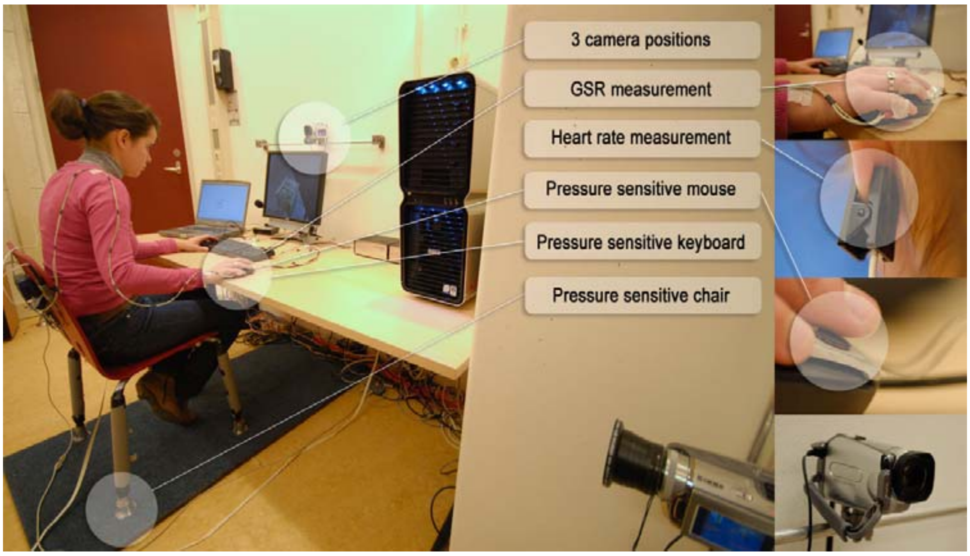

Figure 1. *Measurement systems as used in the experiment.*

of measures, the relation between boredom and behavior, or a combination of these factors. This issue will be addressed through further analysis of our current findings, and future experiments.

References

1. Csikszentmihalyi, M. (1975). *Beyond Boredom and Anxiety*. San Fransisco: Jossey-Bass.
2. Csikszentmihalyi, M. (1990). *Flow. The Psychology of Optimal Experience*. New York: Harper & Row.
3. Mentis, H.M. and Gay, G.K. (2002). Using touchpad pressure to detect negative affect. *Proceedings of Fourth IEEE International Conference on Multimodal Interfaces* 2002, 406 - 410
4. Mota, S. and Picard, R.W. (2003). Automated Posture Analysis for Detecting Learner's Interest Level. Workshop on Computer Vision and Pattern Recognition for Human-Computer Interaction (CVPR HCI). Available: http://affect.media.mit.edu/pdfs/03.mota-picard.pdf
5. Park, N., Zhu, W., Jung, Y., McLaughlin, M., and Jin, S., (2005). Utility of haptic data in recognition of user state. *Proceedings of HCI International 11*. Lawrence Erlbaum Associates. Available: http://imsc.usc.edu/haptics/paper/manuscript_hcii2005_final.pdf
6. Phillips, B. (2006). Talking about games experiences – A view from the trenches. *Interactions, **13*** (5), 22-23.
7. Sykes, J. and Brown, S. (2003). Affective gaming. Measuring emotion through the gamepad. *ACM CHI* 2003, 732-733.