Psychophysiology of digital game playing: The relationship of self-reported emotions with phasic physiological responses

N. Ravaja and J.M. Kivikangas

Center for Knowledge and Innovation Research, Helsinki School of Economics, Helsinki, Finland, ravaja@hse.fi

Digital game playing is the fastest growing form of entertainment media [1]. Given that emotions and emotion-related variables (e.g., competitiveness) play a critical role in gaming behavior [2, 3], increasing our understanding of what actually happens during video game playing in terms of emotional responses is of increasing importance from the point of view of communication researchers, media psychologists, and game industry (game developers).

Emotions are biologically based action dispositions that comprise three components: subjective feeling, expressive behavior, and physiological component [4]. A dimensional theory of emotion holds that all emotions can be located in a two-dimensional space, as coordinates of valence (ranging from negative to positive) and arousal (or bodily activation; ranging from low to high).

Facial electromyography (EMG) is the primary psychophysiological index of hedonic valence [5]. That is, EMG activity increases with the contractions of the facial muscle groups responsible for positive and negative emotional expressions. It is well established that increased activity at the zygomaticus major (cheek) and corrugator supercilii (brow) muscle regions is associated with positive emotions and negative emotions, respectively, when viewing media [5, 6]. In addition, increased activity at the orbicularis oculi (periocular) muscle area has been associated with positive and high-arousal emotions [5, 7]. Electrodermal activity (EDA), commonly known as skin conductance, is an important psychophysiological index of arousal [5]. As people experience arousal their SNS is activated, resulting in increased sweat gland activity and skin conductance. Several studies using picture stimuli, for example, have shown that EDA is highly correlated with self-reported emotional arousal.

However, the interpretation of psychophysiological measures is highly dependent on the context and research paradigm [5] and they have not been properly validated in the context of digital games. Although there is some evidence that tonic (i.e., averaged across the whole play session) facial EMG and EDA are associated with emotional processes during digital game playing [3], it is not clear whether they can be used to index emotional responses to in-game events. Therefore, in this paper, we examine the relationship of phasic facial EMG and EDA responses to different in-game events with self-reported emotions elicited by these events.

Methods

Participants were 40 (21 male and 19 female) volunteering Finnish young adults, who ranged from 18 to 31 (mean = 22.7) years of age and played digital games at least four hours per month.

The game used was FUGAmod, a custom-made mod based on popular first-person shooter (FPS) game Half-Life 2 (Valve Corporation, Bellevue, WA, 2004), played on a powerful desktop computer. According to the story conveyed to the players beforehand, the player character (PC) is a freedom fighter in a dystopian future that needs to rescue some people (allies), one by one, from an occupied building and distinguish these from enemy spies. The facial expression of the non-player characters (NPCs) was also varied. Accordingly, there were (a) smiling allies that should be rescued, (b) smiling spies that should be killed, (c) frowning allies that should be rescued, and (d) frowning spies that should be killed. Each of these NPC subtypes occurred three times during the task, so there were a total of 12 NPC encounters in the entire play period. The game automatically sent codes for different in-game events to the psychophysiological data acquisition system via a serial cable. The played game was stored as digital video. After playing the game, the participants saw 6-s video clips of the in-game events and self-rated their emotional responses on the valence and arousal dimensions to each event.

During the game, skin conductance was recorded with the Psylab Model SC5 24 bit digital skin conductance amplifier that applied a constant 0.5 V across Ag/AgCl electrodes with a contact area of 8 mm diameter (Med Assoc. Inc., St. Albans, VT). Facial EMG activity was recorded from the left corrugator supercilii, zygomaticus major, and orbicularis oculi muscle regions as recommended by Fridlund and Cacioppo [8], using surface Ag/AgCl electrodes with a contact area of 4 mm diameter (Med Assoc. Inc., St. Albans, VT). The raw EMG signal was amplified, and frequencies below 30 Hz and above 400 Hz were filtered out, using the Psylab Model EEG8 amplifier. The digital data collection was controlled by Psylab7 software, and the signal was sampled at a rate of 500 Hz.

Mean values for the psychophysiological measures were derived for one 1-s epoch before each event (this provides a local baseline; Second 1) and for two 1-s epochs after event onset (Seconds 2 and 3). Contrast scores for the linear and quadratic trends across Seconds 1-3 in EMG activity were calculated. The data were analyzed by the Linear Mixed Models procedure in SPSS with restricted maximum likelihood estimation and a first-order autoregressive covariance structure for the residuals.

Results

Table 1 shows the results of the analyses of the relationship of phasic psychophysiological responses to different in-game events with self-reported valence and arousal. It was found that the linear trend across Seconds 1-3 in zygomatic EMG activity (contrast score) was positively associated with self-reported pleasure, $p = .047$. Likewise, the linear trend across Seconds 1-3 in orbicularis oculi EMG activity was positively related to self-reported pleasure, $p = .010$. In addition, the linear trend across Seconds 1-3 in corrugator supercilii EMG activity was negatively related to self-reported pleasure, $p = .003$. Phasic EDA responses were not related to self-reported arousal.

Conclusion

The present study showed that phasic zygomaticus major and orbicularis oculi EMG responses to different events in a FPS game were positively associated with self-reported pleasure elicited by these events when re-watching them. In addition, phasic corrugator supercilii EMG responses to the in-game events were negatively associated with self-reported pleasure. This study provides evidence for the validity of phasic facial

Table 1. *Results of Linear Mixed Models Analyses: Relationship of Self-reported Valence and Arousal with Phasic Physiological Responses to Game Events*

Variable Source	df	F	p
ZM EMG[a]			
Intercept	1, 181.06	2.480	.117
Event type	7, 720.71	.837	.556
Event number[b]	2, 721.57	1.983	.138
Valence[c]	1, 303.77	3.985	.047
Arousal[d]	1, 58.58	.077	.782
CS EMG[a]			
Intercept	1, 328.43	4.336	.038
Event type	7, 747.56	.648	.716
Event number[b]	2, 748.52	.647	.524
Valence[c]	1, 644.82	8.966	.003
Arousal[d]	1, 139.02	.005	.945
OO EMG[a]			
Intercept	1, 231.57	3.887	.050
Event type	7, 719.93	1.225	.286
Event number[b]	2, 725.48	.516	.597
Valence[c]	1, 396.83	6.705	.010
Arousal[d]	1, 82.74	.165	.686

Note. EMG = electromyography; CS = corrugator supercilii; OO = orbicularis oculi; ZM = zygomaticus major.
[a]*Linear trend across Seconds 1 through 3 (contrast score)*
[b]*Sequence number of an event*
[c]*Self-reported valence*
[d]*Self-reported arousal*

EMG responses to in-game events as indices of emotional valence. In addition to being of interest to game researchers and media psychologists, we suggest that information on phasic emotional reactions to game events and event patterns can be applied in game design. Phasic EDA responses were, however, not related to self-reported arousal. This questions the validity of phasic EDA responses as measures of arousal during digital game play.

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