Spatial Presence and Emotional Responses to Success in a Video Game: A Psychophysiological Study

Niklas Ravaja[1], Jari Laarni[1], Kari Kallinen[1], Timo Saari[1], Mikko Salminen[1], Jussi Holopainen[2], and Aki Järvinen[3]
[1]M.I.N.D. Lab/CKIR, Helsinki School of Economics, Finland, [2]Nokia Research Center, Finland, [3]Veikkaus, The Finnish National Lottery, Finland
{ravaja@hkkk.fi, laarni@hkkk.fi, kallinen@hkkk.fi, saari@hkkk.fi, misalmin@hkkk.fi, jussi.holopainen@nokia.com, aki.jarvinen@veikkaus.fi}

Abstract

We examined the relationship of self-reported Spatial Presence with emotion-related psychophysiological responses to success (reaching the goal) in a video game among 36 young adults. Event-related changes in facial electromyographic (EMG) activity (an index of emotional valence), electrodermal activity (EDA; an index of arousal), and cardiac interbeat intervals (IBIs) were recorded. The results showed that Spatial Presence was associated with an increase in zygomatic and orbicularis oculi, and a decrease in corrugator supercilii, EMG activity in response to reaching the goal. Spatial Presence was also positively related to EDA, but unrelated to IBI. High Spatial Presence may result in a greater increase in positive affect, and a greater reduction in negative affect, in response to a positive event. Spatial Presence exerts an influence on both the valence and arousal dimensions of emotions. Phasic corrugator supercilii EMG activity may be a particularly useful measure in Presence research.

Keywords--- **Spatial Presence, emotions, facial electromyography, electrodermal activity, interbeat interval, video games**.

1. Introduction

The experience of media users that they are personally and physically present in the displayed environment has been named “Presence,” or more specifically, “Spatial Presence” [1, 2]. It has been suggested that Spatial Presence may have important emotional consequences. That is, media presentations, such as video games, engendering a strong sense of Spatial Presence have been suggested as eliciting higher arousal and enjoyment [1, 3, 4]. People also differ in their ability to experience Presence [5], and these differences may be associated with the emotional responses to the mediated environment. Examining the relationship of Presence with emotional responses is of import both in its own right and because Presence may exert an effect on other important variables and processes (e.g., attention, memory, entertainment, and persuasion) through the mediating influence on emotions [see 1, 6].

Emotions are biologically based action dispositions that have an important role in the determination of behavior [e.g., 7]. Most theorists endorse the view that emotions are constituted by three aspects or components: subjective feeling, expressive behavior, and physiological arousal; others add motivational state or action tendency and/or cognitive processing [7, 8]. A dimensional theory of emotion holds that all emotions can be located in a two-dimensional space, as coordinates of valence and arousal (or bodily activation) [e.g., 7, 9]. The valence dimension reflects the degree to which an affective experience is negative (unpleasant) or positive (pleasant). The arousal dimension indicates the level of activation associated with the emotional experience, and ranges from very excited or energized at one extreme to very calm or sleepy at the other.

The influence of Spatial Presence on arousal is relatively well established by studies using psychophysiological measures [10, 11]. Electrodermal activity (EDA), commonly known as skin conductance, is the primary psychophysiological index of arousal [6]. As people experience arousal their sympathetic nervous system (SNS) is activated, resulting in increased sweat gland activity and skin conductance. EDA has recently been used in a couple of studies examining Presence in virtual environments (VEs). These studies showed that EDA was positively associated with self-reported Presence during exposure to VEs depicting an airplane flight [10] and a pit room with an unguarded hole in the floor leading to a room 20 ft. below [11]. Meehan et al. also found that EDA was higher during exposure to the frightening (i.e., arousing) virtual height situation compared to a non-frightening virtual room [11]. Although these studies showed that EDA is positively related to Presence when the media content is arousing, there is no reason to expect that EDA would increase with increasing Presence when the content of the mediated environment is non-arousing (e.g., a deserted beach of a Caribbean island).

Some studies have associated Presence also with heart rate (HR) changes. Meehan et al. showed that the aforementioned stressful VE depicting a pit room evoked notable HR acceleration (i.e., a decrease in interbeat intervals, IBIs) [11]. In addition, changes in HR correlated positively with self-reported Presence. Apparently, the VE (pit room) was stressful enough to elicit arousal-related HR acceleration that is mediated by the SNS [see 6]. In contrast, Wiederhold et al. found that changes in HR correlated negatively with self-reported Presence when participants were presented with the aforementioned VE depicting an airplane flight [10]. This VE (airplane flight) is likely to have prompted increased attention resulting in HR deceleration that is mediated by the parasympathetic nervous system (PNS) [see 6]. Thus, there are obvious interpretative difficulties associated with HR responses: HR may be either positively or negatively associated with Presence depending on the content of the mediated environment and task demands (e.g., attentional demands).

The relationship of Presence with the valence dimension of emotions is not well established, and psychophysiological studies on this issue are lacking. Although some studies using self-report measures have suggested that Presence may result in greater overall enjoyment [3, 4], the relationship of Spatial Presence with positive and negative emotional responses to specific events in the mediated environment has not been investigated. According to Frijda, events appraised as real elicit emotions, and their intensity corresponds to the degree to which the events appear real [12]. That being so, high Spatial Presence might result in more positive emotional responses to a positive event, for example.

In the present study, we used facial electromyography (EMG) to examine the relationship of Spatial Presence with positive and negative affective responses to success (reaching the goal) in a video game (Super Monkey Ball 2). The facial EMG provides a direct measure of the electrical activity associated with the facial muscle contractions underlying emotional expression, and is the primary psychophysiological index of hedonic valence [6, 13]. 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, during affective imagery and when viewing media [14, 15, 16, for a review, see 6]. In addition, tonic activity at the orbicularis oculi (periocular) muscle area has been associated with positively valenced high-arousal emotions [6].

The preceding discussion provided the foundation for the following hypotheses. Reaching the goal (i.e., a positive event) in a video game would be expected to elicit an increase in zygomatic (Hypothesis 1) and orbicularis oculi (Hypothesis 2) EMG activity for participants reporting high Spatial Presence during the game, but not for participants reporting low Spatial Presence. In contrast, reaching the goal would be expected to prompt a decrease in corrugator EMG activity for participants reporting high Spatial Presence, but not for participants reporting low Spatial Presence (Hypothesis 3). In regard to emotional arousal, there is likely to be high anticipatory arousal before attaining the goal, after which arousal diminishes. However, it would be expected that this reduction in arousal, as indexed by EDA, would be more pronounced for participants reporting low Spatial Presence compared to those reporting high Spatial Presence (Hypothesis 4). We also hypothesized that Spatial Presence would not have an influence on IBI response to reaching the goal (Hypothesis 5). This is because (a) the video game used is likely to elicit both emotional arousal (cardiac sympathetic activity increases) and attentional engagement (cardiac parasympathetic activity increases) and (b) the SNS and PNS have opposing effects on cardiac IBI [6].

2. Methods

2.1. Participants

Participants were 36 (25 male and 11 female) Finnish undergraduates with varying majors (1 participant was about to apply to the University), who ranged from 20 to 30 years of age. All participants played video or computer games at least once a month. They participated in return for three movie tickets.

2.2. Video game

In the present study, we used a video game called Super Monkey Ball 2 (Sega Corporation, Tokyo, Japan). The game was played with the Nintendo GameCube (Nintendo Co., Ltd., Kyoto, Japan) and presented on a screen using the Panasonic PT-LC75E Multimedia Projector (Matsushita Electric Industrial Co., Ltd., Osaka, Japan). The image size was 114 cm (width) × 85 cm (height), and the distance between the player's eyes and the screen was about 200 cm.

The game takes place in a surrealistic world with bright colors and includes a game board hanging in the air and a cute little monkey trapped in a transparent ball. The game view is from behind the monkey. The player's task is to tilt the board to roll the ball towards a particular goal without falling off the edge of the board to the deep. The player needs to avoid obstacles and pick objects as the monkey rolls around the stages. The aim was to clear each stage with as high a score as possible. The player had 1 min to clear each stage and earned extra points for clearing the stage in 30 s or less. The practice session was played at the Beginner level, and the actual two play sessions, easy and difficult, were played at the Beginner and Advanced levels, respectively. Super Monkey Ball 2 is a relatively nonviolent game with happy background music and atmosphere. It requires fast reflexes and some strategy.

2.3. Procedure

When arriving to the laboratory, the participant returned a number of questionnaires (e.g., gaming habits, personality, temperament) that had been sent to him or her beforehand. After a brief description of the experiment (the participant was told that the researchers were interested in measuring his or her psychological processes and physiological activity during playing video games), the participant filled out an informed consent form. Electrodes were then attached and the participant was seated in a comfortable armchair, followed by a rest period of 7 min. The participants played four different video games in a random order. There were three 5-min game sessions for each of the four games; that is, a practice session and two actual play session (i.e., easy and difficult). In the present study, we used only data from Super Monkey Ball 2 played at the Beginner level. The participant was told that the three best male and female gamers would be awarded one movie ticket as a bonus. After each of the actual game sessions, the participant rated the sense of Presence experienced during the game and his or her emotional responses to the game on several dimensions (the items were presented on a computer screen). The room was dimly illuminated during the rest period and when playing the games. After playing all games, the electrodes were removed, the participant was debriefed, and thanked for his or her participation.

2.4. Presence

The sense of Presence of the participants was measured after each game with the ITC-Sense of Presence Inventory (ITC-SOPI), a 44-item self-report instrument [17]. Previous work with the ITC-SOPI has identified four separate factors: (a) Spatial Presence (19 items; e.g., "I had a sense of being in the game scenes," "I felt I was visiting the game world"), (b) Engagement (13 items; e.g., "I felt involved [in the game environment]," "My experience was intense"), (c) Ecological Validity/Naturalness (5 items; e.g., "The content of the game seemed believable to me," "The game environment seemed natural"), and (d) Negative Effects (6 items; e.g., "I felt dizzy," "I felt nauseous"). In the present study, we used only the items addressing the Spatial Presence factor. The wording of some of the items was slightly altered to adapt the instrument specifically for use with video games. Each of the items was rated on a 5-point scale, ranging from 1 (strongly disagree) to 5 (strongly agree). The psychometric properties of the instrument have been shown to be acceptable.

2.5. Physiological data collection

Electrocardiogram (ECG) was recorded using the Psylab Model BIO2 isolated AC amplifier (Contact Precision Instruments, London, UK), together with three EKG leads in a modified Lead 2 placement. IBIs (ms) were measured with the Psylab Interval Timer.

Facial EMG activity was recorded from the left corrugator supercilii, zygomaticus major, and orbicularis oculi muscle regions as recommended by Fridlund and Cacioppo [18], using surface Ag/AgCl electrodes with a contact area of 4 mm diameter (Med Assoc. Inc., St. Albans, VT). Electrodes were filled with TD-240 electrode gel (Med Assoc. Inc). 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 raw signal was rectified and integrated using the Psylab INT8 contour following integrator (time constant = 50 ms).

EDA (skin conductance level, SCL) 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.). Electrodes were filled with TD-246 skin conductance electrode paste (Med Assoc. Inc.) and attached to the middle phalanges of the first and second fingers of the subject's nondominant hand after hands were washed with soap and water.

The digital data collection was controlled by Psylab7 software, and all physiological signals were sampled at a rate of 500 Hz.

2.6. Video recording of the game

During the game, the output signal (video and audio) from the GameCube was stored as digital video (25 frames per second) with the V1d Random Access Video Recorder/Player (Doremi Labs, Inc., Burbank, CA). Psylab7 software was used to trigger the V1d Disk Recorder to start recording the game screen at the same time when the physiological data collection started. After calibrating the timing, the recorded video image of the game screen was in time synchrony with the physiological data with a one-frame (40-ms) accuracy.

2.7. Event scoring

The exact onset time of reaching the goal was determined by examining each of the played games, frame by frame, using V-ToolsPro 2.20 software. The onset times were saved as CSV files that were then converted with special software (V1 Clip Converter for Psylab) and imported into Psylab7 software. The participants reached the goal, on the average, 6.6 times (range: 4 to 9).

2.8. Data reduction and analysis

Mean values for the psychophysiological measures (i.e., facial EMG, SCL, IBI) were derived for two 1-s epochs before reaching the goal (this provides a local baseline; seconds 1 and 2) and for six 1-s epochs after the attainment of the goal (seconds 3 to 8).

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. Participant ID was specified as the subject variable, and the sequence number of an event and second (seconds 1 to 8) were specified as the repeated variables. We created seven (orthogonal) contrast variables that compared the different seconds; for example, Contrast 1 was seconds 1 and 2 (local baseline = Time 1) vs. seconds 3, 4, 5, 6, 7, and 8 (time after event onset = Time 2). These contrast variables and Spatial Presence were entered as covariates. This results in an analysis that is identical to an analysis with second as a factor, but enables the examination of interactions between second (or the contrast variables) and the (continuous) Spatial Presence score. We specified a fixed-effects model that included (a) the main effects of the seven contrast variables, (b) the main effect of Spatial Presence, and (c) the Contrast 1 × Spatial Presence interaction. When interpreting the results, high and low Spatial Presence was defined as scores 1 *SD* above and 1 *SD* below the mean on the Presence measure, respectively.

3. Results

The average Spatial Presence rating was 2.7 (SD = 0.8). In agreement with Hypothesis 1, the Linear Mixed Models procedure showed that the Contrast 1 × Spatial Presence interaction was significant in predicting zygomaticus major EMG activity, $F(1, 166.12) = 9.47$, $p = .002$. Inspection of the estimated marginal means revealed that reaching the goal elicited an increase in zygomatic activity for participants reporting high Spatial Presence during the game (Ms = 2.69 ln[μV] and 2.76 ln[μV] for Time 1 and Time 2, respectively), whereas it prompted a decease in zygomatic activity for participants reporting low Spatial Presence (Ms = 2.97 ln[μV] and 2.93 ln[μV] for Time 1 and Time 2, respectively).

In addressing Hypothesis 2, it was found that the Contrast 1 × Spatial Presence interaction only approached statistical significance when predicting orbicularis oculi EMG activity, $F(1, 171.84) = 3.71$, $p = .056$. Attaining the goal tended to elicit a more pronounced increase in orbicularis oculi activity for participants reporting high Spatial Presence (Ms = 2.42 ln[μV] and 2.59 ln[μV] for Time 1 and Time 2, respectively) compared to those reporting low Spatial Presence (Ms = 2.15 ln[μV] and 2.26 ln[μV] for Time 1 and Time 2, respectively).

As hypothesized (Hypothesis 3), there was a significant Contrast 1 × Spatial Presence interaction in predicting corrugator supercilii EMG activity, $F(1, 145.64) = 17.07$, $p < .001$. Reaching the goal elicited a decrease in corrugator activity for participants reporting high Spatial Presence (Ms = 2.88 ln[μV] and 2.80 ln[μV] for Time 1 and Time 2, respectively), but not for participants reporting low Spatial Presence (Ms = 3.70 ln[μV] and 3.71 ln[μV] for Time 1 and Time 2, respectively).

In agreement with Hypothesis 4, the Contrast 1 × Spatial Presence interaction was significant in predicting SCL, $F(1, 35.67) = 7.48$, $p = .010$. Attaining the goal prompted a more pronounced reduction in SCL for participants reporting low Spatial Presence (Ms = 0.640 log[μS] and 0.637 log[μS] for Time 1 and Time 2, respectively) compared to those reporting high Spatial Presence (Ms = 0.678 log[μS] and 0.677 log[μS] for Time 1 and Time 2, respectively).

As expected (Hypothesis 5), the Contrast 1 × Spatial Presence interaction was nonsignificant in predicting IBI, $F(1, 200.35) = 0.01$, $p = .930$.

4. Conclusions

This study is the first to show that Spatial Presence is related not only to the arousal dimension of emotions, but also to the valence dimension as measured by facial EMG. The results showed that self-reported Spatial Presence was associated with an increase in zygomatic and orbicularis oculi EMG activity in response to reaching the goal in the video game (i.e., a positive event; in the case of orbicularis oculi activity, the association narrowly failed to reach statistical significance, however). That is, given that zygomatic and orbicularis oculi activity index positive emotions [6], high Spatial Presence resulted in more positive emotional responses to a positive event.

The results also showed that Spatial Presence was strongly associated with a decrease in corrugator supercilii EMG activity in response to reaching the goal. That is, given that corrugator supercilii EMG activity indexes negative emotions [6], high Spatial Presence resulted in a greater reduction in negative affect in response to a positive event.

The bipolar valence dimension has been suggested to represent the integration of two separable and partially distinct components of the affect system, that is, positive affect and negative affect [16, 19]. It is somewhat unclear, however, whether zygomatic and corrugator activities are uniquely sensitive to positive affect and negative affect, respectively, or whether positive and negative affect have reciprocal effects on facial EMG measures [16]. Thus, the stronger relationship of Spatial Presence with corrugator compared to zygomatic activity may (a) indicate that Spatial Presence is more strongly related to negative affect compared to positive affect or (b) be due to the previously observed stronger linear effect of valence on activity over corrugator supercilii versus zygomaticus major [14].

Several authors have suggested that psychophysiological parameters might be used as measures of Presence [11, 20]. The present study provides evidence for the validity of facial EMG, particularly corrugator supercilii activity, as a measure of Presence. An apparent limitation of the present study was, however, that we did not compare different mediated environments putatively eliciting varying levels of Presence [cf. 11]. Therefore, sensitivity of facial EMG as a measure of Presence remains to be established. It should also be emphasized that facial EMG is primarily a measure of hedonic valence (or positive and negative emotions) rather than a direct measure of Presence [6]. This is the case for all psychophysiological measures, however (i.e., they are primarily measures of arousal or attention) [6].

It is also of note that we measured phasic EMG responses to a specific event in the mediated environment. There is no reason to expect that tonic EMG activity averaged across a longer exposure to a mediated environment involving both positive and negative events would be related to Spatial Presence. That is, when examining tonic EMG activity, Presence-related increases in positive and negative responses would be expected to cancel each other out. Thus, in most connections, only phasic EMG responses may be useful as measures of Presence.

In agreement with prior studies [10, 11], the results showed that Spatial Presence was positively related to arousal as measured by EDA. Although all participants experienced a reduction in (anticipatory) arousal after attaining the goal, this reduction was less pronounced for participants reporting high Spatial Presence compared to those reporting low Spatial Presence. An apparent advantage of EDA as a measure of Presence-related emotional arousal is that, physiologically, it is influenced only by the SNS (this results in high diagnosticity) [6].

In disagreement with some prior studies [10, 11], we found that Spatial Presence was unrelated to cardiac IBI changes. This is probably because the video game (i.e., an active coping task requiring sensory intake) may elicit both emotional arousal and attentional engagement. That is, in this connection, high Spatial Presence may prompt heightened (a) emotional arousal accompanied by SNS activity and (b) attention accompanied by PNS activity. Thus, given the opposing effects of the SNS and PNS on IBI [6], Spatial Presence is likely to be unrelated to IBI when the mediated environments prompts both arousal and attentional engagement (sensory intake). However, IBI (or HR) may be a useful measure of Presence when the mediated environment elicits only (or mostly) arousal or only (or mostly) increased attention, Presence being negatively and positively related to IBI, respectively.

In interpreting the present findings, the correlational nature of the present study should be allowed for. That is, in principle, it is possible that emotional reactions exert an influence on Spatial Presence rather than vice versa. For example, it is possible that emotional arousal influences the distribution of attention, thereby exerting an effect on Spatial Presence [see 6]. However, we feel that it is unlikely that the valence dimension of emotions would have a causal effect on Presence.

In sum, the present study showed that a high sense of Spatial Presence was related to increased positive, and decreased negative, emotional responses to success in a video game as measured by facial EMG. Spatial Presence was negatively and particularly strongly related to activity over corrugator supercilii. Spatial Presence was also related to higher arousal as measured by EDA, but it was unrelated to IBI. Spatial Presence may exert an influence on both the valence and arousal dimension of emotions.

References

[1] Lombard, M., & Ditton, T. (1997). At the heart of it all: The concept of presence. *Journal of Computer Mediated Communication [Online],* *3*(2). http://www.ascusc.org/jcmc/vol3/issue2/lombard.html.

[2] Wirth, W., Hartmann, T., Böcking, S., Vorderer, P., Klimmt, C., Schramm, H., Saari, T., Laarni, J., Ravaja, N., Gouveia, F.R., Biocca, F., Sacau, A., Jäncke, L., Baumgartner, T., & Jäncke, P. (2003). *Constructing presence: A two-level model of the formation of spatial presence experiences*. Manuscript submitted for publication.

[3] Heeter, C. (1995). Communication research on consumer VR. In F. Biocca & M.R. Levy (Eds.), *Communication in the age of virtual reality*. Lawrence Erlbaum Associates, Hillsdale, NJ, pp. 191-218.

[4] Lombard, M., Reich, R.D., Grabe, M.E., Bracken, C.C., & Ditton, T.B. (2000). Presence and television: The role of screen size. Human Communication Research, 26, 75-98.

[5] Witmer, B. & Singer, M. (1998). Measuring presence in virtual environments: A Presence Questionnaire. *Presence: Teleoperators and Virtual Environments, 7*, 225-240.

[6] Ravaja, N. (2004). Contributions of psychophysiology to media research: Review and recommendations. *Media Psychology, 6,* 193-235.

[7] Lang, P.J. (1995). The emotion probe. Studies of motivation and attention. *American Psychologist, 50,* 372-385.

[8] Scherer, K.R. (1993). Neuroscience projections to current debates in emotion psychology. *Cognition and Emotion, 7,* 1-41.

[9] Larsen, R.J., & Diener, E. (1992). Promises and problems with the circumplex model of emotion. In M. Clark (Ed.), *Review of personality and social psychology* (Vol. 13). Sage, Newbury Park, CA, pp.25-59.

[10] Wiederhold, B.K., Jang, D., Kaneda, M., Cabral, I., Lurie, Y., May, T., Kim, I.Y., Wiederhold, M.D., & Kim, S.I. (2001). An investigation into physiological responses in virtual environments: An objective measurement of presence. In G. Riva & C. Galimberti (Eds.), *Towards CyberPsychology: Mind, Cognition, and Society in the Internet Age*. IOS Press, Amsterdam, pp 176-183.

[11] Meehan, M., Insko, B. Whitton, M., & Brooks Jr., F. P. (2002). Physiological Measures of Presence in Stressful Virtual Environments. *ACM Transactions on Graphics, Proceedings of ACM SIGGRAPH 2002, 21(3)*, 645-653.

[12] Frijda, N. (1988). The laws of emotion. *American Psychologist, 43,* 349-358.

[13] Tassinary, L.G., & Cacioppo, J.T. (2000). The skeletomotor system: Surface electromyography. In J.T. Cacioppo, L.G. Tassinary, & G.G. Berntson (Eds.), *Handbook of psychophysiology* (2nd ed.). Cambridge University Press, New York, NY, pp. 163-199.

[14] Lang, P.J., Greenwald, M.K., Bradley, M.M., & Hamm, A.O. (1993). Looking at pictures: Affective, facial, visceral, and behavioral reactions. *Psychophysiology, 30,* 261-273.

[15] Ravaja, N., Kallinen, K., Saari, T., & Keltikangas-Järvinen, L. (2004). Suboptimal exposure to facial expressions when viewing video messages from a small screen: Effects on emotion, attention, and memory. *Journal of Experimental Psychology: Applied, 10,* 120-131.

[16] Larsen, J.T., Norris, C.J., Cacioppo, J.T. (2003). Effects of positive and negative affect on electromyographic activity over zygomaticus major and corrugator supercilii. *Psychophysiology, 40,* 776-785.

[17] Lessiter, J., Freeman, J., Keogh, E., & Davidoff, J. (2001). A cross-media presence questionnaire: The ITC-Sense of Presence Inventory. *Presence: Teleoperators and Virtual Environments, 10,* 282-297.

[18] Fridlund, A.J., & Cacioppo, J.T. (1986). Guidelines for human electromyographic research. *Psychophysiology, 23,* 567-589.

[19] Cacioppo, J.T., & Gardner, W.L. (1999). Emotion. *Annual Review of Psychology, 50*, 191-214.

[20] Pugnetti, L., Meehan, M., & Mendozzi, L. (2001). Psychophysiological correlates of virtual reality: A review. *Presence: Teleoperators & Virtual Environments, 10,* 384-400.