Effects of non-diegetic information on presence: A content manipulation experiment

David Nunez
ACSENT Laboratory
Department of Psychology
University of Cape Town
david.nunez@uct.ac.za

Abstract

The role of VE content in the presence experience is controversial. Although a strong theoretical argument has been made that presence depends on the form of information presented and not the content, several relational studies have shown that content is strongly associated to presence. This paper presents an experiment which manipulated non-diegetic music played during exposure to a strongly themed VE into three conditions: Music related to the VE theme, music unrelated to the VE theme, and a baseline with no music. The results (using the ITC-SOPI as measure of presence) show that non-diegetic music affects how natural the subjects experience the VE as being, but not spatial presence. A surprising result was the predictive power of emotion (as measured by the Izard DES-II) on all presence factors. The implications of the findings to presence theory in general, and to a cognitive expectation based view of presence in particular, are discussed.

Keywords--- **Presence, Content, Cognition, Non-diegetic, Music, Theory.**

1. Introduction

Among the debates which exist in the presence literature, that of the role of VE content on the experience is perhaps the most interesting, and certainly among the most theoretically important. Slater [1] outlined the debate in a short but important paper which separated *spatial presence* from other concepts such as *engagement* and *involvement* with the content. One might summarize this paper by stating that presence is about feeling *that* one is in a place, and not *how* one feels about being there (the example used in [1] is that presence would be the sense that one is physically in a concert hall, and this would be independent of engagement with the content - whether one enjoyed the music there, or found it boring). An opposing view had been previously expressed by others such as Fencott [2] and Schubert *et al*. [3], who argued that the contents of the VE (both in terms of objects, structure, and the events that unfold in it) can be strong determinants of presence. Others such as Baños *et al*. [4, 5] and, indirectly, Lessiter *et al* [6], have presented similar arguments and data which suggest a relationship between spatial presence and engagement (particularly emotional engagement) with the VE content. Most recently Nunez & Blake [7] empirically demonstrated a direct relationship between spatial presence and content related factors by showing that spatial presence (as well as engagement) is well predicted by measures of a subject's interest in and familiarity with the content of the VE.

There also exist some predictions in extant models of presence for a relationship between content and presence. The models of Waterworth & Waterworth [8] and Riva & Waterworth [9] argue that presence occurs due to a selection of and orienting towards information which is important to the organism. One must assume that important events and information in the environment are not marked as such, but are previously known to be important in some way by the organism. Therefore, some content of the environment would be important and relevant to presence, while other might not. In a VE, the inclusion or exclusion of this important information should thus affect the presence experience. Some evidence for this comes from Bouchard *et al.* [10] who found that for subjects with a phobia for snakes, the knowledge that a VE contained snakes (important information to such a person) affected their presence experiences. A second model which explicitly considers the role of content in the VE is the measures, effects, conditions (MEC) model of Wirth *et al.* [11], which proposes that *domain-specific interest* (DSI - a measure of how personally invested the subject is in the content of the VE) is an important determinant of spatial presence. According to this model, DSI acts by attracting and maintain the subject's attention on VE elements which are attuned to the subject's idiosyncratic DSIs.

Although this evidence is suggestive of a relationship between the content of the VE and presence, the studies in this area are mostly relational in design, which prevents a conclusive inference of causality [12]. This paper presents a experiment, which manipulates VE content and should thus be capable of determining if VE content is a causal factor in presence.

1.1 Non-diegetic music

Non-diegetic music is a term used by film-makers to refer to music which does not arise from the space in

which the film action occurs [13]. Although it is not located spatially in the environment of the film, it is usually semantically or emotionally related to the events portrayed on the screen. From a presence perspective, non-diegetic music is interesting because it reduces the fidelity of the display. Data from Nunez & Blake [14] however suggests that veteran game players consider non-diegetic music an important contributor to their presence experiences. From a theoretical point of view, the role which non-diegetic music may play in a presence experience is unclear. For example, the three-pole model [15] would predict that non-diegetic music would reduce presence, as it would pull the presence experience away from the VE pole towards the mental imagery pole. Similarly, the environment selection model [16] would predict that non-diegetic music would reduce presence as it would be a non-immersive distracter. On the other hand, the focus-locus-sensus model [8] would predict that non-diegetic music could stimulate the sensus dimension, thereby enhancing presence; similarly, the measures effects and conditions (MEC) model [11] would predict that non-diegetic music would help direct focused attention on the medium, and the music might interact with domain-specific interest to enhance presence. An empirical investigation of a possible non-diegetic music effect is therefore necessary to resolve this theoretical ambiguity.

1.2 A mechanism for the interaction of non-diegetic music and immersive VE content

A model of the interaction of content with the subject's knowledge was outlined by Nunez & Blake [7]. In this model, the subject's knowledge of a particular content area is encoded in declarative memory as a network of knowledge schemata. On initially interacting with a VE, some of these schemata are activated, and by the connections between them, the activation spreads to form a thematic processing bias, in the form of expectations for the experience. The data presented in that paper suggests that the degree to which these expectations are matched predicts the degree of presence experienced by the subject [7]. The model therefore sees presence as the interaction of top-down information (schemata based expectation) and bottom-up information (perception of the immersive display) in a specific semantic context, provided partly by the subject's own experience and knowledge, and partly by the content of the VE.

As an information source, non-diegetic music encodes nothing about the VE itself. The music does not originate from any place in the VE, and is therefore not subject to any spatial transformations (such as distance attenuation, echoes, etc). Also, it does not contribute towards the fidelity of the system; in fact it probably detracts from the fidelity of the system by making the experience hyperreal [17]. Non-diegetic music can, however, encode semantic information (such as themes and moods) which matches the expectations created by the content of the VE. It is therefore possible for non-diegetic music to match theme related expectations which the subject may hold, and thereby affect the presence experience. In effect, non-diegetic music can add to the thematic bias under which the subject processes the VE.

1.3 Predicted effects of non-diegetic music on the presence experience

It should be noted that because non-diegetic music does not encode any spatial information, it is not expected to affect the subject's spatial presence experience. Rather, it is expected that the semantic information contained in non-diegetic music will affect forms of presence which rely more on semantic processing rather than perceptual processing, such as engagement with the VE, and the sense of naturalness or realism of the experience [6, 7]. It should be noted that the positive effect on presence hypothesized above refers only to the case where the non-diegetic information matches the VE content. For the case where the non-diegetic information does not the expectation, two equally plausible outcomes exist. The first outcomes assumes that presence requires a certain degree of coherence among the various information sources which a subject uses to construct the presence experience [11, 18]. A mismatch between the diegetic and non-diegetic information sources will prevent a coherent semantic context from forming, and the low content bias will lead to a poor construction of the environment, and an impoverished presence experience. The second outcome assumes that attention filters sensory stimulation partly based partly on semantic content, as evidenced by priming effects on attention [19, 20]. In this case, the lack of fit between non-diegetic music and the subject's expectation will lead to the music being filtered out, and as it is not processed further, will have no effect on the presence experience.

2. Procedure

2.1 Sample

A total of 181 subjects participated (145 women and 36 men; Age M = 21.45, S = 3.46). A self-rating measure of computer and gaming experience (on a 6 point scale, with 6 indicating expert status) showed the same to be novices at computer use (M = 1.6; S = 0.6) as well as computer game playing (M = 0.2, S = 0.8).

2.2 Design

This study examines the interaction of content from two sources: From the semantic theme of the VE itself (which is held constant across subjects), and from non-diegetic music which plays in the background during the VE experience. It was decided not to manipulate VE content because it is not known on which dimensions content varies;

it is therefore extremely difficult, given two VEs, to show that they are equivalent in all respects except in terms of the semantic content. It would have been possible to adopt the strategy used by Nunez & Blake [7], and select only subjects which have an interest in or knowledge of the content chosen – but that technique precludes random sampling [which is essential to an experimental design – 12]. It was therefore decided to use a single VE, with true randomization of subjects across a single factor (type of non-diegetic music – see 2.3.2 below). Although the content of the VE is constant across conditions, it plays a role in the presence experience by providing the semantic context against the non-diegetic music manipulations can be evaluated.

2.3 Apparatus

The study ran on five desktop computers with the same hardware configuration (17" CRT monitor, Pentium 4 2.8 GHz, 512MB RAM, GeForce 6200128MB graphics card, stereo sound, mouse and keyboard input). The machines produced a measured update rate in the experimental VE ranging between 17Hz and 28Hz at a resolution of 1024x768. The study was run in a dedicated room, which was kept quiet and dark during the duration of the study. The machines were separated by partitions such each subject could only see their own machine during the experiment.

2.3.1 Virtual environment

The experiment used a custom VE system, which simulates an egocentric interactive building walkthrough, and provides an object search and collection task. The system ran on the desktop system described above, using the Quake Keys interaction metaphor [21] for navigation and interaction. Immediately prior to the experiment, subjects were presented with a training VE to familiarize them with the system interface and task. This training VE used a different layout to the main VE used in the experiment, and was not related in theme to the main VE used in the experiment; this was done to avoid learning or priming effects. The main VE represented a European monastery from the medieval period during a stormy and foggy evening. The VE contained two buildings (the monastery and a chapel) and a courtyard between them. The VE contained nineteen rooms spread over three levels. During an experiment run, there were no characters other than the subject in the VE. Each subject performed the task in the VE for a timed period of fifteen minutes.

2.3.2 Non-diegetic music

Non-diegetic music was manipulated into three conditions: fit, no-fit and baseline. In the fit and no-fit conditions, the subjects heard background music during their entire VE experience. In the baseline condition, no background music was played. To select the music for the fit and no-fit conditions, seven candidate pieces of music were presented to ten independent judges, together with a set of fifteen screenshots of the monastery VE. The judges were asked to rate, on a seven point scale, to what extent the theme or genre of the images matched that of the music. The pieces with the highest (M=6.0 out of 7) and lowest (M = 1.7 out of 7) ratings were then chosen for the fit and no-fit conditions. For the purposes of this experiment, no attempt was made to control for one particular reason for music fit (e.g. monastery as mysterious as opposed to monastery as sacred). As the experiment aims only to show that the degree of non-diegetic music fit interacts with VE content during presence, it was sufficient to only ensure that a known degree of fit existed between the VE and the non-diegetic music.

2.4 Measures

Presence was measured using the ITC Sense of Presence Inventory (ITC-SOPI) [6]. This questionnaire measures four factors of the presence experience: Spatial presence (a sense of being in the space), engagement (psychological engagements with the content and enjoyment of the experience), naturalness (congruency with real-world experience or a sense of realism) and negative effects (eyestrain, fatigue, simulator sickness, etc.). The ITC-SOPI was chosen as its factorial structure allows the measurement not only of special presence [as emphasized by 1], but also more strongly semantic factors such as a subject's connection with the content, and their evaluation of the realism (factors which have been implicated in the presence experience by [7]). This allows for great flexibility and range in the interpretation of the subject's experience.

An interesting potential confound in this study was emotion. Bever [22] presented a theoretical argument that music, by its tone and rhythm, can encode particular emotions which are widely recognized by listeners; this theoretical notion is echoed by Pinker [23], although with the qualification that this effect is culture bound. Nevertheless, a number of empirical studies have shown that subjects show a remarkable degree of agreement in their decoding of emotions present in a musical piece [24]. More recent work has identified mode, rhythm and tempo as important variables in producing particular emotional responses [25]. These effects are important as emotion has been theorized as being a significant component of presence: Alcañiz *et al*. [26] and Riva *et al*. [27] have proposed that emotion acts as mediator to the content of virtual environments in the presence experience. This notion has some empirical support. In two studies, Baños *et al*. [4, 5] showed that presence correlates with emotion, and that presence scores can be changed by manipulating the emotional tone of the environment.

Because the design of this study requires the manipulation of background music in the environment, it is possible that the music pieces selected will lead to a

difference in presence scores across conditions due to emotional differences produced by the music, and not due to the semantic fit between the VE content and the music. This was a particularly concern in this study as the music selected by the judges for the for the fit condition was dark and moody, while that chosen for the no-fit condition was upbeat and light. As a control for this potential problem, the study included a measure of emotion response as a control - the second edition of Izard's differential emotions scale (DES-II [28]). This scale contains 30 items, each either a word or phrase describing an emotion; subjects are asked to rate the degree to which they felt that emotion during the experience on a seven point scale. The DES-II has been recently validated and psychometrically evaluated for research use [29].

3. Results

3.1 Factorization of the DES-II

The DES-II data were factor analyzed to produce two factors, using a varimax rotation to maximize inter-factor variance. Items were considered as loading on a factor if the factor loading was higher than 0.7; 10 of the original 30 items were retained. The resulting factor structure (shown in Table 1 below) supports the two-factor model (positive emotion/negative emotion) proposed by Izard for this scale [28]. The negative emotion factor explains 0.23 of the total variance (eigenvalue 6.983), while the positive factor explains 0.20 of the total variance (eigenvalue 5.740). For the purpose of this study, a third factor was constructed a-priori from the DES-II, to measure attention focus. No item loaded on more than one factor.

Positive emotion *(R^2 = 0.20)*	***Negative emotion*** *(R^2 = 0.23)*	***Attention Focus*** *(a priori)*
Happy	Disgusted	Alert
Joyful	Disdainful	You were concentrating
Surprise	Downhearted	Attentive
Amazed	Angry	
	A feeling of revulsion	
	Scornful	

Table 1: DES-II items included in each of the factors. The positive and negative emotion factors were produced by a factor analysis; the attention focus (not a standard DES-II factor) factor was produced *a-priori*.

3.2 Manipulation effects on emotion

Each of the three DES-II emotion factors were analyzed using a one-way analysis of variance, to test for differences in emotion produced by the different music conditions. No such effects were found on any of the three DES-II factors (see Table 2 below).

3.3 Relationship between emotion and presence

To test if emotions were associated with presence scores (as predicted by [5, 26]), we conducted zero-order correlations between the four ITC-SOPI factors and the three DES-II factors. All correlations were significant, with positive emotion and attention focus being positive predictors of presence, and negative emotion being a negative predictor of presence. The results are shown in Table 3 below.

DES-II factor	***df***	***F***	***p***
Positive emotion	2	0.223	0.800
Negative emotion	2	1.605	0.347
Attention focus	2	0.042	0.959

Table 2: ANOVA results for effect of Non-diegetic music condition on each DES-II factor.

DES-II factor	***ITC-SOPI factor***			
	Spatial	***Engagement***	***Naturalness***	***Negative Effects***
Positive emotion	0.56	0.69	0.47	-0.32
Negative emotion	-0.18	-0.26	-0.19	0.32
Attention focus	0.55	0.65	0.41	-0.31

Table 3: Zero-order correlations between presence and DES-II scores. All correlations are significant at the 0.05 level.

3. 4 Modeling presence from emotion and music fit condition

Due to the significant zero-order correlations between presence and the DES-II factors, it was decided to include these into the analysis of presence as covariates. The data were analyzed with a set of general linear models (GLM), which allow the modeling of a single continuous dependent variable using a mix of continuous and categorical predictors [30, 31]. Each ITC-SOPI factor was predicted using a model which included the non-diegetic music fit condition and the three DES-II factors.

3.4.1 Spatial factor

For this factor, the overall model is significant: $F(5, 175) = 23.231$, $p < 0.0001$, $R^2 = 0.381$. See Table 4 below for effects (the intercept results have been excluded

from the table for the sake of clarity). Analysis of the effects shows that it is only the DES-II positive emotion and attention focus factors which are significant predictors. Positive emotion has a partial correlation of 0.322 (R^2 = 0.377), while attention focus has a partial correlation of 0.337 (R^2 = 0.354).

3.4.2 Engagement factor

For this factor, the overall model is significant: F(5, 175) = 49.285, p < 0.0001, R^2 = 0.584. See Table 5 below for effects (the intercept results have been excluded from the table for the sake of clarity).

Effect	*df*	*F*	*p*
Izard Attention Focus	*1*	*22.46*	*0.0001*
Izard Positive	*1*	*20.38*	*0.0001*
Izard Negative	1	1.12	0.292
Non-diegetic music	2	1.37	0.258

Table 4: GLM results for the ITC-SOPI spatial factor. Significant effects (p < 0.05) are in italics

Analysis of the effects shows that all three DES-II factors predict engagement (but not the experimental conditions). Positive emotion has a partial correlation of 0.469 (R^2 = 0.377), negative emotion has a negative partial correlation of -0.192 (R^2 = 0.056), and attention focus has a partial correlation of 0.431 (R^2 = 0.354).

Effect	*df*	*F*	*p*
Izard Attention Focus	*1*	*39.94*	*0.0001*
Izard Positive	*1*	*49.51*	*0.0001*
Izard Negative	*1*	*6.74*	*0.010*
Non-diegetic music	2	0.01	0.991

Table 5: GLM results for the ITC-SOPI engagement factor. Significant effects (p < 0.05) are in italics

3.4.3 Naturalness

For this factor, the overall model is significant: F(5, 175) = 14.507, p < 0.0001, R^2 = 0.293. See Table 6 below for effects (the intercept results have been excluded from the table for the sake of clarity). Analysis of the effects shows a similar pattern to the spatial factor: the positive emotion and attention focus factors of the DES-II scale predict engagement. Positive emotion has a partial correlation of 0.280 (R^2 = 0.377), and attention focus has a partial correlation of 0.202 (R^2 = 0.354). For this ITC-SOPI factor however, the non-diegetic music fit condition was significant. A Fisher's LSD post-hoc test shows that there was no significant difference between the no-fit (M = 2.896) and no music (M = 3.000) conditions; but the fit condition (M=3.301) was significantly larger than the other two conditions.

Effect	*df*	*F*	*p*
Izard Attention Focus	*1*	*7.507*	*0.006*
Izard Positive	*1*	*14.940*	*0.0001*
Izard Negative	1	0.902	0.343
Non-diegetic music	*2*	*4.984*	*0.007*

Table 6: GLM results for the ITC-SOPI naturalness factor. Significant effects (p < 0.05) are in italics

3.4.4 Negative effects

For this factor, the overall model is again significant: F(5, 175) = 8.475, p < 0.0001, R^2 = 0.194. See Table 7 below for effects (the intercept results have been excluded from the table for the sake of clarity). Analysis of the effects shows that only the negative emotion and attention focus factors predict negative effects. Negative emotion has a partial correlation of 0.281 (R^2 = 0.056); while attention focus has a partial correlation of -0.176 (R^2 = 0.354).

Effect	*df*	*F*	*p*
Izard Attention Focus	*1*	*5.64*	*0.019*
Izard Positive	1	2.69	0.103
Izard Negative	*1*	*15.03*	*0.0001*
Non-diegetic music	2	0.001	0.998

Table 7: GLM results for the ITC-SOPI negative effects factor. Significant effects (p < 0.05) are in italics

4. Discussion

4.1 Support for the predictions of non-diegetic music effects on presence

The predictions made about the role of non-diegetic information on presence were partly supported by the data. Although the non-diegetic music manipulation did not have an effect on the spatial and engagement factors, it was a predictor of the naturalness factor. This non-diegetic effect on naturalness cannot be attributed to any change in emotion produced by the music itself, firstly because there was no main effect of music on emotion, and secondly because the GLM factors out DES-II effects from the music manipulation factor. Finally, the effect cannot be ascribed to the music simply providing more sensory data (as one might argue the multimodality effect works, such as in [32]), because it is only the VE relevant music which gives the benefit. One must therefore conclude that this is a content effect, and not simply an immersion or information load effect.

It was also predicted that the non-relevant music would produce either a negative effect, or no effect at all. There is data to support this prediction, and it has a similar level of support to the positive effects prediction discussed above. Again, only naturalness shows the predicted result: there was no significant difference between the baseline (no-

music) condition and the VE-irrelevant music condition. This suggests that, consistent with the attention based prediction, subjects filter out the semantically irrelevant music such that it has no effect on subsequent processing and therefore no effect on the naturalness of the experience. This finding supports the notion that data for the presence experience (or at least, for the sense of naturalness of the VE), is selected at least partly due to its content.

A subtle but important theoretical point is made by these findings, as they are contrary to what Biocca has termed the 'sensorimotor immersion assumption' [15]. This is the assumption that presence will increase as display fidelity and realism in the simulation increase. The findings of this study show that decreasing the fidelity of the system can (in particular cases) lead to an increase in presence, or to no change at all, depending on the degree of semantic fit between the music and the VE content. This finding is further supported by the finding by Nunez & Blake [14], that experienced computer gamers (which presumably have evolved strategies to maximize their own presence experiences during play) consider background music as an important part of the presence experience.

4.2 Naturalness and the role of expectation in presence

It is interesting that this factor, which could be interpreted as being closely tied to fidelity of the system, should benefit from non-diegetic music, which actually reduces fidelity. A closer examination of the ITC-SOPI factors which define naturalness shows that the factor measures a general sense of the likelihood of the portrayed events happening in the real world, rather than the more specific, physical sense of realism which is measured by the spatial presence factor; this suggests that the naturalness factor (and indeed the evaluation of the realism of the VE) is heavily influenced by content related expectation. This finding echoes the results of Nunez & Blake [7], which found that naturalness was the only ITC-SOPI factor for which thematic inertia (a measure of the degree of cognitive integration of a content area by) and the evaluation of the realism of the VE were equally strong predictors.

A general point which could be made based on this naturalness finding is that presence is not simply a consequence of replacing the subject's sensory stimuli with other, similar stimuli originating from the VE (the definition of immersion given in [33]), but rather that presence occurs when any set of sensory stimuli matches the subject's expectations for what should be occurring in that situation. From this perspective, the reason that non-diegetic music contributes to presence is that when placed in front of a display and shown moving images, subjects have expectations associated with films and television, including an expectation for non-diegetic music which matches the images they see. This accounts for the seemingly counter-intuitive finding that subjects find the interactions more natural or realistic when content relevant non-diegetic is playing – it is not more natural when one expects the VE to be like an unmediated experience (i.e. reality), but it is more natural when one expects the VE to be like a television or film experience.

4.3 Emotion and presence

A surprising finding in this study was the predictive power of the Izard DES-II scale. All four factors were predicted by one or both of the Izard emotion factors. The positive emotion factor predicted three of the four (spatial, engagement and naturalness), while the negative emotion factor predicted two of the four (engagement and negative effects). Furthermore, the pattern of findings is highly intuitive: positive emotion is positively correlated with presence, and negative emotion is negatively correlated with presence. This pattern supports Lessiter et al's [6] suggestion than engagement is associated with enjoyment of the VE (as enjoyment would no doubt generate positive emotions), but the effect seems to generalize out to the other factors of presence, including the fairly automatic spatial presence factor. Although the link between emotion and presence has been demonstrated by Baños et al. [4, 5], it was surprising that after factoring out all the experimental manipulations as well as attention allocation (as measured by the DES-II attention focus factor), the positive and negative emotion scales still emerged as good predictors of presence. Currently, only the levels of presence model of presence [9] provides a significant role for emotion to play in presence, but at the model's current state of development, this is done at a level of abstraction which makes it difficult to make specific predictions. Nonetheless, the findings of this study together with those of Baños et al. [4, 5], suggest that emotion may be an important factor in presence, and should no doubt be included in predictive models in the future. At the very least, measures of emotion (such as the DES-II) should be included into future studies as controls for extraneous variance.

Acknowledgements

This material is based upon work financially supported by the National Research Foundation. Any opinion, findings and conclusions or recommendations expressed in this material are those of the author(s) and therefore the NRF does not accept any liability in regard thereto.

References

[1] Slater, M., *A note on presence terminology*. Presence Connect, 2003. **3**.

[2] Fencott, C. *Presence and the Content of Virtual Environments*. in *2nd International Workshop on Presence*. 1999. Essex, U.K.

[3] Schubert, T.W., F. Friedmann, and H.T. Regenbrecht, *The experience of presence: Factor analytic insights.* Presence: Teleoperators and Virtual Environments., 2001. **10**: p. 266-281.

[4] Baños, R., et al. *Mood Induction Procedures Via Virtual Reality: Induction and Change of Sadness and Joy.* in *38th Annual Association for Advancement of Behavior Therapy Convention*. 2004. New Orleans, USA.

[5] Baños, R.M., et al., *Immersion and Emotion: Their Impact on the Sense of Presence.* Cyberpsychology & Behaviour, 2004. **7**(6): p. 734 -741.

[6] Lessiter, J., et al., *A cross-media presence questionnaire: The ITC-Sense of Presence Inventory.* Presence: Teleoperators and Virtual Environments., 2001. **10**(3): p. 282-297.

[7] Nunez, D. and E.H. Blake. *Content knowledge and thematic inertia predict virtual presence*. in *The ninth international workshop on presence (PRESENCE2006)*. 2006. Cleveland, OH.

[8] Waterworth, J.A. and E.L. Waterworth, *Focus, Sensus and Locus: The three dimensions of virtual experience.* Cyberpsychology & Behaviour, 2001. **4**(2): p. 203-213.

[9] Riva, G., J.A. Waterworth, and J.A. Waterworth, *The layers of presence: A bio-cultural approach to understanding presence in natural and mediated environments. .* Cyberpsychology & Behaviour, 2004. **7**(4): p. 405-419.

[10] Bouchard, S., J. St-Jacques, and P. Renaud, *Anxiety Increases the Feeling of Presence in Virtual Reality.* Presence Connect, 2005. **4**.

[11] Wirth, W., et al., *A Process Model of the Formation of Spatial Presence Experiences.* Media Psychology, 2007. **9**(4).

[12] Rosenthal, R. and R.L. Rosnow, *Essentials of behaviour research: Methods and data analysis.* 1991, New York, NY: McGraw Hill.

[13] Monaco, J., *How to Read a Film: The World of Movies, Media, Multimedia: Language, History, Theory*. 2000, New York, NY: Oxford University Press.

[14] Nunez, D. and E.H. Blake, *Learning, experience and cognitive factors in the presence experiences of gamers: An exploratory relational study.* Presence: Teleoperators and Virtual Environments, 2006. **15**(4).

[15] Biocca, F., *Can we resolve the book, the physical reality and the dream state problems? From the two-pole to a three-pole model of shifts in presence.*, in *EU Future and Emerging Technologies Presence Initiative Meeting*. 2003: Venice, Italy.

[16] Slater, M., *Presence and the sixth sense.* Presence: Teleoperators and Virtual Environments., 2002. **11**(4): p. 435-439.

[17] Favero, P., *"O' Sole Mio": Italian Charter Tourists' Experiences of the Midnight Sun in North Cape, Norway* Anthropological Quarterly, 2000. **73**(1): p. 1-19.

[18] Nunez, D. *A constructionist cognitive model of presence.* in *7th International workshop on presence. (PRESENCE 2004)*. 2004. Valencia, Spain.

[19] Maxfield, L., *Attention and semantic priming: a review of prime task effects.* Consciousness and cognition., 1997. **6**: p. 204-218.

[20] Lavigne, F. and S. Denis, *Attentional and Semantic Anticipations.* International Journal of Computing Anticipatory Systems, 2001. **8**: p. 74-95.

[21] Dalgarno, B. and J. Scott, *Motion control in virtual environments: A comparative study.*, in *Workshop on Usability Centred Design and Evaluation of Virtual 3D Environments*, V. Paelke and S. Volbracht, Editors. 2000, University of Padeborn: Padeborn, Germany.

[22] Bever, T., *A cognitive theory of emotion and aesthetics in music.* Psychomusicology, 1988. **7**(2): p. 165-175.

[23] Pinker, S., *The blank slate: The Modern Denial of Human Nature*. 2002, New York, NY: Viking Adult Press.

[24] Sloboda, J.A., *Music structure and emotional response: Some empirical findings.* Psychology of Music, 1991. **19**: p. 110-120.

[25] Gabreilsson, A. and E. Lindström, *The influence of musical structure on emotional expression*, in *Music and Emotion: theory and research.*, J.A. Sloboda and P.N. Juslin, Editors. 2001, Oxford University Press: New York, NY. p. 223-249.

[26] Alcañiz, M., et al., *The EMMA project: Emotions as a determinant of presence.* Psychnology, 2003. **1**(2): p. 141-150.

[27] Riva, G. and J.A. Waterworth, *Presence and the Self: a cognitive neuroscience approach.* Presence Connect, 2003. **3**(3).

[28] Izard, C.E., *The psychology of emotions*. 1991, London, UK: Plenum Press.

[29] Fuenzalida, C., et al., *Validation of the Differential Emotions Scale in 613 mothers.* Motivation and Emotion, 2005. **5**(1): p. 37-45.

[30] Neter, J., W. Wasserman, and G.A. Whitmore, *Applied statistics.* 1988, Boston, MA.: Allyn and Bacon.

[31] Hastie, T. and R. Tibshirani, *Generalized Additive Models.*, in *Encyclopedia of Statistical Science*. 1997, Wiley: New York, NY.

[32] Sallnäs, E.L. *Presence in multimodal interfaces.* in *2nd International workshop on presence (PRESENCE1999).* 1999. Essex, UK.

[33] Slater, M., *Measuring presence: A response to the Witmer and Singer presence questionnaire.* Presence: Teleoperators and Virtual Environments, 1999. **8**(5): p. 560-565.