

# Presence: Is your heart in it?

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## Introduction

Various researchers have proposed physiological measures as objective correlates of presence (the subjective sensation of 'being there' in a displayed environment). The unifying idea behind this approach is that as presence within a displayed environment increases, physiological reactions will tend towards those that would be observed in a real environment. For example, short-term physiological responses to novel, interesting and threatening stimuli within immersive environments should be more intense as the sense of presence increases (Barfield & Weghorst, 1993; Held & Durlach, 1992). In addition and in line with the behavioural realism approach, the long term physiological characteristics of the affective impact of a content should also be more apparent as the sense of presence increases (Freeman, Avons, Meddis, Pearson & Ijsselsteijn, 2000; Ijsselsteijn, de Ridder, Freeman & Avons, 2000).

Previous research suggests that autonomic information, such as Skin Conductance (SC) and Heart-Rate (HR), may be useful indices of presence. Enhancing display properties, such as increasing screen size and adding motion to images, produces patterns of SC and HR activation usually indicative of attention, as well as more intense reports of subjective arousal (Detenber, Simons & Bennet, 1998; Simons, Detenber, Roedema & Reiss, 1999; Reeves, Lang, Kim & Tatar, 1999). Such display enhancements are also expected to heighten feelings of presence. Indeed, standard presence measures and HR change have been shown to correlate when participants confront a 20ft virtual drop through a head-mounted display, (Meehan, 2000).

One way of further exploring the relationship between presence and autonomic activation would be to examine viewers' reactions to monoscopic and stereoscopic video presentations. Adding binocular depth cues to monoscopic video presentations is a reliable method of enhancing presence (Hendrix & Barfield, 1996; Freeman et al., 2000). Hence, HR and SC should distinguish between these display types if they are to be considered as presence measures. Alternatively, these objective, continuous measures could provide additional information about viewing experiences which are not tapped by post-test subjective ratings scales, which may be prone to demand characteristics and memory biases.

The relationship between autonomic measures and presence may vary according to the type of content presented particularly when the contents differ in emotional impact. Specifically, presence enhancing display manipulations should intensify subjective arousal and autonomic responses in a content congruent way. However, such an investigation has yet to be undertaken. Hence this study presented viewers with monoscopic and stereoscopic versions of one of two opposing contents: one clip depicting a fast paced rally car sequence, the second clip depicting a leisurely boat-ride along a rural waterway.

The effects of a Vistral CRL screen surround were also investigated in this experiment, as it was expected to interact with the other experimental manipulations. The screen surround appears to float around the edges of a standard television screen and is designed to enhance depth in monoscopic images. It may affect presence in a number of ways. It may enhance presence by making the edges of an ordinary television screen appear less apparent. It could also reduce presence if attention were drawn to the edges of the screen, due to its unusual appearance and novelty. The screen surround could also affect presence by providing disguising the picture plane and providing depth information. Any effect of the Vistral on presence and subjective arousal should be mirrored in autonomic measures, if they are reliable indicators of presence.

### **Summary of Design and Method**

119 students from Goldsmiths College and volunteers, recruited from local press advertisements (60 female, 59 male, average age = 24.03 yrs, SD = 6.9), with at least 30sec-arc stereo-acuity took part in the experiment. Participants viewed both monoscopic and stereoscopic versions of either a 100sec rally-sequence or a 100sec boat-sequence, with the Vistral either switched on or off. Thus, Content (Rally vs. Boat) and Vistral (V-on vs. V-off) were between groups factors whereas View (Mono vs. Stereo display) served as a within groups factor. The order of video presentation was counterbalanced. The videos were presented on a 100Hz Phillips 28" monitor at a distance of 1m, rendering a 34.45 degree visual angle. Participants wore Crystal-Eyes polarised spectacles.

Following each presentation participants completed the ITC-Sense of Presence Inventory (ITC-SOPI: Lessiter, Freeman and Keogh, 2001). The ITC-SOPI is a post-test subjective measure of presence. It has three subscales relating to different elements of presence (Sense of Physical Space, Engagement, Ecological Validity) and one subscale addressing adverse physical consequences associated with presentations (Negative Effects).

Before and after each presentation participants completed the Profile of Mood States (POMS: McNair & Douglas, 1984). The POMS is divided into six bipolar scales: Energetic-Tired, Clearheaded-Confused, Elated-Depressed, Composed-Anxious, Agreeable-Hostile and Confident-Unsure. Thus, it addresses specific mood states plus aspects of high and low, positive and negative arousal. An index of mood change over the course of each presentation for each scale was calculated by subtracting the 'before' score from the 'after' score. A positive score indicated change towards a positive mood state while a negative score indicated change towards a negative mood state.

Electrocardiogram (ECG) and SC recordings were taken 100secs before, during and after each of the two presentations participants viewed.

## **Results and Discussion: ITC-SOPI**

### ***Results***

A 2 x 2 x 2 (Content x Vistral x View) Analysis of Variance (ANOVA), with repeated measures on the last factor was calculated for each of the four subscales (See Figure 1 for means)

*Content:* Main effects of Content were found on all four subscales. The boat-sequence received greater ratings of presence and lower ratings of negative effects than the rally-sequence: Physical Space ( $F_{(1,115)} = 14.83, p < .001$ ), Engagement ( $F_{(1,115)} = 15.20, p < .001$ ), Ecological Validity ( $F_{(1,115)} = 19.15, p < .001$ ) and Negative Effects ( $F_{(1,115)} = 4.27, p < .05$ ).

*View:* As predicted, main effects of View were found on the three presence subscales. Stereoscopic presentation was rated higher in presence than monoscopic presentation: Physical Space ( $F_{(1,115)} = 15.07, p < .001$ ), Engagement ( $F_{(1,115)} = 23.60, p < .001$ ) and Ecological Validity ( $F_{(1,115)} = 7.92, p < .01$ ).

*Content x View:* Significant View x Content interactions on two scales indicated that the effects of stereo presentation on presence ratings was most pronounced for the boat-sequence: Physical Space ( $F_{(1,115)} = 7.00, p < .01$ ) and Engagement ( $F_{(1,115)} = 12.20, p < .001$ ).

*Content x Vistral:* Significant Content x Vistral interactions indicated that the difference between contents on two scales was most evident in the V-on condition. In this condition the boat sequence received higher ratings of engagement and lower ratings of negative effects than the rally-sequence: Engagement ( $F_{(1,115)} = 5.50, p < .05$ ) and Negative Effects ( $F_{(1,115)} = 3.96, p < .05$ ).

***Figure 1: ITC-SOPI subscale scores***





### ***Discussion***

*Overall, as predicted, stereo video presentation generated relatively higher ratings of presence than mono presentation. This was most effective for the boat-sequence, possibly because binocular depth cues were more redundant for the rally-sequence, which contains stronger motion-parallax depth cues. However, the conditions were created under which the physiological measures could be evaluated as potential presence measures.*

Interestingly, the boat-sequence generated higher presence ratings than the rally sequence, which generated more reports of negative effects. Thus the ITC-SOPI has been shown to be sensitive to two of the determinants of presence: media form and media content. The boat sequence may have been rated higher in presence due to its greater familiarity. In fact many of the participants had actually visited the location of this sequence.

These differences between contents, for Engagement and Negative Effects, were most apparent when the Vistral was used. It is possible that there is some overlap between Negative Effects and Engagement as the latter includes items relating to whether a mediated experience is a positive experience. The vistral may have been disorienting for viewers during the fast-paced rally sequence in which attention may have frequently been drawn to the edges of the screen and so to the screen surround. The opposite may have been the case for the slower paced boat-sequence. Attention may have been focused more often on the centre of screen and the vistral may have enhanced presence by making the edges of the screen less apparent.

## **Results and Discussion: POMS**

### ***Results***

A 2 x 2 x 2 (Content x Vistral x View) Analysis of Variance (ANOVA), with repeated measures on the last factor was calculated for each of the six subscales:

*Content:* Main effects of Content were found on three subscales: Energetic-Tired ( $F_{(1,115)} = 5.363, p < .05$ ), Agreeable-Hostile ( $F_{(1,115)} = 10.404, p < .01$ ) and Composed-Anxious ( $F_{(1,115)}$

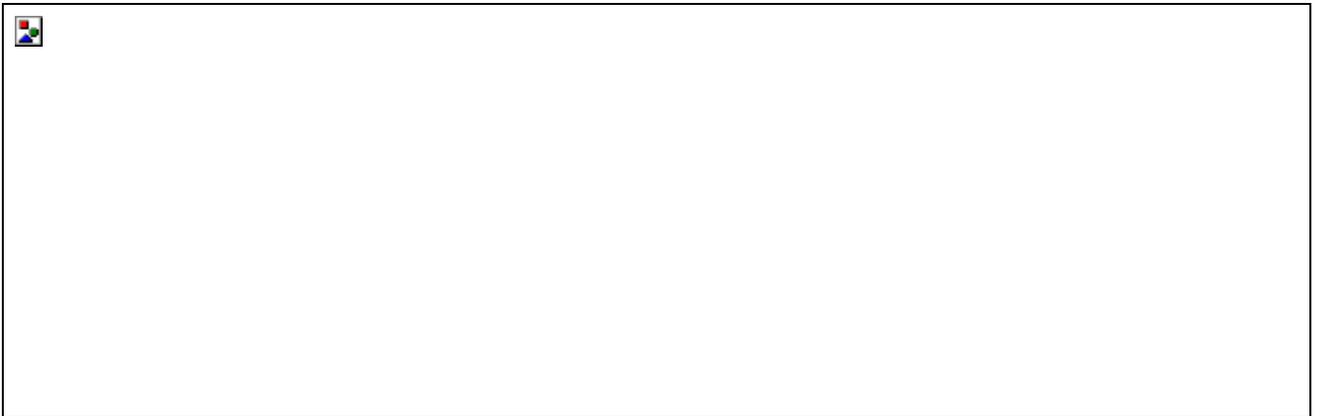
= 22.033,  $p < .001$ ). Overall the boat sequence produced changes towards states of low subjective arousal (tiredness, composure and agreeableness) relative to the rally sequence

*View*: Main effects of View were found on two subscales indicating that stereo presentation maintained some aspects of positive arousal (energy and elation) relative to mono presentation: Energetic-Tired ( $F_{(1,115)} = 12.08$ ,  $p < .01$ ) and Elated-Depressed ( $F_{(1,115)} = 6.44$ ,  $p < .05$ ).

*Content × View*: A significant interaction of Content and View was found on the Composed-Anxious scale ( $F_{(1,115)} = 5.422$ ,  $p < .05$ ). While overall the boat sequence generated a change towards a composed state and the rally-sequence generated a change towards an anxious state, this was significant for stereo presentation only (see Fig. 2).

*Content × Visual × View*: A three way interaction was found on the Clearheaded-Confused scale ( $F_{(1,115)} = 4.366$ ,  $p < .05$ ) indicating that the boat sequence generated a significant change towards clear-headedness relative to a change towards confusion for the rally sequence, for stereo presentations in the V-on condition only (see Fig. 2 for mean scores in the V-on condition only).

***Figure 2: Interactions on the Composed-Anxious and Clearheaded-Confused subscales of the POMS.***





### ***Discussion***

Overall, stereo video presentation was a more positive experience than mono presentation. Interestingly, these effects on mood were independent of content. Whether presence enhancing display properties are generally more arousing or rewarding than standard displays requires further investigation.

The Boat sequence generated changes towards low subjective arousal, relative to the Rally sequence. In line with the behavioural realism approach, this effect was enhanced for stereo presentation in terms of composure-anxiety. That is, as expected, trends that were present during standard video presentation were enhanced during presentations that elicited higher presence.

The use of the Vistral screen surround in conjunction with stereo presentation appeared to have a positive effect for the boat sequence and a negative effect for the rally-sequence. While it was expected that the Vistral would interact differently with different contents and displays its effects on subjective ratings are complex. It is possible that, as the vistral disguises the picture plane, the vistral is confusing for viewers when watching the rally sequence which contains fast-paced motion, particularly when this sequence is presented in stereo, as conflicting depth cues may co-occur (ie. motion, picture plane, and binocular depth cues).

## **Results and Discussion: Skin Conductance**

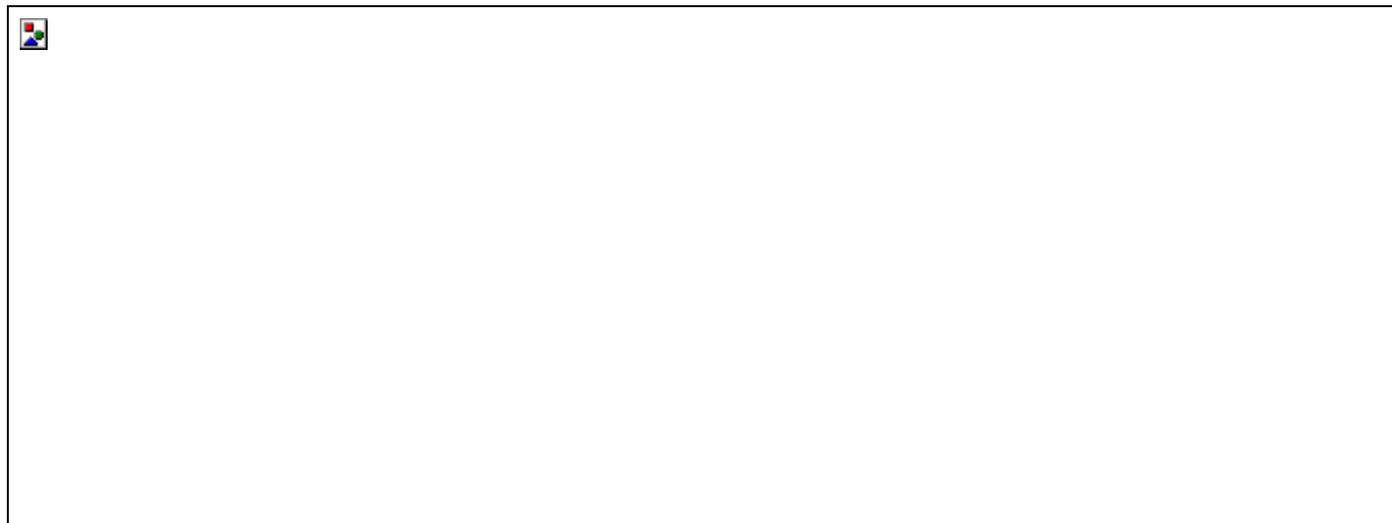
### ***Results***

Each participants SC data, for each condition, was standardised by expressing data points as standard deviations from the mean SC level taken over the 300sec recording periods. The 100sec periods during viewing were then divided into five 20sec segments. These segments were expressed as mean change from baseline (the 20sec period directly before video onset). The data were analysed using a 2 x 2 x 2 x 5 (Content x Vistral x View x Time) ANOVA,

with repeated measures on the last two factors. The assumption of sphericity was violated and Greenhouse-Geisser corrections were used with adjusted degrees of freedom.

A main effect of Time ( $F_{(4,112)} = 85.90, p < .001, \epsilon = .414$ ) revealed that SC was generally reduced over the course of viewing. A significant three way interaction of Content x Vistral x Time ( $F_{(4,112)} = 5.70, p < .01, \epsilon = .414$ ) was also observed. Given that different SC recording equipment was used in the V-on and V-off conditions, results concerning the Vistral must be treated with caution. Hence, these conditions were then analysed separately. Main effects of Time were observed in both the V-on ( $F_{(4,54)} = 38.24, p < .001, \epsilon = .415$ ) and V-off ( $F_{(4,54)} = 47.892, p < .001, \epsilon = .411$ ) conditions. A significant interaction of Time x Content ( $F_{(4,54)} = 3.952, p < .05, \epsilon = .415$ ) was observed for the V-on condition only (see Figure 3). In this condition SC reduced more during the boat sequence than the rally sequence and this was most apparent towards the end of the viewing period.

**Figure 3: Skin Conductance by Content in the Vistral-On condition**



### ***Discussion***

The SC data did not behave in the same way as the subjective data, indicating limited use as a general presence measure. SC also did not mirror the subjective mood results. SC did, however, discriminate between Contents when the Vistral was used, as did subjective Engagement and Negative Effects scores. Given that Engagement was also sensitive to View (whereas SC was not) it may be the case that SC has reflected some non-presence related consequences of the Vistral, such as the occurrence of physical side-effects. Importantly, had a less detailed measure of presence been used, SC and presence may have appeared to be related in this condition as these constituted the highest and lowest presence scores (see Fig. 1)

## Results and Discussion: Heart-Rate

### *Results*

HR, expressed as beats-per-minute (bpm), was averaged for each 100sec baseline period (prior to video onset) and 100sec viewing period. Group mean changes from baseline to viewing were then calculated for each condition (as broad HR changes occur over longer periods of time than SC). A 2 x 2 x 2 (View x Content x Vistral) ANOVA was used to examine HR change, with repeated measures on the first factor. A main effect of Content was found ( $F_{(1,115)} = 5.280, p < .05$ ). No other significant effects were found. However a main effect of Vistral approached significance ( $F_{(1,115)} = 3.831, p = .053$ ).

### *Discussion*

The HR data did not behave in the same way as the subjective data, indicating limited use as a general presence measure. However, HR was significantly lower during the boat-sequence than the rally sequence. This content was associated with higher presence plus greater composure, tiredness and agreeableness. Decreased HR is typically associated with low subjective arousal and increased attention, these may be appropriate interpretations of the HR data in this case. HR may also have been sensitive to the overall effects of the Vistral, which subjective measures were not.

## General Discussion

Overall the ITC-SOPI is sensitive to manipulations of two determinants of presence: media form and media content. This indicates that good conditions were created in order to test the utility of autonomic measures of presence. However, the ITC-SOPI also revealed unexpected interactions between displays and contents, which must be considered as a factor in future research.

While, the behavioural realism approach is supported, in that high presence conditions intensified emotional responding on a composed-anxious dimension, the displays and contents had a more complex effect on subjective arousal. Again, the fact that the media form, content and combinations of the two may have diverse effect on subjective states must be considered in future methodology.

The physiological data did not behave in the same way as either the presence or mood measures, indicating limited utility as alternative presence measures in this context. Rather the physiological data provided an extra source of information concerning participants viewing experiences. For example, SC may be useful for examining negative physical consequences of viewing while HR may be useful for examining different contents. Importantly, SC distinguished between conditions in which the highest and lowest Engagement and Negative Effects ratings had been given. Therefore, it is possible that conditions may be created in which presence and SC may appear to be related, but where the source of arousal is unclear.

It may also be the case that given the between subjects nature of the content and vistral manipulations and the fact that significant SC results were only observed after a certain

period of time, that alternative designs and analyses may produce alternative findings. Indeed, Dillon, Freeman, Keogh & Davidoff (2000) examined autonomic changes in response to the boat and rally sequences in both mono and stereo (without the confounding visual surround) in a fully repeated-measures design. While the display manipulation produced only slight effects on presence ratings, content had a stronger effect on both presence and autonomic arousal. The content associated with the higher presence ratings (the boat-sequence) produced the greatest change in autonomic arousal. This finding will be investigated in future research.

## Conclusion

In answer to the question 'Presence: Is your heart in it?' the answer must be that in some circumstance presence and physiological arousal may appear to be related but in other circumstances they will not. Rather, it can be seen that measures of autonomic arousal (such as HR and SC), subjective mood and subjective presence are sensitive to different aspects of mediated experiences and so may be useful when used in conjunction with each other. Physiological measures are an addition to, not a replacement for, subjective presence measures.

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