

Development of a New Cross-Media Presence Questionnaire:

The ITC-Sense of Presence Inventory

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Summary

- Previous studies have attempted to measure presence using simple post-test rating scales (e.g., Slater, Usoh & Steed, 1994; Barfield & Hendrix, 1996).
- The stability of simple post-test ratings has been questioned (Freeman Avons, Pearson & Usselsteijn, 1999).
- More detailed, carefully piloted and psychometrically-sound questionnaires offer a solution to potential instabilities in simple post-test ratings. This approach has been adopted by Schubert, Friedmann and Regenbrecht (1999), Witmer and Singer (1998), and Kim and Biocca (1997).
- These attempts have limitations, such as restricted media applications.
- We present research documenting the development of a new cross-media presence questionnaire - the ITC-Sense of Presence Inventory (ITC-SOPI).
- Preliminary results indicate four components: Physical Space, Engagement, Naturalness and Negative Effects.

1 Introduction

Until recently, the subjective state of presence has been measured using between one and three simple post-test rating scales that require judgements comparing either: (i) the mediated experience to real life (Hendrix & Barfield, 1996; Slater & Usoh, 1994; Slater, Usoh & Steed, 1994), or (ii) one mediated environment to another (e.g., Welch, Blackmon, Liu, Mellers & Stark, 1996). Typically, the rating scales have been comprised of statements relating to the extent to which an individual: (i) feels physically located in a given mediated space, (ii) senses that a mediated environment "becomes more real, or present, compared to the real [*physical*] world", and/ or (iii) has a sense that the mediated space is more than merely a mediated multi-sensory presentation; it feels like something they have 'lived'. These questions attempt to capture the essence of presence, and do give some indication of fluctuations in presence arising from manipulations of various parameters believed to enhance presence (e.g., field of view, extent of sensory input). There are, however, several issues relating to the use of these simple rating scales. For instance, Hendrix and Barfield's questions assume an understanding of 'presence' - a relatively unfamiliar

term to most non-experts (e.g., Freeman, Avons, Meddis, Pearson, & IJsselsteijn, 2000). Furthermore, other evidence (Freeman, Avons, Pearson & IJsselsteijn, 1999) suggests that simple rating techniques are affected by prior experience and are thus potentially unstable.

More detailed questionnaires have been developed to elucidate the presence construct, and to provide a more reliable and valid index of the dimension(s) related to presence. Such questionnaires may be less susceptible to bias. For instance, Witmer and Singer (1998) developed a 32-item Presence Questionnaire (PQ). Data derived from 152 participants, who completed questionnaires after performing one of a range of tasks in a virtual environment, were subjected to a cluster analysis. This revealed three clusters: 'Involved/Control', 'Natural' and 'Interface quality'. Slater (1999) takes issue with some of Witmer and Singer's presence questions. He argues that the PQ confounds the objective, physical properties of the technology with subjective, experiential aspects of presence. While some of Witmer and Singer's items could indeed be construed as technology-related, it is reasonable to expect that participants based their responses on their own perceptions and experiences. The likelihood of the items being treated as measures of objective, physical properties of a mediated environment could be reduced by re-phrasing the items. If such items are carefully worded, respondents' ratings to a given mediated environment could reasonably be expected to show inter-individual variation, as it is likely that individual participants' evaluations of the items would be influenced by their prior experience and expectations.

Schubert, Friedmann and Regenbrecht (1999) administered 75 questions to 246 participants (90% male) - most of whom completed the questionnaire with reference to a 3D computer game playing session. Schubert *et al.*'s first-order principal components analysis revealed three components related to presence: 'Spatial presence', 'Involvement' and 'Realness (comparability of the virtual environment to the real world)'. Finally, Kim and Biocca (1997) developed an 8-item scale based on definitions of presence and simple rating scales found in the literature, including those discussed above. The 8-item scale was used to measure presence elicited by video stimuli presented on either a 9, 20 or 32 inch television. Data from 96 participants were subjected to factor analysis, yielding two factors: (i) 'arrival' (a sense of being there in the mediated environment), and (ii) 'departure' (a sense of not being there in the physical environment). One limitation related to all these studies, however, is that the questionnaires used were tailored to the specific media used in each. As such no scale is currently available that is generalisable to a *range* of mediated environments.

Direct reports from participants suggests that there are distinct similarities in sensations of 'being there' elicited by different types of mediated environment (e.g., Freeman & Avons, 2000; Usoh, Arthur, Whitton, Bastos, Steed, Brooks & Slater, 1999). Therefore, a good general presence questionnaire should have applications across a range of media. To this end, we have developed a new cross-media presence questionnaire, with the goals of good generalisability and broad application. Here, we present the development and factor analysis of the ITC-Sense of Presence Inventory (ITC-SOPI) and compare the results of the factor analysis to those of other studies that have investigated the structure of presence through self-report.

2 Method

2.1 ITC-SOPI development

Sixty-three items were generated that tapped possible manifestations of 15 different content areas deemed relevant to presence on the basis of theoretical and empirical papers*, including those described above (e.g., Slater, Usoh & Steed, 1994; Witmer & Singer, 1998). The content areas included: a sense of space, involvement, attention, distraction, control and manipulation [i.e. autonomy], realness, naturalness, time, behavioural realism, para-social presence, co-presence, personal relevance, arousal, negative effects. A 5-point Likert scale (1 = Strongly Disagree - 5 = Strongly Agree) was chosen as the response option for all items. The questionnaire was presented in two parts, A (7 items) and B (56 items), respectively relating to respondents' experiences *after* and *during* the mediated environment.

2.2 Samples

The ITC-SOPI was administered to a total of 604 people following their experience of a mediated environment. The sample was divided into five sub-samples, each of which experienced a different level of physical immersion (e.g., 3D vs. 2D, ability to control aspects of the environment vs. no control, large screen vs. small screen, surround sound vs. stereo) and different content. The content was varied, both within and between the different media formats, for an important reason: presence is not simply a function of display parameter (or media format) variation. A good general experiential measure of a media experience should be sensitive to all potentially pertinent elements of the experience. To maximise the likelihood of our study revealing these factors, content was varied. Varying content had the additional benefit that the results could not be confounded by, or their relevance restricted to, a specific type of content. In effect, the stability of the relations between the items on the ITC-SOPI could be examined independently of content.

Respondents were recruited from an IMAX cinema (presenting 2D and 3D films; n = 22 and 196 respectively), a well-known cinema chain in the UK (n = 238), Goldsmiths College Students' Union Film Night (where VHS films are projected onto a 7' x 5' [approx.] display screen with fairly poor audio-visual fidelity; n = 26), and two experimental settings based in the Psychology Department at Goldsmiths College. One of these involved participants viewing one of six video shorts (<30 min; n = 73) before completing the ITC-SOPI, the other entailed participants playing a racing game on a consumer video-games console (n = 49).

Fifty-one percent of the sample were male and respondents were aged between 9 and 73 years (mean age of 29 years).

3 Results

3.1 Principal axis factoring

Data for the 63 items were entered into a principal axis factoring analysis. The criterion of examining 'elbows' in the Scree plot suggested either a 3, 4 or 5 factor solution. Further criteria based on comparing the number and spread of 'marker' variables for each factor solution (Watson, Clark, Weber, Assenheimer, Strauss & McCormick, 1995; Bedford, 1997) suggested that four factors provided the best solution, and

cumulatively accounted for 42% of the variance in the data. These factors were subjected to Varimax rotation. Our labels for the four rotated factors, accompanied by items representative of the factors, are given below:

Factor 1: Physical Space

e.g., "I had a sense of being in the scenes displayed"; "I felt I was visiting the places in the displayed environment"; "I felt that the characters and/or objects could almost touch me"

Factor 2: Engagement

e.g., "I felt involved (in the displayed environment)"; "I enjoyed myself"; "My experience was intense".

Factor 3: Naturalness

e.g., "The content seemed believable to me"; "I had a strong sense that the characters and objects were solid"; "The displayed environment seemed natural"

Factor 4: Negative Effects

e.g., "I felt dizzy"; "I felt disorientated"; "I felt nauseous"

3.2 Reliability

First, to examine the stability of the items on each of the four factors, the data-set was randomly divided into two sub-samples. Most of the items showed the same loadings as those obtained in the large sample.

Second, internal reliability coefficients (alpha) were computed for each of the four factors. Items were excluded if their loading on a factor did not exceed 0.3, or if they were deemed conceptually or statistically inconsistent following the structure reliability check described above. Alphas were high, ranging from 0.94 (Physical Space) to 0.76 (Naturalness).

3.3 Validity

Preliminary validation of the ITC-SOPI was carried out by comparing scale scores computed for each factor for the different media across which data were collected. The results were very positive - especially given that content was deliberately varied across the different media. For instance, the first factor, 'Physical Space', showed sensitivity to media format, with IMAX 3D having the highest score, followed by the interactive Computer Game and IMAX 2D.

To compare these results with the simple post-test rating scales used in other studies (e.g., Slater, Usoh & Steed, 1994), a new variable (P2) was computed based on the three questions that were comparable, though not identical, to those used previously ('I had a sense of being in the scenes displayed'; "I felt I was visiting the places in the displayed environment"; "I felt that the displayed environment was part of the real world"). While P2 discriminated between the different media formats to some extent (e.g., IMAX formats had the highest scores), it was less intuitively related to physical immersion than was factor 1 (Physical

Space). For instance, the Video Shorts condition scored higher than either the Computer Game or Cinema conditions. Further studies are planned to directly compare the ITC-SOPI with Slater *et al.*'s questions.

3.4 Revised ITC-SOPI

A total of 44 items were retained following the analyses detailed above. Items that were dropped either: (i) failed to load above 0.3 on any factor (8 items), (ii) showed unstable factor loadings when the sample was randomly split or were deemed of low importance, or relevance, to their factor (6 items), or (iii) elevated the internal consistency of their respective factors when deleted in the alpha check (5 items).

4 Discussion

The first factor, 'Physical Space' contains two of the three items used in simple, post-test rating scales which have previously been considered to tap key elements of presence (e.g., Slater, Usoh & Steed, 1994). It is of note that while these items had primary loadings on the first factor, they also cross-loaded on 'Engagement' and 'Naturalness'. Presence is likely to be related not only to a sense of a physical, spatial environment but also to a personal evaluation of the appeal, and the naturalness/believability, of both the displayed environment and its content. At this stage, it is not clear whether the three dimensions we have identified contribute to a sense of presence in an additive or a more complex, interactive manner. While each sub-scale may be examined separately, our current view is that for simplicity presence may be calculated by summing the scores on the first three factors (or sub-scales) of the revised ITC-SOPI. Work is currently in progress to establish measurement guidelines.

Based on 604 responses to the ITC-SOPI across a variety of media formats and content, we have identified a factor structure that is in many respects similar to previous attempts to elucidate the structure of presence, using more limited samples. This suggests that there are indeed distinct similarities in respondents' experiences of 'being there' elicited by different display media.

Witmer and Singer's (1998) first cluster, 'Involved/Control' is comparable to an amalgamation of the 'Physical Space' and 'Engagement' factors presented here. Their second and third clusters, 'Natural' and 'Interface quality' are akin to 'Naturalness' identified here. 'Negative Effects' is not represented in Witmer and Singer's structure as they did not include questions relating to possible physiological side effects/ correlates of presence.

Schubert, Friedmann and Regenbrecht's (1999) three components ('Spatial presence', 'Involvement', and 'Realness [comparability of virtual environment to the real world]') have striking parallels with the first three factors identified in the present study ('Physical Space', 'Engagement' and 'Naturalness').

It is less clear how the factors identified here relate to Kim and Biocca's (1997) two-factor solution. It is likely that their limited number of items (8) did not provide a comprehensive coverage of all the possible facets of presence that were incorporated into the ITC-SOPI.

From a theoretical perspective, our data are consistent with Slater and Wilbur's (1997) notions of the influence of immersion on presence. They argue that presence is associated with the extent to which an individual is provided with an inclusive, extensive, surrounding and vivid display. This is not to suggest that our questionnaire measures objective physical properties of the technologies used; it clearly measures

subjective experience. However, our dimensions do contain items that are sensitive to variation in these more objective parameters.

The preliminary results reported in this paper are encouraging but require replication with new samples. The revised ITC-SOPI will be administered to new respondents in our next series of studies. Analysis of new data will enable a test of the stability of both the factor structure identified here and its constituent items. A more rigorous validation of the ITC-SOPI is also planned using experimental designs controlling for factors such as novelty and content. Finally, corroborative evidence will be sought from behavioural and [physiological measures of presence](#) collected concurrently with the ITC-SOPI.

* Close discussions were held with Matthew Lombard during the early stages of the development of our questionnaire. Matthew Lombard and Teresa Ditton will be presenting data from their questionnaire analysis at Presence 2000. We plan for our collaboration to continue.

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