Impact of Cognitive Style upon Sense of Presence

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Abstract

The role played by cognitive style upon sense of presence has been addressed in the presence literature. However, no experimental study was carried out in order to investigate this hypothesized relationship. This paper highlights the relationship between each of four bi-polar dimensions of cognitive style, such as extraversion–introversion, sensing–intuition, thinking–feeling and judging –perceiving, and the experienced level of sense of presence. Implications of these individual differences for understanding sense of presence and for designing virtual environments to address these differences are discussed.

1 Introduction

One of the psychological phenomena experienced by users while (and not only) they interact with virtual reality systems, is a *sense of presence*. It allows them to *be there* (Schloerb & Sheridan, 1995), to feel themselves immersed and moreover to perceive the virtual world as another world where they really exist. In our previous work, we defined presence as a psychological phenomenon, through which one's cognitive processes are oriented toward another world, either technologically mediated or imaginary, to such an extent that he or she experiences mentally the state of being (there), similar to one in the physical reality, together with an imperceptible shifting of focus of consciousness to the proximal stimulus located in that other world (Sas & O'Hare, 2001). Sense of presence is particularly experienced when the task being carried out requires a high involvement of both cognitive and affective resources. The experience within the remote world is a complete one, encompassing cognitive, emotional and behavioural aspects. In other words, the more the users think, feel and act in the remote world and the more collateral activities are inhibited within the real worlds, the more sense of presence they will experience (Sas & O'Hare, 2002).

Understanding users' preferred manner of processing information opens a door towards their perception of world, either physical or virtual. The term of cognitive style was coined by Allport (1937) and is rooted in Jung's theory of psychological types (1971). Despite the large number of meanings attributed to it, cognitive style refers to enduring patterns of cognitive behaviour (Grigorenko, 2000). It describes the unique manner in which the unconscious mental processes are used in approaching and/or accomplishing cognitive tasks.

Curry's Onion Model (1983), presented by Riding (1991) proposes a hierarchical structure of cognitive styles, with the outmost layer referring to the individual's choice of learning environment, with the middle layer referring to the information processing style and with the innermost layer consisting of cognitive personality style. Defined as the individual's tendency to assimilate information, cognitive personality style is an enduring and context-independent feature. Therefore, it should make little difference if the context of providing cognitive stimulation is technologically mediated or not, as long as the given task involves information processing.

Cognitive style was referenced in presence literature as a possible significant issue affecting presence (Lombard, Ditton, 1997, Heeter, 1992). However, to the best of our knowledge no experimental study has been carried out to investigate this relationship.

2 Methodology

2.1 Procedure

The Virtual Environment (VE) utilised was that of the ECHOES system (O'Hare, Sewell, Murphy, Delahunty, 2000) a non-immersive training environment, which addresses the maintenance of complex industrial artefacts. Adopting a physical world metaphor, the ECHOES environment comprises a virtual multi-story building, each one of the levels containing several rooms: conference room, library, lobby etc. Subjects can navigate from level to level using a virtual elevator. The rooms are furbished and associated with each room there is a cohesive set of functions provided for the user.

After users gained familiarity with the environment and particularly learned movement control, they were asked to perform an exploration task. The exploration task lasts for approximately 25 minutes. In order to induce motivation for an active exploration, users were asked to find a valuable painting hidden within the virtual building. The sample consisted of 30 undergraduate and postgraduate students from the Computer Science Department, 18 males and 12 females, within the age range 20-38. The study hypothesis states that different dimensions of cognitive style have an impact upon presence.

2.2 Methods

2.2.1 Presence Questionnaire

Presence was measured using a questionnaire devised by the authors, which was shown to lead to measurements which were both reliable and valid (Sas, O'Hare, 2002). It contained initially 34 items, typical for tapping the presence concept (Lombard, 2000), measured on a 7-point Likert scale, ranging from 1 (not at all) to 7 (completely). The presence score was computed as the averaged score of the items composing the questionnaire, with the minimum value of *Min* = 1.74, the maximum value of *Max* = 5.17 and the mean of *Mean* = 3.38.

2.2.2 Myers-Briggs Type Indicator

Myers-Briggs Type Indicator (MBTI) (Myers & McCaulley, 1998) measures the strength of preference for the manner in which one processes information. Its development is grounded on Jung's theory of personality types (Jung, 1971), and the four basic dimensions of which are: Extraversion (E)–Introversion (I); Sensing (S)–Intuition (N); Thinking (T)–Feeling (F) and Judging (J)–Perceiving (P). The (E)–(I) continuum explains the orientation of attentional focus as a source of energy. While (E) are energized by interacting with others, (I) are energized by their inner world of reflections and thoughts.

The (S)–(N) continuum suggests the manner of perceiving and acquiring information. (S) people are usually realistic, organized and well structured, relying heavily on their five senses to perceive information. Quite contrarily, (N) individuals are creative and innovative looking at the overall picture rather that its details and acting on their hunches.

The (T)–(F) continuum refers to how one filters and organizes information in order to elaborate decisions. While analysis and logics are fundamentals for (T) people, leading them to make decisions, which are strongly coherent with their principles, (F) individuals value more feelings, kindness and harmony, which drive them to decide.

The (J)–(P) continuum describes the preferred life–style and work habits. (J) individuals are those which try to order and control their world, well-organized, good planners and potentially not very

open-minded. On the other hand (P) people are spontaneous, flexible, multiplex, but with a risk of not accomplishing the multiple approached tasks.

3 Discussions

In order to test the impact of cognitive style upon presence we conducted t-tests, comparing the level of sense of presence experienced by groups of users, identified on the basis of their scores for cognitive style dimensions. Thus we considered two independent groups for each dimension, with the cutt-off point of the second quartile. The findings suggest significant differences between groups of users formed along the feeling-thinking. With respect to the introversion-extroversion and the intuitive-sensitive dimensions, the cutt-off point had to be moved to the first quartile in order to reveal differences between level of sense of presence experienced by the two groups. As shown in Table 2, the differences were noticeable, with two significant at the level .05, indicating that persons who are more sensitive and feeling type experience a higher level of presence. Without being statistically significant, findings suggest that individuals who are more introvert or more judging type are more prone to experience presence.

Table2: *T-Tests* Comparing Presence Experienced by Users Grouped along Cognitive Style Dimensions

Variables (N = 30)	**Group 1**		**Group 2**		**Presence**
	Mean	*SD*	*Mean*	*SD*	*t*-Test
(I) – (E)	Introvert		Extrovert		
	3.74	0.65	3.29	0.82	1.49
(N) - (S)	Intuitive		Sensitive		
	3.24	0.76	3.90	0.92	1.95*
(T) - (F)	Thinking		Feeling		
	3.03	0.62	3.70	0.89	1.97*
(J) - (P)	Perceiving		Judging		
	3.16	0.44	3.46	0.44	1.51

* $p < .05$.

Furthermore we present an interpretation of these findings in the light of study hypothesis, which states that different dimensions of cognitive style have an impact upon presence. Breaking down this general hypothesis, we summarize the following results. Along the (E)–(I) dimension, the contemplative nature of (I) individuals allow them to construct the mental model of the virtual world, providing also the energy needed to explore, understand and eventually become immersed within it. The level of presence experienced by (I) individuals is significantly greater than that experienced by (E) individuals (Fig. 1).

In the special case of the present study, where the participants have undertaken solitary tasks, our finding seems appropriate. However, it is expected that in Collaborative Virtual Environments, (E) individuals will experience a greater level of *social presence*.

In the context of our research, the results indicate that (S) individuals experienced a greater level of sense of presence (Fig. 2). However, this finding should be considered in relation with task characteristics. The main task of our experimental design consisted in wandering for 25 minutes within the virtual building and searching for a hidden painting. It was a highly perceptual task. Probably during learning curve, intuitive people were highly stimulated by learning new skills (i.e. navigating), while after this stage is met, the routine involved in practising it could lead to less involvement of cognitive and affective resources.

On the contrary, the more time (S) individuals spent within the environment, carrying the same task which requires attention and precision, the more focused they become. It seems that sensitive people are better anchored in the concrete, tangible reality (even when it is a virtual one), fact which enables them to achieve a superior level of spatial orientation.

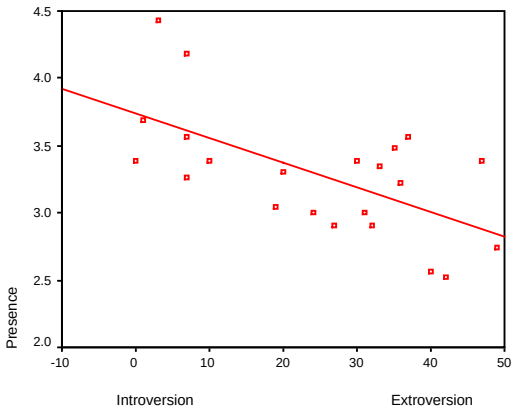

Figure 1: Relationship between Presence and (I)-(E) dimension

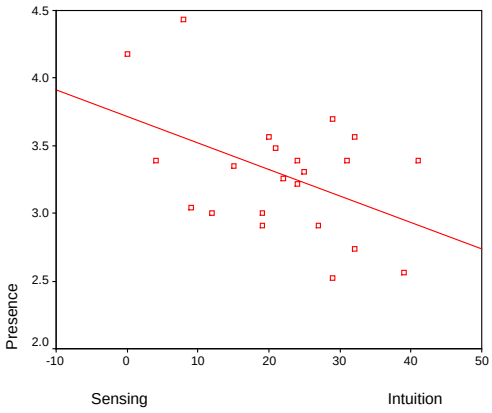

Figure 2: Relationship between Presence and (N)-(S) dimension

They easily become absorbed within the activity they get engaged with, while the remote world offers the context for *here and now*. Heeter (2001) posed a very interesting question: "is presence for an intuitive more conceptual, while presence for a sensate is more perceptual?" The answer seems to be affirmative. Probably in order to feel presence, (I) individuals need to be stimulated with novel, symbolic information which challenges their abilities of grasping ideas.

Along the (T)–(F) continuum, (F) type is the empathic one. Empathy was already discussed as a quality which increases the experienced degree of presence (Sas, O'Hare, 2001). Since (F) people can potentially experience a greater level of empathy, they experience also a greater sense of presence (Fig. 3). This result can be better understood by analysing the relationship between willingness to be transported within the remote world and (T)-(F) dimension. The results indicate that (F) individuals are significantly more willing to be transported, than the (T) individuals ($t(28) = -2.43$, $p < .05$) (Fig. 4).

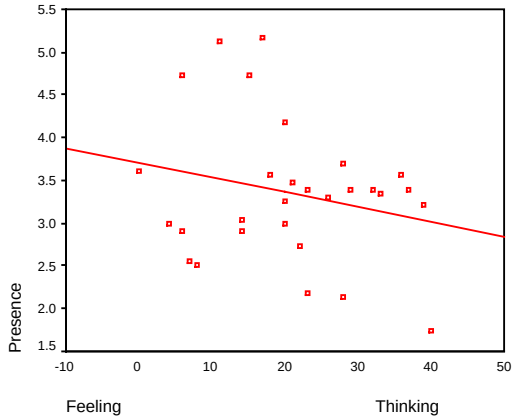

Figure 3: Relationship between Presence and (T)-(F) dimension

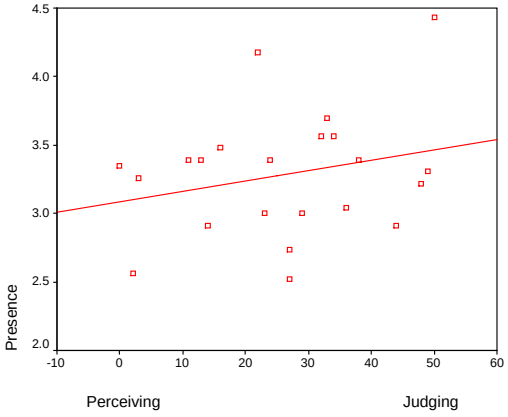

Figure 4: Relationship between Presence and (J)-(P) dimension

4 Conclusions

The main objective of this study was to investigate the relationship between personality cognitive style and the sense of presence. The results suggest that individuals who are sensitive type, feeling type, more introvert or more judging type are more prone to experience presence. These results should however be taken cautiously, within the given context of task characteristic: a highly perceptual, solitary navigational task performed within a non-immersive virtual environment. Whether the ultimate goal of a VE is an increased sense of presence, disregarding the controversial relationship it holds with task performance, then attention should be given to the VE design. In order to allow users who are more intuitive, thinking, extrovert and perceiving type to experience presence as well, one should consider designing a large variety of tasks which challenge these dimensions of cognitive style. Probably social tasks for enhancing the extroverts' sense of presence, or more abstract, strategic tasks consisting of manipulating symbolic data, for enhancing the intuitive users' sense of presence, tasks which require more reasoning to address the needs of thinking type could be solutions in this direction.

It is more likely that the cognitive style dimensions do not in and of themselves carry a great impact upon presence. Everything else being equal, they would nonetheless manifest themselves in particular ways, giving a distinct *flavour* to the sense of presence experienced by users. However, these cognitive style dimensions should be considered in the broader context of other personality traits, of willingness to suspend disbelief, of activity being undertaken, of media and so forth.

Future work will focus on the relationship between the dimensions of personality cognitive style and the others cognitive factors such as creative imagination, absorption, empathy and willingness to be transported within the virtual worlds, which has been proven to impact upon sense of presence. Another future direction will assess the controversial relationship between presence and task performance, and in this light will try to formulate suggestions for a better design the VE in order to accommodate these individual differences impacting upon sense of presence.

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