# The Presence Equation: An Investigation Into Cognitive Factors Underlying Presence

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## Abstract

*Psychological approaches to the study of presence are limited, and those with experimental support even more limited. This work is an attempt to highlight the human factors involved which may lead to a better understanding of individual differences in relation to the experience of presence. We investigated the relationship between four cognitive factors namely absorption, creative imagination, empathy and cognitive style, and their effect upon the experienced users' sense of presence. The results enable us to describe a presence equation, employing a deeper and more thorough approach to the psychology of presence.*

## 1. Introduction

Construction of world, consciousness and mediated experience are issues we discuss initially, in order to provide a broader frame for the study methodology. Their implications on virtual reality are also discussed. A theoretical approach of presence allowed us to define and operationalize presence, followed by the devising of a presence questionnaire. Section 3 will focus on experimental design, describing the virtual reality system used as an experimental testbed, the study objectives and hypothesis. Section 4 will present the methodology, within a relevant theoretical framework for each of the administered instrument. Penultimately we provide a discussion of the salient results, and hypothesis validation. Some conclusions and future directions will point out the implication of our study for the psychology of presence.

### 1. 1. Construction of world

Encompassing the external world is a long-term process, which requires constructs and functions achievable through both genetic inheritance and educational environment. The manner, in which one perceives and understands the world, is determined by the way in which the world was previously internalized and an inner representation of the world was consequently created.
Within virtual realities, we exercise previously acquired systems of cognitive functions in order to build a mental representation of the virtual world. Within the "metaphysical testbed", as Lauria (1997) identified virtual reality, individuals construct its representation and plunge into it in order to explore its understanding. Revonsuo (1996) considered immersion and sense of presence as being "basic features of the high level structure of conscious experience". The paradox of *out of*

*the brain experience*, consisting in the fact that the brain creates the experience of sense of presence within a world outside the brain, leads eventually to a *natural virtual reality*. Since conscious experience is an internal construction of the brain, the virtual reality metaphor could provide a significant testbed for investigating important aspects of consciousness.

Dealing with the mediation issue, Shapiro and McDonald (1993) proposed a dichotomy of the ways in which the reality is built. Information provided by the mediated presentations or memories will take the form of reconstructed reality, while the filter applied to this information in terms of grasping the essence of its realism would lead to the constructed reality. The constructed reality is governed by the degree of acceptance of primary consciousness content as being real.

## 1. 2. Mediation

New communication and information technologies, in particular teletechnologies provide ever increasing access to ever increasing amounts of information. While the quantity is certainly increased the relevance, reliability, authenticity and recency of this content are often brought into question. Teletechnologies force us to reconsider the role of mediation in knowledge acquisition. In other words, new communication mechanisms raise epistemological questions which resurrect "Descartes' doubts" (Dreyfus, 2000) and could bring, once again, the idea that our knowledge is basically indirect and mediated by our sense organs. *Teleepistemology*, a term coined by Golberg (2000), refers to the study of knowledge acquired at distance, through technical mediation or so-called "second degree mediation". Lombard (2000) considered also the first and the second order mediation applicable to the study of presence, where the second relies upon both the human senses and technology. Underlying the failure of mediation awareness, Lombard & Ditton (1997) conceptually delimit presence as "the perceptual illusion of non-mediation".

# 2. Presence

## 2.1. Presence Definition

Even though the idea of telepresence was earlier anticipated by Robert Heinlein (1950) in his novel *Waldo*, the term was coined by Marvin Minsky (1980) and consists of a "sense of being physically present at a remote environment mediated by the system interface". In an overused and widely accepted assertion, Sheridan (1992) describes telepresence as a "sense of being physically present with virtual objects at the remote teleoperator site". As Loomis (1992) points out, presence is a basic state of consciousness, the attribution of sensation to some distal stimuli, or more broadly to some environment. According to Schloerb & Sheridan (1995), telepresence occurs when "the person perceives that he or she is physically present" in a remote environment.

Following on from current presence definitions, we were interested in identifying, according with traditional definition theory, their *genus* and *differentia*. Thus, the concepts used for delineating the genus were *state of consciousness, psychological state, subjective experience, (subjective) perception, sense, illusion* and *feeling*. Considering presence as a sense is, in our opinion, less general than it ought to be. At the same time however, the state of consciousness enlarges the boundaries of genus more than necessary, since everything that occurs in the internal world represents states of consciousness. While we have identified a quite large array of terms delineating genus, the distinguished features, which are supposed to differentiate sense of presence from the other psychological phenomena, were better expressed by a focused set of

terms. Among them the idea of *being there* acquired the highest prevalence. The unanimously accepted point of view is the inner aspect of presence, which occurs within one's consciousness. We consider that in this case we should talk about a shift of focus of consciousness (Lauria, 2000) from the local environment to the remote one, which happens insidiously making user's awareness of it even more difficult. Furthermore we approached the presence definition, without any pretensions of being original, but rather seeking a closer juxtaposition to theoretical framework underlying it.

Presence is 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 sliding of focus of consciousness to the proximal stimulus located in that other world.

*2.2. Presence Operationalization*

| Dimensions | Variables |
|---|---|
| Being there | Perceiving |
| | Recalling |
| | Imagining |
| | Thinking |
| | Affective processes |
| | Willingness |
| | Acting there |
| | Attentional resources |
| Not being here | Not perceiving here |
| | Self perception |
| | Not recalling from here |
| | Affective processes |
| | Refuse to experience it |
| | Acting here |
| | Attentional resources |
| | Returning experience |
| Reflective Consciousness | Awareness of oneself |
| | Awareness of outside |

*Table 1:* Presence operationalization

Prior to any attempt at operationalizing presence, we define the *consciousness* concept. Through a working definition, Farthing (1992) considered *consciousness* as "a subjective state of being currently aware of something, either within oneself or outside of oneself." According to him, primary consciousness consisted of direct experience and spontaneous response to it, while reflective consciousness focuses on conscious experience *per se*, which becomes the object of one's thoughts. According to Kim and Biocca's (1997) findings, two presence dimensions consist in *being there* and *not being here*. Both facilitate access to the content of primary consciousness. Additionally we consider *reflective consciousness* (e.g. awareness of being there). Based on these observations, we conceived and identified presence dimensions and associated variables as they are summarized in Table 1.

# 3. Experimental Design

## 3.1. Experimental Test-bed

The virtual reality system was provided by the ECHOES[1] (O'Hare et al., 1999, O'Hare et al., 2000) a non-immersive training environment, which addresses the maintenance of complex industrial artifacts. Adopting a *physical world metaphor*, it seeks to provide a *comfort zone*, which engineers will visit and revisit throughout the lifetime of their career. The ECHOES

training environment is comprised of a virtual multi-story building, each one of the four levels containing numerous rooms: conference room (*Fig.1*), library (*Fig.2*), lobby room, training room 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.
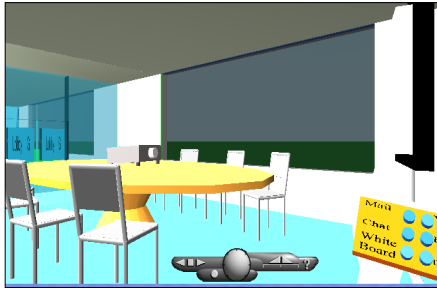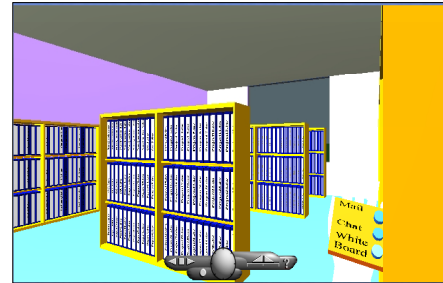


*Figure 1:* Virtual Conference Room                 *Figure 2:* Virtual Library

## 3.2. Why non-immersive virtual environment?

Since we are interested in subjective factors determining presence, we considered among the virtual reality systems, the desktop one as being the most suitable testbed for our experimental study. The qualitative performance of devices, such as resolution, scale, field of view, and lag are significantly decreased within non-immersive VR systems. Where the technological infrastructure is less advanced (e.g. non-immersive environments), the user's experience of presence is mainly due not to system characteristics, but to the associated human factors.

## 3.3. Experimental Tasks

The experimental design was comprised of exploration and searching tasks, both grounded on navigation. In order to gain familiarity with the environment and learn movement control, the subjects were asked to perform an *exploration task* within the virtual building for a duration of 25 minutes. For an active searching we conceived a scenario where users should find a valuable painting hidden somewhere within the virtual building. *Searching tasks* consisted of finding the library in the virtual building followed by the information retrieval task, which consisted of locating some specific pieces of information, within the virtual library, given some spatial landmarks. The *sample* consisted of 15 undergraduates and postgraduate students from the Computer Science Department, 9 males and 6 females, within the age range 20-38.

## 3.4. Objectives

We were focused on measuring presence with an appropriate tool. This can only be achieved by firts defining and operationalizing the presence concept. A particular interest was that of cognitive factors, which we considered being related to presence, followed by an attempt to state an *equation of presence.* The study objectives are summarized below:

1. Defining and operationalizing presence.
2. Identifying a set of cognitive factors determinant for presence.
3. Describing a *presence equation*.

### 3.5. Hypothesis

Based upon the objectives presented above, we formulated three hypotheses.

H1. Creative imagination, absorption and empathy are cognitive factors affecting presence.
H2. Among empathy subscales, fantasy subscale will be the one presenting the highest impact upon presence.
H3. Introvert type, Intuitive type, Feeling type and Perceiving type are those, which influence presence.

Among the four sets of polar dimensions delineating cognitive style (dimensions briefly presented in the next section), we hypothesized that a particular one on each continuum will affect presence (e.g. H3). The motivations underlying H2 and H3 will be postponed until the subsequent section, in order to allow the reader to get familiar with the dimensions involved in the applied psychological tests.

## 4. Methodology

### 4.1. Technological factors vs. human factors

The determinant factors affecting presence can be grouped into technological factors, which regard the system and its characteristics, and human factors referring to users' cognitive and personality aspects. A large amount of work has been carried out in the area of technological factors affecting presence. Lombard & Ditton (1997) provided a detailed presentation in this direction, part of these factors being briefly summarized below. Visual display characteristics such as image quality, image size, viewing distance, visual angle, motion, color, dimensionality, camera techniques; aural presentation characteristics like frequency range, dynamic range, signal to noise ratio, high quality audio or dimensionality such as 3-D sound. As stimuli for other senses, Lombard & Ditton (1997) referred to olfactory output, body movement, tactile stimuli, and force feedback. Comparatively, the amount of studies trying to delineate the associated human factors determinant on presence is significantly less.
Psotka and Sharon (1994) considered two categories of factors determinant of immersion, such as susceptibility to immersion and quality of immersion. The first set refers to human factors with an emphasis on cognitive factors like imagination, vivid imagery, concentration, attention and self-control, while the second set is primarily concerned with technological factors like affordances of VR environment, and also distractions from the real world or physiological effects.
The present work counts itself among the few others trying to highlight the human factors involved which may lead to a better understanding of individual differences in relation to the experience of presence. The cognitive factors upon which we have focused are those of absorption, creative imagination, empathy and cognitive style.

### 4.2. Why these cognitive factors?

The cognitive factors we focused upon are occasionally referred in presence literature. *Empathy* is probably the most frequently mentioned cognitive aspect, which may affect presence

(Lombard, 2000). Consistent with this idea, Lombard & Ditton (1997) suggested that intensity and polarity of emotions experienced by users during mediated activities could prove their significance upon presence, even though no empirical study had yet demonstrated it. *Imagination* seems to be also likely to affect presence (Heeter, 1992). Calling it "foundational in virtual reality", Lauria (1997) emphasized its role in constructing the virtual space. *Cognitive style* was also referenced in presence literature as a possibly significant issue affecting presence (Lombard & Ditton, 1997; Heeter, 1992). Lombard and Ditton (1997) also suggest *absorption* as a factor which may influence the experience of presence, referring to Quarrick's (1989) work, who indicates that during absorption, sense of self and time fades as the person merges with a fascinating stimulus.

The main reasons, which caused us to design the psychological test battery as we did, were theoretical perspectives in the hypnosis area. Thus, all cognitive factors we focused on are part of a theoretical framework, broadly defined within the psychology of hypnosis. Moreover, the work carried out within this field, provided not only some valuable theoretical issues, which can be harnessed to study presence, but accompanied with them were devised valid instruments with which to investigate these cognitive factors.

## 4.3. Methods

The present investigation represents a case study, following the line of exploratory studies. These are primarily oriented to problem formulation and hypothesis development, as an important initial step in any research process.

In order to achieve the objectives and test the hypothesis, the tools which were used, consisted of a psychological test battery and a presence questionnaire. Furthermore we present the psychological test battery together with the theoretical background, which underlies its design. We consider each in more detail in the following sections.

- Tellegen Absorption Scale.
- Creative Imagination Scale.
- Davis's Interpersonal Reactivity Index.
- Myers Briggs Type Indicator.

### 4.3.1. Tellegen Absorption Scale

We do not seek to build a relationship between presence and hypnosis but rather to note that part of the work carried out in this area can be used in presence study. The first researcher who discovered the personality aspects related to hypnotizability, was Josephine Hilgard (1970). Through an extensive interview study, she identified that highly hypnotizable individuals tend to present a high level of imaginative involvement in domains such as reading, drama, religion, affective arousal, adventures and artistic creativity. Following the line opened by Hilgard's findings, Auke Telegen and Gilbert Atkinson (1974) developed the *Absorption Scale* in order to measure the extent to which people become involved or immersed in everyday events or the tendency to totally immerse oneself with the attentional objects.

The *absorption* construct elaborated by Tellegen (1982) is defined as "a state of receptivity or openness to experiencing, in the sense of readiness to undergo whatever experiential events, sensory or imaginal, that may occur, with a tendency to dwell on, rather than go beyond, the experiences themselves and the objects they represent". The author referenced Maslow's (1968)

concepts of fascination and absorption that characterize peak experiences. These are felt as self-validating or self-justifying moments which carry their own intrinsic value. Attention described in Absorption items "is a *total* attention, involving a full commitment of available perceptual, motoric, imaginative and ideational resources to a unified representation of the attentional object" (Tellegen & Atkinson, 1974). This kind of attentional process is the core of absorption. Furthermore we briefly outline the main dimensions of the absorption construct.

*1. A heightened sense of reality of the attentional object*

The object, either perceived or imagined, grasped in one's attentional focus is experienced as being present and real. The authors assumed that an already engaged representational system of the focal object is incompatible with any other reflective consciousness about this primary consciousness content, which otherwise would allow statements as "this is only in my mind".

*2. An altered sense of reality in general and of self in particular.*

Absorbed attention focuses on some facets of reality, emphasizing to a greater extent the experience regarding them, and limiting the awareness of other facets.

*3. Imperviousness to normally distracting events.*

Since one object becomes the focal object it completely holds the attentional resources, such that it is perceived entirely, in all its details while the individual becomes less distracted by the collateral external events.

*4. Cognitive aspects: empathy and cognitive style*

Tellegen and Atkinson considered the "ability to operate different representational modalities synergistically" in order to achieve a unified experience, as a significant cognitive aspect of absorption. Another is *empathy*, while a *distinctive cognitive style* seems also to be associated with highly absorbed people.

*5. The motivational-affective component*

The motivational-affective component of absorption is "*openness to experience* as a desire and readiness for object relationship temporary or lasting, that permit experiences of deep involvement".

*4.3.2. Creative Imagination Scale*

Barber and Wilson (1979) also investigated the personality correlates of hypnotizability. Specifically they elaborated the Creative Imagination Scale and proved its correlations with hypnotizability and other measures of imagination and creativity. It can also be associated with absorption. (Crawford, 1982). The scale measures the ability to vividly imagine suggested scenes and situations (e.g. setting of the sun, or the smell of ripe oranges). It involves ten tests in which the subject is invited to imagine a number of things followed by the assessment of their vividness.

The theoretical framework presented in section 4.3.1 and this section, prove that the parallel we drew between hypnosis' findings and presence seems to be justified. Each of the aspects characterizing absorption can also be considered as being specific for presence. Actually, Csikszentmihalyi's (1990) *psychology of optimal experience*, which seems so close of absorption psychology, already offered an additional insight into the study of presence, since it led to presence as *flow* experience theory (Draper, Kaber & Usher, 1998). Almost all presence theories refer to the attention as a significant issue underlying presence. For example, Witmer & Singer (1998) proved that focusing one's attention on a meaningful stimulus set supports one's sense of presence. Draper, Kaber & Usher (1998) proposed an integrative approach to telepresence,

featuring a structured attentional resource model, while Kim & Biocca (1997) stressed the role of attention in each of physical, mediated or imaginal space, where user could become immersed.

### 4.3.3. Davis's Interpersonal Reactivity Index

Davis (1994) identified empathy with a set of constructs associated with the responses of one individual to the experience of another. It involves the ability to engage in the cognitive process of adopting another's psychological point of view, together with the capacity to experience affective reactions to the observed experienced of others. In order to develop such capacities and exhibit empathic behavior, one should be able to assume *perceptual*, *cognitive* and *affective* roles. *Perceptual role taking* allows the individual to imagine how objects appear to someone who occupies a different physical location*, cognitive role taking* enables the individual to infer something about another's thoughts or reasons, while *affective role taking* allows the individual to infer the emotional reaction experienced by another person.

Davis's Interpersonal Reactivity Index contains 4 7-items subscales, each measuring a separate facet of empathy. *Fantasy subscale* measures the tendency to imaginatively transpose oneself into fictional situations. *Perspective taking subscale* measures the reported tendency to spontaneously adopt the psychological point of view of others in everyday life. *Empathic concern* assesses the tendency to experience feeling of sympathy and compassion for unfortunate others. *Personal distress* taps the tendency to experience distress and discomfort in response to extreme distress in others. We were particularly interested in identifying the correlation between Fantasy Subscale and presence (hypothesis H2), considering that the ability to imaginatively transpose oneself into fictional situations could be considered a prerequisite for transposing oneself into a virtual world.

### 4.3.4. Myers-Briggs Type Indicator

Cognitive style describes the unique manner in which the unconscious mental processes are used in approaching and/or accomplishing cognitive tasks. Myers-Briggs Type Indicator (MBTI) (Myers & McCaulley, 1998) measures the strength of one's preference for the manner in which he/she 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). Each polar dimension will be considered in order to explain the hypothesis H3.

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 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 is expected to be greater for (I) individuals especially in the case of solitary tasks, while co-presence should be better experienced by (E) individuals.

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 need for concreteness of (S) people could impede them in experiencing a high degree of immersion within a virtual world, whereas the power of creative imagination, characteristic for (N) people can creates "really" immersive worlds.

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. On this polar continuum it is pretty obvious that (F) type is by far the empathic one. Empathy was already discussed as a quality which may increase the experienced degree of presence, due to the adjacent inner ability to transpose oneself not only into someone else's point of view, but also somewhere else, either into an imaginary or virtual world. Since (F) people can potentially experience a greater level of empathy, we would expect them to experience also a greater sense of presence.

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. From this brief description, it seems that (P) individuals are those more *open to new experience*, in term of absorption theory. We have already pointed out the relationship between absorption and presence, so the openness to new experience allowed (P) people to be more absorbed and eventually to experience a greater sense of presence.

## 5. Results and Discussions

### 5.1. Presence questionnaire

The presence operationalization, previously presented allowed us to build a presence questionnaire, which initially contained 34 items measured with a 7-point Lickert Scale, part of them being typical for measuring presence. In order to perform items analysis we calculated internal consistency of the questionnaire. Item total-correlation analysis allowed us to identify the variables that are not internally consistent with the questionnaire, and can be deleted. Using the criterion of 0.33 as the cut-off point for retaining variables, 7 items were deleted, the questionnaire now having 27 items. Table 2 presents the mean, median and standard deviation for the variables investigated.

The Cronbach's alpha coefficient: $\alpha = 0.9148$ proved the *reliability* of our questionnaire, while the correlation with Slater & Steed's (2000) presence questionnaire, which was also administered, particularly for testing the *concurrent validity*, is a

| Dimensions | Variables | Mean | Median | SD |
|---|---|---|---|---|
| Being there | Perceiving | 3.86 | 4.00 | 1.34 |
| | Self-perceiving | 3.80 | 3.33 | 1.50 |
| | Recalling | 3.40 | 3.00 | 1.29 |
| | Imagining | 3.93 | 4.00 | 1.70 |
| | Thinking | 4.33 | 5.00 | 1.58 |
| | Acting there | 4.15 | 4.00 | 1.00 |
| | Attentional resources | 5.00 | 5.00 | 0.80 |
| Not being here | Not perceiving here | 3.86 | 4.00 | 1.06 |
| | Self perception | 2.86 | 3.00 | 1.64 |
| | Recalling from here | 3.53 | 3.00 | 2.03 |
| | Affective processes | 3.06 | 3.00 | 1.22 |
| | Acting here | 4.46 | 5.00 | 1.45 |
| | Attentional resources | 3.20 | 3.00 | 1.56 |
| | Returning experience | 3.40 | 3.00 | 1.80 |
| Reflective consciousness | Awareness of oneself | 3.88 | 3.80 | 0.78 |
| | Awareness of outside | 3.46 | 3.00 | 1.30 |

*Table 2*: Presence variables results

highly significant one: r = .795, p< 0.01. We can conclude that our questionnaire is both reliable and valid, a prerequisite whose accomplishment had to be tested prior to any other data analysis. The highest values among presence variables are associated with the dimension of *being there*, stressing the cognitive resources focused towards the virtual world in terms of both solving strategies involved (*thinking* Median = 5.00), and the attentional resources (Median = 5.00). Another high score, (*acting here* Median = 5.00) emphasizes the need to inhibit any collateral activities within the physical world, in order to focus them on interactions with the remote world.

## 5.2. Hypothesis validation

In order to prove the validity of H1, the correlation coefficients between presence, as an overall score of our questionnaire, and the previously mentioned cognitive factors, were computed. We found indeed a significant correlation between *presence* score and *creative imagination* score: r = .721, p<0.05 (Fig. 3), and a positive correlation, though not significant, between presence and absorption r = .565 (Fig. 4). *Presence* also correlates significantly with the total score of *empathy scale* r = .605, p<0.05 (Fig. 5).
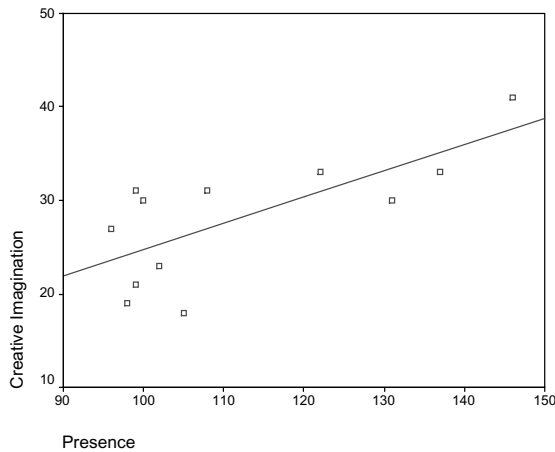
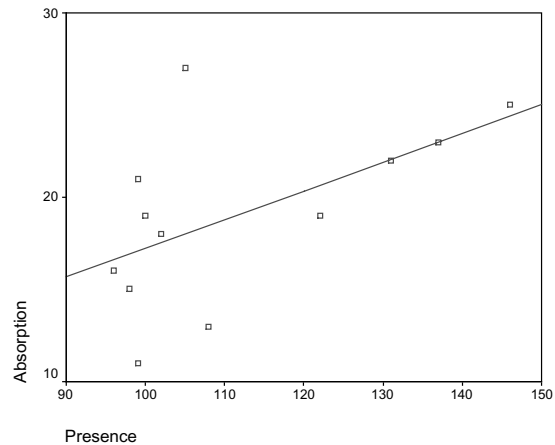*Figure 3*: Presence and Creative Imagination

*Figure 4*: Presence and Absorption

A detailed analysis revealed that among the four dimensions captured by the empathy subscales (H2), the strongest impact upon presence has the *fantasy subscale* r = .753, p<0.01 (Fig. 6).
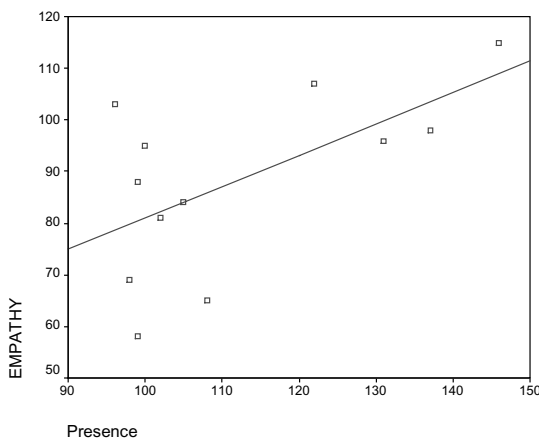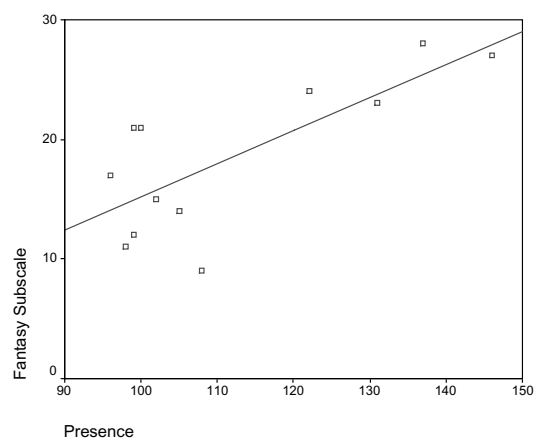
*Figure 5*: Presence and Empathy

*Figure 6*: Presence and Fantasy Subscale

In an attempt to identify the gender role upon presence and its determinant cognitive factors, we computed the associated significant differences. No significant difference was found on any of these aspects: presence, absorption and creative imagination by gender.

With regard to the empathy dimension, the ANOVA results indicate that there was a significant difference $F_{(1,10)} = 12.96$, $p<.005$ on empathy concern scale and perspective taking $F_{(1,10)} = 7.21$, $p<0.05$ by gender, the female group presenting unsurprisingly higher scores.

Due to the limited size of the sample and the broad dispersion of the results along the four polar dimensions of cognitive style, H3 remains promising but as yet unproven. Future work should be conducted in order to prove its entire validity. The most we could obtain were just some trends, since no significant correlation emerged. The highest correlation coefficient was found between Presence and *Perceiving*: r=.430. On the Judging–Perceiving dimension, the *Perceiving* type seems to be associated to those individuals open to experience, spontaneous and who are more flexible. Thus, people with higher scores for the Perceiving dimension, will get absorbed more easily, since there is also a positive correlation between *Perceiving* and *Absorption*: r = .491, and consequently their sense of presence will be higher.

The other positive correlation was found between Presence and *Feeling* type: r=.364. On the continuum Thinking–Feeling, feeling individuals rather than *Thinking* ones, seem to be more empathic. We found indeed positive correlation between the *Feeling* dimension and Empathy as n overall score: r = .642, p<0.05, and among its four subscales, the strongest correlation appears to be between *Feeling* and Empathic Concern: r = .760, p<0.01, which could eventually lead to a higher degree of presence. Within this frame, the *critical thinking* involved in the *Thinking* dimension could impede subjects in experiencing a higher degree of presence.

The results for the other two dimensions: Introversion–Extroversion and Sensing–Intuitive are still ambiguous, a larger sample could disambiguate these and support the validation of H3.

## 5.3. Presence equation

The results obtained at this stage can be interpreted in a unified manner, which would help us to grasp not only the singular relationships between presence and each of its cognitive factors, but also to describe presence as a function of them, together with the appropriate weights. For this purpose, we performed a regression analysis with presence as a dependent variable. The results suggest that *Creative Imagination* (Beta=.463), *Absorption* (Beta=.270) and *Fantasy Subscale* (Beta = .232) are all factors in the regression equation: $R2=.661$, $F(3,8)=5.198$, $p<0.05$ (Table 3).

|  | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Regression | 2208.182 | 3 | 736.061 | 5.198 | .028 |
| Residual | 1132.735 | 8 | 141.592 |  |  |
| Total | 3340.917 | 11 |  |  |  |

*Table 3*: ANOVA

These results can be used to describe a presence equation (1):

  *Presence =$f$ (Creative Imagination; Absorption; Empathy –> Fantasy Subscale; K)*      (1)

This equation needs to be refined (e.g. factor K replaces symbolically important aspect which have been omitted by us) but it points the way, which may lead to a better understanding of individual differences in relation to the experience of presence.

## 6. Conclusions and Future Work

Within this paper we thought to investigate presence. In order to carry out a subjective measurement of presence, adequate to both the system and tasks characteristics, we defined and operationalized the presence concept, and subsequently developed a presence questionnaire. The second objective consisted of identifying cognitive factors underlying presence. An analysis of the presence literature accompanied by an insightful approach of hypnosis psychology, lead us to absorption, creative imagination, empathy and cognitive style. It was proved that creative imagination, absorption, empathy and especially fantasy subscale play distinctive roles in the experience of presence (H1, H2), while collectively they can be used to describe a presence equation (1).

Cognitive style is another issue to be taken into account in order to understand better the presence phenomenon. Even though, the results obtained in this direction are of limited value, they still give us some directions for further research. Thus it seems that Perceiving and Feeling type are definitely those who can experience a higher degree of presence. Future work should be conducted in order to prove its validity.

Present results are merely preliminary the study proving that tools developed for studying hypnosis and particularly the personality correlates to hypnozability could successfully be applied in the study of presence. They present the advantage of being carefully designed by psychologists in order to measure psychological constructs, grounded on a powerful theoretical framework, and moreover validated on large samples of subjects. To harness their potential in order to carry out a thorough study, could prove extremely beneficial for the study presence. To date we have only identified the work of Tromp (1995) work, were the hypnosis results were also theoretically exploited in investigating presence.

Fortunately, not only investigation in the area of virtual reality can benefit from hypnosis research. The potential of virtual reality as a research tool for studying consciousness and cognition, should not be neglected. Lauria (1997) considered that virtual reality directs our attention to the nature of reality, namely to consciousness as the experience of being, while Glickson and Avnon (1997) founded that highly absorbed subjects within virtual reality systems, were predisposed to experience an altered state of consciousness.

Our future work will focus on increasing the sample size, in order to get statistically relevant results. Since the tasks to be accomplished within the virtual world were solitary tasks, another study direction will consist in testing the same cognitive factors and their influence in condition of social presence.

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