# Longitudinal effects on presence: Suspension of disbelief or distrust of naive belief?

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**Abstract**

*We propose two models of how a subject's growing experience in a medium affects presence: The Spin model (based on Spinoza) which predicts that subjects begin as present and then learn to become non-present; and the SoD model (based on Coleridge) which predicts that subjects expend effort to suspend their disbelief during presence. In a longitudinal study, 47 subjects (divided randomly into an attention-focussing and attention-neutral group) were exposed to the same VE over three days, and measured with the ITC-SOPI after the first and final exposures, and then again after a 72 hour delay. The data show the attention-neutral subjects experienced a slight increase in spatial presence, while the attention-focussed subjects showed no change over time. After the delay, the attention-focussing group experiences an increase in spatial presence and the attention-neutral group remains unchanged. We argue that this is, within the limits of the study, evidence for the Spin model. We conclude by discussing the theoretical and measurement implications of the models and results.*

*Keywords*--- **Presence, Content, Cognition, Memory, Theory.**

## 1. Introduction

Currently, the literature shows a good understanding of cross-sectional effects on presence, particularly with respect to the role of media factors on the experience (see [1] for a review). However, the number of studies covering longitudinal factors in presence is limited. Subject age (see for instance [2, 3]), and self-rated media experience (such as [3, 4]) have been examined as covariates to presence, but longitudinal manipulations of presence are generally rare. This deficit extends into theory - none of the extant explanatory models of presence (such as [5-7]) provide a satisfactory prediction of what longitudinal effects might exist in presence. This paper presents two possible models of how an increase in one's experience in a medium might affect the presence experience, as well as a first empirical study into longitudinal effects (such as medium accommodation) on presence.

### 1.1 Two possible models: 'Present unless disproved' and 'Suspension of disbelief'

It is perhaps easiest to understand our point of departure by contrasting Spinoza and Coleridge. From our point of view, Coleridge believed that cognition works to remove disbelief and to create presence:

> *"so as to transfer from our inward nature a human interest and a semblance of truth sufficient to procure for these shadows of imagination that willing suspension of disbelief for the moment, which constitutes poetic faith"*. [8] pp 168-169.

Contrary to this view, Spinoza believed we naturally tend to be present unless we discover subsequently that the environment is false:

> *"If the human body is affected by a mode*[1] *which involves the nature of some external body, the human mind will regard that same external body as actually existent, or as* ***present*** *to it, until the body is affected by an affection which excludes the existence or* ***presence*** *of that body"*. (Spinoza, Ethics Part Two, Proposition 17, see [9] p132; emphasis added).

Of these two ideas, Coleridge's is perhaps the more accepted by presence researchers (the idea is explicitly mentioned in, for instance, [10, 11]). These two ideas however present competing explanations for how the presence experience changes over time for a subject.

If one frames a "suspension of disbelief" (*SoD*) model from Coleridge, then one would expect subjects to expend mental effort to believe a VE; however, the purpose of VE design is often to reduce effort for the user – indeed, Lombard & Ditton have argued that presence is most likely to occur when the subject is processing the VE in an effortless way [12]. For longitudinal effects, the *SoD* model implies that if one experiences repeated exposure to a VE (or to very similar VEs), then there is no reason to suppose that suspending disbelief would become more difficult (in fact, one might expect it to become easier over time, if it is subject to practice effects). One might thus expect that when we are

[1] Spinoza's doctrine of modes is beyond the scope of this paper, for our purposes one can perhaps read "mode" as "signifier".

exposed to a VE repetitively over time, presence will either increase or remain constant.

A Spinozan (*Spin*) model of belief implies an initial acceptance of the VE, and then, after being unable to incorporate the VE into other mental constructs, one could expect a decrease in the presence over the long term. In addition, the stronger the belief in an initial reality that is subsequently not matched by the VE, the more profound will be the rejection of the VE, and the more impoverished the presence experience. Note that under the *Spin* model, no effort is required to become present; it is the default position. This basic notion has some support in presence theory – Lee [13] has argued that presence occurs automatically without effort, and Jacobson [14] has similarly argued that presence (in literary contexts at least) occurs without conscious effort by the reader. Empirically, this model has some support from the findings in [3], which shows that as experience with a content area increases, presence tends to decrease.

Of course, these are simple models which exclude many others factors which may come into play. For the sake of parsimony, this initial study examines only one factor: the consequences for presence over time depending of the extent to which attention is focussed on the objects in the VE. Attention is interesting in this context because of its potential impact on the information which the subject processes from the medium [15]. The effect of attention should be to increase the rate of rejection of the false notion under the *Spin* model, while under the *SoD* model attention should have a neutral or perhaps positive effect (see 1.2 below for a discussion of these possible effects).

Implicit in the arguments presented above is that presence beliefs exist over time (or, alternatively, that presence experiences can be stored in long-term memory, and subsequently retrieved). Thus we assume that one can legitimately ask about a presence experience some time after the actual VE experience, and get a reasonable approximation to the actual experience (this is supported by the methods used in [3, 16]). Such questions are less legitimate if one believes that presence is a binary state of consciousness (such as expressed in [17]). This assumption relates to the corollary to Proposition 17 (quoted above) where Spinoza states:

> *"The mind will be able to regard, as if they were present, external bodies by which the human body was once affected, even though they neither exist nor are present"* [9], p132.

This raises interesting questions of how memory affects, if not presence itself, then presence measures.

### 1.2 Predictions for the *Spin* and *SoD* models

There is substantial evidence to suggest that a subject's previous knowledge of a content area can lower presence scores [3]. It is not clear, however, if this effect extends to knowledge of the *medium.* Repeated exposure to the medium might lead the subject to learn to pick out the limits and rendering artefacts of the medium, while focussing attention on the medium might enable subjects to more easily spot such artefacts, and thereby reduce presence.

Under the *Spin* model, all information is initially accepted and only later rejected as mental effort is expended and shows that the information is incompatible with other beliefs. Thus, under repeated exposure presence should decrease. The *SoD* model makes no such prediction.

If being present is the default position (*Spin* model) and effort has to be expended to reject it then one might expect that if attention is focussed on the environment it will increase the *Spin* effect and that presence will decrease.

If on the contrary disbelief is the default position (*SoD* model) and effort has to be expended to attain presence then one might expect presence to increase with attention, or at least remain constant.

## 2. Procedure

We conducted an initial study to see how presence is affected by repeated exposure, and if that interacts with attention being focussed on the VE. We used the data from the False Memory Study (see elsewhere in these proceedings) and analysed those data for longitudinal and attention effects.

### 2.1 Measures

Presence was measured using the ITC Sense of Presence Inventory (ITC-SOPI) [4]. 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 spatial presence but also more strongly semantic factors such as a subject's connection with the content, and their evaluation of the realism. This allows for great flexibility and range in the interpretation of the subject's experience.

### 2.2 Sample and design

We sampled 47 subjects, university students, 19 women and 28 men (age M = 19.93, S = 1.83). We did not, for this study, select subjects for a particular level of medium experience, nor did we measure previous media experience (in two large studies of computer gamers [3, 16], previous medium experience proved to be an unreliable predictor of presence experiences). We did however control for the environment they experienced by using a VE which the subjects had not previously experienced (As the ITC-SOPI measures experiences in particular environments and not in particular systems, we reasoned that it should still be possible

to detect learning effects even if previous medium experience is a factor).

Subjects came in for four sessions. The first session was preceded by a brief training session on an unrelated VE. The first three sessions were conducted on successive days before a weekend and the final session was held following an extended break of 72 hours. The subjects experienced the same VE in each of the first three sessions for fifteen minutes (see 2.3 and 2.3.1 below for a description of the VE and tasks). There was no VE experience session after the 72 hour break. The ITC-SOPI questionnaire [4] was administered after sessions 1 and 3 and after the break. The SUS questionnaire [18] was administered after session 2 in order to break expectations regarding questionnaires (it was not analysed).

We randomly divided our sample into two groups: an attention-focussed group who were given a short set of VE content questions to test their memory of the VE immediately after each experience, and an attention-neutral group who did not receive any questions. We reasoned that the repetition of the test after each session would focus their attention of subjects on the VE content. We did not analyse the memory question data for this study.

After a 72 hour delay, both groups were asked to recall their VE experience during the third day, and to respond to the ITC-SOPI with that experience in mind.

## 2.3 Apparatus

The study ran on four desktop computers with the same hardware configuration, which 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 arranged such each subject could only see their own machine during the experiment.

#### *2.3.1 Virtual environment*

The VE used simulated an egocentric interactive building walkthrough using the Quake Keys interface [19]. The VE represented a medieval European monastery, containing nineteen rooms spread over three levels of two buildings. Subjects performed an object search and collection task; in each session they searched for a different object (books, candlesticks or small chests) which were placed in different locations in each run.

## 3. Results

## 3.1 Repetition effects

Each of the four ITC-SOPI factors were analysed using a two-way factorial analysis of variance, with session (1st and 3rd session scores) and attention condition as factors – the session factor was within subjects, while the attention factor was between subjects.

#### *3.1.1.1 Spatial factor*

No main effect was found for either the attention factor ( $F(1, 45) = 0.370$, $p < 0.543$ ), or session ( $F(2, 90) = 1.31$, $p < 0.258$ ). However, there was a significant interaction effect ( $F(2, 90) = 10.21$, $p < 0.003$ ). A set of post-hoc Fisher's LSD tests revealed that the difference was a modest increase in spatial scores between the sessions, for the attention-neutral group only.

#### *3.1.1.2 Engagement factor*

No main effect was found for either the attention factor ( $F(1, 45) = 0.042$, $p < 0.838$ ), or session ( $F(2, 90) = 0.054$, $p < 0.817$ ). There was also no significant interaction effect ( $F(2, 90) = 0.496$, $p < 0.485$ ).

#### *3.1.1.3 Naturalness factor*

Again, no main effect was found for either the attention factor ( $F(1, 45) = 0.113$, $p < 0.739$ ), or session ( $F(2, 90) = 1.492$, $p < 0.230$ ). There was also no significant interaction effect ( $F(2, 90) = 0.526$, $p < 0.593$ ).

#### *3.1.1.4 Negative effects factor*

No main effect was found for either the attention factor ( $F(1, 45) = 0.014$, $p < 0.905$ ), or session ( $F(2, 90) = 0.052$, $p < 0.821$ ). There was also no significant interaction effect ( $F(2, 90) = 3.305$, $p < 0.088$ ).

## 3.2 Delay effects

The next set of analyses focused on differences between each of the four ITC-SOPI factors over the 72 hour delay. Again, we used a two-way factorial analysis of variance, with delay (at-event and post-delay measures) and attention condition as factors – the delay factor was within subjects, while the attention factor was between subjects.

#### *3.2.1.1 Spatial factor*

No main effect was found for either the attention factor ( $F(1, 45) = 1.119$, $p < 0.279$ ), or session ( $F(2, 90) = 0.978$, $p < 0.328$ ). As for the repetition manipulation, there was a significant interaction effect ( $F(2, 90) = 6.036$, $p < 0.018$ ). A set of post-hoc Fisher's LSD tests revealed that the difference was a modest increase in spatial scores over the delay, for the attention-focussed group only.

#### *3.2.1.2 Engagement factor*

No main effect was found for the attention factor ( $F(1, 45) = 0.288$, $p < 0.594$ ). However, there was an effect for delay ( $F(2, 90) = 0.376$, $p < 0.05$ ), with engagement scores being marginally higher post-delay. There was no interaction effect ( $F(2, 90) = 0.001$, $p < 0.981$ ).

#### *3.2.1.3 Naturalness factor*

This factor behaves similar to the engagement factor: No main effect was found for the attention factor ( $F(1, 45) = 0.120$, $p < 0.914$ ), but a significant difference for delay ( $F(2, 90) = 9.112$, $p < 0.004$ ), with naturalness scores being marginally higher post-delay. There was no significant interaction effect ( $F(2, 90) = 0.590$, $p < 0.162$ ).

#### *3.2.1.4 Negative effects factor*

No main effect was found for the attention factor ( $F(1, 45) = 0.134$, $p < 0.716$ ), or delay ( $F(2, 90) = 0.590$, $p < 0.447$ ). There was also no significant interaction effect ( $F(2, 90) = 2.025$, $p < 0.432$ ).

### 3.3 Accumulated ITC-SOPI error over delay

To estimate the error which the event-measure delay incurs on the ITC-SOPI, simple correlations between ITC-SOPI scores at the event and after the 72 hour delay. The $R^2$ values show a very high fit (low decay over the interval) between the scores: Spatial $R^2 = 0.91$, Engagement $R^2 = 0.76$, Naturalness $R^2 = 0.72$, Negative effects $R^2 = 0.69$.

## 4. Discussion

The duration of this study (three exposures) was likely too short to bring out major longitudinal effects; an extension of this study would be required before definitive conclusions could be reached about longitudinal effects in presence. Nevertheless, the sample used was large enough to draw some valid conclusions of shorter term effects as investigated. The most interesting result was the very high correlation between presence scores before and after the delay in measurement; this shows that the experience of presence is a long-lasting belief which is encoded in memory and decays slowly. It also shows that self-report measures are capable of measuring accurately after a delay (see 4.2 below).

### 4.1 Support for predictions

Although the ITC-SOPI measures four factors, only one of them (spatial presence) is non-controversial; it overcomes the argument presented by Slater in [20], and is conceptually common with other measures of presence such as the PQ [21], MEC-SPQ [22] and TPI [23]; our findings for this factor thus probably generalize well across measures. The findings themselves are suggestive of interesting longitudinal effects:

1. The attention-neutral group showed an increase in spatial presence scores from exposure 1 to exposure 3 - see 3.1.1.1. The attention-focussed group (who had their attention focussed by the memory questions) showed no differences over repeated exposures.
2. The attention-focussed group showed an increase in spatial presence scores *after* the 72 hour delay - see 3.2.1.1. (there were also small delay effects for the engagement and naturalness factors).

The first finding can be explained if one considers interface effects as well as presence effects in the subjects' interactions with the VE. Initially, VE navigation becomes more familiar as the subject learns to use the system, and that enhances presence (this is interface effect on presence is predicted by [12], and is supported, albeit across conditions and not longitudinally, in [24]). Any differences between the *SoD* and *Spin* models would probably only become apparent after this initial human-system interaction artefact is overcome. However, when one considers the lack of a similar effect in the attention-focussed group, then some indirect support for the *Spin* model becomes apparent. Recall that under the *Spin* model, attention is predicted to accelerate the rate of rejection of false information, and therefore to reduce presence. The fact that the attention-focussed group saw no increase in presence after repeated exposure (as one would expect as they are also learning the interface and becoming used to the system) suggests that their scores are in fact decreased as compared to the attention-neutral group. To make this conclusion more definitive, future studies should include measures of interface familiarity before the first VE exposure and after the last exposure, so that this can be factored out in the analysis.

The spatial presence findings are also in general agreement with the findings of Gerrig who employs a metaphor of *transport* in the study of literary narratives (which is uncannily similar to the concept generally accepted by the presence community – see [25]). Gerrig argues that *transport* correlates with a lack of a critical attitude towards the information presented in a story. He adopts a position of "the willing *construction* of disbelief" ([25], p230, our emphasis) in a narrative world which he supports with the explicitly Spinozan results of Gilbert [26]. Gilbert makes the point that

> *"Organisms immediately believe what they see and only question their percepts subsequently and occasionally. … Perception, then, is quintessentially Spinozan… As perception construes objects, so cognition construes ideas. In both cases, the representation of a stimulus (an object or idea) is believed that is, empowered to guide behaviour as if it were true--prior to a rational analysis of the representation's accuracy."* [26], p107.

Several interesting questions are brought up by our findings which require investigation, particularly with regard to the increase in presence after the 72 hour delay exhibited by the attention-focussed group. For the *SoD* model, this may suggest that disbelief requires continuous effort; therefore, after 72 hours of not exerting disbelief, the effect fades. For the *Spin* model, this may indicate that at the time the subjects recall their experiences, due to a lack of any actual stimuli against which to test their beliefs, they fail to reject them and

therefore have a better presence experience. Further empirical work will be needed to clarify these questions.

### 4.2 Stability of ITC-SOPI over repetition and delay

A useful secondary finding relates to the temporal stability and test-retest reliability of the ITC-SOPI. Although the authors of the scale stress that it be used as soon as possible after the VE experience [4], our data suggests that even after a 72 hour delay, the scale retains a surprising amount of accuracy (see 3.3 above). Similarly, the scale is extremely robust over repeated measures of the same environment, for all subscales; the repetition factor was not significant in any of the models we tested (see 3.1 above). As our design included an ITC-SOPI measure after three exposures to the same environment, we can conclude, with some certainty, that the scale is proof to novelty effects; and because the two measurements were spaced over 48 hours, we can say with some certainty that it is robust against subjects recalling their original responses and repeating the, (of course, the size of the scale – 44 items – defends against this also). We would urge other scale developers to evaluate their scales on similar designs, so as to facilitate the study of longitudinal effects on presence.

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