Attention, Spatial Presence and Engagement: Implications for Virtual Environment Learning Platforms

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Abstract

This paper will examine one of the factors posited to influence the emergence of spatial presence – attention. By examining how elements within a virtual environment, specifically Second Life™, as well as how the environment is utilized – individually, in small or large group gatherings. The study is expected to shed light on the role distractions have on impeding the attention necessary for forming spatial presence.

1. Introduction

I had just finished positioning the pilings that would be used to support the floor of my new home, built just offshore looking out over a shimmering sea. I had only recently purchased the land in which the pilings were anchored, after selling a rather bleak and gray parcel that offered only constant wind and never-ending low-lying clouds, quite depressing to be there, really. I was beginning to doubt my new purchase as it was all completely underwater and my building skills were perhaps less then what was needed for the job. Worse yet, once I emerged from the duty of placing pilings I found I had replaced the bleakness and low clouds with the ever present noise of a nearby casino. So I decided to put this new piece of land up for sale after less than a day or so of ownership and see what fate would bring me next.

In little to no time a prospective buyer came by, she was dressed as a provocative school girl but in conversation it was evident she was older then she looked and wiser then her seductive nature let on. Her name was Tashi Insoo and she was the 1st to teach me my most important lesson of my very young life. She asked if I wanted to see the house she was currently renting, a skybox – very peaceful, quiet and private – located hundreds of meters above the ground. Upon arrival I quickly understood her chosen appearance; she was a prostitute albeit a virtual one and she had chosen one of the oldest professions to earn money to pay her rent.

The scenario described actually took place, but not between two people, per se. Instead it took place between two avatars both located in the world of Second Life™. As we talked late into the evening I explaining my exploration of Second Life as an education platform, Tashi discussing her occupation, and my head exploding with the seemingly limitless possibilities of what could be done within the confines of a computer screen, she reminded me the simplicity of it all – "Its all in the mind" Tashi said, and indeed it truly is.

What I experienced that night (and perhaps you did just now while reading those passages) is spatial presence – the sense of "being there" where the "there" is different from the physical location of your body and mind. Instead your mind is transported in a sense to another location, that is the feeling of being immersed in a virtual environment while at the same time being unaware of the technology interface used to deploy the virtual environment [15]. What Tashi reminded me is now being empirically tested as various new studies have begun to find that Spatial Presence has known correlates in the mind/brain. Using both transcranial Doppler monitoring [1] which demonstrated increased blood flow volume when subjects actively participated in a virtual environment (using a joystick to navigate a maze) or passively observed the navigation through the maze in the middle cerebral arteries (both left and right) and the left anterior cerebral artery. The study also found significant correlation between blood flow volume in the active virtual environment and left middle cerebral artery. Using fMRI [1], [9], were able to show that a network of brain structures are involved in the modulation of spatial presence experience. The results of these studies indicate a distributed network which comprises extra-striate areas, the dorsal visual stream, the superior parietal cortex (SPL) and inferior parietal cortex (IPL), parts of the ventral visual stream, the premotor cortex (PMC), and the brain structures located in the basal and mesiotemporal parts of the brain.

While my interactions with Tashi were mediated by a computer screen, we both felt as we were "there", located in the world of Second Life not in front of our computers. This sense of being there has implications beyond our interest in understanding the neural and behavioral constructs that give rise to this perception. Presence has been shown to be an important factor in training and education in virtual environments. A relationship has been found between presence and course instrumentality and satisfaction [6] and between presence and student engagement [3]. Thus presence has implications for enhancing training and education outcomes. However, not all learners exposed to the same virtual environment will develop the same level of

sense of presence. This is important since, only when a person develops a sense of presence will they identify the potential actions that can be undertaken in the space [12]. Thus a better understanding of this phenomenon can lead to better design of these environments, increased perceptions of spatial presence, and with it increases in learning outcomes (Hornik, in press). The following sections will describe a model examining the process of SP [15], and discuss one particular element from the model that may be of importance in explaining why certain learners fail to perceive SP – attention vs. distraction.

2. Spatial Presence

Recently spatial presence has been described as a two-dimensional construct: "The core dimension is the sensation of being physically situated within the spatial environment portrayed by the medium ("self-location"). The second dimension refers to the perceived possibilities to act..." (p. 497) [15] . Wirth et al., (2007), propose in their model that the perception of spatial presence is a two-step process. In the first, a mental model of the mediated space, the Spatial Situation Model (SSM) is developed. This development hinges on the individuals attention to the media. As the SSM becomes fully formed, the second step involves a test of the primary egocentric reference frame (PERF). Here the individual assesses whether the spatial representation from the SSM is where they are situated or if they remain situated in the non-mediated surroundings. According to the theory the strength of the hypothesis - does the SSM conform more closely to their "self-location, perceived possible actions and mental capacities [as being] ... bound to the mediated space" (p. 506) - determines its acceptance. Two user characteristics associated with this determination are involvement and suspension of belief. Involvement concerns intense interactions with the mediated environment [11], [16] while suspension of belief [10], [14] is the act of not paying attention to external, as well as internal stimuli that could distract from the mediated environment (the SSM). Involvement is expected to foster acceptance of the PERF hypothesis "because it adds more and more stimuli to focus on, and leads attention away from stimuli favoring the real environment" (p. 163) [12]. In addition to the testing of the SSM to the PERF, Schubert (2009) argues for an additional cue that is necessary to bridge the unconscious to conscious gap, cues associated with possible actions in the mediated space, specifically "the representation of potential interactions with the environment and its objects" (p 172). This paper will focus on the 1st stage and in particular the effect that an individuals attention or distraction can have in their ultimate perception of spatial presence.

2.1. Spatial Presence and Attention

The psychologist William James defined attention as "the taking possession of the mind, in clear and vivid form, of one out of what seem several simultaneously possible objects or trains of thought. Focalisation, concentration, of consciousness are of its essence. It implies a withdrawal from some things in order to deal effectively with others" [5]. According to Wirth (2007), "only those users who pay attention to the mediated environment will experience Spatial Presence" (p 499). Attention in the model is proposed to be either bottom-up or involuntary (i.e. not directly controlled by the individual) or top-down (i.e. within the control of the user). Bottom-up attention arises as a result of affordances in the media such as a novel scene or quickly changing elements of the media. Likewise the features that meet the needs, motives or interests of the individual will end up vying for their attention. In controlled attention, the user is specifically motivated to attend to the media perhaps because it seems interesting, entertaining or is needed to complete a requirement (e.g. in training or learning setting)[1]. Thus, the amount of attention an individual pays to the media is one of they key factors in the development of an SSM and as explicated by [15], the stronger the SSM the greater the possibility that an individual will accept the media as PERF, and thus perceive spatial presence. "However, attention must constantly be bound by the medium and may not be interrupted if higher cognitive processes, such as building a mental representation of a mediated space, are to occur" (p. 499) . Just as the media contains factors that can lead to attention; factors can become distractions in the mediated environment.

For example the number of "others" (avatars) located in the same space, amount of screen text spam (resulting from chat between avatars and/or objects), technological hurdles (i.e. learning curves necessary for navigation within the mediated environment) and/or technological problems (system crashes, slowness (lag)). These and other factors can create distractions to users of virtual environments. If attention, both bottom-up and top-down are precursors to the development of an SSM, anything that might interfere with the attention an individual is placing in the mediated environment, that is distractions, could weaken the ability of the user to develop a strong SSM and thus reduce the likelihood of that individual developing a

[1] The authors also suggest that as the immersiveness of the media increases (virtual environment vs. book) the need for controlled attention diminishes, presumably as a result of the bottom-up attention affordances (though an important question thus arises as to the lasting impact of media affordances with continued use, if they become less novel and interesting perhaps more top-down attention is needed in order to enable the construction of an SSM).

media as PERF, as a weaker SSM will require more confirmatory evidence from the mediated environment then may exist or conversely only require a relatively small amount of contradictory information to disprove [8], thereby prohibiting that individual from the feeling of "being there".

Thus the research question to be examined is: how do distractions evident in a virtual environment, specifically Second Life impede a persons feeling of spatial presence? The next sections will describe Second Life, the research setting and the proposed experiment for exploring the research question.

3. Second Life™

"Second Life builds a visual, aural, participatory world on top of--and as an expression of--the dead network of computers that forms the Web" [13]. Second Life is a 3-D Multi-User Virtual Environment (MUVE) created by Linden Labs. An avatar is your virtual representation or presence within Second Life and the means by which you communicate and interact with other avatars and objects. Communication takes the form of either text chat and/or 3-d voice chat. The physics along with the objects created in Second Life allow your avatar to walk, fly, and interact with objects. Second Life's ability to create the feeling of immersion within an environment coupled with the capabilities inherent in the client for building and scripting objects have the potential to capture students' interest and along with that attention foster student engagement in course content. It is this potential – for heightened engagement - that may lead to gains in learning outcomes if students become engaged not just with the Second Life environment, but with the learning objects that the students interact with. However, before engagement can take place and students take the time and effort to use learning objects to their fullest extent, it will be necessary for these students to feel as if they are in this virtual environment. That is, they need to perceive spatial presence. The absence of this can preclude the actions necessary (Thomas W. Schubert, 2009) to enjoy optimal learning outcomes.

As described above a precursor to spatial presence, the development of a strong SSM requires attention toward the virtual environment. Certainly Second Life as a 3-D virtual world inhabited by other avatars each given abilities not possessed in our physical world – flying, locating oneself on platforms floating in air or underwater – present novel stimuli needed to gain the attention of the user. Likewise, unique and aesthetically vibrant scenes can be expected to capture the attention of users. Therefore, Second Life contains many elements that can contribute to the involuntary attention which allows a visitor to this virtual world to orient oneself within the world. Additionally, using Second Life in an education setting needed to fulfill requirements provide the motivation for controlled attention towards the environment.

However, these environments are fairly new on the scene and hardware requirements for using them are relatively high compared to the requirements for say using a web browser or course management system, as is the knowledge necessary to use these environments. These factors can cause distractions and conspire against the attention initially crated by the novelty, and motivation to use these environments, thereby reducing the possibility of developing a strong enough SSM for the individual to eventually feel as if they are located in the environment. Depending on the degree to which avatars need to interact with objects within the virtual environment, these interactions can be both another source of involuntary and controlled attention, but at the same time can create breaks in SSM. The next section describes the use of Second Life in a specific educational setting – a first year financial accounting course - and describes the learning objects built for student interaction, focusing on aspects of these tools for both attention and distraction.

3.1 Really Engaging Accounting, an educational setting in Second Life

The classroom in Really Engaging Accounting had the following learning areas: lecture viewing areas; study group areas including student accessible message boards; instructor office space which included a message board, calendar of all due dates, and pager. The lecture viewing areas were set up so that students' in-world could watch video lectures of the course material. Lectures are streamed into Second Life and student avatars are able to choose from any lecture from any chapter. While the above content was created to foster a sense of place for the students in this new environment, the heart of the class was the use of the interactive accounting equation model (basic and expanded); and an interactive T-account model. Students interacted with the accounting models via various techniques: text chat or through the use of notecards. While in their current form the models are set up

for one-to-one interaction, groups of students can and did participate.

An accounting equation (Assets = Liabilities + Equity) model contained separate 3-D cubes representing assets, liabilities and stockholders equity (for the basic model) and additionally revenues and expenses (for the expanded model). Each cube within the model was shaded a different color and the liability and equity cubes were linked so that students could visualize their relationship to the total size of the assets cube. In addition to the 3-D cubes, the equation was also displayed textually and updated in real time as transactions were entered into the model. Students would interact with the model by "talking" with the model via chat using the same interface they use to talk with other avatars. Each cube was scripted to listen to a specific text chat channel. For a typical business transaction involving one debit and one credit, students were required to "say" each part of the transaction individually, thus chatting with the model twice. The students could also write a transaction(s) on a notecard (a text file used in Second Life) and drag the notecard onto a homework collection box which would then process the entire transaction. The model allowed students to visualize how a debit or credit would increase or decrease one of the account types and the impact that increase or decrease would have on the accounting equation – as the transaction was processed the appropriate cube would increase or decrease in size. As students interacted with the model they would continuously receive feedback from the model (in the form of text chat) indicating what a particular debit or credit transaction was doing and whether or not a particular transaction was balanced. See figure 1 for an example of students using the interactive 3-D accounting equation.

Figure 1. 3-D Interactive Accounting Equation

The interactive 3-D T-account (see figure 2) allowed students to work on the use of t-accounts by having their avatars become a debit or credit and actually walking onto a t-account. The concept is to have the students become pieces in an accounting game. This enabled students to practice their understanding of the concept of normal account balances. The model would provide students with random accounts along with a description of whether the account was increasing or decreasing. Upon receiving this information the student would become a debit or credit – facilitated via a cube attached to their heads - and step on the correct side of the t-account to reflect the proper accounting treatment for the account. Students would receive feedback from the model (in the form of text chat) indicating if they were positioned on the t-account correctly and of the proper type, debit or credit. If they were not, the model would provide feedback on the error, both visually (the t-account board would flash red for wrong, and green for correct) and textually via chat from the t-account and the students could make the correction and ask for feedback from the model again.

Figure 2. Interactive T-Account

Nowhere else can students encounter a visual 3-D epresentation of the accounting equation, let alone one that listens" for transactions and corresponds accordingly. ikewise, nowhere else can students become debits or credits norph into game pieces on a t-account board. Thus, tudents' attention towards these models should be enhanced y the novelty of it, their movements and their ability to nteract with the student – all elements which should increase nvoluntary attention. As the use of the model was a equirement the students' motivation and thus controlled ttention should also be activated. However, for some tudents notably those using the models in large groups and hose failing to follow (or understand) instructions regarding teps for interacting with the model could easily be distracted y the text chat and/or voice chat of others around them as hey attempt to use the model. Also, anytime the model failed to work as expected might lead to distractions away from the virtual environment and towards explanations (on the course web site) for how to use it. While occasionally technical problems did occur with the learning models, and instructions were certainly not followed by some percentage of users, data on these instances were not collected. However, data related to when a user interacted with these models was collected and can be used as a proxy for

distractions arising due to the amount of other avatars present when working with them.

4. Proposed Experimental Procedure

4.1 Research Setting

The research utilized a first year financial accounting course. The course is taught as a hybrid course with reduced class seat time. To accommodate the reduction in class time, all course lectures were provided online. Face-to-face class time was spent covering various exercises and problems from the textbook. The course met one evening per week. The enrollment for the course in the spring '09 semester was 732. Students were required to complete five Second Life assignments. For the interactive accounting equation assignments, students would type a transaction onto notecards and drop them in the homework box. The model would process the transaction and send the homework data (the transactions) to a MySql database.. For the interactive T-Account game, students were required to work with the model and get a specific number of transactions correct within a pre-defined amount of time (15 correct within 5 minutes). Again, when students completed the assignment the results (number of correct responses and time on task) were sent to a database. As students completed their assignments and these were sent to a database for later evaluation each student assignment was time stamped. Thus using these time stamps it is possible to ascertain when students were in Second Life individually, in small groups and in larger groups. Large groups were most often encountered during the last day an assignment was due. Using this data, coupled with the survey data collected (discussed below) it should be possible to determine if large or small group interactions within Second Life are enough to create distractions to weaken these users SSM and thus bar them from reaching a state of spatial presence. Additional data is expected to be collected during the Fall 2009 semester with class enrollment expected to be over 900. During this semester students will be assessed via survey concerning attention toward the virtual environment as well as motivation to use it. This data will lend support to the data already collected concerning when students use the models (individually, small vs. large groups). Many of the technical issues (though not the need to learn how to use the tools and the environment) should be reduced. Data related to submissions in which instructions are not clearly followed will also be collected.

4.2 Measures

The research instrument used during the spring 09 and to be used in the fall 09 study is the ITC-Sense of Presence survey [7]. The instrument is intended to be used in any immersive environment and thus is agnostic to the platform. The instrument measures spatial presence, engagement, ecological validity, and negative effects (hereafter referred to as adverse reactions). The survey contains 40 questions and uses a 5-point strongly agree to strongly disagree response format for all questions. Correlations between spatial presence scores and student model interaction (individually, small group, large group) will be conducted, as will be correlations between spatial presence and engagement and between engagement and learner performance.

4.3 Possible Implications

The process model of spatial presence foundation rests on the attention that users of mediated environments give to the environment [15] and to the attention paid on the interactions possible in the mediated environment [12]. Relatively new virtual environments like Second Life™ contain many affordances to enhance a user's attention. At the same time little is known related to how these affordances might possible break down as the number of users congregate to use the environment at the same time. The results of this study is intended to shed light on the effect that certain distractions might have related to the emergence of spatial presence.

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