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Predicting users' return to virtual worlds: a social perspective

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Abstract. *Virtual worlds or three-dimensional computer-based simulated environments have received considerable attention as platforms for entertainment, education and commerce. In contrast to a web site, for example, where a user interacts with a two-dimensional site, virtual worlds provide a platform in which users can interact with other individuals, sometimes including strangers, within three-dimensional environments. Virtual worlds afford a form of 'socialness' unlike many other technologies, often motivating a user – by virtue of these social experiences – to return. Drawing on the Spatial Model of Interaction and Awareness-Attention Theory, we demonstrate that besides social aspects, which include social awareness and social perception, flow experience, which is the mental state of being fully absorbed and somewhat lost in time, is an essential ingredient in an individual's decision to return to a virtual world. We also demonstrate how characteristics of the technology are linked to the social aspects experienced in virtual worlds. A laboratory study conducted in a virtual world, Second Life, supports our assertions and identifies state predictors of flow that influence individuals' intentions to return to the virtual world environment.*

Keywords: virtual worlds, social perception, social awareness, temporal dissociation, focused immersion, intention to return

INTRODUCTION

Virtual worlds (VWs) have been touted as one of the most promising emerging technological breakthroughs (HBR, 2008). ICANN's[1] CEO, Paul Twomey, elevated VWs as the future of global commerce (Riley, 2007). VWs are computer-based simulated environments where users, represented 'in-world' by avatars, can communicate synchronously over a network (Robbins & Bell, 2008). According to the Gartner Research group, 'eighty percent of active

[1]Internet Corporation for Assigned Names and Numbers.

Internet users will have a "second life" in the virtual world by the end of 2011' (Gartner Research, 2007). Moreover, the number of VWs available is believed to have grown exponentially since 2005 (Castranova, 2005). In 2009, there were over 200 worlds serving the youth market alone (Virtual Worlds Management, 2009). Moreover, more than $1.38 billion had reportedly been invested in virtual goods-related investments over the course of 2009.[2]

A VW is a computer-simulated three-dimensional (3D) environment in which individuals interact (Chesney *et al*., 2009). One distinguishing feature of VWs is the experiences people have when they interact in them (Goel *et al*., 2011). People may return to a VW not just for the 3D replicas of buildings or cars but also for the social interactions they experience in that world (Gutwin *et al*., 1995). VWs afford a 'socialness' that is unlike other Web-based platforms. By socialness, we refer to the technological conditions that lay the foundation for human beings to interact, thus establishing awareness of a collective existence in a technology-mediated environment and providing a platform for experiences to take place. Although a substantial body of literature in computer science and information systems (IS) has noted the importance of social aspects in VWs (e.g., Schroeder, 2002; Jäkälä & Pekkola, 2007; Hendaoui *et al*., 2008; Chesney *et al*., 2009; Goel & Prokopec, 2009; Messinger *et al*., 2009; Thomas & Brown, 2009), the development of social constructs remains fragmented. Concepts such as co-presence (Kahai *et al*., 2007), social presence (Junglas & Steel, 2007), social awareness (Prasolova-Forland *et al*., 2007; Thomas & Brown, 2009) and social interaction (Mennecke *et al*., 2008) have been suggested as important in VWs. As yet, there is a lack of a coherent explanation in the field of IS for features of VWs that afford such social aspects, and how these social aspects may affect people's desire to use the technology in the future (Davis *et al*., 2009). The aim of this paper is to theorise on the social aspects of the VW, and how such aspects predict future use of the technology. We provide an alternate explanation for why people return to VWs – an explanation rooted in the socialness of VWs.

Our theoretical basis is the Spatial Model of Interaction (SMI) and Awareness-Attention Theory. These models help to explain a user's experiences when visiting the virtual environment – experiences that ultimately cause him to return. While the SMI asserts that properties of the environment deliver fundamental cues for human interaction (Benford & Fahlen, 1993), Awareness-Attention Theory holds that these cues, stemming from either the environment or the interactions that take place within it, cause an individual to internalise (or become attentive of) these experiences (Davenport & Beck, 2001). Like in a real world, certain properties of the virtual environment shape, constrain and influence how an individual perceives the environment and others within it, as well as the way he interacts with others in that environment. By internalising these experiences, i.e., by shifting awareness to attention, individuals experience flow, a state in which an individual finds himself fully immersed in what he is doing and simultaneously absorbed and lost in time. Flow, so we argue, will influence an individual's inclination to revisit these experiences. However, whereas prior literature has emphasised traits as predictors of the flow experience, we offer state predictors that come from the social aspects of the VW environment. While traits are individual dispositional factors that are

[2]http://www.engagedigitalmedia.com/press/01-19-2010.html.

relatively stable over time (McCrae & Costa, 1999) and cannot be manipulated, state variables are situational factors that can be influenced by designing situations that enhance or mitigate their influence.

We hence propose as theoretical contributions (1) the notion of flow experiences and how they occur in VWs as an explanation for their use, (2) the influence of social aspects, particularly of social awareness and social perception, as state predictors on the flow experience of an individual in a VW and (3) an explanation of how technological characteristics of VWs, as identified by the computer science literature, which are closely linked with social aspects of VWs.

The report of this work proceeds as follows. The next section describes the theoretical background of our study, highlighting the attributes of a VW that have been overlooked in the IS literature; it also describes what those attributes are and how they are related to factors that can predict intention to use a VW. We then describe our hypotheses, which predict how the constructs in our research model are related to each other. Next, we describe the research method used to test our model. Our results and associated discussions, including implications for researchers and practitioners, are presented in the final two sections.

THEORETICAL BACKGROUND

Being social is one of the most fundamental aspects of human existence. The term not only refers to the notion of one human interacting with another human being but also to the conception of a collective existence among them. While literature has acknowledged the impact of social factors when studying the latest generation of technologies, such as VWs, there is a lack of consensus on what the exact nature of those factors are (Davis *et al.*, 2009). What is generally agreed upon is that VWs are different from other technology-mediated environments in the 'socialness' they afford (Goel & Prokopec, 2009). While, for example, web sites are limited in their support for interactions between users, VWs are simulated environments that combine textual, audio, video and tactual sensory inputs to facilitate interaction between users in a way that comes closer to real-life-like interaction. While web sites might allow for an interactive chat with one person, VWs provide users an environment in which they can 'sense' multiple others' openness for interactions. Such interactions can be highly immersive and cause a person to lose track of time. Preceding any interaction among human beings or avatars in a VW, however, is their understanding of the social environment. This includes two aspects: a person's perception that others exist in the same place and an aware state of mind that he can interact with the others in the same place in a social sense. Based on these ideas, Figure 1 depicts our research model to predict why individuals intend to return to a VW environment.

Social perceptions and social awareness in virtual environments

Any real-life environment is perceived in ways determined by our sensory system. We are engaged with people and things through our five senses. At the periphery, we experience

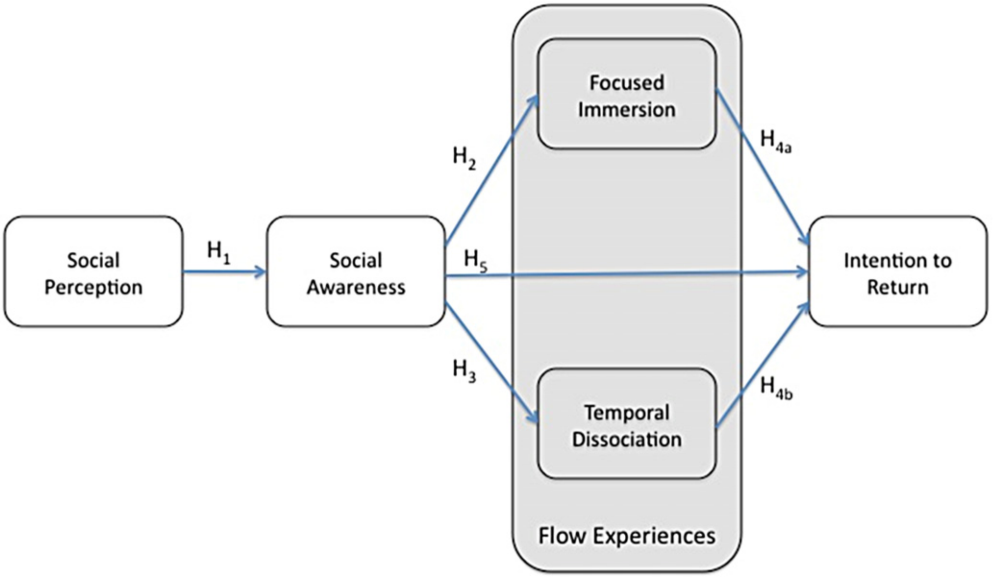

Figure 1. Proposed research model.

objects and people through sight. This area is primarily static space. Closer to us, our sight and hearing allow us to experience objects and people as they move, creating a dynamic space. Closest to us is an area of space that we can experience first by smell, then by taste and touch (Tuan, 2001). Sensory perceptions provide information about the space around us and cause a human mind to be aware of its surroundings.

The relationship between an individual's sensory perceptions and his interactions has its root in the SMI. SMI (Benford *et al*., 1994) uses the properties of the environment as its basis for human interaction (Benford & Fahlen, 1993). Certain properties of the environment shape, constrain and influence perception of others. In the case of VWs, an individual's sensory perceptions are restricted to the sensory inputs of sight and hearing, and properties that enable such perception are embedded in the design characteristics of the environment. For VWs, three properties are particularly relevant for interactions to occur. They comprise the characteristics of aura, focus and nimbus (Benford *et al*., 1994).

Aura is the mechanism by which the medium (audio, vision or text) in the VW comes into being in relation to an object (Benford *et al*., 1994). We use the term object to denote any virtual artefacts, including avatars, in the VW environment. For example, an avatar might be more easily seen than heard implying that its visual aura is greater than its audio aura. Aura provides a subspace that bounds the presence of an object (Fahlen *et al*., 1993). It is the aura of an avatar that allows its presence to be perceived by others.

Focus is the ability to delimit an observed object's interest such that the more an object is within your focus, the more aware of it you are (Benford & Fahlen, 1993; Benford *et al*., 1994).

Hence, focus represents the receiver's control of information. Nimbus, on the other hand, is the ability to represent an observed object's projection towards you (or your respective avatar). One can think of nimbus as a complement of focus as you (the avatar) is the recipient of an object's focus. It represents you (or the avatar) as the object of another's focus and describes the transmitter's control of information.

The perception of presence has been variously referred to as co-presence (Goffman, 1959; Biocca *et al*., 2001, 2003), social presence (Short *et al*., 1984; Gunawardena, 1995) and co-location (Biocca *et al*., 2003). Despite the many multiple labels, they all refer to the idea of the perception of others as being in the same space. We refer to this idea as *social perception*.

While aura, nimbus and focus are characteristics of virtual environments and fundamental for sensory perceptions to form, they are also essential prerequisites to arouse somebody's awareness about others. Awareness, as defined by Davenport & Beck (2001), is a state in which a person is processing vague, general information. This information might be cues that come from others with whom a person is engaged. In this context, aura, focus and nimbus provide more than just the perception of the presence of another; they allow for an awareness of the actions and behaviours, such that an understanding of others can develop. For example, watching an avatar engaged in a task, such as building a virtual structure, might provide cues of the person's level of skill in that task. Similarly, watching the way in which avatars move in a virtual space may indicate that they are shopping or browsing through products.

Such an understanding of others through social interaction (Heath *et al*., 2002; Schmidt, 2002) has been variously referred to as availability awareness (Short *et al*., 1984), workspace awareness (Gunawardena, 1995), psychological involvement (Biocca *et al*., 2003), context awareness (Bardram & Hansen, 2004) and user awareness (You & Pekkola, 2001). Olson & Olson (2000) state that an 'awareness of the state of one's co-workers, both their presence–absence and their mental state', is essential for collaborative work (p. 161). We refer to the notion that one can understand and interact with others in the same space in a social sense as *social awareness*.

In summary, SMI describes properties of a VW that make social perception possible. Social perception, or the cognisance one has that others are in the same space, is afforded by the properties of aura. As such, avatars convey a sense of someone's presence through their aura (Benford & Fahlen, 1993; Biocca *et al*., 2001, 2003). The virtual environment plays a part in making others seem present because space enables a person to 'see at glance' another person's avatar (Benford & Fahlen, 1993). Aura moves with an avatar (as well as with other objects) and therefore helps to define the presence of it (them) with respect to a medium (Benford & Fahlen, 1993). Simultaneously, the flow of information is evidence of the perception of others. Because such information flow occurs via a range of media such as audio, vision[3] or text, perception can also be conceived as a function of these media (Short *et al*., 1984; Keng & Lin, 2006).

On the other hand, social awareness, defined as the cognisance one has that one can understand and interact with others in the same space in a social sense, results from the

[3]By vision, we mean what can be seen in a VW.

perceptions that we have received about others in the environment. With respect to a VW, we consider others to be avatars as they represent users. According to Awareness-Attention Theory, being able to understand others in a social sense is central to the notion of social awareness. Once the presence of another is confirmed, this type of understanding comes into play – and is reflective of social awareness (Black & Rojewski, 1997). This understanding is about what appropriate actions are to be taken with respect to the presence of another, based on what is happening in a space and why it is happening (Black & Rojewski, 1997). For example, in the presence of another, one can signal that she does not wish to be interrupted through body posture and attention (Benford *et al*., 1994). An avatar in a VW can also show such a signal by turning and walking away, for example. The properties of focus and nimbus can also be used to signal an avatar's readiness for interaction. For example, as an avatar gets closer to (or farther away from) another avatar such that focus and nimbus are at play, their orientation and gaze signal their readiness for (or lack of interest in) interacting (Benford *et al*., 1994). As to be able to understand others' actions and behaviours in an environment, it is important to first be cognisant of their presence; we hypothesise that

H1: Social perception is positively related to an individual's social awareness in the VW environment.

Social awareness and flow experiences in VWs

VWs support many-to-many interactions in the virtual space. For instance, when an activity is underway, a person is aware whether another person is available for interaction based on what her avatar is doing (Benford *et al*., 1994; Schroeder, 2002). This notion is the basis for social awareness and it takes into account the opportunity that there is for a person to interact in a social sense.

There is a positive experience that can come about in a VW from the activity of getting to know another person in the VW. For example, a person can use the properties of focus and nimbus in a VW to help another understand that she is ready to engage socially. To be able to understand another in this way is what we refer to as social awareness. The properties of focus and nimbus might not always be used to signal this kind of awareness. There are times when they might signal a readiness to get a task done, as opposed to say socialise. At such times, social awareness may not occur.

However, when social awareness does occur, it serves a couple of important functions in a VW. The meaningfulness of activities is socially constructed (Milligan, 1998), and it might be so in a VW as well. Moreover, due to social awareness, a person is less likely to misunderstand the actions of others and is more likely to find it easier to interact with them. Also, because of this awareness, a person's memories can be triggered in such a way as to reduce cognitive dissonance or confusion (Darley & Fazio, 1980). Hence, when there is social awareness, an individual is able to understand and attend to cues in the environment.

There is a process that underlies how social awareness arises. In a VW, such as Second Life (SL) is, people are confronted with large amounts of information on places, objects and what is deemed from others in the VW. Because of a combination of their attention and awareness, people select, process and store only some of this information. When they attend to information, it enters their awareness, and they think and have feelings about it (Davenport & Beck, 2001). One can think of attention as detecting information as a stimulus. Tied to this notion of attention is the concept of awareness in such a way that these concepts are said to be interconnected (Schmidt, 2001). Awareness is the subjective experience or knowledge a person has that he or she is attending to information. Moreover, social awareness exists to the extent that the information being attended to by a person is thought of as being social. However, it should be noted that attention is finite, and as such there is a limit on the amount of information people will be aware of socially.

There is a state of flow that we contend is associated with social awareness. Flow is experienced when a person is engaged in an activity that is said to be autotelic (Csikszentmihalyi, 1990). Such an activity yields rewards from the act of doing it, rather than its outcome. It was theorised initially that flow is experienced when two conditions are met (Nakamura & Csikszentmihalyi, 2002). One is that the activity allows a person to perceive challenges or opportunities for action that stretch but do not overmatch their skill. Another is that the activity must have clear proximal goals and immediate feedback about progress being made. A third condition was conceived later. It is that a person is able to choose the activity of interest and be able to do it without demands or pacing (Csikszentmihalyi *et al*., 2005). Under the named conditions, both a person and the environment shape flow in an interactive way (Nakamura & Csikszentmihalyi, 2002).

A person can find flow in almost any activity, but routine ones can bore or create anxiety (Nakamura & Csikszentmihalyi, 2002). It is, however, the subjective challenges and subjective skills, not objective ones, which influence the quality of a person's experience (Nakamura & Csikszentmihalyi, 2002). The activity of getting to know a person in a VW and what is being done in the VW can create the conditions necessary for a flow experience. This will derive from the information that a person attends to selectively and the opportunities for action that he or she perceives. Moreover, staying in flow requires that attention be held by the limiting field of information (Nakamura & Csikszentmihalyi, 2002). Proximal goals can come from interaction within the VW. Moreover, immediate feedback on what progress is being made can also be ascertained. In addition, because of inherent uncertainties about the social construction of meaning in the VW, there are opportunities for a person to find challenges in the VW. Moreover, these challenges will demand use of their skills. In such a context, what a person experiences are those capacities for action, and attentional resources and biases that are engaged by their presently encountered environment (Nakamura & Csikszentmihalyi, 2002).

Indeed, past studies have suggested that users of gaming VWs experience flow (Hsu & Lu, 2004). Similarly, flow has been found essential in web site usage (Agarwal & Karahanna, 2000). In these studies, flow has been attributed to personality traits of the users (Moon & Kim, 2001) or to the nature of the games (Chen, 2007; Jegers, 2007; Wu *et al*., 2008). As stated by Csikszentmihalyi (1990), flow depends on 'how we experience work, and our relations with other people' (p. 164). The term 'work' is used to denote any activity an individual is engaged in (such as playing a musical instrument, climbing a rock or playing a video game). Most studies in IS have explored the role of flow in this regard.

Under the right conditions, the flow experience seamlessly unfolds from moment to moment, and a person enters the state with some discernable characteristics (Nakamura & Csikszentmihalyi, 2002). These include the following: an intense and focused concentration on the present moment; their action and awareness are merged; a sense that he or she can control his or her action; a distortion of temporal experience; and he or she experiences his or her activity as intrinsically rewarding. Of these characteristics, Csikszentmihalyi note that a particularly important one is the intense and focused concentration on the present moment (1993, p. 179). Csikszentmihalyi (1993) describes this as 'a merging of action and awareness' (p. 182).

We term the aspects of the flow experience having to do with intense and focused concentration 'focused immersion'. It would be based on a person's attention to and awareness of information, some of which will be of a social nature. Moreover, given the process by which flow arises, we would expect focused immersion to be associated with what we describe as social awareness in the VW. In particular, as the opportunity to interact in a social sense can create the condition for flow in a VW and social awareness would be characteristic of this experience, we hypothesise the following:

H2: Social awareness is positively related to an individual's focused immersion in the VW environment.

Previously, we noted that under the certain conditions, the flow experience seamlessly unfolds from moment to moment, and a person enters the state with some discernable characteristics. In addition to the one we focused on above, another salient characteristic is a distortion of temporal experience. One can think of this as a sense that time has passed faster than normal to a person engaged in an activity. The sensation of losing track of time is referred to as temporal dissociation and describes the idea that time is excluded from the cognitive consideration of the individual. As Csikszentmihalyi (1990) states, 'one of the most common descriptions of [flow] is that time no longer seems to pass the way it ordinarily does'.

The state of temporal dissociation can happen as follows. As a person is intensely focused on an activity, she resists distractions and loses track of time (Sykes *et al*., 2009) as her awareness is limited to the here and now (Dietrich, 2004). A person loses track of time when she directs all her cognitive attentional resources to a particular activity such that it becomes the exclusive content in her working memory buffer (Dietrich, 2004). The flow experience is also quite intrinsically rewarding and leads a person to seek to replicate it (Nakamura & Csikszentmihalyi, 2002). As the person focuses on such effort, she will also lose track of time. In addition, the moment-by-moment occurrence of flow could also account for a person losing track of time.

As a person gives attention to information of a social nature, we would expect their social awareness to be associated with the state of temporal dissociation as it is characteristic of the flow experience. Further, the social awareness is reflective of how the person is making sense of the social aspect of the activity in which he or she engages through the technological properties of nimbus and focus. This could involve matching their skill with the uncertainty of the social situation, causing the person to lose their sense of time. Hence, we predict the following relationship.

H3: Social awareness is positively related to an individual's temporal dissociation in the VW environment.

Flow experiences and intention to return to VW

Intention to return refers to the idea that a user will come back to the VW. We argue that there are a couple of reasons why people who use a VW will want to return to it. One reason has to do with deeply involved experiences in the VW that are of emotional significance. Because a VW facilitates social interaction, in a symbolic sense, it is possible for these experiences to result from the nature of such interaction in it. An interaction between people in the VW could be quite emotional. This could be because the anonymity of the VW makes people less inhibited. Indeed, people who have spent time in a VW have acknowledged that their experiences there are highly engaging and have caused them to have deeply felt emotions (Corbett, 2009). Such meaningful experiences shape future behaviour; a person will want to return to where these experiences were had (Milligan, 1998). Hence, a person will want to return to a VW for these experiences and their associated emotions.

One might even think of the experiences described above as having the potential for flow to occur with them. However, flow can also occur in another way and cause people to want to return to a VW. This state of flow can result from a person's use of a VW. Such use can afford rich opportunities for action, where skills and challenges come into play and give rise to flow (Nakamura & Csikszentmihalyi, 2002). Prior literature describes this idea as experiences that can result from users' involvement with a technology. For example, Hoffman and Novak note that the flow state can occur in interactions with symbolic systems (Hoffman & Novak, 1996). The flow experience is intrinsically rewarding and leads a person to seek to replicate it (Nakamura & Csikszentmihalyi, 2002). The key idea is that as a person masters challenges in an activity, she develops greater levels of skill, but so as to restore flow, she identifies and engages in more complex challenges (Nakamura & Csikszentmihalyi, 2002). In this way, not only is flow rewarding and enjoyable, but it is a reason for a person to return to an activity and where it occurs (Csikszentmihalyi, 1990; Nakamura & Csikszentmihalyi, 2002).

Earlier, we noted that two salient characteristics of flow are the states of focused immersion and temporal dissociation. Moreover, based on the ideas presented above, we conclude that the experience of flow would be the basis for a person to return to a VW. Therefore, with respect to the two characteristics of flow and returning to a VW, we make the following predictions:

H4a: Focused immersion is positively related to an individual's intention to return to the VW environment.

H4b: Temporal dissociation is positively related to an individual's intention to return to the VW environment.

Social awareness and intention to return to VW

So far, a couple of our predictions are (1) flow is influenced by social awareness and (2) the intention to return to a VW is influenced by salient characteristics of flow. Given this multistage series of influences, one wonders whether intention to return to a VW is influenced by social awareness in the absence of flow. Otherwise, does flow play a mediating role between social awareness and intention to return to a VW? The answer to this question will yield an important insight as to whether mere social awareness is enough for a person to want to return to a VW.

We conceive of social awareness as being able to understand whether another person in a VW is ready to engage socially. The understanding of such readiness is made possible by properties of the VW such as nimbus and focus, as well as from the information that a person attends to. What is understood is also shaped by a person's experiences and general knowledge.

A person might expect signals of readiness to engage socially to be the same as they know them in the real world (Berger & Luckmann, 1966). This is in line with the argument of sociologists Berger & Luckmann (1966) who proposed that the concepts of 'reality' and 'knowledge' are socially relative. To make sense of new contexts and reality, individuals translate the unfamiliar experiences into everyday life. They use language and meanings from the reality they are familiar with and associate them with objects in an unfamiliar domain. Hence, an individual who is familiar with the experience of a tree in real-life calls pieces of code, software and hardware used in the virtual representation of a 'tree', a 'tree'. Dragons and warriors in simulated virtual games are interpreted due to the association of their representations with the words 'dragon' and 'warrior' and their meanings. Viewing a simulated reality as an unfamiliar context[4] allows us to make the transition between cognitive and social processes that occur in the VW to those in the real world.

As human behaviour is in general unpredictable, signals of readiness in a VW might be in accord with expectations and give positive social interactions. However, these signals will also not be in accord with expectations at times and in such instances lead to negative social interactions. Whereas positive interactions could provide a basis for a person to return to a VW, negative interactions would have an opposite effect. At this point, we have no reason to support the greater likelihood of one of these outcomes over the other, thus we predict the following:

H5: Social awareness will not have a significant influence on an individual's intention to return to the VW environment.

[4]An unfamiliar context for a person is a situation that she has not experienced before. In Berger & Luckmann's (1966) example, an American city would be an unfamiliar context for a Tibetan monk.

RESEARCH METHOD

The research model (see Figure 1) was tested through a survey instrument and as part of a laboratory study that used the VW SL. SL was chosen because of our decision to focus on non-gaming VWs. While research on gaming worlds, such as World of Warcraft, can be insightful, there are additional factors, such as addiction or social pressure, which may play a role in users' intentions to return. In non-gaming VWs, those factors are mitigated due to the fact that activities and content are user-defined rather than predetermined by aspects of a game. By taking advantage of the user-defined flexibility of SL, we were able to control the settings as well as the task that the subjects were required to do.

A study was carried out in a computer lab where subjects had access to a set of computers running SL. The site for our experiment was a simulated or 'virtual' lab within SL. This 'Telecommunication Lab' was exclusively built for the purpose of this study on 'ITWorld', a private island in SL. The virtual environment was made to support subjects' involvement with specific activities such that their senses were engaged to heighten their perception and awareness of others and of objects in the virtual environment (Jacobson, 2001). As part of the laboratory setup, five avatars were pre-created to represent subjects. However, only a number of avatars equal to the number of users present were active at any given time. Each avatar was unique in appearance with a default male or female 'look' stored as a template. This allowed each avatar to have a distinct aura so that subjects could uniquely identify each. Hence, with the click of one button, the same avatar could be either a male or a female. While the subjects were filling out the pre-test instrument, the researcher logged into the respective avatar and changed the gender of the pre-designed avatar to match that of the subject. This was done from the researcher's machine, and the subjects were unaware of it. Also, visual and haptic cues, such as informational notecards, pictures and virtual tables with networking hardware, placed in the virtual lab drew attention to the activity that the group needed to engage in.

Stimulating interactions between avatars in the virtual environment as part of the activity allowed for development of meanings as interactions occurred. Specifically, avatars were allowed to spend time to 'socialise' before being asked to start working on the task. During this time, they were asked to talk about personal and impersonal topics. Personal topics included finding out (1) the real names of their group members, (2) one interesting thing about them such as a hobby or past experience and (3) how information technology (IT) savvy their group members were – whether they used computers at school, work and/or for gaming. As all the students were part of the introductory Information Systems course, the impersonal topic chosen was that of the class. Students were asked (1) the name of their instructor and (2) what they were doing in the course that week.[5] Subjects were also given the option to change the appearance of their avatars in any way – such as change their body shape, clothes and hairstyle. In this way, subjects could develop a sense of how others expressed themselves. Subjects were allowed to explore their 'inventory', which had different objects like 'wings', 'glass of wine' or 'ball' that they could play with or give to other group members. Each subject

[5]The script was similar to structured social chat described by Dabbish & Kraut (2008).

in a group had different sets of objects. Subjects were able to describe these objects and say what they represented. In this way, they could develop common meanings for these objects.

Measurements

Social perception was measured using items from Harms & Biocca's (2004) co-presence scale as they were the closest in meaning to our concept of social perception. The construct incorporates the idea of noticing others and being aware of their presence in the same space. We measured social awareness, using items from Harms & Biocca's (2004) instrument that focused on perceived message understanding. These items were selected in accordance with our definition of the social awareness concept. Temporal dissociation and focussed immersion were measured with items adopted from the respective scales of Agarwal & Karahanna (2000). Although Agarwal & Karahanna (2000) choose five reflective flow constructs to measure cognitive absorption, our choice of temporal dissociation and focussed immersion only were based on the following reasons: the first reason is that the lower order reflective constructs of cognitive absorption correlate with one another; thus measuring any one of them is approximately equivalent to measuring the others. For this reason, Burton-Jones & Straub (2006) also measured cognitive absorption along a single dimension. The second reason is that we conceive of the state of flow with a focus on users' immersive experience and the temporal disassociation dimension. This focus has been substantiated by prior studies on subjective time loss experiences of video game players, which demonstrate a correlation with positive experiences and immersion (Wood *et al*., 2007). Items for intention to return were developed as part of pre-studies and mirrored the instrument development procedure suggested by Moore & Benbasat (1991).

All construct items were measured on a seven-point Likert scale with anchors ranging from 'strongly disagree' (1) to 'strongly agree' (7). During an 8-month period, scales were tested and fine-tuned as part of a qualitative and quantitative pre-study. Table A1 in the Appendix includes all items in the various scales. Covariates such as subjects' age, gender, prior knowledge of the topic, comfort with computers, familiarity with SL and group size were controlled for. Past research has identified traits such as innovativeness and self-efficacy as significant predictors of flow (Agarwal & Karahanna, 2000). We measured and control for these two factors. The results do not significantly change with or without these factors in the model. As we also assigned subjects randomly to each group, it is unlikely that other differences could have any confounding effects.

Sample

The sample consisted of 175 students enrolled in an introductory IS course at a large, public university located in a large city in the south central United States. As students are the generation of IT workers most likely to use VW technologies in the next few years, we considered the student sample representative of the target population. Subjects received extra class credit for participation. The demographic analysis showed that subjects were on average

21 years old, almost evenly split between males and females. More than 93% considered themselves very or extremely familiar with computers ($\mu = 6.22$); 58% considered themselves familiar or extremely familiar with 3D computer games such SIMS, World of Warcraft or PlayStation ($\mu = 4.67$); 15% had used SL before the experiment. Data collection took place over 3 months, though each subject's participation required only between 45–90 minutes; data were drawn from teams of subjects that varied in team sizes of three, four and five; each team was asked to work on the same task.

Task

The task the subjects were asked to solve can be characterised as a complex cognitive one (Campbell, 1988). While complex tasks can have multiple solutions and multiple ways to achieve a solution, simple tasks only have one solution (Campbell, 1988). Our task involved a team working inside a virtual 'Telecommunications Lab' to design and build a network typology that conformed to pre-specified rules (see detailed task description in Figure A1 in the Appendix). The task was chosen so that interactions between participants were salient to all involved. Further, the task was designed to match the subject matter expertise of a typical IS undergraduate student.

Study procedure

At the start of the laboratory study procedure, each subject was given a questionnaire to complete, taking about 5 minutes. The questionnaire consisted of several control variables such as familiarly with SL, VWs, 3D games and computers. We also collected data on personality traits such as personal innovativeness and self-efficacy. Demographic variables such as age and gender were also measured. During that time, the researcher used her machine to assign appropriately gendered avatars to each participant. Each avatar looked unique and had a default male and female 'look' stored. Hence, with the click of one button, the same avatar could be either a male or a female. While the subjects were filling out the pre-test instrument, the researcher logged into the respective avatar and changed the gender of the pre-designed avatar to match that of the subject. This was done from the researcher's machine, and the subjects were unaware of it.

Once subjects had completed the questionnaire, subjects were asked to log into SL; in doing so they entered directly into the lab's virtual 'welcome room'. In order to confirm that each subject knew his or her avatar, each subject had to identify their own avatar by using arrow keys on their keyboard to move around. All communications were done in-world. As voice interaction was not permitted, subjects were also told that they could use the chat functionality to communicate with other avatars. Noteworthy is that nimbus and focus are properties built into the design of SL. Mechanisms such as foreshadowing of a chat message by the movement of avatars' hands and the perception of 'depth' of a space based on how big or clear objects seem are some examples of nimbus and focus that may come into play.

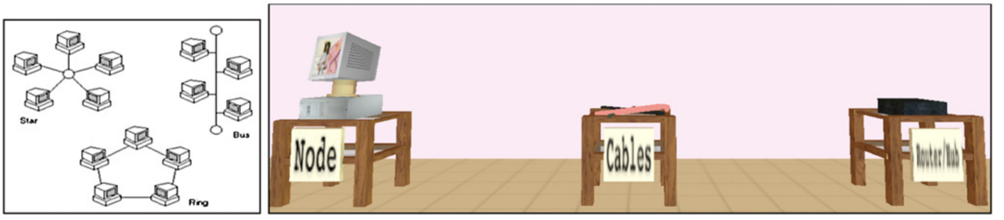

Figure 2. Visual and textual cues about virtual objects that were in the virtual lab's foyer.

As part of the familiarisation phase, subjects were allowed to spend as much time as they needed, typically 15–20 minutes, to interact with others and to get comfortable with in-world behaviours, such as moving around, communicating via chat and changing their avatars' appearances. Noteworthy here is that subjects without prior VW experience were made familiar with the aura of her own avatar, those of others and of the objects in the virtual space, as well as with nimbus and focus properties that helped them interact in the virtual space. Flying was disabled during the experiment; to further constrain the avatars to the experimental lab neither doors nor windows permitted visual or physical access to other parts of the VW.

After the familiarisation phase in the 'welcome room', subjects' avatars were led by one of the researchers' avatar into the 'foyer' of the telecommunications lab. Subjects were then presented with their task in the form of notecards[6] that had been pre-stored in their SL inventory.[7] One notecard contained the actual task description; other notecards contained necessary definitions and some textual cues regarding different types of network typologies. Additional cues, in the form of text and virtual objects, were also part of the room. For example, the foyer of the Telecommunications Lab contained displays of network components, such as virtual routers and cables, and pictorial representations of the various network topologies (see also Figure 2).

As part of the 'foyer' phase, subjects were allowed to spend as much time as they needed, usually about 10–15 minutes, to interact with one another, to check out the foyer of the lab and to read the notecards. Once completed, the researcher's avatar led them to the main room of the virtual lab. At the centre of this room resided a big virtual table that held all technical components to solve the task, including five virtual computers (one laptop and four desktops), virtual peripherals such as keyboards and two virtual hub devices that were on the virtual floor. Adjacent to the table, were three 'connection switchboards' that allowed subjects, through their avatars, to connect (or disconnect) cables between various devices with the press of a button. By pressing a button on the connection switchboard with the hands of an avatar, a virtual cable

[6]Notecards are simple text documents that one can create and share in Second Life. Notecards are accessible in an avatar's inventory.

[7]Inventories are virtual storage areas, where avatars can store things, such as clothing items, notecards or objects that the avatar owns. The inventory can be organised using folders and it is virtually unlimited in size. Items are automatically placed in folders based on type.

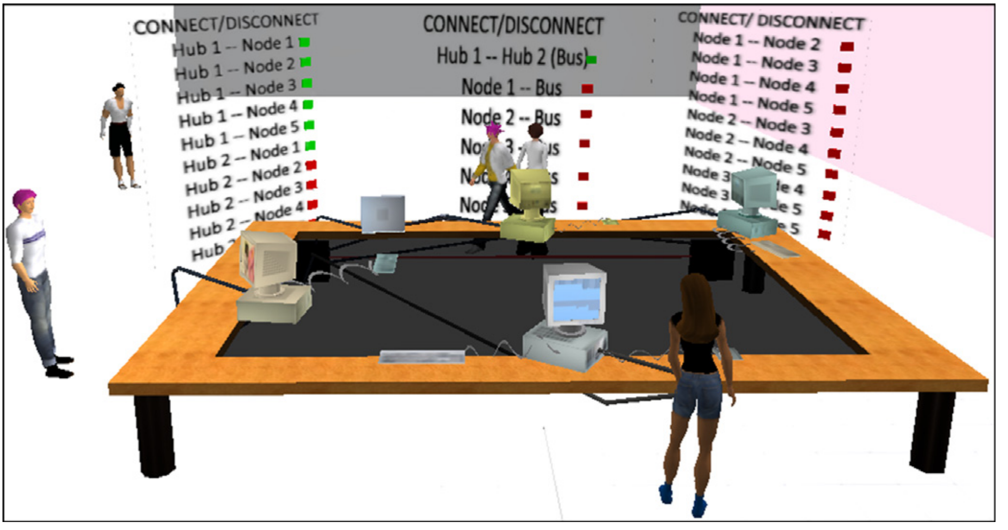

Figure 3. Inside the experimental lab.

would appear (or disappear) between the components specified. This mechanism was implemented to simplify the cabling challenges that may (or may not) occur during task execution. A screenshot of subjects performing the task is shown in Figure 3.

While subjects were performing their task, the researcher stayed in the room, in real-life and in-world, but stayed out of view and was therefore not easily seen, if at all, by subjects. The researcher's avatar was also kept far enough away from the subjects so that (1) her aura, nimbus and focus, could not have any bearing on the subjects and (2) and subjects' interaction with the researcher was prohibitively difficult. She also avoided communication with subjects to ensure that she had no influence on the study.

Figure 4 shows another screenshot of the virtual lab from the researcher's perspective. After a group of subjected completed its task, their avatars were led back to the 'welcome room' by the researcher's avatar, and they were instructed to quit SL and to complete a questionnaire based on their experience with SL. Responses to this post-study questionnaire comprised the dataset for our study.

From a design perspective, it is important to point out that for all virtual artefacts and objects within the telecommunications lab, auras were kept as close as is possible, in terms of features, to what they would be in reality. For example, the size and proportion of each object with respect to the avatars and the virtual space were kept as realistic as possible; visual aids were added to clarify the nature of the objects; computer screens showed displays as real computers would; buttons on the connection switchboard needed to be clicked to be activated; and 'lights' on the connection switchboards changed colour when buttons were clicked to indicate whether a particular connection was established or not. By explicitly

Figure 4. The researcher's perspective.

considering aura, nimbus and focus in the design of the telecommunications lab, we sought to highlight the awareness that the users had of each other through their respective avatars.

ANALYSIS

Useable data were gathered from 166 students and analysed using structural equation modelling – more specifically, partial least squares (PLS), version 3 (Chin, 1998; Gefen *et al.*, 2000), was applied; invalid data that resulted from technological failures or incomplete responses were discarded.

PLS, as every structural equation modelling technique, differentiates between a measurement and a structural model. Whereas the measurement model analyses the relationship between the latent constructs and their associated items by scrutinising their internal, convergent and discriminant validity, the structural model estimates the strengths of the relationship between latent constructs by providing estimates for path coefficients and variance explained.

Table 1. Measurement model results

Construct	Variable name	Factor loadings	Items per construct	Composite reliability	Mean	Standard deviation
Social perception	SP1	0.84	3	0.935	6.09	1.10
	SP2	0.91				
	SP3	0.86				
	SP4	0.92				
Social awareness	SA1	0.75	4	0.892	5.12	1.24
	SA2	0.86				
	SA3	0.84				
	SA4	0.83				
Focused immersion	FI1	0.97	2	0.967	4.48	1.68
	FI2	0.97				
Temporal disassociation	TD1	0.95	3	0.955	5.06	1.66
	TD2	0.90				
	TD3	0.96				
Intention to return	INTENT1	0.90	3	0.939	3.81	1.80
	INTENT2	0.92				
	INTENT3	0.93				

Measurement model

When examining the internal validity of the constructs, represented by the loadings to their respective construct, one ensures that the items measuring one construct are indeed measuring the construct they were designed for (Chin & Newsted, 1999).

Table 1 shows that each item loads above 0.7 on its respective construct, displaying acceptable validity (Comrey, 1973). Further, all constructs display sufficient composite reliabilities. Convergent validity is established if the average variance extracted (AVE) is above a suggested level of 0.5 (Fornell & Larcker, 1981); all constructs surpass this criterion. In order to establish discriminant validity, the AVE also has to be greater than the squared correlations (i.e., shared variance) for each construct (Chin, 1998) (see Table 2), and constructs should load higher on their respective constructs than on others, as illustrated through their cross-loadings in the Appendix, Table A2.

Structural model

The structural model results include estimates of the path coefficients, which indicate the strengths of the relationships between the variables and the R^2 values, which represent the amount of variance explained. As Figure 5 shows, our model explains 34% of the variance in intention to return to VWs. Focused immersion and temporal dissociation were each found to significantly influence an individual's intention to return, providing support for H4a and H4b. Social awareness was a significant predictor of both focused immersion and temporal disso-

Table 2. Correlation matrix and average variance extracted (AVE)

	AVE	Social perception	Social awareness	Focused immersion	Temporal disassociation	Intention to return
Social perception	0.784	0.885				
Social awareness	0.674	0.389	0.821			
Focused immersion	0.935	0.204	0.340	0.967		
Temporal disassociation	0.877	0.206	0.336	0.392	0.936	
Intention to return	0.836	0.142	0.236	0.411	0.537	0.914

Note: The diagonal contains the square root of the AVE.

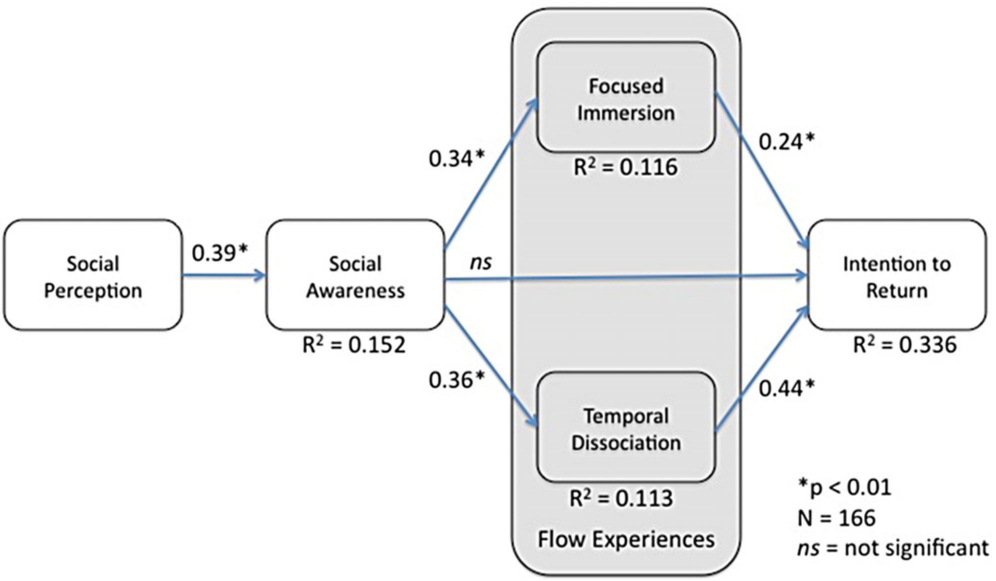

Figure 5. Structural model results.

ciation, supporting H2 and H3. Social perception significantly influenced social awareness, which is in accord with H1. There was no significant relationship between social awareness and intention to return, which supports H5.

Mediation analysis

We used Baron and Kenny's method to test for mediation using a covariance-based structural equation modelling tool, Analysis of Moment Structures (AMOS). We performed a Monte Carlo parametric bootstrap with 2000 samples, with the bias-corrected confidence intervals set at 90, and examined the direct, indirect and total effects. We found complete mediation by social awareness between social perception and focused immersion, and between social perception and temporal dissociation. We also found complete mediation by focused immersion and by temporal dissociation between social awareness and intention to return. In each case, there was a reduction in the absolute size of the direct effect, such that the direct effects, which were significant in isolation of the mediator, became insignificant when the mediator was added, though the relationships still remained significant in the same direction.

DISCUSSION

Our study yields certain theoretical and practicable insights. We first discuss the significant theoretical contributions to research in VWs, and IS in general, in the following areas.

Conceptualisation of social perception and social awareness

While the role of social interaction has recently been recognised as an important factor in studying technology (e.g., Bagozzi, 2007), there has been little work that integrates the fragmented literature. In pre-VW technologies, the role of social factors has been limited to that of social norms, which describes the degree of influence others have on an individual's technology adoption decision (Venkatesh *et al*., 2003). In that regard, social norms are unilateral; they describe the perceived pressure exercised by others that is pointed at a single individual.

In VWs, in contrast, interaction between individuals takes centre stage. Social factors that come from interacting with others within the environment play a vital role due to the affordance of the technology, which separates it from all other existing Web-based platforms. A typical e-commerce web site, such as Amazon for example, does not provide an environment in which a user can see if another web site visitor is logged on to the same site nor does it provide an environment in which web site visitors can interact with one another. VWs are able to provide exactly this, and prior studies in VWs have acknowledged that such social interactions with others are important (Schroeder, 2002; Bainbridge, 2007). Yet, to our knowledge, there is a gap in IS literature that explains how these factors come into being and how they impact individual outcomes. In this paper, we use the SMI to explain how social perception and social awareness occur in VWs due to features of the environment. In doing so, we offer two rich conceptualisations, that of social perception and social awareness, which should help researchers to better understand how individuals experience social interactions in the context of VWs.

The role of the SMI

The SMI subsumes three properties embedded in the design of 3D VW environments. The focus of research using the SMI has typically been on how these properties enable interaction between users and objects in any large virtual environment where a spatial metric, i.e., a way of measuring position and direction, can be identified (Benford & Fahlen, 1993). The model has been applied to explain and control mutual levels of perception, which influence awareness, in computer-supported collaborative work environments (Benford & Fahlen, 1993). For example, based on the properties of focus and nimbus alone, Benford *et al*. (1994) outline 10 modes of mutual awareness, ranging from no mutual awareness to fully reciprocal mutual awareness. We use the SMI as a basis to explain perception and awareness of a social nature between avatars in Web-based VW environments. Hence, we differentiate social awareness as a concept unique to VW environments from related notions such as social presence, which have been defined in environments such as two-dimensional (2D) web sites or chat rooms where properties of SMI do not fully apply. Another distinction between social presence and social awareness is that social presence is defined as the property of the technological medium (Short *et al*., 1984; Gunawardena, 1995; Yoo & Alavi, 2001), while we define social awareness as a property of the interaction between others over the medium. We note that presence is just about being, whereas awareness is about being as well as interacting. While such cognisance may indeed depend on technological factors, different individuals may experience different levels of social awareness in the same medium. While SMI provides the basis for social awareness, we extend the model using Awareness-Attention Theory to explain how the social awareness enabled by SMI can lead to a state in which an individual is cognitively immersed and loses track of time, thus experiencing flow.

A further theoretical contribution is the explanation of the state predictors of flow as they relate to properties of the VWs. The properties of aura, nimbus and focus from the computer science literature outlined in the SMI provide an explanation for how avatars interact with one another in a social sense within the virtual environment. To our knowledge, this explanation is missing in the IS literature. These properties can be used, for example, to differentiate how one environment differs from another in the socialness it affords. Social networking sites like Facebook or MySpace allow users to ‘see’ if their friends are online in a manner similar to an instant messaging tool. However, this social perception is very different from the social perception in VWs. The aura of users in a social networking site is static (for example, a green dot indicating a user is online or a grey one when the user is off), whereas the aura in a VW is highly customisable and not limited to a 2D visual representation. Focus and nimbus are meaningless in 2D environments but extremely important in defining interactions in a 3D space where avatars can move. Directions for future research would be to explore these properties in the context of IS and possibly use them to define ‘social’ technological environments. Prior theories such as social presence or media richness have been very useful when contrasting different environments such that it is possible to identify one medium as being richer or having higher social presence than the other. However, there is still a gap in research that explains exactly how a medium affords social presence or richness in terms of user interactions. The SMI may fill this gap.

State predictors of flow

While the concept of flow has been studied and applied extensively in studying the use of technologies, research has primarily identified trait variables such as playfulness or self-efficacy as predictors of the state of flow (Agarwal & Karahanna, 2000). Trait variables are characteristics inherent to the individual; they are part of an individual’s personality profile and are expected to remain constant over an individual's lifetime. Considering only trait variables as predictors of flow would mean that a state in which an individual finds himself fully immersed in what he is doing and simultaneously absorbed and lost in time can only be achieved by those individuals that expose one or both of the two traits; others would be, per definition, excluded. It is only recently that IS researchers found that web site complexity affects flow, suggesting the possibility that technological characteristics may influence flow (Guo & Poole, 2009). In this study, we offer the state variables of social perception and social awareness as predictors of flow in the context of VWs. Opposed to trait variables, state variables can be manipulated by designers of virtual environments and hence used to influence the degree of flow that can be experienced by an individual. By varying the level of an individual's social perception and awareness, designers can affect his flow experience. The challenge for designers is to ensure that an individual is able to form perceptions in a VW while simultaneously heightening her awareness. This can be done, for example, by enhancing the degree of aura, nimbus and focus.

Further, prior studies in flow have focused on flow experience as it relates to a task, such as web site usage. The role of others, i.e., the influence of social factors on the flow experience, has thus far been ignored. In this study, we focus on flow that results from the awareness of others in the environment and not from the task.

Our identification of social factors as predictors of flow is in the spirit of what Markus & Robey (1988) term as a 'process theory'. Based on the distinction by Mohr (1982), process theories are differentiated from variance theories, which focus on identifying causes as necessary and sufficient conditions for an outcome. In our case, social awareness does not always cause flow but may require other factors in conjunction for flow to occur. Our explanation, hence, is in line with a process theory, in which precursors are assumed insufficient to cause the outcome but are necessary for it to occur. For a process theory, necessary conditions can comprise a satisfactory causal explanation by telling how outcomes occur in that 'outcomes are predictable from knowledge of the process, not from the level of predictor variable' (Markus & Robey, 1988, p. 590). Our outcome variable, the flow experience, is not conceived as one with a range of values. It is instead a discrete phenomenon of a change of state. This conception meets the requirement for a process theory as described by Markus & Robey (1988).

Mediating role of flow in the relationship between social awareness and intention to return to a VW

For social technologies, like VWs, it is intuitive to anticipate that what draws an individual back to the environment is the presence of social factors. Social networking sites, such as Facebook and MySpace, are considered successes due to their ability to connect users with others, and the higher such social connections, the more people are expected to want to be a part of the network. However, in our study, we find that the influence of the two social elements – perception and awareness – on the intention to return to the VW is fully mediated by aspects of flow experiences. It is not sufficient for a person, who solely processes information from behavioural cues that come from others with whom she interacts, to form positive intentions to return; only if the individual finds herself in an immersed state in which she loses track of time as a result of processing these informational cues, positive intentions can form. We speculate that this could be so because users take for granted the ability to understand others in the VW. That is, users expect the behaviours and actions in the VW to mimic those in the real world, and thus be easy to understand and interpret.

The non-significant relationship between social awareness and intention to return implies that neither the negative experiences nor the positive ones, with regard to understanding of others, are more prevalent. It could be the case that there are factors that can cause an understanding of others to be more positive or more negative, thereby influencing an individual to form intentions to return without necessarily experiencing flow. It would be interesting to explore this issue further. However, for now, we have only the understanding that experiences characterised by the state of flow are what have a positive influence on users' intention to return to a VW.

Contribution to practice

Besides theoretical implications, this study also provides insights to practitioners and designers of virtual environments. A major problem faced by early adopters of VWs is the inability of companies to draw people back to the environment. After enjoying a high initial acceptance, patronage wanes and places designed in VWs are often seen as deserted and empty. This research offers an explanation for this phenomenon – individuals that experience flow are likely to return. The flow experience of individuals can be influenced by designing virtual places such that they leverage the social perception and social awareness that people have of one another in the virtual environment. Hence, focusing on creating 3D virtual places, such as malls or offices, will not suffice in enticing people to return if they are often empty. The virtual spaces need to foster social experiences between avatars. It is also not enough to just see others in the virtual space. It is the meaningful interactions that cause individuals to experience flow and thus return to the environment. This implication supports the importance of in-world events where avatars get a chance to interact with others. Besides focused immersion and temporal dissociation as experiential states, it is possible that more prolonged or repeated experiences in the environment would have increased the effects of social awareness on flow, thus further impacting individuals' intention to return. The particular task, which in this case was selected by the researcher, not the participant, might also be expected to impact the degree of subsequent flow.

LIMITATIONS

This study has its limitations stemming from the challenges always inherent in choosing a particular balance of external validity, internal validity and realism. By conducting the study in a virtual environment, we were able to achieve a degree of realism. Internal validity was enhanced by the controls imposed on the sample, task and measures as outlined in the research methodology. However, as there is no way to maximise all the three desiderata of research (McGrath, 1981), there are some compromises made in terms of external validity or generalisability.

We chose a task conducted in a lab that exemplified a simple group decision-making task. Our choice of task limits the generalisability of our study to tasks with these characteristics. Other tasks, such as shopping in a mall or group training in an organisational setting, might add more insights. Simple tasks are exemplified by the existence of a single solution and a single path to reach it (Campbell, 1988). It is conceivable that there are tasks that can have multiple possible solutions. Future research may explore the influences of social factors in such complex tasks. Similarly our results may be tested in tasks not explicitly set up as group tasks, but one in which a solitary user is aware of and influenced by the presence of others that are not directly interacting with her.

Other relevant foci for future studies might be utilitarian vs. hedonic notions. In the case of our study, it is quite possible for both complex and simple cognitive tasks to bring out the hedonic and utilitarian needs of a person. The literature in neuroscience demonstrates that participation in learning is linked with that part of the brain that is activated in a hedonic experience (Kringelbach, 2005). In addition, shopping has been shown to have both hedonic and utilitarian components (Babin *et al*., 1994). As our study focuses on cognitive absorption, which subsumes an emotional flow experience, we are inclined to believe that our task might bring out the utilitarian and hedonic needs of our subjects. Thus, we refrain from referring to our task as utilitarian or hedonic. However, an explicit consideration of utilitarian vs. hedonic task characteristics might be insightful. Additionally, a different sample pool – for example, employees or consumers – would also alleviate concerns of external validity.

A possible concern in our study is that the mean of our dependent variable, intention to return, is 3.81, which could be perceived as low. We speculate that the mean intention to return could be low because subjects might have been doubtful as to what would they do on return. As such we would have needed to increase the scope of our research to consider the many reasons why people would return. We acknowledge that our research is not intended to provide a comprehensive model to explain intentions to return. Theories such as the technology acceptance model (TAM) or theory of planned behaviour posit factors such as ease of use, usefulness and social norms as predictors of intention. By including constructs like 'usefulness' in our model, the variance explained increases to 63%. However, we explicitly choose not to take such constructs into account in order to be faithful to our ontological position, which is not about TAM but instead is focused on social factors.

A further concern may be low variances explained in our mediating variables. The variance explained for social awareness is 15%, focused immersion is 12% and temporal dissociation is 11%. Our explained variances might not be as low as they seem to all readers because such levels are common in behavioural research (Winston & Albright, 2009). Our reference theories of SMI and awareness-attention fall in this domain with its focus on people's experiences and their interactions with others and with their settings. Still, the apparent low variances of our study could be for two reasons. One reason is that our model is predicated on intention to return that arises from subjects' social experiences. Our results may have been stronger if our subjects were exposed to the experimental condition for longer than we allowed as such exposure would likely lead to more and varied experiences. Moreover, this in turn could increase the explained variances in our model. The other reason has to do with the number of variables in our model. It is well established that explained variances tend to be low when there are fewer variables, and higher when there are relatively more variables, which make up a model (King, 1986). This might explain why, compared with models posited by Agarwal & Karahanna (2000) and Jiang & Benbasat (2007), our explained variances seem low. In fact, Agarwal & Karahanna (2000), Jiang & Benbasat (2007) and other studies that have looked at constructs, such as flow or social factors, do so by integrating them into the existing framework of theories such as TAM and thus consist of many more variables than we have looked at. Future research can expand our model by incorporating theoretical perspectives and constructs to increase the predictive power of intention to return. We hope that these limitations may serve as avenues for future research.

CONCLUSION

In conclusion, VWs are technological environments that need to be studied differently from other environments. For one, VWs afford a novel way in which users can interact with each other. In order to provide a theoretical explanation for how this interaction comes about, this study proposes the lens of the SMI. We further propose two social constructs, social perception and social awareness, in the context of VWs, which can influence the degree to which an individual experiences flow such that he is cognitively immersed and loses track of time. While flow experiences have been shown as important for such immersive environments, this study offers an explanation for how they occur, an explanation rooted in Awareness-Attention Theory. Finally, our research model provides an explanation and prediction for why individuals return to VW environments.

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APPENDIX

Notecard: Task Description
In the next room is a table that has a network connected in a star layout (topology). Your task is to modify the layout based on the following conditions: 1. The modified topology should be fault tolerant, i.e., each node should be able to communication with the other computers even if one connecting cable breaks down. 2. The modified topology should be based on the information provided to you. The new topology can be a combination of two or more of the same or different topologies, i.e., any combinations of star, bus and ring. You can modify the existing topology using the buttons on the menu boards to connect or disconnect a cable between two particular nodes. For example, clicking on the button next to “Node 1 – Node 2” will attach a cable between Node 1 and Node 2. After your group has finished and agreed upon a new topology that meets conditions 1 and 2, please tell {name} what your new topology is as a group.
Notecard: Network Typology Definition
In networking, the term "physical topology" refers to the layout of connected devices on a network. Components of the network include the nodes (computers), routers (or hub/switch) and cables.
Notecard: Types of Typologies
Types of Topologies: 1. Star: A star network features a central connection point called a hub, switch or router. A failure in any star network cable will take down that node's network access. If the hub fails, the entire network fails. There is only one path connecting any two nodes. 2. Ring: In a ring network, every node has exactly two neighbours for communication purposes. A failure in any cable or device breaks the loop and can take down the entire network. There is only one path connecting any two nodes. 3. Bus: Bus networks use one common cable as a backbone to connect all devices. A failure in the cable brings down the entire network. There is only one path connecting any two nodes.

Figure A1. Task description.

Table A1. Questionnaire items

Construct	Variable name	Questionnaire item
Intention to return to VW	INTENT1	I intend to use Second Life over the next year.
	INTENT2	I intend to use Second Life at every opportunity over the next year.
	INTENT3	I plan to increase my use of Second Life over the next year.
Focused immersion		In the virtual environment of Second Life. . .
	FI1	. . . As I interacted with my group members and did the task, I was absorbed in it all.
	FI2	. . . As I interacted with my group members and did the task, I was immersed in it all.
Temporal disassociation		In the virtual environment of Second Life. . .
	TD1	. . . Time appeared to go by quickly when I was interacting with my group members.
	TD2	. . . Sometimes I lost track of time when I was interacting with my group members.
	TD3	. . . Time went by real fast when I was interacting with my group members.
Social awareness		In the virtual environment of Second Life. . .
	SA1	. . . My thoughts were clear to my partners.
	SA2	. . . My partners' thoughts were clear to me.
	SA3	. . . It was easy to understand my partners.
	SA4	. . . My partners found it easy to understand me.
Social perception		In the virtual environment of Second Life. . .
	SP1	. . . I noticed my partners.
	SP2	. . . My partners noticed me.
	SP3	. . . My partners' presence was obvious to me.
	SP4	. . . My presence was obvious to my partners.

VW, virtual world.

Table A2. Cross-loadings

	Social perception	Social awareness	Focused immersion	Temporal disassociation	Intention to return to VW
SP1	**0.870**	0.140	0.123	-0.030	0.118
SP2	**0.898**	0.194	0.187	0.087	0.013
SP3	**0.896**	0.213	0.105	0.100	0.021
SP4	**0.930**	0.252	0.177	0.180	0.022
SA1	0.204	**0.790**	0.161	0.305	0.232
SA2	0.192	**0.851**	0.329	0.262	0.068
SA3	0.133	**0.804**	0.073	0.219	0.139
SA4	0.152	**0.847**	0.115	0.182	0.095
FI1	0.146	0.236	**0.971**	0.363	0.340
FI2	0.160	0.227	**0.968**	0.337	0.326
TD1	0.071	0.345	0.388	**0.951**	0.440
TD2	0.164	0.224	0.288	**0.903**	0.386
TD3	0.028	0.325	0.334	**0.964**	0.473
INTENT1	0.077	0.139	0.329	0.451	**0.958**
INTENT2	0.037	0.168	0.288	0.389	**0.946**
INTENT3	0.057	0.156	0.340	0.461	**0.976**

FI, focused immersion; INTENT, intention to return; SA, social awareness; SP, social perception; TD, temporal disassociation; VW, virtual world.
Bold numbers indicate loadings of items on their respective constructs.