Peach Summer School 2007 Extended Abstract:

On Affordances and Agency as Explanatory Factors of Presence

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Abstract – **In this abstract we propose a set of hypotheses that help explain factors of presence in virtual environments. The hypotheses are based on the concepts of affordance and agency and help to explain factors necessary for presence and factors leading to Breaks-in-Presence. They also provide a simple framework that can unify various presence concepts. Additionally a combined afforded agency hypothesis introduces the idea that both the virtual and physical interact to affect presence. Finally, the ideas presented form an initial basis for guiding the design of presence experiences.**

*Keywords –***Presence, Breaks in Presence (BIPs), Affordances, Agency**

I.   MOTIVATION

Presence has become an accepted concept in relation to the effectiveness of Virtual Environments and related technologies.   However, even the definition of what Presence entails has not yet solidified. The workings of Presence in the human and the factors contributing to it remain active research directions, as witnessed by massive projects like: Peach, Presencia, and Presenccia.

Early work in presence focused on directly rating the user's presence. Self-report methods using questionnaires were developed to measure presence. An important secondary focus was proposed by Slater et al. in [8], where they suggested to instead determine when the participant's presence was disturbed, an event they called a Break in Presence (BIP). This led to methods that could detect changes in the participant's physiological signals to indicate that such a BIP had occurred [9]. Combined with a study that showed a negative correlation between BIPs and reported level of presence [1], the BIPs direction provides a direct measurement method.

Throughout the course of presence research, some factors have been found to contribute to the user's presence and to BIPs. The most intensely investigated factors have been hardware factors, in particular display size and tracking latency. Little is known about contributing factors in regards to content and the authors are not aware of any theories of presence that integrally integrate the known hardware factors or regard content. Presently, there are also no guidelines available for how to design an experience that will achieve user presence.

A new theory is proposed in this abstract that takes into account both the Virtual Environment (VE) content and interface. The proposed theory also provides initial design criterion for the development of effective environments. This theory bases on two well known principles from other fields, Norman's affordances [4] and Laurel's agency [3]. The presented theory does not encompass all facets and factors in presence; however, it can explain many of the seeming disparate results in a clean manner. It does so with a particular focus on causes of BIPs, thereby providing new guidelines for design.

This abstract will begin with a small review of the presence work to provide the context of the work.   In Section III, affordance as an overarching factor in presence will be proposed and explained. Section IV presents a theory of agency for presence and its relationship to the affordance proposal. A short discussion of the relation of the proposed theories to existing works and of a few of the implications of the theory is presented in Section V. Finally, the paper will be concluded in Section VI.

II.   PRESENCE BACKGROUND

Early presence research was searching for an ideal theory of what it meant when people found themselves "present" in a Virtual Environment. The idea of presence is sometimes described as the feeling of "being there," where the there is a VE. The term presence is now used in many different contexts and has been expanded to include concepts such as social presence and different levels of presence. The focus of much presence research has been to find a means to measure how present people were. The traditional way to detect presence is through various self-report questionnaires, a listing of which can be found in [11].

With the expansion of presence ideas, new ideas of what presence is have surfaced and, through this expansion of ideas, discussion of presence has been become difficult. A definition that seems to be gaining popularity, though is as such not published, is the definition that will be used here:

"if you react as if it is real, then you are present."

This definition of presence has numerous advantages. While it closes out some of the expanded ideas of presence, such as playing a video game, it allows concepts

such as social presence. This also implies a point that Laurel phrases well in her viewpoint: the difference is in if the user feels the pain themselves, or if they feel for the pain of another [3]. In this view, the first is presence and the second is not. "Real reaction" based presence definitions have been presented by Fred Brooks in his keynote speech at IEEE VR 2005 and during the 1st Peach Summer School in talks.

A slightly more complex explanatory version of this appears in [7], where Sanchez-Vives and Slater say:

> "Presence occurs when there is a successful substitution of real sensory data by computer-generated sensory data, and when people can engage in normal motor actions to carry out tasks and to exercise some degree of control over their environment. By 'successful', we mean that the person responds to the virtual stimuli as if they were real."

This explanation has several components that make it of importance in the context of this paper. Particularly important are the additions of the ability to interact having an effect on presence and the importance of the user taking influences on the environment. Although these concepts are not truly unique to their definition, it is a rarity to be incorporated in the definition and the combination may prove to be important.

The momentum of a "real reaction" based definition of presence can also be seen in the movement towards using physiological sensors to determine presence and Breaks in Presences. In [9], Slater and Steed showed that BIPs could be detected via simple physiological factors and in [1] Brogni et al. showed this could be correlated to presence level.

III. AFFORDANCE AND BREAKS-IN-PRESENCE

The concept of Breaks in Presence seems to be a very valuable concept in the presence research, as it provides an indicator of when the user's experience is disturbed. In [1] Brogni et al. reported a negative correlation between reported presence and the number of BIPs, i.e. the more BIPs the user had the lower the presence. While it seems reasonable to believe that the number BIPs should be reduced, there are no workable hypotheses on the causes of BIPs. In this section, we will propose a new explanation to the cause of BIPs.

a. Affordance Background

Affordance is a concept introduced by Donald Norman in his book *The Psychology of Everyday Things* [4]. Although Norman is speaking primarily to desktop interface interaction design, his concept is based in the design of physical objects. Norman claims that objects, those physical and onscreen alike, *afford* certain expectations through their appearance, properties, user's

cultural learning, etc. Norman argues that these expectations are intrinsic to the user's perception of the object. Norman uses numerous explanatory examples, typically physical objects, such as teapots and doors.

Norman is concerned with good design. He wants people to create interfaces that afford the right thing. The idea is that when the affordances of the object and the actual interaction with the object do not match, usability will suffer. Following Norman's theory, *affordance matching* is vital to good design, as the afforded interaction and interaction method is what the user will automatically attempt first. When the user tries to interact in an afforded way and this does not work, it leads inevitably to user frustration. Norman hypothesizes that when the affordances of an object are matched it not only works, but makes the object a "joy" to work with.

Throughout this work, a single of Norman's examples will be used as an illustration. Norman undergoes an investigation of doors and how they open. He proposes that many doors are poorly designed, because the affordances are not matched to their actual operation. This manifests itself in one of two parts (or both) of the door interaction: the direction the door opens and the method of releasing the door catch. Doors are not only universally understood, but are also a common part of many VEs.

b. Affordance and Presence

The idea of affordance of objects transfers particularly well to Virtual Environments. One is often dealing precisely with virtual objects that are familiar to the user from the real world. Also, there are the affordances of the devices that are presenting the environment to the user and the devices they are using to interact with. Our conjecture of how affordances and presence are related is:

> Hypothesis 1: When the affordances of the user's experience are not met, Breaks in Presence will occur.

The concept, in other words, is that the expectations of the user, based on all factors of his or her experience, determine if the user accepts the environment or not. If the expectations of the user, based on the affordances of the environment and/or an object, are not met, then we hypothesize that a Break-in-Presence will occur. For instance, the user would not expect the world to suddenly go black (as it did in the test BIP case of [8]), as the world they had been presented with afforded permanence.

The wording of this hypothesis is important. Here, we have chosen not to specify only the affordances of the VE, as is classically the case, but the complete user experience. This expansion is necessary in order to incorporate both the affordances provided by the physical interface and interaction methods. The generality is also there to acknowledge that the user does not enter devoid of expectations that come from their previous experience.

IV. AGENCY AS A FACTOR IN PRESENCE

The concept of affordance mis-match as a cause of Breaks-in-Presence seems to fit much of the evidence and observed behavior collected in presence research to date. Unfortunately, the affordance theory in itself is only valid for a conjecture of the cause of BIPs and does not relate directly the idea of the user achieving presence in the environment. However, by expanding to include the user's place in the virtual environment, we can better address a more complete view of presence.

We propose the usage of the concept of *agency* to achieve this. Agency is a theory brought to the forefront by Brenda Laurel in her seminal interactive storytelling book *Computers as Theatre* [3]. Although Laurel used different terminology, her discourse in the section "Engagement: The First Person Imperative" is very reminiscent of the concepts found in presence literature.

Laurel conjectured that in order for the user to experience a "First Person Experience" (her description fits largely to the accepted ideas of presence), they had to feel themselves an *agent* in the world they were experiencing. She says "the person's experience of agency – the power to take action" is a key factor in having a first person experience. Based on Laurel's idea of agency we hypothesize:

> Hypothesis 2: The user's feeling of agency is a necessary precondition for presence.

This hypothesis is essentially an encapsulation of the action portion of the presence discourse from Sanchez-Vives and Slater found in Section II. However, it is more general and allows coverage of a larger set of possible presence aspects than their definition, which is tied to specific actions like physical movement. In contrast, we propose that the user's perceived ability to take action is a precondition of presence. Of importance in this statement is the user's *feeling* of agency. This indicates that users must only have the perception that they have the power to take action, not that they must, in reality, have that power or that they must perform an action with said power.

This hypothesis places agency as a factor in the user achieving a level of presence in the environment. The addition of interaction to the environment adds numerous complications to achieving presence. Unfortunately, interactions performed with today's interfaces have an impact on the experience of the user. To deal with this we propose a third hypothesis:

> Hypothesis 3: When the user's afforded agency is not met, a Break-in-Presence will occur.

This hypothesis requires our consideration on two points. One is that the environment must react to the user appropriately. As we saw with the affordance concept, the objects and entities of the Virtual Environment afford certain interactions. For instance, if we see a door handle, we expect to be able to interact with it in order to open the door.

The second aspect is that we better incorporate the effects of the interface on the user's experience. Here, we mean both the hardware interface the user is presented with and also the software interaction capabilities (interaction method and interaction metaphor included). We contend that the interface provides certain affordances to the user, beyond those of just the environment. For instance, returning to our door handle example, the interface hardware the user is equipped with will color their expectations of how they can interact with the door handle. A glove interface will afford the natural physical interaction, where a wand affords having to use a different method, based on ray selection, etc.

V. DISCUSSION

In this subsection, we discuss some of the relevancies of the proposed affordance and agency theories to other works. A few of implications they have on designing for presence will also be presented. In a future expanded work we hope to provide a more complete investigation of these ideas, in particular the relevance to a broader spectrum of presence concepts and a complete look at how the affordance and agency theories can explain many of the disparate results found in presence research.

The most relevant work in relation to our proposed theories is a paper discussing the relationship of "movement, action, and situation" on presence [2]. After presenting their positions on those three aspects, their discussion of the movement, action and situation ideas uses both agency and affordances terms in their clarification. Although they are not defined, they seem to be used with similar meaning as used here. That discussion and the information presented prior to it, have direct relation to the meaning of applying our hypotheses. However, the essences of their argument and our proposed theories are different.

A number of recent works on presence that are based in perceptual psychology are relevant to the hypotheses (1&3) based of affordances. In general, those works say that presence is built out of perception, rooting the presence phenomena in the human perceptual mechanisms [5, 10]. The affordance principle relies heavily on user perception, but is independent of the exact mechanisms that cause presence phenomena.

The ability for the user to interact is commonly cited as an important aspect of obtaining presence, but there is surprisingly little literature directly connected to our proposed agency theories. There are three interaction and presence threads of importance in existing literature: the ability of the user to move through the world, interaction with virtual characters, and a single piece that investigates the impact of perceived interaction. These three are discussed in the following paragraphs.

When presence researchers have spoken of interaction as being important, this has typically meant movement through the environment. It is well accepted that giving the user the power to control their movement through the environment is positively correlated to presence level. This aspect has been founded in studies that investigated the difference between movement methods involving bodily movement in comparison to virtual methods [12]. That research, based on earlier experiments, compares walking versus flying in small, reality-based environments. They find that physical action is better than flying, indicating that there may be a relationship between the level of agency and the level of immersion.

Interaction with virtual characters has been the focus of the majority of presence research involving interaction. However, the research has not investigated the effect of this interaction to the user's presence, but instead shown that the users are present in such environments, even when the interaction is highly limited. The only work we are aware of that does directly investigate the effect of providing interaction on presence is the work of Regenbrecht and Schubert [6]. They investigated the effect of the user's perception of interactivity with an "avatar" on their presence level. The truly interesting result of their work was that after being told they could interact with the "virtual characters" (the avatars were only walking feet) the user's level of presence increased over a group that wasn't told this. In both cases, the characters did not respond at all to the users, though they did not come within the user's direct vicinity. Here, we see that not only did interaction have an effect on presence, but that the perception of agency was all that was required. We believe this supports our perceived agency conjecture.

Finally, an interesting implication of the afforded agency matching conjecture is that the complete interface and environment work together to create the user's agency. This would seem to have a number of repercussions. For instance, technology that allows natural human interaction with the environment would increase the user's expected level of agency with the virtual environment. If we put gloves on the user, do they expect physical feedback as in the real case? We believe this is the case, and, when these affordances are not addressed, BIPs will occur. This creates a difficult situation for determining what the user's true affordances will be, as they are contingent on the Virtual Environment, the physical interface, and even the user's experience.

However, this could also be used to our advantage. If we use input methods, such as traditional wand-base interactions, the user is aware of the abstraction and necessarily reduces their expectations of agency in the world. In this way, we may be able to work around technology limitations. Likewise, increasing levels of immersion may actually be detrimental until interaction technology can match its fidelity.

VI. CONCLUSIONS

In this paper we have presented new hypotheses on presence and factors that lead to the disruption of a successful presence experience for the user. These three hypotheses are based on two ideas, affordance and agency. We propose that perceived user agency in the environment is a requirement for presence in the world and the level of perceived agency is positively correlated with the level of presence possible.

Additionally, we have proposed that Norman's affordances principle is a major factor involved in the production of BIPs. We contend that BIPs occur when the affordances of not only the environment, but of the complete user experience, are not met. This encompassing view of affordances is of importance, particularly in respect to the conjectured agency relationship. The afforded interactions of the combined environment and interface have direct consequences on the afforded agency and, therefore, on presence also.

In this extended abstract, we have introduced these hypotheses. We intend to expand on the discussion presented here in future works, including further supporting evidence from the existing literature. Naturally, a next step is to empirically verify the validity of these conjectures. If these conjectures hold as expected, we feel that this provides not only a solid foundation for a more unified understanding of presence, but also for providing better guidelines for the design of interfaces, environments and their combination.

VII. ACKNOWLEDGEMENTS

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