Exploring Self-Presence in Collaborative Virtual Teams

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ABSTRACT

The concept of self-presence provides a framework for understanding how people connect to virtual self-representations on three distinct levels (body, emotions, and identity). The present study aims to build on previous support for the reliability and construct validity of this framework. Participants (N=81) who used avatars in a semester-long collaborative virtual group project were examined. A factor analysis of the Self-Presence Questionnaire (SPQ) was mostly consistent with the framework of self-presence, though a new sub-factor emerged, possibly due to new SPQ items or limitations of the virtual environment. Factors of self-presence were related to social presence as expected, but not to frequency of avatar changes. These findings support the framework, but deeper explorations of the concept are still necessary.

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1. Introduction

In our increasingly complex media landscape, people connect to numerous self-representations in a variety of ways. Such self-representations often incorporate customizable, anthropomorphic virtual bodies, or avatars. There is a growing body of research on how the use of virtual self-representations affects many factors both within virtual environments and outside of them. Regarding the former, for example, certain guidelines for developing an avatar can lead to greater feelings of interactivity in the virtual environment (Jin, 2009). Having a choice of avatar (as opposed to no choice) or

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a specific point of view (e.g., third person) can lead to higher physiological arousal, as indicated by heart rate and skin conductance, when using the virtual environment (Lim & Reeves, 2009). And people can manipulate facets of their self-representations, such as facial features or head movements, to gain influence or accomplish other social goals in the virtual environment or outside of it (Bailenson, Yee, Blascovich, & Guadagno, 2008).

Research on the Proteus Effect has shown that users' expectations of how an avatar should behave affects behavior, such as confidence in social interactions and negotiations, both within and beyond the virtual environment (Bailenson et al., 2008; Yee, Bailenson, & Ducheneaut, 2009). Aspects of virtual self-representations can also affect other behaviors outside of the virtual environment, such as eating candy (Fox, Bailenson, & Binney, 2009), exercising (Fox & Bailenson, 2009), implicit feelings of racial bias (Groom, Bailenson, & Nass, 2009), feelings of aggression and group cohesion (Pena, Hancock, & Merola, 2009), and self-judgments regarding body size (Chandler, Konrath, & Schwarz, 2009).

Although these studies examine different effects of different facets of virtual self-representation, they all implicitly require that users feel connected to their self-representations in some way. However, few of these studies theorize about such connections and no two use the same operationalization for this concept. The notion of self-presence can potentially fill this gap by offering a standardized framework and operationalization for describing how people connect to their virtual self-representations.

This paper aims to support the claim that the concept of self-presence is relevant to all research involving a connection between individuals and their virtual self-representations. After touching on the concept's foundation in the field of presence, this paper will describe the three-level framework of self-presence, previous studies that have utilized this framework, a new study that supports the formulation of the framework, and future research that aims to further the understanding and usefulness of the concept of self-presence.

2. From presence to self-presence

The notion of self-presence initially appeared as a tangent to the concept of presence, which essentially describes how people become immersed in virtual

environments. The number of discussions and theorists in the field of presence is too vast to cover within the auspices of the present paper, but only a few directly led to current formulation of the concept of self-presence. Namely, Biocca (1997) adopted the term "presence" to mean the illusion of "being there" regardless of whether "there" is physical, mediated, or imagined. He described how sensory and motor engagement contribute to the feeling of "physical" presence and that inducing this feeling is the purpose of virtual reality technologies. Biocca also introduced the term "self-presence" to represent users' mental model of themselves inside the virtual world as it relates to the perception of their body, physiological states, emotional states, perceived traits, and identity. Alternatively, Lee (2004) defined presence as a psychological state in which virtual objects are experienced in sensory and non-sensory ways, where virtual objects can be either para-authentic, having real-world correlates, or artificial, without real-world correlates. Similarly, he defined self-presence a psychological state in which virtual selves are experienced as the actual self (identity and/or body) in sensory and non-sensory ways. While Biocca (1997) and Lee's (2004) definitions differ significantly, they both distinguish between presence and self-presence as either related to the environment or self, respectively.

Riva, Waterworth, and Waterworth (2004) provided a neuroscientific perspective on presence that did not address the concept of self-presence but is integral to the current framework of self-presence. Namely, they applied Damasio's (1999) three-level framework of the self to presence. The first level, the *proto* self, is the sense of physical being, which is based on a neural map of body schema. Next, the *core* self is an emotional state (at the fundamental physiological level), generated through encounters between the proto self and objects in the environment. And last, the *autobiographical* self is the idea of self, or identity, that is dependent on memories of past experiences. Riva et al. (2004) used this framework to create a corresponding three-level framework of presence. They defined proto presence as an organism's ability to couple perceptions and actions and thus differentiate itself from its environment. Core presence is defined as an organism's ability to focus sensorial experience on present tasks and relevant objects in the environment. Extended presence[1] is an organism's ability to recognize the significance of previous experiences as they relate to the self. Virtual environments can induce each level of

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[1] Although Damasio uses the term "autobiographical self" for the third layer of self, Riva, Waterworth, and Waterworth use the term "extended self", and thus "extended presence", because extended consciousness consists of more than autobiographical memories, but also the self-conscious idea of self. The remainder of this paper refers to "extended" self similarly.

presence, though the media complexity required to do so is highest for proto presence and lowest for extended presence.

This application of Damasio's (1999) framework to the concept of presence is a valuable contribution to the understanding of how people experience virtual environments, but it does not describe the connection between people and their virtual self-representations. As discussed earlier in this paper, there is a growing body of research that would benefit from a standardized construct for understanding such connections. While Biocca (1997) and Lee (2004) both identified the notion of self-presence as potentially fulfilling this goal, neither provided a thorough explication of self-presence, which led to various disparate uses of the concept (Jin & Park, 2009; Ratan, Santa-Cruz, & Vorderer, 2007; Ribbens & Malliet, 2009). Following from Riva et al.'s (2004) innovative interdisciplinary approach, Damasio's (1999) framework of the self is applied to the concept of self-presence.

3. The framework and measurement of self-presence

The framework of self-presence described here builds on previous definitions and incorporates Damasio's (1999) framework of the self in an attempt to develop the concept as a useful tool for research on a wide variety of virtual self-representations. Whereas Biocca (1997) and Lee (2004) describe self-presence as a binary, on or off psychological state, the concept would be more useful to research on virtual self-representations if it were considered on an ordinal sliding scale so that relative differences could be compared. In other words, the concept of self-presence should describe the extent to which someone feels a connection to a virtual self-representation. Further, there are different types of connections that people feel to such self-representations, so the concept of self-presence should identify all of them. These types of connections can be distinguished according to the aspect of the self to which they are relevant. Thus, Damasio's (1999) three-level framework of the self is used to delineate three levels of self-presence. Before describing each level in greater detail, self-presence is defined broadly as *the extent to which some aspect of a person's proto (body-schema) self, core (emotion-driven) self, and/or extended (identity-relevant) self is relevant during media use*.

Proto self-presence, which can also be called body-level self-presence, is defined as *the extent to which a mediated self-representation is integrated into body schema.*

Body schema can be modified by faux body parts (Armel & Ramachandran, 2003; Botvinick & Cohen, 1998; Ehrsson, Spence, & Passingham, 2004; Tsakiris & Haggard, 2005) or physical tools (Berti & Frassinetti, 2000; Farnè & Làdavas, 2000; Iriki, Tanaka, & Iwamura, 1996; Maravita & Iriki, 2004; Yamamoto & Kitazawa, 2001). Similarly, body schema can integrate tools used to interact with virtual objects (Ijsselsteijn, de Kort, & Haans, 2006; Iriki, Tanaka, Obayashi, & Iwamura, 2001; Slater, Perez-Marcos, Ehrsson, & Sanchez-Vives, 2008). Proto self-presence occurs when someone uses such a tool as an extension of the body without thinking about the mediation involved. In other words, the experience of proto self-presence requires that a virtual self-representation be integrated into body schema to some extent.

Core self-presence, which can also be referred to as *emotion-level self-presence*, is defined as *the extent to which mediated interactions between a self-representation and mediated objects cause emotional responses*. Here, "emotional" is used in the immediate physiological-response, not affective, sense of the term. An example of such a response is a heart-rate decrease immediately after an individual is surprised. In research on faux body parts, individuals responded emotionally (measured by electrodermal activity) when such parts were (falsely) injured (Armel & Ramachandran, 2003). This implies that if a virtual self-representation is integrated into an individual's body schema (i.e., the experience of proto self-presence), then the individual may respond emotionally to interactions between virtual objects and this virtual self-representation, thereby experiencing core self-presence to some extent.

Extended self-presence, which can also be called identity-level self-presence, is defined as *the extent to which some aspect of a self-representation is related to some aspect of personal identity*. People engage in selective self-presentation (Goffman, 1959), presenting various "possible selves" (Higgins, 1987; Markus & Nurius, 1987), especially during computer-mediated communication (Bargh, McKenna, & Fitzsimmons, 2002; Gibbs, Ellison, & Heino, 2006; Zhao, Grasmuck, & Martin, 2008). Regardless of the reality of an identity expressed through Computer-Mediated Communication (CMC), this mediated identity can be important to the individual's sense of self (Turkle, 1995). For example, an individual may choose black hair for his avatar because he likes his black hair in real life. Alternatively, he may choose blonde hair for his avatar because he has always wondered what it would be like to be blonde. Or this individual may not care about hair color in real life or the mediated environment and thus choose an option randomly for his avatar. In the first two cases, the avatar's hair color is related to the individual's identity, and so he has experienced a degree of

extended self-presence. Overall, when some aspect of a self-representation is connected to some aspect of the individual's identity, the individual experiences extended self-presence to some extent.

While each level of self-presence is experienced separately, all of the levels should be positively related to each other, just as the levels of self in Damasio's framework are distinct but positively related. Further, the composition of all three levels of self-presence comprises a general state of self-presence, which can be defined simply as *the extent to which the self is relevant during (and only during) media use.*

Drawing from these definitions, the Self-Presence Questionnaire (SPQ) aims to provide a measurement tool for each level of self-presence. Because some of the processes involved in self-presence occur beneath the level of consciousness, self report is not the most reliable method. This is especially true for proto self-presence because people are not normally conscious of body schema (Damasio, 1999). However, previous research has found a positive relationship between neural activity in the premotor cortex, where body schema is processed, and self-reports on the integration of false body parts into body schema (Ehrsson et al., 2004). Regarding core self-presence, while people may not recognize the physiological precursors of their emotions, most are aware of their subjective emotional experiences that result from such physiological reactions (Hugdahl, 1996). And regarding extended self-presence, developing identity requires a self-definition process about which people are quite aware (Baumeister, 1987). Given these finding and also the rigorous reliability and validity testing that must be conducted on the SPQ before it can be accepted as a research tool, self-report is an acceptable method for measuring self-presence.

Proto self-presence questions gauge the extent to which a self-representation is considered to be an extension of the individual's body. An example proto self-presence question is, "When using your avatar, to what extent do you feel like your arm is elongated into the game/virtual environment?"

Core self-presence questions address the emotional responses to interactions between virtual self-representations and virtual objects. An example of a core self-presence question is, "When happy events happen to your avatar, to what extent do you feel happy?"

Extended self-presence questions measure the extent to which some aspect of a self-representation is related to some aspect of the individual's identity. An example of an extended self-presence question is, "To what extent is your avatar's appearance related to some aspect of your identity?"

A summary of the theoretical framework with sample SPQ items can be found in Table 1. The SPQ version used in this paper can be found in the Appendix, though updated versions and updates on this project can be found at http://self-presence.com.

	Proto Self-Presence	Core Self-Presence	Extended Self-Presence
Also referred to as	Body-level self-presence	Emotion-level self-presence	Identity-level self-presence
Definition	The extent to which a mediated self-representation is integrated into body schema.	The extent to which mediated interactions between a self-representation and mediated objects cause emotional responses.	The extent to which some aspect of a self-representation is related to some aspect of personal identity.
High Self-Presence Implies	Self-representation feels like an extension of the body.	Strong emotional responses when self-representation interacts with mediated objects.	Some aspect of a self-representation is significant to personal identity.
Relevant Aspect of Self	Body schema.	Emotional responses.	Identity.
Sample Questionnaire Item	When using your avatar, to what extent do you feel like your arm is elongated into the game/virtual environment?	When happy events happen to your avatar, to what extent do you feel happy?	To what extent is your avatar's appearance related to some aspect of your identity?

Table 1. Summary of the Self-Presence Theoretical Framework and SPQ.

4. Testing the concept and measurement tool

The concept of self-presence cannot be accepted as a standard tool for research on virtual self-representations until the reliability and validity of the framework and operationalization have been established. Two previous studies have been conducted with this aim in mind (Ratan, 2010; Ratan & Hasler, 2009). In both studies, the primary goal was to determine reliability by examining whether a factor analysis of the SPQ resulted in factors that were consistent with the three theorized levels of self-presence

(i.e., proto, core, and extended). A secondary goal was to test for construct validity by comparing these factors with measures of theoretically-related concepts.

In Ratan and Hasler's study (2009), which served as a pilot for the study presented in the current paper, the SPQ was administered to 31 students who used a 3D virtual world to collaborate on teamwork for a semester-long seminar. While the sample size was not large enough for a reliable factor analysis, this study still provided a preliminary assessment of the SPQ, finding that the factors aligned distinctly with the three levels of self-presence but were also interrelated, as the framework of self-presence suggests. Both proto and extended self-presence were positively related to self-reported avatar design time, though the latter far more than the former. This finding contributes to construct validity, as does the finding that both proto and core self-presence were positively related to social presence and appreciation of the virtual world experience.

In Ratan's (2010) study, the SPQ was administered to 360 online gamers. Results of the factor analysis indicated that the factors aligned distinctly with the three levels of self-presence but were also interrelated, as the framework of self-presence suggests. Further, proto self-presence was higher for First Person Shooter (FPS) players than Massively Multiplayer Online Game (MMO) players, extended self-presence was higher for MMO players than FPS players, and core self-presence was marginally higher for MMO players than FPS players. These findings, as well as the finding that the relationship between social presence and extended self-presence was weaker than the relationships between social presence and both proto and core self-presence, contributed to construct validity.

These studies indicate that the SPQ can be treated as a reliable measure of self-presence and support the concept's construct validity, but this does not mean that such tests are sufficient. It is important to replicate these findings because of limitations in the studies' designs and samples. Specifically, Ratan and Hasler's (2009) sample size was prohibitively small, while Ratan (2010) tested the SPQ on online gamers, but not users of other types of virtual environments. Further, as a result of these studies and other developments in this project, items have been added to the SPQ that were not included in the versions tested earlier. Thus, the current version of the SPQ should be tested on a sufficiently large sample of virtual-world users. These tests should attempt to replicate the factor analyses and findings regarding construct validity from the two previous studies in this line of research (Ratan, 2010; Ratan & Hasler, 2009). The expectations for the results of such tests are similar to those in the previous studies.

First, as the framework of self-presence suggests, the factors of self-presence are expected to be both distinct and interrelated.

Hypothesis 1: According to a factor analysis of the SPQ, the levels of *self-presence* (*proto, core,* and *extended*) form distinct but interrelated dimensions.

Both previous studies on the SPQ found that social presence was positively correlated with proto and core self-presence but not (or not strongly) with extended self-presence. This can be explained through the relationship between self-presence and media richness. Media richness, which is based on the number of cues and channels available in a given medium, is directly related to social presence (Daft & Lengel, 1984; Short, Williams, & Christie, 1976). The experience of proto and core self-presence relies on more complex cues and channels within a medium than the experience of extended self-presence. In other words, lean or rich media can easily transport identity-related information, but only rich media can facilitate emotional or seemingly physical connections between people. Thus, social presence should be more strongly related to proto and core self-presence than extended self-presence.

Hypothesis 2: Proto and core self-presence will be more strongly correlated with social presence than extended self-presence.

Ratan and Hasler's (2009) finding that avatar design time was strongly and positively related to extended self-presence makes sense because an individual who experiences higher levels of extended self-presence is likely to spend more time crafting the virtual self-representation to properly illustrate relevant aspects of identity. Similarly, frequency of changes to a self-representation should also be positively related to extended self-presence.

Hypothesis 3: Frequency of avatar changes and extended self-presence will be positively related.

5. Method

The present study's design followed from the pilot study described above (Ratan & Hasler, 2009), with the intent of conducting factor and validity tests of the SPQ.

5.1 Participants and Context

The SPQ was administered as an online questionnaire to participants of the ShanghAI Lectures – a global virtual lecture series on "Embodied Intelligence"[2]. The lecture series was presented by the Artificial Intelligence Lab of the University of Zurich from Shanghai Jiao Tong University to a global audience involving 18 universities from five continents. Two hundred and eighty-two students (223 men and 59 women) collaborated remotely in three- to four-member international virtual teams on mandatory weekly group assignments and projects over the course of the semester.

Participation in the research project, i.e., using a 3D Collaborative Virtual Environment (CVE) to collaborate on the group assignments, was an optional part of the lectures which had no bearing on participant's academic evaluation. The online registration form contained detailed information about the purpose of the research project, the in-world behaviors and questionnaire measures that would be collected, and the privacy-protection procedures. Online registration also required that participants read and respond to an informed consent form.

An incentive was introduced to increase the rate of participation in the online surveys. The students who filled in all questionnaires were invited to take part in a competition to win a 100 Euro voucher for Amazon.com. About one third of the students (N=81) used the CVE and filled in the questionnaires. The participants were 59 men and 22 women between the ages of 20 and 40 (M = 24.73, SD = 3.15).

5.2 Materials and Measures

A CVE (called "UNIworld") was offered to the students for their international virtual teamwork. UNIworld was designed based on Sun Microsystems' Project Wonderland toolkit (version 0.5)[3]. It offered various collaboration features, such as in-world video players and application sharing. The students communicated via text chat, "immersive audio" (i.e., voice communication that takes the distance between avatars into account), and a set of basic avatar gestures and postures.

Freedom to customize avatar appearance was limited (as compared to similar commercial applications) in this field study. Participants began with cartoonish gender-neutral avatars (see Nigel, Bea and Thierry in Figure 1) and were able to customize gender, clothing accessories (e.g., hats or glasses), and color of skin, eyes, hair, pants, shirt, and shoes. These customizations were categorical and did not allow for gradual

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[2]   http://shanghailectures.org
[3]   http://www.projectwonderland.com/https://lg3d-wonderland.dev.java.net/

changes. All students were able to name their avatars and provide profile information (real name, sex, birthday, nationality, language, occupation, university, major, and minor) that was available to other students.

Participants' behavior in the virtual world, including the number of avatar-appearance changes, was automatically recorded, and all other measures were collected via survey. The number of avatar-appearance changes was divided by total login time to create a metric of frequency of avatar changes. In addition to the SPQ, participants responded to questions on social presence (Bailenson, Blascovich, Beall, & Loomis, 2001). Cronbach's alpha for the three-item measure (see Appendix) was .79.

Figure 1. International virtual team meeting in UNIworld, the 3D virtual environment used for collaboration in the ShanghAI Lectures.

6. Results

Because dimensions of self-presence are theorized to be interrelated, an exploratory principal-axis factor analysis with an oblique rotation (Kim & Mueller, 1978) was conducted in order to assess the SPQ's factor loadings. After removing items that loaded onto more than one factor or had low loadings, the remaining 16 items formed distinct factors that were mostly consistent with the levels of self-presence. The eigenvalues for the first, second and third factors were 7.34, 2.08, and 1.35, respectively. The pattern and structure matrices can be found in Tables 2 and 3.

	Factor		
	1	2	3
P_part_of_body	0.93	-0.04	0.02
P_arm_elong	0.87	-0.10	0.02
P_reach_in	0.79	-0.08	-0.08
P_body_extend	0.78	-0.05	-0.06
C_disgusting	-0.06	-0.07	-0.96
C_upsetting	-0.10	0.05	-0.91
C_arousing	0.07	-0.01	-0.90
C_surprising	0.12	-0.01	-0.83
C_scary	0.08	-0.03	-0.82
E_gender	-0.16	0.90	-0.02
E_sex	0.01	0.80	0.14
E_race	-0.07	0.72	-0.12
E_clothing	0.38	0.42	-0.01
E_profile	0.47	0.33	-0.17
E_name	0.34	0.33	-0.13
E_appearance	0.44	0.29	-0.26

Table 2. Pattern Matrix of SPQ.

	Factor		
	1	2	3
P_part_of_body	0.91	0.17	-0.53
P_arm_elong	0.84	0.10	-0.48
P_reach_in	0.82	0.13	-0.54
P_body_extend	0.81	0.16	-0.52
C_disgusting	0.61	0.28	-0.94
C_upsetting	0.51	0.21	-0.90
C_arousing	0.62	0.27	-0.90
C_surprising	0.46	0.30	-0.87
C_scary	0.57	0.24	-0.86
E_gender	0.07	0.87	-0.20
E_sex	0.11	0.76	-0.11
E_race	0.18	0.74	-0.30
E_clothing	0.48	0.52	-0.37
E_profile	0.65	0.50	-0.55
E_name	0.67	0.47	-0.62
E_appearance	0.49	0.44	-0.43

Table 3. Structure Matrix of SPQ.

While these results lend partial support to Hypothesis 1, unexpectedly, some of the extended self-presence items did not factor consistently with the others. A further factor analysis, conducted only on the extended self-presence items, indicated that there were two distinct extended self-presence factors, one with four items and the other with three items. The pattern and structure matrices for this analysis can be found in Tables 4 and 5.

	Factor	
	1	2
E_profile	0.93	0.09
E_appearance	0.83	0.06
E_name	0.63	-0.05
E_clothing	0.55	-0.17
E_gender	-0.02	-0.91
E_sex	-0.07	-0.85
E_race	0.16	-0.64

Table 4. Pattern Matrix of Extended SP.

	Factor	
	1	2
E_profile	0.89	-0.35
E_appearance	0.81	-0.34
E_name	0.65	-0.34
E_clothing	0.63	-0.43
E_gender	0.41	-0.89
E_sex	0.34	-0.82
E_race	0.46	-0.72

Table 5. Structure Matrix of Extended SP.

A reliability analysis was also conducted on each set of items. Cronbach's alpha for proto self-presence was .93, for core self-presence was .96, for all extended self-presence items (now coined "Ext_All") was .84, for the four-item extended self-presence factor (now coined "Ext_Main") was .82, and for the three-item extended self-presence factor (now coined "Ext_Secondary") was .84, indicating high internal

consistency for the items within each factor. Thus, the items were averaged in order to create composite measures of each factor. Further, an overall measure of self-presence was calculated by averaging all 16 SPQ items that were retained in the factor analysis (Cronbach's alpha of .91).

A zero-order Pearson correlation analysis was used to test the interrelations between the levels of self-presence as well as relationships with the other variables measured. Corroborating the framework of self-presence and previous findings (Ratan, 2010; Ratan & Hasler, 2009), most of the factors of self-presence were positively related to each other. However, Ext_Secondary was not significantly correlated with any of the other factors. Thus, Hypothesis 1 was only partially supported. Supporting Hypothesis 2, social presence was more strongly related to proto and core self-presence than to the extended self-presence measures. Unexpectedly, frequency of avatar changes was not correlated with extended self-presence. Thus, Hypothesis 3 was unsupported. The correlation coefficients for these relationships can be found in Table 6.

	All	Proto	Core	E_All	E_Main	E_Sec
SPQ_All	1					
SPQ_Proto	-	1				
SPQ_Core	-	.63**	1			
SPQ_E_All	-	.41**	.48**	1		
SPQ_E_Main	-	.59**	.59**	-	1	
SPQ_E_Sec	-	.06	.20	-	.44**	1
Social Pres	.66**	.62**	.56**	.50**	.51**	.29**
Frequency Avy Changes	.00	.02	.14	-.04	.05	-.11

$N = 81$, Note: *$p < .05$, **$p < .01$

Table 6. Pearson correlation between SPQ, SPQ factors, and other variables.

7. Discussion

The present exploration of self-presence corroborates the theory and previous findings in many respects, but also raises some important questions about the SPQ, especially with respect to the extended self-presence items. As expected, the proto and core self-presence items formed factors that were distinct, internally consistent, and interrelated. Unexpectedly, the extended self-presence items formed two factors, of

which only the first is consistent with expectations (i.e., correlates with proto and core self-presence).

A possible cause for these unexpected results is that the present version of the SPQ contains two extended self-presence items that were not included in the previous versions. These items (regarding avatar race and sex) were both part of Ext_Secondary. In Ratan's (2010) examination of the SPQ, the gender item was also problematic (low factor loading) and thus removed from that analysis. This indicates that race, sex, and gender identification with an avatar may constitute a different type of extended self-presence from the items in the Ext_Main factor. The Ext_Main items seem to represent aspects of identity that are more fleeting or malleable, while the Ext_Secondary items represent more stable or immutable identity characteristics. This qualitative distinction between these items should be examined further in order to determine if the extended self-presence category should be split into two.

Another possible explanation for this finding is that the type of customization allowed by the present virtual environment may have favored the expression of some identity characteristics over others. Namely, participants were given more freedom to customize facets of avatar appearance that related to items in the Ext_Main factor than in the Ext_Secondary factor. For example, they could create any name for their avatars, but could only make a binary choice of avatar gender (male or female). Similarly, there were many possible combinations of colors for clothing items, and while avatar skin and eye color options were customizable, there are many more race-related facets of appearance that can be expressed in an avatar (Groom et al., 2009).

The concept of self-presence should be applicable across all virtual environments, regardless of the specific customizable facets of avatars in the environment. However, as the present results suggest, some items in the SPQ may not be appropriate for certain environments. Thus, the SPQ should be treated as an inventory of potential self-presence questions from which researchers should select appropriate items depending on the context. In many cases, it may be difficult to anticipate which items are appropriate, and so researchers should include as many items as possible and conduct their own factor analyses on the SPQ to identify which items to retain. Researchers may choose to run a factor analysis on the entire SPQ or conduct separate analyses on the items for each level of self-presence. As the present findings suggest, if the latter method is employed, the researcher should pay particular attention to the extended self-presence items. Regardless of method, the researcher should

report which items are included in the final analysis and provide possible explanations for why any items were removed.

The finding of a positive relationship between social presence and self-presence is consistent with previous findings (Ratan, 2010; Ratan & Hasler, 2009). However, these previous studies found that extended self-presence had a relatively weak correlation with social presence compared to proto and core self-presence, but in the present data only Ext_Secondary has a far weaker relationship with social presence than the other factors. This distinction may also be due to differences in the types of items split between Ext_Main and Ext_Secondary, as discussed above. Or perhaps this virtual environment was not a rich (Daft & Lengel, 1984) enough medium to facilitate a strong difference between the types of self-presence. Future research on self-presence should continue to include measures of social presence and explore this relationship.

Contrary to expectations, none of the factors of self-presence were positively related to the frequency of avatar appearance changes. This is surprising because Ratan and Hasler (2009) found that both proto and extended self-presence were positively related to avatar design time. However, frequency of avatar changes and avatar design time may not be similar measures. Future research should compare self-presence to a variety of behavioral avatar-design-investment measures to clarify this issue.

These results represent another step toward understanding and establishing self-presence as an important tool for research involving connections between people and virtual self-representations. However, while this study made significant improvements on the preceding research, further examinations and improvements are necessary. For example, while the ratio of cases to variables represents a great improvement over the pilot study (Ratan & Hasler, 2009), this ratio is still too small to consider the factor analysis as definitive. Thus, this analysis can only lend limited support to the claims regarding the SPQ. Further, while the current study examined a more controlled virtual environment than Ratan's (2010) survey of online gamers, there were no experimental manipulations in the current study and only one behavioral measure. Such control would be necessary to establish enough construct validity to standardize the concept of self-presence. Future research on self-presence should make these and other improvements on the current research.

8. The Near Future of Self-Presence

There are additional projects underway aimed at providing additional and stronger support for the framework of self-presence and the SPQ, some of which rely on survey-based methods and others that utilize experimental manipulations to induce specific types of self-presence. For example, in one study, participants build an avatar that is either an accurate self-depiction or an opposite-gendered version of the self. This manipulation is expected to affect extended self-presence, and physiological differences while playing a game with this avatar are expected to relate to core self-presence.

Beyond further factor and construct validity testing, these studies examine how self-presence influences certain effects of media use, such as performance on tasks that are related or unrelated to the mediated context. For example, the study described above will examine whether people who experience more proto self-presence while playing an active (Wii) game are more likely to exercise in the week following the game activity. This study will also test whether people who experience higher levels of self-presence in general report higher levels of enjoyment while playing the game.

These studies may be the first to use the proposed framework of self-presence as a tool for understanding how connections to virtual self-representations affect users, but it is hoped that they represent only a small portion of the contribution that this concept will make to the field.

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10. Appendix

10.1 Self-Presence Questionnaire (version used in present study)

(note: Updates of the SPQ can be found here: http://self-presence.com)

Proto Self-Presence – Included in factor analysis

1. When playing the game/using the virtual environment, how much do you feel your avatar is a part of your body?
    a. [not at all/somewhat/moderately/very much/absolutely]
2. When using your avatar, to what extent do you feel like your arm is elongated into the game/virtual environment through your avatar?
3. When using your avatar, to what extent do you feel like you can reach into the game/virtual environment through your avatar?
4. When playing the game/using the virtual environment, how much do you feel like your avatar is an extension of your body within the game/virtual environment?

Proto Self-Presence –Removed from factor analysis

5. When something happens to your avatar's body, to what extent does it feel like it is happening to any part of your body?
6. When playing the game/using the virtual environment, to what extent do you feel like your hand is inside of the game/virtual environment?
7. When using your avatar, how physically close do you feel to the objects in the virtual environment?

Core Self-Presence – Included in factor analysis

1. When upsetting events happen to your avatar, to what extent do you feel angry?
    1. [not at all/somewhat/moderately/very/extremely]
2. When disgusting events happen to your avatar, to what extent do you feel disgusted?
3. When arousing events happen to your avatar, to what extent do you feel aroused?
4. When surprising events happen to your avatar, to what extent do you feel surprised?
5. When scary events happen to your avatar, to what extent do you feel afraid?

Core Self-Presence – Removed from factor analysis

6. When happy events happen to your avatar, to what extent do you feel happy?

7. When sad events happen to your avatar, to what extent do you feel sad?

Extended Self-Presence – Included in factor analysis

1. To what extent is your avatar's gender related to some aspect of your personal identity?

    1. [not at all/somewhat/moderately/very much/absolutely]

2. To what extent is your avatar's sex related to some aspect of your personal identity?

3. To what extent is your avatar's race related to some aspect of your personal identity?

4. To what extent is your avatar's clothing related to some aspect of your personal identity?

5. To what extent does your avatar's profile info represent some aspect of your personal identity?

6. To what extent does your avatar's name represent some aspect of your personal identity?

7. To what extent is your avatar's appearance related to some aspect of your personal identity?

Extended Self-Presence – Removed from factor analysis

8. To what extent do you identify with your avatar?

10.2 Social Presence Items

1. When interacting in the virtual world, I feel [...] like I am in the presence of another person in the room with me.

    1. [not at all/slightly/moderately/very much/extremely]

2. When interacting the in the virtual world, I feel [...] that the other people are watching me and are aware of my presence.

3. The other avatars appear to be [...] sentient (conscious and alive) to me.