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Toward A New Framework for Presence Evaluation: A Representational Design Perspective

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ABSTRACT

Although researchers suggest that presence is a multi-dimensional concept, little research is available to explain the underlying relationships among the dimensions and variables. Presence is regarded as ill-defined because of this measurement issue. This article proposes to look at presence as a representational issue and to inspect presence using a systematic approach. A new framework with four components for presence evaluation is introduced. It argues that investigating how media content affects presence is the solution to achieving a more complete understanding of presence and to taking individual characteristics and contexts as important factors in presence study. The article also presents a plan of empirical study designed to test narrative contrasted to expository text in an instructional design to evaluate presence.

INTRODUCTION

Presence is the sense of being, sense of reality (either realistic or symbolic), and feeling of immersion and interaction in the physical and social environment. It is a mental state that is subjective to the experience of the individual (Sheridan, 1992). Presence becomes an important concern for the science of Human-Computer Interaction (HCI) because of the increasing application of multi-media in information transformation, and presence is now regarded as a multi-dimensional concept.

In origin, researchers have proposed that when people interact with high-resolution information displayed in a symbolic system, the sense of presence increases. It became a conventional view that visual images are attended to more readily than language; therefore, visual images should be easier in making an impression (Argyle, Alkema, & Gilmour, 1971). Steuer (1992) also suggests that presence depends on two aspects: “the ability of a technology to produce a sensorially rich mediated environment” when vividness is felt and “the degree to which users of a medium can influence the form or content of the mediated environment” when interactivity occurs (p. 41). Steuer’s interpretations largely reflect the early understandings of presence. Among them, system content is only peripherally mentioned, and the focus is clearly on technology’s ability to transfer graphics or to provide users a certain control by allowing them to manually modify. This is similar to what Biocca (2003) later called “the two-pole model” dilemma, which has only considered the virtual and the physical spaces but not the mental imagery space (or the cognitive aspect). As Biocca suggested, the two-pole model could be useful in the initial engineering research on telepresence, but it was erroneously generalized to all media and became a cognitive theory of presence.

Recent investigations clearly show more perspectives on the study of presence. Researchers found that simply increasing sensory input fidelity does not automatically imply greater presence (Slater, 2003), and content that allows readers to relate to self influences intimacy levels even more than media differences do (Tidwell & Walther, 2000). Using multi-media to present content does not necessarily function better than using other tools such as plain text to provide social and personal presence, and users transfer and acquire social cues using whatever a medium provides. Furthermore, visual presentation might demand additional or unique information processing that leads to correspondence bias if it is under-processed, but information loss in non-visual presentations can have positive consequences (Gilbert & Krull, 1988).

Identifying presence as a complex phenomenon, researchers eagerly call for broader investigation of it. Factors that contribute to the generation of presence are widely discussed. Sheridan and colleagues point out that presence depends on several other factors beside hardware and software (Sheridan, 1992; Barfield, Zeltzer, Sheridan, and Slaters, 1995). Slater and Usoh (1993) also report that presence can be enhanced if the virtual environment creates

an emotional response. Researchers suggest that the social and environmental factors that mediate the self-other relationship are critical to the emergence of presence (Heeter, 1992; Lombard & Ditton, 1997). Witmer and Singer (1998) emphasize that a valid measure of presence should address factors that influence involvement as well as those that affect immersion. These concerns indicate that presence is a multi-dimensional construct, and explanation of it might be done through the study of other fundamental issues in human cognition. Later, experts in presence research suggest that “presence science [PS] belongs to a wider class of research fields studying how cognitive systems build models of their environment and interact with it” (p. 9), and they call for experiential studies from cognitive and psychological fields in the investigation of presence (Ruffini, 2006). Recently, researchers also turn to cognitive neuroscience and adopt human consciousness and mental model as new perspectives to investigate presence (see Sanchez-Vives & Slater, 2005).

Investigation of the underlying issues related to presence is valuable for system design. Among many suggestions for the further investigation of presence, this study agrees with researchers (Schubert et al., 2001; Rey, Alcaniz, Lozano, et al., 2004) that especially call to extend the presence studies from mere focusing on manipulations of media form to media content and believes that investigating how content affects presence is the solution to achieving a more complete understanding of presence and to taking individual characteristics and contexts as important factors in presence study. In this stance, the article proposes to look at presence as a representational issue and to inspect presence from the system design perspective. It regards promoting a sense of presence as one task for knowledge representation and suggests that presence will be evaluated with performance. In this effort, it does not intend to disregard or devalue the effect of media form but rather to show how form and content function differently and coordinately. Moreover, the study believes that shifting the focus from media to content is the foremost step in the investigation of presence with an integrated view and therefore is capable of covering most of the dimensional factors. The central question of this study is this: what are the components in the evaluation of presence in contextualized system design and evaluation?

This article argues that presence is a deep representational issue with broad considerations, and it proposes to dissect the investigation of presence into several components along with how representational systems are designed and evaluated, and especially how information is transferred. It therefore proposes to investigate presence with functional and pragmatic views when various presentational issues are examined. The article then introduces an empirical study designed to test the different effects of text representational methods, and narrative is contrasted to expository text in an instructional design with the purpose of evaluating presence.

PRESENCE AND REPRESENTATION

Presence

Presence has been generally defined as the sense of being somewhere in space and time, and it applies to any medium-induced sense of presence, such as the feeling of involvement and immersion from reading a book, watching a movie, playing a video game, or attending a videoconferencing class. From the system design point of view, presence belongs to the possible interactions of the individual with a symbolic system. The interactions are reflected through a process of how the individual perceives the meanings of the external representations as they are configured through a certain media, and how the individual responds in the form of internal and external representations within the environment. The individual might feel the effect of presence within this larger process of information transformation.

Presence as a Deep Representational Issue

As an emergent product of human interaction with the outside world, presence is fundamentally a representational issue, which in many ways reflects the embodied human cognition. It primarily concerns how semantics—the meanings—are transferred as the interactions of the individual with the symbolic system are reflected through many aspects of human learning: perception, self-regulation or control, and belief change, etc. Gibson’s idea of “information pickup” and “how the mind actually processes perceptual information” in Norman work (1999) both emphasize the paramount importance of the process of human inference. Norman says, “[i]n graphical, screen-based interfaces, the designer primarily can control only perceived affordances,” (p. 39) which was later interpreted by

Hartson as cognitive affordance. Confirming Norman and Gibson's underlying emphasis on the importance of semantics, Hartson (2003) suggests, "shared meanings and representations (through common language) are an absolute must in science, art, and everything-in-between" (p. 315). Later presence studies also confirm that presence is more dependent on the coherence of the stimulus flow of the symbolic system, which enables the focusing of attention of the individual (Slater & Wilbur, 1997). This stimulus flow explains how the individual perceives and draws inferences from the external representations of the symbolic system, and this process is in many ways a complex one.

The complex factors that affect presence in a symbolic system firstly come from the multifaceted mechanism of how humans interact with the environment of the symbolic system, which includes how humans perceive information, process the information in the working memory, associate the information with their immediate physical and social world, retrieve those information associated in the long-term memory, and finally integrate the information, etc. Shaped through evolution, this human mechanism might be very elastic and can be further modified in every new environment. Individual difference might also show significant impact on this cognitive mechanism. In every cognitive process, time, intensity of the association, and the self-relevance of the information all influences the felt level of presence.

The complexity of this cognitive process is multiplied when stimuli in different formats are in the picture. Humans are sensitive to the modality of the representations. Pictorial representation has been proven to benefit to human cognition in general because it gives some sort of concreteness and therefore transfers a sense of reality. Conclusions on the concreteness of pictorial and object representations as compared to verbal ones are consistent (Paivio, 1971; Paivio & Csapo, 1973). The use of pictorial representations is superior to the use of verbal representations for recall, recognition, and associative learning across a number of tasks because of the picture effect (or concrete effect). The evidence of the picture effect, however, depends upon whether there is a demand for verbal or pictorial response to tasks. Moreover, there are results indicating that picture limits the extent of semantic processing (Durso & Johnson, 1980). Words have also been found to have different concreteness and image levels (Paivio, 1971; Richardson, 1975). Research shows that words do not necessarily create less sensory-perceptual experiences than pictures. A word with a high image level and abstract words presented with context proved to motivate readers more than pictures do. In a word, the semantic meanings that the stimuli are transformed may have more impact than the different modalities used on human cognition.

Additionally, the manner in which the information is presented also influences the ability of the symbolic system to transfer a sense of presence that affects the quality of the learning experience. For readers, content knowledge represented by dense context has proven as memorable as when it is presented in pictures. The critical point of achieving a memorable learning experience is allowing readers to generate images. Image generation, which may intrinsically involve semantic processing because creating images entails accessing to knowledge from long-term memory, ensures that both the linguistic channel and the visual channel are actually employed.

Since surface structures of symbols (or syntax values) cannot give all the explanations to their functions in human interaction, the investigation of presence must comprise the consideration of the pragmatics of the individual. The syntax values, as well as the semantic values, have to be interpreted based on the impacts they make on the cognitive processes applied by the individual. In other words, neither the surface representation of picture nor the surface representation of word has been proven to prevail one or the other in its effects on giving a sense of presence. The solution must come from the result that tells which kind of representation optimally engages the human mind or gives a sense of presence that supports task performance.

Context is the main emphasis of all pragmatic methodologies. The author of the external representations assigns semantic meanings using certain carriers of expression, whereas a reader perceives the meanings pragmatically according to the contexts in which the external representations are presented. The context includes several dimensions, the textual context, the speaker and the listener-shared context (or the cognitive context), and the situational context (Schiffrin, 1994). The pragmatic dimension of the situational context might create a very different perspective on the affordances of the external representations to the listener. Compared to semantic meanings that are generally assigned, pragmatic meanings are more situated and changeable from circumstance to circumstance, and they are necessarily important components of the evaluation of presence. Individual differences, which include affect factors and personal goals, also directly influence the experience of presence that must be considered.

MODELING THE EVALUATION OF PRESENCE IN A SYMBOLIC SYSTEM

The Framework of Presence Evaluation

From the above discussion, the investigation of presence is suggested to be put into a larger environment when humans actually adopt representations and symbolic systems as tools in their everyday or advanced knowledge communications. Therefore, the study suggests dissecting the investigation of presence along with how individuals interact with the symbolic systems, especially with the external representations. Four components are identified:

1. **the symbolic system**, in which content is transferred through external representations with certain representational method(s);
2. **the hidden intermediary**, in which affordances of the external representations are indicated;
3. **individual response**, in which internal and external representations controlled by the mental model of the user are regarded; and
4. **presence evaluation**, in which different evaluation tasks and methodologies are considered.

As identified by the framework, most variables and contextual factors that affect the generation and evaluation of presence could be categorized as shown in Table 1. In *the symbolic system*, the variables that affect presence directly come from the selection of representational methods. In *the hidden intermediary*, variables are used to describe perceptual qualities of the external representations, which are the affordances; in system design and evaluation, the investigation of affordances must use a functional view when both source stimuli and perception of the potential users are considered. Individual characteristics and response context are two important contextual factors that define the *individual response*, which are mediated through the mental model of the individual. As Schubert and Crusius (2002) also state, “the fact that presence can emerge both from the perception of visual stimuli and the understanding of symbols shows the necessity of another layer in a theoretical model of presence, namely that of mental representations.” In Table 1, the bold arrows pointing from one component to another indicate the direct affordance and direct perception separately.

Table 1. *Components and Variables—Evaluation of Presence in Representational Symbolic Systems*

Component	The Symbolic System	The Hidden Intermediary	Individual Response	Presence Evaluation
Variable and Instrument	<p>External Representations</p> <p>Representational Method</p>	<p>Affordances Intermediary</p> <p>Cognitive affordance Physical affordance Sensory affordance</p>	<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: auto;"> <p>Internal Representation</p> <p>The Mental Model</p> <p>External Representation</p> </div>	<p>Objective Assessment</p> <p>Subjective Assessment</p>
Environmental Context Variable	<p>System Characteristics and Representational Context</p>		<p>Individual Characteristics and Response Context</p>	<p>Methodology and Testing Context</p>

The Symbolic System

System design is one major form of knowledge representation, which concerns the selection of representational methods and the quality of the external representations. Selecting representational methods depends on several factors: human cognitive mechanisms in information processing, characteristics of different text types (e.g., narrative, expository text, or picture) and modalities of the representations (e.g., print, video, or animation), domain tasks and design context, and the pedagogical implications of using the specific representational method according to the learner. System design needs to implement a range of design tasks to ensure the affordances of various interactions of the user: perceiving, decoding, and creating of external representations, which necessarily lead to a positive learning experience.

In order to interpret how humans as embodied entities communicate through symbolic systems, a brief discussion of internal and external representations and knowledge representation is required. From this discussion, fundamental issues of human learning that affect the different aspects of presence will be revealed. These issues relate to the tasks of representation and a series of contextual factors when knowledge is represented, perceived, and further represented.

Internal and External Representations

Representations are conceptually identified entities that are comprised of reflections and reactions to an object or other reactively identified and excerpted “passing thoughts” (Demmin, 2003, p. 144). Representations show their presence in nearly every human action: instinctive activities, inner monologues, visual imageries, imagined feelings, and explicit reflections. They are usually put into two categories, internal representations and external representations in the research field of artificial intelligence. Human actions, both conscious and unconscious, are constantly mediated by representations. Unconscious, instinctive, and unintentional actions like behavior routines are response based. Even though they are functionally goal-oriented, the thoughts underlying these actions do not have the property of being perceived and interpreted as they belong to the internal representations (Demmin, 2003). Searle (1998) says that intentional states function to relate us to our environment via representations that act on the environment. This interpretation identifies the mediation function of the intentional thoughts. External representations have a communicative nature in addition to their intentional nature, and they are those internal representations that are articulated, and they comprise the knowledge that is manageable and is ultimately used to guide human behaviors.

Natures of External Representation

External representations are regarded as the objective form of the representations and are explicitly recognized discrete entities. The objective nature of the external representation also indicates that the representations are not closely tied to the agent’s immediate circumstances in causal and epistemological terms, which allows them to be used as communicative knowledge. This leads to the second nature of external representations, context dependent. According to Kant, every individual application of the representations creates a syntagmatic unit of discourse “schema,” which becomes the “unity in the determination of sensuousness” (Frank, 1997, p. 14); this syntagmatic unit contains both the carrier, which is the structure and the rules of the expression and the expression itself, which includes not only the content but also the context. As Schleiermacher (Frank, 1997) suggests, the meanings of the schema are defined horizontally by its surroundings. The context of a representation also includes both the creator and the receiver of the representation in the way that their cultural experiences participate in the cognition and mediate how they give meanings to a representation in a shared symbolic system.

Knowledge Representation

Knowledge representation involves presenting objects and their relations to each other in the world. These objects can be sensory percepts, including the sense of objects and aspects of them. Contrasted with these sensory percepts are the objects of judgments, the concepts or the mental representations upon other objects and their relations. The task of knowledge representation is to represent these objects with certain communicative media, such as print, video, or TV in the form of linguistic texts, pictures or animations. The semantic value has to be distinguished from the vehicle of the representation, which is the syntactic structure that acts as the physical realization of the

representation. Because all semantic distinctions are preserved syntactically, the syntactic type of the representations has a causal property for the functions of the symbolic system (Host, 1996). The functions of these different representational modalities, however, were emphasized more than those of semantic content in the presence science. A recent study by Banos et al (2005) indicates that though virtual representation of the environment might help to maintain the felt presence, the user's imagination alone is adequate to the generation of presence. As this study proposes, the effect of semantic content on presence necessitates more investigation.

Another concern of knowledge representation is the level of representation, which directly relates to the quality of representation. Different from the concept of knowledge level, which indicates what kind of content is represented, the level of representation specifies the adequacy of the representations. The issues of richness and psychological adequacy of the representations and the degree to which they create the desired results are regarded as important issues (Forbus, Gentner, Markman, & Ferguson, 1997). The adequacy of knowledge representation consists of the role of primitives, which answers the question of what primitives are appropriate to build into a representation and at what level, and the role of meta-representations, which includes the externalization and explanation of the use of structures and rules in the representations.

The Hidden Intermediary

A fundamental concern for ecological and cognitive psychology is to explain how agents are situated, that is, functionally coupled to their environments so as to facilitate adaptive actions. Gibson's ecological view has a significant impact on general psychology applied in HCI. Gibson (1982) suggests that affordances are properties of the environment relative to animals and these affordances create an intermediate domain between the physical world and the human mind. He interprets affordance as an action possibility available in the environment to an individual, and this law governs the informational coupling that is independent of the individual's ability to perceive. Norman (1999) introduces this concept into human-computer interaction and transformed the concept into perceived affordance (to support individual cognitive actions) and real affordance (to support individual physical actions). For further clarification, Hartson (2003) calls them cognitive affordance and physical affordance, and he adds sensory affordance to emphasize that sensory input gives rise to internal representations that support cognition. Cognitive and physical affordances are generally regarded as basic usability concepts for interaction design, whereas sensory affordance has a supporting role to them. For system designers, these affordances are hidden until they are identified. Fully understanding the differentiating and correlating relationships between the affordances in this hidden intermediary can be the route to a complete interpretation of presence.

Individual Response

Presence is fundamentally how the individual responds to the designed stimuli with different environmental references. The conscious or controlled responses of the individual have to be distinguished from the unconscious and uncontrolled responses in the investigation of presence. Moreover, the high-level responses (which the mediation is through the interpretation of the semantic content) are far more complex than those low-level responses (which the form of technology or media is regarded as the mediator) and should be distinguished from each other in the evaluation of presence. For example, Bailenson and colleagues (2003) suggest that "holding all sensory information constant," "for high-level responses (e.g., meaningful conversations), the slope of the social influence threshold is relatively steep, but for low-level responses (e.g., reflexes, less consciously controlled processes), the slope of the threshold is relatively shallow." The distinctions between these high-level and low-level responses will allow precise methodologies applied to the investigation of presence. Conversely, no matter how we categorize the individual responses, we have to fully understand that they come from integrated human existence. As Schubert and colleagues (Schubert et al., 2001) suggest, all physical, imagery or virtual realities are a consequence of internal processing mediated by the mental model. This paradox also implies the complexity involved in the evaluation of presence.

Presence Evaluation

Presence could be either in the form of human consciousness or unconsciousness. The responses to a symbolic system could be natural gestures and bodily movements, which are internal representations; the responses could also be conscious interactions between the individual and the system through exerting new external representations or

reconfiguring the existing external representations. In the current presence studies, both objective assessment and subjective assessment are employed. Subjective assessment is the most used method and it requires participants to give an introspective judgment regarding their experience. Objective assessment includes behavioral measures, which measure automatic responses that are correlated with being present in a particular environment, and physiological measures, which measure the change in heart rate, the change in skin conductance and temperature, etc (Insko, 2003). Though both methods are used in the presence studies, the problem seems that researchers seldom explain how the behavioral and physiological measures account for the psychological significance of the investigation. The discussions and reasoning of theories are apparently discrete. Researchers suggest that even the subject/object distinction is conflicting and prone to criticism (Zahorik & Jenison, 1998). This separation of application of assessment methods undoubtedly comes from the limited understanding of internal and external representations.

A complete investigation of presence has to start with the fundamental issue of representation and regards system use as the interaction between the individual and the content—the external representations. Also, with regard to individual responses, presence as a highly subjective experience must be studied when the action of the person is fully seen from its environment. This subjective experience implies a close connection of the inner emotions of the individual with what he or she externally expressed, so the study of presence must take both the internal and the external responses of the individual into consideration. Thinking and memory are united; the individual's unconscious mind contains more knowledge than his or her conscious mind in the way that the conscious cognition is embodied in its own unconscious whole. Human consciousness includes both internal representations and external representations. Body language and other explicit signs of individuals' physiological conditions convey many cues about the intent, inner feelings, and personality of a person, which have been regarded as important in the presence study, but few tools and techniques are available to measure them (Encarnacao, Gross, Reiner, et al., 2005). In order to effectively apply current tools and to find new methodologies, researchers have to investigate the relationships between the internal representations and the external representations. The quality of the experience in a virtual environment could only be fully explained with an embodied view when both forms of representations are considered.

A PLAN OF EXPERIMENT

Narrative

Face-to-face interaction, which is regarded as giving a full presence, has been a central part of education and of other human services. In order to compensate for the paucity of human support and presence in the online environment, narrative has been applied in the virtual world, intelligent tutor systems, and other hypertext interfaces to promote caring relationships and dialogues among users. Narrative has been suggested as a method of creating artifacts grounded in the social world and structural coupling to the environment. Researchers also regard narrative as at the heart of a persistent virtual community (Slater & Van De Velde, 2005). In Biocca's (2003) three-pole model, narrative is said to achieve a level of presence by making use of the imagery space; though it is highly possible, this assumption itself needs to be tested. A study comparing the sense of presence between virtual and imaginary environments shows that narrative has a strong priming effect on presence compared to when VR environment is used (Banos, et al., 2005). However, in the study, the lack of consideration of individual differences, such as the individual's ability to create mental imagery, is also mentioned. Additionally, whether the quality of the narrative representation has an effect on the result is unknown. These are similar to the fundamental questions: Does narrative differ from plain text in creating a sense of presence? How do individual differences affect the effect? To answer these questions, the study plans a comparison between narrative and plain text when an online course is presented.

The Design

There are two versions of the course: the original design in expository text and the transformed design in narrative form. Participants will be randomly assigned to one of these two groups. While taking the course, a pre-test, a post-test, a questionnaire, and a course survey will be administered. In the questionnaire, participants will be asked to report on their learning experience and sense of presence; individual characteristics and situational factors will also

be considered. The research questions are these: Do the individuals generate more sense of presence using the narrative form than those using the expository text? How do individual differences affect the outcome?

Measurement

Physical Behavior To assess the individual behavior, time spent on learning the online course and completing the tasks will be collected from system reports. Users will also be asked to report learning time, the manner of how learning is conducted, and the physical constraints, etc.

Sense of Presence To assess the personally felt presence, several questions are asked, which relate to the following aspects: 1) elicitation of emotions, 2) enjoyment rate of experience, 3) content realistic rate, 4) the degree of the sense of presence felt in the scenarios, 5) memorable rate of the content 6) meaningfulness of the content, 7) coherence of the content, and 8) self-relevancy of the content.

Individual Characteristics Motivation, creativity level (similar to the ability of the individual to create imagery), and other general individual differences will also be assessed. The current empirical study also adopted and transformed two items (3 and 9) from the Immersive Tendencies Questionnaire (ITQ) designed by Witmer and Singer (1998), which were designed to measure the capability or tendency of individuals to be involved or immersed: 1). How easily do you get emotionally involved when you read or hear some stories? (The original item 3 is: how frequently do you get emotionally involved {angry, sad, or happy} in the news stories that you read or hear?) 2). How easily do you identify yourself with the characters in a story? (The original item 9 is: how frequently do you find yourself closely identifying with the characters in a story line?) Other items are those asking personal traits, learning style, and communication style of the individual.

CONCLUSIONS

Although researchers suggest that presence is a multi-dimensional concept, little research is available to explain the underlying relationships among the separate dimensions. This article proposes a framework with several components according to how symbolic systems are designed. It identifies content as a central factor in the investigation of presence; from this, the evaluation of presence can be investigated around the issue of content representation. By proposing this framework, it expects the study of various factors that might affect the generation and sustainment of presence with certain level of integration. This article then describes a proposed study of presence involving an experiment where two groups of participants will each experience a different form of representation of the same course. What is unique is an emphasis on the power of text to help individuals imagine, at a time when images and visual displays are touted as the clearest means to creating a quality experience. Moreover, in the effort to address the fundamental and theoretical issues regarding representation, the author expects more presence studies will be done in this direction.

Though this is just the beginning of the study, it provides a new perspective on the interpretation of presence. It emphasizes the scientific underpinnings of new information designs and uses in an attention economy. The undergoing investigation will provide valuable empirical support promoting narrative-centered applications in education.

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