Measuring Presence: The Temple Presence Inventory

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Abstract

This paper describes the development and testing of the Temple Presence Inventory. The TPI questionnaire is a multidimensional, literature-based measure of telepresence that has demonstrated sensitivity to media form and content in studies discussed here.

1. Introduction

The phenomenon of telepresence (hereafter, presence), in which users of advanced media technologies such as virtual reality as well as traditional media such as television, experience a sense of connection with real or fictional environments and the objects and people in them, has become increasingly important to those who study and create mediated experiences.

The increased attention to presence is partly due to the need to understand the psychological and social impacts of technological advancement in mediated displays, acoustics, haptics, and interactivity. In particular the more advanced the media become the more they are capable of creating qualitatively different experiences from less advanced media - experiences that lead to the misperception that a mediated experience is not created by technology or what Lombard and Ditton [1] called an "illusion of nonmediation." Such presence illusions can, and increasingly will be, purposefully created and used to influence and manipulate people's responses, and this trend is expected to have important implications in a wide variety of contexts.

Researchers have long called for the development of an underlying science of presence: The study of presence needs to begin with a "'presence science' which explains the origin and nature of presence and the factors on which it depends" [2, p.359] (see similar calls [3; 4]). The course of action suggested is to begin with a rough theory, create a measure based on this theory, check this measure against existing measures of presence and refine the theory and the measure in parallel.

Lombard and Ditton [1] provided a detailed explication of the multidimensional concept based on a comprehensive review and synthesis of literature related to presence and its causes and consequences. Although there are still variations in meanings assigned to the term (see [5]), this paper adds to the body of existing presence research and theory by presenting a comprehensive review and synthesis of scholarship related to the measurement of presence and its components along with a new paper-and-pencil measurement instrument based on the literature and recommendations for presence researchers regarding measurement decisions.

The paper first reviews the importance of the presence concept; then outlines the preliminary multidimensional conceptual definitions; reviews the methodological approaches and instruments used in prior work related to measuring presence; presents two studies conducted to develop and validate the new measurement instrument; and provides recommendations regarding the use of different measurement tools and techniques.

2. The importance of presence

Presence is an important concept for (at least) three reasons. First, presence is a central concept for scholars and practitioners in a very wide range of fields, including computer science and artificial intelligence, business, education, health and medicine, the military, politics, entertainment, art, psychology, cognitive science, philosophy, and ethics. While the terms presence and telepresence are not always invoked, the concept behind the terms is key to a growing number of phenomena and endeavors in these and many other areas.

Presence is also important because the trends in the evolution of technology suggest that the misperceptions we're identifying as presence will become increasingly common, which means that we need to better understand how they happen and their causes and consequences in order to make decisions about how to use and design technology in the 21st century.

Third, and related to the last point, many important potential effects of presence - physiological, psychological, behavioral, social - have been identified, such as enjoyment, improved skills training and task performance, desensitization (not just to phobia objects but e.g., to violence), persuasion, parasocial relationships, and changes in memory and social judgment. Research is needed to confirm and better understand these and other effects of presence.

3. Presence explicated

"Presence is a multi-dimensional concept; i.e., there are

different types of presence" [6]. Lombard and Ditton [1] identified six conceptualizations of presence in various literatures. Others have proposed a variety of dimensions of presence, but most are captured in these six [5]. These conceptualizations are briefly reviewed here.

Presence as Transportation. The most frequently used conceptualization captures the sense of presence in which media users feel that they or other objects, people, or environments have been transported. This includes: presence as "you are there," often used in discussions of virtual reality, which takes users to a virtual environment and leads to the "suspension of disbelief that they are in a world other than where their real bodies are located" [7, p. 222] (see also [3; 8; 9; 10; 11; 12; 13]); "it is here," in which instead of transporting the user to a different place, a sense of presence may bring the objects and people from another place to the media user's environment [14; 15] and "we are together" (shared space), found in literature concerning video conferencing as well as virtual reality.

Presence as Realism. A second conceptualization of presence concerns the degree to which a medium can produce seemingly accurate representations of objects, events, and people -- representations that look, sound, and/or feel like the "real" thing. There are two separate components to this dimension: Social realism is the extent to which a media portrayal is plausible or "true to life" in that it reflects events that do or could occur in the nonmediated world. While presence as realism may include this type of social realism it also includes a perceptual element, Perceptual Realism, that is separate: A scene from a science fiction program may be low in social realism but high in perceptual realism because although the events portrayed are unlikely, the objects and people in the program look and sound as one would expect if they did in fact exist. On the other hand, the people and events in an animated presentation may be high in social realism but because they are not "photorealistic," be low in perceptual realism.

Presence as Immersion. The third dimension identified by Lombard and Ditton [1] emphasizes the idea of perceptual and psychological immersion. The physical component of immersion is the extent to which the user's senses are extended into the mediated environment and how natural these extensions are when the senses are employed. Presence as immersion also includes a psychological component. When users feel immersive presence they are involved [16], absorbed [17], engaged, engrossed.

Presence as Social Richness. To some scholars, primarily those who study communication in organizations, presence is the extent to which a medium is perceived as sociable, warm, sensitive, personal or intimate when it is used to interact with other people. Social presence theory [18] and media richness theory [19] were developed to better match communication media and organizational tasks to maximize efficiency and satisfaction.

Presence as Social Actor within a Medium. The fifth dimension is best exemplified by parasocial interaction [20], in which media users respond to social cues presented by persons they encounter within a medium even though it is illogical and even inappropriate to do so. Studies have shown that people respond to interpersonal distance cues in [14], and even talk to [21], the pictures of people on the television screen or to virtual actors (see [22]). The mediated nature of the "interaction" is ignored and the media personality is incorrectly perceived as a social actor. This phenomenon occurs even in interactive media environments such as virtual worlds when users treat avatars as social entities of their own rather than representations of other users.

Presence as Medium as Social Actor. The sixth dimension refers to an anthropomorphism of the medium such that the user experiences the medium/technology itself as a social actor. For example, Nass and his colleagues have demonstrated in a series of studies [23; 24; 25; 26; 27; 28; 29; 30; 31] that because computers use natural language, interact in real time, and fill traditionally social roles (e.g., bank teller and teacher), even experienced computer users tend to respond to them as social entities. In these social responses to computers and televisions (and robots and androids) users again ignore, in a counter-logical way, the technologically mediated nature of a communication experience. Basic social cues exhibited by the medium lead users to treat the medium as a social entity.

Most scholars have focused on one or a few of these and other types or dimensions of presence in the literature, but little is currently known concerning how the interplay between types alters the overall experience of presence. This is due in substantial part to the fact that no single measure of presence approaches the concept with both adequate depth and breath. A small number of researchers are attempting to empirically test the validity of some of these dimensions using various types of indicators. However, as of yet, there is no publicly distributed standard technique or comprehensive instrument for measuring presence as currently conceptualized by scholars within the presence community.

4. Approaches to presence measurement

Systematic research on a number of important research fronts has been hindered by the absence of a presence measure or measures that not only incorporate all of the dimensions of presence discussed above, but also permit comparisons across media systems, formats, and contents. Since the first calls for the development of a standardized measure of presence [4; 32; 2; 3], researchers have taken a number of different (although not necessarily mutually exclusive) approaches to creating standard measures of presence. These approaches can be grouped into two main categories: objective approaches, and subjective approaches.

4.1. Objective approaches

Objective approaches to presence measurement involve the use of participants' automatic responses as indicators of their levels of presence. One objective approach to presence measurement involves the use of physiological indicators of the concept such as skin conductance, cardiovascular (blood pressure, heart rate) and ocular responses, muscle tension, respiration, and posture. Another objective approach to presence measurement involves the use of what has been called behavioral, "direct," "Class A" or performance measures of presence. In this approach, subjects are presented with virtual and real cues which conflict; the degree to which subjects respond to the virtual cues rather than the real ones indicates presence perceptions [33; 2].

Most scholars agree that physiological and behavioral indicators of presence are most useful as adjuncts to measuring presence by asking subjects or users to describe their experience subjectively. Physiological and behavioral measures of presence provide much less depth in measurement (e.g., autonomic arousal and ducking or flinching could be a response to both the perceptual realism of the experience or the sense of spatial immersion created by the experience) and may only be useful for specific stimuli (e.g., high action, point-of-view movement) or when specific independent variables are being manipulated (e.g., display characteristics).

4.2. Subjective approaches

While not without their own substantial limitations, subjective measures of presence are far easier to administer, more adaptable across different media contexts and media content, and allow for a more intricate analysis of the underlying dimensions of presence because indicators of what are believed to be the various dimensions or types of presence can be included. Subjective approaches include both qualitative methods and presence questionnaires.

4.2.1 Qualitative methods There are a number of qualitative methods researchers use to measure users' sense of presence. These methods include ethnographic observation, focus groups, and free format interviews. Qualitative methods allow researchers "to produce information which is not arrived at by any means of quantification" [34, p. 27]. While this can help researchers gain a deeper and more detailed understanding of the presence concept, these methods typically yield data low in reliability and external validity; subsequently, it is difficult to generalize findings to a population of interest or compare findings across studies. Therefore, qualitative methods are best suited for exploratory research, or in conjunction with other measures of presence, such as presence questionnaires.

4.2.2 Presence questionnaires Presence questionnaires are the most widely used measures of presence. Self-report measures of presence are potentially very useful, as the quantification of users' presence experiences allow for statistical comparisons across different media, stimuli, and subject groups. However, currently different researchers use different items to test different hypotheses in a variety of different contexts, making comparisons across studies difficult. What is needed is a standardized self-report measure of presence that would allow for these comparisons.

A standardized measure of presence that allows for comparisons across media, stimuli, subject groups, contexts, and studies must demonstrate evidence of meeting several criteria. First, a presence questionnaire must be *reliable*, both externally and internally consistent (internal consistency is typically assessed by computing Cronbach's alpha). Second, a presence questionnaire must demonstrate evidence of *validity*. Establishing the validity of a measurement instrument is an ongoing process of "accumulating evidence to provide a sound scientific basis for the proposed score interpretations. … Validation can be viewed as developing a scientifically sound validity argument to support the intended interpretation of test scores and their relevance to the proposed use" [35, p. 9].

There are many approaches to establishing validity, including confirmatory factor analysis, correlation with other known presence measures (i.e., the objective corroborative measures of presence discussed in Section 4.1), correlation analyses of interrelationships among items, convergent correlational studies of relationships between the presence measure and variables that are theoretically related to presence, and known group comparison studies [36].

The third criterion, *sensitivity*, serves as evidence of validity. A presence questionnaire that is reliable and valid also must demonstrate sensitivity, meaning that it is able to "detect any change in the construct being measured, in other words, it can measure an effect caused by manipulating a variable known to influence that construct" [37, p. 3]. A highly sensitive measure of presence should be able to distinguish between multiple levels of presence.

Fourth, a presence questionnaire must be *conceptually comprehensive*, capturing and operationalizing the multidimensional nature of the presence concept, thereby assessing all of the dimensions of presence that have been identified in the literature. Finally, a standardized measure of presence must have high *applicability*, meaning that the instrument "can be used in different conditions and environments" [38, p. 5] These last two criteria are particularly difficult to meet in the case of presence because it is arguable whether any measure could capture all types of presence in all contexts.

This section concludes with an evaluation—in light of the criteria discussed above—of six prominent presence questionnaires, selected for the reasons described below (see [34] for information on more than 25 questionnaires).

The first two questionnaires, the SUS and the PQ, were chosen because they have been used in more studies than any other measures of presence.

Researchers often construct presence questionnaires using

a combination of newly developed items and items drawn from previously established self-report measures of presence. The third questionnaire, the IPQ, was developed using items from both the SUS and PQ; the IPQ was thus chosen as an example of this additive approach to instrument construction.

The next two questionnaires, the MEC-SPQ and ITC-SOPI, are noteworthy in that both measures were developed to allow for cross-media comparisons of users' presence experience. While the instruments differ in terms of the conceptual modeling and operationalization of the presence experience, these measures converge on the criterion of applicability, as both were specifically developed to be applicable to a range of media conditions and environments.

The final questionnaire, the IPO-SPQ, was selected because it taps into dimension(s) of presence that the SUS, PQ, IPQ, MEC-SPQ, and ITC-SOPI do not account for. While those 5 questionnaires assess various dimensions of users' sense of physical presence, the IPO-SPQ measures users' sense of social presence.

Each of the six questionnaires is described and evaluated briefly below.

Slater-Usoh-Steed (SUS) Questionnaire [39]. The SUS is a short (6-item) self-report measure that has been widely used in presence studies. The items were developed directly from the research and theory of its authors, and address 3 aspects of a single dimension of presence: presence as transportation (as defined by [1]). The authors of the SUS have not reported the reliability of their measure. The SUS has been found to correlate with objective corroborative measures of presence in a number of studies [40; 41; 42], and these findings are the strongest evidence of the instrument's validity. The sensitivity of the SUS has been called into question by its authors due to its failure to significantly distinguish between real and virtual environments [43; 44]. Lastly, in terms of applicability, the SUS was designed to measure presence in immersive virtual environments.

Presence Questionnaire (PQ) [45]. The most widely used full-length self-report measure of presence is the (Version 2.0) PQ. The PQ is a 32-item questionnaire assessing 2 dimensions of presence in 3 factors (extended to 4 factors in Version 3.0): presence as realism and presence as immersion (as defined by [1]). The questionnaire has been found highly reliable by its authors (α=.88), and there is considerable evidence for the validity of the measure. The authors conducted preliminary validation of the PQ across four experiments. Validity was assessed by correlating the instrument with objective and subjective corroborative measures of presence, such as task performance, the Immersive Tendencies Questionnaire (ITQ), and the Simulator Sickness Questionnaire; after combining the data over the 4 experiments, the authors reported significant correlations between the PQ and corroborative measures [45]. The sensitivity of the PQ was tested in two experiments; results indicated that the PQ was able to distinguish between high and low presence conditions [46; 47]. The PQ was developed to measure presence in virtual environments, but is also applicable to semi-immersive media environments.

Igroup Presence Questionnaire (IPQ) [48]. The IPQ was constructed using a combination of items from existing presence questionnaires [44; 49; 50; 51; 52; 53] the authors' own research [54], and new items developed by its authors. Exploratory factor analyses were then conducted on these items, resulting in a 14-item, 3-factor model of presence, which assessed the following presence dimensions: presence as transportation, presence as immersion, and presence as realism (as defined by [1]). The IPQ was found highly reliable in 2 preliminary studies (α=.85; α=.87), and confirmatory factor analysis of the 3-factor model provided initial evidentiary support of the new measure's validity [48]. The IPQ has demonstrated sensitivity; it was able to distinguish between multiple levels of presence in several studies [55; 56; 57]. In terms of applicability, the IPQ was designed to measure users' sense of presence in virtual environments.

MEC-Spatial Presence Questionnaire (MEC-SPQ) [58; 59]. The MEC-SPQ was developed from the theoretical framework of the MEC model of Spatial Presence. This model differs from existing conceptions and theories of presence because "the MEC model explicitly distinguishes presence, involvement, and attention by definition. This distinction and the integration of mental mechanisms allow for empirically testable predictions about the formation of Spatial Presence experiences" [60, p. 225]. The three 8-item subscales of the MEC-SPQ not only assess the presence as transportation dimension of the concept, but also presence as immersion (as defined by [1]). The reliability of each MEC-SPQ subscale was preliminarily assessed separately by the authors, with Cronbach's alphas ranging from α=.78 to α=.94, and the validity of the measure was initially supported by significant intercorrelations among subscales [60]. The measure was also validated in subsequent studies, as evidenced by strong correlations with related criterion, and known physiological and performance, measures of presence [61; 62]. The measure has also demonstrated high sensitivity, distinguishing between multiple levels of presence in both initial and subsequent studies [60; 61; 63]. A main strength of the MEC-SPQ is its widespread applicability: the questionnaire was specifically designed as a cross-media measure of presence.

ITC-Sense of Presence Inventory (ITC-SOPI) [64]. Copyrighted by the UK Independent Television Commission, the ITC-SOPI is a 44-item 4-factor cross-media questionnaire measuring 3 dimensions of the presence concept: presence as transportation, presence as immersion, and presence as realism (as defined by [1]). The authors computed Cronbach's alphas for each of the ITC-SOPI subscales; values ranged from α=.76 to α=.94, indicating satisfactory reliability. Strong correlations among the ITC-SOPI subscales, and between the instrument and established presence questionnaires [39; 45] offered preliminary evidence for the validity of the measure [64]; several correlational studies have also found corroborative

evidence of the validity of the ITC-SOPI [65; 66; 67]. In other studies, the ITC-SOPI has demonstrated its ability to distinguish between multiple levels of presence [68; 69].

IPO Social Presence Questionnaire (IPO-SPQ) [70]. The IPO-SPQ is a 17-item instrument that uses both the semantic differential technique and attitude statements to measure social presence. The semantic differential subscale contains 12 items, with a reported reliability of α=.90; the attitude statements subscale contains 5 items, with a reported reliability of α=.72 [70]. In terms of evidence of validity and sensitivity, this questionnaire has strongly correlated with objective corroborative measures of presence, and has also been able to distinguish between multiple levels of presence in a number of studies [71; 72; 73; 74]. The applicability of the IPO-SPQ is limited, as it was designed to measure users' experience of social presence with telecommunication applications.

In summary, while the presence questionnaires discussed above do meet several of the necessary criteria, not one of these instruments measures all dimensions of presence. Furthermore, only the MEC-SPQ and ITC-SOPI have met the remaining criteria: both are cross-media measures of presence that have demonstrated evidence of validity, sensitivity, and reliability.

5. Method of questionnaire development

The authors conducted a set of studies to develop a standardized, cross-media measure of presence based on a wide literature that extends beyond the study of virtual environments and relatively narrow conceptualizations of presence. The items are based specifically on literature and conceptualizations within the literature; that is, nearly every item included has been used in research in the past. Furthermore, recent presence research emphasizes social presence and the factors that contribute to it. This new instrument (hereafter, the Temple presence inventory or TPI) includes the dimensions that address parasocial interactions and social richness (as conceived by Short, Williams, & Christie [18]) as well as the dimensions measured by all of the other existing scales (e.g., spatial presence/transportation, psychological and physical immersion, perceptual realism/naturalness and plausibility or social realism, and engagement/attention). The sections that follow describe the construction of the new presence instrument, the initial testing of the instrument's validity based on manipulation of media form, and additional empirical validation of the TPI based on the manipulation of media content.

5.1 Building the questionnaire

A large number of potentially appropriate measures were collected from the studies identified by Lombard and Ditton [1] and those published since that review. These items were supplemented with new items created by the researchers so that each of five conceptualizations of presence was well represented (the sixth dimension, medium as social actor, was excluded because of its arguably distinct nature and the practical limitations of testing the large number of potential items that would be required). Additional items were also added, including measures of the respondents' tendency to suspend disbelief, media use habits, and demographics. The resulting questionnaire contained 114 presence items.

The initial set of items was pre-tested with undergraduate and graduate students at three universities. Approximately 10 students at a large public 4-year university, approximately 20 students at a small private Catholic university, and approximately 20 students at a community college participated in the pretesting. The participants watched an emotionally dramatic television program, an episode of the 1998-1999 CBS series *L.A. Doctors* in which four physicians who together operate an upscale medical clinic deal with personal and professional problems. The episode, titled "Denial," was shown with commercials and projected on different size screens in the different pretests. The participants watched the program, completed all of the measures of presence and the other items on the questionnaire, and then together discussed their interpretations of and reactions to individual items and the experience as a whole. Following these pretests, duplicate and unclear items were cut and others were rewritten.

The complete questionnaire developed for further testing of the presence measures was 10 pages long. It contained 137 items, 72 of which measured presence responses corresponding to the five conceptualizations of presence and 33 of which measured other presence-related responses (e.g., parasocial relationships, simulator sickness). In addition to the suspension of disbelief, the other 32 items asked respondents about their overall evaluation of the viewing experience and of the quality of the picture and sound; their prior experience with the medium and content, the screen size of the television they watched most often, and the distance from which they typically watched that television; their prior experience with and knowledge of 3D IMAX technology, video games and interactive virtual reality; and their age, race, and gender.

5.2 Procedure and participants

The potential items were assessed by having a large, diverse group of individuals complete the items following one of two distinct types of mediated experiences. These experiences were selected or created so that perceptions of presence (of each kind/dimension) could reasonably be expected to vary. Specifically, different media formats were selected in order to distinguish between a high and low presence mediated environment. Because of the exploratory nature of the study, the conditions were limited to non-interactive audio-visual presentations. Print stimuli were excluded because the processing strategies they invoke are arguably distinct; stimuli involving motor interaction with virtual environments were excluded due to practical limitations

of testing a large number of potential measurement items with a large number of participants.

5.2.1 High presence condition Subjects in the high presence viewing environment (*n*=307) were exposed to large, high resolution, three-dimensional, color images, and full spectrum surround sound audio as they watched the 45-minute film *T-Rex: Back to the Cretaceous* at a Sony 3D IMAX film presentation. The IMAX large screen format, and in particular the IMAX 3D format, are qualitatively different from a standard film experience. The director of this film, Brett Leonard says, "Imax 3-D is the closest thing to true, immersive virtual reality on the planet right now…You've got two strips of 15-perf, 70-mm film slamming in the projectors. It fills your peripheral vision and is three-dimensional, so you're watching the action and it's happening to you at the same time" [43]. The viewing environment was designed for an uninterrupted experience with few distractions.

Potential participants were approached by a member of the research team prior to their entering the IMAX theater, given a flyer, and asked to participate in a study by "university researchers" of "people's responses to the film." As they exited the theater, the volunteers were given the questionnaire, a clipboard, and a pen and directed to one of several benches in a relatively self-contained area of the theater lobby. It took the participants between 10 and 30 minutes to complete the questionnaire.

There were an equal proportion of males and females in the high presence sample, and the age of the volunteers ranged from 16 to 76 years (*M*=33; *SD*=12.88). Fifty-nine percent of the participants in the sample were White, 18 percent were Hispanic, 10 percent were Asian, 6 percent were African American, and 7 percent identified their race as Other.

5.2.2 Low presence condition Subjects in the low presence mediated environment (*n*=162) were exposed to small, black and white images and monaural sound as they watched an old episode of *Three's Company*, an American situation comedy based on the British sitcom *Man About the House* and aired on the ABC television network from 1977 to 1984.

Viewing took place in a brightly lit office in which a small number of viewers (one to three) sat on old office chairs, could freely converse, and saw the technology that created the mediated presentation. Participants in the low presence condition were recruited from staff and students at Temple University beginning during fall 1999. The one to three volunteer(s) who agreed to participate at a given time were met by a member of the research team and escorted into the small office where the volunteer(s) watched the episode of *Three's Company*, and then completed the questionnaire. The entire procedure took approximately 55 minutes.

The sample for the low presence condition was 61 percent female, and participants were aged between 16 and 52 years (*M*=26; *SD*=9.01). Thirty-nine percent of the volunteers in this sample were African American, 34 percent were White, 14 percent were Asian, 5 percent were Hispanic, and 18 percent reported their race as Other.

6. Results

6.1 Dimension evaluation and item reduction

Based on standard techniques for the development of psychological tests (see [36; 37; 38; 39; 40; 41; 42]), exploratory factor analyses were conducted on all presence measures across all subjects to determine which factors (dimensions) emerged. Initially the factor analyses were conducted using PAF extraction (which assesses both shared and unique variance among the items) and oblimin (nonorthogonal) rotation (which allows the discovered factors to be correlated with each other), both of which are said to be more useful for exploratory theoretical analyses.

Analyses were repeated with more and less conservative cutoff values for factor loadings, the use and nonuse of a rule requiring values on different factors to be separated by .20 or more, and the specification of a required number of factors. And a series of analyses were conducted using both Principal Components (PC) and Principal Axis Factoring (PAF) extraction methods and both orthogonal (Varimax) and nonorthogonal (Oblimin) rotation. These analyses revealed a consistent pattern of stable factors with minor variations depending on the rules of thumb followed. The set of factors that emerged was created using PAF extraction and oblimin rotation, a required minimum of .40 for a loading, and not forcing the number of factors. The solution contained 8 factors.

Item analysis and scale construction were conducted for each separate dimension identified in the factor analyses to build an efficient set of presence indices. First, confirmatory factor analysis was performed for each of the 8 sets of items (based on the responses of all 469 subjects). The requirements that factor eigen values be at least 1.0 and that factor loadings be at least .50, and that the sets of items be conceptually and theoretically logical were used to cut items as needed. Second, the reliability of each set of items was initially assessed using Cronbach's alpha; all indices were required to have an Alpha of at least 0.60.

Factor analyses (with PAF extraction and oblimin rotation) were then conducted for all presence items remaining in the 8 sets, separately for the responses from subjects in the high and low presence groups (using all subjects and a randomly selected subset of the larger high presence group). These calculations were followed by confirmatory factor analyses and reliability testing using Cronbach's alpha for each index, separately for the two groups of subjects (again, with all subjects and a randomly selected subset of those in the high presence group). The reliability of the results was further evaluated by conducting the confirmatory factor analyses and

Cronbach's alpha analyses using two randomly selected subsets of all of the subjects. Based on all of these analyses, (additive) indices for each of the 8 sets of items were constructed. The total number of items retained for the TPI is 42.

6.1.1 Factor structure The 8 presence factors are presented in Table 1. The first factor was defined as Spatial Presence (e.g., presence as transportation). The 2 items that loaded the highest on the factor were "How much did it seem as if the objects and people you saw/heard had come to the place you were?" (.88) and "How much did it seem as if you could reach out and touch the objects or people you saw/heard?" (.88).

The items loading highest on factor 2 were "How often did you have the sensation that people you saw/heard could see/hear you?" (.83) and "To what extent did you feel you could interact with the person or people you saw/heard?" (.82). This factor was labeled Social Presence-Actor Within Medium (e.g., parasocial interaction). Factor 3 was defined as Passive Social Presence; its highest loading items were "During the media experience how well were you able to observe the facial expressions of the people you saw/heard?" (.89) and "During the media experience how well were you able to observe changes in the tone of voice of the people you saw/heard?" (.85). The highest loading items on the fourth factor, Active Social Presence, were "How often did you make a sound out loud (e.g., laugh, speak) in response to someone you saw/heard in the media environment?" (.78) and "How often did you smile in response to someone you saw/heard in the media environment?" (.78).

The items loading highest on factor 5, defined as Presence as Engagement (e.g., presence as immersion), were "To what extent did you feel mentally immersed in the experience?" (.86) and "How involving was the media experience?" (.80). Factor 6 was labeled Presence as Social Richness; all items loading on this factor are measured on a semantic differential scale [18] in which participants are asked to rate their media experience in terms of bipolar word pairs. The highest loading items were "The media experience was remote-immediate" (.85) and "The media experience was unemotional-emotional" (.83).

Factor 7 was named Presence as Social Realism. The items loading on this factor asked participants to indicate their level of agreement with the given statements. Items loading highest on this factor were "It is likely that the events I saw/heard would occur in the real world" (.87) and "The events I saw/heard could occur in the real world" (.76). The items loading highest on the last factor, Presence as Perceptual Realism, were "Overall, how much did touching the things and people in the environment you saw/heard feel like it would if you had experienced them directly?" (.73) and "How much did the heat or coolness (the temperature) of the environment you saw/heard feel like it would if you had experienced it directly?" (.63).

6.2 Checking reliability and internal consistency

First, the appropriateness and internal logic of each of the indices and of the indices together were assessed by examining the correlations among the scores for each of the 8 indices. The results indicate that the Presence as Social Richness and Presence as Engagement indices are most strongly correlated (r=.72) and the Passive Social Presence and Presence as Social Realism indices are least strongly correlated (r=.12), which is consistent with expectations based on the presence literature.

Because all of the items in the indices are intended to measure a common "umbrella" concept, a single overall factor was created from all of the items. Cronbach's alpha for this overall index was .83. Correlations between the overall index and each of the 8 indices were calculated and range from .39 to .81. Results are similar when the analyses are repeated separately for the subsets of subjects in the high and low presence groups.

Table 1. Factor Structure

Factor	Label	*N* Items*	Cronbach's Alpha
1	Spatial presence	7	.91
2	Social presence-actor	7	.90
3	Passive social presence	4	.88
4	Active social presence	3	.77
5	Presence as engagement	6	.90
6	Presence as social richness	7	.93
7	Presence as social realism	3	.75
8	Presence as perceptual realism	5	.78

*Complete list of items available online at http://XXX.

Cronbach's alphas were computed again for each of the presence indices detailed above to further assess subscale reliability (see Table 1). The resulting Alphas were high for each presence measure. Cronbach's alpha was lowest for Presence as Social Realism (α=.75), and highest for Presence as Social Richness (α=.93).

6.3 Validity: Sensitivity to media form

In order to initially establish the validity of the new presence measure, t-tests were used to assess the differences in mean values for the 8 presence indices, with the expectation

that the means for the subjects in the high presence group would be higher than those for subjects in the low presence group. More specifically, the difference in sample means was expected to be highly significant on the measures of Spatial Presence and Presence as Perceptual Realism.

The results of the independent samples t-tests are displayed in Table 2 and confirm the aforementioned expectations with two exceptions: The means for both the Passive Social Presence and Active Social Presence indices are not significantly different; the means are actually higher for the low presence condition. In retrospect, this result could be expected, given differences in both the form and content of the mediated experiences in the two conditions. For those in the high presence condition, the *3D T-Rex* movie featured unknown actors, stilted scripting and dialogue, little character development, and no close-up shots of the actors due to the giant screen format. In the low presence condition, on the other hand, participants viewed the sitcom-format show *Three's Company*, featuring familiar actors often seen in close-up views; well-developed, likeable characters; and scripted jokes and pauses that provide cues for the live and viewing audiences to react and laugh.

Table 2. T-Test Results

Subscale	High Presence *M* (*N*)	Low Presence *M* (*N*)	T-Value
Spatial	**5.05** (307)	2.12 (162)	28.27***
Social-actor	**3.34** (304)	2.00 (162)	10.52***
Passive social	5.33 (306)	**5.42** (162)	0.62
Active social	3.16 (304)	**3.46** (162)	1.69
Engagement	**5.19** (307)	3.53 (162)	14.26***
Social richness	**4.87** (302)	3.22 (162)	12.50***
Social realism	**3.41** (303)	3.10 (159)	20.03*
Perceptual realism	**3.79** (307)	2.41 (162)	11.27***

Note. Boldface indicates the higher sample mean.
*p< .05. **p< .01. ***p< .001.

7. Testing validity based on media content

The paper-and-pencil measurement instrument developed via the series of analyses described above assesses 8 components of presence. It contains 42 items in 8 factors as presented in Table 1. While the measure passed a series of standard tests of reliability and validity in the context of distinct media formats, the next study tested the validity and reliability of the TPI through the manipulation of media content.

7.1 Procedures, stimuli, and participants

The new presence measure was tested using a repeated-measures experimental design. One-at-a-time, each participant in the sample (N=46) was exposed to three different media stimuli, each representing a distinct media genre/content type. All stimuli were approximately 5 minutes in length, and were viewed in the same environment (Temple University's MIND lab), presented on the same large film screen by an Eiki projector, and played at the same volume level. Before viewing, the experimenter introduced the title/source of the media clip. The order in which participants were exposed to the three stimuli was varied to control for order effects. After each of the three stimuli, participants completed the 42-item presence measure. Following their final stimulus and completion of the presence items, participants completed a set of demographic and media use questions. The stimuli are described below, followed by a description of the participants.

7.1.1 Stimuli

7.1.1.1 ***Lord of the Rings*** This clip was chosen to represent the genre of science fiction/fantasy. Based on the novels of J.R.R. Tolkien and directed by Peter Jackson, the Lord of the Rings trilogy was a critical and commercial success. The first installment "accomplishes what no other fantasy film has been able to do: transport viewers to an entirely different reality, immerse them in it, and maroon them there" [44]. The segment viewed by participants featured perceptually realistic talking trees; the DVD source was presented with surround sound 5.1 audio.

7.1.1.2 ***Daily Show*** Hosted by comedian Jon Stewart, *The Daily Show* is a half-hour, late night satirical news program that offers political commentary and comedic content. According to the program's website,

> Over the past 10 years, Stewart has redefined political satire in American culture from his perch atop the anchor chair on Comedy Central's 'The Daily Show with Jon Stewart.' In fact, surveys have shown that the overwhelming majority of men and women under the age of 35 list 'The Daily Show' as their primary source of television news. [45]

The video segment viewed by participants was presented from a standard (stereo) VHS recording and revolved around a

celebration of the St. Patrick's Day holiday.

7.1.1.3 ***Civil War*** This clip was taken from Ken Burns' critically acclaimed documentary, which was originally presented as a multi-episode series on PBS in 1990. The eleven-hour documentary combines shots of historical artifacts such as archival, black and white photographs and newspaper clippings with contemporary music and character narratives. Not only is Burns' documentary "both scholarship and art, 'The Civil War' is just plain fascinating as a story and as entertainment. Movies try to show us what people were like in an era, but this project shows us exactly what they were like" [46]. The DVD audio was in stereo.

7.1.2 Participants Participants were recruited from Communications courses at Temple University and given extra credit. The sample was 74 percent female, with an average age 19.6 years (*SD*=1.77). Fifty-nine percent of participants reported their race as White, 28 percent African American, 4 percent Asian, 2 percent Hispanic, and 7 percent identified their race as Other.

7.2 Results

7.2.1 Factor structure

Confirmatory factor analyses using Principal Axis Factoring (PAF) extraction and direct oblimin rotation with the requirement that factor loadings be greater than .40 were carried out for each presence index. The factor loadings confirmed the factor structure resulting from the previous study with one exception: The loading for the item, "How often did you want to or did you speak to a person you saw/heard in the media environment?" on the Active Social Presence subscale was .30, and therefore did not meet the aforementioned requirement for the analysis (the item also decreased the reliability of the Active Social Presence subscale).

Table 3. Intercorrelations Among Presence Indices (*N*=46)

Subscale	1	2	3	4	5	6	7	8
1 Spatial	__	.88***	.37*	.40**	.71***	.60***	.25	.53***
2 Social-actor		__	.38**	.36*	.65***	.50***	.24	.53***
3 Passive social			__	.00	.49***	.23	.42**	.28
4 Active social				__	.52***	.51***	.45**	.40**
5 Engagement					__	.77***	.38**	.50***
6 Social richness						__	.45**	.56***
7 Social realism							__	.54***
8 Perceptual realism								__

*p< .05. **p< .01. ***p< .001.

7.2.2 Checking reliability and internal consistency

The internal logic and consistency of the indices together was assessed through the examination of the intercorrelations among the 8 indices. As presented in Table 3, 23 of the 28 bivariate correlations are significant. The results also indicate that the Spatial Presence and Social Presence-Actor within Medium indices are most strongly correlated (r=.88), which is consistent with the literature in the field which generally views spatial and social presence as related dimensions of the same concept. Conversely, the Passive Social Presence and Active Social Presence indices are least strongly correlated (r=.00), demonstrating that at least in some circumstances, there are

distinct subdimensions of social presence that should be measured and theorized about separately.

Reliability was evaluated by computing Cronbach's alphas for each of the presence indices; resulting values were high for each presence measure. Cronbach's alpha was lowest for Presence as Perceptual Realism (α=.71), and highest for Spatial Presence (α=.92).

As previously stated, because all of the indices are intended to measure a common "umbrella" concept, a single overall factor was created from all of the items. Cronbach's alpha for the overall index was .87, indicating the measure's high reliability. Correlations between the overall index and each of the 8 indices were calculated and range from .55 to .86. Results are similar when the analyses are repeated separately for the 3 media stimuli

7.3 Validity: Sensitivity to media content

Additional validation of the new presence measure was performed through the evaluation of differences in the mean scores computed for each presence index across the 3 types of media content. This was accomplished using repeated measures analysis of variance (ANOVA) tests. Based on the literature, the main expectations were the following:

For *Lord of the Rings* (science fiction/fantasy), means were predicted to be high in Spatial Presence and Presence as Perceptual Realism, and low in Presence as Social Realism. *The Daily Show* (satirical newscast/late night talk show) was hypothesized to have high means on all presence indices, especially for the Social Presence-Actor within Medium and Presence as Social Richness subscales. The *Civil War* (documentary) was expected to be high in Presence as Social Realism, but to have low mean values on the other indices.

The results of the repeated measures ANOVAs and post-hoc comparisons, as presented in Table 4, confirmed these expectations. As hypothesized, *Lord of the Rings* scored highest on the Spatial Presence subscale (*M*=3.96), and the *Civil War* scored lowest (*M*=1.93). There was a highly significant difference in Spatial Presence means across the 3 types of media content (F (2.88)=41.87; $p< .001$) and Bonferroni's post-hoc comparisons revealed significant differences between all 3 types of media content ($p< .001$).

For the Social Presence-Actor within Medium subscale, as predicted, *The Daily Show* had the highest mean (*M*=3.17), and the *Civil War* had the lowest (*M*=1.86). The omnibus test was significant (F (2,88)=20.30; $p< .001$) and the post-hoc comparisons revealed that all 3 types of media content were significantly different from one another ($p< .001$).

Both the Passive Social Presence and Active Social Presence indices displayed sensitivity to media content. As hypothesized, the *Civil War* stimulus scored lowest on both the Passive Social (*M*=2.81) and Active Social (*M*=1.47) Presence subscales. There was a highly significant difference across media content for Passive Social Presence (F (1.37,60.22)=118.78; $p< .001$), as well as for Active Social Presence (F (2,88)=64.95; $p< .001$) and post-hoc comparisons indicated significant differences between all pairs of media stimuli for both indices. *Lord of the Rings* (*M*=6.02) had the highest mean for Passive Social Presence, and *The Daily Show* had the highest mean (*M*=5.43) for Active Social Presence.

A highly significant difference in the mean scores for the Presence as Engagement subscale was found across media content (F (2,88)=57.36; $p< .001$); as predicted, the *Civil War* (*M*=2.47) scored lowest on this presence subscale. Post-hoc comparisons revealed significant differences between the *Civil War* and *Lord of the Rings* means ($p< .001$), and the *Civil War* and *The Daily Show* means ($p< .001$) but not the means for *The Daily Show* (*M*=4.50) and *Lord of the Rings* (*M*=4.88), indicating that viewers were highly involved and engrossed in both media stimuli.

Next, as predicted by the authors, *The Daily Show* (*M*=5.05) had the highest mean on the Presence as Social Richness subscale, while the *Civil War* (*M*=2.60) scored lowest. The omnibus test was significant (F (1.66,72.95)=71.51; $p< .001$) and post-hoc comparisons

Table 4. Repeated Measures Pairwise Comparisons

Subscale	Lord of the Rings *M* (*SD*)	Daily Show *M* (*SD*)	Civil War *M* (*SD*)
Spatial	3.96_a (1.47)	2.86_b (1.39)	1.93_c (0.98)
Social-actor	2.87_a (1.34)	3.17_b (1.49)	1.86_c (0.97)
Passive social	6.02_a (0.94)	5.62_b (1.15)	2.81_c (1.51)
Active social	2.24_a (1.32)	4.53_b (1.65)	1.47_c (1.07)
Engagement	4.88_a (1.30)	4.50_a (1.28)	2.47_b (1.24)
Social richness	4.83_a (1.08)	5.05_a (1.05)	2.60_b (1.23)
Social realism	1.32_a (0.52)	5.06_b (1.34)	4.10_c (1.75)
Perceptual realism	3.39_a (1.16)	3.84_a (1.47)	2.17_b (0.90)

Note. Means in the same row that do not share subscripts differ significantly for Bonferroni's adjustment for multiple comparisons. Of the 21 significant pairwise comparisons, 18 differ at $p< .001$, 2 at $p< .01$, and 1 at $p< .05$. N=45 following casewise deletion for missing values.

revealed significant differences between the *Civil War* and *Lord of the Rings* means ($p < .001$), and the *Civil War* and *The Daily Show* means ($p < .001$) but not the means for *The Daily Show* and *Lord of the Rings*.

Both of the hypotheses for the Presence as Social Realism subscale were confirmed: As postulated, this subscale was the only presence measure for which the *Civil War* (M=4.10) did not have the lowest reported mean score; as expected, *Lord of the Rings* (M=1.32) had the lowest Presence as Social Realism mean. Both the omnibus test (F (2,88)=114.50; $p < .001$) and all post-hoc comparisons were significant; the *Daily Show* and *Civil War* means differed at $p < .01$, while the other 2 pairs differed at $p < .001$.

Finally. a highly significant difference in the mean scores for the Presence as Perceptual Realism subscale was found across media content (F (2,88)=29.09; $p < .001$); as predicted the *Civil War* documentary (M=2.17) had the lowest mean on this subscale. Post-hoc comparisons revealed significant differences between the *Civil War* and *Lord of the Rings* means ($p < .001$), and the *Civil War* and *The Daily Show* means ($p < .001$) but not the means for *The Daily Show* (M=3.84) and *Lord of the Rings* (M=3.39).

These analyses offer additional validation of the TPI. In the first study, the measure showed sensitivity to media format, and the second study indicated the questionnaire's sensitivity across media content. While the measure has been validated across media form and content, it needs to be tested on a range of media systems and environments, particularly in highly immersive mediated environments and with interactive technology.

8. Conclusions

Presence is and will be an increasingly important concept and phenomenon in a wide range of fields. In order to better understand it, its antecedents and potential positive and negative effects, we need to complete, and continuously revisit, a thorough theoretical and empirical explication.

For research and theory on presence to live up to its potential, we need comprehensive, multidimensional, explicit, valid, and reliable (and thus standardized) measures of presence related phenomena. As reviewed here, researchers have many – in some ways too many – choices when they set out to measure presence (whether they use that term or not). Objective techniques to date are useful only in limited contexts. Qualitative subjective techniques can be immensely useful but make generalizations and comparisons difficult. Presence questionnaires designed to be used, and to permit comparisons, across studies measure a narrow set of presence dimensions, and/or are only appropriate for particular media contexts, and/or have not met criteria of reliability, validity and sensitivity.

The multidimensional TPI builds on the comprehensive, literature-based explication of Lombard and Ditton [1] and initial tests have established its reliability, validity and sensitivity across a variety of media forms and content. The instrument can be used in whole or part: Given the diversity of presence conceptualizations and variations in the nature of presence cues provided by different media (e.g., some media are interactive, others not), different subscales of the instrument might be required in different studies. For example, the realism/spatial/engagement measures may be most appropriate for testing presence in the navigation of virtual environments, while the social richness/social actor within medium subscales may be more appropriate for testing presence in social interaction contexts. The TPI distinguishes itself from existing presence questionnaires, including those most often used in presence research such as the ITC-SOPI, PQ, and SUS, not only by measuring the multiple dimensions of physical presence, but also by allowing researchers to use the same instrument to assess social presence as well. Additionally, the 8-factor structure of the TPI gives researchers the ability to selectively measure only those dimensions of presence that are related to their research. The conceptual comprehensiveness and adaptable structure of the TPI indicates that the new measure can be a valuable and useful tool for presence researchers.

However, while the evidence thus far is promising, the TPI does not include a subscale that measures the medium as social presence dimension identified by Lombard and Ditton [1]. Furthermore, the TPI must be further tested in order to determine the extent of its utility and adaptability in a wider variety of presence environments, contexts, and studies. More specifically, validity studies must be conducted to see whether the TPI shows sensitivity to more immersive virtual environments and interactive media systems. Additionally, studies correlating the TPI with related subscales of existing presence measures must also be carried out in order to establish convergent validity. Further, researchers must also determine to what degree the wording of TPI items can be adjusted to fit the context of a study and still maintain its reliability and validity.

Given their many choices in deciding upon which presence measure to use, researchers should first determine which dimensions or types of presence they intend to measure, the media environment in which they will be testing and the type of media system(s) they will be using, and take into consideration the empirical validity and reliability that existing measures have thus far exhibited (see the Appendix for a summary of the questionnaires discussed here).

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Appendix. Comparison of Presence questionnaire attributes

Questionnaire	Primary Reference	N Items	(N) Presence Subscales	(N) Dimensions Assessed[1]	Intended Applicability
Slater Usoh Steed Presence Questionnaire (SUS)*	[39] Slater, Usoh, & Steed. (1994). Depth of presence in virtual environments.	6 Items	No Separate Subscales	(1) Transportation	Virtual Environments
Presence Questionnaire (PQ)*	[45] Witmer & Singer. (1998). Measuring presence in virtual environments: A presence questionnaire.	32 Items	+(2) Involvement/Control Natural	(2) Immersion; Realism	Virtual Environments
Igroup Presence Questionnaire (IPQ)*	[48] Schubert et al, (2001). The experience of presence: Factor analytic insights.	14 Items	(3) Spatial Presence Involvement; Realness	(3) Transportation; Immersion; Realism	Virtual Environments
MEC Spatial Presence Questionnaire (MEC-SPQ)*	[58; 59] Vorderer et al, (2004). Development of the MEC Spatial Presence Questionnaire (MEC SPQ).	3 Versions (Items Per Subscale) Long- 8 Medium- 6 Short- 4	+(3) Spatial Presence: Self Location; Spatial Presence: Possible Actions; Cognitive Involvement	(2) Transportation; Immersion	Cross-Media
ITC Sense of Presence Inventory (ITC-SOPI)	[64] Lessiter et al, (2001). A cross-media presence questionnaire: The ITC-Sense of Presence Inventory.	44 Items	+(3) Sense of Physical Space; Engagement; Naturalness (Ecological Validity)	(3) Transportation; Immersion; Realism	Cross-Media
IPO Social Presence Questionnaire (IPO-SPQ)	[70] de Greef, P., & IJsselsteijn, W. A. (2001). Social presence in a home tele-application.	17 Items	(2) Subscales not labeled by authors, but distinguished by method of measurement: bipolar scaling and attitude statements	(2) Social Richness; Social Actor within a Medium	Telecomm. Applications
Temple Presence Inventory (TPI)		42 Items	(8) Spatial Presence; Social Presence-Actor within Medium; Passive Social Presence; Active Social Presence; Engagement; Social Richness; Social Realism; Perceptual Realism	(5) Transportation; Immersion; Realism; Social Actor within a Medium Social Richness	Cross-Media

*Questionnaire items available online at www.presence-research.org

+Questionnaire contains additional subscale(s) assessing constructs other than dimensions of presence

[1]Presence dimensions as defined in [1] Lombard, M., & Ditton, T. B. (1997). At the heart of it all: The concept of presence.