

Technological Predictors of Social Presence:  
A Foundation for a Meta-Analytic Review and Empirical Concept Explication

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### Abstract

Social presence is a commonly considered effect within the empirical literature on virtual environments and the wider field of computer-mediated-communication. However, the term has been applied to a series of arguably distinct concepts, including mutual awareness, sense of co-location, perceived agency of non-human and mediated human entities, and degree of behavioral, cognitive, or emotional connection between mediated interactants. Considering the increasing preponderance of interactive digital platforms, ranging from Google Docs to virtual reality, this paper outlines a meta-analytic review of the technological features contributing to the experience of social presence. The goal of the proposed analysis is twofold. First, similar to the analysis provided by Cummings & Bailenson (2016) of immersion and spatial presence, the current project would identify the relative contribution of different technological features, which may guide decisions when designing for social presence. Second, by examining the relative impact of each feature with respect to different conceptualizations of social presence, this analysis would be able to identify whether particular features more strongly relate to specific conceptualizations. Should some feature-conceptualization relationships prove stronger than others – that is, distinct, even divergent causal patterns are observed – this would provide empirical support for potentially decomposing and refining “social presence” into separate concepts. The current paper reviews past conceptualizations of social presence, outlines the rationale and steps for the proposed meta-analysis, and provides a collection of relevant empirical studies. Our future work will employ this list to conduct the quantitative phase of the proposed meta-analysis.

*Keywords:* social presence, co-presence, media richness, meta-analysis

## Technological Predictors of Social Presence:

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#### **Social Presence: Conceptual Definitions**

The concept of presence is a commonly emphasized factor in the study and design of virtual environments (VEs). This focus is perhaps due to the seemingly implicit assumption that achieving presence is a goal of immersive technologies – indeed, this is reflected not only in the wide literature on the effects of technological immersion on presence, but also in the promotion and design of immersive media products for mainstream audiences. For more than two decades researchers have defined and explicated the concept of presence in a variety of ways (Heeter, 1992; Lee, 2004; Slater and Wilbur, 1997; Witmer and Singer, 1998; Lombard and Ditton, 1997; Steuer, 1992; McMahon, 2003). Often, these definitions make a key distinction between what is variously referred to as *general*, *physical*, or *spatial presence* and a separate concept, *social presence*. Unlike spatial presence – which despite an assortment of definitions ultimately refers to, generally, a sense of “being there” – social presence has been conceptualized several times over to house several different dimensional characteristics, each varyingly emphasized in a given study or line of research.

In *The Social Psychology of Telecommunications*, Short, Williams, and Christie (1976) formally introduced the concept of social presence, defining it as “the degree of salience of the other person in the interaction and the consequent salience of the interpersonal relationships (p.482).” In their conceptualization, social presence was thought to be composed of two key dimensions, tracing back to the work of Argyle and Dean (1965): *intimacy*, the sense of affiliation between oneself and others, and *immediacy*, the psychological distance perceived between oneself and others.

In the decades since, the empirical literature on computer-mediated communication has grown exponentially, in concert with the development and adoption of new digital communication technologies. Within that literature, studies have extensively examined both the precursors and effects of social presence across a variety of mediated interactions. However, the conceptual definition of the term has varied across this work, at times alternatively emphasizing aspects of intimacy, aspects of immediacy, or other elements altogether.

For instance, Gunawardena (1995) defined social presence as “the degree to which a person is perceived as a ‘real person’ in mediated communication”. This viewpoint aligns with Lombard and Ditton’s (1997) conceptualization of presence as *social actor within medium*, referring to when “users’ perceptions and the resulting processes lead them to illogically overlook the mediated or even artificial nature of an entity within a medium and attempt to interact with it” (para. 27). This is also in line with Lee’s (2004) explication of social presence as a psychological state in which “nonhumanness of artificial objects is unnoticed” (p.32) and “virtual (para-authentic or artificial) social actors are experienced as actual social actors in either sensory or nonsensory ways” (p.45). Alternatively, a subset of the literature has focused on how users might experience social presence not with the entities within a media message, but with the delivery channel itself. This line of research aligns with the computers as social actors paradigm (Nass, Steuer, & Tauber, 1994) and Lombard and Ditton’s definition of presence as *medium as social actor* (para. 27), in which “basic social cues exhibited by the medium lead users to treat the medium as a social entity” (para. 31).

Frequently intertwined with social presence is the concept of *co-presence*. This has been variously defined as “the sense of being with another” (Biocca, Harms, & Burgoon, 2003, p.460), “the feeling that one is present with another person in a mediated environment” (Sallinäs,

2005, p.438), “the sense of being with other people in a shared virtual environment, or equivalently, the sense of togetherness” (Durlach & Slater, 2000, p.214); a “sense of being together” in a mediated environment (de Greef & IJsselsteijn, 2001, p.308), and a sense of “spatial relatedness” to another entity (Bente, Rüggenberg & Krämer, 2004). Common to all of these definitions, is some sense of another entity’s presence. At minimum, co-presence requires a sense of *mutual awareness* between two or more individuals, by which they become “accessible, available, and subject to one another” (Goffman, 1963). In turn, co-presence may also come to include a sense of *co-location*, referring to “the feeling that the people with whom one is collaborating are in the same room” (Mason, 1994, p.33) or “the tangibility and proximity of other people that one perceives in a communication situation” (McLeod, Baron, Marti, & Yoon, 1997, p.708). However, the understanding of co-presence in relation to social presence has not been uniform, with some researchers equating the two and others drawing clear distinctions. For instance, while Lim, Hwang, Kim, and Biocca (2015) note that in a mediated environment, “social presence refers to the degree to which users perceive one or many others as being present via the mediated interface” (p.5), it has been alternatively suggested that “[c]o-presence is distinguished from social presence in that while social presence relates to the quality of the medium and users perception of the medium, co-presence addresses more psychological interaction of the individuals.” (Bulu, 2012, p. 155). That is, depending on one’s working definitions of social presence and co-presence, the two concepts may be deemed synonymous, separate, or with one a dimension of the other.

Yet other conceptualizations of social presence have focused less on individual subjective experience and more on dyadic or group-level perceptions and behavior. For instance, in a learning context, Rourke, Anderson, Garrison, and Archer (2001) defined social presence as “the

ability of learners to project their personal characteristics to their group members and classmates” (p.689). McCreery, Vallett, and Clark (2015) similarly focus on shared identity and community cohesion, describing social presence in terms of “a shared social identity that emerges from group development and social interaction” (p.204). Other conceptualizations emphasize alignment between interactants, describing social presence with respect to the extent parties are cognitively, emotional, and behaviorally in sync (Bente, Rüggenberg & Krämer, 2004) or able to “effectively [negotiate] a relationship through an interdependent, multi-channel exchange of behaviors” (Palmer, 1995, p.291).

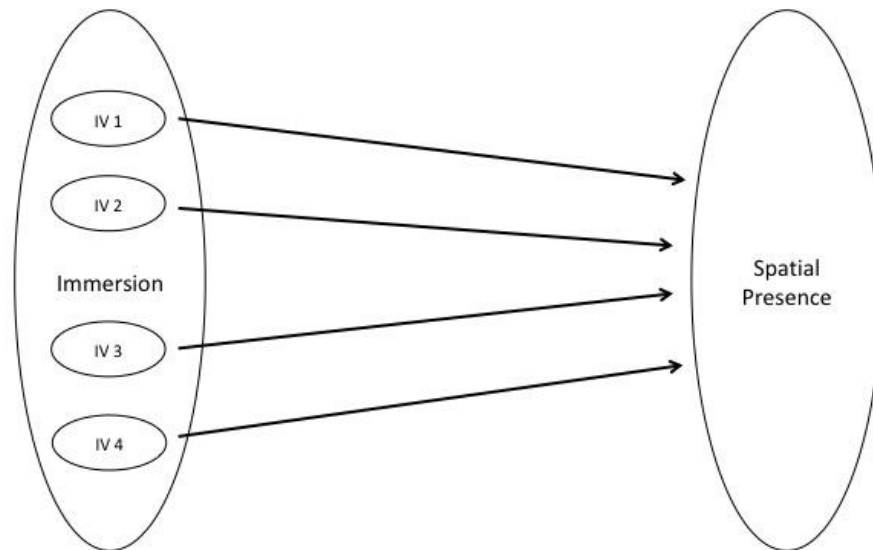
### **Designing for Social Presence**

Regardless of conceptual and operational definitions used, the empirical literature suggests that the experience of social presence may enhance the cognitive, emotional and behavioral engagement users experience with mediated others. To this end, achieving social presence is a presumed goal when designing mediated environments for shared usage. This may be the case now more than ever, with the preponderance of an increasing number of interactive digital platforms, ranging from Google Docs to virtual reality. For instance, immersive VEs have long been deemed a relatively solitary user experience, in light of their physical divorcing of users from immediate social reality, as well as their main uses to date: academic research scenarios, flight simulators, physical and psychiatric therapy, and the like. However, this may soon change with the mainstreaming of commercial VR. Indeed, Oculus, perhaps the most established consumer-facing VR platform, is owned by Facebook, arguably the most pervasive social networking service. Recently Facebook has made major investments into the development and promotion of shared immersive VE experiences, such as Facebook Spaces. To achieve mainstream, cross-over appeal, the company is working to ensure that new platforms are not just

presence-inducing (a perennial goal of immersive VE technologies), but also capable of providing compelling levels of social presence.

Cummings & Bailenson (2016) completed a systematic review of the literature on technological immersion and psychological presence to help address the question of “how immersive is enough?” when designing for spatial presence. Through a series of meta-analyses (one per technological factor) their review revealed the relative contribution of different immersive features (e.g., field of view, tracking level, stereoscopy, update rate) towards self-reported levels of presence (see Figure 1). A similarly robust meta-analytical review of contributing factors would aid efforts to effectively design for social presence, whether for immersive VEs, video games, instant messaging apps, or video chat and teleconferencing platforms. However, such an exercise would differ in from Cummings & Bailenson’s (2016) work in two key ways.

First, the technological features eliciting social presence may be quite different than those that contribute to the formation of spatial presence. For instance, while spatial presence may be enhanced through different structural features of the immersive system, social presence may be more tightly related to message features, particularly social cues beyond the message itself. Indeed, since the introduction of the concept by Short et al. (1976), they and other researchers have emphasized that social presence may be directly related the ability to convey or detect physical proximity, eye-contact, facial expressions, body orientation, gestures, and other nonverbal cues (Lombard & Ditton, 1997). Rather than technologies of immersion, it is likely factors related to the richness of the mediated message – such as the number of cues and modality channels available, or capacity for synchronous message transmittance and feedback – that contribute to social presence (Daft & Lengel, 1986).



*Figure 1.* Conceptual depiction of Cummings & Bailenson’s (2016) meta-analysis of the effects of immersive technologies on spatial presence. The review provided in that study consisted of multiple analyses, one for each technological feature (independent variable) in order to examine their relative contribution to the experience of spatial presence.

Second, which factors predict social presence – and any ranking of those factors’ relative contribution to the experience – very likely depends on the conceptualization of social presence considered. As noted above, social presence has been defined and discussed in a variety of fashions, each varyingly emphasizing particular component dimensions (mutual awareness and salience, co-location), scenarios (construing a non- or mediated entity as a social actor), or correlates (synchronicity, amount and quality of exchange). We might reasonably assume the relative importance of different media variables for inducing social presence is contingent upon which of these elements is the focus. Indeed, salience of another may be greatly aided by the number of social cues and channels incorporated in the message. Immediacy of feedback,



however, may be a much more important factor for predicting a sense of co-location. Degree of anthropomorphism (for instance, not just the number of message channels, but the inclusion of channels typical of communication exchanges between two human interactants, such as speech) may be key if the goal is to get users to recognize content or devices as social actors.

To this end, a meta-analysis of the media variables predicting social presence may be more complex than Cummings & Bailenson's (2016) exercise in predicting spatial presence in that the latter was dealing with, relatively speaking, a unidimensional dependent variable: in essence, "being there". With respect to the typology of presence outlined by Lombard and Ditton (1997), spatial presence draws mainly on the notion of "presence as transportation" (arguably also on "presence as immersion", though less so if, like Cummings & Bailenson one adopts Slater and Wilbur's (1997) delineation of immersion [a property of technology] and presence [a user state]). In contrast, social presence, throughout the literature, has taken on aspects of "presence as transportation;" (co-location), "presence as social richness" (salience, mutual awareness), "presence as social actor within medium", and "presence as medium as social actor" (Lombard & Ditton, 1997). A meta-analytic approach to identifying the importance of different factors in predicting social presence must therefore consider the different conceptualizations of social presence used within the corpus of candidate studies in addition to the different respective predictors.

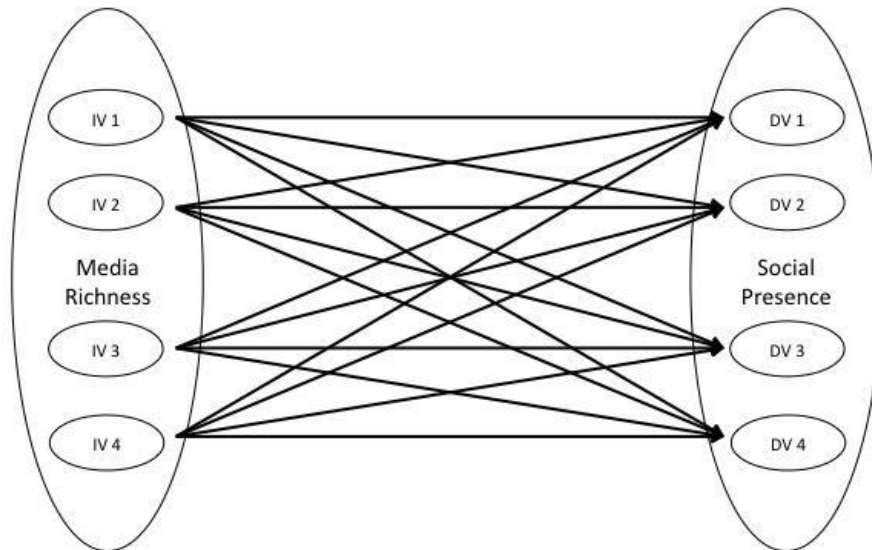
### **A Meta-Analysis of the Technological Factors Predicting Social Presence**

Similar to the initial proposal by Cummings, Bailenson, and Fidler (2012), which described the rationale and needed steps for a meta-analysis of the relative contribution of different immersive technology features to the experience of spatial presence, the current proposal represents the first steps for systematically evaluating the relative contribution of different media richness variables

to the experience of social presence. The goals of the proposed meta-analytic review are twofold. First, similar to the final analysis provided by Cummings & Bailenson (2016), the current project would seek to identify the relative value of different predictor variables in eliciting a particular outcome. This result would help developers make informed decisions about investments of time and money when designing for social presence. Second, by examining the relative impact of each richness variable with respect to different conceptualizations of social presence (salience, co-location, perceiving non-humans as social actors, etc.), this analysis would be able to identify whether particular features more strongly relate to specific conceptualizations (see Figure 2). Such findings would not only further inform developer investments (a firm could implement certain features if simply seeking to achieve a sense of mutual awareness through their platform, or other features if wanting to elicit a sense of co-location or social actor agency), but also serve as an empirical exercise in concept explication, highlighting a scenario in which a single term is being used to capture distinct phenomena (Chaffee, 1991). Should some feature-conceptualization relationships prove stronger than others – that is, if distinct, even divergent, causal patterns are observed – it would suggest the potential need for decomposing and refining “social presence” into separate concepts, similar to Strömer-Galley’s (2004) proposal for delineating interactivity-as-product from interactivity-as-process.

Completing a meta-analysis includes six general steps, as outlined by Rosenthal and DiMatteo (2001). These include:

- 1) Defining the independent and dependent variables of interest.
- 2) Systematically collecting relevant studies.
- 3) Examining the variability among obtained effect sizes.
- 4) Combining the effects using several measures of their central tendency.



*Figure 2.* Conceptual depiction of the currently proposed meta-analysis of the effects of media richness features on social presence. Similar to the Cummings & Bailenson (2016) study, this analysis will consist of multiple meta-analyses. However, for each richness feature (independent variable), there will be an average effect size calculated with respect to each conceptualization of social presence described herein (dependent variables). This will permit not only an examination of the relative contribution of each IV to the experience of social presence, but also indicate whether particular features more directly relate to particular social presence conceptualizations.

- 5) Examining the significance level of the indices of central tendency.
- 6) Evaluating the importance of the obtained effect size.

Considering these steps, a meta-analysis may be considered to have two general phases.

The first (steps 1 and 2) is qualitative and descriptive in nature, in which researchers define conceptual parameters for the analysis and organize candidate studies and their findings in light of the variables of interest. The second phase (steps 3-6) is a fully quantitative undertaking, in which researchers complete all statistical analyses of aggregated past findings to produce novel,

meta-level findings. The current project is wrapping up the first of these phases, having identified the variables of interest and now reviewing the existing literature for candidate studies for inclusion. The goals of this paper specifically are to outline the rationale for the current analysis (as done above) as well as present a list of studies to a community of presence researchers for review, to which they might hopefully contribute additional studies (particularly previous unpublished works, both past projects sitting in a the proverbial file drawer [Rosenthal, 1979] as well as those currently underway and soon to be published).

### **Variables of Interest**

#### **Independent Variables: Technological Predictors of Social Presence**

In order to generate a list of prospective predictors, we conducted a literature review of empirical studies examining the impact of different technological factors on social presence. This included volume-by-volume searches through the archives of the following journals: *Presence: Teleoperators and Virtual Environments*; *Human Computer Interaction*; *ACM Transactions on Computer-Human Interaction*; *International Journal of Human-Computer Studies*; *Media Psychology*; *Computers in Human Behavior*; and *CyberPsychology, Behavior, & Social Networking*. Additionally, full reviews were completed of the conference proceedings of the International Society for Presence Researchers (ISPR), and the Institute of Elective and Electronics Engineers (IEEE) Virtual Reality annual conference, and the Association for Computing Machinery's (ACM) Special Interest Group on Graphics and Interactive Techniques (SIGGRAPH). These sources provided a primary list of candidate studies that included at least one technological manipulation and one dependent measure of social presence.<sup>1</sup> From that list, we have also back-referenced citations in order to identify additional studies for inclusion.

This process has resulted in the list of studies included in Table 1. Studies have been grouped into feature categories based upon similar technological manipulations. These features, derived bottom-up from the empirical literature, include:

- *Behavioral Realism*. This refers to the extent to which agents and avatars in a VE behave humanlike in terms of body language, nonverbals, and other social cues. One example would be comparing the effects of a computer-controlled agent that remains still and looks straight ahead to those of one that fidgets and blinks.
- *Anthropomorphism*. Distinct from behavioral realism, this manipulation concerns the extent to which interactants are depicted as human-like on a visual and/or auditory level. Examples would include users interacting via video vs. interacting via motion-captured cartoon depictions, or via anthropomorphic avatars and agents vs. animated shapes or emoji.
- *Perceived Agency of Interactant*. Manipulations of this type vary whether users are made to think that interactants are other humans vs. presentations controlled by software.
- *Level of Embodiment*. Embodiment refers to the extent to which interactants are physically embodied at users' locations. Manipulations include interacting with a toy versus interacting with a digital representation of the same toy, as well as group video-conferencing via a single, large wall-mounted computer screens vs. each participant presented on human-sized computer screens positioned around a table.
- *Level of Homophily*. This refers to the extent to which others that the user interacts with are similar, rather than different from the user. Manipulations include interacting with computer agents of the same rather than different genders or of similar, rather than

different, personalities. Embedded in this manipulation is the notion that users may experience more social presence when interacting with those similar to themselves.

- *Synchronicity*. Studies in this category manipulate the rate of message exchange, for instance, comparing live discussion using messenger services to asynchronous conversation through channels such as email.
- *Inclusion of Imagery (Still)*. This refers to the inclusion of still images to enhance text and/or audio, either to depict the source of a message or to enhance the richness of the message (e.g., news stories with vs. without accompanying photos, text chats with vs. without avatar icons, the relative inclusion of emoji in text)..
- *Inclusion of Imagery (Dynamic)*. This is quite similar to the above category, though refers to the inclusion or absence of a representation of an interactant or message that is visually dynamic over time (e.g., video footage, animated avatars).
- *Inclusion of Voice*. This manipulation concerns the inclusion or absence of participant voices in communication, either in the form of a pre-recorded script or live audio chat.
- *Inclusion of Haptic Feedback*. This refers to the inclusion of tactile or force feedback when engaging in tasks in a VE.
- *Overall High vs. Low*. Lastly, as in Cummings and Bailenson's (2016) analysis, this category serves as a catch all for both (a) studies whose manipulations confound multiple factors preventing isolation of the relative contribution of individual features and (b) studies whose technological manipulations of richness do not fit into any of these modal manipulation categories above (e.g., the presence or absence of a display of an interactant's heart beat).

Notably, while all of the above alter the richness of a mediated communication exchange some of these features pertain more to the message channel of a communication act (e.g., synchronicity, the relative inclusion of certain modalities), whereas others relate more to the depiction and perception of the other interactant or message source (e.g., behavioral realism, human-likeness, embodiment, perceived agency, level of homophily, synchronicity). In turn, as suggested earlier, each feature may differentially contribute to alternate conceptualizations or aspects of social presence.

### **Dependent Variables: Conceptualizations of Social Presence**

The proposed meta-analysis will also include variant conceptualizations of social presence, with separate effect sizes calculated for each social presence conceptualization per each technological feature. These conceptualizations, similar to the technological features, have been derived largely from the empirical literature on social presence, discussed above.

Additionally, the list of conceptualizations selected here are in part based upon previous explications of presence and social presence. Specifically, Biocca et al.'s (2003) classification of social presence definitions – which categorized existing definitions as forms of co-presence, psychological involvement, or behavioral engagement – provided a basis. Complementing this is the presence typology outlined by Lombard and Ditton (1997). Review of the wider literature in complement with these previous categorization schemes resulted in the following list of social presence dimensions or conceptualizations:

- *Social Salience*. Drawing heavily from Short et al.'s initial definition, as well as Lombard and Ditton's (1997) description of *presence as social richness*, this conceptualization focuses on the extent to which a user is aware of the presence of a mediated other. This

dimension aligns with original descriptions of social presence with respect to media richness theory (Daft & Lengel, 1986).

- *Co-location.* As emphasized in Biocca et al.'s review and Lombard and Ditton's definition of *presence as transportation*, this conceptualization focuses on the extent to which a user senses that he or she is occupying the same space as or "there together" with a mediated other.
- *Perception of Mediated or Non-Human as Social Actor.* Derived from Lombard and Ditton's definitions of *presence as social actor within medium* and *presence as medium as social actor*, this aspect of social presence focuses on the extent to which a non-human object or a mediated human is experienced as an actual human interactant. This dimension of social presence aligns with the *computers as social actors* paradigm, the media equation (Reeves & Nass, 1996), and perceptual elements of parasocial interaction.
- *Social Association.* Several definitions of social presence alternatively focus on the extent to which a user feels a sense of association, connection, or identification with a mediated other. This conceptualization focuses on self-reported alignment of behavior, attitudes, or emotions with a mediated other, as well as willingness to disclose and feelings of psychological closeness or intimacy.
- *Overall Social Presence.* Many studies do not specify one conceptualization over another, or do not report individual scores for subscales that uniquely capture the above dimensions. Calculating an aggregate effect size for an overall measure of social presence will allow for consideration of such studies, as well as holistic comparison to the alternate conceptualizations noted above.



In differentiating these conceptualizations, the intended meta-analysis can lend theoretical insight into the predictors of alternate definitions of social presence, as well as empirical support for some of the top-down explication work already provided by Biocca et al. (2003) and Lombard & Ditton (1997).

### **Intended Analysis & Closing Remarks**

The proposed meta-analysis will technically include a series of meta-analyses, one per technological factor per social presence conceptualization (as depicted in Figure 2). In addition to the analyses of the direct effects of each of these factors on each of these conceptualizations, this exercise will statistically account for potential moderators, including publication venue, date of publication, country of study, whether conducted by social scientists or engineers, self-report instrument used, and various aspects of the mediated task (dyadic experience vs. group scenarios, goal-directed vs. open interaction, whether game-based, and whether narrative-driven).

As noted above, the current paper, similar to the proposal completed by Cummings, Bailenson, and Fidler (2012) prior to their full analysis, provides the rationale and initial steps for completing a meta-analytic review of the technological features influencing multiple aspects of social presence. This piece, in reviewing the various existing conceptualizations of social presence, outlines an analysis that would provide (1) a crucially needed empirically-driven explication of the concept, as well as (2) practical insights into how to design for the user experience of specific components of social presence. Additionally, we wish to share here a preliminary list of relevant studies for any scholars interested in the technological predictors of social presence. Further, through presentation at a venue expressly focused on issues of presence – definitions, measures, causes, and effects – this list may be made more replete through

discussion with and contribution from experts. A refined list would then be created, allowing for progression to the remaining quantitative stages of the proposed meta-analyses.

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## Footnotes

<sup>1</sup>For sake of parity and internal validity, only studies including a self-report measure of social presence (as opposed to purely observational or behavioral metrics) have been included.

Table 1

Primary List of Studies Investigating the Effect of Immersive System Quality on Self-reported Levels of Social Presence

<b>Author(s)</b>	<b>Year</b>	<b>Immersive Quality</b>	<b>Manipulation Operationalization</b>
Bailenson, Swinth, Hoyt, Persky, Dimov, & Blascovich	2006	Anthropomorphism	Interacting with human vs. non-human agents in a VE
Bailenson, Yee, Merget, & Schroeder	2005	Anthropomorphism	Videoconferencing vs. audio chat with motion-captured low-fidelity 'emotibox' avatars
Nowak & Biocca	2003	Anthropomorphism	Humanlike vs. non-humanlike avatar faces in a VE
Tanaka, Nakanishi and Ishiguro	2015	Anthropomorphism	CGI motion-capture of interactant vs video of interactant
Bailenson, Blascovich, Beall, & Loomis	2003	Behavioral Realism	Computer agent using realistic eye-contact behavior (e.g., blinking, moving its head to track participants) vs non-moving computer agent.
Bailenson, Swinth, Hoyt, Persky, Dimov, & Blascovich	2006	Behavioral Realism	Realism of head movements of an agent in a VE
Garau, Slater, Pertaub, & Razaque	2005	Behavioral Realism	Stationary characters vs. moving characters vs. responsive characters in a virtual environment
Heerlink, Krose, Evers & Wielinga	2009	Behavioral Realism	Less social embodied and disembodied agents vs more socially responsive embodied and disembodied agents
Tanaka, Nakanishi and Ishiguro	2015	Behavioral Realism	Robot that mimicked interactant's body movements vs. unmoving robot
Jin	2009	Inclusion of Voice	Text chat vs. audio chat
Bente, Rüggenberg, Krämer, & Eschenburg	2008	Inclusion of Voice	Text chat vs. audio chat
Frisby, Limperos, Record, Downs, & Kerckmar	2013	Inclusion of Voice	Presentation vs. presentation with accompanying audio

Hess, Fuller & Campbell	2008	Inclusion of Voice	Text vs. text and audio
Sallnäs	2005	Inclusion of Voice	Text chat vs. audio chat
Walther & Bazarova	2008	Inclusion of Voice	Text chat vs. audio chat
Walter, Ortbach & Niehaves	2015	Inclusion of Voice	Text chat vs. audio chat
Basdogan, Ho, Srinivasan & Slater	2000	Inclusion of Haptic Feedback	Presence of haptic feedback on task in VE
Jordan et al.	2002	Inclusion of Haptic Feedback	Presence of haptic feedback on task in VE
Bailenson, Yee, Merget, & Schroeder	2005	Inclusion of Imagery (Dynamic)	Audio chat vs. video conferencing
Bente, Rüggenberg, Krämer, & Eschenburg	2008	Inclusion of Imagery (Dynamic)	Audio chat vs. video chat
De Greef & Ijsselsteijn	2001	Inclusion of Imagery (Dynamic)	Audio chat vs. video conferencing
Frisby, Limperos, Record, Downs, & Kerckmar	2013	Inclusion of Imagery (Dynamic)	Presentation with audio vs. presentation with accompanying audio and video
Hess, Fuller & Campbell	2008	Inclusion of Imagery (Dynamic)	Text and audio vs. text, audio and animated figure with human body language
Homer, Plass & Blake	2007	Inclusion of Imagery (Dynamic)	Audio and powerpoint slides vs. video and powerpoint slides
Lyons, Reysen and Pierce	2011	Inclusion of Imagery (Dynamic)	Inclusion of video of professor during online lectures
Sallnäs	2005	Inclusion of Imagery (Dynamic)	audio chat vs. video videoconferencing
Tanaka, Nakanishi and Ishiguro	2015	Inclusion of Imagery (Dynamic)	Audio recording with interactant vs animated avatar of interactant
Tanaka, Nakanishi and Ishiguro	2015	Inclusion of Imagery (Dynamic)	Audio call with interactant vs video conferencing with interactant
Walther & Bazarova	2008	Inclusion of Imagery (Dynamic)	Audio chat vs. video conferencing
Yoo & Alavi	2001	Inclusion of Imagery (Dynamic)	conference call vs. video conferencing with computer application sharing

Walter, Ortbach & Niehaves	2015	Inclusion of Imagery (Dynamic)	Audio chat vs. video conferencing
Cyr, Hassanein, Head & Ivanov	2007	Inclusion of Imagery (Still)	Presence of photos on an online shopping website
Nowak & Biocca	2003	Inclusion of Imagery (Still)	Low and high quality CGI image 'avatars' with text chat vs no avatars.
Park & Sundar	2014	Inclusion of Imagery (Still)	Text and emoticons vs. text
Tourangeau, Couper & Steiger	2003	Inclusion of Imagery (Still)	Inclusion of picture of researcher's face in a survey
Westerman, Spence and Lin	2015	Inclusion of Imagery (Still)	Presentation of news article with vs. without accompanying picture
Ahn et al.	2014	Level of Embodiment	Human sized vs. smaller displays
Chuah, Robb, White, Wendling, Lampotang, Kopper & Lok	2013	Level of Embodiment	High vs. low physicality of embodied conversational agent
Jung and Lee	2004	Level of Embodiment	Interacting with a video of a robot ("April") vs. interacting with a robot ("April")
Walther & Bazarova	2008	Level of Embodiment	Interacting in same room vs. videoconferencing
Tanaka, Nakanishi and Ishiguro	2015	Level of Embodiment	Robot with motion capture of interactant's body language vs. video
Lee & Nass	2003	Level of Homophily	Extroverted vs. introverted computer agents
Bailenson & Yee	2005	Level of Homophily	Gender of a computer controlled agent in a VE
Tourangeau, Couper & Steiger	2003	Level of Homophily	Gender of researcher images present while taking a survey
Tourangeau, Couper & Steiger	2003	Level of Homophily	Gender of voice reading a survey
Ahn et al.	2014	Overall high low	Stereoscopic vs. monoscopic display
Axelsson, Abelin, Heldal, Schroeder & Wideström	2001	Overall high low	CAVE-like VR system vs. desktop VR system
Bailey, Wise, & Bolls	2009	Overall high low	Using custom avatars vs. assigned

			avatars in a VE
Bente, Rüggenberg, Krämer, & Eschenburg	2008	Overall high low	Low fidelity avatar vs. high fidelity avatars
Bente, Rüggenberg, Krämer, & Eschenburg	2008	Overall high low	Avatar in a collaborative virtual environment vs. disembodied communication
Bente, Rüggenberg, Krämer, & Eschenburg	2008	Overall high low	Text chat vs. videoconferencing
Frisby, Limperos, Record, Downs, & Kerckmar	2013	Overall high low	Powerpoint presentation vs. Presentation with accompanying video and audio
Hess, Fuller & Campbell	2008	Overall high low	Text-boxes with messages vs voice chat from animated CGI agent
Järvelä , Kätsyri, Ravaja, Chanel and Henttonen	2016	Overall high low	Inclusion of text chat while watching movie with partner
Järvelä , Kätsyri, Ravaja, Chanel and Henttonen	2016	Overall high low	Inclusion of monitor depicting partner's heart while watching movie together
Jung and Lee	2004	Overall high low	Interacting visually and haptically with an embodied robot (Aibo) vs visually with a graphical representation of that robot.
Slater, Sadagic, Usoh, & Schroeder	2000	Overall high low	HMD (with head-tracking) vs. desktop
Walter, Ortbach & Niehaves	2015	Overall high low	Text-chat vs videoconferencing
Walther & Bazarova	2008	Overall high low	Text-chat vs videoconferencing
Bailenson, Blascovich, Beall, & Loomis	2003	Perceived Agency of Interactant	Presenting agent in a VE as either a human or AI
Bailenson et al.	2004	Perceived Agency of Interactant	Presenting agent in a VE as either a human or AI
Hoyt, Blascovich, & Swinth	2003	Perceived Agency of Interactant	Computer Controlled Characters vs. Human Controlled Characters in a VE
Nowak & Biocca	2003	Perceived Agency of Interactant	Describing a character in a VE as either a human or AI

Walter, Ortbach & Niehaves	2015	Perceived Agency of Interactant	Presentation of feedback source as human or computer agent
Tu	2002	Synchronicity	Real time discussion vs. email and bulletin board posting
Cyr, Hassanein, Head & Ivanov	2007	Synchronicity	Synchronous chat vs. asynchronous reviews
Park & Sundar	2014	Synchronicity	Synchronous chat vs 1 hour response delay vs 6 hour response delay