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A 1 x 2 multivariate analysis of covariance was conducted to assess the influence of auditory feedback on presence in *Super Smash Bros. Brawl*. 41 participants were assigned to a gameplay treatment condition of muted audio or sound effects only. Dependent variables were measured by the Self-Assessment Manikin, ITC-Sense of Presence Inventory, and Temple Presence Inventory. Covariates included familiarity with controls, visuospatial working memory, the Immersive Tendencies Questionnaire, recent gameplay experience, computer opponent difficulty level, age, sex, and handedness. A significant multivariate effect of treatment condition was observed, but further results were inconclusive. Possible explanations and reliability analyses are discussed.

Headings:

    Presence

    Immersion

    Video games

    Console gaming

    Working memory

    Super Smash Bros. Brawl

    MANCOVA

USER-ENACTED DETERMINANTS OF PRESENCE:
SOUND EFFECTS AND FEEDBACK IN MULTIPLAYER CONSOLE GAMEPLAY

by
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Introduction

Different ontologies, approaches, disciplines, domains, assumptions – they all converge when it comes to studying presence. Related fields include psychology and cognitive science, computer science and virtual reality (VR), games studies and ludology, anthropology and folklore, game design and user experience, human-computer interaction and communications – and the list goes on. As a media experience, presence has been often linked to technological advancements (Ivory & Kalyanaraman, 2007). These may include video conferencing, virtual reality simulations, large-format films (IMAX), or computer and video games. Comprehending presence enables developers of such technologies to optimize their use, usefulness, and therefore profitability (Lombard & Ditton, 1997). Other scholars may study presence to "understand psychological and physiological processes as they occur in [non-mediated] settings" and "how humans organize and interpret information in their environment" (Lombard & Ditton, 1997, "Introduction", para. 2). Researchers may use mediated environments or stimuli to extrapolate and deduce what may actually occur in non-mediated contexts (see Lombard & Ditton, 1997 for a list of several examples). Since presence can influence a user's enjoyment (Heeter, 1995) and tendency to respond socially (Nowak & Biocca, 2003) in the context of a media experience, implications of the phenomenon of presence are indeed relevant to console video games.

What is Presence?

Definitional Issues

Basically speaking, presence is "a psychological state in which the virtuality of experience is unnoticed" (Lee, 2004, p. 32). But, in a surface examination of the literature on presence, it is obvious that definitional issues abound (Brockmyer et al., 2009; Darken, Bernatovich, Lawson, & Peterson, 1999; Grimshaw, Charlton, & Jagger, 2011; Mantovani & Riva, 1999; McCreery, Schrader, Krach, & Boone, 2013; Nacke & Lindley, 2008; Slater, 1999; Slater, 2003; Waterworth & Waterworth, 2003; Zahorik & Jenison, 1998). Various proposals for standardizing the vocabulary used in presence research have been made (Lee, 2004; Mantovani & Riva, 1999; Slater, 2003; Waterworth & Waterworth, 2003; Zahorik & Jenison, 1998), though even if a good controlled vocabulary exists, it must be adopted by researchers to serve as an actual standard.

In the realm of computer and video games, *immersion* tends to be the preferred term (e.g., Brown & Cairns, 2004; Grimshaw et al., 2011; Jennett, 2010; Jennett et al., 2008; Nacke & Lindley, 2008; Nacke, Grimshaw, & Lindley, 2010). However, scholars and designers of virtual reality (VR) systems prefer the term *presence* (e.g., Aymerich-Franch, 2010; IJsselsteijn, de Ridder, Freeman, & Avons, 2000; Sacau, Laarni, & Hartmann, 2008; Slater, 2003; Waterworth & Waterworth, 2001), though this is not a strict rule (e.g., Takatalo, Häkkinen, Komulainen, Särkelä, & Nyman, 2006; Witmer & Singer, 1998). Essentially, the two concepts, as treated by their respective fields, are at their core largely synonymous. A point of confusion arises in that many VR academics

use *immersion* to describe features of the VR system. For example, does the system offer haptic feedback? Does it track both eye and head movements? Is there a surround sound system, or are only over-the-ear headphones used? By and large, many VR systems attempt to simulate a reality with high fidelity, which is less often the case for video and computer games. So, for VR researchers, a system's immersion are the features offered; ergo, a system is immersive if it offers such features while presence is a user's reaction to them (Slater, 2003).

Typology and Definitions

Lee (2004) presents a comprehensive typology of human experience that reconciles conundrums of terminology in the field of presence research. Moreover, Lee's (2004) account is also able to account for the experience of presence in media such as books, film (Schubert & Crusius, 2002), or narrative performance (Busselle & Bilandzic, 2009; Sturm, 2000), which do not allow the user to actively modify the mediated environment, in addition to other "low-tech" virtual environments, such as text-based online games (Schiano, 1999; Towell & Towell, 1997; Voiskounsky, Mitina, & Avetisova, 2004). Indeed, according to McCreery et al., (2013), "Lee (2004) provides the most inclusive conceptualization" (p. 1636). Therefore, Lee's (2004) typology provides primary guidance for this research and delineates key definitions.

Lee (2004) more precisely defines presence as "a psychological state in which virtual (para-authentic or artificial) objects are experienced as actual objects in either sensory or [non-sensory] ways" (p. 37). That is to say, when presence happens, the virtual experience merges with real experience. Sensation, which "is triggered by some impression on a sense organ that causes a change in experience", may be distinguished

from perception, which "includes a conception of an object or a relationship that is being perceived, plus the immediate and irresistible conviction of the existence of objects or a spatial organization" (Coren, 2003, p. 88). More simply, sensation is the process of sensing while perception is the interpretation of such. When complete presence is experienced, it is perceived.

Here (Lee, 2004), "[v]irtual experience is the sensory or [non-sensory] experience of virtual (either para-authentic or artificial) objects" (p. 37). More granularly, a virtual object can be para-authentic or artificial. An artificial object has no "authentic connection to actual objects" (p. 35) while a para-authentic object "holds some kind of valid connection with the actual object that it represents" (p. 34). Further, virtual experience is encompassed in three domains: physical, social, and self. These ideas are contextualized in Figure 1, which graphically represents Lee's (2004) typology of human experience, and further in Figure 2, which focuses on the typology of human virtual experience, which is the concern of presence research.
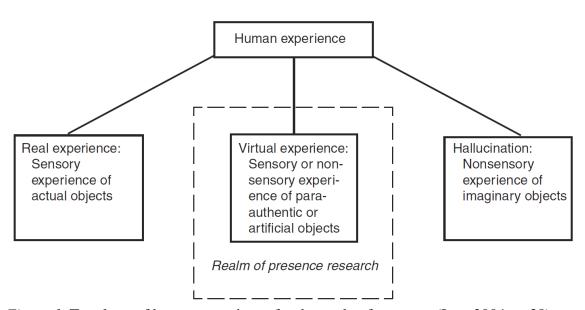

Figure 1. Typology of human experience for the study of presence (Lee, 2004, p. 38).

Domains of virtual experience	Characteristics of Virtuality	
	Para-authentic	**Artificial**
Physical	Experience of para-authentic objects: experiencing virtual physical objects and environments that have authentic connection with the corresponding actual physical objects and environments.	Experience of artificial objects: experiencing virtual physical objects and environments artifically created or simulated by technology.
	Examples: remote exploration of a tele-operating system; telesurgery; broad-casting of sports events; television news.	Examples: exploration of a prehistory battlefield depicted by "Dungeons and Dragons" games; watching science fiction movies; reading nonfiction.
Social	Experience of para-authentic social actors: experiencing the representation of other humans who are connected by technology.	Experience of artificial social actors: experiencing artificial objects manifesting humanness.
	Examples: CSCW (computer-supported cooperative work); videoconference; Internet chatting; seeing a person on a television; seeing a photographed image of someone.	Examples: conversation with a talking machine; social interaction with computers; social robots; software agents.
Self	Experience of a para-authentic self: experiencing the representation of one's own genuine self—either physically mani-fested or psychologically assumed—inside a virtual environment.	Experience of an artificial alter-self(selves): experience an alter-self(selves) constructed—either physically or psychologically—inside a virtual environment.
	Examples: seeing oneself in a video-conference; exploring environment reacting to user inputs; using a robot representing a user in a teleoperating system.	Examples: readers' identification with novel or movie characters: gender-swapped avatars in MUDs; user-chosen characters in a role-playing game.

Figure 2. Typology of virtual experience (Lee, 2004, p. 41).

Layers of Presence: The Bio-Cultural Approach

Lee's (2004) typology is comprehensive, but descriptive; it does not explain why

the phenomenon of presence came to be or what processes compose its functions. As

such, Riva, Waterworth, and Waterworth's (2004) contemporaneous model of the layers

of presence is presented here as well, as it is akin to Marr's (1982) intentional and representational levels of theory.

According to Riva et al. (2004), presence is a layered psychological experience that evolved because it was adaptive to survival. First, three layers of self (Damasio, as cited in Riva et al. 2004) and consciousness are laid out: proto, core, and extended self (or consciousness). The proto self is cognizant of the present moment; the core self integrates the present with past experience; and the extended may potentially transcend both the past and a hypothetical future. Arising from these three layers are three analogous layers of presence:

- *Proto presence* – The proto self is proposed to have evolved "[t]o predict the characteristics of the external world as it is experienced through sensorial inputs" (p. 406). Accordingly, the sense of presence that is possessed by the proto self is proto presence, which is defined as "an embodied presence related to the level of perception-action coupling (self vs. non-self)" (p. 406-407). Since proto presence "is based on proprioception and other ways of knowing bodily orientation in the world" (Riva, Waterworth, Waterworth, & Mantovani, 2011, p. 30), it allows an organism to distinguish between what constitutes its self and what does not.

- *Core presence* – The evolutionary goal of the core self is to integrate "specific sensory occurrences into single precepts" (Riva et al., 2004, p. 407). Consequently, core presence involves the activity of "selective attention made by the self on perceptions" (p. 408). Since emotions alert us to significant events worth attending to, one of the main functions of core presence, then, is to monitor changes in core affect, or current emotional state.

- *Extended presence* – The role of extended presence is to verify the relevance of possible and future events and to assess the significance of events experienced in the real world to survival, broadly speaking (Riva et al., 2004; Riva et al., 2011). Because extended consciousness involves tracking goal states and hypothetical events, it relies crucially on working memory (Damasio, as cited in Riva et al., 2004). In addition, extended presence "requires intellectually and/or emotionally significant content" (p. 411). When extended consciousness is concerned with one thing but proto and core consciousness are attending to another, absence of mind arises (Riva et al., 2004).

Figure 3 illustrates Riva et al.'s (2004) conceptualization of the three layers of consciousness with respect to time, while Figure 4 summarizes their model and indicates that presence is optimized when all three layers of consciousness are simultaneously directed at the same point of focus.
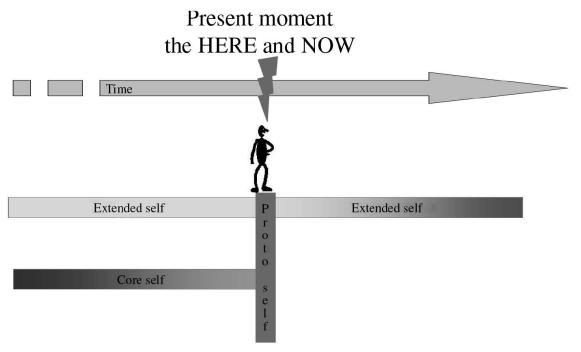

Figure 3. The three layers of the self (Riva et al., 2004, p. 405).

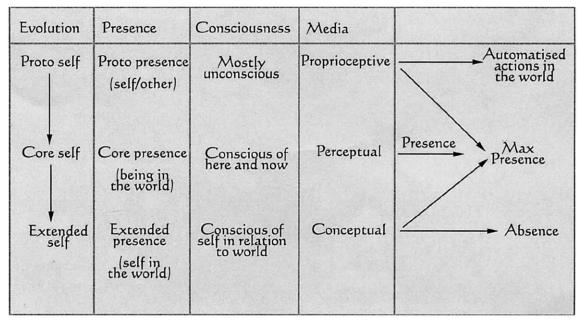| Evolution	Presence	Consciousness	Media	
Proto self	Proto presence (self/other)	Mostly unconscious	Proprioceptive	Automatised actions in the world
Core self	Core presence (being in the world)	Conscious of here and now	Perceptual	Presence → Max Presence
Extended self	Extended presence (self in the world)	Conscious of self in relation to world	Conceptual	Absence

Figure 4. Layers, media, and mental states (Riva et al., 2004, p. 413).

Here, consciousness is type-independent; that is to say, all three layers of consciousness are involved in the perception of all three domains of human experience, as outlined by Lee (2004). Consciousness becomes presence when it deals with virtual experience. Interestingly, to the extent that dreams may be treated as virtual environments, presence can be experienced in dreams (Slater & Steed, 2000). Likewise, since perception is mediated by sensation, "scholars define natural perception as the first-order mediated experience and technology-mediated perception as the second-order mediated experience" (Lombard, as cited in Lee, 2004, p. 30). It follows that in everyday experience, one may be completely physically present, but experience absence of mind (Slater, 2003). In Riva et al.'s (2004) characterization, proto/core consciousness are differentially engaged than extended consciousness. For instance, some clinical psychologists study a concept called mindfulness, which is a psychological state that intrinsically involves "present-centered attention and awareness" (Brown & Ryan, 2004, p. 242). As a person sits at an outdoor café, he or she may be mindful of the current

situation, perhaps people watching or meditating on the sights and sounds, experiencing

extended presence as all levels of consciousness align. Or conversely, he or she may be

daydreaming, planning the next meal, or simply absent-minded (see Slater, 2003).

Conceptualizing Presence in Console Gaming

This study is concerned with user-enacted determinants of the phenomenon of presence console gaming. The following section will situate console gameplay under the theoretical frameworks described above.

As of 2016, the current three most popular developers of game consoles – Microsoft (Xbox series), Nintendo (Wii-U, most recently as of 2016), and Sony (PlayStation series) – released online console gaming capabilities within the last twenty years. Xbox live became available for the original Xbox in 2002 (James, 2015); Nintendo first launched its Nintendo Wi-Fi Connection in 2005 (Machkovech, 2015); Sony released its PlayStation Network in 2006 (Arce, 2015).

In contrast to many VR systems, console gaming systems often make no attempt to make invisible the hardware of mediation. Only in limited cases, such as the Wii-mote of the Nintendo Wii, is proprioception even a salient factor. Therefore, console games tend to elicit low levels of proto presence. However, according to the bio-cultural approach described above, "if presence is really an evolved psychological mechanism, it should exist independently of a given medium" (Riva et al., 2004, p. 412). Indeed, evidence of presence has been confirmed in a variety of media:

- Storytelling (Busselle & Bilandzic, 2009; Stallings, 1988; Sturm, 1999; 2000)

- Novels and other text (Schubert & Crusius, 2002)

- Computer games (Grimshaw et al., 2011; Jennett, 2010; Nacke & Lindley, 2008)

- VR systems (Malbos, Rapee, & Kavakli, 2012; Mikropoulos, Tzimas, & Dimou, 2004; Pausch, Proffitt, & Williams, 1997; Slater & Usoh, 1993)

- Film (referred to in film theory as the diegetic effect, Burch, 1982)

- Text-based multi-user domains/dungeons (Schiano, 1999; Towell & Towell, 1997)

As it stands, both immersive VR systems and games played on console platforms (as well as other media described above) may be characterized as virtual environments. VR and most console games are similar in that they generally afford user interaction with the virtual environment. Consequently, to the extent that both VR systems and console gameworlds are virtual environments through which technology mediates virtual experience, and to the extent that presence arises out of consciousness, many of the findings from research on presence in VR systems should be generalizable to console gameplay as well.

Presence in Gameplay

Presence is often simply defined as a sense of 'being there' in a virtual environment (e.g., Heeter, 1992; IJsselsteijn et al., 2000; Sheridan, 1994). This idea is salient in virtual reality, where a user may literally be inside a rendered environment (Tougaw & Will, 2003), as in the case of the cave automatic virtual environment, a type of immersive virtual reality environment made up of three (Cruz-Neira, Sandin, & DeFanti, 1993) to six walls (Cruz-Neira et al., 1993), inside which the human user stands. But in non-immersive virtual environments, the converse gains saliency. Presence becomes just as much about 'not being *here*' (Sas & O'Hare, 2003). In fact, the sense of *arrival* in the virtual world and *departure* from the physical world may be separable

dimensions of presence; in some cases, the sense of departure may even be more pronounced than the sense of arrival (Kim & Biocca, 1997). According to Schubert, Friedmann, & Regenbrecht (2001), construction of a mental model for the virtual environment (as in arrival) and suppression of stimuli from the real world (as in departure) "go hand in hand. Both processes are active processes, which must be learned and may break down under overload" (p. 268).

Using a grounded theory approach, Brown & Cairns (2004) asked gamers what immersion was like for them. Their findings suggest that presence is a gradual phenomenon that progresses sequentially from a feeling of engagement (an interest in the game and a desire to keep playing) to engrossment (engagement, accompanied by an emotional investment and a sense of departure) before "total immersion", which is akin to presence. These findings are roughly consistent with Riva and colleagues' (2004) model, in which "emotional processes directly influence … core presence and extended presence" (p. 409).

Determinants of Presence in Gaming

According to Riva et al. (2004), "proto presence is determined only by form, core presence by both form and content, and extended presence only by content" (p. 413). To evoke proto presence, the technology that constitutes form tends to impose greater technical demands. As such, console game systems would ostensibly elicit presence by engaging extended consciousness and core consciousness, which is the pivot for alignment and integration of the three layers. Depending on the kind of game and how it is played, inducing presence could be accomplished in several different ways. For

example, Ermi and Mäyrä's (2005) gameplay experience model identifies sensory, challenge-based, and imaginative immersion.

In regards to form, the most traditional input devices are handheld controllers such as the Nintendo GameCube controller depicted in Figure 5. But more and more, console developers have begun innovating in input devices. For example, games in the *You Don't Know Jack* series published in the early 2010s require an internet browser to play, so mobile phones are often used as input devices. As early as 1999, *Dance Dance Revolution* was released for the Sony PlayStation. Based on a dance, rhythm, and music arcade game popular at the time, its primary input device is a large dance pad with four directional arrow buttons on it, large and sturdy enough to reasonably accommodate the movement and pressure of dancing feet. The Wii Remote for the Nintendo Wii was one of the first consoles whose input devices featured multiple hand configurations, so that it could be played with one hand or two. In addition, it was one of the first input devices to utilize an accelerometer and optical sensor technology to sense motion, pointing, and gesture recognition. Hence, games that use traditional controllers might be less suited for eliciting proto presence than *Dance Dance Revolution* or games that leverage gyroscope technology. But generally speaking, though VR and three-dimensional console games do exist (LaViola, 2008), they are not ubiquitous yet. Most extant console games do not design for proprioception, head tracking, etc. In fact, by and large, the display field is two-dimensional, with depth cues providing an illusion or implication of three-dimensionality (e.g., Julesz, 1960; Wagemans et al., 2012).

Figure 5. A standard black Nintendo GameCube controller.

As for content, Ermi and Mäyrä (2005) found that the three key dimensions of presence in the gameplay experience are sensory immersion, challenge-based immersion, and imaginative immersion (in their terms):

- *Sensory immersion* refers to "the audiovisual execution of games". With advances in processing power and computer-generated graphics, game designers can generate "audiovisually impressive, three-dimensional[,] and stereophonic worlds that surround their players in a very comprehensive manner". Players may play on a large screen and turn up the volume to "overpower the sensory information coming from the real world" (Ermi & Mäyrä, 2005, p. 7). Indeed, "[a]ny mediated presence is in competition with presence in the real world" (Riva et al., 2004, p. 410). Unrelated stimuli can distract players from experiencing the virtual environment at hand (e.g., Wang, Otitoju, Liu, Kim, & Bowman, 2006), causing a break in presence (Slater & Steed, 2000).

- *Challenge-based immersion* is attained when a player achieves "a satisfying balance of challenge and abilities" (Ermi & Mäyrä, p. 7), not unlike the classic flow state (Csikszentmihalyi & LeFevre, 1989; Moneta & Csikszentmihalyi, 1996). Challenges can involve one or more of a variety of skills, such as hand-eye coordination, fine motor skills, logic and problem solving, strategy, etc.

- *Imaginative immersion* is more amorphous and comprised of heterogeneous elements. Ermi and Mäyrä (2004) describe it as "the area in which the game offers the player a chance to use her imagination, [empathize] with the characters, or just enjoy the fantasy of the game" (p. 8). However, this idea strongly resembles Riva et al.'s (2004) extended presence.

Ermi and Mäyrä (2004) call their model of these three dimensions the SCI-model, which is illustrated in Figure 6. They include in this model a player component. Sacau and colleagues (2008) review the influence of individual factors on presence. IJsselsteijn et al. (2000) also identify user characteristics as one of the four classes of factors that function as determinants of presence. Such factors may include gender differences (Heeter, 1992), hypnotizability (Wiederhold & Wiederhold, 1999; 2000) or predisposition to experience presence in various forms of media (Witmer & Singer, 1998).
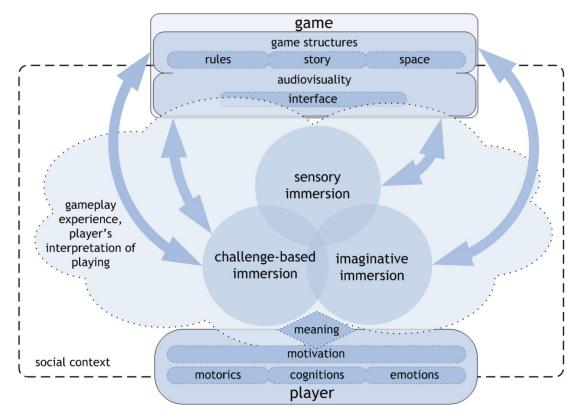
Figure 6. The SCI-model (Ermi & Mäyrä, 2005, p. 8)

Performance feedback. According to Riva and colleagues (2011), the main

experiential outcome of the presence process is a sense of agency, in which the player is

both author and owner of his/her actions within the virtual environment; the feeling of

presence is in fact closely related to the quality of agency. For Lee (2004) the quality of

agency is exemplified as successfully supported user action. In the context of interactive

realms, user actions are successfully supported when the user perceives the virtual

environment's reaction to his/her actions as legitimate.

A form of environmental reaction can be found in gameplay as performance

feedback. Many games are designed with immediate performance feedback and clear

goals (Csikszentmihalyi, as cited in Rich 2013). When Link, the player-controlled

protagonist of the *Legend of Zelda* series, obtains a key item, a now-iconic bar of three

ascending notes plays. Commonly, after a victory of some sort has been achieved by the

player, a victory theme song is played each time. Or perhaps the game controller vibrates when the on-screen environment is disturbed or when the player's character takes damage. For example, Brown and Cairns (2004) found that for even low levels of presence to be realized, game controls and associated feedback need to correspond in an appropriate manner such that the players can become adept in at least the main controls of the game.

Clear goals and immediate performance feedback are "conditions for flow" (Rich, 2013, p. 48). Moneta and Csikszentmihalyi (1996) define flow as "a psychological state in which the person feels simultaneously cognitively efficient, motivated, and happy" (p. 277). In accordance with this notion, Limperos, Schmierbach, Kegerise, and Dardis (2011) found that enjoyment may be driven more by a player's sense of control than by achieving a game's designed goals (though one may conceivably experience presence without enjoyment). According to flow theory and Brown and Cairns (2004), flow parallels presence in that "attention is needed, sense of time is altered, and sense of self is lost" (p. 1300). Though the precise relationship between flow and presence may not be clear, it is evident that there is a strong connection between the two constructs (Brockmyer et al., 2009; Brown & Cairns, 2004; Bryce & Rutter, 2001; Ermi & Mäyrä, 2005; Limperos et al., 2011; Nacke, Grimshaw, & Lindley, 2010; Nacke & Lindley, 2008; Voiskounsky et al., 2004).

Working memory and presence. Working memory is "the system or systems that are assumed to be necessary in order to keep things in mind while performing complex tasks such as reasoning, comprehension[,] and learning" (Baddeley, 2010, p. R136); it is "the site where most cognitive processes take place, and where the contents

of awareness exist" (Baddeley, as cited in Nunez, 2004, p. 44). Given a set of stimuli, the contents of working memory equates to all stimuli that are attended to (Jonides et al., 1996; Nunez, 2004).

A cognitive load or cognitive burden can be characterized as a hindrance to working memory or an allocation of working memory capacity (van Merriënboer & Sweller, 2005). Cognitive load theory, though primarily concerned with theories of learning, identifies three types of load (Schrader & Bastiaens, 2012) that are relevant to information processing in general (Paas, Tuovinen, Tabbers, & Gerven, 2003; Rey & Buchwald, 2011; Sweller, 2008; Sweller, van Merrienboer, & Paas, 1998):

- *Intrinsic load* is induced by the complexity of the information involved with the task itself that must be processed. In learning contexts, it is often analogous to level of difficulty of content to be learned (Edgcomb, Vahid, & Lysecky, 2015). Intrinsic cognitive load is typically treated as an inherent constant (Sweller, 2010). In multiplayer gameplay, this may involve tracking the actions and positions of an opponent's avatar in relation to one's own.

- *Extraneous load* is induced by the manner in which information or tasks are presented. For example, the concept of a triangle may be expressed via verbal description or by drawing on a whiteboard; the two mediums, while conveying the same core concept, are associated with different extraneous loads (Edgcomb et al., 2015). In gameplay, this could be the difference between a well-designed and poorly designed user interface. Another potential corresponding example may be the ease of use of different control schemes or different input devices. For instance, the Nintendo GameCube controller is generally the preferred input

device for *Super Smash Bros. Brawl*, which is a game for the Nintendo Wii. Though *Brawl* may be played using the Wii Remote as well, the older GameCube controller is the preferred input device at the competitive level because of its greater ease of use and more-reliable responsivity.

- Generally speaking, instructional designers seek to minimize extraneous load while enhancing germane load. *Germane load* reflects the mental effort by which cognitive schemata are formed to organize information. Efficient use of schemata for pattern matching and pattern identification is essential in the development of expertise (Sweller et al., 1998). Simon and Gilmartin (1973) found that chess grandmasters could accurately reproduce configurations of chess pieces with ease, so long as the configurations were taken from real chess games. When the configurations were instead random pieces dispersed on a chessboard, they performed no better than did novices. In gameplay, germane load may be involved in identifying and recognizing recurrent patterns in gameplay.

Because "[e]xtended consciousness relies on working memory" (Damasio, as cited in Riva et al., 2004, p. 404) individual differences in working memory capacity influence the experience of presence (Rawlinson, Lu, & Coleman, 2012). Of course, different types of games involve different domains of working memory to differing degrees. The gameplay environment presents a set of external stimuli that must be processed. Logically, some engagement of working memory is a prerequisite for achieving presence (Nunez, 2004, p. 45):

> "If one accepts that such a processing task is necessary for presence, and given that all processing requires some working memory, then it follows that for presence to occur, some amount of working memory will be required to process the environment."

However, it may be critical for some balance to be attained between focused concentration and ease of processing. For example, while reading a potentially immersive novel, if the germane load afforded by the text is too low, there is no challenge. Flow is unachievable by definition. Likewise, reading would not require the requisite utilization of working memory faculties that yields presence. Attention may be more likely to wander spontaneously to reality testing, thereby directing attention outside of the virtual environment. On the other hand, if obscure vocabulary and complex syntactic structures were used, the process of reading may revert to a word-by-word and phrase-by-phrase decoding instead of an easy chunking of ideas and meaning. The reader may be unable to reach a state of presence since the mental work is too difficult. The intrinsic load is too high (B. W. Sturm, personal communication, January 21, 2016).

The Problem and Goal

Measuring presence with reliability and validity is a significant problem for presence researchers (Slater, 1999). It can be difficult to disentangle the construct of presence from related or epiphenomenal constructs such as flow, attention, or psychological absorption (Slater, 2003). Following from such definitional issues, it is pointedly difficult to develop good standardized measures for presence. Darken et al. (1999) identify two major concerns in this vein (p. 1):

1. As previously noted, "[p]resence is an extremely ambiguous term with no widely accepted definition."

2. Consequently, "[t]here are no reliable, repeatable measures for presence. There is something of a 'chicken-and-egg' problem here. If there is no accepted definition of presence, then there can be no measures for presence".

The self-report approach (e.g., Witmer & Singer, 1998; Jennet et al., 2008; Lessiter, Freeman, Keogh, & Davidoff, 2001; Lombard et al., 2000; Wissmath, Weibel, & Mast, 2010) is typically used in the assessment of presence (Schubert et al., 2001; Slater, 2004) and commonly in related concepts as well, such as flow (Jackson & Marsh, 1996) or game engagement (Brockmyer et al., 2009). However, the limitations to relying solely on subjective self-reported questionnaires are well known in social science (Buhlin, Gustafsson, Andersson, Håkansson, & Klinge, 2002; Evan & Miller, 1969; Hilbert, 2012; Hofstee, Berge, & Hendriks, 1998; Sallis & Saelens, 2000; Warnecke et al., 1997) and in presence research as well (Slater, 1999). Slater (2004) demonstrates how

a fictitious concept (colorfulness of one's day) could be fabricated and "measured" using a questionnaire and discusses other special limitations to using questionnaires to evaluate presence. A questionnaire alone cannot rule out that resultant evidence of the occurrence or experience of presence is merely a methodological artifact. Logically, a number of presence researchers have advocated for the inclusion of objective physiological or behavioral measures alongside traditional questionnaires (Guger et al., 2004; IJsselsteijn et al., 2000; Malbos et al., 2012; Mikropoulos et al., 2004; Nacke & Lindley, 2008; Slater, 2004; Slater & Steed, 2000). That is not to say that questionnaires are completely meritless. Even Slater (2004), who encourages researchers to "abandon the easy but ultimately useless employment of questionnaires", concedes that "previous questionnaire-based studies might be thought of as hypothesis generators" (p. 492) at least. But since presence is a psychological phenomenon (Lee, 2004; McCreery et al., 2013; Riva et al., 2004; Schubert et al., 2001), it is necessarily subjectively experienced. Therefore, subjective measures are still appropriate, but due to the shortcomings of subjective measurement, they should be corroborated with objective measures (IJsselsteijn et al., 2000). Even with abundant consensus of subjective evidence, the additional support of objective measurement can only strengthen a claim. The broader goal of this study is thus consistent with that of Darken et al. (1999, p. 14):

> "If a number of studies such as this can be completed to show what does and what does not seem to be related to presence, we can then work towards an aggregate model, and subsequently a measurement, of presence that is reliable, repeatable, and consequently widely accepted by our research community."

First, this study seeks to manipulate the presence experienced during multiplayer console gameplay (*Super Smash Bros. Brawl*) against a computer opponent by manipulating the immediate performance feedback available to players. Secondarily, this

study also seeks to compare existing presence questionnaires. Because performance feedback can influence flow states and affect a player's sense of agency, I hypothesize that measures of presence will be greater when performance feedback mechanisms are enabled than when they are disabled.

The Game

Super Smash Bros. Brawl is a console game published by Nintendo in 2008 for

the Wii. Its standard multiplayer play mode can be classified as a fighting two-

dimensional platformer. The default multiplayer mode is a timed battle in which each

player seeks to score the most points. After navigating to the multiplayer play mode

through the game's GUI, players select a character, whose avatar they control during

gameplay proper. After the selection screen, a stage is selected. When the match

commences, players may attempt to use their characters' attacks to inflict damage upon

other players. As a character accumulates more and more damage, the character becomes

more susceptible to knockback from subsequent attacks. In the default timed mode,

knocking another character out of the stage scores +2 points, while falling off or being

knocked off scores -1 points. Whichever player has scored the most points by the end of

the match is the winner.

Super Smash Bros. Brawl was chosen as the game of study for several reasons:

- *Super Smash Bros. Brawl* is a game with which I am personally familiar. Many

  scholars of games studies argue that researchers should play the games they study

  (Consalvo & Dutton, 2006). Some have even argued that researchers should attain

  a certain level of expertise in the games they study in order to achieve a deep

  understanding of gameplay (Aarseth, 2012). I have not earned any international

  accolades, but I have been playing *Brawl* since its release and am familiar with its

- two predecessors (*Super Smash Bros.* and *Super Smash Bros. Melee*) as well. I have also played its successor (*Super Smash Bros. for Wii U*) a few times as well.

- In my view, *Brawl* is just old enough to reach a sort of "critical mass" in player audience. Its two sequels (*Super Smash Bros. for Wii U* and *Super Smash Bros. for Nintendo 3DS*) were only just released in 2014. Sales for *Brawl* then may theoretically have already reached an upper limit. Yet, only eight years have elapsed since its release, so its original intended audience is probably comprised of living people who still play games.

- *Brawl* is non-controversial. The extent of its violence is cartoon violence. The parental advisory rating given it by the Entertainment Software Rating Board is T for Teen. Thus, the game should be appropriate for a sample population of adults.

- *Brawl* is popular, or at least it was around its release date. On January 11, 2016, it had a rating of 93% from 81 game critics and 8.9/10 from 1577 user ratings on Metacritic.com (Super Smash Bros. Brawl, 2016) and a rating of 92.84% on GameRankings.com based on 78 reviews (Super Smash Bros. Brawl for Wii – GameRankings, 2016). It won GameFAQs.com's Best of 2008: Game of the Year award (Poll of the Day - BEST OF 2008: Game of the Year (Final, Final Vote) – GameFAQs, 2009). The point is, more familiarity amongst gamers can be expected for *Brawl* compared to more obscure games. Brown and Cairns (2004) identified mastery of basic controls as a prerequisite for attaining a state of presence in gaming. This barrier could be lowered if participants are already familiar with the game before recruitment.

- As evidenced by the four generations of the franchise, findings regarding *Brawl* are likely to be replicable in future sequels of the franchise, and perhaps to other games of the genre.

- Finally, certain gameplay settings of interest are customizable. In particular, haptic vibratory performance feedback and a damage gauge overlaid on the bottom of the screen, which are enabled by default, can be disabled.

Types of Performance Feedback in *Super Smash Bros. Brawl*

Performance feedback features of *Brawl* can be broken down into three sensory modalities: visual, auditory, and haptic.

Visually, in-game avatars will move a certain way when certain buttons are pressed on the controller. If a player is hit, the avatar will flinch or fly opposite the direction of impact. Damage accrued by a character is demarcated at the bottom of the screen as a percentage next to an icon representing the character; this percentage may range from 0% to 999%, with 0% anchored at no damage. Or, if a player's avatar interacts with the environment in some way, this will generally be reflected in some graphical animation on-screen.

Auditorily, characters make predictable sounds in accordance to the type of user input received and the current character. There are likewise consistent sound effects for taking damage and particular moves. Sound also marks key events in gameplay. For example, there is a specialized set of sound effects for successful ring-outs or for the charging of a "smash" attack. A male announcer's voice says "Three, two, one, go!" before every multiplayer match and a certain theme song is played for every character's

victory scene at the end of a match. Otherwise, music serves primarily as a soundtrack for stages or for GUIs.

From my experience, the vast majority of players prefer playing using GameCube controllers like that depicted in Figure 5. Haptic feedback correlates with significant game events by vibrating the controller. For example, consistent vibration patterns are differentially generated when a character is ringed out, is hit by an attack, or wins a match. In addition, players can perceive with their thumbs whether certain buttons are depressed or if a joystick is tilted in a certain direction.

In terms of game performance, access to vision is naturally the most crucial. Vision allows a player to track the location of his/her own avatar and that of his/her opponent's. Haptic and sound effect feedback provide secondary information to vision. When a player visually loses track of an avatar, perhaps due to a sudden chaotic turn of events, sound and haptics become focal. For example, Captain Falcon is a playable character whose signature move, the Falcon Punch, has become iconic. This character always precedes execution of this powerful attack by yelling, "Falcon Punch!" Just hearing "Falcon" can alert other players that a Falcon Punch is incoming. And if a player is hit by such an attack, but has failed to visually track his/her own avatar, s/he can verify that his/her avatar was indeed struck. First, the player would feel the vibration of the controller. Next, the player might attend with peripheral vision to movement in the area of the screen where the damage gauges are, signaling a change in percentages, while focal vision remains engaged with visual tracking.

The Manipulation: Sound Effects

Auditory feedback is the chosen manipulation of this experiment. More specifically, the comparison group will play the game with all audio muted, while the treatment group will play with only sound effects enabled (no music).

Sound effects were chosen over visual modalities of feedback to increase the generalizability of findings. It is not uncommon for many games of different genres and eras for different platforms to include some sort of sound feedback. On the other hand, visual feedback in *Brawl* as described above is either immutable, peculiar to *Brawl*, or uncharacteristic of other game genres. Manipulation of auditory feedback was preferred over haptic feedback also for generalizability, as many older consoles do not support vibrating input devices. Moreover, nearly every possible player action with any character generates a sound effect (with the exception of Zelda's down taunt).

It should be noted that the default audio setting is for both music and sound effects to be enabled. The deviation from the default setting for the comparison condition is justified by the potential burden to both verbal (Iwanaga & Ito, 2002) and visuospatial (Crawford & Strapp, 1994) working memory that background music may present. Although under some conditions music may have no effect on (Furnham & Allass, 1999) or enhance (Kiger, 1989; Mammarella, Fairfield, & Cornoldi, 2013) working memory as measured by task performance, background music generally impairs working memory (Cassidy & MacDonald, 2007; Crawford & Strapp, 1994; Furnham & Allass, 1999; Furnham & Bradley, 1997; Furnham & Strbac, 2002; Iwanaga & Ito, 2002; Salamé & Baddeley, 1989). Therefore, at the cost of ecological validity, totally muting all audio yields tighter control.

Methods

Measurements

Appendix A contains the final conglomerate paper-and-pencil instrument administered. Some changes from the originals in format and the instructional text were made so that each questionnaire would be more consistent with each other. The dependent construct, presence, was measured by ten variables. Eight covariate factors were taken as well.

Presence measurements. Three instruments for measuring presence were administered in conjunction, since the secondary goal of this research is to compare existing measures of presence.

Independent Television Commission-Sense of Presence Inventory (ITC-SOPI). The ITC-Sense of Presence Inventory (ITC-SOPI) was developed by Lessiter et al. (2001). In development, it was tested with over 600 participants on a variety of media, including a console video game. The ITC-SOPI has seen recent use (as of 2016) by other authors as well (Khan, van de Kraan, Mason, & Aliakseyeu, 2016; Kosunen et al., 2016; Newbutt et al., 2016; Perpiñá & Roncero, 2016; Rosa, Morais, Gamito, Oliveira, & Saraiva, 2016).

The questionnaire measures four dimensions of presence using 7-point Likert items: spatial presence (the feeling of transportation), engagement, ecological

validity/naturalness, and negative effects (e.g., headaches or eyestrain). This yields four different factor scores.

Temple Presence Inventory (TPI). The Temple Presence Inventory (TPI) was developed by Lombard et al. (2000) with about 300 participants and later refined in 2009 by Lombard, Ditton, & Weinstein. Like the ITC-SOPI, it has also seen recent use in other studies (Cesta, Cortellessa, Orlandini, & Tiberio, 2016; Vrellis, Avouris, & Mikropoulos, 2016). Similarly, the TPI was also designed to be useful with a variety of media.

The TPI also measures different dimensions of presence using 7-point Likert items. This study subsets the TPI dimensions to yield five different factor scores: spatial presence, passive interpersonal social presence, active interpersonal social presence, engagement, and social richness. Here, social presence has to do with "the extent to which a medium is perceived as sociable, warm, sensitive, personal[,] or intimate when it is used to interact with other people" (Lombard & Ditton, 1997, p. 3) while social richness has to do with the intimacy and immediacy of the experience (Lombard & Ditton, 1997). The parasocial interaction, social realism, and perceptual realism modules were omitted. A console video game played on a single two-dimensional monitor is low in system immersion compared to a virtual reality apparatus. In addition, the gameplay is set in a fantasy realm. As such, items like 'The way in which the events I saw/heard occurred is a lot like the way they occur in the real world' or '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?' may be absurd in the context of this study.

Presence Self-Assessment Manikin (SAM). Wissmath et al. (2010) developed a single-item 9-point pictorial scale measure for presence based on work by Bradley and

Lang (1994). Using 162 participants, the authors found no difference in reports of

presence using the self-assessment manikin (SAM) online during an immersive task and

afterwards. Their findings also suggested that the manikin may assess presence more

directly than a verbal measures and that it may take less effort for participants to respond.

A simplified 5-point version is used in this study.

Covariate measurements. Given the smaller sample size of this study, eight

covariates were included in the model to statistically manage variability between

treatment groups.

Previous gameplay experience. According to Lee (2004), "[s]uccessfully

supported action occurs when environmental reaction to user action meets user

expectations" (p. 30-31), thereby according to the player a sense of agency, which may

be important in the experience of presence. For example, if a player does not anticipate

strong vibratory haptic feedback, the sensation may startle him/her out of the progression

towards presence. Moreover, having to learn a new control scheme may tax working

memory capacity such that presence is precluded (van Merriënboer & Sweller, 2005, p.

149):

> "Working memory must inevitably be limited in capacity when dealing with
> novel, unorganized information because as the number of elements that needs to
> be organized increases linearly, the number of possible combinations increases
> exponentially."

Therefore, participants were asked, "Prior to today, have you played *Super Smash*

Bros. Brawl in the past year (12 months)?" This response was recorded as a binary

covariate.

Familiarity with controls. The participant's familiarity with the default control is

measured by a 5-point Likert scale item anchored at both ends ("Prior to today, how

familiar were you with the controller scheme you just used?"), included in Appendix A. As noted above, only players with recent experience were recruited. However, *Brawl* allows customization of the control scheme. Also, there are several input devices available that may be used with the Wii console. Therefore, it is critical to collection additional information regarding participants' familiarity with the controls.

Sex. Other researchers have identified potential gender differences in experiencing presence (Eastin, 2006; Nicovich, Boller, & Cornwell, 2005). Therefore, biological sex was included as a covariate as well. Since all participants identified as either male or female, this is a binary covariate.

Age. Although almost all participants were between the ages of 18 and 24 years old, there was some variation in the sample. It has been hypothesized that due to age-related cognitive decline, older people may find it more difficult to experience presence, due to problems with working memory faculties (Sacau et al., 2008). In fact, Salthouse (1996) found age differences in processing speed on a variety of cognitive tasks while van Schaik, Turnbull, Wersch, and Drummond (2004) found a significant negative rank-order correlation between age and spatial presence. To mitigate any potential statistical noise this factor may present, age was included as a covariate in the model. Ages were recorded as one of the following: 18-24 years, 25-30 years, 31-35 years, 35+ years.

Immersive Tendencies Questionnaire (ITQ). The Immersive Tendencies Questionnaire (ITQ) assesses an individual's propensity for experiencing immersive states in daily life (Witmer & Singer, 1998). If an individual tends to experience focused involvement in everyday activities, s/he may be more likely to experience presence in a console gaming context as well. The ITQ consists of 18 7-point Likert items with

endpoint and midpoint anchor text that yield a single score between 18 and 126 for each participant.

      Computer player difficulty level. Participants chose the difficulty level of the computer opponents themselves prior to gameplay, much as a player would outside a laboratory. Because this factor was not controlled and because it influences the intrinsic load of the task, this difficulty level was taken as a covariate as well. Computer player level may range from 1 to 9, discretely.

      Visuospatial working memory task. As noted above, engagement of working memory faculties plays a central role in experiencing presence. Therefore, visuospatial working memory capacity was chosen as a covariate as well. Stone & Towse (2015) developed a set of open-source computerized versions of cognitive tasks commonly used in cognitive research. Of these, there are three verbal tasks and four visuospatial tasks. Of the visuospatial tasks, two are complex span tasks, which "follow the paradigm of item storage with concurrent processing of a demanding task in which there are a set number of item storage and cognitive processing events" (p. 1). Of these remaining two, only the symmetry span task was chosen over the rotation span task for ease of administration; although a composite score may be desirable, only one task was chosen to avoid participant fatigue.

      After receiving on-screen instructions, the participant is shown a series of grid locations on a 4 x 4 grid of squares in the center of the screen, one location at a time. After each presentation of a grid location, an 8 x 8 patterned grid (10-20 black squares and 44-54 white squares) is displayed. This grid is either vertically symmetrical or asymmetrical. The participant judges whether this grid is vertically symmetrical and

responds with the left or right arrow key. Once all the grid locations have been displayed, the participant will be presented with a blank 4 x 4 grid and will recall the grid locations, clicking or tapping them in the order displayed. The instruction sheet for this task is included in Appendix C.

The task consists of 20 trials with 4, 6, 6, and 4 trials with a span size of 2, 3, 4, and 5, respectively. These span sizes were chosen to center around the number of objects that can be held in working memory (Baddeley, 1994; Miller, 1956; Saaty & Ozdemir, 2003). Trials are presented in random order. For each participant, this measure yields a discrete score between 0 and 20, counting each successfully completed recall trial; the symmetry judgments do not factor into this score. An illustrative example of a 2-span trial of this task is illustrated in Figure 7.
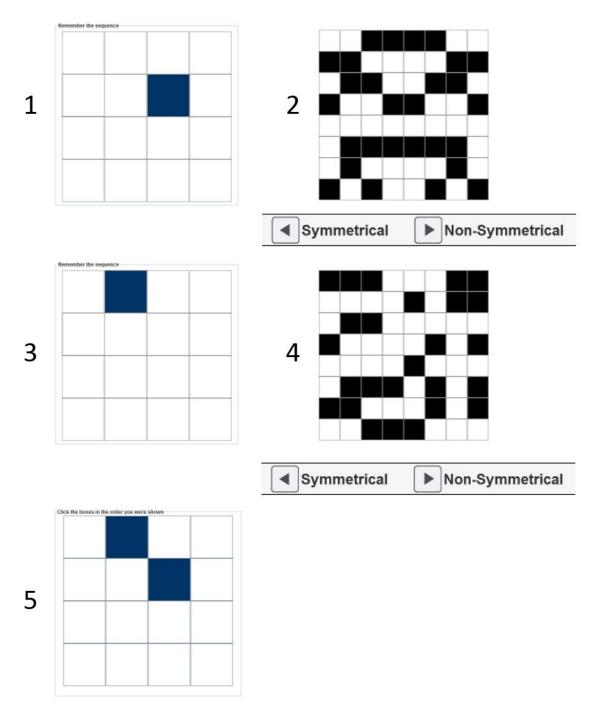
Figure 7. An example of a two-span trial of the symmetry span visuospatial working memory task (Stone & Towse, 2015).

The task consists of 20 trials with 4, 6, 6, and 4 trials with a span size of 2, 3, 4,

and 5, respectively. These span sizes were chosen to center around the number of objects

that can be held in working memory (Baddeley, 1994; Miller, 1956; Saaty & Ozdemir,

2003). Trials are presented in random order. For each participant, this measure yields a discrete score between 0 and 20, counting each successfully completed recall trial; the symmetry judgments do not factor into this score.

   Handedness. Participants were asked, "Which is your dominant hand?" Handedness has been a factor of consideration in other studies of presence (Bouchard et al., 2012; Ma & Kaber, 2006) and in cognition more broadly (Gur et al., 1982; Moffat & Hampson, 1996; Mazoyer et al., 2016; Sahu, Christman, & Propper, 2016).

Other Materials

   The lights were turned off during gameplay and all blinds were closed. The room measured approximately 13.5 x 13.5 x 7.25 feet. A sign that read "VIDEO GAME STUDY" was placed on the playing room's door. Figure 8 illustrates the approximate layout of the room. The game was displayed on an LCD screen (LG Model No. 55UF7600-UJ), which measured approximately 4 feet by 2 feet 4 inches and placed about 6 feet away from the chair. For the treatment group, the monitor's volume level was set to 50 (with a maximum value of 100). The visuospatial working memory task was administered on a Lenovo X1 Carbon ThinkPad. Participants completed paper-and-pencil questionnaires with a black Pilot EasyTouch fine-point ballpoint pen.
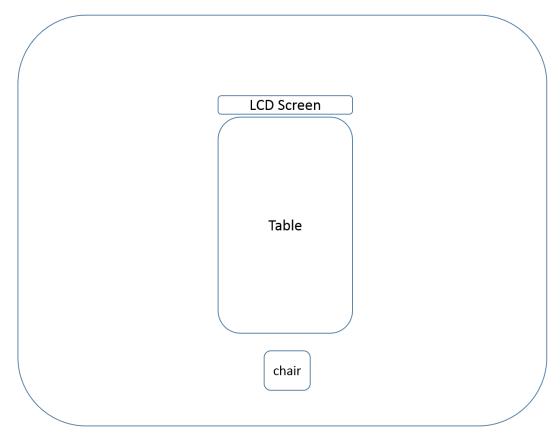
Figure 8. Room layout.

A Nintendo Wii with a single black standard Nintendo GameCube controller in the Player 1 slot was used. All playable characters were already previously unlocked. Background music was disabled. All items were turned off. By setting stage selection to random and customizing the stage selection pool, stage selection was limited to the Battlefield stage. Battlefield is one of the two traditional tournament stages (the other being Final Destination), since it affords a static environment and is symmetrical. Battlefield was preferred over Final Destination since it is smaller, allowing participants to engage with a computer opponent more quickly. All custom player names and profiles were deleted. The scoring mode was set to the default Time setting and limited to five minutes. In-game pause was disabled as well, as is standard in tournament settings.

Procedure

The administration area was staged as described above and all equipment calibrated according to treatment condition prior to the arrival of participants. When a participant arrived, they were welcomed and consent was obtained. The consent form (Appendix B) includes a brief description of the study as well. In addition, at the end of the consent form, participants marked what level opponent they would like to play against.

Before the consent process, participants were verbally screened; they were asked if they were over 18 years of age, fluent in English, or prone to seizures. All participants met these criteria (over 18, fluent, not prone to seizures). Once the consent form was signed, participants were asked to close their eyes and take a few deep breaths for about 30 seconds (timed). This act served two purposes. First, participants may feel more relaxed and acclimate their eyes for the dark room they were about to enter. Second, thirty seconds was sufficient time for the administrator to set the computer opponent's level, so that participants would not have to set it themselves.

As the participant was escorted into the playing room, the sound was unmuted for those in the treatment condition. Gameplay began at the character selection screen. The administrator asked the participant to inform the administrator when the match was over and then left the room to allow gameplay to carry on.

When the match was over, participants filled out the paper-and-pencil questionnaire. When the questionnaire was complete, participants were given an instruction sheet (Appendix C) for the visuospatial working memory task and then

completed the task. Finally, participants were debriefed, thanked, and dismissed. See

Appendix D for the standardized script used with all participants.

Participants

A total of $N = 41$ participants were recruited via convenience sampling in the

Durham-Chapel Hill area. The treatment group consisted of 21 participants (10 male, 10

female) and the comparison group of 20 participants (6 female, 14 male). Almost all

participants ($n = 37$) were right-hand dominant; of the remaining 4, 1 left-hand dominant

participant was assigned to the treatment group while 2 left-hand dominant and 1

ambidextrous participant were assigned to the comparison group. All were fluent in

English as a recruitment prerequisite. 9 participants in the comparison group and 8

participants in the treatment group had played *Brawl* at least once in the past twelve

months prior to study participation. Participants were assigned to treatment groups on

order of intake. See Table 1 for a summary of participant demographics and other

covariate scores.

Table 1

Summary of Covariate Data

Covariate	Comparison ($n = 20$)				Treatment ($n = 21$)				Sample Total ($N = 41$)			
Age	18-24	25-30	31-35	35+	18-24	25-30	31-35	35+	18-24	25-30	31-35	35+
	14	2	0	4	14	3	1	3	28	5	1	7
Dominant Hand	Right	Left	Amb.		Right	Left	Amb.		Right	Left	Amb.	
	17	2	1		20	1	0		37	3	1	
Sex	Female		Male		Female		Male		Female		Male	
	6		14		5		16		11		30	
Prior Recent Experience (12 months)	Yes		No		Yes		No		Yes		No	
	9		11		8		13		17		24	
	M		*SD*		*M*		*SD*		*M*		*SD*	
Computer Opponent Difficulty Level	4.95		3.07		4.81		2.70		4.88		2.85	
Familiarity with Controller Scheme	2.95		1.57		3.00		1.48		2.98		1.51	
Visuospatial Working Memory Task Score	10.00		5.41		11.52		5.07		10.78		5.23	
Immersive Tendencies Questionnaire Score	83.23		16.11		89.62		11.33		86.50		14.07	

All participants completed all tasks completely; there were no missing data. 2 participants circled two adjacent answer choices on a Likert item. In these cases, an average was taken. Several participants ($n = 11$) circled the anchor text in the TPI instead of an answer choice. When this occurred, the item was scored as the lowest or highest of the appropriate answer choices.

Results

Hypotheses

The treatment condition was hypothesized to result in higher ratings of presence than the comparison condition. Namely, a main effect of treatment condition was expected to be observed.

Measures of presence are expected to correlate with each other, since they purport to measure the same or highly related constructs. The most similar measures of presence (e.g., spatial presence as measured by the ITC-SOPI and TPI) were expected to correlate strongly. Some correlation between the other measures was expected as well. For instance, the immersive tendencies scores ostensibly would predict measures of presence, since those scoring highly on the ITQ would be naturally more predisposed to experiencing presence in any situation.

Spatial presence scores were not expected to be high. Since console gaming is low-immersion compared to a VR system, in this context the sense of departure may be more salient than the sense of arrival. Correspondingly, negative effects were expected to be minimal as well. As for the interpersonal social factors, these were expected to be low as well, since it was obvious that the opponent was a computer player. Engagement was expected to be the highest scoring of all presence factors.

Main Analyses

Data analyses were conducted with SPSS. The dependent variables were measures of presence and treated as ordinal variables. From the ITC-SOPI were the following: spatial presence, engagement, ecological validity/naturalness, and negative effects. From the TPI were the following: spatial presence, passive interpersonal social presence, active interpersonal social presence, engagement, and social richness. Finally, the SAM yielded one dependent measure as well. This was a total of ten dependent measures (Table 2).

Table 2

Dependent Measures

Lessiter et al. (2001) ITC-Sense of Presence Inventory	Lombard et al. (2000) Temple Presence Inventory	Wissmath et al. (2010) Self-Assessment Manikin
Engagement	Engagement	Presence
Spatial Presence	Spatial Presence	
Ecological Validity/Naturalness	Passive Interpersonal Social Presence	
Negative Effects	Active Interpersonal Social Presence	
	Social Richness	

First, normality of dependent variables was assessed. A Shapiro-Wilk test of normality at an alpha level of .05 revealed that the SAM ($W(41) = 0.68$, $p < .001$), passive interpersonal social presence ($W(41) = 0.94$, $p = .041$), active interpersonal social presence ($W(41) = 0.94$, $p = .023$), ITC-SOPI engagement ($W(41) = 0.93$, $p = .015$), and negative effects ($W(41) = 0.92$, $p = .007$) violated assumptions of homoscedasticity for subsequent analyses; the SAM ($KS(41) = 0.239$, $p < .001$) and ITC-SOPI engagement ($KS(41) = 0.15$, $p = .022$) were additionally flagged by a Kolmogorov-Smirnov test of normality with Lilliefors significance correction at an alpha level of .05 (Table 3).

Table 3

Tests of Normality

Dependent Variable	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	*df*	*p*	Statistic	*df*	*p*
Self-Assessment Manikin	0.24	41	.000[***]	0.86	41	.000[***]
TPI Spatial Presence	0.07	41	.200[*]	0.97	41	.481
TPI Passive Interpersonal Social Presence	0.11	41	.200[*]	0.94	41	.041[**]
TPI Active Interpersonal Social Presence	0.12	41	.138	0.94	41	.023[**]
TPI Enagement	0.12	41	.177	0.97	41	.365
TPI Social Richness	0.10	41	.200[*]	0.98	41	.560
ITC-SOPI Spatial Presence	0.07	41	.200[*]	0.97	41	.377
ITC-SOPI Engagement	0.15	41	.022[**]	0.93	41	.015[**]
ITC-SOPI Ecological Validity/Naturalness	0.12	41	.161	0.95	41	.057
ITC-SOPI Negative Effects	0.12	41	.168	0.92	41	.007[**]

*. This is a lower bound of the true significance.

**. $p < .05$

***. $p < .001$

a. Lilliefors Significance Correction

Next, a correlation matrix between all dependent variables was generated to assess possible multicollinearity (Table 4). Since certain dependent variables were not normally distributed, both Pearson's product-moment correlation and Spearman's rank-order correlation were used. Though some multicollinearity was detected, no significant correlation coefficient (parametric or nonparametric) at $\alpha = .05$ exceeded .80, also confirming the hypothesis that correlations would be observed between measures of presence.

Table 4

Correlations Between Dependent Variables

Measure		1	2	3	4	5	6	7	8	9	10
		Spearman's rank-order correlation									
1- TPI Spatial Presence	ρ	1.00	.16	-.38*	.00	-.21	-.05	-.23	-.24	-.04	-.12
	p (2-tailed)	——	.309	.015	.980	.197	.758	.155	.129	.806	.453
2- Passive Interpersonal Social Presence	ρ	.16	1.00	.46**	.29	.38*	.40*	.63**	.21	.50**	.13
	p (2-tailed)	.309	——	.002	.067	.015	.010	.000	.192	.001	.402
3- Active Interpersonal Social Presence	ρ	-.38*	.46**	1.00	.36*	.47**	.38*	.56**	.51**	.45**	.12
	p (2-tailed)	.015	.002	——	.022	.002	.014	.000	.001	.003	.471
4- TPI Engagement	ρ	.00	.29	.36*	1.00	.42**	.24	.36*	.38*	.05	.08
	p (2-tailed)	.980	.067	.022	——	.006	.124	.020	.015	.761	.616
5- Social Richness	ρ	-.21	.38*	.47**	.42**	1.00	.61**	.74**	.70**	.47**	-.01
	p (2-tailed)	.197	.015	.002	.006	——	.000	.000	.000	.002	.929
6- ITC-SOPI Spatial Presence	ρ	-.05	.40*	.38*	.24	.61**	1.00	.51**	.70**	.41**	-.04
	p (2-tailed)	.758	.010	.014	.124	.000	——	.001	.000	.007	.807
7- ITC-SOPI Engagement	ρ	-.23	.63**	.56**	.36*	.74**	.51**	1.00	.64**	.62**	.05
	p (2-tailed)	.155	.000	.000	.020	.000	.001	——	.000	.000	.759
8- Ecological Validity/Naturalness	ρ	-.24	.21	.51**	.38*	.71**	.70**	.64**	1.00	.36*	.04
	p (2-tailed)	.129	.192	.001	.015	.000	.000	.000	——	.021	.806
9- Negative Effects	ρ	-.04	.50**	.45**	.05	.47**	.41**	.62**	.36*	1.00	.19
	p (2-tailed)	.806	.001	.003	.761	.002	.007	.000	.021	——	.226
10- Self-Assessment Manikin	ρ	-.12	.13	.12	.08	-.01	-.04	.05	.04	.19	1.00
	p (2-tailed)	.453	.402	.471	.616	.929	.807	.759	.806	.226	——
		Pearson's product-moment correlation									
1- TPI Spatial Presence	r	1.00	.14	-.47**	-.01	-.19	-.04	-.17	-.15	-.06	-.13
	p (2-tailed)	——	.392	.002	.944	.223	.819	.276	.345	.731	.420
2- Passive Interpersonal Social Presence	r	.14	1.00	.31*	.37*	.42**	.38*	.63**	.24	.47**	.17
	p (2-tailed)	.392	——	.047	.017	.006	.013	.000	.124	.002	.294
3- Active Interpersonal Social Presence	r	-.47**	.31*	1.00	.27	.48**	.27	.53**	.46**	.43**	.11
	p (2-tailed)	.002	.047	——	.085	.001	.093	.000	.002	.005	.511
4- TPI Engagement	r	-.01	.37*	.27	1.00	.43**	.25	.40**	.34*	.05	-.01
	p (2-tailed)	.944	.017	.085	——	.005	.113	.010	.031	.750	.927
5- Social Richness	r	-.19	.42**	.48**	.43**	1.00	.68**	.76**	.78**	.48**	.06
	p (2-tailed)	.223	.006	.001	.005	——	.000	.000	.000	.002	.717
6- ITC-SOPI Spatial Presence	r	-.04	.38*	.27	.25	.68**	1.00	.56**	7.00	.43**	-.10
	p (2-tailed)	.819	.013	.093	.113	.000	——	.000	.000	.005	.543
7- ITC-SOPI Engagement	r	-.17	.63**	.53**	.40**	.76**	.56**	1.00	.69**	.61**	.15
	p (2-tailed)	.276	.000	.000	.010	.000	.000	——	.000	.000	.341
8- Ecological Validity/Naturalness	r	-.15	.24	.46**	.34*	.78**	.77**	.69**	1.00	.38*	.13
	p (2-tailed)	.345	.124	.002	.031	.000	.000	.000	——	.015	.421
9- Negative Effects	r	-.06	.47**	.43**	.05	.48**	.43**	.61**	.38*	1.00	.18
	p (2-tailed)	.731	.002	.005	.750	.002	.005	.000	.015	——	.247
10- Self-Assessment Manikin	r	-.13	.17	.11	-.01	.06	-.10	.15	.13	.18	1.00
	p (2-tailed)	.420	.294	.511	.927	.717	.543	.341	.421	.247	——

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

Box's test of equality of covariance matrices revealed no multivariate

heterogeneity of variance between treatment groups ($M = 58.69$, $F(55, 4885.72) = 0.77$, *p*

= .893). Similarly, Levene's test of equality of error variances revealed no heterogeneity of variance between independent variable groups for any dependent variable (Table 5).

Table 5

Levene's Test of Equality of Error Variances

Dependent Variable	F (1, 39)	p
Self-Assessment Manikin	0.01	.906
TPI Spatial Presence	0.11	.744
Passive Interpersonal Social Presence	0.09	.762
Active Interpersonal Social Presence	0.56	.457
TPI Enagement	0.03	.872
Social Richness	0.02	.900
ITC-SOPI Spatial Presence	1.32	.258
ITC-SOPI Engagement	0.20	.660
Ecological Validity/Naturalness	1.17	.286
Negative Effects	0.44	.513

A 1 x 2 (mute vs. sound effects only) MANCOVA with bootstrapping was performed with one independent variable of two levels: treatment vs. comparison group. There were eight covariate predictor variables included in the model: familiarity with controls, previous recent gameplay experience, age, sex, handedness, visuospatial working memory score, computer opponent difficulty, and ITQ score (Table 6). In this way, the effect of the independent variable on the dependent variables may be tested while controlling for the effects of the covariates. As noted above, assumptions of homogeneity of variance and covariance between groups were not violated. Though some multicollinearity between dependent variables was detected, none of the significant correlations exceeded .80, which is below the cutoff of $r \geq .90$ used by Schliermann, Heydenreich, Bungter, and Anneken (2016) for MANCOVA. Since heteroscedasticity was detected by Kolmogorov-Smirnov tests for the SAM and ITC-SOPI engagement (in

addition to active interpersonal social presence, passive interpersonal social presence, and

negative effects, according to the Shapiro-Wilk tests), SPSS's bootstrapping module with

simple sampling (1000 samples) was utilized with the MANCOVA. According to the

SPSS user guide for the bootstrapping module, bootstrapping is useful for parametric

tests, including the MANCOVA, when assumptions of normality are in doubt ("IBM

SPSS Bootstrapping 21," 2012).

Table 6

Covariates

Measure	Range	Type of Measurement	Type of Variable
Familiarity with controls	[1 - 5]	Likert	ordinal
Visuospatial working memory task	[0 - 20]	number correct	ratio
Immersive Tendencies Questionnaire score	[18 - 126]	sum of Likert scores	ordinal
Computer player difficulty level	[1 - 9]	in-game setting	ordinal
Age	[1 - 4]	multiple choice	ordinal
Sex	[0 - 1]	multiple choice/write-in	binary
Previous experience	[0 - 1]	yes/no	binary
Handedness	[0 - 2]	multiple choice/write-in	categorical

The full MANCOVA yielded a Wilks' lambda that revealed a significant

multivariate effect of the treatment condition while controlling for all covariates ($\lambda =$

0.47, $F(10.00, 22.00) = 2.48$, $p = .037$, partial $\eta^2 = 0.53$); all multivariate tests are

recorded in Table 7. Post hoc tests of between-subjects effects for each dependent

variable by treatment condition (Table 8) did not reveal any significant effects of

treatment condition, likely because of a lack of power due to the inclusion of weak

covariates and to correlations between dependent variables.

Table 7

Multivariate Tests - Full MANCOVA

Effect	Wilks' λ	F (10.00, 22.00)	p	Partial η^2
Condition	0.47	2.48	.037[*]	0.53
Handedness	0.66	1.15	.373	0.34
Age	0.70	0.94	.521	0.30
Sex	0.73	0.80	.629	0.27
Prior recent experience	0.54	1.89	.102	0.46
Computer opponent level	0.68	1.05	.436	0.32
Familiarity with controls	0.86	0.36	.953	0.14
Visuospatial working memory score	0.75	0.73	.689	0.25
Immersive Tendencies Questionnaire	0.62	1.35	.266	0.38

*. p-value is significant at the 0.05 level (2-tailed).

Table 8

Tests of Between-Subjects Effects - Post Hoc ANCOVA

Dependent Variable	F (1, 40)	p	Partial η^2
Self-Assessment Manikin	1.69	.204	0.052
TPI spatial presence	1.37	.251	0.042
Passive interpersonal presence	0.40	.532	0.013
Active interpersonal presence	0.17	.683	0.005
TPI engagement	3.81	.060	0.109
Social richness	0.03	.873	0.001
ITC-SOPI spatial presence	0.31	.583	0.010
ITC-SOPI engagement	0.11	.738	0.004
Ecological validity/naturalness	0.00	.964	0.000
Negative effects	0.93	.343	0.029

To explore the main hypothesis further and to gain more degrees of freedom, a reduced MANCOVA model with bootstrapping was constructed using only covariates with a demonstrated relationship with the dependent variables. A nonparametric two-tailed correlation matrix between predictor variables and dependent variables was

produced (Table 9). Of the eight covariates, only ITQ scores were significantly correlated with any dependent measures. ITQ scores were significantly correlated with social richness ($\rho(39) = .37$, $p = .017$) and ITC-SOPI engagement ($\rho(39) = .54$, $p < .001$).

Table 9

Nonparametric Correlations between Covariates and Dependent Variables

		Handedness	Age	Sex	Prior experience	Computer opponent level	Familiarity with controls	Visuospatial working memory score	ITQ
TPI Spatial Presence	ρ	-.06	-.10	.04	-.15	-.17	-.12	.24	.11
	p (2-tailed)	.725	.539	.795	.340	.302	.449	.138	.481
Passive Interpersonal Social Presence	ρ	-.26	-.03	-.12	.02	.03	-.08	.09	.22
	p (2-tailed)	.099	.856	.459	.917	.848	.598	.593	.172
Active Interpersonal Social Presence	ρ	-.06	-.10	.15	-.09	-.04	-.01	.17	.04
	p (2-tailed)	.730	.543	.337	.584	.810	.952	.277	.798
TPI Engagement	ρ	.15	-.09	-.03	.11	-.03	.06	.01	.24
	p (2-tailed)	.365	.583	.851	.506	.845	.698	.934	.129
Social Richness	ρ	-.05	-.07	.06	.03	.17	.15	.18	.37[*]
	p (2-tailed)	.746	.644	.696	.876	.291	.358	.269	.017
ITC-SOPI Spatial Presence	ρ	-.08	-.11	-.14	.03	-.11	-.07	.06	.29
	p (2-tailed)	.631	.505	.368	.866	.496	.683	.729	.071
ITC-SOPI Engagement	ρ	-.12	-.05	-.12	.13	.11	.10	.10	.54[**]
	p (2-tailed)	.468	.760	.459	.411	.507	.514	.514	.000
Ecological Validity/Naturalness	ρ	.01	.07	-.03	-.05	-.06	-.01	.13	.18
	p (2-tailed)	.958	.676	.873	.744	.733	.957	.423	.272
Negative Effects	ρ	-.17	.11	-.19	.03	-.25	-.14	-.06	-.11
	p (2-tailed)	.274	.479	.223	.865	.113	.377	.725	.497
Self-Assessment Manikin	ρ	.30	-.10	.13	.08	.05	.19	.22	-.07
	p (2-tailed)	.056	.528	.430	.607	.734	.230	.168	.683

[**]. Correlation is significant at the 0.01

[*]. Correlation is significant at the 0.05

The reduced MANCOVA therefore included only a single covariate: ITQ scores. Multivariate tests revealed significant influence of treatment condition ($\lambda = 0.55$, $F(10.00, 29.00) = 2.36$, $p = .035$, partial $\eta^2 = 0.45$) and non-significant influence of ITQ scores ($\lambda = 0.69$, $F(10.00, 29.00) = 1.33$, $p = .262$, partial $\eta^2 = 0.31$). Post hoc ANCOVA testing (Table 10) indicated a significant effect of treatment condition on TPI engagement ($F(1, 40) = 4.98$, $p = .032$, partial $\eta^2 = 0.12$). Examination of estimated marginal means revealed that the muted condition ($M = 4.62$, $SE = 0.24$) experienced more engagement as

measured by the TPI than did the treatment group ($M = 3.87$, $SE = 0.23$), opposite of what was hypothesized.

Table 10

Post Hoc ANCOVA for Reduced Model

Dependent Variable	$F(1, 40)$	p	partial η^2
Self-Assessment Manikin	1.36	.250	0.03
TPI spatial presence	0.39	.535	0.01
Passive interpersonal presence	0.28	.598	0.01
Active interpersonal presence	0.05	.816	0.00
TPI engagement	4.98	.032[*]	0.12
Social richness	0.14	.710	0.00
ITC-SOPI spatial presence	0.25	.618	0.01
ITC-SOPI engagement	0.06	.812	0.00
Ecological validity/naturalness	0.04	.852	0.00
Negative effects	0.54	.467	0.01

*. p-value is significant at the 0.05 level (2-tailed).

To gain a more granular perspective on the effect of condition on engagement, further analyses were conducted on the items composing the TPI engagement subscale. These are the 6 items that make up the engagement module:

- #15: To what extent did you feel mentally immersed in the experience? [Not at all – Very much]

- #16: How involving was the media experience? [Not at all – Very much]

- #17: How completely were your senses engaged? [Not at all – Very much]

- #18: To what extent did you experience a sensation of reality? [Not at all – Very much]

- #19: How relaxing or exciting was the experience? [Very relaxing – Very exciting]

- #20: How engaging was the story? [Not at all – Very much]

    Both Shapiro-Wilks and Kolmogorov-Smirnov (with Lilliefors significance

    correction) tests of normality revealed that all 6 item response distributions were

    heteroscedastic (Table 11).

Table 11

Tests of Normality for TPI Engagement Items

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
Item	Statistic	df	p	Statistic	df	p
#15	0.23	41	.000**	0.89	41	.001*
#16	0.18	41	.002*	0.92	41	.009*
#17	0.19	41	.001*	0.93	41	.014*
#18	0.19	41	.001*	0.90	41	.002*
#19	0.19	41	.001*	0.92	41	.006*
#20	0.18	41	.001*	0.86	41	.000**

*. $p < .05$
**. $p < .001$
a. Lilliefors Significance Correction

A 2-way repeated measures MANOVA was conducted with condition as the

between-subjects factor and item number as the repeated measure. Box's test of equality

of covariance matrices did not reveal a violation of this assumption ($M = 24.87$, $F(21$,

$5563.65) = 0.99$, $p = .477$). Multivariate tests revealed a significant main effect of item

number (Wilks' $\lambda = 0.25$, $F(5.00, 35.00) = 20.99$, $p < .001$, partial $\eta^2 = 0.75$), but no

significant interaction between item number and condition (Wilks' $\lambda = 0.95$, $F(5.00$,

$35.00) = 0.41$, $p = .838$, partial $\eta^2 = 0.06$) on average item responses.

Mauchly's test indicated that the assumption of sphericity was violated ($W = 0.43$,

$\chi^2(14) = 31.04$, $p = .006$). Thus, degrees of freedom were corrected using the Huynh-

Feldt estimate of sphericity ($\varepsilon = .89$). A test of within-subjects effects for item number

corroborated the multivariate test ($F(3.87, 151.07) = 32.31$, $p < .001$), indicating that

respondents tended to answer different items in different ways. A test of between-

subjects effect for treatment condition did not suggest a main effect ($F(1, 39) = 0.07$, $p =$

.794, partial $\eta^2 < 0.01$), though the assumption of equality of error variances was violated

for item number 16, $F(1, 39) = 4.28$, $p = .045$ (Table 12). Subsequent examination of

pairwise comparisons of estimated marginal means with Bonferroni adjustment for

multiple comparisons indicated that items #18 and #20 were answered similarly, but

significantly differently than the other items, which were likewise answered similarly

(Table 13), as illustrated in Figure 9. Item means are reported in Table 14.

Table 12

Levene's Tests for TPI Engagement Items

Item Number	$F(1, 39)$	p
#15	3.16	.083
#16	4.28	.045[*]
#17	0.58	.450
#18	0.76	.387
#19	1.42	.241
#20	0.11	.738

*. $p < .05$

Table 13

Pairwise Comparisons of Estimated Marginal
Means for TPI Engagement Items

(I) item	(J) item	Mean Difference (I-J)	*SE*	*p* [a]
	#16	-0.19	0.18	1.000
	#17	0.05	0.22	1.000
#15	#18	1.64*	0.28	.000
	#19	-0.20	0.25	1.000
	#20	2.20*	0.32	.000
	#15	0.19	0.18	1.000
	#17	0.24	0.16	1.000
#16	#18	1.84*	0.26	.000
	#19	0.00	0.24	1.000
	#20	2.39*	0.29	.000
	#15	-0.05	0.22	1.000
	#16	-0.24	0.16	1.000
#17	#18	1.59*	0.28	.000
	#19	-0.25	0.24	1.000
	#20	2.14*	0.31	.000
	#15	-1.64*	0.28	.000
	#16	-1.84*	0.26	.000
#18	#17	-1.59*	0.28	.000
	#19	-1.84*	0.29	.000
	#20	0.55	0.29	.982
	#15	0.20	0.25	1.000
	#16	0.00	0.24	1.000
#19	#17	0.25	0.24	1.000
	#18	1.84*	0.29	.000
	#20	2.39*	0.26	.000
	#15	-2.20*	0.32	.000
	#16	-2.39*	0.29	.000
#20	#17	-2.14*	0.31	.000
	#18	-0.55	0.29	.982
	#19	-2.39*	0.26	.000

*. The mean difference is significant at the .001 level.
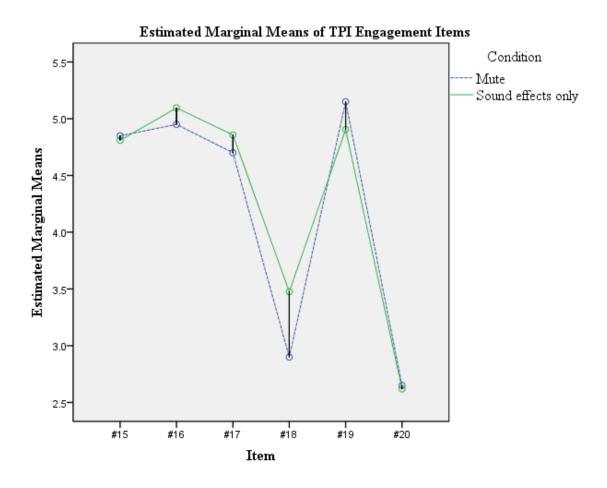
a. Adjustment for multiple comparisons: Bonferroni.

Figure 9. Estimated marginal means of TPI items.

Table 14

TPI Engagement Item Means

Item	Group	M	SD	N
	Mute	4.85	1.981	20
#15	Sound effects	4.81	1.289	21
	Total	4.83	1.642	41
	Mute	4.95	1.605	20
#16	Sound effects	5.10	1.136	21
	Total	5.02	1.369	41
	Mute	4.70	1.658	20
#17	Sound effects	4.86	1.493	21
	Total	4.78	1.557	41
	Mute	2.90	1.683	20
#18	Sound effects	3.48	1.861	21
	Total	3.20	1.778	41
	Mute	5.15	1.531	20
#19	Sound effects	4.90	1.044	21
	Total	5.02	1.294	41
	Mute	2.65	1.814	20
#20	Sound effects	2.62	1.564	21
	Total	2.63	1.670	41

Comparison of Reliability of Similar Dependent Measures

To compare the spatial presence and engagement dimensions between the TPI and the ITC-SOPI, Cronbach's alphas (Cronbach, 1951) were obtained for the corresponding subscales by treatment condition. 12 reliability scores were derived in this way: TPI spatial presence, ITC-SOPI spatial presence, TPI engagement, ITC-SOPI engagement, TPI and ITC-SOPI spatial presence combined, and TPI and ITC-SOPI engagement combined. 6 additional reliability scores were derived from all participants. Reliability analyses revealed Cronbach's alphas that ranged from 0.65 (7 items; TPI spatial presence, comparison group) to 0.94 (19 items; combined engagement, comparison group). Six

Feldt tests (Feldt, Woodruff, & Salih, 1987), one for each treatment-specific construct, were performed using the online tool created by Diedenhofen and Musch (2014). A significant difference was found in reliability scores for the three spatial presence scales in the comparison group ($\chi^2(2, n = 20) = 6.65, p = .036$). To probe this effect, three additional Feldt tests were conducted pairwise on these three scores. A significant difference was found between the combined scale and the TPI scale ($\chi^2(1, n = 20) = 4.99$, $p = .026$) and between the ITC-SOPI scale and the TPI scale ($\chi^2(1, n = 20) = 5.85, p = .016$), but not between the combined scale and the ITC-SOPI scale ($\chi^2(1, n = 20) = 0.05$, $p = .816$). Table 11 summarizes these reliability analyses. In addition, Table 12 lists the reliability scores of other modules of the instruments. Generally speaking, reliability alphas were robust ($\alpha > 0.55$), with the exception of negative effects in the mute condition ($\alpha = 0.20$, 7 items).

Table 15

Comparison of Reliability Scores

Construct	Scale	Cronbach's α	Number of items	Feldt's $\chi^{2\ a}$	p
		Treatment Group ($n = 21$)			
	Combined	0.84	19		
Engagement	TPI	0.65	6	2.45	.293
	ITC-SOPI	0.80	13		
	Combined	0.90	26		
Spatial Presence	TPI	0.69	7	5.69	.058
	ITC-SOPI	0.89	19		
		Comparison Group ($n = 20$)			
	Combined	0.94	19		
Engagement	TPI	0.89	6	1.73	.421
	ITC-SOPI	0.91	13		
	Combined	0.89	26		
Spatial Presence	TPI	0.65	7	6.65	.036[*]
	ITC-SOPI	0.90	19		
		All Participants ($N = 41$)			
	Combined	0.91	19		
Engagement	TPI	0.82	6	4.31	.116
	ITC-SOPI	0.87	13		
	Combined	0.89	26		
Spatial Presence	TPI	0.66	7	12.92	.002[*]
	ITC-SOPI	0.89	19		

a. All Feldt's tests were conduected with $df = 2$.

*. $p < .05$

Table 16

Other Reliability Analyses

Construct	Cronbach's α	Number of items
Treatment Group ($n = 21$)		
Passive interpersonal social presence	0.78	4
Active interpersonal social presence	0.72	3
Social richness	0.79	7
Ecological validity/naturalness	0.80	5
Negative effects	0.76	7
Immersive tendencies questionnaire	0.69	18
Comparison Group ($n = 20$)		
Passive interpersonal social presence	0.76	4
Active interpersonal social presence	0.66	3
Social richness	0.88	7
Ecological validity/naturalness	0.63	5
Negative effects	0.20	7
Immersive tendencies questionnaire	0.86	18
All Participants ($N = 41$)		
Passive interpersonal social presence	0.75	4
Active interpersonal social presence	0.69	3
Social richness	0.84	7
Ecological validity/ naturalness	0.72	5
Negative effects	0.59	7
Immersive tendencies questionnaire	0.79	18

The Self-Assessment Manikin was excluded from Table 12 since it is only one item. Mean scores on the SAM were 2.65 ($SD = 0.93$) for the mute condition, 2.90 ($SD = 0.70$) for the treatment condition, and 2.78 ($SD = 0.82$) for both conditions combined. Table 13 summarizes the means of dependent variables.

Table 17

Means of Dependent Variables

Dependent Variable	M (SD)		
	Mute (n = 20)	Sound efffects only (n = 21)	Total (N = 41)
Self-Assessment Manikin	2.65 (0.93)	2.90 (0.70)	2.78 (0.82)
TPI spatial presence	2.86 (1.16)	2.73 (0.91)	2.79 (1.03)
Passive interpersonal presence	3.35 (1.60)	3.27 (1.35)	3.31 (1.46)
Active interpersonal presence	3.05 (1.51)	3.05 (1.56)	3.05 (1.52)
TPI engagement	4.52 (1.17)	3.97 (1.04)	4.24 (1.13)
Social richness	4.09 (1.32)	4.40 (1.18)	4.25 (1.24)
ITC-SOPI spatial presence	2.55 (0.70)	2.55 (0.73)	2.55 (0.71)
ITC-SOPI engagement	3.37 (0.72)	3.58 (0.73)	3.48 (0.73)
Ecological validity/naturalness	1.92 (0.72)	2.06 (0.74)	2.01 (0.72)
Negative effects	1.78 (0.68)	1.64 (0.52)	1.72 (0.60)

Free-Response Comments

In the paper-and-pencil questionnaire, participants were afforded two opportunities to provide written free-response comments. The first of these was part of the end of the Temple Presence Inventory and was presented before the Immersive Tendencies Questionnaire. The prompt read, "Please use the space below to provide your comments about the media experience:". The second of these was part of the ITC-Sense of Presence Inventory and was presented at the end of the questionnaire. The prompt read, "If there is anything else you would like to add, please use the space below:". All but 9 participants provided a response for at least one of the prompts. No analyses were conducted on these comments, but they were transcribed literatim and are included in Appendix E.

Discussion

Main Hypotheses

As predicted, the treatment had a significant effect. However, contrary to the initial hypothesis, this effect was in the opposite direction anticipated. That is to say, participants who played with no sound at all experienced significantly less engagement (as measured by the Temple Presence Inventory) than did those who played with sound effects only. No other significant effects of condition were detected.

One possible explanation for the reversed effect is that sound effects induced more extrinsic load than germane load, thereby inhibiting participants' ability to allocate cognitive resources towards experiencing engagement. That is to say, with fewer distractions, a player may focus better on the task at hand. Another explanation is that the sound effects were such unexpected forms of feedback that participants found this sensation jarring. However, it is important to note that while the full model indicated only multivariate significance, a reduced model and additional post hoc ANCOVA was necessary to pinpoint which variable was influenced. Each additional test increases the chance of false positive Type I error.

In a natural gameplay setting, sound effects would be present in tandem with any number of incidental and extraneous stimuli. A player may be exposed to the ambient sound of an air conditioning unit, scents and noises from the kitchen, and the stereo music of the neighbors. These other stimuli do not provide any information regarding a player's interaction with a game, but rather distract from it. In a more naturalistic context,

sound effects may serve to draw attention away from distractions, out-competing irrelevant stimuli.

Further probing of the TPI engagement scale revealed that all participants tended to experience a low "sensation of reality" (#18) and find the "story" unengaging (#20). This is perhaps unsurprising. Player avatars are rendered cartoonish characters from works of fiction (other videogames) and only move along two dimensions. Multiplayer gameplay in *Brawl* is not structured around any sort of narrative. However, it should also be noted that none of these item scores were normally distributed. Nevertheless, the direction of these differences is clear.

It was also predicted that the other measures of presence would be higher for the treatment group than for the comparison group. No such effects were observed. There are several possible explanations.

Many covariates were included in the original research design. Though each covariate could theoretically affect the experience of presence, these influences may be too small to make a discernible impact on the model. Inclusion of weak covariates may decrease the power of an analysis of covariance. In fact, only one covariate (ITQ) had any demonstrable correlation with the dependent variables. Similarly, substantial multicollinearity between measures of presence was detected, thus confirming the secondary hypothesis of this study. Though these correlation coefficients did not exceed .90, the additive effect may decrease the power of the MANCOVA.

Regardless of treatment condition, measures of presence were not high. Compared to VR systems, the immersion of a console system is much lower. It may be that multiplayer *Brawl* simply does not afford sufficient system immersion for players to

experience presence in a laboratory setting. Apart from form factors, the gameplay content may not adequately engage extended consciousness. Or perhaps participants did not play long enough for a sense of departure to ensue.

The diversity of participants aids the generalizability of these findings. However, such diversity is also a confounding factor. The ideal population to detect significant effects would be homogenous and/or balanced in every way. In this context, many participants without recent gameplay experience and with low familiarity with the controls were recruited. If one is focusing attention towards basic mastery of movement, it is impossible to experience presence. Though participant demographics were fairly balanced between groups, the sample size may not have been large enough to account for distributed confounds.

There were other participant threats to internal validity as well. One participant did not properly understand the instructions for the visuospatial working memory task. Another played two five-minute rounds instead of one. A handful of participants tied with the computer opponent and entered "sudden death" mode, which is essentially a tiebreaker round.

Finally, it may be that the instruments used left some dimension of presence uncaptured. The spatial presence modules of the ITC-SOPI and TPI both deal primarily with the sense of transportation or of 'being there'. However, in some contexts, the sense of departure may be more pronounced than the sense of arrival (Kim & Biocca, 1997). In fact, there are only two items between both the instruments that explicitly deal with a sense of departure ("I lost track of time." and "I paid more attention to the displayed environment than I did to my own thoughts (e.g., personal preoccupations, daydreams

etc.)"), both from the ITC-SOPI engagement subscale. The departure component of presence may be more involved with a perceptual illusion of non-mediation or conceivably akin to the loss of self-consciousness experienced in flow states (Jackson & Marsh, 1996). Perhaps an item regarding a participant's awareness of the input device or attention to periphery vision may be suitable.

Comparison of Instruments

All measures of presence tended to correlate with each other, thereby lending convergent validity to the instruments. Also, there were no significant differences between the reliability alphas for the TPI and the ITC-SOPI modules. However, the spatial presence module of the ITC-SOPI demonstrated significantly greater reliability than that of the TPI within subjects assigned to the comparison group, though, as with all repeated significance testing, the chance for Type I error is increased. This difference may be due to the fact that many participants circled the anchor text of the TPI, rather than the response choices. The anchor text format of the ITQ or ITC-SOPI may be a better choice for future studies utilizing the TPI.

Neither instrument contained any items that were reverse coded. A more comprehensive assessment of presence might take into account what presence is not. Inclusion of items that ask about wandering thoughts or reality checks could serve this purpose. Such endeavors could lend discriminant validity to these instruments.

Other issues with instruments. The Self-Assessment Manikin was originally a 9-point pictorial Likert item with five pictographs and the spaces between them as response choices. This study modified the SAM into a 5-point item. However, the

instructional text for the SAM uses six descriptions of the pictographs while there are only five. This may have been confusing for participants.

The Immersive Tendencies Questionnaire contains items that begin with "Do you ever" or "Have you ever". Items like these imply a yes/no response, but the anchor text reads "NEVER – OCCASIONALLY – OFTEN". This may have been confusing for participants as well. These items may be better worded as "How often do you" to better match the anchor text.

Items #5 and #10 of the TPI and item B24 of the ITC-SOPI deal specifically with sounds heard during the media experience. Since the null condition involved muting all system audio, these three items should only yield the lowest possible responses for participants in the mute condition. Surprisingly, of the 20 participants in the mute condition only 11, 11, and 15 chose the lowest response choice for items #5, #10, and B24, respectively. In fact, there was at least one maximal response choice recorded for each of these items from the mute condition. A substantial number of participants may have been responding haphazardly to the media questionnaires. Alternatively, they may not have understood the item text or misread it.

Concluding Remarks

Research is an iterative process. More-targeted approaches will be more successful when built on the foundation of empirical exploration. This study yielded lessons learned in the layout of anchor text for Likert items and the inclusion of too many weak covariates in an analysis of covariance. In addition, this study was able to replicate the reliability of the engagement and spatial presence subscales of two popular measures of presence: the Temple Presence Inventory and the ITC-Sense of Presence Inventory.

However, since presence may not be as easily achievable in low-immersion systems, future work may seek to enhance the sensitivity of presence measurement, particularly in regards to the sense of departure associated with transportation. Furthermore, the development of media-agnostic objective measures of presence should continue to be pursued.

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Appendix A – Questionnaire

[Note that the formatting of this Appendix has been disturbed. Please contact the author at Michael.Chen.0@gmail.com for a copy of the actual materials used.]

For the following section, please circle a single answer choice for each question.

Which is your dominant hand?

    Right hand   Left Hand   Other _____

What is your biological sex?

    Male   Female   Other _____

Are you fluent in English?

    Yes   No

What is your age?

    18-24 years   25-30 years   31-35 years   35+ years

Prior to today, have you played *Super Smash Bros. Brawl* in the past year (12 months)?

    Yes   No

Prior to today, how familiar were you with the controller scheme you just used?

    (unfamiliar)   **1**   **2**   **3**   **4**   **5**   (familiar)

[insert page break]

Media Questionnaire

[This is the Temple Presence Inventory (Lombard et al., 2000).]

Thank you very much for agreeing to complete this questionnaire.

The questions on these pages ask about the media experience you just had.

There are no right or wrong answers; please simply <u>give your first impressions</u> and <u>answer all of the questions</u> as accurately as possible, even questions that may seem unusual or to not apply to the particular media experience you just had. For example, in answering a question about how much it felt like you were "inside the environment you saw/heard," base your answer on your feeling rather than your knowledge that you were not actually inside that environment.

Throughout the questions, the phrases "the environment you saw/heard" and "objects, events, or people you saw/heard" refer to the things or people that were presented <u>in</u> the media experience, <u>not</u> your immediate physical surroundings (i.e., the actual room you were in during the media experience).

Please circle the responses that best represent your answers. All of your responses will be kept strictly confidential.

_____

How much did it seem as if the objects and people you saw/heard had come to the place you were?

          Not at all   1 2 3 4 5 6 7   Very much

How much did it seem as if you could reach out and touch the objects or people you saw/heard?

Not at all   1 2 3 4 5 6 7   Very much

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[insert page break]

How often when an object seemed to be headed toward you did you want to move to get out of its way?

Never   1 2 3 4 5 6 7   Always

To what extent did you experience a sense of 'being there' inside the environment you saw/heard?

Not at all   1 2 3 4 5 6 7   Very much

To what extent did it seem that sounds came from specific, different locations?

Not at all   1 2 3 4 5 6 7   Very much

How often did you want to or try to touch something you saw/heard?

Never   1 2 3 4 5 6 7   Always

Did the experience seem more like looking at the events/people on a movie screen or more like looking at the events/people through a window?

Like a movie screen   1 2 3 4 5 6 7   Like a window

During the media experience how well were you able to observe…

…the <u>body language</u> of the people you saw/heard?

Not well   1 2 3 4 5 6 7   Very well

…the <u>facial expressions</u> of the people you saw/heard?

Not well   1 2 3 4 5 6 7   Very well

…<u>changes in the tone of voice</u> of the people you saw/heard?

Not well   1 2 3 4 5 6 7   Very well

…the <u>style of dress</u> of the people you saw/heard?

Not well   1 2 3 4 5 6 7   Very well

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[insert page break]

How often did you make a sound out loud (e.g., laugh, speak) in response to someone you saw/heard in the media environment?

Never   1 2 3 4 5 6 7   Always

How often did you smile in response to someone you saw/heard in the media environment?

Never   1 2 3 4 5 6 7   Always

How often did you want to or did you speak to a person you saw/heard in the media environment?

Never   1 2 3 4 5 6 7   Always

To what extent did you feel mentally immersed in the experience?

Not at all   1 2 3 4 5 6 7   Very much

How involving was the media experience?

Not at all   1 2 3 4 5 6 7   Very much

How completely were your senses engaged?

Not at all   1 2 3 4 5 6 7   Very much

To what extent did you experience a sensation of reality?

Not at all   1 2 3 4 5 6 7   Very much

How relaxing or exciting was the experience?

Very relaxing   1 2 3 4 5 6 7   Very exciting

How engaging was the story?

Not at all   1 2 3 4 5 6 7   Very much

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[insert page break]

For each of the pairs of words below, please circle the number that best describes your evaluation of the media experience.

Impersonal   1 2 3 4 5 6 7   Personal

Unsociable   1 2 3 4 5 6 7   Sociable

Insensitive   1 2 3 4 5 6 7   Sensitive

Dead   1 2 3 4 5 6 7   Lively

Unresponsive   1 2 3 4 5 6 7   Responsive

Unemotional   1 2 3 4 5 6 7   Emotional

Remote   1 2 3 4 5 6 7   Immediate

Please use the space below to provide your comments about the media experience:

_____

_____

_____

_____

_____

_____

_____

_____

_____

[insert page break]

[This is the Immersive Tendencies Questionnaire (Witmer & Singer, 1998).]

For the next section, please circle the responses that best represent your answers. Please consider the entire scale when making your responses, as the intermediate levels may apply. For example, if your response is once or twice, the second number from the left should be circled. If your response is many times but not extremely often, then the sixth (or second number from the right) should be circled.

1.　　　　Do you easily become deeply involved in movies or TV dramas?

　　　　　1　　2　　3　　4　　5　　6　　7

　　　　　NEVER　　　OCCASIONALLY　　　OFTEN

2.　　Do you ever become so involved in a television program or book that people have problems getting your attention?

　　　　　1　　2　　3　　4　　5　　6　　7

　　　　　NEVER　　　OCCASIONALLY　　　OFTEN

3.　　　　How mentally alert do you feel at the present time?

　　　　　1　　2　　3　　4　　5　　6　　7

　　　　NOT ALERT　　　MODERATELY　　FULLY ALERT
　　　　　　　　　　　　　　ALERT

4.　　Do you ever become so involved in a movie that you are not aware of things happening around you?

　　　　　1　　2　　3　　4　　5　　6　　7

　　　　　NEVER　　　OCCASIONALLY　　　OFTEN

5.　　How frequently do you find yourself closely identifying with the characters in a storyline?

1   2   3   4   5   6   7

NEVER   OCCASIONALLY   OFTEN

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[insert page break]

6.   Do you ever become so involved in a video game that it is as if you are inside the game rather than moving a joystick and watching the screen?

1   2   3   4   5   6   7

NEVER   OCCASIONALLY   OFTEN

7.   How physically fit do you feel today?

1   2   3   4   5   6   7

NOT FIT   MODERATELY   EXTREMELY
               FIT   FIT

8.   How good are you at blocking out external distractions when you are involved in something?

1   2   3   4   5   6   7

NOT VERY   SOMEWHAT   VERY GOOD
GOOD   GOOD

9.   When watching sports, do you ever become so involved in the game that you react as if you were one of the players?

1   2   3   4   5   6   7

NEVER   OCCASIONALLY   OFTEN

10.   Do you ever become so involved in a daydream that you are not aware of things happening around you?

1   2   3   4   5   6   7

NEVER OCCASIONALLY OFTEN

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[insert page break]

11. Do you ever have dreams that are so real that you feel disoriented when you awake?

     1 2 3 4 5 6 7

     NEVER OCCASIONALLY OFTEN

12. When playing sports, do you become so involved in the game that you lose track of time?

     1 2 3 4 5 6 7

     NEVER OCCASIONALLY OFTEN

13. How well do you concentrate on enjoyable activities?

     1 2 3 4 5 6 7

    NOT AT ALL MODERATELY VERY WELL
          WELL

14. How often do you play arcade or video games? (OFTEN should be taken to mean every day or every two days, on average.)

     1 2 3 4 5 6 7

     NEVER OCCASIONALLY OFTEN

15. Have you ever gotten excited during a chase or fight scene on TV or in the movies?

     1 2 3 4 5 6 7

     NEVER OCCASIONALLY OFTEN

[insert page break]

16.   Have you ever gotten scared by something happening on a TV show or in
      a movie?

          1   2   3   4   5   6   7

          NEVER   OCCASIONALLY   OFTEN

17.   Have you ever remained apprehensive or fearful long after watching a
      scary movie?

          1   2   3   4   5   6   7

          NEVER   OCCASIONALLY   OFTEN

18.   Do you ever become so involved in doing something that you lose all track
      of time?

          1   2   3   4   5   6   7

          NEVER   OCCASIONALLY   OFTEN

[insert page break]

[This is the ITC-Sense of Presence Inventory (Lessiter et al., 2001).]

Please read the instructions below before continuing.

Instructions:

We are interested in finding out what you feel about the experience you have just
had in the 'DISPLAYED ENVIRONMENT'. We use the term 'displayed
environment' here, and throughout this next section, to refer to the film, video
game that you have just encountered. Some of the questions refer to the
'CONTENT' of the displayed environment. By this, we mean the story, scenes or
events, or whatever you could see, hear, or sense happening within the
displayed environment. The displayed environment and its content (including

representations of people, animals, or cartoons, which we call 'CHARACTERS')
are different from the 'REAL WORLD': the world you live in from day-to-day.
Please refer back to this page if you are unsure about the meaning of any
question.

There are two parts to this section of the questionnaire: PART A and PART B.
PART A asks about your thoughts and feelings <u>once the displayed environment
was over</u>. PART B refers to your thoughts and feelings <u>while you were
experiencing</u> the displayed environment. Please do not spend too much time on
any one question. Your first response is usually the best. For each question,
choose the answer CLOSEST to your own.

Please remember that there are no right or wrong answers – we are simply
interested in YOUR thoughts and feelings about the displayed environment.
Please do not discuss the questionnaire with anyone who may also complete it,
as this may affect your answers or theirs.

All of your responses will be treated confidentially.

<div align="center">Page 10 of 15</div>

<div align="center">[insert page break]</div>

<div align="center">**PART A**</div>

**Please indicate HOW MUCH YOU AGREE OR DISAGREE with each of the
following statements by circling just ONE of the numbers using the 5-point
scale below for each statement.**

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
1	2	3	4	5

<u>**AFTER**</u> **MY EXPERIENCE OF THE DISPLAYED ENVIRONMENT…**

1. I felt sad that my experience was over. 1   2   3   4   5

2. I felt disoriented. 1   2   3   4   5

3. I had a sense that I had returned from a journey. ....

                                              1   2   3   4   5

4. I would have liked the experience to continue. ....

                                                1   2   3   4   5

5. I vividly remember some parts of the experience. ....

                                                1   2   3   4   5

6. I'd recommend the experience to my friends. ....

                                                1   2   3   4   5

[insert page break]

PART B

Please indicate HOW MUCH YOU AGREE OR DISAGREE with each of the following statements by circling just ONE of the numbers using the 5-point scale below for each statement.

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
1	2	3	4	5

<u>DURING</u> MY EXPERIENCE OF THE DISPLAYED ENVIRONMENT…

1. I felt myself being 'drawn in'. 1   2   3   4   5

2. I felt involved (in the displayed environment). ....

                                                1   2   3   4   5

3. I lost track of time. 1   2   3   4   5

4. I felt I could interact with the displayed environment. ....

                                     1   2   3   4   5

5. The displayed environment seemed natural. ....

                                     1   2   3   4   5

6. It felt like the content was 'live'. 1   2   3   4   5

7. I felt that the characters and/or objects could almost touch me. ....

                                     1   2   3   4   5

8. I enjoyed myself. 1   2   3   4   5

9. I felt I was visiting the places in the displayed environment. ....

                                     1   2   3   4   5

10. I felt tired. 1   2   3   4   5

11. The content seemed believable to me. 1   2   3   4   5

12. I felt I wasn't just watching something. 1   2   3   4   5

[insert page break]

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
1	2	3	4	5

DURING MY EXPERIENCE OF THE DISPLAYED ENVIRONMENT…

13.　　I had the sensation that I moved in response to parts of the displayed environment. ....　1　　2　　3　　4　　5

14. I felt dizzy. ....　1　　2　　3　　4　　5

15. I felt that the displayed environment was part of the real world. ....

1　　2　　3　　4　　5

16. My experience was intense. ....1　　2　　3　　4　　5

17. I paid more attention to the displayed environment than I did to my own thoughts (e.g., personal preoccupations, daydreams etc.). ....
1　　2　　3　　4　　5

18. I had a sense of being in the scenes displayed. ....

1　　2　　3　　4　　5

19. I felt that I could move objects (in the displayed environment). ....

1　　2　　3　　4　　5

20. The scenes depicted could really occur in the real world. ....

1　　2　　3　　4　　5

21. I felt I had eyestrain. ....　1　　2　　3　　4　　5

22. I could almost smell different features of the displayed environment. ....

1　　2　　3　　4　　5

23. I had the sensation that the characters were aware of me. ....

1　　2　　3　　4　　5

24. I had a strong sense of sounds coming from different directions within the displayed environment. ....　1　　2　　3　　4　　5
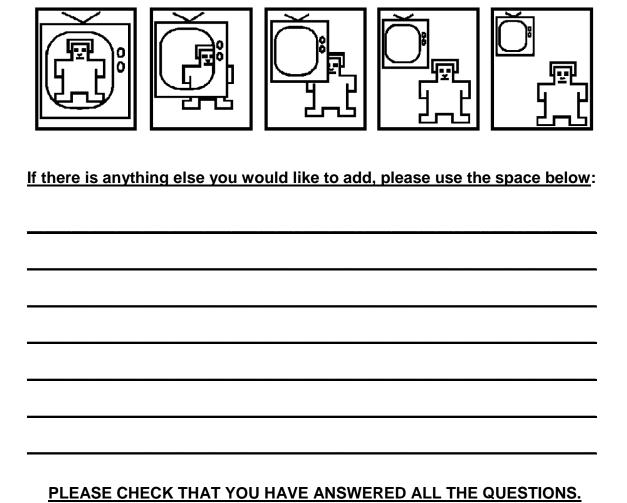
25. I felt surrounded by the displayed environment. ....

                                                         1   2   3   4   5

26. I felt nauseous. 1   2   3   4   5

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[insert page break]

Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
1	2	3	4	5

<u>DURING</u> MY EXPERIENCE OF THE DISPLAYED ENVIRONMENT…

27.   I had a strong sense that the characters and objects were solid. ....

                                                         1   2   3   4   5

28.   I felt I could have reached out and touched things (in the displayed

environment). 1   2   3   4   5

29. I sensed that the temperature changed to match the scenes in the

displayed environment. 1   2   3   4   5

30. I responded emotionally. 1   2   3   4   5

31. I felt that all my senses were stimulated at the same time. ....

                                                          1   2   3   4   5

32. The content appealed to me. 1   2   3   4   5

33. I felt able to change the course of events in the displayed environment. ....
                                                 1   2   3   4   5

34. I felt as though I was in the same space as the characters and/or objects.

          1   2   3   4   5

35. I had the sensation that parts of the displayed environment (e.g., characters or objects) were responding to me.   1   2   3   4   5

36. It felt realistic to move things in the displayed environment.

          1   2   3   4   5

37. I felt I had a headache.   1   2   3   4   5

38. I felt as though I was participating in the displayed environment.

          1   2   3   4   5

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[insert page break]

Please use the figures below to indicate your feelings or emotional response to the media experience. The pictures go from a person who feels he or she is INSIDE THE PICTURE, A PART OF THE STORY, A PART OF THE ACTION on the left end, to a person who feels he or she is OUTSIDE THE PICTURE, REMOVED OR SEPARATED FROM THE STORY, NOT PART OF THE ACTION on the right end. Please put an 'X' through the picture that best represents how you felt during the media experience.

[This is the Self-Assessment Manikin (Wissmath et al., 2010).]

If there is anything else you would like to add, please use the space below:

_____

_____

_____

_____

_____

_____

_____

PLEASE CHECK THAT YOU HAVE ANSWERED ALL THE QUESTIONS.

THANK YOU VERY MUCH FOR YOUR TIME AND PARTICIPATION.

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Appendix B – Consent Form

You are invited to participate in a research study (IRB number 16-2054) conducted by Michael Chen, from the University of North Carolina at Chapel Hill, School of Information and Library Science. I hope to learn more about what it is like to play video games.

If you decide to participate, you will play a round of *Super Smash Bros. Brawl* against a computer opponent. Then, you will fill out a brief questionnaire and complete a visual memory task. The entire procedure should last about 15 minutes.

Your participation will help contribute to the body of knowledge in this field. Though I cannot guarantee that you personally will receive any benefits from this research, I would sincerely appreciate your participation.

Any information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission or as required by law. Participant identities will be kept confidential by identifying participant data only through a randomly generated number. In addition, all signed consent forms will be securely destroyed at the conclusion of this study.

Your participation is voluntary. Your decision whether or not to participate will not affect your relationship with the University of North Carolina at Chapel Hill. If you decide to participate, you are free to withdraw your consent and discontinue participation at any time without penalty.

If you have any questions about the study, please feel free to contact me via email at Michael.Chen.0@gmail.com. My advisor, Dr. Brian Sturm, may also be contacted at bstrum@ils.unc.edu. If you have questions regarding your rights as a research subject, please contact the Institutional Review Board (IRB) via email at IRB_subjects@unc.edu or via phone at 919-966-3113.

You will be offered a copy of this form to keep.

Your signature below indicates that you have read and understand the information provided above, that you willingly agree to participate, that you may withdraw your consent at any time and discontinue participation without penalty, that you will receive a copy of this form, and that you are not waiving any legal claims.
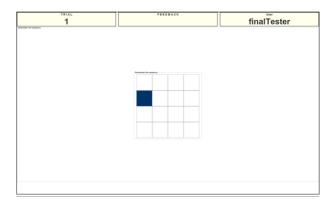
Print name _____

Signature _____ Date _____

In a moment, you will be playing *Super Smash Bros. Brawl* against a single computer opponent. Please choose what level of difficulty you would like your opponent to be (circle one):

1	2	3	4	5	6	7	8	9

Easiest   Hardest

Appendix C – Visuospatial Working Memory Task Instruction Sheet

You will be shown a **4 x 4 matrix** in the center of the screen.

A number of the grids in this matrix will **turn blue** one at a time (between 2 and 5 grids in any one trial).
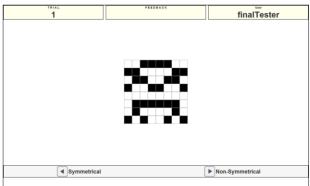
The image below shows an example of what the matrix looks like while one of the grids is colored.
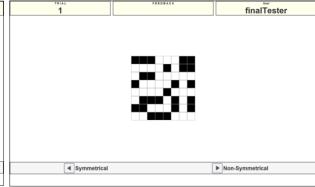

After seeing the grids light up, you will then be shown a new matrix in the middle of the screen with a filled pattern.

You need to **decide if this pattern is symmetrical or not**.

The images below show an example of each. The left image is a **symmetrical** pattern while the right image is a **non-symmetrical** pattern. Use the **left and right arrow keys** to give your judgment.

Press the **left arrow key** if the pattern is **symmetrical**.

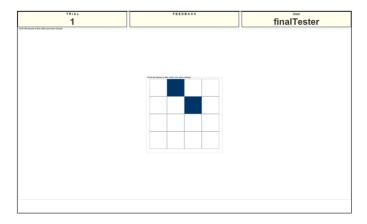Press the **right arrow key** if the pattern is **non-symmetrical**.

After you have been shown the grids to remember and have judged the symmetry of the pattern, you will be presented with an empty grid that you can use to input your response.

Simply **TAP *or* CLICK the grids in the ORDER** you remember seeing them light up.

Once you click a grid, it will change color to indicate that you have selected it.

The image below shows an example of what the task looks like while somebody is midway through inputting their response.

Remember that a trial is only completely correct if your symmetry judgments are also accurate; both parts of the trial contribute to your score.

There will be a total of 20 trials.

<div align="center">

Press the **right arrow key** to start the task.

</div>

Appendix D – Standard Procedure

1. Participant arrives.

2. Say, "Thank you for coming in today. Before we begin, please sign this consent form. Your participation is voluntary and you may stop at any time. Please let me know when you have finished with the consent form."

3. [Hand the participant a pen, a clipboard, and a copy of the consent form.]

4. Participant finishes with the consent form.

5. [Collect the consent form and check what level opponent the participant would like to play against.]

6. Say, "Thank you. You are about to begin the gameplay portion of this study. Please close your eyes and take a few deep breaths while I finish setting up the room. I will let you know when the room is ready for you."

7. [Begin the timer. Open the playing room door, enter, and then close the door. Set the computer's level. If the participant is in the treatment condition, unmute the television. Exit the playing room and close the door. Wait for the timer to expire.]

8. Say, "Thank you for waiting."

9. [Open the playing room door.]

10. Say, "Please go in and have a seat. You may select a character using the joystick in your left hand and the green A button. After you have selected a character, please press the Start button in the center of the controller to begin. Please let me know when the match is over."

11. [Wait for participant to sit down. Exit the room and close the door. Prepare the questionnaire and a pen.]

12. Participant finishes the match.

13. Say, "Thanks for playing. Please complete this questionnaire and let me know when you are done."

14. [Give participant the questionnaire, a clipboard, and a pen. Turn off the television. Prepare the visuospatial working memory task.]

15. Participant finishes the questionnaire.

16. Say, "Thank you. You're almost done. In a moment, you will be asked to complete the task described on the instruction sheet I am about to give you. Please read the instructions carefully and try your best. Once you understand the instructions, you may press the right arrow key to begin."

17. [Give the participant a copy of the instruction sheet. Stand aside and wait for the task to complete.]

18. Say, "Thank you for your participation. This study was concerned with the phenomenon of presence, which is a sense of being there in a virtual environment, and how sound effects influence this feeling. Here is a copy of the consent form you signed earlier."

19. [Give the participant a blank copy of the consent form.]

20. Say, "Thank you again. You are free to go."

21. Participant leaves.

22. Reset the playing room. Wipe down the controller. Check all game settings again.

Appendix E – Participant Comments

Participants in the mute condition:

TPI	ITC-SOPI
It moved quite quickly but seemed to draw you in due to the speed of the game.	I didn't feel that I was in the picture but felt I could control the outcome if tried harder.
I love this game!	I feel that I'm not in the environment but I can feel the same with the character I play.
I was focused and engaged with the task at hand, but I wouldn't say I felt departed from reality outside of the video game. I was aware of my setting and the timer helped me keep track of time so that I never quite "lost myself" or felt fully immersed.	I felt engaged and attentive but not immersed in the sense that I felt like I was present somewhere other than the testing room. I don't think I was sensing enough things (e.g. hearing, smelling, etc.) directly from the game to really pull me away from the "real world". Also, the game isn't meant to get the player acquainted with the character's personalities and there is no plot to follow so my mind was not occupied with those things and so I could still pay attention to my "real world" surroundings.
There was no one else in the room & it was dark. The game was fun and the T.V. nice. It did not feel personal/social/unemotional.	I found some of the questions confusing / was not sure how to interpret some of them.
I FEEL LIKE THIS EXPERIENCE WAS NOT AS REAL OR "LOOKING THROUGH A WINDOW" TYPE BECAUSE OF THE CHARACTERS AND SITUATION. TO ME, IT IS NOT REALISTIC FOR A PRINCESS AND LUIGI TO FIGHT, AND FALL OFF OF CLIFFS ONLY TO LIVE AGAIN. IT WAS FUN BUT I'VE NEVE REALLY BEEN ABLE TO GET INTO VIDEO GAMES.	THE GAME WAS FUN, BUT DID NOT FEEL REAL IN ANY WAY TO ME. I WAS VERY AWARE THAT I WAS IN A UNC BUILDING STILL

All games I have ever played, I always had sound. With this game, there was no sound, so it felt very 1-Dimensional, whereas games usually at least feel 3-Dimensional. So sound is important to me. Not understanding these controls (I am a PS4 + X-box) also took away from any immersion I usually feel while playing these types of games.	This game itself is not at all the type I usually play, and in fact I avoid. I hate fighting games like this, so automatically I was completely dissasociated from any story-line or feelings games usually engender in me. If this was Fall-Out New Vegas, this questionnaire would have been completely different in my responses.
Fast, confusing, colorful	
I felt that the lack of sound was the most jarring and unrealistic aspect of the experience, especially considering I knew sound should have been present.	
Interesting. Never played the game. Unsure how to fight the CPU.	
It bugged me that I had no sound during the match. I've played Brawl a lot and not having sound threw me off a bit. I also haven't played in several months and over judged my capabilities.	
It was a roller coaster of muscle twitching. Goodness…	
Sound was a little too quiet, which may have impacted my ability to engage w/ the media.	
The fact that the CPU fighter wasn't really a character definitely played a role in making the experience feel more removed.	
The media experience held my attention & immersed me into the environment of the game.	
There was no sound but the speed of the game gave it a sense of urgency/immediacy.	

Participants in the sound effects only condition:

TPI	ITC-SOPI
MY CHARACTER WAS WEARING A MECHA SUIT AND THE OTHER WAS LIKE STICK FIGURE.. SO NOT MUCH EMOTION THERE.	DIDN'T KNOW THE MOVES. SPENT MOST OF THE TIME TRYING TO FIGURE THOSE OUT. WAS MORE MENTAL THAN NATURAL.
	Have you ever implies a yes or no answer (not a 1-7 answer) I was unsure if "I" or "me" in the question was referring to me physically or the character I was playing as.
The experience was engaging yet distant, odd combination. Could have been a result of the removed music.	I was a part of the action in a sense that I controlled a part of it but the majority was not up to me
	I've never play this game before, or much of any video game. Two characters fighting each other is not something that appeals to me. At the start of the game, I didn't even know how to use the game control. After I figure out a little how the control works, I became interested. To my surprise, my character won, and I became much more interested. I felt I would like to try to play it hte 2nd time because I won. And it felt like I played the game longer than 5 minutes.
Lucario's pretty good	not the most immersive game
I COULDN'T UNDERSTAND WHY THE OPPONENT HAD SPECIAL TOOLS TO USE - IN THIS CASE AMMO + BARBELLS - AND MY CHARACTER EITHER FOUGHT WITHOUT THEM, OR WHETHER I WAS UNABLE TO ENGAGE WUCH TOOLS DUE TO MY NASCENT FAMILIARITY W/ THE GAME, HAVING ONLY PLAYED IT ONCE BEFORE.	SOME of THE QUESTIONS, SUCH AS #11 + #12 SUPPLY A SCALE of ANSWERS THAT CAN BE WORDED BETTER. ALSO THE "YOU" "ME" STUFF COULD BE BETTER EXPRESSED AS IF IT REFERRED TO ME, AS A PERSON, OR ME AS A CHARACTER IN THE GAME.

The media experience provided me with immersive gameplay and audio. The light dimness offered a very cinematic experience as well. I was not entirely immersed because the screen projection was not the highest fidelity and the game play felt awkward at times. Once I got the hang of the controls, moving my character and attacking was much easier and I felt more in control.	The distance from the screen was one of the main reasons I did not feel totally immersed. Sound was loud & responsive and animation fidelity seemed slightly low.
It's exciting, and longer than I had expected, and not too hard.	Wish I had a chance to learn the game
I liked being in the dark, it made me feel very immersed in the experience. I noticed there wasn't any music, but I didn't mind! I have a personal rivalry with samus, so the experience against CPU Samus was emotional	Yeah, I don't feel like smash bros really has a story that I felt immersed in or that I could physically touch the characters, but it was definitely fun and immersive!
1. Description of pictures is confusing i.e. in writing there are 6 descriptions when only 5 are shown 2. excessive commas, Best to list description or use term "respectively" & have matching pics --> A. B. C. □A □B □C 3. For the last scale used (strongly disagree - strongly agree) I would have like to have had a "somewhat" agree/disagree	
An immersing experience.	
As I became more able to move my character and get him to do what I wanted when I wanted, the more immersive the experience became. The vibration of the hand set made the experience seem more realistic.	

I didn't really feel there was a story to be immersed in, but I got attached to (and talked to) my character anyway. Part of that was laughing at myself, though - I'm notoriously bad at video games. I'd probably describe it as escapist rather than immersive; I didn't feel like I was there, but it did take me away from the present for a few minutes.	
I got demolished by the CPU and got competitive so talked a lot… didn't seem real but was engaging	
It was a good break from my day to distract me from other things going on. It felt long but at the end I wanted to keep playing.	
Level 9 Brawl is different from Melee! Ike does not work well on Pikachu. There is a disconnect between the experience of "interacting" with the things in the game and with the physical objects outside of it… I was aware of the experience, the act of playing the game through the physical controller, and was immersed in that I was focused on adapting to try and win.	
The activity was very engaging when proposed. The actions required to complete the activity, however, felt very delayed. Asides from this, my other senses (sight, hearing,) were very engaged.	