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Tilo Hartmann, Werner Wirth, Holger Schramm, Christoph Klimmt ...+8 more authors

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The Spatial Presence Experience Scale (SPES):

A Short Self-Report Measure for Diverse Media Settings

Rapid advances in communication technologies have changed the way that people use and experience media. New videoconferencing systems like Cisco's TelePresence Suit™ , video games, 3d-movies, and high-definition television are typical examples of such media change. A basic concept that emerged with growing research examining new media is *spatial presence* (Lombard & Ditton, 1997; "physical presence," Lee, 2004; "telepresence," Draper, Kaber, & Usher, 1998).[1] Spatial presence can be briefly defined as the user's subjective feeling of "being there" in the space displayed by a medium (ISPR, 2001; IJsselsteijn & Riva, 2002; Sheridan, 1992; Slater & Wilbur, 1997). The concept emerged from the observation that users of virtual reality systems feel physically located in the mediated space (Slater & Steed, 2000; Steuer, 1992), but other research suggests that users can also feel spatially present while using video games (Tamborini & Skalski, 2006), television (Bracken, 2005), and even books (Schubert & Crusius, 2002).

Spatial presence is considered an important concept in both psychology (Blascovich et al., 2003) and communication science (Lee, 2004). It has been linked to relevant constructs such as learning (e.g., Tichon, 2007), therapeutical issues (Robillard, Bouchard, Fournier, & Renaud, 2003), social behavior (Yee & Bailenson, 2007) including aggression (Eastin & Griffiths, 2006), enjoyment (e.g., Tamborini & Skalski, 2006), and the effectiveness of advertisement (Jin, 2010). Various measurements to assess spatial presence have been proposed in the past (Insko, 2002; Laarni, Ravaja, Saari et al., in press). Because spatial presence is considered a conscious experience or feeling (e.g., Biocca, 1997; Lombard & Ditton, 1997; Sheridan, 1992; Schubert, 2009; Witmer, Jerome, & Singer, 2005), subjective self-report measures represent an important branch. Although several self-report measures of spatial presence exist, the "market" still offers a niche for a short, easily and flexibly applicable, and theoretically substantiated scale. In the present article, we introduce such a measure: the Spatial Presence Experience Scale (SPES).

SPES rests on a theoretical model of spatial presence (Wirth et al., 2007), it is short (8 items), and it can be applied to diverse media settings. We report two studies (N_1 = 290, N_2 = 395) that confirm sound psychometric qualities of SPES and discuss the scale's practicability and applicability.

Review of Existing Self-Report Measures of Spatial Presence

Researchers concerned with the study of spatial presence are able to choose from various self-report tools (see for overviews Laarni et al., in press; Schuemi, van der Straaten, Krijn, & van der Mast, 2001). According to our own experience, the most popular tools designed to assess spatial presence include the Presence Questionnaire (Witmer & Singer, 1998; Witmer et al., 2005), the Independent Television Commission - Sense of Presence Inventory (Lessiter, Freeman, Keogh & Davidoff, 2001), the Igroup Presence Questionnaire (Schubert, Friedmann, & Regenbrecht, 2001), and the Temple Presence Inventory (TPI, Lombard, Ditton, & Weinstein, 2009). Subscales of these tools can also be used as short measures of spatial presence. In addition, scholars proposed stand-alone short measures of spatial presence (Hendrix & Barfield, 1996; Kim & Biocca, 1997; Slater, Usoh, & Steed, 1995).

Existing Popular Scales of Spatial Presence

PQ. The *Presence Questionnaire* (PQ) was developed to measure spatial presence in immersive virtual environments that allow users to navigate through sceneries conveyed by highly immersive technology (e.g., head-mounted displays). The PQ not only aims to assess the intensity of spatial presence as a state, but also strives to assess contributing factors (Witmer & Singer, 1998, p. 230). A second version of the PQ (Witmer & Singer, 1998) consisted of 17 items that could be collapsed into a total Presence score (α = .88). Witmer and Singer (1998) report a significant negative correlation between the PQ total score and the Simulator Sickness Questionnaire (Kennedy, Lane, Berbaum, & Lilliental, 1993), indicating the validity of the PQ. However, subsequent assessments of the validity of the PQ yielded mixed results (Youngblut & Perrin, 2002; Nystad & Sebok, 2004; Johns et al., 2000). More recently, Witmer et al. (2005)

proposed a revised third version of the PQ with several additional items. Data pertaining to 325 users of immersive virtual environments resulted in a four-factor solution that included 29 items. The four factors were labeled involvement (i.e., a "focusing one's mental energy and attention on the stimulus," p. 308), sensory fidelity (i.e., the accuracy of sensory stimulation), adaptation/immersion (i.e., "perceiving oneself to be enveloped by, included in, and interacting with an environment […]," p. 308), and interface quality (i.e., the degree to which "display devices interfere/distract from task performance," p. 299).

The PQ is well suited to assess users' experiences in interactive virtual reality systems, particularly if users perform a task. Potential problems associated with the PQ, however, may include its narrow scope (i.e., wording is bound to *interactive* virtual environments; see Lessiter et al., 2001), a mix of states of spatial presence (e.g., feeling immersed) and determinants (e.g., identification of sounds), the absence of an explicated theoretical basis of spatial presence (Waller & Bachmann, 2006), and mixed findings regarding the validity of the measure.

IPQ. As with the PQ, the *Igroup Presence Questionnaire* (IPQ; Schubert et al., 2001; Schubert, 2003) aims to measure spatial presence as a sense "of being there" in interactive virtual environments. The 13-item IPQ was derived based on both explorative and confirmative factor analyses conducted in two survey studies (N = 246 and N = 296). Although embedded in an intriguing conceptualization of spatial presence ("embodied cognition framework;" Schubert et al., 2001, p. 267; Schubert, Friedmann, & Regenbrecht, 1999), the IPQ's initial item pool consisted of 75 items mainly sourced from existing presence questionnaires. The IPQ measures three potential subcomponents of presence (Schubert, 2003): spatial presence (being surrounded by the VE, directly interacting in it […], and a sense of transportation to another place, p. 70), involvement (focusing on the VE instead of focusing on the real world, p. 70), and realness (how real the VE is judged to be, p. 70). The scales yielded acceptable internal consistency (all $\alpha > .62$; Schubert, 2003), and the results of experimental tests support the validity of the IPQ (Schubert, 2003; Regenbrecht & Schubert, 2002). The IPQ builds on sound methodological steps, although the strong theoretical conceptualization is not fully reflected in the approach. Consequently, only one of the three IPQ subscales actually measures spatial presence, whereas *involvement* and *realness* may address closely related constructs or determinants rather than actual sub-dimensions of spatial presence.

ITC-SOPI. The *Independent Television Commission - Sense of Presence Inventory* (ITC-SOPI; Lessiter, Freeman, Keogh, & Davidoff, 2001) was designed to assess spatial presence across different types of media. The ITC-SOPI was developed based on an initial pool of 63 items (p. 287) collected to indicate “possible manifestations of different content areas deemed relevant to presence” (p. 287), such as a sense of space, attention, and potential negative effects. In a study involving 604 subjects and based on explorative factor analyses, a four-factor solution (with a total of 43 items) was chosen "that made the most conceptual sense" (p. 290). The four subscales address a sense of physical space (physical placement in the mediated environment, and interaction with the environment), engagement (feeling psychologically involved and enjoying the content), ecological validity (perceiving the mediated environment as lifelike and real), and negative effects (“adverse physiological reactions,” p. 290). Internal consistency is not reported for the final scales, but previous versions yielded α values > .76. Preliminary evidence reported by Lessiter et al. (2001) supports the validity of the scales. In summary, the ITC-SOPI is a frequently used spatial presence scale that can be applied to various types of media. With 43 items it is a rather lengthy measure, however. In addition, some of the four inductively derived factors (e.g., negative effects) may not resemble theoretically meaningful dimensions of spatial presence.

Existing Short Scales of Spatial Presence

Hendrix and Barfield (1996) applied a *two-item measure* to assess spatial presence in virtual environments. One item asked participants to directly rate their sense of presence: “If your level in the real world is 100, and your level of presence is 1 if you have no presence, rate your level of presence in this virtual world”. Another item asked participants on a five-point scale how strongly they felt a sense of presence or "being there" in the virtual environment. Both items were applied in a smaller experimental study (*N* = 12) that tested effects of technological manipulations (e.g., monoscopic versus stereoscopic display) on spatial presence. These manipulations significantly affected both items. In addition, items were correlated with a measure of realism. The two-item measure by Hendrix and Barfield is very short and preliminary evidence supports its validity. However, both items still need to be validated at bigger samples and more extensive psychometric testing seems necessary. In addition, the wording of the first item is quite complicated and may be difficult to understand for some participants (Lessiter et al., 2001).

Kim and Biocca (1997) developed an *eight-item measure* of spatial presence, understood as a sense of being transported to the media world. The scale was applied in a two (presence of real-world visual stimuli: yes, no) x three (viewing angle: low, medium, high) between-subjects experiment on spatial presence in television exposure (*N* = 96). Unexpectedly, a factor analysis of the scale suggested two factors that distinguished positive from negative items. Accordingly, one factor was interpreted as "arrival – or being in the media environment", the other as "departure – or not being present in the media environment". All but one item had only marginal cross-loadings. Unfortunately, the measure did not respond to the experimental manipulation. The scale by Kim and Biocca follows an interesting approach, but contrary to expectations, it did not assess a unidimensional construct. In addition, the non-significant findings of the experiment provide a serious challenge for the validity of the scale.

Slater, Usoh and Steed (1995) developed another short measure of spatial presence, the *Slater-Usoh-Steed (SUS) questionnaire*. The SUS exists in an (older) three-item version (Slater, Usoh, & Steed, 1994, 1995) and in a more recent six-item version (Usoh, Catena, Arman, & Slater, 2000). The original three items assess on a seven-point scale users' sense of being in a virtual environment, the extent to which the virtual environment becomes the dominant reality, and to which users feel like visiting somewhere rather than seeing pictures of something. In a small experiment by Slater et al. (1995, $N = 16$), participants scored higher on the three-item SUS if they navigated through a virtual environment by naturally walking "in a place" in the lab than if navigating with a more artificial device, i.e., by pressing a mouse button. The SUS has been applied in a range of other studies, usually with satisfactory results supporting its validity (e.g., Bormann, 2005). In a study that applied the six-item version of the SUS (Usoh et al., 2000, $N = 20$), only two of the six items successfully discriminated a sense of spatial presence in the real world from a sense of spatial presence in a virtual environment. In addition, the six-item SUS was not significantly correlated with Witmer and Singer's (1998) PQ among participants using a virtual environment.

Concluding Remarks About Existing Spatial Presence Scales

Researchers developed a couple of valuable measures in the past to assess spatial presence. All of these measures contributed to progress in the field (Laarni et al., in press; Schuemi et al., 2001) and helped to advance towards a standardized assessment of spatial presence. From a more critical point of view, a couple of caveats can be noted, however. Only a few of the published scale developments included an extensive testing of the scale's psychometric qualities (e.g., IPQ or ITC-SOPI). Accordingly, it is difficult to evaluate the quality of the some of the existing measures. Furthermore, some of the existing scales, like the PQ, IPQ, or ITC-SOPI, were derived based on an inductive approach, relying on factor analyses. Inductive approaches to scale development, however, have not been free of criticism (Clark & Watson, 1995; Cronbach & Meehl, 1956; Smith et al., 2003; Waller & Bachmann, 2006). The dimensions of some of the inductively derived measures may not necessarily represent the spatial presence concept, but may also be the result of methodological factors (Witmer et al., 2005; Waller & Bachmann, 2006). For example, little has been said in theory regarding "negative effects" (as assessed by the ITC-SOPI) as a dimension of spatial presence. And the *realism* subscale of the IPQ or the *interface quality* subscale of the PQ may rather capture determinants than dimensions of spatial presence.

The present approach introduces the SPES as an alternative short measure of spatial presence experiences.[2] In contrast to the ITC-SOPI and IPQ, the SPES is derived based on a deductive rather than inductive approach. In contrast to the SUS that focuses on immersive virtual environments, the SPES is particularly designed and tested as a measure of spatial presence across diverse media settings.

Theoretical Foundations of SPES

SPES builds on a process model of the formation of spatial presence experiences proposed by Wirth et al. (2007; see for empirical confirmations Hofer, Wirth, Kühne, Schramm, & Sacau, 2012), which was subsequently further enhanced by Schubert (2009) and by Wirth, Hofer and Schramm (2012). Within the present approach, the model helps to achieve two things. First, it provides a theoretical view on the actual phenomenon, i.e., spatial presence, and offers information about its dimensionality and characteristics. Second, the model explicates determinants of spatial presence. Accordingly, it embeds spatial presence within a nomological network (Cronbach & Meehl, 1955) of potentially correlated concepts. Hypotheses derived from this nomological network will allow to test the validity of the SPES.

Akin to other approaches (Herrera, Jordan, & Vera, 2005; Kim & Biocca, 1997; Schellenberg, 2007; Schubert, 2009; Slater, 2002), in the Wirth et al. model, spatial presence is understood as a user's experience of being located within a space depicted by the media environment instead of the real environment. It is assumed that this shift in self-location also implies a shift in perceived action possibilities. Accordingly, if spatially present, users are assumed to perceive possible actions within the media environment rather than their real environment.

The Wirth et al. model conceptualizes a shifted self-location but also a shifted perception of action possibilities as dimensions of spatial presence. In this respect, the Wirth et al. model resembles the embodied-cognition-based approach towards spatial presence proposed by Schubert et al. (1999, 2001). According to this view, spatial presence arises if users focus on a media stimulus and develop a spatial mental model of the virtual environment and their perceived possible actions in it. Accordingly, users feel spatially present if they mentally represent actions of their own body in the virtual world (Schubert, 2009). The crucial role of perceived action possibilities for spatial presence experiences is stressed in both approaches.

Determinants of Spatial Presence

The Wirth et al. model argues that spatial presence emerges on the basis of two critical steps. First, users need to develop a mental model of the space depicted by a media offering. This spatial mental model is regarded a necessary albeit not sufficient precondition of spatial presence. Second, users may accept the spatial model as their own egocentric viewpoint. If they do, spatial presence is assumed to emerge. According to the Wirth et al. model, the process of accepting a spatial mental model is unconscious and automatic. The acceptance process is assumed to follow the mechanisms outlined in the context of perceptual hypothesis testing (Bruner & Postman, 1949). Accordingly, it is assumed that users automatically activate the most convincing - i.e. consistent, error-free, evident - spatial model from existing alternatives to define their egocentric viewpoint. Spatial presence occurs if users accept the spatial model inferred from the media environment as their own egocentric viewpoint, and drop the model bound to the real environment. Accordingly, the model by Wirth et al. assumes that *spatial presence increases the more concise (consistent, error-free, evident) the spatial mental model that users develop* (H1). If spatially present, users will feel like being physically located within the media environment and perceive their action possibilities within the mediated rather than the real environment. They will feel like if they could actually take part in the action of the media presentation, rather than merely observing it.

Across both steps, the Wirth et al. model conceptualizes various determinants of spatial presence. In line with the literature (e.g., Draper et al., 1998; Schubert et al., 2001), attention is considered the most basic determinant of spatial presence. According to the Wirth et al. model, users' attention onto the media stimulus enhances the likelihood that they will develop a convincing spatial mental model based on the media input, and will be shielded from potentially conflicting spatial information from the real-world. Accordingly, the model assumes that *attention onto a spatial media stimulus is positively associated with spatial presence* (H2). One reason why users may direct their attention onto a media stimulus is that they share a general interest in the topic depicted by the stimulus. According to the model, such *a domain-specific interest positively affects (attention and thus) spatial presence* (H3).

In addition, the Wirth et al. model argues that users are more likely to develop convincing spatial mental models the greater their skills to visually imagine spatial sceneries. Spatial imagery skills are an important part of a person's general spatial ability (Hegarty & Waller, 2006). Spatial imagery skills ease the integration of retrieved spatial information and the filling of incomplete spatial information. The ability to produce vivid spatial images should therefore support the development of convincing spatial models derived from the media. Accordingly, the Wirth et al. model hypothesizes that *spatial imagery skills positively affect spatial presence* (H4).

Another determinant of spatial presence outlined in the model is cognitive involvement, which is among the typical factors of spatial presence considered by most researchers (e.g., Lessiter et al., 2001; Schubert, 2003; Witmer & Singer, 1998). Users are cognitively involved if they are preoccupied with the media stimulus and actively try to comprehend the depicted environment. When users are highly involved with media content, their mental capacity is primarily devoted to the media and not to reality. Conversely, the majority of their information processes will be media-related and enrich their spatial mental model. Accordingly, the Wirth et al. model assumes that *cognitive involvement is a positive predictor of spatial presence* (H5).

Furthermore, the model assumes that *users' trait absorption positively influences (involvement and thus) spatial presence (*H6). Trait absorption refers to an individual's motivation and skill in dealing with objects in an elaborate manner (Wild, Kuiken, & Schopflocher, 1995). High-absorption individuals are easily involved in things and "fascinated" without much effort. Trait absorption includes several abilities, of which synesthetic abilities may be most relevant for spatial presence. Synesthetic abilities could cause media stimulation of one sensory channel to trigger sensation across other sensory channels. This may strengthen the vividness of a media stimulus and users' involvement in a media stimulus. Accordingly, higher trait absorption should result in a heightened cognitive involvement in a media offering, and consequently, more intense experience of spatial presence (Wirth, Hofer, & Schramm, 2012).

Spatial Presence in Diverse Media Settings

In line with other conceptual accounts, the Wirth et al. model argues that spatial presence can be experienced in varying degrees while using diverse media, ranging from highly immersive virtual reality systems (Steuer, 1992) to interactive audiovisual video game applications (Tamborini & Skalski, 2006), non-interactive television (Bracken, 2005), and even books (Schubert & Crusius, 2002; Green, Brock, & Kaufman, 2004). Accordingly, the SPES was developed to measure spatial presence across diverse media settings.

Initial Item Pool

Both the construction of SPES items and the empirical test of the scale's quality closely followed recommendations offered in the methodological literature (Bearden, Netemeyer, & Mobley, 1993; Clark & Watson, 1995; DeVellis, 2003). Because the *initial item pool* exerts a strong influence on the validity of the developed instrument (Clark & Watson, 1995), SPES builds on a pool of English-language items inspired by the conceptualization by Wirth et al. (2007). Spatial presence was considered to be a narrow construct, with the two sub-dimensions (self-location and possible actions) covering only a few different facets. The goal was to develop SPES as a short and convenient-to-apply scale consisting of just eight items: four items per subscale. The literature suggests starting with a number of items about twice as large as the anticipated length of the final scale (DeVellis, 2003), especially if the construct is narrow (Clark & Watson, 1995). Accordingly, in the present case the initial item pool comprised 20 items. Ten items reflected users' self-location, ten items reflected their perceived possible actions (see Table 1).

Self-location items included variants of users' feeling of "being there" or "being physically present" in the media environment (SL1 to SL4). Self-location may also imply that users feel like departing from their real environment and feel like stepping into another place (SL5, Kim & Biocca, 1997). The experience of a shifted self-location has been linked to the feeling of being enveloped by or surrounded by a media environment (e.g., Witmer & Singer, 1998). This was reflected in three additional items (SL6 to SL8, e.g., "I was convinced that things were actually happening around me.") Items SL9 and SL10 rephrased the sensation of being enveloped by a medium in a more specific way, by asking users to what extent they "experienced both the confined and open spaces in the presentation as though [they were] really there" and to what extent they were "convinced that the objects in the presentation were located on the various sides of [their] body."

Most possible action items dealt with users' subjective impression that they would be able to carry out actions in the environment (PA2,PA3,PA6) and to manipulate it (PA8,PA9). A set of items specifically referred to the way users perceived action possibilities attached to *objects* presented in the environment (PA1,PA4,PA5,PA7). For example, items captured users impression that they could actually touch objects (PA7) or use them as an utensil (PA1). Some items focused on movement and assessed the extent users felt like it was possible to move around in the environment (PA5,PA10).

All items were phrased in such a way that they could be applied in a post-test after any kind of media exposure. For example, most items simply referred to "the environment of the presentation" in referring to the spatial scenery depicted by the medium. The wording was selected to be clear and non-ambiguous, and each item expressed only a single idea (Spector, 1992, p. 23). Lengthy items were avoided (DeVellis, 1991). All items were designed to be answered on a 5-point Likert scale ranging from 1 (*I do not agree at all*) to 5 (*I fully agree*). The chosen response format (i.e., degree of agreement) was preferred over alternatives such as frequency estimations or duration assessments, because post-test scales are unlikely to accurately assess the latter experiential aspects (Schwarz & Oyserman, 2001).

Study 1

Method

Participants. To choose a final set of items for SPES and to assess the scale's quality, we conducted four one-factorial (distracted vs. non-distracted) between-subjects experiments involving a total of $N = 290$ participants. The sample size met the previously proposed recommendation to sample at least five times more participants than items tested (i.e., 20 items × 5 subjects/item = 100 subjects; Nunnally & Bernstein, 1994; Osborne & Costello, 2004.). Sample size was also close to the general rule-of-thumb in scale developments to work with a sample of at least 300 subjects (Clark & Watson, 1995, p. 314). The four experiments were carried out at three different locations (Los Angeles, USA; Helsinki, Finland; Porto, Portugal) with either native English speakers or students screened for English proficiency. In Finland and Portugal, students were recruited at international schools and from English classes at local universities. The mean age of participants was 21.4 years ($SD = 5.2$; *Min.* = 15 years; *Max.* = 54 years). The majority of the participants were female ($N = 212$, 73.6%).

Each of the four experiments applied a specific medium: a text excerpt from a book or a film (Los Angeles), hypertext (Helsinki), and a virtual environment technology (Porto)[3]. This approach was taken to establish a basis for the cross-media applicability of SPES (see for a similar approach Lessiter et al., 2001). Of the 290 participants, 80 read the linear text, 81 watched the film, 80 read the hypertext, and 49 navigated through the virtual environment. The average ages of subjects in the hypertext sample ($M = 24.4$ years, $SD = 3.7$) and the virtual environment sample ($M = 22.9$ years, $SD = 9.5$) were slightly higher than those in the text and film samples (text: $M = 19.7$, $SD = 3.9$; film: $M = 19.5$, $SD = 1.4$). Gender balance differed between the samples (female subjects: text, 88.5%; film, 84.0%; hypertext, 63.8%; virtual reality, 49.0%).

Experimental manipulation. Each of the four one-factorial experiments involved a distraction-based manipulation of the subjects' attention onto the presented media stimulus. Because attention allocation was considered a crucial determinant of Spatial Presence, distracting participants seemed a plausible way to test the validity of the SPES (Draper et al., 1998; Schubert et al., 2001; Vorderer et al., 2004; Witmer & Singer, 1998). In addition, a study by Brogni, Slater and Steed (2003) employing an alternative Presence measure found that awareness towards distracting real-world stimuli may disrupt or lower the experience of spatial presence. Accordingly, in line with H2, it was expected that spatial presence experiences would be stronger among non-distracted users compared with distracted users of a medium. Consequently, in all experiments, half of the participants, chosen at random, were distracted in the exposure situation to limit their attention on the stimulus and, in turn, to decrease their feeling of spatial presence. In the other experimental condition participants were not distracted.

Distraction was manipulated based on a dual-task procedure adapted from Bourke, Duncan and Nimmo-Smith (1996). While using the presented medium, distracted participants had to perform a secondary task in the exposure situation. Audio signals were given at specific times. Participants were instructed to produce five "random numbers" of three digits each, as soon as the audio signal was heard. The volume of the signal was chosen in such a way that it was clearly perceivable, but did not obscure the audio of the media stimulus (if any). In the film and text study, distracted subjects were instructed to write their random numbers on a piece of paper. In the hypertext and virtual environment studies, in which distracted subjects had no free hand available, they were instructed to speak their random numbers aloud for the lab assistant to write down.

Procedure. After being welcomed, subjects were placed behind tables situated about two meters in front of the projection screen (film), or in front of a computer screen (hypertext and VR), or in front of printouts (book). In each of the VR, hypertext or film experiments, participants were seated at the same distance from the screen. Participants in the distraction condition were instructed on how to deal with the audio signals during the exposure situation. Upon receiving the instructions, participants spent a total of 10 minutes with the media stimulus. In the distraction condition, an audio CD containing the sequence of distracter signals was started simultaneously with the beginning of the reception of the media stimulus. Subsequent to the media exposure, all participants filled out the post-test questionnaire. Upon completing the questionnaire, participants were thanked and dismissed.

Measures. In addition to the initial pool of spatial presence items, the post-test questionnaire also assessed all hypothesized determinants of spatial presence. Measures were taken from the precursor of the SPES, the MEC-SPQ (Vorderer et al., 2004). All scales ranged from 1 (*I do not agree at all*) to 5 (*I totally agree*):

- domain-specific interest (eight items; example: “The [medium] corresponded very well with what I normally prefer.”; $\alpha = .93$; $M = 2.32$; $SD = .97$);
- spatial imagery skills (eight items; example: “When someone shows me a blueprint, I am able to imagine the space easily.”; $\alpha = .82$; $M = 3.5$; $SD = .71$);
- attention allocation (eight items; example: “My attention was caught by the [medium].”; $\alpha = .93$; $M = 3.45$; $SD = .94$);
- conciseness of user’s spatial mental model (eight items; example: “Even now, I could still draw a plan of the spatial environment in the presentation.”; $\alpha = .9$; $M = 2.88$; $SD = .88$);
- cognitive involvement (eight items; example: “I thought about how much I know about the things in the presentation.”; $\alpha = .78$; $M = 2.85$; $SD = .76$); and
- trait absorption (nine items adapted from Tellegen & Atkinson, 1974; example: “I can be greatly moved by poetic language.”; $\alpha = .81$; $M = 3.55$; $SD = .75$).

[Please place Table 1 about here]

Selection of SPES Items

Items were selected for the final SPES in three steps (e.g., Clark & Watson, 1995; DeVellis, 2003). First, the response distributions of all items were analyzed to exclude strongly skewed or difficult items, or those that showed little variance. Second, items were investigated using a Varimax-rotated Principal Component Analysis (PCA; forced two-factor solution; Kline, 1994). Third, standard reliability criteria were examined (corrected item–total correlation and Cronbach's α). Table 1 provides a summary of the obtained results.

Step 1: Item distribution and item difficulty. Clark and Watson (1995) suggest to identify and eliminate items that have highly skewed and unbalanced distributions. One reason for this approach is that strongly unbalanced items convey little information. An analysis of the distributions obtained in the present study revealed that all items showed reasonable variance ($1.03 < SD < 1.22$). None of the item distributions revealed a strong ceiling effect or bottom effect ($1.98 < M < 3.01$). However, none of the items showed a normal distribution (all *K-S Tests* > 2.81; $p < .01$); instead, most of the items' response distributions were skewed toward "no agreement" (–0.23 < *skewness* < 1.06), especially items SL10 (*skewness* = 1.05) and SL6 (*skewness* = .8). Clearly, the use of the expression "I was convinced …" in these two items made it especially difficult for the subjects to agree with the statements. Both items were dropped from subsequent analyses.

Additional indices for item difficulty *p* were computed by dividing the item mean minus 1 by the theoretical maximum (5) minus 1, such that *p* had a range between 0 and 1. It is preferable for items to yield *p* values between .2 and .8 (Fisseni, 1997). The values for all of the remaining 18 items fell within this recommended range (Table 1).

Step 2: Factor structure and factor loadings. All remaining items shared variance to a very high degree (*KMO* = .95). The respondent:item ratio for the current sample was 16:1, clearly exceeding the recommendation of at least five respondents per item (Kline, 1994; MacCallum, Widaman, Zhang, & Hong, 1999).

In accordance with the deductive approach, we conducted a forced two-factor PCA with Varimax rotation[4]. All remaining 18 items were entered; missing cases were deleted listwise. The two obtained factors accounted for 60.05% of the variance (Factor 1: 36.33%; Factor 2: 24.72%). Factor loadings are listed in Table 1. Most of the *self-location* items loaded strongly on the first factor, whereas most of the *possible actions* items loaded strongly on the second factor. Accordingly, the first factor was regarded to reflect a shift in the user's self-location, whereas the second factor was thought to reflect the degree of perceived possible actions in a media environment. Items were retained if they loaded higher than 0.3 on their primary factor and if this primary loading was at least 0.2 higher than any of their cross-loadings. Items SL5, SL7, PA4, PA6, and PA7 failed to meet this criterion and were subsequently dropped from consideration, leaving 13 remaining items.

Step 3: Internal consistency. PA2 and PA3 of the remaining items were almost identical in wording, with PA2 having slightly better psychometric qualities. To avoid "a scale with high internal consistency by writing the same items in different ways" (Bearden et al., 1993, p. 4), PA3 was dropped.

As a first test of internal consistency, we examined corrected item–total correlation r_{itc}. The remaining six self-location items and the remaining six possible actions items were analyzed separately. Items were required to have an acceptable r_{itc} value of at least .5 (Fisseni, 1997). All items met this criterion (see Table 1) except for PA9 and PA10, which were dropped.

In a second step, we examined Cronbach's α. The remaining four possible actions items (PA1, PA2, PA5, PA8) yielded a satisfactory α value of .81. To obtain the most homogenous four-item subset among the remaining six self-location items, AlphaMax (Hayes, 2005) was applied, which checks α for all possible short forms of a k-item composite measure. The four-item subset resulting in the highest α value (.92) consisted of SL1, SL2, SL3, and SL4.

Results

Validity test based on factor analyses. A Varimax-rotated PCA of the finally selected eight SPES items suggested a two-factor solution (Eigenvalues 4.66, 1.15, .71, …). After rotation, Factor 1 accounted for 40.17% of the variance, and Factor 2 for another 32.48%. All SPES items clearly loaded on their dedicated factors, and had only marginal cross-loadings (see Table 1, seventh and eighth columns).

Validity test based on experimental manipulation. As expected, simple t-tests (see Table 2) revealed that non-distracted participants attained higher scores on the SPES self-location subscale and on the SPES possible actions subscale compared with distracted participants, although the latter mean difference only approached significance (p = .057). The total SPES scale also responded to the distraction treatment, as expected, with non-distracted participants reporting significantly higher scores than did distracted participants. In summary, the results speak for the validity of SPES.

[Please place Table 2 about here]

Validity test based on correlates of spatial presence. According to the nomological network derived from the model by Wirth et al. (2007; see also Hofer et al., 2012), SPES was expected to be positively correlated with users' domain-specific interest, spatial imagery skills, attention allocation, spatial mental model, cognitive involvement, and trait absorption (see hypotheses H1 to H6). As shown in Table 3, all obtained correlations were highly significant and in the predicted direction. These results confirm H1 to H6 and suggest a good validity of SPES. As further evidence of the validity of SPES, correlations with traits (domain-specific interest, spatial imagery skills, trait absorption) were considerably lower than those with immediate determinants of spatial presence (e.g., attention allocation, spatial mental model, cognitive involvement; Steiger's Z for all r_{trait} vs. $r_{\text{process factor}}$ comparisons, $p < .01$). As a further indication of the good psychometric quality of SPES, all obtained correlations between SPES scores and determinants were considerably weaker than the item-total correlations r_{itc} of the SPES items (see Table 1, sixth column; Clark & Watson, 1995, p. 16).

[Please place Table 3 about here]

Discussion

Study 1 aimed to establish and validate the SPES as a short measure of spatial presence experiences. Based on the conceptual foundation laid out by Wirth et al. (2007), spatial presence was operationalized as a two-dimensional concept that includes a shift in users' self-location and perceived action possibilities. Study 1 provided support for the reliability and validity of the SPES. The validity was confirmed in three approaches. First, factor analyses provided preliminary support of the two dimensional structure of the SPES. Second, an experimental approach confirmed expectations and showed that total SPES scores were significantly higher in non-distracted than distracted participants. Third, also in line with hypotheses, SPES was significantly correlated with various determinants of spatial presence. Taken together, Study 1 resulted in a two-dimensional eight-item measure of spatial presence experiences with good psychometric properties.

Study 2

To examine the psychometric qualities of the SPES further, a second study was conducted. In Study 1, items were selected for the SPES partly based on exploratory factor analyses. An observed factor structure of a scale needs to be replicated in a sample different from the one in which it was initially obtained (e.g., Floyd & Widaman, 1995). This was the main purpose of Study 2. More specifically, Study 2 aimed to replicate the two-dimensional structure of the SPES in the context of different media stimuli than the ones used in Study 1. A reconfirmation of the factor structure in a set of different media offerings would suggest that the SPES is a reliable and robust measure that can be applied to various media settings.

Method

SPES was administered to a sample of 395 participants at four European universities: in Helsinki (Finland), Porto (Portugal), Hanover (Germany), and Zurich (Switzerland). At each university, a researcher and a professional translator translated SPES from English to Finnish, Portuguese, or German as required. The items were then back-translated to English by a second professional translator, to check that the meaning of each item was retained (Cha, Kim, & Erlen, 2007).

The same procedure was applied as employed in Study 1. All participants filled out SPES after using a spatial media stimulus for at least 10 minutes. Participants were assigned to one of three different spatial media stimuli, all of which enabled the user to take a walk through a virtual Mozart museum. Subjects either used a hypertext with screenshots of the virtual walk-through (N = 208), watched a film that showed a pre-recorded walk through the museum (N = 82), or navigated through the museum in an interactive virtual environment that was stereoscopically displayed (N = 105). The gender balance was approximately equal in the sample (51.9% female) and the mean age was 23.87 years (SD = 4.72)[6].

Results

Replication of factor structure in Principal Component Analysis (PCA). A forced two-factor PCA with Varimax rotation (KMO = .91) resulted in two factors that together explained 71.62% of the variance (Factor 1, 39.1%; Factor 2, 32.52%; Eigenvalues 4.76, .97, …). All SPES items loaded strongly on their dedicated dimension (SPES-SL .87 to .77; SPES-PA .79 to .66). Cross-loadings were marginal. No item had a factor-loading on the other dimension greater than .41. Results of the PCA confirm the factor structure of SPES obtained in Study 1.

Replication of factor structure in Confirmatory Factor Analysis (CFA). After replacing missing values by multiple imputation (EM-A), the dimensionality of SPES was further examined in a Confirmatory Factor Analysis (CFA) using the software LISRE. A test of multivariate normality confirmed that the variables were not normally distributed (X^2 = 144.06; p < .001). Therefore, a robust maximum likelihood estimation was applied, and Satorra–Bentler scaled chi-square statistics were employed to evaluate model fit (Hoyle & Panter, 1995). Paths from the latent variable self-location to SL01 and from the latent variable possible actions to

PA01 were set to 1. In line with the theoretical model, both latent constructs, self-location and possible actions, were allowed to covary. Fitting of the data to a congeneric model using robust maximum likelihood estimation revealed a good model fit[7] (Satorra–Bentler $X^2 = 27.6$ ($df = 18$), $p = .07$; NFI = .99; RMSEA = .037; $CI_{.90} = .000, .063$; SRMR = .03). All paths of the model were both substantial and significant (standardized path coefficients SPES-SL .91 to .76, $p < .05$; SPES-PA .70 to .64, $p < .05$; see Figure 1).

Internal consistency. Analyses of the two subscales using Cronbach's Alpha also confirmed a good internal consistency ($\alpha_{\text{self-location}} = .91$, $\alpha_{\text{possible actions}} = .84$). The CFA also provided support for the proposal that both self-location and possible actions are two dimensions of the joint construct spatial presence, because the two latent constructs showed a reasonable correlation (standardized path coefficient = .81, $p < .05$). In fact, all items of SPES could also be collapsed into one internally consistent ($\alpha = .89$) total scale[5]. In summary, Study 2 confirmed the structure of SPES obtained in Study 1, and indicates a good validity of the measure.

Overall Discussion

Interest in the concept of spatial presence has grown rapidly in recent years (Lombard et al., in press). The present article introduces a new self-report measure (SPES) to assess media users' experience of spatial presence. The present findings demonstrate that the eight-item scale reflects two dimensions of spatial presence (self-location and possible actions; Wirth et al., 2007) in a reliable and robust way. Validity tests showed that the experience of spatial presence, i.e., scores on the SPES, increases with the amount of users' attention allocation onto the media stimulus, the conciseness of their spatial mental model, and their cognitive involvement in the media stimulus. In addition, in the present studies, spatial presence assessed with SPES was positively correlated with users' interest in the applied media stimuli, their visual imagery skills, and their absorption tendency. These observed relationships confirm the validity of the SPES. Strengths of SPES include its derivation based on a deductive approach (Cronbach & Meehl,

1956) and its compactness. Items of SPES are also designed to measure spatial presence in diverse media settings. SPES is available in English, German, Portuguese, and Finnish. Depending on the interest of the researcher, the intensity of the spatial presence experience can be assessed by the total scores of SPES, or in a more differentiated way by examining the two sub-dimensions of SPES: self-location and possible actions.

Limitations and Outlook

The tests performed as part of the present studies suggest a good psychometric quality of SPES, however, additional tests may help to further illuminate the scale's quality. Study 1 revealed that the traits that represent distant determinants of spatial presence correlate less strongly with SPES than with the immediate causes of the formation of spatial presence. However, the study did not include more extensive tests of discriminant validity. It would be interesting to further examine whether SPES correlates with the assessment of constructs that are theoretically unrelated to spatial presence. Unlike broader concepts of non-mediation (e.g., transportation; Green et al., 2004), spatial presence is expected to be unrelated to, for example, users' parasocial interaction with media characters. More extensive tests of convergent validity should also examine the degree to which SPES correlates with alternative spatial presence scales. We assume that SPES (and particularly the self-location dimension) should positively correlate with the spatial presence subcomponent of the IPQ and the spatial presence factor of the ITC-SOPI. Given that we do not consider perceived realism an inherent dimension of Spatial Presence, we would expect considerably lower correlations of SPES with subscales measuring perceived realism, e.g., of the IPQ (e.g., in studies applying otherwise identical spatial scenarios in either a fictional/unrealistic or non-fictional/realistic setting). Finally, the use of retrospective assessment involves the possibility of having to deal with biased estimates or the memories of respondents (Schwarz & Oyserman, 2001). Accordingly, it would be valuable to further examine the convergent validity of SPES with objective correlates of spatial presence experiences (e.g., Baumgartner, Valko, Esslen, & Jäncke, 2006; Freeman, Avons, Meddis, Pearson, & IJsselsteijn, 2000; Meehan, Insko, Whitton, & Brooks, 2001).

Participants were sampled in the present studies from different locations and were using different types of media. On the one hand, the fact that our results confirm the expected dimensionality and a good psychometric quality of the SPES even in such heterogeneous samples may be considered evidence for the robustness of the scales. On the other hand, exploratory tests of the latent factor structure across the subsamples collected in Study 2 failed to confirm measurement invariance. This finding is difficult to assess, as subsamples were small and differed across locations and applied media stimuli. However, measurement invariance of the SPES across media types and different samples deserves further scrutiny in future research.

Finally, in the present studies, SPES items were not normally distributed but skewed towards lower scores. This skew may be a consequence of the media stimuli that we applied in the present approach, like books or non-interactive films. Whereas we believe that even readers of books may feel spatially present, it seems more likely that the sensation is experienced by users of highly immersive virtual reality technology (Witmer & Singer, 1998). However, in the present studies, the SPES has been only partially investigated in the context of such immersive systems.

The list of potential uses of SPES is as long as the list of communication contexts in which spatial presence is of relevance. SPES offers another choice for researcher interested in assessing spatial presence. With SPES, researchers can apply a theoretically plausible, validated, psychometrically sound, flexible, and particularly short self-report measure of spatial presence in addressing the challenges of current and future media technologies.

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Notes

[1]Spatial presence is a specific construct of a broader class of presence phenomena (Lombard & Ditton, 1997). Spatial presence focuses on "spatial illusions" and can be distinguished from s*ocial* presence ("the feeling of sharing a social situation with others," Lee, 2004) and transportation ("the feeling of being part of a narrative," Green, Brock, & Kaufman, 2004; "narrative presence," Ryan, Rigby, & Przybylski, 2006). The way we use it, spatial presence refers to the same user experience that others addressed as physical presence (Lee, 2004) or telepresence (Draper, Kaber, & Usher, 1998).

[2]The SPES evolved from the MEC Spatial-Presence-Questionnaire (MEC-SPQ; Vorderer et al., 2004). The MEC-SPQ was conceptualized to measure spatial presence and potential determinants of spatial presence. To date, the MEC-SPQ has not been officially published in a peer-reviewed journal. The SPES is simply a shortened and fine-tuned version of the two spatial presence-related scales of the MEC-SPQ that assess self-location and perceived possible actions. Due to more extensive analyses in the present approach, the items selected for the SPES and the self-location and perceived possible actions scales of the MEC-SPQ are not identical. We propose the SPES replaces both scales of the MEC-SPQ in the future. The MEC-SPQ remains a valuable tool to assess potential determinants of spatial presence.

[3]The text stimulus was an excerpt taken from the bestselling novel "The Pillars of the Earth." The 12-page episode portrays how the protagonist, Jack, breaks into a cathedral, sets a fire, and attempts to escape from the rapidly spreading flames. While rushing through the different sections of the cathedral, the spatial environment is described in detail. As hypertext stimulus, we used "The Art of Singing"—a commercial multimedia production. Users navigated through rooms of an environment displayed as a series of screenshots on a desktop computer. The film stimulus showed a sequence taken from the movie "The Boat – Director's Cut." The movie tells the story of a German submarine crew during World War II. The selected episode was approximately five minutes long and portrayed the submarine's assault on an allied convoy

crossing the Atlantic Ocean. The movie received awards for outstanding recording of the atmosphere within a submarine. In the interactive virtual environment stimulus, users navigated through the three-dimensional environment of a museum. The environment was displayed stereoscopically on a normal desktop computer. Users wore shutter-glasses to perceive the environment in three dimensions.

[4]Varimax was preferred over oblique rotation, although the enforced factors were expected to belong to Spatial Presence as a common factor. However, as suggested by Kline (1994), the observation and interpretation of factor loadings (a crucial aspect of the second step) are relatively hazardous with oblique factor rotation and relatively easy with orthogonal structures. In addition, an exploratory application of Promax oblique rotation with Kappa = 4 resulted in a similar solution to that obtained using Varimax rotation.

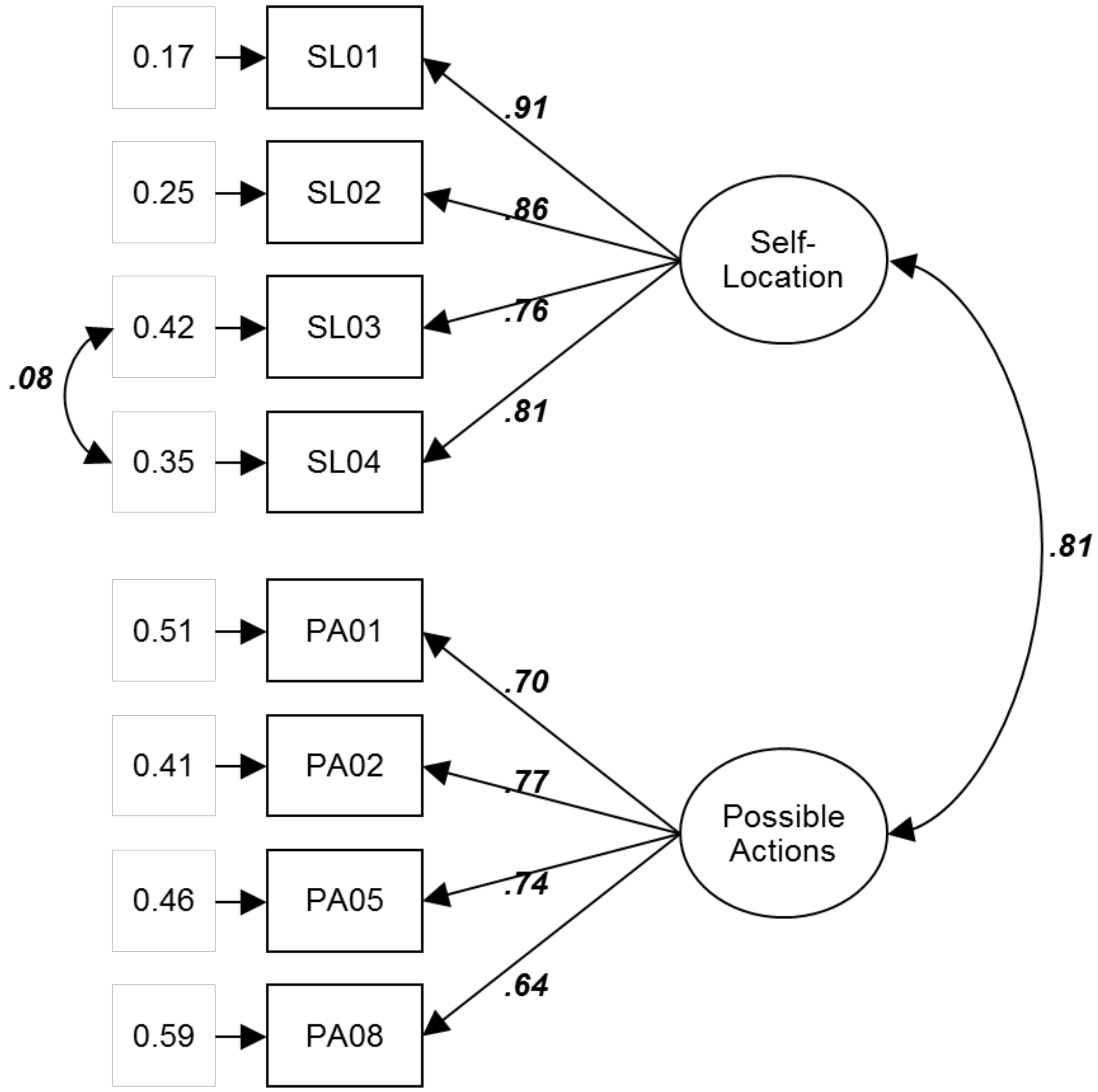
[5] Are possible actions and self-location indeed two dimensions of spatial presence or is one a determinant of the other? We argue that both are subdimensions of spatial presence that usually co-occur. Possible actions are strongly correlated ($r = .6$) with self-location, whereas zero-order correlations to theoretically proposed determinants are considerably weaker (all $r < .47$). Maybe more importantly, a joint VARIMAX rotated factor analysis with all items entered both from the two subdimensions and from all suggested determinants yielded an eight-factor solution in which all SPES items jointly load on a single factor and have only marginal cross-loadings with other factors. Both results support our view that both self-location and possible actions are dimensions of a joint underlying construct rather than a cause or consequence of each other.

[6]In summary, Study 2 collected SPES data at four different locations, with three different media stimuli, in three different languages.

[7] An initial analysis suggested a slightly improved model fit if the error terms of SL03 and SL04 were allowed to covary, which they marginally did. We opted for letting the two error terms correlate, as we interpreted the correlation as resulting from the similar wording of the two items.

Figures

Figure 1. Confirmatory factor analysis of the Spatial Presence Experience Scale (SPES) obtained in Study 2. Standardized path coefficients are formatted in bold and italicized.



Tables

Table 1

The Spatial Presence Experience Scale (SPES) – self-location (SL) and possible actions (PA)

Sub		Item	M	SD	p	F_{1-1}	F_{1-2}	r_{itc}	F_{2-1}	F_{2-2}	*SPES*
SL	1	I felt like I was actually there in the environment of the presentation.	2.56	1.15	0.39	.853	.268	0.84	.845	.280	**SL**
SL	2	It seemed as though I actually took part in the action of the presentation.	2.33	1.08	0.33	.737	.389	0.78	.839	.313	**SL**
SL	3	It was as though my true location had shifted into the environment in the presentation.	2.32	1.11	0.33	.848	.243	0.81	.855	.260	**SL**
SL	4	I felt as though I was physically present in the environment of the presentation.	2.09	1.07	0.27	.788	.274	0.77	.870	.234	**SL**
SL	5	I experienced the environment in the presentation as though I had stepped into a different place.	2.61	1.22	0.40	**.599**	**.480**				
SL	6	I was convinced that things were actually happening around me.	2.05	1.06							
SL	7	I had the feeling that I was in the middle of the action rather than merely observing.	2.21	1.11	0.30	**.543**	**.493**				
SL	8	I felt like the objects in the presentation surrounded me.	2.72	1.17	0.43	.653	.279	0.62			
SL	9	I experienced both the confined and open spaces in the presentation as though I was really there.	2.94	1.18	0.49	.698	.124	0.63			
SL	10	I was convinced that the objects in the presentation were located on the various sides of my body.	1.99	1.18							
PA	1	The objects in the presentation gave me the feeling that I could do things with them.	2.23	1.08	0.31	.272	.829	0.70	.243	.851	**PA**
PA	2	I had the impression that I could be active in the environment of the presentation.	2.43	1.11	0.36	.285	.848	0.69	.320	.812	**PA**
PA	3	I had the impression that I could act in the environment of the presentation.	2.36	1.10	0.34	.270	.839				
PA	4	I had the impression that I could reach for the objects in the presentation.	2.40	1.15	0.35	**.708**	.398				
PA	5	I felt like I could move around among the objects in the presentation.	2.44	1.11	0.36	.368	.653	0.63	.361	.698	**PA**
PA	6	I felt like I could jump into the action.	2.40	1.12	0.35	**.790**	.271				
PA	7	The objects in the presentation gave me the feeling that I could actually touch them.	2.43	1.14	0.36	**.801**	.221				
PA	8	It seemed to me that I could do whatever I wanted in the environment of the presentation.	2.16	1.11	0.29	.241	.495	0.51	.130	.655	**PA**
PA	9	It seemed to me that I could have some effect on things in the presentation, as I do in real life.	2.12	1.04	0.28	.061	.673	**0.46**			
PA	10	I felt that I could move freely in the environment of the presentation.	3.00	1.21	0.50	.413	.103	**0.30**			

Note. p indicates item difficulty. r_{itc} indicates corrected item–total correlation. *F1-1* indicates factor loading on Factor 1 of the *first* factor analysis conducted in Study 1. *F2-1* indicates factor loading on Factor 1 of the *second* factor analysis conducted in Study 1. Criteria formatted in bold represent the basis for the item being dropped.

Table 2

Validation of SPES based on a distraction paradigm

	Distracted		Non-Distracted		
	M	*SD*	*M*	*SD*	*t(df)*
SPES Self-location	2.16	.97	2.49	.98	2.89 (288)**
SPES Possible actions	2.22	.92	2.41	.83	1.91 (288)$^{+}$
SPES Total	2.19	.85	2.45	.79	2.71 (288)**

Note. $^{+}p < .1$, $^{**}p < .01$

Table 3

Validation of SPES based on zero-order correlations with potential correlates of spatial presence suggested by Wirth et al. (2007)

		1	**2**	**3**	4	5	6	7	8	9
1	**SPES Self-location**	**-**								
2	**SPES Possible actions**	**.60****	**-**							
3	**SPES Total**	**.91****	**.88****	**-**						
4	Spatial mental model	**.47****	**.42****	**.50****	-					
5	Attention	**.45****	**.41****	**.48****	.40**	-				
6	Involvement	**.38****	**.43****	**.45****	.49**	.51**	-			
7	Spatial imagery skills	**.21****	**.24****	**.25****	.38**	.16**	.32**	-		
8	Domain-specific interest	**.23****	**.30****	**.30****	.24**	.26**	.43**	.28**	-	
9	Trait absorption	**.26****	**.23****	**.27****	.26**	.19**	.37**	.38**	.24**	-

Note. **$p < .01$; correlations with the SPES are formatted in bold