A Process Model of the Formation of Spatial Presence Experiences

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In order to bridge interdisciplinary differences in Presence research and to establish connections between Presence and "older" concepts of psychology and communication, a theoretical model of the formation of Spatial Presence is proposed. It is applicable to the exposure to different media and intended to unify the existing efforts to develop a theory of Presence. The model includes assumptions about attention allocation, mental models, and involvement, and considers the role of media factors and

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user characteristics as well, thus incorporating much previous work. It is argued that a commonly accepted model of Spatial Presence is the only solution to secure further progress within the international, interdisciplinary and multiple-paradigm community of Presence research.

Unsystematic observation of recent years' theoretical dynamics in new media research clearly reveals the rapid career of the concept of Presence (e.g., Biocca, Freeman, & Ijsselstein, in press; Bracken, 2005; Lee, 2004; Lombard & Ditton, 1997; Steuer, 1992; Reeves & Nass, 1996). Presence has emerged as the theoretical response to the challenges that new media and virtual reality impose on communication scholars' understanding of how users process and experience media form and content (Biocca & Delaney, 1995). These challenges arise from new media's immersive capacities, that is, their capability to make users believe that they are personally and physically "present" in the displayed environment.

Early approaches to this experiential phenomenon were solely driven by a technological (rather than theoretical) perspective (e.g., Steuer, 1992) and failed to acknowledge that "Presence" displays striking similarities with existing concepts in communication and media psychology, most importantly, attention (e.g., Anderson & Burns, 1991) and involvement (e.g., Perse, 1998), but also a number of further constructs, such as perceived reality (e.g., Shapiro & Chock, 2003) or transportation (e.g., Green & Brock, 2000). More recent conceptualizations (e.g., Freeman, 2004; Schubert, Friedmann, & Regenbrecht, 2001) have, mostly based on factor-analytic evidence from survey data, considered some of those similarities, but argue for conceptual elements that distinguish Presence from the existing terms. However, these distinctions have not been elaborated on the basis of an integrative, theory-based model of what Presence is and how it emerges during media use.

Because a wide range of academic disciplines (from computer sciences to neuro- and social sciences to philosophy) is interested in "Presence", substantial terminological and (meta)theoretical confusion ranks around the concept (Hartmann et al., in press; Lombard & Ditton, 1997). Most importantly, some (broad) descriptions of Presence are very similar (if not equal) to human perception of nonmediated reality (Mantovani & Riva, 1999), which in turn would render Presence redundant with basic concepts of general psychology (e.g., "perception", "spatial orientation"). Alternative conceptualizations (e.g., Lombard & Ditton, 1997) require a mediated environment as precondition for Presence to occur, but still fail to explicate the differences between Presence and other concepts.

Theoretical confusions of this kind have prevented the psychological explication of Presence in terms of commonalities and differences with the available theories of user responses to media. Consequently, subtypes of Presence have been discussed that allow a more precise definition, clear explication, and empirical measurement. The subtype that is closest to the original formulation of Presence (Minski, 1980) is "Spatial Presence" (Ijsselstein, de Ridder, Freeman, & Avons,

2000). It is commonly referred to as "a sense of being there" which "occurs when part or all of a person's perception fails to accurately acknowledge the role of technology that makes it appear that s/he is in a physical location and environment different from her/his actual location and environment in the physical world" (International Society for Presence Research, 2001). This definition is virtually identical to the older notion of "telepresence" (Draper, Kaber, & Usher, 1998; Steuer, 1992), but the latter term is, as will be discussed in this paper, more general, because it is independent from specific media technologies (i.e., virtual reality) that have typically been discussed in the context of "telepresence".

The main characteristic of Spatial Presence is the conviction of being located in a mediated environment. This property makes Spatial Presence an important variable in numerous fields of communication applications. Spatial Presence can be (1) a required facilitator of media effects, for instance,

- in medical tele-operation that is only effective if the surgeon feels located at the site of the patient (e.g., Westwood, Hoffman, Robb, & Stredney, 1999),
- in simulation-based learning that can only succeed if the learner feels located within the simulated environment (e.g., Regian, Shebilske, & Monk, 1992).

Moreover, Spatial Presence can (2) intensify existing media effects, such as enjoyment of using entertainment media (for instance, in video games, Klimmt & Vorderer, 2003; Tamborini & Skalski, 2006) coordinated action in organizations, which is improved if members of the organization feel present in the shared virtual space that videoconferencing and other organizational communication tools provide (e.g., Finn, Sellen, & Wilbur, 1997), successful psychotherapy, which benefits from clients' perception to be present in a simulated environment relevant to their disorder (Rizzo, Buckwalter, Neumann, Kesselman, & Thiebaux, 1998).

The theoretical discrepancy between current notions of Spatial Presence and existing theories of user responses to media, as well as the potential importance of Spatial Presence for media effects research, demand an integrative reconstruction of Spatial Presence and its development during media use. Such a reconstruction can isolate the properties of Spatial Presence that differentiate the concept from similar terms and inform research on the diverse communication applications related to Spatial Presence. We therefore propose a model of Spatial Presence that integrates existing theories from psychology and communication, which have primarily been applied to "old media", into a unified process structure. In turn, we argue that Spatial Presence is not bound to virtual reality, but can also occur in users of conventional media, such as books (e.g., Schubert & Crusius, 2002) or television (Bracken, 2005). Metaconceptually, our model moves beyond existing explications of Spatial Presence (or telepresence), because it (1) incrementally builds on existing bodies of theory from communication and psychology and (2) develops a process-oriented view that allows for explanatory and predictive application.

DEFINING SPATIAL PRESENCE

Lee (2004, p. 37) defines Presence as "a psychological state in which virtual (para-authentic or artificial) objects are experienced as actual objects in either sensory or nonsensory ways". While this definition is in line with the general notion of Presence as "perceptual illusion of nonmediation" (Lombard & Ditton, 1997), it does not mention the experience of being *located* in the midst of the mediated (virtual) objects, which is the conceptual core of Spatial Presence and is reflected in the other common metaphor of Presence as "being there" (Lombard & Ditton, 1997; see also Steuer, 1992).

The focus on perceived self-location in the mediated environment is evident in alternative definitions of Spatial Presence. Biocca (1997), for example, argues that VR environments address several sensory channels synchronously and thus facilitate sensory engagement, motor engagement, and sensor motor engagement (Biocca, 1997). These processes enhance the user's feeling of embodiment – the experience of being located in the mediated environment. Such feelings of self-location may also arise without much external stimulation: The "book problem" (Schubert & Crusius, 2002) refers to the fact that feelings of "being there" can also occur in readers of texts, because readers can *imagine* very vividly to be present in the book's world. More precisely, readers may construct a mental model of their bodies and of possible actions in the environment described by the book (Biocca, 1997). Glenberg (1997) integrates mental models and possible actions within their "embodied cognition" framework. Mental representations of mediated spaces, which can include assumptions of what kind of actions are possible in a given space, are required for Spatial Presence. In most cases, then, Spatial Presence is an experience which can be enriched by, but does not completely depend on, external (media-based) information such as visual, auditory, haptic, or proprioceptive impulses and feedbacks (Gibson, 1973; Kebeck, 1997). The more senses a media environment activates in its users the more likely it is that the receivers will feel like they "are" in the environment. Researchers in the field of Presence describe features that give rise to Presence as immersive properties of the media. For example a media system that offers display and tracking technologies that increasingly match and support the spatial fidelity of real-world perception and action is considered immersive (Bystrom, Barfield, & Hendrix, 1999; Draper, Kaber, & Usher, 1998; Ijsselstein, 2004; Slater, 2003). According to Ijsselstein (2004), Presence is conceptualized as the experiential counterpart of immersion. In short: If the media provide high immersive technologies, humans may respond with feelings of Spatial Presence. However, if immersive impulses are not provided by the media product, internal processes, for example, imagination, can compensate for that deficit in external stimulation – at least to a certain degree. Therefore, Spatial Presence is not limited to the experience of using sensory rich VR-technology – it can also occur when using less immersive media (i.e., stimuli that control the sensory input to all modalities

of the user to a smaller degree; Draper, Kaber, & Usher, 1998), or even text-based media with no direct sensory input (Lee, 2004).

In sum, Spatial Presence is regarded as a two-dimensional construct. The core dimension is the sensation of being physically situated within the spatial environment portrayed by the medium ("self-location"). The second dimension refers to the perceived possibilities to act: An individual who is experiencing Spatial Presence will perceive only those action possibilities that are relevant to the mediated space, but will not be aware of actions that are linked to her/his real environment. However, the list of phenomena defining Spatial Presence does not need to include the user's experience of nonmediation, i.e., the deactivation of cognitive information that defines a given situation as a media exposure. Rather, the experience is distinct from Spatial Presence because it can occur regardless of spatial information processing (Short, Williams, & Christie, 1976). Users can experience nonmediation without feeling spatially present. Nevertheless, throughout this article we argue that nonmediation might be construed as consequence of Spatial Presence.

Similar to Slater (2002), we regard the state of Spatial Presence as binary (on/off). Based on these considerations, we propose the following definition: Spatial Presence is a binary experience, during which perceived self-location and, in most cases, perceived action possibilities are connected to a mediated spatial environment, and mental capacities are bound by the mediated environment instead of reality.

This definition is in harmony with most existing definitions (e.g., ISPR, 2001; IJsselsteijn et al., 2000; Kim & Biocca, 1997; Lessiter et al., 2001; Schubert, Friedmann, & Regenbrecht, 1999, 2001), but is more explicit in suggesting necessary conditions (and contributing processes) for Spatial Presence that must be considered in the development of theoretical models. Specifically, a general model of Spatial Presence should be based on the integration of related psychological concepts that exist, such as attention and involvement.

A PROCESS MODEL ON THE FORMATION
OF SPATIAL PRESENCE

Overview

The model is organized around two critical steps towards the experience of Spatial Presence. The first step is the construction of a mental model of the (mediated) situation that includes space-related information (in a sense, on this level, users deal with the questions "is this stimulus a space/room?" and "if yes, what kind of space/room is it?"). This process is based on attention allocation, that is, the devotion of mental capacities to the media product, as suggested in our definition of Spatial Presence. The "spatial situation model" (SSM) is a precondition for Spatial Presence to occur. The second level of the model refers to the actual formation of Spa-
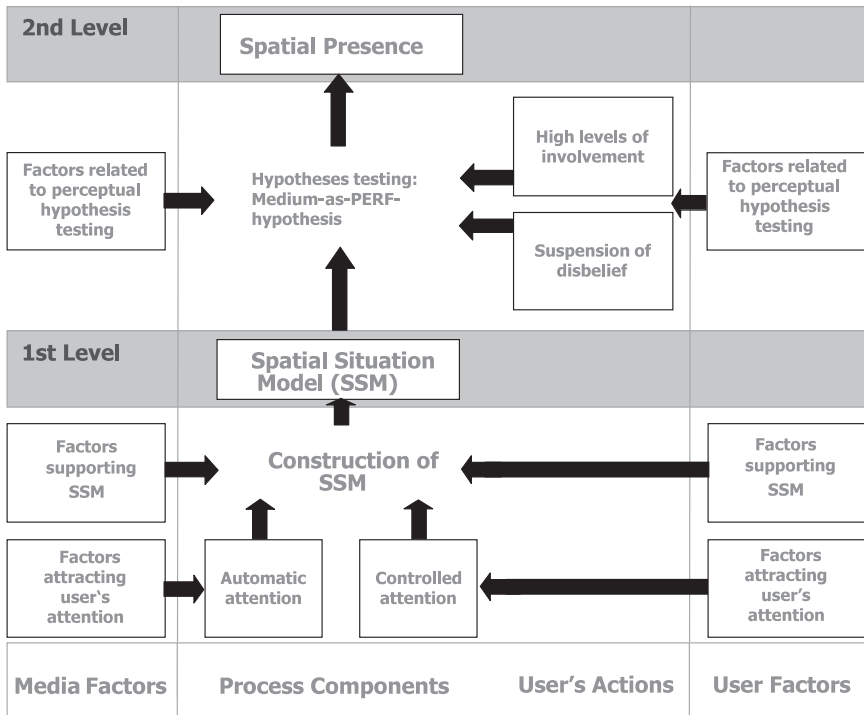
FIGURE 1   Visualization of the two-level model of Spatial Presence.

tial Presence, which emerges from the SSM through the confirmation of a specific perceptual hypothesis, the so-called "medium-as-PERF-hypothesis" (PERF = primary egocentric reference frame; in a sense, on the second level, users deal with the question "am I located in this space/room?"). Experiencing the mediated environment as PERF implies perceived self-location in that environment, and, in most cases, noticing possible actions within the environment (see the definition of Spatial Presence above). Various |media factors and user characteristics are in effect at both stages of the model and may support or impede the processes that lead to the state of Spatial Presence (see Fig. 1). These processes will be explicated in the following sections.

Attention Allocation and the Construction of a Spatial Situation Model (SSM)

Because Spatial Presence is considered to be an experience that only occurs during media exposure, a model of its formation must consider the basic processes of perception and cognition on which higher forms of experience can be constructed

(Darken, Allard, & Achille, 1998; Taylor, 1997). Only those users who pay attention to the mediated environment will experience Spatial Presence. Users' attention can be directed towards a mediated stimulus for two reasons: (1) The medium can trigger attention allocation without requiring the user to want to be attentive, which is called involuntary attention allocation, and (2) users may devote their attention towards the media product because they want to, for example, because it appears to be interesting or enjoyable. This process is labeled controlled attention allocation.

Media factors and involuntary attention allocation

Certain attributes of a media product cause involuntary, unintended attention processes of specific or nonspecific selection. In the case of specific selection, the mediated environment offers features that meet a user's needs, motives or interests. During nonspecific selection, in contrast, novel stimuli or rapid and surprising changes of the stimulus trigger attention processes such as orienting reactions (Posner, 1980). They arise from a comparison of stimulus characteristics with the neuronal representation of the previous level. Berlyne (1960) called these stimulus characteristics collative properties, which also included novelty, surprise, complexity and relevance (although relevance might be a textual rather than formal property, and accordingly tied to specific selection processes).

At the first stage of involuntary attention, an orientation reaction is triggered, preparing the sensory organs and the information processing system for input (Lang, Simons, & Balaban, 1997; Öhmann, 1979, 1997). Spontaneous eye and head movements towards the presumed direction of the stimuli source occur. The organism is activated. Subsequently, the second stage of involuntary attention commences, most often accompanied by exploratory behavior. The activation level in the cortical areas is elevated, and higher processes of attention and awareness are activated (Schmidt & Thews, 1997). Consequently, the user's attention establishes a relatively stable stream of stimuli.

However, attention must constantly be bound by the medium and may not be interrupted if higher cognitive processes, such as building a mental representation of a mediated space, are to occur. Otherwise, adjacent cognitive processes might not emerge, or may collapse, before they reach the required intensity. Therefore, the *media factors* relevant to Spatial Presence are the variables that affect both short-term orienting responses and more persistent attention allocation.

The literature on Spatial Presence does not identify media factors which specifically address attentional processes, but lists those factors within a larger set of determinants of Spatial Presence. In contrast, attention-eliciting message characteristics have been isolated in television research (e.g., Huston & Wright, 1983). Findings from this line of research indicate that short-term orienting responses are primarily affected by form (as opposed to content) variables; the cognitive processes involved are supposed to be very fast-paced and automatic, making a more

complex content-oriented interpretation of the presented stimuli improbable (Anderson & Burns, 1991). With respect to more persistent forms of attention allocation, both form and content variables are expected to be important. In research on Spatial Presence, labels like "sensory factors" (Witmer & Singer, 1998), "sensory richness" or "vividness" (Steuer, 1992) refer to media factors that contribute to enduring attention allocation. The underlying assumption is that the more sensory information a particular media product emits, the more likely it is that users' attention allocation will persist, as the media product covers more and/or larger portions of the users' perceptual range. More specifically, the number of sensory modalities that a medium addresses is regarded as a factor of attention attraction ("breadth," Steuer, 1992, p. 81). The "depth" of the presented information, that is, the amount of data the media product encodes within one given modality (Steuer, 1992; Biocca, 1997), is also important. In sum, a continuous stream of highly detailed information should sustain users' involuntary attention allocation more effectively than an interrupted and/or less-detailed stream of input. In contrast, however, an excess of overly complex and detailed information can cause sensory overload and overstrain the organism, producing fatigue instead of presence (de Rijk, Schreurs, & Bensing, 1999).

Media content affects the persistence of attention allocation as well. For example, Anderson and Burns (1991) report humor and comprehensibility as content variables that influence (young) viewers' attention to television. However, the processing of most content-related features of a media product also includes more complex processes of involvement (see below), and the boundary between mere attention and higher cognitive involvement is somewhat difficult to define. Nevertheless, enduring involuntary attention allocation is facilitated by content variables to a certain extent (Hawkins et al., 2002).

Interest, other user characteristics, and controlled attention allocation

Attention processes are not affected by external sources of information alone. Individuals may voluntarily direct their attention towards a media product even if there are no salient stimuli which trigger such behavior. If, for example, the content of the media product matches the *domain-specific interest* of a given receiver, his/her motivation to attend to the product will increase. Domain-specific interest is the relationship between an individual's motivational dispositions and the content or issue of an object (Krapp, 1993). If a person finds an object or activity interesting, s/he does not require motivational resources to sustain engagement in it (Hidi, 1995). Thus personal interest may affect a media user's situational motivation towards a media product and its content, and lead to controlled attention allocation.

Domain-specific interest may not be the only trait factor relevant to attention allocation. From television research, intelligence, gender and age are known user

variables that determine (controlled) attention allocation (Anderson & Burns, 1991); however, most related studies have been conducted with children. As controlled attention is primarily driven by motivational processes, we regard domain-specific interest as the most important trait here. Nevertheless, it is possible to expand the model to include other personality factors that also affect attention allocation to media products.

In addition to trait variables, user states may also influence the intended allocation of attention; however, given the unlimited number of states (e.g., fatigue or various emotional conditions) that might be considered relevant here, no predictions about the influence of state variables on controlled attention allocation should be included in a general model of Spatial Presence. Rather, the importance of state variables for users' motivational disposition should be noted, as these may affect processes of controlled attention (see as an example for the effects of fatigue: Vervaeck, Deboeck, Hueting, & Soetens, 1982).

Combinations of both paths of attention allocation

In most cases, media-induced (involuntary) and the user-directed (controlled) processes of attention allocation are not independent of each other. Both types of attention may be involved in the development of Spatial Presence, but their relative contributions may vary. Specifically, we presume that intended and focused processes of attention are negatively related to the immersiveness of a mediated representation. For example, during reading, Presence requires motivational processes, because reading is an active procedure that may hardly be sustained without motivation. On the other hand, a virtual environment may involuntarily attract users' attention, thus diminishing the role of motivational processes towards experiencing Presence.

The concept of Spatial Situation Models (SSMs)

Once the audience's attention is directed towards the media product and away from the real environment, the medium can unfold its capabilities to induce Spatial Presence. Many media products contain cues that enable attentive users to establish cognitive representations of space. For example, a television broadcast can display some white surfaces separated by black lines, which would make the viewers see a room with white walls. Attentive media users will process spatial cues and incorporate them into their mental representation of the depicted space. We call this process the formation of a Spatial Situation Model (SSM). An SSM is a mental model (Johnson-Laird, 1983; Sanford & Garrod, 1981) of the spatial environment that the individual constructs based on (1) spatial cues she/he processes and (2) relevant personal spatial memories and cognitions (McNamara 1986). Depending on the

skill and perspective of different receivers, mental models of the same space may be constructed differently (Dutke, 1994).

The formation of SSMs includes processes of construction and interpretation (Oostendorp, 1994; Rinck, Hähnel, Bower, & Glowalla, 1997). Mental models develop gradually while the receiver is processing the represented object or domain, but at all times, the model is complete (Schnotz, 1988). Media users develop their SSM further, as they integrate the observed spatial cues with their existing spatial knowledge.

The first spatial cues perceived trigger the activation of so-called spatial scenarios – rather complex spatial cognitions. The media users perceive some spatial cues, organize them into a spatial structure and "search" for a suitable spatial scenario in their mind. The activated scenario contains the newly perceived spatial cues (bottom-up components) and, in addition, "empty slots", which the users fill in with their previous knowledge of spatial environments. The latter elements are concept-managed (top-down components) and are inserted by means of plausible assumptions and prior experience. Subsequently, individuals perceive more of the spatial cues offered by the media product. While these cues are processed, media users continuously evaluate the congruence of their SSM with the perceived spatial environment. If there are major discrepancies between the perceived spatial data and the SSM, the model is restructured accordingly; it may be extended, specified or replaced by a new model entirely (van Dijk & Kintsch, 1983).

To construct an SSM from perception and memory, users must have a "library" of spatial experiences in their mind and must be able to imagine objects and spaces (i.e., they must possess figural imagination). Both spatial knowledge and spatial imagination become more relevant if the mediated representation of the space is less intuitive and more fragmented (e.g., when reading textual descriptions of space).

Spatial cues as media factors supporting the construction of SSMs

Many *media characteristics* (both form and content), which previous research has presumed to facilitate Spatial Presence, should be regarded as determinants of the SSM that media users build from the mediated information. The central mental construction process at the first level of Spatial Presence formation refers to whether or not the user believes that the media stimulus depicts a space, and also to the way a space is imagined, i.e., either how many aspects/details are salient that fill the imagination as well as how plausible and coherent the imagined space is.

In general, *spatial cues* can be regarded as the central building blocks of SSMs. Spatial cues have traditionally been used within media contexts to create the illusion of spatial arrangements. For example, for centuries painters have applied perspective to their drawings in order to evoke the sensation of depth (Cutting, 1997;

IJsselstein, 2002). A broad range of spatial cues has been introduced in the litera-
ture (e.g., Surdick, Davis, King, & Hodges, 1997; Barfield, Hendrix, Bjorneseth,
Kaczmarek, & Lotens, 1995). Most spatial cues are linked to the visual modality,
for example, *static monocular cues* like occlusion, height in the visual field, rela-
tive size, relative density and texture effects, aerial perspective and relative bright-
ness, foreshortening and accommodation (Cutting, 1997; Gibson, 1973; Murch &
Woodworth, 1977; Surdick, Davis, King, & Hodges, 1997); *dynamic monocular
cues* like motion parallax (Faubert, 2001) or *binocular cues* like stereopsis (Murch
& Woodworth, 1977, p. 157) and convergence (Cutting, 1997). But spatial cues
have been identified for other modalities as well, for example, spatial audio
(Hendrix & Barfield, 1996), haptic cues (Sallnäs, 1999), or vestibular cues
(Riecke, von der Heyde, & Bülthoff, 2001). In the text modality, spatial cues are
connected to both language form and content. A more complete review of spatial
cues is provided by Vorderer et al. (2003).

SSMs can differ with regard to their (1) accuracy or internal logical consistency
and (2) the richness or quantity of the spatial elements (e.g., objects) they cover.
The more spatial cues a stimulus offers, the easier the construction of a *rich* SSM
should be. In addition to quantity, the *conciseness* and *consistency* of spatial cues
affect SSM construction. Imagine, for example, a visual stimulus field that shows a
fluent color gradient without any sharp edges, borders or color contrasts
("null-stimulus," Zeltzer, 1992, p. 128). The user would not be able to discriminate
a single object, and the stimulus would evoke no illusion of spatiality at all. Thus,
on a very basic level, *contrast* is necessary to enable the users to identify edges,
lines, and objects. This is a precondition for a spatial perception or imagination
(Zeltzer, 1992). In order to extract spatial cues, users must be able to assemble dis-
criminated elements (e.g., lines or sounds) into meaningful objects, which in turn
must be cognitively linked to each other. Such a "*sensory integration*" (Witmer &
Singer, 1998) is probable, for example, if a quick sequence of simple stimuli pre-
sented in the same modality can be interpreted as a meaningful whole: "In the case
of the auditory system, our ability to recognize the particular sounds, such as those
of different musical instruments or different voices, results from the simultaneous
perception of a complex combination of amplitude and frequency cues, as well as
differences in arrival time and intensity between the signals from the two ears (see
Wenzel, 1992)" (Steuer, 1992, p. 83).

In multimodal media environments, the information provided must be *conso-
nant* across the modalities in order to increase consistency of the SSM. Audio and
video information about a virtual room should be synchronized and designed to
"make sense" to the user (Witmer & Singer, 1998; Held & Durlach, 1992). The im-
portance of meaningful interpretation of space-related information provided by the
media product is closely associated with the *plausibility* that the user can detect in
the perceived stimulus (Lombard & Ditton, 1997). Plausibility, as it is meant here,
implies that the objects, for example, should be scaled in a proper way, and they

should be colored and textured in accordance with the user's spatial knowledge, in order to be accepted as "spatial building blocks" and applied to the construction of a coherent SSM (Gregory, 1980; Neisser, 1976; Slater, 2002).

In sum, media offerings that display a variety of concise spatial cues (preferably within different perceptual channels), which are linked in a consistent and plausible manner, should evoke both richer and more internal consistent SSMs than those presenting only a few, diffuse or inconsistent cues. One could argue that incongruent media offerings are exceedingly vivid, and therefore should attract attention. In fact, incongruent cues do attract attention, but in our view they cannot contribute to a strong and coherent SSM (Zwaan & Radvansky, 1998). Later in this article we argue why richness and consistency might be regarded as pillars of the strength of a SSM for the formation of Spatial Presence. Albeit, we also assume that the perception of media offerings that provide an unfavorable setting of spatial cues can result in strong SSMs, because in addition to media factors, internal processes based on *user characteristics* also affect the construction and quality of the SSM.

Spatial Imagery as personological factor in SSM construction

The processing capabilities of the individual user partly determine whether he/she will establish a solid and vivid mental representation of the spatial arrangements portrayed by a given media product. Most important is *spatial visual imagery,* one of the skills that belong to the construct of spatial ability (Hegarty, Richardson, Montello, Lovelace, & Subbiah, 2002). The ability to produce vivid spatial images may support the formation of SSMs, as it increases the cognitive salience of spatial structures and makes it easier to "understand" the spatial quality of the mediated environment. Moreover, individuals with higher spatial visual imagery may find it easier to fill in missing space-related information from their memory, thus increasing the richness and/or internal consistency of the SSM if the spatial data provided by the media product is poor (Dean & Morris, 2003). Similar to user variables that may affect controlled attention (see above), it is possible to identify other trait and also state variables that are equally relevant for the building of SSMs compared to spatial visual imagery.

Second Step: From SSMs to Spatial Presence

The existence of an SSM is conceptually distinct from the sensation of Spatial Presence, because SSMs are mental representations, whereas Spatial Presence is regarded as an experiential state. Users who have built an SSM may or may not feel as though they are a part of the mediated spatial surroundings represented in the SSM. Additional cognitive and/or perceptual processes must occur in order for a

user to move from an SSM to Spatial Presence. To clarify, determining whether or not a SSM is constructed indicates whether the observed stimulus is a room or space to the user at all, whereas analyzing the experience of Spatial Presence involves assessing whether the user is self-located in an already existing room or space.

Once the media users have constructed a stable SSM, the question arises (either consciously or unconsciously) where they subjectively position their own physical experience within the two spatial surroundings available to them: Does s/he feel located in the mediated spatial environment (which means that s/he has entered the state of Spatial Presence), or is s/he staying within the "real" space (i.e., Presence does not occur)? In perceptual terms, the individual must define her/his *primary egocentric reference frame* (*PERF*, see Riecke & von der Heyde, 2002). The theory of perceptual hypotheses (TPH; Bruner & Postman, 1949) explicates how this decision process may be conceptualized (see below).

Primary Ego Reference Frames (PERF)

According to the proposed model, Spatial Presence emerges from SSMs through a perceptual and cognitive process that convicts media users that they are personally located within the environment represented in their SSM. This end state of the Spatial Presence process is very similar to everyday experiences of being present in a real room, landscape, or car (Lee, 2004). Therefore, the explication of the mechanism which links SSMs to Spatial Presence refers to spatial information processing outside of media contexts.

In order to determine their own position within a spatial environment, individuals must constantly monitor their spatial surroundings and check for inconsistencies between this outer representation and their internal sensory feedbacks related to their location (for example, vestibular cues). To do so, they continuously construct the spatial world within an *egocentric reference frame* (ERF; Franklin & Tversky, 1990; Sholl, 1999; Carlson, 1999). An ERF is defined as a mental model of the world that is organized from a first-person perspective (Mou & McNamara, 2002) and contains at least the immediate surroundings (Radvansky, Spieler, & Zacks, 1993; Freksa et al. 1999; Sholl, 1999, see also McNamara, 1986). The individual sustains an ERF through permanent updating of his/her spatial mental model (van Oostendorp, 1994; Blanc & Tapiero, 2001; Riecke & von der Heyde, 2002; Bjork, 1978). Spatial updating creates the perceptual sensation of a constant environment that the individual feels part of. Such ERFs are constructed not only by visual information, but also through other sensory input such as vestibular cues (Riecke, von der Heyde, & Bülthoff, 2001). All perceived objects, including one's own body, are located in reference to ERF. Thus, an ERF tells us where we are in a spatial environment.

Mediated environments may also offer ERFs, for example, in first-person shooter video games (Schneider, Lang, Shin, & Bradley, 2004). Such a media-bound ERF is an integral part of the SSM the user constructs while processing a media stimulus. Therefore, a mediated environment may offer an ERF that is different from the users' real-world ERF (Riecke & von der Heyde, 2002). Since an ERF is created from various sensory perceptions, different modalities can indicate different ERFs. For example, the visual channel (as stimulated by the computer game) may support a different ERF than the vestibular channel (which is not addressed by the game). Under such circumstances, the media users, in order to retain their capability to act and avoid excessive confusion, are most likely to try to return to the homoeostatic condition of one congruent ERF. This congruent ERF is labeled the *Primary Ego Reference Frame (PERF)*, because the individual will prefer to align his/her spatial perceptions and perceived action possibilities with this reference frame over any other possible frame. According to our definition, Spatial Presence occurs when a person accepts a mediated environment as PERF, because in this case, perceived self-location, perceived possible actions and mental capacities are all bound to the mediated space.

If media users have built an SSM of the mediated environment, more than one ERF is available to them: one is originated by the media product, while the other is their actual environment. In this situation, users have to decide which of these ERFs is their PERF. Spatial Presence will only emerge if users accept the mediated ERF as PERF. If they fail to do so, they will continue feeling located in their real environment, although they may have a vivid impression of how the mediated ERF looks. The decision which leads to the acceptance or rejection of the mediated ERF as PERF is a perceptual-cognitive process explicated by the theory of perceptual hypotheses. Its result is crucial for the emergence of Spatial Presence, which can only occur if the mediated spatial environment is accepted as the PERF. The *theory of perceptual hypotheses* explains how users make this fundamental decision.

The Theory of Perceptual Hypotheses

According to Bruner and Postman (1949), perception is a cognitive interaction between an organism and its environment, a process based on the reception and interpretation of stimuli using available hypotheses about the environment (Lilli, 1997; see also Gregory, 1980, 1981; Neisser, 1976). TPH regards perception as comprised of four heuristic functions (Lilli & Frey, 1993): selection, organization, accentuation, and fixation. The perceived objects are those which the users' select out of the diversity of environmental stimuli. Perception itself is the result of organization, meaning that whatever is perceived is already arranged in a way which makes sense for the observer. Thus, in order to make sense of the diverse stimuli, the perceiving organism emphasizes some aspects of stimuli more than others.

Finally, every perception is the result of prior perceptions which have proved successful in similar situations. TPH divides perception into three stages:

Provision of expectation hypotheses

Any process of perception starts with a hypothesis of expectation which stems from prior experiences of perception and is considered as a perceptual set or cognitive predisposition. This hypothesis tells the observer what kind of information to watch out for.

Input of information about the object of perception

The chosen hypothesis affects to a certain degree what is currently perceived. "The [perceived] information content thus depends not only on what is but on the hypothetical stored alternatives of what may be" (Gregory, 1980, p. 183).

Confirmation or disproof of the hypothesis

If the expectation hypothesis is confirmed through perceived information, the perceptual test of the hypothesis is terminated. If the received data does not confirm the expectation hypothesis, the perception cycle starts anew. Successful hypotheses guide subsequent processes of perception (Bruner & Postman, 1949). This way, prior perceptions not only suggest to the observer what to look for, but also indicate how to interpret current perceptions. Demonstrably, perceptual organization is powerfully determined by expectations built upon past contact with the environment (Bruner & Postman, 1949).

An example for such a three-step process of perception is a person watching an action drama on TV. Think of a sequence in which the protagonist discovers a dark archaeological site and wonders what kind of ancient building s/he has entered. Available knowledge about such typical action drama situations allows the viewer to formulate the expectation hypothesis that the building might be a historic temple. This expectation causes the viewer to look for indicators of the religious function of the building, for example, symbols and statues. As soon as the media product reveals information supporting the expectation hypothesis (e.g., the protagonist finds an altar), the perceptual test of the hypothesis is terminated. If information that contradicts the expectation is detected, however, a new hypothesis is formulated (e.g., the building is an ancient fortress), and the perceptual process targeting the nature of the site starts over again.

Observers may hold one or more hypotheses at the same time. If they hold more than one, the hypotheses can vary in strength. The degree to which perception is affected by a certain expectation hypothesis is determined by the strength of the competing hypotheses. If the observers have formed a strong hypothesis, the result

of the perception process is primarily determined by this hypothesis (i.e., concept-driven or top down information processing). On the other hand, if the observers have built a rather weak hypothesis, information processing is data-driven (i.e., bottom up). Thus, the strength of a hypothesis determines its impact on the result of perception.

Lilli and Frey (1993) have posited three important assumptions concerning the strength of a hypothesis and its influence on perception. They are (1) the stronger a hypothesis, the larger the probability that the hypothesis is activated (i.e., priming), (2) the stronger a hypothesis, the smaller the amount of information necessary to confirm it, (3) the stronger a hypothesis, the larger the amount of contradictory information necessary to disprove it. In summary, people always form hypotheses which they (try to) verify using their perceptions (expectation-hypotheses; Nickerson, 1998). Normally, observers establish several hypotheses at the same time. Therefore, they must decide which hypothesis to rely on during the ongoing process of perception. Which hypothesis is chosen depends on the strength of each of the competing hypotheses.

Test of the "Medium-as-PERF-Hypothesis" and the emergence of Spatial Presence

Situations that feature some uncertainty about the PERF caused by a media product arise when two competing perceptual hypotheses exist: one indicates that the real word is the PERF, and the other indicates that the mediated environment is the PERF (the so-called medium-as-PERF-hypothesis; see Slater, 2002, for a similar notion). Once a SSM has been established due to the elaboration of spatial cues provided by a media offering, the ERF inherent to this SSM challenges the user's given primary reference frame (e.g., to be located in the spatial system of the real word) and the referring perceptual hypothesis (e.g., to assume one is located in a living room) by constituting a medium-as-PERF-hypothesis. In the course of perception and imagination, the processed information may support one of the hypotheses over the other. *Spatial Presence occurs when the medium-as-PERF-hypothesis is confirmed repeatedly through processed information and is thus stabilized over time*. If, on the other hand, the medium-as-PERF-hypothesis is weakened by contradictory information (e.g., a microphone that appears in a movie as an artificial object), the medium-as-PERF-hypothesis will be dropped—that is, the state of Spatial Presence does not occur (or persist)—and the alternative hypothesis will be selected and tested (i.e., the reality-as-PERF-hypothesis; Bruner, Postman, & Rodrigues, 1951).

We argue that the experience of nonmediation, which often is defined as an essential component of all Presence experiences (ISPR, 2001), is neither a relevant precursor for the formation process of Spatial Presence (see for contributing factors below) nor a crucial aspect of feeling self-located in spatial scenery.

Rather, the experience of nonmediation is a global sensation during media exposure that might be fueled by states of Spatial Presence. If the medium-as-PERF-hypothesis is accepted and stabilized over time, the user approves of the authenticity of the spatial depiction that the medium provides. Therefore, while the user is spatially present, the illusive character of the media imitation is unlikely to shape cognitions regarding his or her current definition of the exposure situation. Experiencing spatial presence, the user perceives no illusion or imitation created by human-made technology, thus establishing or strengthening the overall feeling of nonmediation.

The users' questioning of the medium-as-PERF-hypothesis is initiated whenever contradictory sensory perceptions from a media product disrupts an existing belief about the PERF. For example, the user's belief that s/he is located in a cinema could be irritated by the persuasive spatiality of a movie, which suggests location within the film's world. Such an assumption implies that the medium is able to make "strong claims for the PERF." With respect to the modeled lower level processes, this is true if the medium contains either numerous persuasive spatial cues or strong and vivid images of space that lead to the formation of a strong SSM (which also includes a strong ERF). The model assumes that the strength of the SSM varies by its internal consistency (the more plausible the spatial scenery, the stronger the SSM) and its richness (the more objects entailed, the stronger the SSM). A strong SSM adds to the relative strength of the medium-as-PERF-hypothesis: The more plausible and the richer the SSM, the more plausible and the stronger the resulting medium-as-PERF-hypothesis. Consistent SSMs give rise to plausible, error-free, ergo strong hypotheses. Rich SSMs bind cognitive resources and thus increase the relative salience of the ERF inherent to the SSM, again resulting in stronger hypotheses.

According to TPH, a stronger expectation hypothesis requires a smaller amount of supportive information to confirm it. When a strong SSM has contributed to a very strong medium-as-PERF-hypothesis, then, the probability of its acceptance is increased, as the medium only needs to provide a small amount of additional congruent information to confirm the expectation. If a vague or imprecise SSM has diminished the relative power of the medium-as-PERF-hypothesis, however, the media product must provide much more supportive information for the user to accept it (that is, to enter the state of Spatial Presence). In sum, the "quality" of the users' SSM strongly affects the perceptual test of the medium-as-PERF-hypothesis. However, even very strong SSMs do not automatically cause the acceptance of the medium-as-PERF-hypothesis; information specifically supporting the hypothesis must always be available for it to be accepted.

Thus, similar to attentional processes (see above), both media attributes and users' internal operations can generate information to activate the process of hypothesis testing and to support the medium-as-PERF-hypothesis.

Media factors, perceptual hypothesis testing, and the formation of Spatial Presence

One can imagine numerous factors which could make the ERF offered by a media product so plausible or persuasive that the user is likely to accept it as the PERF. We need not provide a complete list of media factors. But in general, media factors contributing to the formation and strength of an SSM on the first level should still exert an influence on the second level. That is, the more consistent various sensory cues of the media product are, the more likely continued acceptance of the "tested" ERF will be (Slater, 2002).

Certainly, the mediated spatial structures must also be *persistent*. If the represented space vanishes within a short period of time, not only could the SSM shut down due to a lack of incoming spatial cues, but a currently tested medium-as-PERF-hypothesis will remain unconfirmed, as real spatial structures may re-occupy the user's perceptional or imaginative capacity. Exactly how long a previously presented spatial stimulus must be absent before a derived SSM or the medium-as-PERF-hypothesis expires, however, is an empirical question—one of attention allocation. For example, if a commercial break of a television program interrupts the stream of consistent spatial cues, attention may shift to new stimuli representing different SSMs and ERFs. If these ERFs are regarded as highly persuasive, they are likely to abolish previously held beliefs. Sometimes, however, users might successfully block out external stimuli after a spatial stimulus has vanished, and thus preserve an existing belief in their mind until the stimulus returns. *Narrative*, *drama*, and *plot* have repeatedly been identified as supporting the sensation of Presence (Kelso, Weyrauch, & Bates, 1993; Klimmt & Vorderer, 2003). Because suspense may sustain the receivers' interest in the media product, dramatic media content should motivate them to stay connected to the media product, increasing the medium's persistence and stabilizing the medium-as-PERF-hypothesis.

In addition to persistence, the acceptance of the ERF should be more likely when the spatial surrounding perceived by the visual channel matches the perceived posture that is construed on the "inner" vestibular information (afferent-efferent-loop, von Holst & Mittelstaedt, 1950). Virtual reality technology is able to sustain such a match between sensory modalities, for example, through tracking devices that detect movements of the user's head and generate an appropriate visual illusion of movement in real-time (Biocca & Delaney, 1995). Afferent information that does not match expectations based on the efferent sensation, however, weakens the currently tested hypothesis. Perhaps the media offering only needs to match those space-related afferent-efferent-loops in a natural way with regard to *realism* (while it can be fictional or unnatural in other aspects). The availability of afferent-efferent-loops depends on the interactivity of a display. *Interactivity* can provide strong support for the medium-as-PERF-hypothesis, be-

cause receiving feedback on one's actions (e.g., visual responses to movements) may be very convincing for media users. On the media side, the degree of interactivity depends on the adequacy of the given feedback as well as on breadth of possible interactive actions (Steuer 1992; Witmer & Singer, 1998; Zahorik & Jenison, 1998). Interactivity may, if the interface is calibrated properly to the users' natural efferent-afferent loop, serve as an amplification of the medium-as-PERF-hypothesis (Slater, Usoh, & Steed, 1995). However, inappropriate configurations, for example, high response latencies, will reveal the artificial quality of the stimulus or even lead to simulator-sickness (DiZio & Lackner, 1992), thus hampering the approval of the medium-as-PERF-hypothesis. In sum, being able to perform certain well-calibrated actions within the mediated environment may attract users' attention. More importantly, their acceptance of the medium as PERF should increase compared to a noninteractive environment (Steuer, 1992).

The availability of single or combined factors from the above examples allows different media products to affect the outcome of the test of the medium-as-PERF-hypothesis. VR technology utilizes most of these factors (e.g., congruence across modalities, persistence, interactivity, realism). Thus, the model can explain the demonstrated power of such media to evoke and sustain Spatial Presence. Other media, such as television or books, may utilize a different and potentially smaller set of factors (e.g., persistence, interactivity), which would decrease their power to evoke Spatial Presence, or at least increase the probability of variations in Spatial Presence during the course of consumption ("breaks in Presence," Slater & Steed, 2000). Under these circumstances, Spatial Presence will only emerge if internal operations of the users overrule the (strong) evidence that contradicts the medium-as-PERF-hypothesis (e.g., by compensating for a lack of interactivity).

Users' active contributions to the emergence of Spatial Presence: Involvement and Suspension of disbelief

If an expectation hypothesis is to be confirmed in the face of strong contradictory evidence, TPH assumes that motivational factors, such as high involvement, must substitute the missing media factors. The stronger the motivational support for a hypothesis, the smaller the amount of corresponding stimulus information required to confirm it, and the larger the amount of contradictory information required to disprove it. Even the activation of the medium-as-PERF-hypothesis itself can be supported by motivational forces.

The consumption of low-immersive media products such as films, books or websites may allow for the construction of an SSM, but those media are probably not capable of disrupting existing beliefs about a PERF, because the spatial environment they portray is not as pervasive as VR (Schubert & Crusius, 2002). In other words, the ERF included in the SSM derived from low-immersive media will

produce a rather weak medium-as-PERF-hypothesis. Nevertheless, we argue that states of Presence may occur while using low-immersive media, if the users are highly motivated to engage in the media offerings. High motivation on the part of the user will strengthen the medium-as-PERF-hypothesis, and the probability of acceptance will also be heightened. Thus, the medium does not need to be powerful enough or to provide a strong medium-as-PERF-hypothesis to trigger hypothesis testing by itself. For example, people want to enjoy watching TV entertainment or in playing computer games (Klimmt & Vorderer, 2003). They expect that concentrating on and becoming immersed in the TV show, the thriller, or the computer game, will contribute to their desired goal (e.g., Schneider et al., 2004). Consequently, and because it is functional, they will be more likely to accept the medium-as-PERF-hypothesis. An SSM constructed from a low-immersive medium may provide an ERF, which can be "picked up" by the readers, used for a perceptual test of the medium-as-PERF-hypothesis, and eventually cause the sensation of Presence. Our model proposes two different types of user variables (internal processes) that affect the perceptual test of the medium-as-PERF-hypothesis: Involvement and suspension of disbelief.

The concept of involvement

Involvement is regarded as a motivation-related meta-concept that includes various forms of intense interactions with a mediated stimulus (Rothschild, 1983; Salmon, 1986; Roser, 1990; Vorderer, 1993; Wirth, 2006). For example, for Krugman, involvement is the number of conscious bridging experiences, connections, or personal references that a viewer makes per minute between his or her own life and a stimulus (Krugman, 1965). More generally, involved users voluntarily and intentionally participate in an information-exchange process (Williams, Rice, & Rogers, 1988), which may have cognitive, affective and conative, and/or behavioral aspects (Chaffee & Roser, 1986). Its *cognitive dimension* includes attentional, inferential, and elaborative components (Batra & Ray, 1985; Roser, 1990). *Affective aspects* of involvement refer to salience and the assignment of relevance (Roser, 1990). Involved users recognize and establish connections between the media content and their own values, experiences and beliefs (Krugman, 1965). Moreover, during media exposure intense feelings and emotional reactions may occur and be appraised and interpreted by the users (Batra & Ray, 1985; Perse, 1988). Finally, users may wish to act in the mediated world (i.e., *conative and/or behavioral level* of involvement, Chaffee & Roser, 1986). For example, a virtual environment may enable its users to open doors and to explore the rooms of a building. The broader the interactive capabilities of the media environment are, the more extensive the opportunities for exploratory activities will be. Concerning less interactive media, such as films, explorative behavior is restricted to visual scanning. While reading a book, mental exploration is the only possibility (see Franklin

& Tversky, 1990). In this case, exploration (as a behavioral component of involvement) is identical to elaborative activities (as a cognitive component of involvement). In sum, while reading, viewing or listening to media users can be cognitively, affectively, and / or conatively involved with the media content for varying reasons. For example, users may be strongly motivated to deal with the content in more depth. Or they may be stimulated and aroused by a film or a story, and thus become involved with it.

Involvement and Spatial Presence

Some authors consider involvement to be a part of the Presence experience (e.g., Regenbrecht & Schubert 2002; Witmer & Singer, 1998). In our view, however, involvement means the *active and intensive processing* of the mediated world, whereas Spatial Presence emphasizes the experience of "being" solely within the mediated world. Involvement is an action that includes higher forms of information processing, such as thinking about, interpreting, elaborating, appraising, and assigning relevance to the media content (Wirth, 2006). Note that although the user does not focus on reality, involvement does not necessarily entail a loss of mental contact with the real world. On the other hand, Spatial Presence is defined as an experience during which people lose mental contact with the real world. In addition, the experience of Presence does not necessarily imply active participation in terms of involvement, but is a possible consequence of involvement. For example, if users are involved with the narration of a film, a text or a role-playing computer game, they think about the narration's characters, their actions and their feelings, but they do not pay attention to the television receiver, the book wrapper or the joystick in their hands. Thus, the probability for accepting the medium-as-PERF-hypothesis increases rather indirectly. When users are highly involved with media content, their concentration and mental capacity are primarily devoted to the media and not to reality. Thus, very few real world cues are processed and mentally represented. Conversely, the majority of the users' information processes are media-related and enriching for the SSM. This should add considerably to the relative strength of the medium-as-PERF-hypothesis. As a result, Presence occurs rather automatically because of the powerful medium-as-PERF-hypothesis, not because users consciously suppress reality as PERF. Thus, presence could be seen as a side-effect of media involvement.

Suspension of disbelief

In our opinion, another process, *suspension of disbelief,* supports feelings of Spatial Presence in an indirect manner. The concept originated in literature theory (Coleridge, 1817/1973; Bystrom, Barfield, & Hendrix, 1999). *Suspension of disbelief is defined as not paying attention to external stimuli and internal cognitions*

that (might) distract from the enjoyment of the mediated story and environment. Such distractions may be of technological kind or of the contents. For example, technologically they may stem from the weight of the head-mounted display or sweaty gloves (VR), the experiences of feeling paper pages or a book wrapper (book), surrounding noises and voices or a smell of popcorn (cinema), the sight of a keyboard, a mouse or the bounds of the monitor (websites, computer games). Content distractions can arise from bad, unrealistic, or implausible narrative plots (Böcking & Wirth, submitted). In many cases users suspend disbelief if they want to be entertained or simply to let themselves sink in the story. In order to reach these goals they ignore or disregard any potential interference (as far this is possible and does not exceed a threshold). As a consequence, users often do not notice any interference at all, though there may be some. Additionally, even if they do happen to notice them, they do not focus on them (Böcking & Wirth, submitted). Let us consider a VR user who wears a head-mounted display that is too heavy or a film viewer who detects serious logical flaws in narrative media content. In the first case, the user may suspend the weight of the head-mounted display in order to remain attentive to the virtual reality content and still be able to benefit from it (e.g., having fun exploring the environment). In the second case, the viewer may not pay attention to story line inconsistencies because doing so would make watching an action movie less entertaining. These examples suggest that users' motives and goals are decisive for the application of suspension of disbelief. However, following research in the area of uses and gratifications, users are not always aware of these motives and goals (e.g., Vorderer, 1992). Thus, we can assume that an individual's suspension of disbelief probably occurs rather unconsciously. However, having seen a movie or having walked through a virtual environment, people should be able to report whether they have suspended disbelief.

Suspension of disbelief and Spatial Presence

How can suspension of disbelief influence the development of the presence experience, i.e., how can it foster the medium-as-PERF-hypothesis? In general, suspending one's disbelief allows the user to weaken or even delete factors from his/ her focus of attention that might contradict the medium-as-PERF-hypothesis. First, suspension of disbelief weakens the reality-as-PERF-hypothesis by the user's lack of attention to distracting information from the surrounding real world. Second, suspension of disbelief allows the user to suppress mediated world information that contradicts real world knowledge, thus making the medium-as-PERF-hypothesis more acceptable. For example, a person watching a science-fiction movie "ignores" the fact that it presents gravity inaccurately, thus allowing him/herself to experience the spaceship as believable despite contradicting evidence. Third, a user who suspends disbelief ignores contradictory information from his mind. For example, a reader of a novel decides to concentrate on the spatial descriptions in the book to

avoid memories from the working day that enter his thoughts and disrupt the incoming stream of space-related information. Finally, suspension of disbelief may assist the medium-as-PERF-hypothesis in interpreting contradictory information as actually supporting this hypothesis. For example, viewers of a fantasy movie may accept the film's presentation of sorcerers moving huge objects with magic spells as "realistic" within the context of the movie and turn an objectively problematic feature of the presentation into a fact that supports the medium-as-PERF-hypothesis (Böcking & Wirth, submitted). In sum, with suspension of disbelief even a weak medium-as-PERF-hypothesis might be sufficient to evoke Spatial Presence.

Note that Spatial Presence may occur in the case of low involvement or low suspension of disbelief as well. If users are only marginally involved with the media content or if users get distracted by logical flaws or technological bugs, they may be drawn into the Spatial Presence experience because it is dictated by the power (the immersiveness) of the presence-inducing technology. During low involvement or low suspension of disbelief the immersive power of the media environment becomes more decisive for Spatial Presence experiences. In short, while highly involved users or users suspending disbelief are able to experience Spatial Presence even with media that do not suggest Spatial Presence technologically (e.g., books), the less-involved or those not suspending disbelief would need a powerful Spatial Presence inducing technology (or formal features) to draw them into the illusion of reality (e.g., VR). Of course, the model expects moderate levels of both immersion and involvement and suspension of disbelief to be able to induce Spatial Presence as well. In other words: To a certain degree, immersion and involvement and suspension of disbelief are considered to be substituting each other.

Trait absorption as personological variable in the emergence of Spatial Presence

As mentioned above, certain media characteristics may influence the outcome of the perceptual test of the medium-as-PERF-hypothesis and thus facilitate the emergence of Spatial Presence. Similarly, user variables may take effect during the test of the medium-as-PERF-hypothesis by activating the modeled user operations, that is, involvement and/or suspension of disbelief. The most important user trait to consider is *absorption*. Trait absorption refers to an individual's motivation and skill in dealing with an object in an elaborate manner (Wild et al., 1995). High-absorption individuals tend to become intensely involved with objects such as media products, and become "fascinated" without much effort. Therefore, absorption is considered to be positively correlated with attention allocation, the identification of spatial structures, involvement, and suspension of disbelief, as all of these processes are connected to states of fascination and experiential involvement. High-absorption individuals will display a greater chance of confirming the

medium-as-PERF-hypothesis and entering the state of Presence, because they are motivated to do so; they are able to influence the outcome of the perceptual test of the hypothesis in terms of increased involvement and/or suspension of disbelief.

The specific effect of trait absorption on the test of the medium-as-PERF-hypothesis may depend on the type of medium consumed. In reading processes, for example, one major component of absorption, the capability to experience vivid and pervasive daydreams (Tellegen & Atkinson, 1974), may be especially important, as this skill facilitates the construction of an SSM and the perception of being located within the imagined spatial structure. During consumption of audio-visual media, the synesthetic component of absorption may be most relevant: In high absorption individuals, sensations in one modality (as stimulated by a medium, for example) can trigger imagined sensations in other modalities which have not been externally stimulated (e.g., Biocca, Kim, & Choi, 2001). Such cross-modal elaborations would enhance the user's SSM and strengthen the medium-as-PERF hypothesis in terms of coherence across modalities, realism, and meaning. Because of its multidimensional structure, alternative mechanisms of influence on the emergence of Spatial Presence might be modeled and demonstrated; for the general framework to be outlined here, we limit the considerations on trait absorption to the mentioned mechanisms. Additional personological variables may of course be found equally important (e.g., Sas & O'Hare, 2001), but among the many potentially influential trait variables, absorption is by far the most interesting and elaborated construct.

Combined media and user factors in tests of the medium-as-PERF-hypothesis

As both media factors and user variables affect the outcome of the test of the medium-as-PERF-hypothesis during media exposure, they each may compensate for shortcomings or obstacles on the other "route": Insufficient spatial cues of the media product may be counteracted by users' involvement and Suspension of Disbelief. Consequently, a lack of user motivation to experience Spatial Presence may be overruled by pervasive and convincing media characteristics. This mutual completion is assumed to be in effect both in terms of media comparison—that is, the relative contributions of media and personological factors to the strength of the medium-as-PERF-hypothesis depending on the type of medium—and with respect to the process of receiving one single medium. Viewers of a TV movie might sometimes feel Spatial Presence. This may result from the space-related information that the show provides during the course of reception, or during other parts of the show because of their strong involvement with the protagonists. During yet other parts of the show, they may feel no Spatial Presence at all because neither media nor personological factors support the medium-as-PERF-hypothesis to a sufficient extent.

SUMMARY AND DISCUSSION

The proposed model of the formation of Spatial Presence centers around two major steps. First, the media users build a mental representation of the space portrayed by the media product, the so-called SSM. Automatic and/or controlled attention allocation is a precondition to the construction of the SSM, and media factors (such as attention-catching content features and spatial cues) as well as user variables (domain-specific interest, spatial visual imagery) will affect its development.

Once the users have constructed an SSM, perceptual hypotheses are activated. In case of persuasive media offerings and/or high involvement of the media users, the receivers test the so-called medium-as-PERF-hypothesis, which states that the spatial environment represented in the media-based SSM is the primary ego-reference frame (PERF). If this hypothesis is perceptually confirmed, Spatial Presence emerges; by accepting the mediated space as PERF, media users position themselves and realized action possibilities within that space. Both media factors (e.g., persistence, realism) and user actions (involvement, suspension of disbelief) can affect the transition from the SSM to Spatial Presence.

In respect to past theoretical and empirical research, this model is an attempt to connect the young concept of Spatial Presence to established constructs in psychology and communication. As a result, the model clearly differentiates Spatial Presence from related concepts that were formerly considered as equal or similar, most importantly, involvement (e.g., Schubert et al., 2001). In this sense, the model does not contradict existing Presence models (e.g., Draper et al., 1998; Freeman, 2004), but rather advances them towards a more coherent and comprehensive conceptualization that allows for hypothesis formulation and testing.

An interesting by-product of this deductive approach is the question about the difference between Spatial Presence and the processing of nonmediated reality (Mantovani & Riva, 1999). Our model argues that media users who are experiencing Spatial Presence rely on several perceptual and cognitive processes that they continuously execute in nonmedia settings (e.g., selective-attentive processing of environmental stimuli, construction of mental models of the immediate surrounding). Therefore, one might suspect Spatial Presence to be a redundant and superfluous concept, as it looks like an assembly of well-known processes of human perception and construction of "reality," which is then applied to media use. Our model provides ample arguments to disagree with this position. It is well-known that the processing of media messages "runs" on the same routines, mechanisms, and cognitive structures that humans have developed in times when there were no (mass) media (Reeves & Nass, 1996). It is therefore imperative to consider those fundamental processes in models of media use and experience, and the proposed model does so in a systematic manner. However, in spite of the congruencies between every-day processing of reality, media experiences—especially Spatial

Presence—still display unique properties that do not exist in nonmedia settings. Specifically, the assumption of an alternative ego-centric reference frame (ERFs) offered by a medium and the possibility to use this reference frame as new PERF is a media-bound phenomenon and determines the unique quality of Spatial Presence. Only during media use, distant and/or fictional and/or virtual spaces can occur as potential ERFs and can be successfully "entered" to become the PERF. This is the key difference between Spatial Presence and the experience of spatial reality, and the proposed model is the first of its kind to explicate this distinction. To a certain extent, daydreaming (Singer, 1975) may facilitate similar situations of multiple ERFs. But these ERFs are necessarily idiosyncratic constructions and thus cannot be compared to Spatial Presence that implies the perceived self-location in spaces outlined, manufactured, and/or simulated *by others*. The proposed model therefore supports the conceptual view of Spatial Presence as an experiential state that must be separated from other states and, most importantly, from nonmediated experience. Consequently, the model's process-oriented causal structure advances our understanding of Spatial Presence significantly and permits a more effective handling of the concept in empirical research.

Future research on Spatial Presence should (1) try to test the model's assumptions, and (2) apply the model to fundamental and applied problems of media psychology and communication research.

The call for tests of the model's assumptions does not imply that there is no empirical evidence supporting the model. For instance, the conceptualization is in line with the findings on attention to television (e.g., Anderson & Burns, 1991) which has identified media factors that evoke viewers' attention allocation. However, there is no integrated research program that has tested the interplay between the theorized model components in the context of Spatial Presence. The most challenging question for such a research program is how to demonstrate empirically the connections between the actual process components that the model suggests. Creative experiments with media stimuli that offer many degrees of freedom for message manipulation (e.g., television, computer games) should try to isolate the conceptualized stages of the process that leads to Spatial Presence. Initial exploratory studies revealed encouraging results (Boecking et al., 2004; Gysbers et al., 2004). Structural equation models can be used to assess the relationships between the discussed process components. Multimethod approaches (e.g., eye-tracking as measure for attention, think-aloud measures for SSMs, questionnaires for Spatial Presence) can also help to illuminate the relationships between the model components.

Aside of the need for integrated testing, the model offers a level of universality which enables researchers to apply Spatial Presence to the study of virtually any media: Processes of attention, the construction of spatial mental models, the theory of perceptual hypotheses, and user actions like involvement and suspension of disbelief are categories which may be useful for understanding how individuals pro-

cess and experience televised, printed, audio-broadcast, computer-mediated, and even interpersonal-oral messages.

An example of where the application of the model would be promising is the consumption of televised sports. Live broadcasts attempt to "transport" the atmosphere of the stadium to the viewers at home. The underlying assumption is that experiencing Spatial Presence would increase the enjoyment of watching the game (Klimmt & Vorderer, 2003). Experimental studies based on the proposed model can disentangle the involved processes and test whether it is really Spatial Presence that facilitates enjoyment, whether a solid SSM of the field is sufficient, or whether the game space is not an important category at all, because involvement with the team and the accompanying suspense are primary (Raney, 2003). As the example indicates, the model offers an increased level of granularity to researchers who are interested in applying the concept of Spatial Presence to questions of media consumption, information processing, and media effects. It may pave the way to expand the applicability of Spatial Presence within the domain of communication beyond the investigation of virtual reality and videoconferencing applications and to find out about the potential role of Spatial Presence as facilitator and/or amplifier of media effects.

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REFERENCES

Anderson, D. R., & Burns, J. (1991). Paying attention to television. In D. Zillmann & J. Bryant (Eds.), *Responding to the screen: Perception and reaction processes* (pp. 3–26). Hillsdale, NJ: Erlbaum.

Barfield, W., Hendrix, C., Bjorneseth, O., Kaczmarek, K. A., & Lotens, W. (1995). Comparison of Human Sensory Capabilities with Technical Specifications of Virtual Environment Equipment. *Presence: Teleoperators and Virtual Environments*, *4*(4), 329–356.

Batra, R. & Ray, M. (1985). How advertising works at contact. In L. Alwitt & A. Mitchell (eds.), *Psychological processes and advertising effects: Theory, research and applications* (pp. 13–43). Hillsdale, NJ: Lawrence Erlbaum.

Berlyne, D. E. (1960). *Conflict, arousal, and curiosity*. New York.

Biocca, F. (1997). The cyborg's dilemma: progressive embodiment in virtual environments. *Journal of Computer-Mediated Communications*, *3*(2), [Online]. Available: http://www.ascusc.org/jcmc/vol3/issue2/biocca2.html.

Biocca, F., & Delaney, B. (1995). Immersive virtual reality technology. In F. Biocca & M. Levy (Eds.), *Communication in the age of virtual reality* (pp. 15–32). Hillsdale, NJ: Lawrence Erlbaum.

Biocca, F., IJsselstein, W. & Freeman, J. (Eds.). (in press). *Handbook of Presence research.* Mahwah, NJ: Lawrence Erlbaum Associates.

Biocca, F., Kim, J., & Choi, Y. (2001). Visual touch in virtual environments: An exploratory study of Presence, multimodal interfaces, and cross-modal sensory illusions. *Presence: Teleoperators and Virtual Environments*, *10*(3), 247–265.

Bjork, R. (1978). The updating of human memory. In G. H. Bower (Ed.), *The psychology of learning and motivation* (Vol. 12). New York: Academic Press.

Blanc, N. & Tapiero, I. (2001). Updating spatial situation models: Effects of prior knowledge and task demands. *Discourse Processes*, *31*(3), 241–263.

Böcking, S., & Wirth, W. (submitted). *Towards conceptualizing Suspension of disbelief for communication research.*

Bracken, C. C. (2005). Presence and image quality: The case of high-definition television. *Media Psychology*, *7* (2), 191–206.

Bruner, J. S. & Postman, L. (1949). On the perception of incongruity: a paradigm. *Journal of Personality*, *18*, 206–223.

Bruner, J. S., Postman, L. & Rodrigues, J. (1951). Expectations and the perception of colour. *American Journal of Psychology*, *64*, 216–227.

Bystrom, K.-E., Barfield, W., & Hendrix, C. (1999). A conceptual model of the sense of Presence in virtual environments. *Presence: Teleoperators and Virtual Environments*, *8*(2), 241–244.

Carlson, L. A. (1999). Selecting a reference frame. *Spatial Cognition and Computation*, *1*(4), 365–379.

Chaffee, S. H. & Roser, C. (1986). Involvement and the consistency of knowledge, attitudes, and behaviors. *Communication Research*, *13*(3), pp. 373–399.

Coleridge, S. T. (1817/1973). *Biographia literaria, Vol. 2*. London: Oxford University Press (Original work published 1817).

Cutting, J. E. (1997). How the eye measures reality and virtual reality. *Behavior Research Methods, Instruments & Computers*, *29(1)*, 27–36.

Darken, R. P., Allard, T. & Achille, L. B. (1998). Spatial orientation and wayfinding in large-scale virtual spaces. *Presence: Teleoperators and Virtual Environments*, *7*(2), 101–107.

Dean, G. M. & Morris, P. E. (2003). The relationship between self-reports of imagery and spatial ability. *British Journal of Psychology*, *94* (2), 245–273.

DiZio, P. & Lackner, J. R. (1992). Spatial orientation, adaption and motion sickness in real and virtual environments. *Presence: Teleoperators and Virtual Environments*, *1*(3), 319–328.

Draper, J. V., Kaber, D. B., and Usher, J. M. (1998). *Telepresence*. Human Factors, 40(3), 354–375.

Dutke, S. (1994). *Mentale Modelle: Konstrukte des Wissens und Verstehens. Kognitionspsychologische Grundlagen für die Software-Ergonomie [Mental models: constructs of knowledge and understanding. Groundwork of spatial cognition for software ergonomics]*. Göttingen: Verlag für angewandte Psychologie.

Faubert, H. (2001). Motion parallax, stereoscopy, and the perception of depth: Practical and theoretical issues. In J. Bahram, M. Storrs, F. Okano (Eds.), *SPIE Proceedings Vol. CR76*.

Finn, K. E., Sellen, A. J. & Wilbur, S. B. (Eds.). (1997). *Video-mediated communication.* Mahwah, NJ: Lawrence Erlbaum Associates.

Franklin, N. & Tversky, B. (1990). Searching imagined environments. *Journal of Experimental Psychology: General, 119*(1), 63–76.

Freeman, J. (2004, May). *Implications for the measurement of Presence from convergent evidence on the structure of Presence*. Presentation to the Annual Conference of the International Communication Association (ICA), 27–31, 2004, New Orleans/USA.

Freksa, C., Habel, C., Wender, K. F. & Hartmanis, J. (Eds.). (1999). *Spatial Cognition, An Interdisciplinary Approach to Representing and Processing Spatial Knowledge. Lecture Notes in Computer Science.* Berlin: Springer.

Gibson, J. J. (1973). *Die Wahrnehmung der visuellen Welt [The Perception of the Visual World].* Weinheim Beltz.

Glenberg, A. M. (1997). What memory is for. *Behavioral and Brain Sciences, 20*(1), 1–55.

Gregory, R. L. (1980). Perceptions as hypotheses. *Philosophical Transactions of the Royal Society of London Series B, 290*, 181–197.

Gregory, R. L. (1981). *Mind in science.* London: Weidenfeld and Nicholson.

Harris, S. R., Kemmerling, R. L. & North, M. M. (2002). Brief virtual reality therapy for public speaking anxiety. *Cyberpsychology and Behavior, 5*(6), 543–550.

Hartmann, C., Wirth, W., Vorderer, P., Klimmt, C., Schramm, H. & Böcking, S. (in press). Spatial Presence theory: State of the art and challenges ahead. In F. Biocca, W. IJsselstein & J. Freeman (Eds.), *Handbook of Presence research.* Mahwah, NJ: Lawrence Erlbaum Associates.

Hawkins, R. P., Pingree, S., Bush Hitchton, J., Gilligan, E., Kahlor, L., Gorham, B. W., Radler, B., Kannaovakun, P., Schmidt, T., Hildur Kobleins, G., Wang, C. & Serlin, R. S. (2002). What holds attention to television? Strategic intertia of looks at content boundaries. *Communication Research, 29*(1), 3–30.

Heckhausen, H. (1989): *Motivation und Handeln [Motivation and Action].* Berlin: Springer.

Heckhausen, H., & Gollwitzer, P. M. (1987). Thought contents and cognitive functioning in motivational vs. volitional states of mind. *Motivation & Emotion,* 11, 101–120.

Hegarty, M., Richardson, A. E., Montello, D. R., Lovelace, K. & Subbiah, I. (2002). Development of a self-report measure of environmental spatial ability. *Intelligence,* 30, 425–447.

Held, R. M., & Durlach, N. I. (1992). TelePresence. *Presence: Teleoperators and Virtual Environments, 1*(1), 109–112.

Hendrix, C., & Barfield, W. (1996). The sense of Presence within auditory virtual environments. *Presence: Teleoperators and Virtual Environments, 5*(3), 290–301.

Hidi, S. E. (1995). A reexamination of the role of attention in learning from text. *Educational Psychology Review, 7*, 323–350.

Holst, E. von, & Mittelstaedt, H. (1950). Das Reafferenzprinzip [The reaference principle]. *Die Naturwissenschaften, 37*, 464–476.

Huston, A. C., & Wright, J. C. (1983). Children's processing of television: The informative functions of formal features. In J. Bryant & D. R. Anderson (Eds.), *Children's understanding of TV: Research on attention and comprehension* (pp. 37–68). New York: Academic Press.

Ijsselstein, W. (2002). Presence in the past: What can we learn from media history? In G. Riva, F. Davide, & W. A IJsselsteijn (Eds.), *Being There: Concepts, effects and measurement of user Presence in synthetic environments* (pp. 17–41). Amsterdam: Ios Press.

IJsselsteijn, W. A., de Ridder, H., Freeman, J., & Avons, S. E. (2000). *Presence: Concept, determinants and measurement.* Proceedings of the SPIE, Human Vision and Electronic Imaging V, 3959–76. Presented at Photonics West-Human Vision and Electronic Imaging V 23–28 January 2000, San Jose, CA.

ISPR (2001). *What is Presence?* [Online]. Available: http://www.temple.edu/mmc/ispr/explicat.htm[9.10.2002].

Johnson-Laird, P. N. (1983). *Mental models. Towards a cognitive science of language, inference, and consciousness.* Cambridge: Cambridge University Press.

Kebeck, G. (1997). *Wahrnehmung. Theorien, Methoden und Forschungsergebnisse der Wahrnehmungspsychologie [Perception. Theories, methods and research findings of the psychology of perception].* Weinheim, München: Juventa.

Kelso, M. T., Weyhrauch, P., & Bates, J. (1993). Dramatic Presence. *Presence: Teleoperators and Virtual Environments, 2*(1), 1–15.

Kim, T., & Biocca, F. (1997). TelePresence via television: two dimensions of telePresence may have different connections to memory and persuasion. *Journal of Computer-Mediated Communication, 3*(2), http://www.ascusc.org/jcmc/vol3/issue2/kim.html

Klimmt, C. & Vorderer, P. (2003). Media Psychology „is not yet there": Introducing theories on media entertainment to the Presence debate. *Presence*: *Teleoperators and Virtual Environments*, *12* (4), 346–359.

Krapp, A. (1993). *The construct of interest. Characteristics of individual interests and interest-related actions from the perspective of a person-object theory* (Studies in Educational Psychology No. 4). Munich: University of the Armed Forces.

Krugman, H. E. (1965). The impact of television advertising: learning without involvement. *Public Opinion Quarterly*, *29*, pp. 349–356.

Lang, P. J., Simons, R. F. & Balaban, M. T. (Eds.) (1997). *Attention and Orienting: Sensory and Motivational Processes*. Hillsdale, NJ.: Erlbaum.

Lee, K. M. (2004). Presence, explicated. *Communication Theory*, *14* (1), 27–50.

Lessiter, J., Freeman, J., Keogh, E., & Davidoff, J. S (2001). A cross-media Presence questionnaire: The ITC-Sense of Presence inventory. *Presence: Teleoperators and Virtual Environments*, *10*, 282–297.

Liebes, T., & Katz, E. (1986). Patterns of involvement in television fiction: A comparative analysis. *European Journal of Communication*, *1*, 151–171.

Lilli, W. & Frey, D. (1993). Die Hypothesentheorie der sozialen Wahrnehmung [The hypotheses theory of social perception]. In D. Frey & M. Irle (Eds.), *Theorien der Sozialpsychologie. Band 1: Kognitive Theorien* [*Theories of Social Psychology, Vol. 1: Cognitive theories*] (pp. 49–78). Bern: Huber.

Lilli, W. (1997). Hypothesentheorie der Wahrnehmung [The theory of perceptual hypotheses]. In D. Frey & S. Greif (Eds.), *Sozialpsychologie* [*Social Psychology*] (pp. 192–195). Weinheim: Beltz.

Lombard, M., & Ditton, T. (1997). At the heart of it all: the concept of Presence. *Journal of Computer-mediated Communication*, *3*(2), http://209.130.1.169/jcmc/vol3/issue2/lombard.html.

Lombard, M., Reich, R. D., Grabe, M. E., Bracken, C. C. & Ditton, T. B. (2000). Presence and television: the role of screen size. *Human Communication Research*, *26*(1), 75–98.

McNamara, T. P. (1986). Mental representations of spatial relations. *Cognitive Psychology*, *18*, 87–121.

McQuail, D. (1985). With the benefit of hindsight. Reflections on uses and gratification research. In M. Gurevitch, & M. R. Levy (Eds.), *Mass communication review yearbook*, Vol. 5 (pp. 125–141). Newbury Park, CA: Sage.

Mantovani, G. & Riva, G. (1999) "Real" presence: How different ontologies generate different criteria for presence, telepresence and virtual presence. Presence*: Teleoperators and Virtual Environments*, *8*(5), 538–548.

Mayer, H. O. (2000). *Einführung in die Wahrnehmungs-, Lern- und Werbe-Psychologie [Introduction into tbe psychology of perception, learning, and advertising]*. München : Oldenbourg.

Minski, M. (1980). TelePresence. *Omni*, 45–51.

Mou, W., & McNamara, T. P. (2002). Intrinsic frames of reference in spatial memory. *Journal of Experimental Psychology: Learning, Memory and Cognition*, *28*, 162–170.

Murch, G. M. & Woodworth, G. L. (1977). *Wahrnehmung [Perception]*. Stuttgart: Kohlhammer.

Neisser, U. (1976). *Cognition and reality. Principles and implication of cognitive psychology.* San Francisco: Freeman.

Nickerson, R. S. (1998). Confirmation bias: A ubiquitous phenomenon in many guises. *Review of General Psychology*, *2*, 175–220.

Öhman, A. (1979). The orienting response, attention, and learning: An information processing perspective. In H. D. Kimmel, E. H. van Olst, & J. F. Orlebeke (Eds.), The orienting reflex in humans (pp. 443–471). Hillsdale, NJ: Lawrence Erlbaum Associates.

Öhman, A. (1997). As fast as the blink of an eye: Preattentive processing and evolutionary facilitation of attention. In P. J. Lang, M. Balaban, & R. F. Simons (Eds.*) Attention and motivation: Cognitive perspectives from psychophysiology, reflexology, and neuroscience*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Oostendorp, H. van (1994). Constructing and updating spatial representations in story comprehension. In F. P. C. M. de Jong & B. H. A. M. Hout-Wolters (Eds.), *Process-oriented instruction and learning from text* (pp. 67–76). Amsterdam: VU University Press.

Perse, E. (1988). *A conceptualization and test of media involvement*. Paper presented at the Annual Conference of the of the International Communication Association (ICA), New Orleans, LA.

Perse, E. M. (1998). Implications of cognitive and affective involvement for channel changing. *Journal of Communication*, *48*(3), 49–68.

Posner, M. I. (1980). Orienting of attention. *Quarterly Journal of Experimental Psychology*, *32*, 3–25.

Potter, W. J. (1988). Perceived reality in television effects research. *Journal of Broadcasting & Electronic Media*, *32*(1), 23–41.

Radvansky, G. A., Spieler, D. H. & Zacks, R. T. (1993). Mental model organization. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *19,* 95–114.

Raney, A. A. (2003). Disposition-based theories of enjoyment. In J. Bryant, D. R. Roskos-Ewoldsen & J. Cantor, (Eds.), *Communication and emotion: Essays in honor of Dolf Zillmann* (pp. 61–84). Mahwah, NJ: Lawrence Erlbaum Associates.

Regenbrecht, H., & Schubert, T. (2002). Real and illusory interactions enhance Presence in virtual environments. Presence*: Teleoperators and Virtual Environments*, *11*(4), 425–434.

Regian, J. W., Shebilske, W. C. & Monk, J. M. (1992). Virtual reality: An instructional medium for visual-spatial tasks. *Journal of Communication*, *42* (4), 136–149.

Reeves, B. & Nass, C. (1996). *The media equation. How people treat computers, television and new media like real people and places*. Stanford: CSLI Publishing.

Riecke, B. E. & von der Heyde, M. (2002). *Qualitative modeling of spatial orientation processes using logical propositions: Interconnecting spatial presence, spatial updation, piloting, and spatial cognition* [Online]. Available: http://www.kyb.tuebingen.mpg.de/publications/pdfs/pdf2021.pdf (21.01.2003).

Riecke, B. E., von der Heyde, M., & Bülthoff, H. H. (2001). How do we know where we are? Contribution and interaction of visual and vestibular cues for spatial updating in real and virtual environments. In H. H. Bülthoff, K. R. Gegenfurtner, H. A. Mallot & R. Ulrich (Eds*.*) *TWK 2001. Beiträge zur 4. Tübinger Wahrnehmungskonferenz [Proceedings of the 4th Tubingen Conference on Perception]* (p. 146). Kirchentellinsfurt: Knirsch-Verlag.

Rijk, A. E. de, Schreurs, K. M., & Bensing, J. M. (1999). Complaints of fatigue: Related to too much as well as too little external stimulation? *Journal of Behavioral Medicine*, 22, 549–573.

Rinck, M., Hähnel, A., Bower, G., & Glowalla, U. (1997). The metrics of spatial situation models. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *23,* 622–637.

Rizzo, A., Buckwalter, J. G., Neumann, U., Kesselman, C. & Thiebaux, M. (1998). Basic issues in the application of virtual reality for the assessment and rehabilitation of cognitive impairments and functional disabilities. *CyberPsychology and Behavior*, *1*(1), 59–78.

Roser, C. (1990). Involvement, attention, and perceptions of message relevance in the resonse to persuasive appeals. *Communication Research*, *17*(5), pp. 571–600.

Rothschild, M. (1983). Perspectives on involvement. Current problems and future direction. In T. Kinnear (Ed.), *Advances in Consumer Research* (Vol. 11, pp. 216–217). Provo, UT: Association for Consumer Research.

Rubin, A. M. (1983). Television uses and gratifications: The interactions of viewing patterns and motivations. *Journal of Broadcasting*, *27*, 37–51.

Sallnäs, E.-L. (1999). *Presence in multimodal interfaces.* Presentation at the 2nd International Workshop on Presence, 6–7 April 1999, Essex, UK.

Salmon, C. T. (1986). Perspectives on involvement in consumer and communication research. In B. Dervin & M. J. Voigt (eds.), *Progress in Communication Sciences* (vol. 7), pp. 243–268),. Norwood, NJ: Ablex.

Sanford, A. J. & Garrod, S. C. (1981). *Understanding written language: Exploration of comprehension beyond the sentence*. New York: Wiley.

Sas, C., & O'Hare, G. (2001). *The Presence equation: An investigation into cognitive factors underlying Presence.* Paper presented at PRESENCE 2001, May 21–23, 2001, Philadelphia, USA (Online). Retrieved from http://nimbus.ocis.temple.edu/~mlombard/P2001/Sas.pdf (28.11.2002).

Schnotz, W. (1988). Textverstehen als Aufbau mentaler Modelle [Understanding written language as structuring mental models]. In H. Mandl & H. Spada (Hrsg.), *Wissenspsychologie [Psychology of knowledge]* (S. 299–330). München, Weinheim: Psychologie-Verlags-Union.

Schmidt, R. F. & Thews, G. (Eds.). (1997). *Physiologie des Menschen* [*Physiology of man*]. Berlin: Springer.

Schneider, E. F., Lang, A., Shin, M. & Bradley, S. D. (2004). Death with a story: How story impacts emotional, motivational, and physiological responses to first-person shooter video games. *Human Communication Research*, *30* (3), 361–375.

Schubert, T. W., & Crusius, J. (2002). Five theses on the book problem. Presence in books, film, and VR. In F. R. Gouveia & F. Biocca (Eds.), *PRESENCE 2002 – Proceedings of the fifth international workshop on Presence* (pp. 53–59). Porto, Portugal: Universidad Fernando Pessoa.

Schubert, T., Friedmann, F., & Regenbrecht, H. (1999). Embodied Presence in Virtual Environments. In R. Paton & I. Neilson (Eds.), *Visual Representations and Interpretations* (S. 268–278). London: Springer-Verlag.

Schubert, T., Friedmann, F., & Regenbrecht, H. (2001). The experience of Presence: Factor analytic insights. *Presence: Teleoperators And Virtual Environments*, *10*(3), 266–281.

Shapiro, M. A. & Chock, T. M. (2003). Psychological processes in perceiving reality. *Media Psychology*, *5* (2), 163–198.

Sheridan, T. B. (1992). Musings on Telepresence and Virtual Presence. *Presence: Teleoperators and Virtual Environments*, *1*(1), 120–125.

Sholl, M. J. (1999). Egocentric frames of reference used for the retrieval of survey knowledge learned by map and navigation. *Spatial Cognition and Computation*, *1*(4), 475–494.

Short, J. Williams, E., and Christie, B. (1976). *The social psychology of telecommunications.* London: Wiley.

Singer, J. L. (1975). *The inner world of daydreaming*. New York: Harper Row.

Slater, M. (2002). Presence and the Sixth Sense. *Presence: Teleoperators and Virtual Environment*, *11(4)*, 435–439.

Slater, M., & Steed, A. (2000). A Virtual Presence Counter. *Presence: Teleoperators and Virtual Environments*, *9*(5), 413–434.

Slater, M. Usoh, M., & Steed, A. (1995). Taking steps: The influence of a walking metaphor on Presence in virtual reality. *ACM Transactions on Computer Human Interaction (TOCHI)*, *2*(3), 201–219.

Surdick, T., Davis, E. T., King, R. A., & Hodges, L. F. (1997). The perception of distance in simulated visual displays: A comparison of the effectiveness and accuracy of multiple depth cues across viewing distances. *Presence: Teleoperators and Virtual Environments*, *6*(5), 513–531.

Steuer, J. (1992). Defining Virtual Reality: Dimensions determining Telepresence. *Journal of Communication*, *42*(4)*,* 73–93.

Tamborini, R., & Skalski, P. (2006). The role of presence in the experience of electronic games. In P. Vorderer & J. Bryant (Eds.), *Playing video games: Motives, responses, and consequences* (pp. 225–240). Mahwah, NJ: Lawrence Erlbaum Associates.

Taylor, W. (1997). *Student Responses to their Immersion in a Virtual Environment.* Human Interface Technology Laboratory, University of Washington [Online]. Available: http://www.hitl.washington.edu/publications/r-97–11/[15.09.2000].

Tellegen, A. & Atkinson, G. (1974). Openness to absorbing and self-altering experiences ("absorption"), a trait related to hypnotic susceptibility. *Journal of Abnormal Psychology*, *83,* 268–277.

Van Dijk, T. A. & Kintsch, W. (1983). *Strategies of discourse comprehension*. New York: Academic Press.

Vervaeck, K, Deboeck, M., Hueting, J., & Soetens, E. (1982). Traces of fatigue in an attention dual task. *Bulletin of the Psychonomic Society*, *19* (3), 151–154.

Vorderer, P, Wirth, W., Saari, T., Gouveia, F. R., Biocca, F., Jäncke, F., Böcking, S., Hartmann, T., Klimmt, C., Schramm, H., Laarni, J., Ravaja, N., Gouveia, L. B., Rebeiro, N., Sacau, A., Baumgartner, T. & Jäncke , P. (2003). *Constructing Presence: Towards a two-level model of the formation of Spatial Presence*. Unpublished report to the European Community, Project Presence: MEC (IST-2001–37661). Hannover, Munich, Helsinki, Porto, Zurich.

Vorderer, P. (1992). *Fernsehen als Handlung: Fernsehfilmrezeption aus motivationspsychologischer Perspektive* [Watching TV as action: The use of TV movies from a motivational psychological perspective]. Berlin: Rainer Bohn Verlag.

Vorderer, P. (1993). Audience involvement and program loyalty. *Poetics*, *22*, 89–98.

Wenzel, E. M. (1992). Localization in virtual acoustic displays. *Presence: Teleoperators and Virtual Environments*, *1* (1), 80–107.

Westwood, J. D., Hoffman, H. M., Robb, R. A. & Stredney, D. (Eds.). (1999). *Medicine meets virtual reality: The convergence of physical and informational technologies options for a new era in healthcare*. Amsterdam: IOS Press.

Wild, T. C., Kuiken, D. & Schopflocher, D. (1995). The role of absorption in experiential involvement. *Journal of Personality and Social Psychology*, *69*(3), 569–579.

Williams, F., Rice, R. E., & Rogers, E. M. (1988). *Research methods and the new media.* New York: Free Press.

Wirth, W. (2006). Involvement. J. Bryant & P. Vorderer (Eds.), *Psychology of Entertainment* (pp. 199–213). Mahwah, NJ: Lawrence Erlbaum Associates.

Witmer, B. G. & Singer, M. J. (1998). Measuring Presence in virtual environments: A Presence questionnaire. *Presence: Teleoperators and Virtual Environments*, *7*(3), 225–240.

Zahorik, P., & Jenison, R. L. (1998). Presence as being-in-the-world. *Presence: Teleoperators and Virtual Environments*, *7*(1), 78–89.

Zeltzer, D. (1992). Autonomy, interaction and Presence. *Presence: Teleoperators and Virtual Environments 1*, 127–132.

Zwann, R. A. & Radvansky, G. A. (1998). Situation models in language comprehension and memory. *Psychological Bulletin*, *123*(2), 162–185.