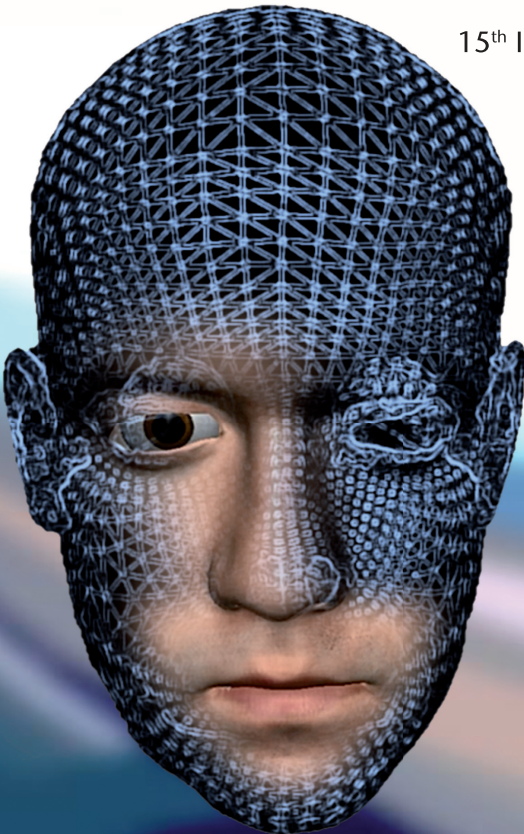


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(Eds.)

# Challenging Presence

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## Mixed Embodied Presence through the lens of embodiment and social presence

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**Abstract.** An analysis of interactive environments in which the body acts as a primary medium between physical and digital space was carried out in the context of previous research in order to identify the parameters and methods that can be applied in the process of designing interactive mixed environments. This analysis was performed in the light of the concept of mixed embodied presence, the primary elements of which were related to the notions of embodied interaction and participation. This paper describes on-going research that attempts to extend and enrich previous work on the subject by measuring how different types of embodied interaction, in conjunction with the presence (or absence) of other entities in the environment and changes in the environment's morphology, are able to effect the sense of mixed embodied presence. A number of sensory-motor and kinaesthetic skills, interactivity properties, as well as various social and spatial conditions are considered with respect to designing an immersive interactive environment.

**Keywords.** mixed embodied presence; embodiment; social presence; interactive environments; spatial morphology

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### Introduction

The concept of mixed embodied presence may be regarded as a valid property of hybrid interactive spaces which can act as the basis of an alternative framework for designing mixed environments, as highlighted in previous research (Papasrantou & Bourdakis, 2012; Papasrantou, 2013). The primary elements of the concept of mixed embodied presence are related to the notions of embodied interaction and participation. Additionally, ways of perceptual transition, as well as the notion of co-presence and shared awareness were examined as important parameters of interaction design. The aim of this paper is to further analyse the parameters of embodied interaction and social presence in order to enrich the primary definition and to investigate the extent to which different types of embodied interaction, combined with issues of sociality, are able to effect the sense of mixed embodied presence. Issues related to the morphological characteristics of the interactive environment are also concerned.

The structure of the paper is as follows: First, the notion of mixed embodied presence is presented, followed by an analysis of the parameters of embodied participation and the notion of social presence in interactive environments.

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Subsequently, a number of dimensions / conditions pertaining to locomotion, co-presence, and the degree of change of an environment's morphological characteristics with respect to mixed embodied presence are proposed. Finally, the initial stages of an on-going research project intended to provide experimental validation to the aforementioned framework are briefly outlined.

### *Mixed embodied presence*

Mixed embodied presence has been defined as the coherent sense of presence that derives from the bodily participation and interaction in an environment consisting of physical and digital entities (mixed environments). It has been characterized as a measure that depends on the nature of interaction and the interface, as well as on embodied cognition, namely the bodily (embodied) skills and senses that are stimulated and applied, while it has also been related to the physical or distant participation and cooperation of other users to the interaction (Papasarantou, 2013). In the following section, the parameters related to embodied interaction and co-presence are analyzed.

### *Embodied interaction*

Previous research highlighted the fact that there is an implicit or explicit relation, between the notions of interaction and embodiment. Since interfaces are designed to enable a dynamic interaction and real time information exchange among users or between users and their surroundings (Fox & Kemp, 2009: 210-230), an increasing interest was placed on the creation of interfaces that sustain interactivity through a variety of embodied skills such as touch, gestures and cognitive control abilities (Larssen et al, 2007).

It was noted that an interactive space should provide the means of creating a space of conversation where movement can be considered as a "mode of communication" and that it should also be associated to behaviours that increase the experience of interaction (i.e chatting, laughing, emotional reactions etc) (Talin, 1994:97). Embodied interaction was also related to haptic, kinaesthetic, and proprioceptive senses as well as perceptual habits (patterns of movement) (Larssen et al, 2007; Diniz, 2008).

According to Dourish (2001:126), embodied interaction is "the creation, manipulation, and sharing of meaning through engaged interaction with artefacts". It is a progressive action that enables users to become familiar with an environment through the bodily involvement. Furthermore, as Biocca (1997: 13) argues, the body is the central entity where all types of communication are formed. He also argues that one of the basic parameters of interfaces is "progressive embodiment" (Biocca, 1997: 14); namely "the steadily advancing immersion and coupling of the body to advanced communication interfaces". However, this progressive embodiment can oscillate between physical and digital environmental aspects. As Spagnolli & Gamberini (2002: 9) argue, the user's spatial experience is extended beyond the limits of the simulation since elements of the physical environment are (also) perceived as parts of the interaction. Thus it could be argued that embodied interaction is one of the factors that enable some form of communication between user and the artefact, the environment or even among other users. Moreover, interaction and communication with an environment can be experienced as mixed embodied presence, a property that emerges from a progressive embodied interaction. Another important aspect that should be taken into account is the fact that the embodied interaction perspective emphasizes not just the way that users "act on technology", but also the way they "act through it" (Dourish, 2001:154). Thus, this property can potentially reveal the bodily and cognitive skills that are mostly used through interaction.

Embodied interaction facilitates the recall of learned information due to the encoding specificity principle (Schacter et al. 2012:184-185), according to which information is more accurately retrieved from memory when the context of retrieval matches the context of encoding. "Context" in this case extends to the interaction modalities employed – i.e. the chance of recalling information that was encoded during similar bodily activity is increased. In an embodied interactive system, embodied (inter)action can contribute toward increasing the system's memorability. However, the attribute of memorability may also be examined from the opposite view. High memorability ensures that users will be able to transfer their skills from the real to the digital world, since embodied interaction attempts to take advantage of the user's procedural memory (Sternberg & Sternberg 2012, Schacter et al. 2012). Thus, it is assumed that different types of interaction and bodily involvement can lead to differences in memorability and learnability. Therefore are properties that will be considered during the design procedure of interactive environments.

Summarizing, embodied interaction is related to the close and accurate coupling between bodily skills and artefacts. Progressiveness and communication are parameters associated with the relationship of the body with itself, other users' bodies as well as the environment. Memorability is also regarded as significant attribute.

### **Social presence: co-presence**

#### *Co-presence from an embodied perspective*

Co-presence is considered as part of the notion of social presence. The former is defined as a condition in which mediated and mutual human interaction in a shared location can be afforded (Goffman, 1963, in Zhao, 2003: 1), while the latter is defined as the "awareness of the co-presence" of other human beings or intelligent entities in a shared environment (Biocca & Nowak, 2001; Gamberini et al, 2004:45). Co-presence is also defined as an individual and a subjective experience of the user which is effected by the "interface characteristics" (Zhao, 2003: 8). There are several categories of co-presence, such as corporeal or virtual co-presence and telecopresence, as well as "hybrid or mixed type" forms that can combine one or more of the previous mentioned categories (Zhao, 2003: 8).

Zhao (2003:6) suggests that there are four interface parameters of human co-presence: embodiment, immediacy (the capacity of the system to support a flow of interaction in a way similar to face-to-face), scale (number of people that an interface can support) and mobility. A measure that defines co-presence is "proximity", which is the area within human senses – plain or augmented – can reach (Zhao, 2003: 2).

It could be argued that co-presence is an embodied property that determines the limits of the sense of shared spatiality. The notion of shared spatiality is not limited to physical presence, in the sense that the physical presence of another user is not mandatory. A physical or virtual simulation (Zhao, 2003:2), a bodily echo or even another intelligent entity can also create the sense of co-presence. However, the sense of co-presence is stronger when mutual and shared human interaction is, even in an imaginary way, encountered (Lombard & Ditton, 1997). Due to being an embodied entity, a user -- can experience and perceive the sense of social presence as a simulation of another moving and expressive body (Biocca, 1997:22).

Biocca and Harms (2002:5) note that there are levels of social presence determined by the nature and the "properties of the medium", the nature of interaction as well as by subjective parameters. The assumption that different levels of social presence can be afforded by different types of mediation is also highlighted. The minimum level of social presence can be observed when the user experiences the presence of another intelligence (Biocca, 1997: 22) – not necessarily human-like or embodied.

*Representing co-presence: ways of representing agency*

Artificial entities that exhibit the ability to have ‘sensations’ and ‘emotion’ (e.g. experience pain, pleasure etc.) or appear to formulate plans or engage in cognitive processes tend to be anthropomorphized more readily. Users tend to perceive computers as possessing agency / intelligence (e.g. Reeves & Nass 1996, Johnson & Gardner 2009), whether by exhibiting actual communicative behaviour directed towards them or by ascribing person-like qualities to them (media equation hypothesis/ Computers As Social Actors).

An additional way of providing space with intelligence is through its inhabitants, or lack thereof. A space may be inhabited by artificial agents in full bodily form. The feeling of other entities being present may also be elicited through the result of their actions (e.g. by stumbling upon traces of prior activity). Such a design choice aims to make the user feel that someone else was or still is active in the same environment.

Some types of interfaces can also create the sense of co-presence. Organic user interfaces for example (Vertegaal & Poupyrev 2008) – which can be seen as a subcategory of tangible user interfaces (TUIs) – assume an appearance and behaviour inspired by biological lifeforms. Parameters of interfaces that may be subject to change include form, colour, and lighting. Colour has often been associated with particular emotional states within a specific culture and lighting has been linked to interpersonal distance and other indicators of intimacy (Argyle 1988, Knapp & Hall 2010). Morphology can result second-order parameters, such as overall spatial layout, thus implicating aspects such as density, order, congruity etc.

Applied to spatial design, this approach can impart a more life-like quality to the environment and being perceived as possessing some form of intelligence; thus, a sense of co-presence may be evoked. As such, the environment may exhibit a more “embodied” quality – to the extent that it may be perceived (partially or in its entirety) as a “body”.

**An empirical evaluation of the impact of agency representations and locomotion techniques on mixed embodied presence**

For the purposes of this research a virtual environment has been designed as a means of investigating the parameters related to embodied interaction and co-presence. It consists of several of interconnected interior spaces of gradually increasing complexity in which a typical “escape from the labyrinth” scenario unfolds. The type of connection between spaces as well as the user’s progression through the spaces that constitute the environment varies. At specific locations, users may discover clues in the form of visual (e.g. written guides) or auditory stimuli. Additionally, they can communicate with artificial agents that are present in the environment.

In the following sections, the parameters to be investigated, as well as the equipment and the questionnaires to be used in the experiment are described.

*Co-presence*

The presence of others in the environment incorporates the approaches to the presence of artificial entities described in the previous sections. More specifically, the presence of others will vary across conditions as follows:

**Avatar condition:** artificial agents will possess an avatar.

**“Echo” condition:** artificial agents will not be visible, but traces of their activity may be discovered by the user.

**Environment condition:** the environment will act as an agent through appropriate variation of several properties, including morphology, colour, lighting etc.

**Control condition:** no other entity apart from the user will be present in the environment, in any form.

Furthermore, the effect that embodiment has on social presence is also investigated.

### *Embodied interaction*

The notion of embodied interaction is realized in this experimental setup and the design of the environment through the utilization of physical movement and locomotion. Bodily movement, such as gestures and simulated walking (or even body posture) becomes an important way of communicating with the environment itself and the entities or elements contained therein. Additionally, the environment encourages or even initiates communication by providing appropriate multisensory stimuli that also act as catalysts for action – e.g. exploratory behaviour

### *Equipment*

The environment is perceived through a V8 stereo HMD by Virtual Technologies with a field-of-view of 60 degrees and a resolution of 640×480 for each eye is used. The user interacts with other entities and elements of the environment in an embodied fashion by using a 6-DOF Polhemus magnetic tracker shaped as a ball (to allow easy grasping) and equipped with a button. Except for the ball shape and the button, this tracker is similar to the one mounted on the HMD.

In addition to aspects of design that pertain to the environment and its elements, the technology employed is also expected to influence the user's sense of embodied presence. In this implementation, the method of locomotion varies across conditions. One user group employs tracker-based locomotion (via a 6-DOF Polhemus magnetic tracker mounted on the HMD), whereas the other group uses a simulated walking technique (users wear overshoes with switches embedded in them so that the speed of their "walking" motion is detected).

An additional source of information that is taken into account as an indicator of social presence is the user's physiological signals, such as skin conductance / galvanic skin response (GSR) and heart rate (HR) / heart rate variability (HRV). Physiological signals are less controllable than overt behaviour, and may thus provide a more accurate picture of the user's state of engagement. A purpose-built device (Psaltis & Mourlas 2011) is used in order to obtain these measurements.

### *Questionnaires*

An expanded version of Witmer & Singer's (Witmer et al. 2005) Presence Questionnaire will be used to measure mixed embodied presence. We expect the above parameters to be affected by video game experience (especially first-person games). The demographics questionnaire to be filled prior to using the virtual environment contains items on the subjects' video game preferences and habits. Another factor which is expected to affect the subjects' experience of presence in all its forms is their personality. The NEO-PI-R questionnaire (Costa & McCrae 1992) is used to assess the subjects' personality dimensions, which may account for differences in the experience of presence. Additionally, motion sickness could be a factor in the overall quality of the subjects' experience of the virtual environment. The Simulator Sickness Questionnaire (Kennedy et al. 1993) is used for that purpose. Furthermore, the users' spatial knowledge is assessed through sketch maps in an attempt to identify the influence of the aforementioned parameters on spatial knowledge acquisition.

## **Discussion and Future Work**

This paper summarizes aspects of an on-going research on the notion of mixed embodied presence and its implementation in the design process of interactive environments. Previous research resulted in the formulation of a primary definition of mixed embodied presence and led to the extraction of two major parameters, namely embodied interaction and co-presence. These parameters were analysed through the lens of locomotion, communication and sociality, resulting in a set of conditions and dimensions of the designed environment.

The dimensions presently include the users' method of locomotion and the type and form of artificial entities present in the environment (including morphological changes of the environment itself). As a result of this analysis, a redefinition of the notion of mixed sense of embodied presence is proposed:

Mixed embodied presence can be described as the coherent sense of presence that derives from the progressively embodied engagement and interaction in environments that incorporate both physical and digital entities. An environment that sustains mixed embodied presence should afford communicative action and behaviour among various entities (human or artificial), while providing numerous stimuli that capture the user's attention. Locomotive, sensory as well as cognitive bodily abilities are considered as aspects of the embodied engagement parameter.

A number of hypotheses are formulated with respect to the aforementioned parameters. Regarding the locomotion method, it is hypothesized that users who locomote by simulated walking will experience a greater degree of mixed embodied presence compared to those who use tracker-based locomotion on account of the former condition's greater physicality and similarity to real walking.

With respect to the specific type of the artificial entities encountered by the user and their impact on co-presence, the following are hypothesized:

Compared to the other two co-presence conditions, subjects in the "avatar" condition can be expected to experience a stronger sense of mixed embodied presence because they can identify with the other entity's humanoid form more easily. The compatibility of the user's human form to the humanoid form of other avatars is expected to facilitate social presence. It is also hypothesized that the perceived presence of others will be reflected in the physiological measurements obtained by the user, possibly as an increase in stress levels.

Among the three conditions, subjects in the "traces" condition may be expected to experience the lowest sense of social presence on account of the lack of direct interaction with other entities. A similar effect is hypothesized on their level of engagement as well.

It is hypothesized that subjects allocated to the "environment" condition will reach a higher level of engagement in a shorter amount of time due to the distinctiveness and salience of the environment's constantly changing morphology. Also, these subjects may perform more poorly on tests and measures of spatial knowledge acquisition; therefore, more errors, omissions, and distortions can be expected in sketches produced by these subjects.

As a next step in this on-going research, the experimental design described above will be realized in order to provide empirical evidence of the impact of embodied locomotion and the form of artificial entities on the mixed embodied presence experienced by persons who navigate virtual environments populated by other agents.

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