

G. Riva, M.T. Anguera, B.K. Wiederhold and F. Mantovani (Eds.)
**From Communication to Presence: Cognition, Emotions and Culture towards the
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1 Communication – Presence Roundtrip: Travelling along Theoretical, Methodological and Applicative Connections

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Abstract: The convergence between telecommunication, virtual reality and artificial intelligence technologies resulted in a dramatical increase and modification of the opportunities to experience the physical and social world. Their diffusion and integration into multi-user and multi-agent virtual worlds highlighted the relevance of addressing from a common psychological perspective the domain of communication and the domain of presence. New theoretical and practical questions are emerging, in the double intent to explain phenomena at the interplay between mind and technology and to design effective technological applications. This chapter has the goal to start an exploration of the links and reciprocal contributions between communication and presence, analyzed at theoretical, methodological and applicative level.

Contents

1.1	Communication, Presence and Emerging Technologies: The Need for an Integrated Psychological Perspective.....	4
1.2	A First Look at the Theoretical Connections between Communication and Presence.....	8
1.3	Methodological Connections: How to Empower Research on Presence and Communication by Reciprocal Contributions.....	9
1.4	Applicative Connections: Design Guidelines from Communication Theory and Empowerment of Interpersonal Communication Through Mediated Presence Technology.....	13
1.5	Conclusions.....	17
1.6	References.....	17

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1.1 Communication, Presence and Emerging Technologies: The Need for an Integrated Psychological Perspective

1.1.1 Background

Main goal of this chapter is a first exploration of the links between communication and presence.

Communication and presence are two processes of great importance in the psychological dimension of the individual. Recently, a potential converging trend of these two domains emerged with the development of new technological applications [1, 2].

We are, in fact, in front of the convergence between two types of technology: on the one hand, *telecommunication* technology, allowing for computer-mediated communication or CMC; on the other hand, Virtual Reality (VR) *simulation* and Artificial Intelligence (AI) technology, allowing for simulation and (re-)production of 3D environments and agents.

In their respective domain, these are specific technological applications, developed along the last 30-40 years, through which we have now opportunities to: communicate with each other over distance (that is, with someone who is not physically present, like in CMC) and do this as if we were physically co-present; communicate and interact with autonomous agents who are not human but electronic (like Intelligent Virtual Agents-IVAs) and do this relating to them as we do to human people; try the experience of feeling present in a place which is different from the one where our body is (like in Virtual Environments or in telepresence situations), and doing this having the sense that we are really “there”.

Applications of these technologies can be found in the most various domains, from health-care (telemedicine, e-therapy, VR therapy) to learning and training (VR training environments, collaborative e-learning), from entertainment (developing interpersonal relationships through meeting and social networking sites, multi-user online gaming) to business and commerce (computer-supported collaborative work, e-commerce), etc. [3-8].

Moreover, advances in the last ten years resulted in the development of hybrid forms, combining the features and applications of telecommunication and simulation technologies described above: it was the birth of multi-user multi-agent 3D worlds, simulated graphic worlds where real people interact and communicate with other people over distance and/or with autonomous agents while they are represented in the simulated world by a 3D character, also called avatar [7, 9]. These most advanced forms combine immersiveness and multimodal input/output typical of VR technology with possibilities of mediated social interaction (with human and/or electronic autonomous agents), leading to a dramatic increase and modification of the possibility of experience of the physical and social world. We are in front of what might be defined “*experiential technology*” [10-12], a technology able to provide a more and more compelling “illusion of nonmediation” to the user [13], who finds herself/himself actively immersed and involved in a world of experience.

This potential for changing and enhancing the very nature of the processes involved in interpersonal communication and in our sense of being-in-the-world with other people (be them real human beings or autonomous artificial agents) favored the birth

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of *new questions* [14-16], both theoretical (in terms of explaining emergent phenomena) and practical (in terms of providing a framework for design and evaluation of effective applications) .

As for practical, *application-relevant questions*, they focus on identifying guidelines for designing effective applications, with issues like [14]: how to design successful CMC (video conference, chats, etc.) applications? How to design effective IVAs? What characteristics do they need to possess in order to be considered believable conversational partners and to elicit a sense of social presence? How to design virtual environments able to elicit a sense of “*being there*” and an “*illusion of non-mediation*” in the user?

The implicit assumption of application developers has been for a long time characterized by a fidelity approach consisting of a sort of technological equation saying “*the more sophisticated (tech), the better*”. Initially, in fact, CMC, AI, and VR developers relied on the hypothesis that a perfect and complete reproduction of reality in technological applications and mediated experiences would ensure their efficacy [17-23]. In most cases the goal of designers was to replicate as precisely and richly as possible the non-mediated processes: for CMC this meant including as many channels as possible, like in videoconference, for VR it meant integrating sophisticated multimodal input and output devices, in order to replicate as well as possible the flow of sensorial inputs and action possibilities.

However, following theoretical reflections and empirical work gradually modified this perspective [24-35; see also Coelho *et al.* in this volume for an overview], due to the acknowledgement of two important issues.

First, the goal of reproducing reality as richly as possible generally requires an effort that is beyond the reach either of technological developments and/or developer’s possibility (time and/or costs).

Second, growing anecdotal and research evidence suggests that this “technological equation” approach does not always hold [28-32], in the sense that high-tech systems do not forcedly result in higher levels of social presence and better success as compared to simpler systems. As an example, phenomena such as the explosion of online relationships established and maintained through text-based CMC challenged media-richness theory and reduced-social-cues theory assumptions [36], according to which text-based chats were not likely to support the development interpersonal relationships due to their lack of nonverbal features (and consequently assumed poverty of socio-emotional communication). In general, it was highlighted that communication, as well as presence, are processes with a complex psychology behind. Since what we need is to make the final process more effective for the user (be it therapy, entertainment, work, etc.) we need to consider the use [29] that the individual makes and her/his psychology (i.e. the psychological features of her/his subjective experience).

Moreover, like a boomerang, experience with -and reflection on- these technologies did not limit to raise application-related issues, but often challenged assumptions in classical theories and elicited questions on the nature of the psychological processes involved [14]: how is it possible that we relate to agents and computer interfaces in a social way, as if they were human, despite the fact that we generally are explicitly aware of the fact they are not human? How is it possible that low graphic realism but high opportunity for action and significance for the individual elicit high sense of presence?

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In some cases these questions even led to open up a systematic investigation of the very foundation of these processes [24, 31, 37] independently from technology (e.g. trying to understand the basis of our sense of presence-as-“being in the world” and sense of social presence-as-“being with others”).

In particular, as discussed in the following section, the questions elicited by the advent of new technologies had a different impact on communication psychology as compared to presence psychology (considered as domains of study): for the first, they entailed adaptation and broadening of classical theoretical framework originally developed for face-to-face [38], for the second they led to the actual identification of presence as a domain for psychological investigation.

1.1.2 Communication and Presence between Technology and Psychology

As a general premise, it should be noticed in fact that communication psychology and presence psychology were in a very different scientific situation at the time when digital technologies started so radically to modify and alter the way we communicate and experience the physical and social world. Technology had therefore a different impact on the development of a psychological approach to these two domains.

The interest for communication as a specific domain of psychological inquiry existed well before the advent of Computer-Mediated Communication: *communication psychology* had developed, by the means of a process of theoretical evolution that took from cybernetic/mathematical approaches [39], from linguistics [40] and pragmatics [41, 42], as well as from sociological and relational perspectives [43, 44] in order to account for face-to-face communicative interaction. Along the last two decades we can say that a specific psychological tradition developed, through a gradual identification of defining features of the psychological processes involved in communication, with emphasis on issues such as: nonverbal behavior and multimodal communication; the role of inferential processes, representations and mental models in the production and comprehension of communicative acts (with cognitive semantics and pragmatics); the notion of intentionality and communicative intention [45, 46]; the detection of “hidden” behavioral patterns [47]; miscommunication and intentional opacity [48, 49].

On the opposite, while communication psychology existed before the emergence of CMC technologies and had developed pretty much for the study of face-to-face communication, it was VR technology that played a key role for the birth of presence as a separate domain of psychological investigation (although, as noticed by Revonsuo [50], the notion of presence did not “inhabit a philosophical vacuum” [51]; see also the analysis of Heideggerian “*Dasein*” in the chapter by Riva in this volume). The term ‘presence’ was coined in 1992 by Sheridan and Furness [21] when they used it in the title of the new journal dedicated to the study of virtual reality systems and teleoperations: *Presence, Teleoperators and Virtual Environments*.

While, therefore, communication psychology was born for the study of non mediated communicative interaction and had to adapt its own categories to the mediated one, presence psychology was born and developed from the study of the experiences in mediated contexts and just more recently evaluated the possibility of addressing presence as a process and phenomenon that is worth investigating also prescinding from technological mediation [52].

In general, we might say that the psychological inquiry of communication and that of presence developed quite independently up to very recently. As pointed out above,

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however, the convergence of new technologies defined an interesting area of study, at the intersection between these two domains, highlighting the need for an integrated psychological perspective on communication, presence and technology.

So, these are the *general questions* that this book aims at answering and that we tried to partially anticipate in this chapter: what are the points of contacts between communication and presence? What is the added value of studying them together, from a common perspective and with a psychological approach? What kind of reciprocal contributions can the world of communication and the world of presence offer each other?

Two background assumptions will drive us along this way towards an integrated perspective.

The first one refers to the existence of a common background for the analysis of technologically-mediated and non technologically-mediated phenomena: processes mediated and non mediated by technology should not be seen as separated, in a radical dichotomy. Cultural psychology [53, 54] (and the concept of mediation and artifacts developed within it) helps us in blurring this distinction: we are never, even in our “real world” in a process of non mediation. It would be, in fact, highly questionable the idea that technologies introduce ways of functioning which are completely different, since technology (meant as an artifact) is nothing but a further mediation beyond natural perception systems and other artifacts such as tools and language that are inherently part of our so-called “natural world”. Therefore, mediated and non-mediated phenomena should be addressed as much as possible within a common theoretical and methodological framework.

The second assumption refers to the idea that communication and presence as psychological phenomena are strongly related and intertwined, both in technological and natural experiences. We argue that this link lies in the concepts of action and experience, and in the framing of communication and presence in a psychology of action [55]: communication on the one hand is considered, since the contribution of pragmatics, an action; presence on the other hand was recently connected to the perception of opportunities and constraints [29, 56] for the user’s interaction (see the chapter by Riva in this volume for a more in-depth analysis of this point).

Within this volume and within this chapter, we argue that considering communication and presence together might offer a number of advantages, at different levels.

The overall goal is to start from the identification of the links between the world of communication and the world of presence in order to define a specifically psychological approach, with a particular focus on the role of new technologies.

We will try to follow this path through an analysis of some of the connections and the reciprocal contributions between communication and presence, which, we argue, might be identified *at three levels*:

- *theoretical level*, with the aim of fostering comprehension of concepts and phenomena in the two domains;
- *methodological/research level*, with the aim of empowering research on communication and on presence;
- *applicative level*, with the aim of enhancing technological applications and processes in the domains of presence and communication.

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1.2 A First Look at the Theoretical Connections between Communication and Presence

Main goal of this paragraph is to discuss some of the links between communication and presence at a theoretical level, with focus on their common inclusion within a framework of psychology of action, as well as on the relevance of the concepts of embodiment and embeddedness for communication psychology.

At a general level we might say that on one side physical/environmental presence and social presence are a requisite for communication, in that communication is rooted in the phenomenal experience of being-in-the-world and being-with-others. Our sense of being in the physical and social world defines a set of opportunities and constraints for communicative exchange. On the other side communication and social interaction are the basis for the construction of this being-in-the-world experience from a developmental point of view, as well as in adult life they represent a tool for negotiating and restructuring it continuously; thanks to communication and social interaction, in fact, we have the opportunity to manage the process of meaning attribution to the world, its objects/people and events and to negotiate the “position” we occupy relatively to them.

Specifically, the link is given by our bodily experience: we are present in a body located in space and ready to act and inter-act, multimodally with other people.

This suggests that is possible to frame both communication and presence within a *psychology of action*, as briefly anticipated in the previous section: on one side, communication is an act (or, better, a “situated inter-act”); on the other side, presence is an evolutionary mechanism to control action. Experience is where these two processes meet. In fact, pragmatics highlighted how communicating is always doing something within a given context, and in order to obtain specific goals [57]. On the other hand Riva and colleagues identified in presence the mechanism deputed to regulating/controlling action through supporting progressive differentiation between self-and non-self [37]. These authors view it as an evolutionary process (relevant both in mediated and nonmediated settings), whose aim is to separate the internal from the external and to define, dynamically and continuously, the opportunities and constraints for action (see the chapters by Riva and by Waterworth and Waterworth in this book).

This vision of communication, presence and action is consistent with recent trends on cognitive sciences (see chapter by Riva in this volume, for a more comprehensive account of these issues): the theory of situated action [58], the activity theory [59, 60] and the Embedded Cognition approach [61-63]. All these visions highlighted the role of body and context and the inadequacy of the idea that cognition is primarily a matter of performing formal operations on abstract symbols. Specifically the *Embodied Cognition* approach underlines the central role of body in shaping the mind [61, 64-69] suggesting that presence has to be understood in the context of its relationship to a physical body that interacts with the world.

The acknowledgement of the key role played by embodiment and by situativeness/embeddedness compliments well the importance of regarding and investigating communicative acts *multimodally* and *in context* [46, 70; see also Ciceri & Biassoni in this volume]. On one side, in fact, meaning is not connected with a unique and exclusive signaling system, but is generated by the network of semantic and pragmatic connections between different signaling systems, from face to gestures, from voice to proxemics, etc. In any communicative exchange, interlocutors

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hence must be able to arrange and tune a set of different signaling systems to communicate and share their communicative intentions [46]. Moreover, meaning is never a fully evident datum, but exhibits an intrinsic opacity insofar as it is the semantic expression of each interlocutor's experience, which does not only generate what is said, but also points out and indexes how to intend what is said. This requires interlocutors to resort to active, inferential processes and to strongly rely on information from the context in which they are 'present'.

Within communication theory, we assisted to a growing acknowledgement of the importance of context and to a progressive modification and broadening of the very notion of 'context'. This modification was characterized by three shifts: from an additive to an interdependent vision of the relationship between 'text' and 'context'; from a definition of context simply indicating spatial-temporal characteristics of the interaction to a notion encompassing many other aspects, such as the relational, social and cultural ones; finally, from an idea of context as a collection of fixed and objective conditions to an idea of context as the result of a choice made –implicitly or explicitly- by the interlocutor(s) within a multiplicity of possible definitions that are available to her/him [71]. As Mc Neill [70] points out, "while context reflects the physical, social and linguistic environment, it is also a mental phenomenon". Social neuroscience has recently shown how neural processes and representations are context-sensitive and can change dynamically with goals and motivations and experience [72, 73], and McIntosh [74] suggested this might come to constitute an intrinsic neural context which complements the extrinsic one.

In synthesis, when we say that *communication* is a situated, multimodal act, we acknowledge the potential interest of deepening the relationship with the inherently human features of embodiment and situativeness implied by the notion of *presence*.

1.3. Methodological Connections: How to Empower Research on Presence and Communication by Reciprocal Contributions

When getting to the methodological level, questions are focused on the contribution of communication to the study of presence and *vice versa*. Within this section we will analyze on the one hand the use of methodologies and corroborative measures coming from communication psychology for the analysis of sense of presence (and in particular social presence in mediated contexts); on the other hand, we will see how technologies able to elicit mediated environmental and social presence could provide useful and innovative experimental test-beds for a systematic investigation of communication processes.

1.3.1 Communication for Presence: Using Input from Communication Psychology to Enhance Social Presence Measurement

Although questionnaires are still the most used measurement tools of presence, in the last ten years we have assisted to a growing interest into the development of different sets of measures (e.g. physiological, behavioral and social responses), to provide corroborative information to self-reports measures [75-82]. Within this framework, it is possible to envisage the use of measures and instruments developed in the domain of communication psychology to integrate and enrich the analysis and measure of

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sense of presence: facial expressions, vocal nonverbal features, gesture and posture, proxemics, etc.

These measures can be considered part of the so-called *behavioral correlates* of presence, and might prove most useful for studying mediated social presence. As pointed out by Biocca [83]: “Behavioral measures are common in studies of face-to-face interactions. Some of the verbal markers or non-verbal indicators such as facial expression may be indicative of social presence. More commonly non verbal behaviors such as *proximity* to the other are used as dependent variables or independent variables in studies of social interaction” (p.10). Moreover, Bente and colleagues [84](p.132) highlighted how “research from the last two decades has significantly advanced methodological knowledge in the definition of adequate descriptive methods of movement analysis in the context of nonverbal communication [85]. A series of transcription procedures and coding strategies have been developed that provide detailed and accurate protocols for both facial behavior and body movement [86, 87]”.

In general, this opens the path to an investigation of social presence in terms of the social and communicative (verbal and nonverbal) responses to embodied avatars and agents [88], with underlying questions such as: is the agent/avatar able to elicit them? And if so, are they consistent with literature on non-mediated (face-to-face) interactions?

A few studies have investigated the social presence elicited by an autonomous agent by verifying whether users displayed similar reactions to those they would with a human partner, in terms of different nonverbal behaviors.

Bailenson and colleagues [89] used *proxemics/interpersonal distance* (minimum distance and reversal count) as a behavioral measure of copresence: building on previous work [81, 90-92], the authors proposed this approach based on the idea that “copresence would be positively related to hesitation in approaching an embodied agent, interpersonal distance, and maintenance of interpersonal distance” (p.6). In a different study [75] they used interpersonal distance as an explicit compliment to self-report measures of social presence, obtaining results that highlighted the sensitivity of proxemic indexes and confirmed the importance of an integrated approach to social presence measurement.

In two other studies [76, 93], user’s *eye-gaze* in videoconferencing and virtual meetings was measured, given its importance in detecting user’s attentive focus and communicative interaction management; both studies reported satisfying results to integrate self-report scales of copresence and social presence.

Moreover, although not specifically addressing the issue of measuring social presence, several authors (see below) measured a number of nonverbal indicators in the analysis of user interactions with Embodied Conversational Agents (or ECAs, sophisticated versions of IVAs that can converse with the user by one or more of the natural modalities of human-human communication [4]). It might be interesting to explicitly include and investigate them within social presence domain.

In their work of search for new parameters and metrics to evaluate multimodal dialogue systems with ECAs, Cerrato and Ekelint [94] showed how user’s *vocal nonverbal features*, such as prosodic variation, and other nonverbal communicative behaviors, such as *head movements* and *facial expressions*, can give an indication of their attitude and overall evaluation of the interaction with the agent.

In order to move towards more comprehensive and sophisticated ways to analyze user social and communicative responses to virtual agents, two promising directions

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concern on the one hand multimodality and on the other hand interactivity and accommodation measures. The chapter by Ciceri and Biassoni (in this volume) suggests the need to focus on co-occurrence and synergy between different channels and systems, as well as on joined and coordinated action between various subjects; the authors discuss how theories and studies from human-human communication can be integrated with observations and research in human-machine interaction in a common framework of analysis. As far as interaction synchrony within communication exchange is concerned, Agliati and colleagues (see chapter in this volume) describe a methodology for the detection of emotional and relational involvement with virtual agents through an analysis of human-agent behavioral patterns. This kind of indicator might represent an interesting measure of the third level of social presence outlined by Biocca [83], the level of *behavioral engagement*, meant as an “interdependent multichannel exchange of behaviors” [95].

In synthesis, for each of the above-mentioned measures, communication psychology might provide both the rationale for its use and specific coding and analysis tools. Its contribution might thus consist both in providing theoretical and empirical accounts for the use of different verbal and nonverbal behaviors as corroborative measures of social presence and in offering standardized and reliable tools for coding and analysis of the selected behavior(s) (e.g. Facial Action Coding System [86] for facial expression coding, Bernese Coding System [87] for movement coding, CSL/Praat for vocal acoustic measurement, Observer for supporting computer-supported frame-by-frame coding and analysis ANVIL [97] and Theme [47] software for multimodal coding and analysis, etc.)

1.3.2 Presence for Communication: Using Presence Technologies and Mediated Social Presence to Enhance Research on Communication Processes

Simulation and immersive technology, given their potential to elicit mediated physical and social presence might represent an innovative methodology for the study of psychological processes involved in human-human communication and social interaction. The combination of virtual reality environments and embodied conversational agents, in fact, can provide controlled experimental settings for a systematic analysis of communication processes and can therefore offer a test-bed for classical theories. In virtue of their potential for embodiment and embeddedness, these technologies (virtual agents and environments) allow for systematic manipulation of multimodal and contextual features: on the whole, they might represent an extremely powerful research tool, offering significant advantages in terms of systematicity, standardization, controllability and repeatability of multimodal behaviors and contextual/situational variables.

This might be fruitful in many domains, from more general social interaction issues (broader issues underlying any communicative interaction) to more specific interpersonal communication domains (e.g. testing relationships between communication and attentional workload hypothesis, person perception processing starting from combination of different multimodal features, etc.)

Blascovich and colleagues [77] suggested the use of IVET (Immersive Virtual Environment Technology) for experimental research in *social psychology*, highlighting its remarkable potential in addressing three methodological problems that have traditionally affected research in this domain: 1. the experimental control/mundane realism trade-off; 2. lack of replication; 3. unrepresentative

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sampling. Blascovich's research team obtained extremely promising results by using IVET in studies designed and modeled after classic social influence experiments (to carry out replications of classical studies) on social facilitation/inhibition, conformity and social comparison paradigms [98, 99].

Schilbach and colleagues [100] have shown the potential of using interaction with 3D agents in virtual environments for *social neuroscience*, for the investigation of "the neural processes underlying our ability to understand other minds" (p.718). In particular, they investigated the so-called *second-person phenomena* (i.e. aspects of the dynamic interplay of being personally involved in social interactions) in mentalizing function by manipulating two variables: the fact of being personally involved in social interaction as opposed to being a passive observer of social interaction between others; the processing of socially relevant facial expressions as opposed to arbitrary facial movements.

Restricting the field, it is possible to hypothesize the use of embodied agents and VR environments to study the various domains specifically related to *communication*. As pointed out by Ruttkay and colleagues [101], "the introduction of ECAs has motivated research in human-human communication, by posing new, succinctly formulated questions, some of which could be answered only by using ECAs as controllable mediums that exhibit the effects to be tested" (p.49).

A domain where ECAs have undoubtedly provided today new stimuli is research on nonverbal communication systems [4, 84, 102]: 3D agent technology (computer graphics and synthesized speech) offers in fact a unique opportunity to manipulate the specific modality feature(s) of interest (e.g. facial action units, gestures, vocal features, etc.) while controlling all other modalities and/or additional cues concerning for example physical appearance (e.g. specific skin color, physiognomy, attractiveness, etc.). Bente and colleagues [84], for example, proposed a method for the 3D computer animation of *body movement* as a new tool for nonverbal communication research, endowed with a broad range of simulated behavior and with realism of the computer animation (realistic 3D-polygon-models with skeleton and skin-like envelope). In a similar fashion, Wehrle and colleagues [103] used 3D synthetic images of *facial expression* (manipulated through a dedicated software tool called FACE) to investigate the influence of changes in the patterning of facial expressive features over time on emotion inferences by judges.

Several researchers have also begun to use agents and VR technologies virtual environments and virtual humans as a tool to investigate *proxemics* and personal space [81, 90-92, 104], by testing classical research hypotheses such as those related multimodal nonverbal compensation effects (e.g. dynamic relationship between mutual gaze and interpersonal distance [105, 106]).

As examples of studies that explicitly investigate issues related to *multimodality* in communication by using virtual agents, Kraemer and colleagues [107] investigated the role of pitch and eyebrows in the perception of focus and prominence through systematic manipulation of a 3D ECA features; in a following study [108] they broadened their work by investigating cross-cultural difference in these multimodal characteristics, comparing Italian and Dutch participants.

Overall, these works demonstrate the potential held by new social and environmental presence technologies for the study of human-human communication and social interaction. Although their advantages are undoubtful, their use needs to address an important issue: is it possible, as a general assumption, to hypothesize that people

G. Riva, M.T. Anguera, B.K. Wiederhold and F. Mantovani (Eds.)
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respond to virtual agents as they would respond to real people? An affirmative answer to this question is a fundamental prerequisite to be able to use virtual reality and embodied agent technology in research settings [84, 100].

A growing amount of literature seems to confirm this hypothesis [81]. The study by Bente and colleagues [84] yielded evidence for a remarkable correspondence between person perception effects of video recorded dyadic nonverbal interactions and the 3D computer animation based on the transcripts of the same interaction behaviors.

Other studies were able to show important similarities between social reactions to virtual agents and findings in traditional social and communication psychology literature describing social responses to human people in specific situations. For example, in their study on emotional reactions in public speaking virtual environments Pertaub and colleagues [109] found that participants reported higher anxiety levels in front of negative audiences as compared to static or positive ones, despite participant's awareness that the agents were computer-generated and that there were no real people in the audience. Results from a study by Bailenson and colleagues [90] showed that consistent gazing lead to more interpersonal distance, coherently with Argyle's intimacy equilibrium theory [110]. Garau and colleagues [88] found that participants characterized by higher levels of social anxiety were significantly more likely to avoid disturbing virtual humans in a VR library, confirming the fact that participants responded to virtual humans as social actors.

These findings in general show that people tend to respond to virtual agents as they would respond to real people and seem to confirm the validity of this approach for communication research; however, a reliable answer to this question should include the development of more complex models able to explain and predict under which conditions this equivalence holds. Blascovich and his colleagues [77], for example, started developing a "threshold model of social influence within immersive virtual environments" with the aim of identifying the relative impact of different factors (such as behavioral realism and belief of being in front of a veritable human being behind the avatar/agent) and moderating variables (self-relevance and user's target response system) on the occurrence of social influence phenomena in virtual environments.

Altogether, these reflections should raise remarkable interest on these technologies as research tools in human communication processes, while at the same time stimulate empirical studies for the development of virtual agents and environments validated *ad hoc* for experimental communication studies.

1.4 Applicative Connections: Design Guidelines from Communication Theory and Empowerment of Interpersonal Communication through Mediated Presence Technology

At an applicative level, the exploration of the links and interdependencies between communication and presence leads us to focus on two main ideas: first, communication psychology might provide a relevant contribution to designing technological applications (in particular embodied agents and avatars) able to elicit high levels of mediated presence and social presence; second, application technologies endowed with physical and social presence affordances might provide an experiential setting to train and empower interpersonal communication processes (also in non-mediated contexts).

G. Riva, M.T. Anguera, B.K. Wiederhold and F. Mantovani (Eds.)
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1.4.1 Towards the Definition of Psychologically Sounded Design Empowering Technological Applications

As we have seen, considerable research efforts are to date devoted to developing humanoid software agents that use speech, gaze, gesture, intonation and other signaling systems in the way humans use them in the communication process as conversational partner, leading to the development of so-called Embodied Conversational Agents [4, 111, 112].

Within this framework, communication psychology might offer guidelines and design principles (coming from theoretical reflections and/or empirical studies on human-human communication) for the design and evaluation of technological applications able to support the emergence of a sense of social presence in the user [112]. As pointed out by Garau and colleagues [113], in fact, simple presence of avatars/agents in a 3D shared space is not enough, what is really critical is that they are *expressive*, in order to contribute meaningfully to the communication process; there is a significant difference between simple liveliness and communicative meaningful expressiveness, which is fundamental for the agent/avatar to be perceived as a conversational partner. Its achievement requires the ability to employ different signaling systems in a synchronic way in order to convey meaning within the communicative exchange [4].

As a support to this effort, communication psychology provides an important basis in the literature sources on human communication [114]: within this section, we will focus specifically on the relevance of *multimodality, accommodation and interaction synchrony*.

Meaning design is quite complex, since it is not connected with a unique and exclusive signaling system, but comes out of the network of semantic and pragmatic connections between different signaling systems (multimodal configurations). As, among others, Anolli [45, 46, 48] pointed out, besides language, there are several other communicational devices to show interactants' own communicative design, like the paralinguistic (or supra-segmental), the face and gestures system, the gaze, the proxemics and the haptics, as well as the chronemics. Each of these communicative systems bears its contribution and participates in defining the meaning of a communicative act in an autonomous way. However, the generative capacity of each signaling system must be connected to produce a global and unitary communicative action, with a more or less high consistency degree. Such a consistency degree involves both the horizontal dimension in the use of each signaling system (i.e., for non verbal signaling systems, consistency among different behaviors within the same system) and the vertical dimension, regarding the convergence in meaning generation between several and different signaling systems (principle of semantic synphony, [46]; see also the chapter by Ciceri & Biassoni in this volume).

Examples of design with specific focus on a multimodal communicative architecture can be found in some recent studies and applications [113-115]. Garau and colleagues [113] focused on multimodal synchrony between speech and eye-gaze. The authors based on social psychology research on the differences in gaze patterns while speaking and while listening in face-to-face interactions, in order to build avatars with *informed eye-gaze* (related to the conversation), and found out that this provides a marked improvement as compared to an avatar that merely exhibits liveliness. Buisine and colleagues [115] implemented different multimodal strategies

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used for combining speech and gestures in the design of a presentation ECA and looked at their effects on user's subjective ratings and recall performance.

Besides the issue of coordination of multimodal signals within the individual interlocutor/agent, an emerging issue concerns the setting of these multimodal configurations within the complexity of interaction with the conversational partner [106; see also the chapters by Ciceri & Biassoni, and Agliati *et al.* in this volume]. Multimodal configurations aimed at meaning generation and negotiation are in fact acted and carried out in *hic et nunc* communicative exchanges, which require participation from both interlocutors, and develop over time. Therefore, considering the multimodal configurations jointly acted by interlocutors (be it human-human or human-agent) over time entails relevant conceptual connections with the issue of interaction synchrony, as related to the convergence of non verbal behaviors in temporal processes of interaction (even exhibiting exactly the same behaviors, as in the case of mirroring phenomena) [106, 116]. According to Burgoon [106], when people communicate, they have to “adapt their interaction styles to one another. For example, they may match each other's behavior, synchronize the timing behavior, or behave in opposite ways”. Indeed, it is widely acknowledged in common observations as well as in the scientific field that participants in communicative interaction are usually engaged in a common rhythm [117].

A first application of these concepts to human-computer interaction was recently proposed by Bailenson and Nick [118]. In their study, assuming the theoretical paradigm of the chameleon effect [117], participants interacted with a virtual agent in an immersive virtual reality environment. The agent either mimicked the participant's head movements (which were tracked and recorded through specific sensors) at 4-second delay or utilized prerecorded movements of another participant as it verbally presented an argument. Mimicking agents were perceived as more persuasive and received more positive trait ratings that nonmimickers, despite participant's inability to explicitly detect the mimicry.

The works described up to this point suggest the valid potential of endowing synthetic characters with increasing embodiment and multimodal affordances in order to increase their social presence; however, this consideration should not result automatically in design trends claiming “the more modalities, the better”.

It seems, in fact, that achieving consistency in the design and implementation of multimodal behavior might be more important than endowing agents with animation and control of all communicative signals humans use. Multimodality should be exploited according to principle of semantic synthyony and synchrony [46], where the attunement of all the communication signals involved prevails on the number and richness.

Consistently with this perspective, the above cited study by Garau and colleagues [113] showed that also very limited, though consistent manipulations can be effective: a surprising result was, in fact, that the inferred eye gaze avatar led to significantly better results than the avatar simply exhibiting liveliness, but was not significantly different from the video condition (full and accurate nonverbal feedback from the face). This, according to the authors, suggested that “an avatar can begin to make a significant contribution to the positive perception of communication even without detailed facial expression”. Moreover, the authors pointed out that the salience and role of a specific nonverbal behavior can change according to the task (e.g. eyegaze when performing equivocal tasks that have no “correct” outcome and

G. Riva, M.T. Anguera, B.K. Wiederhold and F. Mantovani (Eds.)
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require negotiation). The relative importance of the representation/inclusion of different behaviors should be weighted on the application and related user tasks.

Finally, the idea that multimodal animation of the agent should be settled within the interactive flow with the human user and the importance of dynamic adaptation between the interlocutors highlight the possible relevance to endow agents and avatars with “perceptual” capabilities, allowing them a form of sensing and monitoring of user input [101]; as far as this effort is concerned, research carried out within the affective computing domain [119-121] might offer an interesting integration.

1.4.2 Presence Simulation Technologies to Enhance Interpersonal Communication

Technological applications allowing for virtual co-presence and sense of social presence have the potential to empower interpersonal communication processes, by offering tools to simulate a number of professional and interpersonal contexts and situations. Within this section, we will focus on the use of 3D interactive simulations to train communication skills and of VR worlds to enhance therapeutic communication process.

As a first example, we consider the development of interactive simulations for the training of communication and emotional skills for different professional contexts, e.g. health-care, commercial, etc. [122, 123; see also Realdon *et al.* in this volume]. In these simulations trainees find themselves “immersed” in a virtual world populated by 3D characters that engage them in communicative exchanges, modeled after prototypical complex situation found in their actual context (e.g. a physician breaking bad news to a patient, a bank-teller dealing with an angry and polemic customer). This allows trainees to practice communication and relational skills, experiencing the effects of different communication strategies in an experiential, realistic (though “safe”) setting. A careful crafting of the simulation to ensure that the situations and communicative interactions with virtual agents elicit a sense of physical and social presence in the trainee can turn the fact of “playing” the simulation into an involving life experience, fostering the transfer of learning to her/his actual professional contexts.

On the clinical side, a similar rationale underlies the use of VR environments, for the treatment of social phobia and fear of public speaking [109, 124, 125]: in these applications, used in psychotherapeutic settings, the patient faces a number of difficult situations, from meeting new people to speaking in front of a large audience, and gradually learns how to manage related emotions, beliefs and behaviors.

Apart from VR environments specifically devoted to these disorders, we might say more generally that the use of VR-based applications in the therapy of most various disorders, such as eating disorders, phobias and anxiety disorders, might represent a powerful device to enhance communication processes in patient-psychotherapist interaction [126]. Communication is a key feature of therapy, and participation, shared re-attribution of meaning to the experience of the patient play an important role in it. Technologies able to elicit sense of presence might be functional to this process. Within psychotherapeutic process, in fact, exchange and communication between patient and therapist are used to re-evoking worlds, to build new meanings, new mental representations of the situations and of the opportunities for action of the patient: the use of virtual presence technologies might support this process by

G. Riva, M.T. Anguera, B.K. Wiederhold and F. Mantovani (Eds.)
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providing a reification of a common context towards which the attention of both patient and therapist is directed.

1.5 Conclusions

Along this chapter, we tried to open an exploration of the complex and manifold relationships between the domains of communication and presence.

This exploration was stimulated by how digital technologies are changing the ways we communicate and we make physical and social experiences in natural and mediated worlds. Phenomena and questions raised by advanced technologies have defined interesting challenges at different levels, whose implications went well beyond practical/application-related issues and resulted in stimulating inquiries on the very foundations of communication and presence as psychological phenomena. A possible approach to address this challenge is identifying an integrated theoretical and methodological platform within which addressing these issues in a coherent and systematic fashion.

As a first step to outline this framework we started by looking at some of the links between the two domains, which we identified at three different levels:

- *theoretical*, with the settling of communication and presence within a psychology of action, as well as the acknowledgment of importance of embodiment and context;
- *methodological*, with the use of communication psychology to define integrative measures of social presence and the use of technologies eliciting high levels of mediated presence as a tool for research on human-human communication processes;
- *applicative*, with discussion of how communication theory might provide insights for the design of embodied virtual agents and of how virtual reality and virtual agents might constitute an experiential setting for the training and fostering of interpersonal communication skills.

Our goal was to provide some initial stimuli for reflection, rather than exhaustive treatment of the topic. Although we are aware that the coverage of the links is far from being complete, nevertheless we hope this work will stimulate further integration and exploration of this passionating domain at the intersection between communication and presence, psychology and technology.

Of course the road ahead is still very long, and the next part of the journey unfolds along the pages of the other chapters in this volume. So... we wish you to be curious, active and “present” readers ... and to enjoy the journey.

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