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The Immersive Hand: Non-verbal Communication in Virtual Environments

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Hardly anything has become a more popular expression of liking in contemporary online communication than the Facebook 'thumbs up' logo. And, just as the development of the first emoticons in the mid-1980s had, not coincidentally, been related to a smiling face, the same applies to the present-day Facebook illustration. Both of these popular visuals rely on non-verbal communicative cues – a facial expression and a hand gesture – to convey meaning in online interaction.

The importance of integrating non-verbal cues in computer-mediated communication (CMC) is twofold. First, non-verbal expression is the primary communicative ability a person develops, and it remains a key communicative capacity throughout a person's adult life, comprising up to two-thirds of communicative behavior in dyadic interaction (Ekman and Keltner, 1997). The way we understand, persuade, teach, inform, encourage, or hate each other is rooted in our non-verbal abilities. Second, non-verbal expression is one of the human communicative capacities most substantially affected by the development of CMC and virtual environments. To immerse oneself into virtual space, to augment the boundaries of a physical place, to blur the line between the virtual and the physical – all these concepts imply, in essence, transformations in the way various non-verbal stimuli are exchanged, employed, and interpreted in virtual environments. Therefore, in order to grasp increasingly ubiquitous online interaction and its potential socio-cultural implications, it is important to understand non-verbal communication (NVC) in virtual environments.

This chapter begins with an overview of key aspects and functions of NVC in physical and virtual environments. Next, it turns to addressing some of the design principles involved in the development of virtual non-verbal acts. Finally, this chapter explores the future of digital NVC with regard to affective computing, touching upon possible socio-cultural implications of these developments.

Non-verbal communication: the physical, the social, and the virtual body

Non-verbal communication is a broad field that encompasses various perceptual stimuli, created by both people and the environment. Non-verbal information can be conveyed through a variety of semiotic systems, such as architecture, clothing, or the body. Kendon's (Ekman and Friesen, 1981, p. 3) definition focuses more specifically on human interaction, positing that NVC refers to 'all of the ways in which communication is effected between persons when in each other's presence, by means other than words'.

Being so broad, the field of non-verbal communication is commonly differentiated into several code-systems, such as *proxemics* (communicative use of space), *kinesics* (communicative use of the body movements), *haptics* (communicative role of touch), *physical appearance* (communicative use of body endowments, e.g., body shape and size, skin and eye color, and body adornments, e.g., clothing, makeup, tattoos), *oculesics* (communicative eye behavior), *chronemics* (communicative role of time), *objectics* (communicative use of artifacts), and *vocalics* (communicative aspects of voice, such as tone, accent, and loudness). A specific code-system consists of biosemiotic signs – physiological reactions, such as blushing, that function as signifiers in human interaction, although they operate beyond a person's control (Sebeok, 2001). Such signs constitute a significant component of NVC, as well as of affective computing, as we will see below.

Non-verbal code-systems work together in achieving various communicative functions. A non-verbal act can substitute, repeat, augment, illustrate, accent, and/or contradict a verbal message. Conversely, it can be unrelated to the verbal utterance (Ekman and Friesen, 1981).[1] In an interactive event, non-verbal cues play an important role in managing conversation and in facilitating message production, processing, and comprehension. Non-verbal cues also function as potent signifiers in communicating relational themes, for example, group inclusion vs.

group exclusion, and in communicating situational dimensions of an interactive event, for example, private vs. public.

The broad range of functions that non-verbal behavior assumes start to operate from the earliest days of a person's life, as NVC represents the first communicative ability infants develop. Being such a fundamental interactive capacity, NVC is also the entry point to a person's socialization and enculturation. Before a person learns to talk, write, or create avatars, he or she uses the primordial means of communication, the body, learning the non-verbal communicative norms of his or her culture. Non-verbal communication is thus considered a meeting point of nature and culture, or, in the words of Mary Douglas, a meeting point of the physical and the social body (Douglas, 2003 [1970]).

With the development of interaction in virtual spaces, NVC becomes even more complex. It develops into a meeting point of nature, culture, and technology, that is, into a meeting point of the physical, the social, and the virtual body. The possibility of non-verbal expression in virtual spaces has been an important area of investigation since the early days of CMC research. For instance, in *The Network Nation*, Hiltz and Turoff (1978) noted that for novice users the experience of CMC could be a kind of culture shock because the non-verbal channels are missing.

In subsequent research, two main approaches have been developed with regard to NVC in text-based CMC. One is the 'cues-filtered-out' approach, which determines that the lack of non-verbal cues in CMC results in narrowing of communicative abilities of online interactants, while the Social Information Processing theory argues that users adapt their language and style to communicative situations in which non-verbal cues are unavailable (Walther and Granka, 2005, p. 37). Also relevant for an understanding of NVC in virtual environments is the research on emoticons (Riva, 2002; Rivera et al., 1996; Walther and D'Addario, 2001) as well as the early works of Donna Haraway and Allucquere Rosanne Stone (Haraway, 1991; Stone, 2000 [1992]), which inspired, respectively, a series of studies in 'cyborgology' and the analyses of representation of the human body in virtual environments.

The emergence of multiuser, 3D virtual environments shifted the researcher's attention to avatar-based non-verbal expression. Research in computer sciences provided useful insights into the process of designing software solutions for non-verbal communication in multiuser, 3D

virtual environments (Erickson and Kellog, 2000; Fabri and Moore, 2005; Guye-Vuilleme et al., 1999). In the field of social sciences, studies addressed issues such as the role of non-verbal cues in identity formation (Talamo and Ligorio, 2000), non-verbal communication as a source of user experimentation (Brown and Bell, 2004), persistence of non-verbal communicative norms in virtual environments (Yee et al., 2007), practices of looking in virtual environments (Irani et al., 2008), and the role of avatar bodies in social interaction (Schroeder, 2011).

Both computer science and the social sciences research have thus been fine-tuning our understanding of NVC in virtual environments. One of the areas in which these two research fields come into close contact is the area of computer systems design, which brings to the forefront ambiguities of computational and socio-cultural aspects of interaction in virtual environments. In the next section, we will focus on the design principles underlying NVC in virtual environments.

Designing an immersive hand

Interaction in virtual environments involves three equally important components: a new media object, that is, a programmable numerical representation composed of digital code (Manovich, 2001, p. 27), a new media object user, and a new media object designer. A dialectical process unfolding among these actants generates the complexity of interaction in virtual environments (de Souza, 2005).

At the outset of this process, the designer identifies a problem situation that a new media object should solve. The designer then analyzes user needs and expectations related to the identified problem and the projected object as well as the user's estimated socio-demographic characteristics. Once these tasks are completed, the designer creates a new media object. User interaction with the object is the next phase of the process. Through this interaction, the user first decodes the designer's message encoded in the object and then employs it, which is the peak of the dialectical process among the object, the user, and the designer (Ibid.).

The same dialectical process can be observed in designing non-verbal aspects of user interaction in virtual environments. Non-verbal communication in virtual environments represents a constant interplay between the designer's decisions related to options made available to users regarding their non-verbal behavior and the user's ability to

reconcile the physical, social, and technological requirements imposed on their virtual bodies.

To understand this interplay better, let us take a look at one example of new media object design in a multiuser virtual environment, *Second Life* (SL). The object we shall analyze here, the Romantic Flirt Bench, offers users flirt animations that correspond to their mood.[2]

In a previously described dialectical process, the problem this object aims to solve is the lack of flirt-related non-verbal cues in user interaction. To achieve that goal, the bench provides a series of non-verbal acts built into its script, which users' virtual bodies automatically start to perform when seated on the bench.

These non-verbal acts, built into the script, are equivalent to non-verbal cues that Kendon found typical of face-to-face courting interaction in contemporary Western cultures. For instance, the Involvement and Disengagement subphases of the 'kissing round' ritual are clearly recognizable in the series of non-verbal acts built into the script. Further, the female avatar seated on the bench initiates both subphases while the male avatar adjusts his non-verbal acts accordingly, which is again a simulation of contemporary Western courting ritual, often dependent on female solicitation cues (Kendon, 1990; Moore, 1985).

Through such modeling of user non-verbal behavior, the analyzed new media object becomes an intellectual artifact that encodes a particular communicative solution to a particular problem. This solution, however, is deeply rooted in contemporary Western cultural assumptions about gender roles (e.g., the female manages a courting ritual while the male adjusts), the principles of sexual attraction and mating (e.g., a courting ritual is necessarily heterosexual), and the particular non-verbal codes and cues through which courtship is expressed (e.g., the forward lean as a female solicitation cue). In this way, the flirt bench also becomes a metacommunicative artifact that conveys a particular understanding of communicative processes and signification systems in SL user interaction.

Virtual non-verbal acts thus stand as epistemic tools juxtaposed with user agency. Agency is understood here as the socio-culturally and technologically mediated capacity to act; the term epistemic tool is conceived as a specific complement of the more widely used term epistemic object. While epistemic objects generate new questions (Rheinberger, 1997), the term 'tool' is used here to refer to the fact that computer-mediated non-verbal acts 'provide answers,' that is, endorse a specific understanding of non-verbal communicative practices and processes.

A digital non-verbal act assumes the character of an epistemic tool through the process of double objectification. First, a digital non-verbal act is objectified through the use of scientific models of face-to-face communicative practices. As the Romantic Flirt Bench example shows, NVC in virtual environments is often modeled upon findings in NVC scholarship. Yet scientific models of non-verbal behavior are heuristic representations of communicative practice, and, as Bourdieu persuasively argued, those models misconstrue practice by transforming this dynamic process into a fixed object of inquiry (Bourdieu, 1977 [1972]). As a consequence, scientific models of practice never account for all the instances of practice that can and do happen in situ, and a practical activity never actually assumes the form represented in a scientific model.

The second instance of objectification emerges from the transformation of physical activities into numerical, digitally coded representations of those activities. Put differently, a non-verbal act becomes transformed into a new media object. This transformation has two major consequences. First, non-verbal behavior assumes the attributes of a new media object, yielding to its epistemic, representational, and operational principles. For instance, continuous, analogically coded, and transient non-verbal behavior turns into a series of digitally coded, discrete, and persistent units. Second, agency becomes divided between the user – an executor of a non-verbal act – and the computer programmer – a designer of such an act. This dual character results in the coexistence of two discourses in virtual non-verbal behavior – the design discourse and the user discourse.

Through those two discourses, a virtual body simultaneously operates as a subject and as an object of communication. Within the user discourse, user agency feeds the actions of a virtual body, making it a subject of communication. Within the design discourse, agency rests with the computer system, transforming the virtual body into an object of communication, that is, into an item of algorithmic manipulation controlled by the computer system. Within the user discourse, the virtual body augments the user's physical body and acts in a way called for by an interactional situation. Within the design discourse, the virtual body is acted upon in a way called for by the system epistemology and pragmatics.

Such an interplay between computer systems on the one hand and user bodies on the other becomes particularly prominent when we probe possible further directions in virtual non-verbal behavior, which is closely associated with the concept of affective computing.

Towards the affective web

Among the authors researching digital technologies and communication, affect is often identified as 'the next big thing' in networked computing (Baldoni et al., 2008; Becker, 2006; Kambil, 2008; Picard, 2000, 2010; Woolf et al., 2009). Two main lines of predicted development include a kind of semantic web focused on affective content on the one hand and integration of digital technologies and emotion through the use of affective computing on the other. These two directions are closely related, not just in terms of their common orientation on affect but also as a kind of sequential progression towards what might be termed 'artificial emotional intelligence'.

The idea of emotionally intelligent computers is not new, but with recent developments it has assumed more user-centered focus than before. Earlier initiatives have mainly been focused on loading autonomous agents with sets of predefined emotional and behavioral features abstracted from human experience; this precoded emotionality was intended to serve as the source of an agent's reaction to user input, and to make agents more believable interactants in human–computer interaction (HCI) (Bates, 1994).

In such approaches, non-verbal cues are used as an enhancement of agents' precoded emotionality. For instance, Fabri et al. argued that NVC of human-like agents is the essence of their capacity for human behavioral resemblance, as with that capacity 'it [an agent] becomes a genuine representation of the underlying individual, not only visually, but also within a social context' (Fabri et al., 2002, p. 2). Precoded emotionality enhanced with the use of NVC has also become an important aspect of multiuser, 3D virtual environments, such as *Second Life*, where both avatars and agents have more or less sophisticated pools of predefined non-verbal acts (Antonijević, 2008).

More recent approaches rely on extracting affective attributes of actual human behavior rather than on arbitrarily selecting such features from 'theories of affective practice' (to paraphrase Bourdieu). As previously mentioned, one approach refers to a set of semantic web techniques focused on affective data. This method derives from a larger body of research in computer sciences focused on developing algorithms for extracting, analyzing, and synthesizing affective data from various sources, including textual and multimodal web sources (Douglas-Cowie et al., 2007). These data and applications can be used in a variety of settings, such as commercial (Dass and Chen, 2007) or cultural (Baldoni et al., 2008).

Another approach is related to affective computing and technological advances in the areas of sensory and wireless devices. The core idea surrounding this area of study is to enable emotionally sensitive HCI, in which technology can capture, record, and recognize user affect and respond in an emotionally sound way. Similar to affective computing are affective interaction and technology as experience lines of research, which focus, respectively, on affect as socio-culturally constructed and/or as one element in the holistic HCI experience (Boehner et al., 2005; Gaver, 2009; McCarthy and Wright, 2004).

These approaches differ from earlier methods in emotionally intelligent computing primarily because they refocus attention from applications to users. As Picard notes, 'computers do not need affective abilities for the fanciful goal of becoming humanoids; they need them for a meeker and more practical goal: to function with intelligence and sensitivity toward humans.' In order to achieve this kind of emotional intelligence, affective computing relies on devices that provide data about user physiological and psycho-emotional states transmitted through various non-verbal cues, such as facial expressions, gestures, body temperatures, galvanic skin responses, and so on (Picard, 2000, p. 248).

Thus gathered affective computing data can be put into use in various domains. One of them is affective e-learning, in which intelligent web tutors recognize student affect through the input from sensory devices and adjust instruction accordingly. For instance, if pattern recognition software spots a student's facial movements associated with frowning coupled with fidgeting and looking around, the tutor infers that the student is confused and that a pedagogical action is required (Woolf et al., 2009). Another application is affective self-reflection through the use of a system that collects different types of user input, such as time-stamped biosensor data, text messages, and photos, all of which comprise a user's affective diary, providing an opportunity to record one's experiences and reflect on them in a more holistic way (see: http://www.sics.se/interaction/projects/ad/). Computational tracking of non-verbal cues can also assist people with autism to develop better functioning in their socio-emotional experiences (Kaliouby et al., 2006) as well as the general population to better handle stressful situations (Healey and Picard, 2005).

As previously mentioned, the non-verbal code-system of haptics is also widely used in affective computing. Virtual haptics relies on tactile and kinesthetic force receptors, which provide information

such as pressure, temperature, softness, and wetness, as well as on microgeometric and microtexture receptors that, respectively, encode the shape of objects and provide texture information, allowing users to feel virtual objects and to interact with them in virtual environments (Robles de la Torre, 2009; Salisbury et al., 2004). This type of virtual non-verbal communication has been increasingly used in areas such as surgical simulation and medical training, computer-assisted design, sign language recognition, military training, cultural heritage, and virtual museums (McLaughlin et al., 2001; van der Meijden and Schijven, 2009).

All these examples demonstrate the extent to which NVC becomes central to both user–user and human–computer interaction in networked environments. Although these environments started off as 'body-free' communicative spaces characterized by the lack of non-verbal cues, they are progressively turning into arenas in which the importance of non-verbal cues not only meets but potentially even transcends the significance of non-verbal behavior observed in physical space. For instance, it is possible to imagine networked environments in which direct 'body reading', that is, the detection and interpretation of galvanic skin response, facial expressions, and other non-verbal cues, will become a powerful enhancement of, and in some areas maybe a replacement for, written and/or spoken discourse. As the above-mentioned example of e-learning shows, web tutors are already able to infer psycho-emotional information by interpreting student non-verbal cues rather than by engaging in verbal exchange. With further developments in tracking and recognition systems focused on kinetic, haptic, vocalic, and other non-verbal code-systems and with developments in affective computing in general, it is sound to envision virtual environments as interactive spaces saturated with, and reliant upon, non-verbal cues.

The emotional and other communicative nuances conveyed in high-fidelity, high-resolution, and low-latency systems will transform user interaction in virtual environments. Additionally enhanced and fine-grained technologies of immersion and augmentation will also bring changes in terms of user interaction both with other users and with the environment itself. Furthermore, user psycho-affective states that become increasingly observable through technologies such as face and speech recognition and eye tracking will be a rich field of interdisciplinary study. Finally, further developments in ubiquitous computing, ambiance intelligence, and geolocation will all expand the

to learn more about our affective side as well as about expressing it via an immersive hand.

Notes

1. Verbal and non-verbal utterances originate simultaneously, as elements of a single cognitive process (see McNeill, 1992), with verbal and non-verbal discourses making an active communicative interrelationship in an interactive event.
2. See https://marketplace.secondlife.com/p/AA-Romantic-Flirt-Bench/280085?id= 280085&slug= AA-Romantic-Flirt-Bench

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