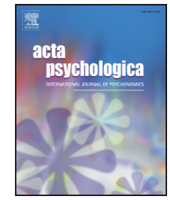
Acta Psychologica 161 (2015) 131–136

Contents lists available at ScienceDirect

Acta Psychologica

journal homepage: www.elsevier.com/locate/actpsy



Near or far? It depends on my impression: Moral information and spatial behavior in virtual interactions

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ARTICLE INFO

Article history:
Received 18 April 2015
Received in revised form 29 July 2015
Accepted 6 September 2015
Available online xxxx

Keywords:
Interpersonal social space
Peripersonal action space
Moral evaluation
Sensorimotor spatial processing
Embodied social cognition

ABSTRACT

Near body distance is a key component of action and social interaction. Recent research has shown that peripersonal space (reachability-distance for acting with objects) and interpersonal space (comfort-distance for interacting with people) share common mechanisms and reflect the social valence of stimuli. The social psychological literature has demonstrated that information about morality is crucial because it affects impression formation and the intention to approach-avoid others. Here we explore whether peripersonal/interpersonal spaces are modulated by moral information. Thirty-six participants interacted with male/female virtual confederates described by moral/immoral/neutral sentences. The modulation of body space was measured by reachability-distance and comfort-distance while participants stood still or walked toward virtual confederates. Results showed that distance expanded with immorally described confederates and contracted with morally described confederates. This pattern was present in both spaces, although it was stronger in comfort-distance. Consistent with an embodied cognition approach, the findings suggest that high-level socio-cognitive processes are linked to sensorimotor-spatial processes.

1. Introduction

When we encounter unknown persons, we spontaneously and quickly form an impression of them. How important for us are the positive or negative impressions that we form on the other people? Does this information have a top-down influence on the regulation of the distance between our and their body? This study focuses on these interwoven questions.

Spatial distance is an intrinsic component of our interaction with other people and the portion of space immediately surrounding the body has a special value in social processes. In social psychology *personal space* defines an emotionally tinged zone around the body that people feel like "their private space" and cannot be intruded upon by others without causing discomfort (Hall, 1966; Hayduk, 1983; Lloyd, 2009; Lourenco, Longo, & Pathman, 2011). Proxemics studies have shown that people tend to extend distance from intruders when feeling in hostile and uncomfortable situations and reduce distance from others when feeling in friendly and comfortable situations (Hall, 1966; Hayduk, 1983; Lloyd, 2009; Kennedy, Gläscher, Tyszka, & Adolphs, 2009).

The space around the body is important not only to qualify social interactions but also to act with objects. In the neuro-cognitive literature *peripersonal space* defines the area within arm reaching where we can act in the here and now (Berti & Frassinetti, 2000; Coello, Bartolo, Amiri, Houdayer, & Derambure, 2008; Delevoye-Turrell, Bartolo, & Coello, 2010; Rizzolatti, Fadiga, Fogassi, & Gallese, 1997). At the neural level, peripersonal space is represented by highly integrated multisensory and motor processes in frontal-parietal and posteromedial areas (Bartolo et al., 2014; di Pellegrino & Làdavas, 2015; Rizzolatti et al., 1997; Ruggiero, Frassinetti, Iavarone, & Iachini, 2014). Peripersonal space, that constitutes the first margin between the surface of our body and the environment, has also been conceived as a safety barrier for protecting body integrity by prompting defensive actions (Coello, Bourgeois, & Iachini, 2012; de Vignemont & Iannetti, 2015; di Pellegrino & Làdavas, 2015; Graziano & Cooke, 2006). Neuro-cognitive studies have shown that the boundary of peripersonal space is plastic and dynamic, under the influence of several factors (for reviews Cléry, Guipponi, Wardak, & Ben Hamed, 2015; Delevoye-Turrell et al., 2010). For example, its size may increase with tool use, arm length or transition from childhood to adulthood (e.g., Longo & Lourenco, 2006, 2007; Delevoye-Turrell et al., 2010), but it may also contract with increased effort related to the arm or perceived danger of the stimuli (Coello et al., 2012; Lourenco & Longo, 2009).

In an integrative socio-cognitive perspective, the space around the body can be seen as the physical space where some social actions occur on the basis of their emotional and motivational relevance

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http://dx.doi.org/10.1016/j.actpsy.2015.09.003
0001-6918/© 2015 Published by Elsevier B.V.

(Iachini, Coello, Frassinetti, & Ruggiero, 2014a; Lloyd, 2009). Some recent literature has shown that social information may modulate the representation of peripersonal space, thereby suggesting a close relationship between basic visuomotor-spatial processing and social processing (Brozzoli, Gentile, Bergouignan, & Ehrsson, 2013; Cléry et al., 2015; Iachini et al., 2014a; Teneggi, Canzoneri, di Pellegrino, & Serino, 2013). For example, Teneggi et al. (2013) have shown that the presence of another person may lead to a contraction of peripersonal space size and a cooperative social exchange may expand one's own peripersonal margin up to include the other.

When studying the relationship between peripersonal action space and interpersonal social space, Iachini et al. (2014a) found that both spaces were modulated by the social meaning of stimuli: distance contracted with humans as compared to objects, and among humans with females as compared to males. Importantly, when participants were active (i.e. approached the others) the two spaces had a similar size, but when they were still interpersonal distance particularly expanded. These findings suggest that peripersonal and interpersonal spaces share a common motor nature and reflect, though at different degrees, basic characteristics of social information.

The above mentioned studies suggest that socio-cognitive processes can exert a top-down influence on the way we represent the space around our body. However, it is not clear if, and to what extent, complex social information may affect spatial regulation mechanisms.

Here we explore whether the size of near body space is modulated by the impression we form about unknown persons. Much research suggests that moral information is central when we have to form a quick impression about a person (Brambilla & Leach, 2014; Goodwin, Piazza, & Rozin, 2014). Morality refers to a general distinction between what is considered right or wrong (Ellemers, Pagliaro, & Barreto, 2013). As such, moral judgments refer to standards of human virtue, and serve as a guideline for individual behavior (Beauchamp, 2001). Researchers have often conflated information relative to morality – being honest or trustworthy – with information relative to sociability – being friendly or good-natured. These classes of information, however, are distinguishable both at the theoretical and empirical level (Leach, Ellemers, & Barreto, 2007). Starting from this distinction, Brambilla and colleagues recently clarified that impression formation about other individuals and groups is dominated by morality information (Brambilla, Rusconi, Sacchi, & Cherubini, 2011; Brambilla, Sacchi, Rusconi, Cherubini, & Yzerbyt, 2012). Subjective measures have shown that individuals are inclined to establish vs. avoid relations on the basis of moral information (Brambilla, Sacchi, Pagliaro, & Ellemers, 2013; Pagliaro, Brambilla, Sacchi, D'Angelo, & Ellemers, 2013). Thus, individuals give priority to the relational implications of social information that is, whether others are likely to be helpful or harmful to the self (Cuddy, Fiske, & Glick, 2008). This evidence has been interpreted in a functionalist way: gathering information about others' morality helps individuals to anticipate their intentions, to understand whether they would be beneficial or harmful (Fiske, Cuddy, & Glick, 2007).

While research about perceived morality has generally used subjective self-reports, proxemics has adopted objective metric measures to study social phenomena. Here, to investigate whether the regulation of proximity is affected by moral information, we devised a behavioral paradigm based on Iachini et al. (2014a). The regulation of body space was measured by classic experimental tasks drawn from neurocognitive and social literature, respectively: reachability-distance (the point where visual stimuli presented at various distances from the body are reachable) and comfort-distance (the point where people still feel comfortable with the other's proximity). By means of Immersive Virtual Reality (IVR), participants approached or were approached by male/female virtual humans (confederates) described in terms of morality by positive, negative and neutral (as a control condition) sentences.

By making comparisons between peripersonal reachability-distance and interpersonal comfort-distance, we should be able to assess if, and to what extent, a complex social process such as moral evaluation is linked to basic sensorimotor spatial mechanisms. From an adaptive point of view, perceived morality can be considered a predictive mechanism involved in the regulation of social behavior (Ellemers et al., 2013). We hypothesize an effect of moral content of this sort: distance from virtual confederates should be larger with negative than positive and neutral descriptions, whereas it should be smaller with positive than neutral descriptions. We expect a strong effect of perceived morality on interpersonal comfort-distance, a distance that has proved to be sensitive to situational and socio-emotional characteristics (Aiello, 1987; Hayduk, 1983; Uzzell & Horne, 2006). However, reachability-distance seems also influenced by environmental and socio-emotional properties, suggesting a quantitative rather than qualitative difference between interpersonal and peripersonal spaces (Coello et al., 2012; Delevoye-Turrell et al., 2010; Iachini et al., 2014a; see also Cléry et al., 2015). Therefore, perceived morality could also affect reachability-distance.

Finally, consistently with long-standing evidence (Aiello, 1987; Hayduk, 1983; Iachini et al., 2014a; Uzzell & Horne, 2006), spatial behavior should also be affected by gender-related effects.

2. Materials and method

2.1. Participants

Thirty-eight right-handed students (22 women), aged 18–30 years ($M = 22.2$, $SD = 3.0$), education (years, $M = 14.8$, $SD = 1.7$) were recruited from the Second University of Naples (SUN) in exchange for course credits. All participants had normal or corrected-to-normal vision. The Edinburgh Handedness Inventory (Oldfield, 1971) was used to measure handedness (*mean score* = 90.10, $SD = 1.90$). The sample size was determined by an a-priori power analysis (with effect size = .25, $\alpha < .05$, Power = .95) that gave a number of 36. Participants gave their written consent to take part in the study. Recruitment and testing were in conformity with the local Ethics Committee requirements and the 2008 Helsinki Declaration.

2.2. Setting, IVR equipment and virtual stimuli

The virtual stimuli and the experimental paradigm were based on Iachini et al. (2014a) study. The experiment was carried out in the Laboratory of Cognitive Science and Immersive Virtual Reality (Department of Psychology, SUN). The IVR equipment was installed in a rectangular room (5 m × 4 m × 3 m) and includes the 3-D Vizard Virtual Reality Toolkit Devices for Integrated VR Setups and Position Tracking System (WorldViz, USA). Virtual stimuli were presented through the nVisor SX (NVIS, USA) head mounted display (HMD) with two micro-displays providing stereoscopic depth (approximately 30 times a sec.). The stereoscopic images ran at 1280 × 1024 resolution, refreshed at 60 Hz. The virtual scenario spanned 60° horizontally by 38° vertically. The IVR system allowed for continuously tracking and recording the participant's position (approx. rate of 18 Hz) by means of a marker placed on the HMD. Head orientation was tracked by a three-axis orientation sensor (InertiaCube3; Intersense, USA) and head position by a passive optical tracking system (Precision Position Tracker, PPT-E4; WorldViz, USA). Graphics displayed in the HMD were updated on the basis of sensed position and orientation of participant's head. Moreover, the Data Glove, a glove equipped with 14 tactile-pressures sensors providing the visual perception and sense of hand movement, was also used. Graphics modeling were created by 3D Google Sketch Up 7.0 free-software. The position and orientation tracking systems allowed participants to realistically experience dynamic and stereoscopic visuo-motor input as if they were in front of natural stimuli.

2.2.1. Virtual environment

The virtual room (3 m × 2.4 m × 3 m) consisted of green walls, white ceiling and gray floor. On the floor, a straight white dashed line (from