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

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A B S T R A C T

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 are for us 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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(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 microdisplays 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

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participants' starting position until the end of the virtual room) traced the path that participants and virtual stimuli followed while moving forward/backward (see Fig. 1).

2.2.2. Virtual humans

A pilot study was performed to select (on the basis of a 5-point scale) the virtual confederates most similar to young Italian adults. Twenty-four virtual confederates (half females) were selected among a colony of 100 highly realistic virtual humans (Vizard Complete Characters, WorldViz; USA). The height of the virtual humans was approximately 175 cm for males and 165 cm for females (see again Fig. 1). The appearance of virtual humans was designed to represent young people of about 30 years of age. The gaze of virtual humans was kept looking straight ahead throughout the study and their facial expression was neutral. As in Iachini et al. (2014a; see also Iachini, Ruggiero, Ruotolo, & Vinciguerra, 2014b), since distance can be affected by familiar size in realistic environments, in a control experiment 16 participants (8 females) had to judge the height of each virtual stimulus while positioned at three counterbalanced positions from them (1.5/2/3 m). Results showed that the height of virtual stimuli was always perceived in the same way ($F < 1$).

2.2.3. Impression formation items

To select the sentences that had to guide the formation of impressions about target-individuals, sixty-six sentences comprising items with positive and negative moral connotation, and neutral items as a control were prepared. They were created according to the following criteria (Havas, Glenberg, & Rinck, 2007): (i) presence of a clearly connoting adjective (honest, dishonest, etc.); (ii) presence of content and context easily understandable; (iii) each sentence included a person's name to favor a quick identification. Male and female names were drawn from a list of the Italian Institute of Statistics for population censuses and surveys (Istat, 2010, the Italian National Institute of Statistics) Q8 according to the national frequency of occurrence.

In two pilot studies, 40 participants (half females; age $= 24.2$, SD $=$ 2.6, range $= 20$–32) rated on a 5-point scale if each sentence was ‘not at all’ or ‘absolutely’ positive/negative/neutral. As inclusion criterion, only items with mean $= 5$ were chosen. At the end, 12 sentences (4 negative, 4 positive, 4 neutral) were selected. As shown in the examples, the same sentences were used for both female and male characters: “Anne/Marc is a dishonest woman/man who tries to cheat others” (negative); “Alice/Francis is a honest woman/man who always tries to be fair with others” (positive); “Sophia/Lawrence is a woman/man who has a computer at home” (neutral).

2.3. Procedure

Participants received written instructions that were then orally repeated by the experimenter. Next, a familiarization phase with the equipment and the virtual stimuli began. The experimenter introduced participants to the IVR devices while they wore the HMD and the Data Glove. Once fully immersed in the virtual room (no part of the physical world was visible), participants were invited to freely explore the virtual room and observe examples of virtual humans. The Data Glove was used to allow participants to perceive their arm as fully stretched in the virtual scene. Participants were asked to describe their perception of the virtual environment and their interaction with the virtual humans and objects. They spontaneously reported they had the feeling of being like “inside a movie”, “in a realistic world”, and “with realistic persons” (Iachini et al., 2014a; Iachini, Ruggiero, Ruotolo, & Vinciguerra, 2014b). Nobody claimed problems with the IVR devices or virtual stimuli. Afterwards, participants were led by the experimenter on a pre-marked starting position and had to hold a joystick in their dominant right hand. Throughout the experimental session, the participants stood with their arms extended along the body, similarly to the posture assumed by the virtual humans (see Fig. 1). The experimental session was divided in four blocks corresponding to the experimental conditions: passive-comfort distance, active-comfort distance, passive-reachability distance, active-reachability distance. For each block, the participant received a training session in which an example of the entire procedure was shown. Each block started with a short presentation of the instructions (2 s) followed by a fixation cross (300 ms), then a negative/positive/neutral sentence appeared (5 s). Immediately afterward, the testing phase started. In half of the trials participants were presented with the comfort-distance instructions (i.e., “*press the button as soon as the distance between yourself and the virtual stimulus makes you feel uncomfortable*”), in the other half, with the reachability-distance instructions (i.e., “*press the button as soon as you can reach with your hand the virtual stimulus*”). This procedure was repeated in passive and active approach conditions. In the passive approach, participants stood still and saw virtual stimuli walking toward them at a constant speed ($0.5\ m \cdot s - 1$) until they stopped them by pressing the button Q9 and the stimuli disappeared. In the active approach, the virtual stimuli remained motionless and participants walked toward them at a constant speed until they stopped and at the same time pressed the button.

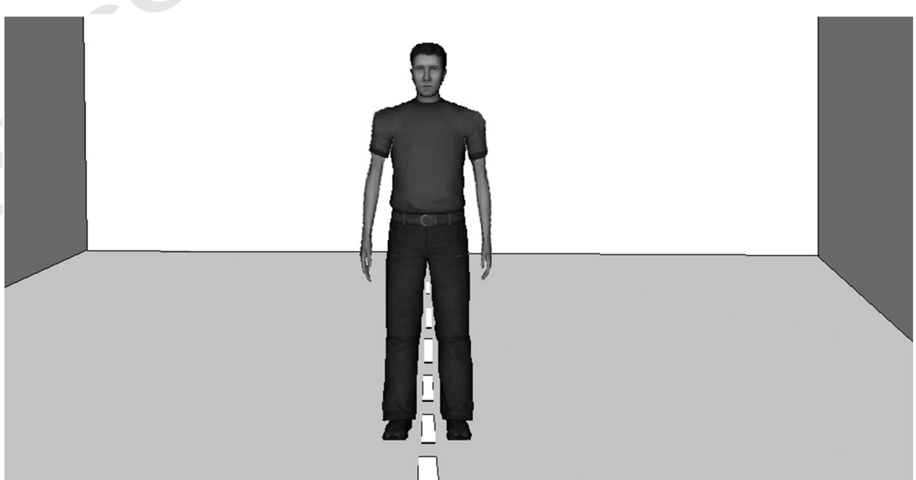

Fig. 1. Figure shows participant's perspective when a virtual confederate (e.g., a male adult) frontally appeared. On the floor, a straight dashed white line represented the path that participants and virtual confederates followed during the approach condition.

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After pressing the button, the virtual stimuli disappeared and participants returned to their starting position. Participants walked forwards and backwards by following the white straight dashed-line on the virtual ground. The starting distance between participants and virtual humans was 3 m. Walking movements of virtual humans reproduced the natural swing of biological motion. After two blocks, participants had to take off the HMD and take a break (5 min).

Within each block, virtual humans were matched to positive, negative and neutral sentences. Virtual humans always had a neutral facial expression. Positive, negative and neutral sentences and persons' names were assigned to virtual humans in a counterbalanced order across participants. In this way virtual humans and descriptions were associated with each other an equal amount of times and we could avoid a possible confound. For each participant, a sentence (e.g., "Marc is a dishonest man who tries to cheat others") was assigned to a specific virtual human. The association virtual human-name-sentence appeared only once per each block, for a total of four times across the entire study. In this way, we had 18 virtual females/males x name x sentence (positive/negative/neutral) combinations per block. Each trial was repeated twice (tot. 144). Order of blocks was counterbalanced across participants according to a Latin square design. Within each block order of trials presentation was quasi-randomized. Each block lasted about 7 min. At the ending of each block there was a manipulation check: participants had to report which task were instructed to do. During the post-experimental interview, participants had to evaluate their experience with the virtual stimuli. No participant reported being aware of the purpose of the experiment. Finally, the experimenter measured the length (cm) of participants' dominant arm from the acromion to the extremity of the middle finger.

2.3.1. Data analysis

Through a continuous participant-virtual human tracking, the distance at which participants stopped themselves or the virtual stimuli according to the task (reachability or comfort distance) and the approach condition (active or passive) was calculated. Within each block, for each type of stimulus the mean participant-stimulus distance (expressed in cm) was computed. Then, participant's arm length was subtracted from the mean distance. The mean length of participants' dominant arm was: males = 75.76, SD = 2.67, females = 69.11, SD = 3.80. The mean distance was analyzed by a 2 × 3 × 2 × 2 × 2 ANOVA for mixed design with Participants' Gender as between factor and 4 within factors: perceived morality (Negative/Positive/Neutral), Distance (Reachability/Comfort), Approach condition (Passive/Active), Virtual Humans' Gender (Male/Female). Data with SD ± 2.5 (12 observations, about 1.3% of the total amount) were excluded from the analyses. Only significant main effects and interactions are reported. The Newman–Keuls test was used to analyze post-hoc effects and the magnitude of effect sizes was expressed by partial eta-squared (η^2_p).

3. Results

3.1. Effects of perceived morality on spatial behavior

A significant effect of Distance emerged, $F(1, 35) = 36.97$, $p < .001$, $\eta^2_p = .51$, due to Comfort-Distance ($M = 56.76$, $SE = 3.74$) being larger than reachability-distance ($M = 38.21$, $SE = 2.81$). A significant main effect of Approach appeared, $F(1, 35) = 115.10$, $p < .001$, $\eta^2_p = .77$, with participants keeping a larger distance in Passive ($M = 64.96$, $SE = 3.59$) than Active ($M = 30.01$, $SE = 3.16$) condition. A main effect of Perceived Morality emerged ($F(2,70) = 11.15$, $p < .001$, $\eta^2_p = .24$) due to the fact that the distance from virtual humans was larger with negative than positive ($p < .001$) and neutral ($p = .014$) connotations, and smaller with positive than neutral connotations ($p = .016$). However, the effect was modulated by the nature of space and moving conditions. Indeed, a significant Distance x Perceived Morality interaction emerged: $F(2,70) = 7.05$, $p = .002$, $\eta^2_p = .17$ (see Fig. 2). The post hoc test showed that the interpersonal social space neatly reflected the morality-immorality attributed to the character: Comfort-Distance was larger when a person was described negatively as compared to positive ($p < .001$) and neutral ($p < .001$) descriptions; Comfort-Distance was smaller when a person was described positively as compared to neutral descriptions ($p < .001$). The same trend characterized reachability-distance, but only the moral – immoral comparison was significant ($p = .026$). Overall, Comfort-Distance in presence of immoral interactants was larger than all other conditions (all $ps < .001$), instead reachability-distance in presence of moral interactants was smaller than other conditions (at least $p < .05$) (except the Neutral reachability-distance).

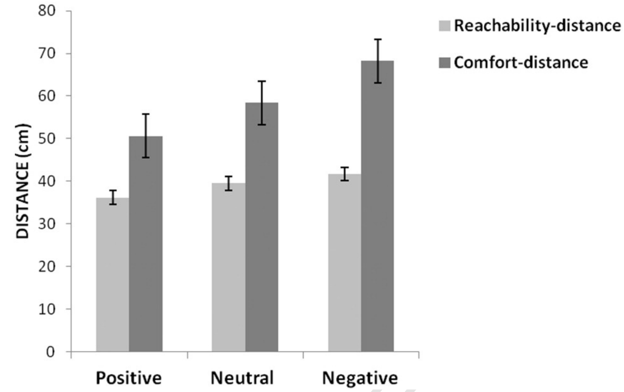

Fig. 2. Mean (cm) reachability-distance and comfort-distance as a function of positive, negative and neutral descriptions. Error bars represent the standard error.

A further significant interaction between Approach and Perceived Morality emerged ($F(2,70) = 4.77$, $p = .015$, $\eta^2_p = .11$), as illustrated in Fig. 3. Within each Passive and Active Approach condition, distance was larger with negative than neutral and positive connotations (all $ps < .001$) and smaller with positive than neutral connotations (at least $p < .01$). However, the effect on distance of the morality – immorality attributed to the character was also modulated by the possibility of moving: distance was larger than all other conditions when interactants were described negatively and participants could not walk toward them (all $ps < .001$); distance was smaller than all other conditions when interactants were described positively and participants could walk toward them (at least $p < .01$).

3.2. Effects of gender

A main effect of Participants' Gender appeared, $F(1,35) = 7.67$, $p = .009$, $\eta^2_p = .18$, due to female participants ($M = 55.72$, $SE = 3.91$)

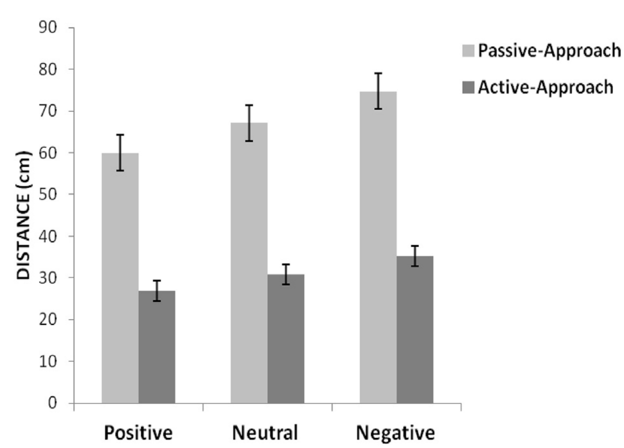

Fig. 3. Mean (cm) passive and active approach modalities as a function of positive, negative and neutral descriptions. Error bars represent the standard error.

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keeping a larger distance from interactants than male participants (M = 39.25, SE = 4.48). A main effect of Virtual Humans' Gender also emerged, $F(1,35) = 67.97$, $p < .001$, $\eta^2_p = .66$, with distance being larger with male (M = 52.08, SE = 3.14) than female (M = 42.89, SE = 2.90) virtual adults. These main effects were qualified by significant interactions. For instance, Participants' Gender interacted with Distance: $F(1,35) = 12.24$, $p = .002$, $\eta^2_p = .26$, due to the Comfort-Distance of female participants being larger than all other conditions (all $ps < .001$). Moreover, Participants' Gender interacted with Approach: $F(1,35) = 6.33$, $p = .016$, $\eta^2_p = .15$. Within each gender group, participants kept a larger distance in the passive than active condition (all $ps < .001$). However, female participants in the passive condition kept a larger distance than all other conditions (all $ps < .001$), whereas there was no difference between men and women when they could actively move ($p = .226$). Finally, an Approach x Virtual Humans' Gender interaction appeared, $F(1,35) = 18.39$, $p < .001$, $\eta^2_p = .34$. When participants were still and dealt with virtual males, distance was larger than all other conditions (all $ps < .001$); instead when participants could move and dealt with virtual females, distance was reduced (all $ps < .001$).

4. Discussion

Moral judgments are fundamental to forming impressions about others and to regulate, accordingly, our behavior in different social contexts. Extending in a substantial way previous evidence based on subjective self-reports, in the present paper we show that moral judgments are embodied in the spatial behavior. To our knowledge, this is the first study in which paradigms and models of social and neuro-cognitive literature are integrated to investigate whether the regulation of spatial proximity is affected by moral information about people. The results revealed that it is: distance expanded when people were described as immoral, while it contracted when people were described as moral. Importantly, both the positive and negative moral descriptions determined a difference with the neutral condition, in which no moral information regarding the virtual confederates was provided. These findings emerged through a well-known and widely adopted manipulation of the (positive vs. negative) morality of the target taken from the social psychological literature (for a review, see Brambilla & Leach, 2014). They confirm the robustness of such a procedure even with different measures such as those related to reachability and comfort distances.

Furthermore, in line with well-established literature, gender-related effects appeared (Aiello, 1987; Argyle & Dean, 1965; Hayduk, 1983; Iachini et al., 2014a). Female participants, especially when still and delimiting comfort-distance, kept a larger distance than male participants. Moreover, participants (particularly when passive) maintained a larger distance from virtual males than females. In line with a previous study that used the same experimental paradigm (Iachini et al., 2014a), the distance was overall larger in passive than active approach. The passive-active difference suggests that the possibility of controlling the motor approach has a critical role in self-other space regulation since the size of space contracts when people perceive that they have the control of interaction rather than not.

The main aim of the current research was to understand how much perceived morality influenced peripersonal-action and interpersonal-social spaces. The effect of perceived morality was particularly neat on interpersonal space: comfort-distance was particularly large when a person was described negatively rather than positively and neutrally, whereas it was smaller when a person was described positively rather than neutrally. The same trend characterized reachability-distance, but only the moral – immoral comparison was significant. This leads to the conclusion that both spaces are endowed, although at different degrees, with finely tuned mechanisms for processing social information (Iachini et al., 2014a). This point bears on the recent debate on the relationship between sensorimotor peripersonal space and social interpersonal space. One of the hot issues of the debate is whether these spaces share a common mechanism or are the expression of different mechanisms (see for example Coello & Iachini, in press). We propose that a common mechanism that regulates the space around the body is represented by approach-avoidance actions that are driven by the social-emotional valence and the action valence of external stimuli (Iachini et al., 2014a; Iachini, Ruggiero, Ruotolo, Schiano di Cola, & Senese, 2015). However, more systematic studies are needed to understand this point.

The effect of perceived morality on distance was modulated by action possibility, as predicted by the functionalist interpretation of moral judgments in social perception (Fiske et al., 2007). Distance was particularly large when people could not move and the virtual confederate was described as immoral, whereas distance was particularly small when people walked toward positively described interactants. In the former case, people had not the whole control of the approach and could only stop the immoral partner: according to the functionalist perspective, this could be considered as the most threatening and thus socially avoidant condition (see also Brambilla et al., 2013). The expansion of distance, thus, may reflect an increased need of controlling the interaction and maintaining a feeling of safety, and this need is particularly cogent when the intruder who invades our space is evaluated as harmful (Argyle & Dean, 1965; Coello et al., 2012; Graziano & Cooke, 2006; Kennedy et al., 2009; Iachini et al., 2014a; Lourenco et al., 2011). Instead, when others are evaluated as beneficial we do not need defending our space and thus we get closer to them in order to facilitate the social interaction (Cole, Balcetis, & Dunning, 2013).

The present findings represent the first empirical evidence of the link between spatial behavior and perceived morality, by showing that the way in which people use the portion of space surrounding their body is determined by how others are defined in terms of morality. We demonstrated that it is possible to modulate the boundaries around the body through top-down moral belief manipulation. How can we explain this effect? The functionalist model suggests that perceived morality is translated in terms of behavioral intentions that can be harmful or helpful for the self (Fiske et al., 2007). The space near the body can be seen as our area of defense and opportunity, where we avoid negative stimuli and approach positive stimuli (Coello et al., 2012; Iachini et al., 2014a). Many social phenomena imply that perceptual and motor processes cooperate in recognizing the negative/positive value of the social context for anticipating appropriate reactions (Cléry et al., 2015; Iachini et al., 2014a). This is consistent with an embodied view of social cognition that considers perception and action processes as the basis not only of high level cognitive processing but also of social cognitive processes such as person perception and social judgment (e.g., Ackerman et al., 2006; Ferguson & Bargh, 2004; Keysers & Perett, 2004; for a review Kaschak & Maner, 2009). In this line, the body acting in space could be conceived as a source of motor potentiality that allows for predictive processes of one's own and others' social behavior (Delevoye-Turrell et al., 2010). Moreover, this body in space gives concrete expression to the emotions and believes shared during social interactions (Gallese & Cuccio, 2015). Therefore, we propose that perceived morality is implied in the active regulation of body distance because it is an important constituent of these anticipatory mechanisms.

In conclusion, the findings highlight a close relationship between basic visuomotor-spatial processing and complex social processing. Everyday language also suggests a link between morality, space and motor action. Let's remember the classic parental advices: "Do not get in touch with nasty people", "Keep farther from bad guys". These social expressions are rooted in the physical experience of the body acting in space and suggest a deep sensorimotor signature of complex social processes. From this "embodied" perspective, social information processing is grounded in bodily states and in the simulation of information in the brain's modality-specific systems for perception, action, and

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introspection (Kaschak & Maner, 2009; Niedenthal, Barsalou, Winkielman, Krauth-Gruber, & Ric, 2005).

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