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Doing the opposite to what another person is doing

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ABSTRACT

The three studies presented here aim to contribute to a better understanding of the role of the coordinate system of a person's body and of the environment in spatial organization underlying the recognition and production of gestures. The paper introduces a new approach by investigating what people consider to be *opposite* gestures in addition to *identical* gestures.
It also suggests a new point of view setting the issue in the framework of egocentric versus allocentric spatial encoding as compared to the anatomical versus non-anatomical matching which is usually adopted in the literature.
The results showed that the role of the allocentric system as a key player was much more evident when participants were asked to "do the opposite" as compared to when they imitated which indicates that the two tasks really are different from each other. Response times were also quicker when people "did the opposite" indicating that this is an immediate response and not the result of "reversing an imitation". These findings suggest that the issue of how the oppositional structure of space impacts on human perception and the performance of gestures has probably been underestimated in an area of research which traditionally focuses exclusively on imitation.

1. Introduction

Being quick to do the opposite of what another person is doing can be crucial when avoiding, for instance, a head-on collision. It is also essential in many situations involving collaborative behavior when two people are face to face, for instance while carrying something, doing surgery or dancing cheek to cheek. And it frequently happens that when two people move toward the same part of the environment one has to move to their left while the other has to move to their right.

Every time two people face each other and "do the same thing", they are at the same time "doing the opposite". When they perform the same action with respect to the environment – i.e. the so-called allocentric frame of reference (for example they both move toward the door/north) – they are doing the opposite with respect to their bodily coordinates — i.e. the so-called egocentric frame of reference (e.g. one individual moves to their left, the other to their right). Vice versa, when they do the same thing with respect to the egocentric frame of reference they are doing the opposite with respect to the allocentric frame of reference (e.g. when both extend their right hand toward their front-left, for instance to shake hands, they are doing the same but at the same time they are extending their arms toward opposite parts of the environment — i.e. if one is moving north-west, the other is moving south-east).

Over the last 20 years, there has been a vast amount of literature on imitation (e.g.: Bekkering, Wohlschlager, & Gattis, 2000; Chaminade, Meltzoff, & Decety, 2005; Genschow et al., 2013; Heyes, 2001, 2011; Heyes & Ray, 2000, 2004; Meltzoff, 2002; Mengotti, Corradi Dell'Acqua, & Rumiati, 2012; Prinz, 2002; Watanabe, Higuchi, & Kikuchi, 2013). In contrast, despite the pervasiveness of oppositional gestures in daily life, there are currently no studies either on whether people perceive that while imitating a gesture they are at the same time doing the opposite or on how this acknowledgment interferes with their perception of doing the same thing (for instance, by slowing down their response time or creating uncertainty). Neither has it been analyzed whether people produce consistent responses when asked to perform opposite gestures or whether this is an indirect task (i.e. people start by figuring out what doing the same would mean and then reverse it) or a direct task which is performed as fast as an imitation task and is not merely a reversal.

This article aims to provide empirical responses to these questions by shifting the focus from studying imitation to studying opposition. In doing this we will suggest a connected theoretical shift: from analyzing

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responses in terms of anatomic versus specular response to analyzing them in terms of allocentric versus egocentric spatial frames of reference. This latter is closer to people's perception of the relations of identity or opposition between body gestures (Bianchi & Savardi, 2008a, 2008b; Savardi & Bianchi, 2009).

1.1. Body and environment: two anchors for oppositional behaviors

Oppositional behaviors can be anchored to body coordinates or to environmental coordinates. The sagittal, coronal and gravitational body axes (Howard & Templeton, 1966) are based on three elementary oppositions defined by the structure of the human body: in front of–behind (sagittal axis), left–right (coronal axis) and above–below (gravitational axis). These are basic opposite directions for movements (e.g. walking forward is opposite to walking backward; turning right is opposite to turning left; ascending is opposite to descending) that also define opposite directions for gestures (e.g. pointing in front of you vs. pointing behind you; pointing to the right vs. pointing to the left; pointing up vs. pointing down).

Not only the structure of the human body but also the perceptual structure of the environment is oppositional (Bianchi, Burro, Torquati, & Savardi, 2013; Bianchi, Savardi, & Kubovy, 2011; Casasola, 2008; Casasola, Cohen, & Chiarello, 2003; Savardi & Bianchi, 2009). Therefore there are at least two different systems which might work as frames of reference to define what "doing the opposite" means: one grounded in human body coordinates (here called the egocentric frame of reference, EGO), the other grounded in the environmental spatial structure (here called the allocentric frame of reference, ALLO).

Many studies have shown that egocentric and allocentric frames of reference are two non-redundant spatial systems that play a role in human perception of space and navigation in space (e.g. Byrne & Becker, 2008; Holmes & Sholl, 2005; Klatzky, 1998; Mou, Fan, McNamara, & Owen, 2008; Mou, McNamara, Rump, & Xiao, 2006; Mou, McNamara, Valiquette, & Rump, 2004; Sholl, 2001; Sorrento & Henriques, 2008; Waller & Greenauer, 2007; Wang & Spelke, 2000). Despite the fact that analyses of imitation have not usually been contextualized within this framework, there is a priori no reason to assume that only one of the two is relevant when describing the spatial relation perceived between two gestures.

In avoidance behaviors between two individuals positioned face to face (e.g. when avoiding a person walking along a street toward you or when sidestepping an opponent in a game of football or basketball), doing the opposite to what the other is doing consists of each person moving quickly away from each other toward two opposite sides of the environment. In these cases it is of secondary importance whether the two people are both moving toward their right (or left) in terms of body-centered coordinates.

Environmental coordinates are also likely to be essential in various other social situations that require quick responses. Think for instance of what happens during a dance or gym class. Instructors implicitly know that by turning their back to their class they make the task of imitation very easy: it is immediately clear which arm or leg the pupils are supposed to move and what direction they are supposed to move in. The only difficulty may be that they can't see the movements made by the instructor well since they are occluded by his/her body. When instructors face their pupils they know that in order to make the imitation quick and easy they have to perform all movements and gestures in an egocentrically opposite way. For example, in order to make them lift their right arms or walk to their right, the instructor has to lift his/her left arm or walk to his/her left. In this case, making a gesture/movement that is quickly perceived by the pupils and the instructor as "the same" (allocentrically the same) implies making egocentrically opposite gestures.

Let us take another example. Imagine that someone walks toward us in the street and asks us directions for a certain road. If we know that this road is right behind us, to the right, we will probably indicate where the road is by stretching out our right arm and pointing behind us. We would then probably see the other person spontaneously looking at and pointing forward in the same direction using their left arm. The person is "doing the same" in terms of environmental coordinates but at the same time is making a contrary gesture in terms of the egocentric body schema. As in the case of the dance class, these are contrary gestures in terms of individual body schemas; there is however also the clear perception that these two people are doing the same thing — and in fact these are all gestures produced with the purpose of *imitating* another person.

These are only few examples of a long list of everyday actions that stimulate us to ask whether the people involved in these situations perceive that they are "doing the same" or "doing the opposite", both while they perform a gesture themselves and while they observe another person performing the same gesture. When does the allocentric component prevail against the egocentric component and vice versa?

1.2. What we know from previous studies on imitational and oppositional patterns

Asking someone to "do the opposite" may seem to be ambiguous, contrasting the (apparent) lack of ambiguity in a request to "do the same". However, as briefly revised here below, previous studies have demonstrated firstly that even imitation is not strictly univocal since it is associated with two different response patterns that not only appear at different developmental phases in childhood but also persist in adult performance (e.g. Avikainen, Wohlschläger, Liuhanen, Hanninen, & Hari, 2003; Chiavarino, Apperly, & Humphreys, 2007; Ishikura & Inomata, 1995; Press, Ray, & Heyes, 2009). Secondly, when asked to "do the opposite", participants behave consistently and the task is not as ambiguous as one might expect (Bianchi & Savardi, 2008a).

1.2.1. Two types of imitation

Developmental studies (Bekkering et al., 2000; Berges & Lezine, 1963; Gleissner, Meltzoff, & Bekkering, 2000; Schofield, 1976) have shown that non-anatomical imitation (also called 'specular imitation' and that is, as we will suggest, a specific case of allocentric imitation) comes more naturally than anatomic (egocentric) imitation until 10 years of age. Anatomic imitation of arm movements represents only 10% of the total of responses at 8 years, but this increases to 50% at 13 years and to 80–85% at 18 years (Wapner & Cirillo, 1968).

Adults instructed to copy a model's lateralized gestures (see Press et al., 2009) generally used the same side of the body as the model (i.e. anatomical matching). However, only in the case when the model was viewed from behind (0°) was anatomical imitation more accurate than specular imitation. Inversely when adults were rotated 180° and 240° with respect to the model, specular imitation was more accurate while no significant differences between the two types of imitation were found at 60°, 120°, and 300°. When positioned at 180° with respect to the model, adults were quicker to non-anatomically rather than anatomically imitate a sequence of ballet poses (Ishikura & Inomata, 1995). In the same position (180°) participants made more errors when instructed to copy anatomically matching hand and arm actions than when instructed to copy non-anatomically matching limbs (Avikainen et al., 2003; Franz, Ford, & Werner, 2007). Taken as a whole, these results suggest a) that anatomical matching is not the only imitational response for adults and b) that at 180°, adults may choose to imitate anatomically even though this is in a sense the most difficult response (Press et al., 2009); they are more accurate and faster when using what in this literature is called specular (or non-anatomical) imitation.

These differences in behavioral performance between anatomical and specular imitation in children and adults have stimulated exploration into whether differences in the activity of the regions of the brain related to imitation are associated with these two types of imitation. Evidence of the critical role of the frontal operculum and posterior parietal cortex in imitation and action observation has been provided by various data (Binkofski et al., 2000; Buccino et al., 2001; Decety, Chaminade, Grezes, & Meltzoff, 2002; Grafton, Arbib, Fadiga, & Rizzolatti, 1996; Grezes,