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Mirror neurons and Intentional Attunement: A commentary on David Olds.

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Introduction

"A path leads from identification by way of imitation to empathy, that is to the comprehension of the mechanism by which we are enabled to take up any attitude at all towards another mental life".

(S. Freud, 1921, p. 110)

Psychoanalysis has always identified the body as the source of the energies alimenting psychic representations. Interestingly, some recent developments in cognitive neuroscience have emphasized the role of the acting body and of sensory-motor systems in constituting the way our mind represent reality, by shaping our cognitive schemas (see Gallese and Umiltà 2002; Gallese et al 2004; Gallese 2005a, b).

In his very timely and stimulating paper David Olds discusses the relevance of some recent neuroscientific discoveries for a rethinking of psychoanalytic theory and clinical practice. In particular, he emphasizes the possible role played by mirror neurons in building identity relations, implying that they could provide a sub-personal explanatory framework for intersubjectivity. I think Olds' hypothesis is very important because it suggests a specific topic for a fruitful multidisciplinary exchange between psychoanalytic theory and clinical practice and cognitive neuroscience.

Capitalizing upon Olds's suggestions, in my commentary I will first focus on some properties of the mirror neuron system in monkeys and humans and provide a neuroscientific perspective on an enlarged account of empathy, the shared manifold of intersubjectivity. I will show that the same neural circuits involved in action control and in the first person experience of emotions and sensations are also active when witnessing the same actions, emotions and sensations of others, respectively. I will posit that the mirror neuron systems, together with other mirroring neural clusters outside the motor domain, constitute the neural underpinnings of embodied simulation, the functional mechanism at the basis of "intentional attunement",

our capacity to pre-reflexively identify with the others. The implications of this perspective on the dialogue between neuroscience and psychoanalysis will be discussed.

The mirror neuron system for actions in monkeys and humans: empirical evidence

About ten years ago we discovered in the macaque monkey brain a class of premotor neurons that discharge not only when the monkey executes goal-related hand actions like grasping objects, but also when observing other individuals (monkeys or humans) executing similar actions. We called them "mirror neurons" (Gallese et al. 1996; Rizzolatti et al. 1996). Neurons with similar properties were later discovered in a sector of the posterior parietal cortex reciprocally connected with area F5 (PF mirror neurons, see Rizzolatti et al. 2001; Gallese et al. 2002).

Action observation causes in the observer the automatic activation of the same neural mechanism triggered by action execution. We proposed that this mechanism could be at the basis of a direct form of action understanding (Gallese et al. 1996; Rizzolatti et al. 1996; see also Gallese 2001, 2003a, b, 2005 a,b; Gallese et al. 2004; Rizzolatti et al. 2001; Rizzolatti and Craighero 2004).

Several studies using different experimental methodologies and techniques have demonstrated also in the human brain the existence of a mirror neuron system matching action perception and execution. During action observation there is a strong activation of premotor and parietal areas, the likely human homologue of the monkey areas in which mirror neurons were originally described (for a review, see Rizzolatti et al. 2001; Gallese 2003a; Rizzolatti and Craighero 2004; Gallese et al. 2004). Furthermore, the mirror neuron matching system for actions in humans is somatotopically organized, with distinct cortical regions within the premotor and posterior parietal cortices being activated by the observation/execution of mouth, hand, and foot related actions (Buccino et al. 2001).

More recently, it has been shown that the mirror neuron system is directly involved in the perception of communicative actions (Buccino et al. 2004a), in processing action-related sentences (Tettamanti et al. 2005), in imitation (Iacoboni et al 1999; Buccino et al. 2004b), and in basic forms of mind reading (Iacoboni et al. 2005).

Action observation as action simulation

The mirror neuron system for action is activated both by transitive, object-related actions, and also by intransitive, communicative actions. When a given action is planned, its expected motor consequences are forecast. This means that when we are going to execute a given action we can also predict its consequences. The action model enables this prediction. Given the shared neural mapping between what is acted and what is perceived – constituted by mirror neurons – the action model can also be used to predict the consequences of actions performed by others. Both predictions (of our actions and of others' actions) are instantiations of embodied simulation, that is, modeling processes.

The same functional logic that presides over self-modeling is employed also to model the behavior of others: to perceive an action is equivalent to internally simulating it. This enables the observer to use her/his own resources to experientially penetrate the world of the other by means of a direct and automatic process of simulation.

Embodied simulation automatically establishes a direct experiential link between agent and observer, in that both are mapped in a neutral fashion. The stimuli whose perception activates mirror neurons, all consist of the specific interaction between an agent and a target. It is the agentive relational specification to trigger the mirror neurons' response. The mere observation of an object not acted upon indeed does not evoke any response. Furthermore, the agent-target interaction must be successful. Mirror neurons respond if and only if an agentive relation is practically instantiated by an acting agent,

regardless of its being the observer or the observed. The agent parameter must be filled. Which kind of agent is underspecified, but not *unspecified*. Indeed, not all kinds of agents will do. The abovementioned recent brain imaging experiment on communicative actions shows that only stimuli consistent with or closely related to the observer's behavioral repertoire are effective in activating the mirror neuron system for actions (Buccino et al. 2004a).

To summarize, action observation constitutes a form of embodied simulation of action. I submit that this simulation process also constitutes a basic level of experiential understanding, a level that does not entail the explicit use of any theory or declarative representation.

Mirroring emotions and sensations

Emotions constitute one of the earliest ways available to the individual to acquire knowledge about its situation, thus enabling to reorganize this knowledge on the basis of the outcome of the relations entertained with others. The coordinated activity of sensory-motor and affective neural systems results in the simplification and automatization of the behavioral responses that living organisms are supposed to produce in order to survive. The integrity of the sensory-motor system indeed appears to be critical for the recognition of emotions displayed by others (see Adolphs 2003; Adolphs et al. 2000), because the sensory-motor system appears to support the reconstruction of what it would feel like to be in a particular emotion, by means of simulation of the related body state.

We recently published an fMRI study showing that experiencing disgust and witnessing the same emotion expressed by the facial mimicry of someone else, both activate the same neural structure – the anterior insula – at the same overlapping location (Wicker et al. 2003). This suggests, at least for the emotion of disgust, that the first- and third-person experiences of a given emotion are underpinned by the activity of a shared

neural substrate. When I see the facial expression of someone else, and this perception leads me to experience *that* expression as a particular affective state, I do not accomplish this type of understanding through an argument by analogy. The other's emotion is constituted, experienced and therefore directly understood by means of an embodied simulation producing a shared body state. It is the activation of a neural mechanism shared by the observer and the observed to enable direct experiential understanding. A similar simulation-based mechanism has been proposed by Goldman and Sripada (2005) as "unmediated resonance".

Let us focus now on somatic sensations as the target of our social perception. As repeatedly emphasized by phenomenology, touch has a privileged status in making possible the social attribution of lived personhood to others. "Let's be in touch" is a common clause in everyday language, which metaphorically describes the wish of being related, being in contact with someone else. Such examples show how the tactile dimension be intimately related to the interpersonal dimension.

We have shown that the first-person experience of being touched on one's body activates the same neural networks activated by observing the body of someone else being touched (Keysers et al. 2004). Within SII-PV, a multimodal cortical region buried within the parietal operculum and partly overlapping with the second somatosensory area, there is a localized neural network similarly activated by the self-experienced sensation of being touched, and the perception of an external tactile relation. This double pattern of activation of the same brain region suggests that our capacity to experience and directly understand the tactile experience of others could be mediated by embodied simulation, that is, by the externally triggered activation of *some* of the same neural networks presiding over our own tactile sensations. A similar mechanism likely underpins our experience of the painful sensations of others (see Hutchison et al. 1999; Singer et al. 2004).

In the next section, capitalizing upon the reviewed evidence, I would like to develop a point only peripherally touched by Olds: the hypothetical link between the mirror neuron system and the autistic syndrome.

Autism as a disturbance of intentional attunement

The autistic syndrome is a severe and chronic developmental disorder, characterized by social and communicative deficits and by a reduced interest for the environment, towards which restricted and often stereotyped initiatives are taken (Dawson et al., 2002). To be an autistic child means, with variable degrees of severity, to be incapable to establish meaningful social communications and bonds, to establish visual contact with the world of others, to share attention with the others, to be incapable to imitate others' behavior or to understand others' intentions, emotions, and sensations.

Let us focus on some of the early onset symptoms. Towards the end of the first year of life, autistic children experience difficulties or even the impossibility to orient on the basis of cues provided by others. They are incapable to share attention with the others, incapable to react in a congruent fashion to others' emotions. They are also highly impaired in recognizing human faces or in displaying imitative behaviors. All of these early manifestations of autism share a common root: the cognitive skills required to establish meaningful bonds with others are missing or seriously impaired.

My hypothesis is that these deficits are to be ascribed to a deficit or malfunctioning of "intentional attunement". If it is true that at the basis of our social competence is *in primis* the capacity to co-conctruct a directly shared we-centric intersubjective space, a "shared manifold of intersubjectivity" (Gallese 2001, 2003a, 2005a, b) enabling us to establish a link with the multiple intentional relations instantiated by others, then it follows that a disruption of this shared manifold should be one core problem of the autistic mind. The incapacity to develop a full and comprehensive intentional attunement with the others

implies, as a consequence, the development of an incomplete or malfunctioning shared manifold, that is the impossibility to empathize with others.

The lack of a full-blown or a disrupted intentional attunement will produce various and diversified cognitive and executive deficits, all sharing the same functional origin: a lack or malfunctioning of embodied simulation routines, likely underpinned by impairments in connectivity and/or functioning (either in terms of down- or up-regulation) of the mirror neuron system. A series of experimental data in the literature seems to suggest this to be the case. Autistic children have problems in both symbolic and non-symbolic imitative behaviors, in imitating the use of objects, in imitating facial gestures, and in vocal imitation (see Rogers, 1999). Furthermore, they experience severe problems in the facial expression of emotions and their understanding in others (Snow et al., 1988; Yirmiya et al., 1989; Hobson et al., 1988, 1989), and they score much worse than healthy controls in reproducing the affective qualities of observed actions (Hobson and Lee 1999). According to my hypothesis all these deficits could be instantiation of a defective intentional attunement.

Why this might be relevant for psychoanalysis

During the last two decades, social cognition has become the challenging empirical target of neuroscientific research. This fact not only represents a major turn in the history of the scientific study of brain functions, but it also enables the possibility of establishing a dialogue with a discipline like psychoanalysis. In fact, one of the most relevant developments that have characterized the psychoanalytic movement in the last decades is a renewed interest in interpersonal relations and in the conceptualizations of the relationship between Self and others. Terms such as “relational” or “interpersonal” psychoanalysis, “two-body psychology”, “intersubjectivity”, and so on, have become widespread in psychoanalytic theorizing.

Neuroscience, by investigating neurons, instantiates a *sub-personal* level of description. However, this epistemic strategy provides knowledge that can be used also to better understand the *personal* level of description. Neuroscience and psychoanalysis thus are partly tackling the same issues (see Solms & Turnbull, 2002; Stern 2004; Karlsson, 2004).

The results of neuroscientific investigation, as those reviewed in this commentary broaden the possibility of establishing a dialogue between our disciplines. The development of intersubjectivity, its neural bases, its role in shaping the acquisition of a full-blown self-conscious self, the development of social intelligibility, and its pathological disruptions represent possible targets for a multidisciplinary research agenda.

Sigmund Freud repeatedly emphasized the role of empathy in interpersonal relations (see Pigman 1995). In Inhibitions, Symptoms and Anxiety (1926, p. 104) Freud writes: "…it is only by empathy that we know the existence of psychic life other than our own". Neuroscientific research is unveiling the neural mechanisms at the basis of this fundamental ingredient of intersubjectivity. The mirror neuron systems in our brain mediate between the personal experiential knowledge we hold of our lived body, and the implicit certainties we simultaneously hold about others. Such personal, body-related experiential knowledge enables our intentional attunement with others, which in turn constitutes a shared manifold of intersubjectivity (Gallese 2001, 2003a, 2005a,b). This "we-centric" space allows us to personally characterize and provide experiential understanding to the actions performed by others, and the emotions and sensations they experience.

The shareability of the phenomenal content of the intentional relations of others, by means of their shared neural underpinnings, produces intentional attunement. Intentional attunement, in turn, by collapsing the others' intentions into the observer's ones, produces the peculiar quality of familiarity we entertain with other individuals. This is what "being empathic" is about. By means of a shared neural state realized in two different bodies that nevertheless obey to the same functional rules, the "objectual other" becomes "another self".

A direct form of "experiential understanding" is achieved by modeling the behavior of other individuals as intentional on the basis of the equivalence between what the others do and feel and what we do and feel. This parsimonious modeling mechanism is embodied simulation. The mirror neuron system is likely a neural correlate of this mechanism. This account shades some light on too often sidelined aspects of social cognition. More generally, it emphasizes the role played in social cognition by neural sensory-motor integration.

We do not just “see” an action, an emotion, or a sensation. Side by side with the sensory description of the observed social stimuli, internal representations of the body states associated with these actions, emotions, and sensations are evoked in the observer, ‘as if’ he/she would be doing a similar action or experiencing a similar emotion or sensation. This proposal opens new interesting perspectives for the study of the neural underpinnings of psychopathological states (see Gallese 2003b) and psychotherapeutic relations.

The present commentary focused on the experiential aspects of intersubjectivity. The same perspective, however, can also be used to characterize language, the cognitive tool employed to organize, elaborate, and self-consciously structure our own social experiences. In fact, conceptual content is also embodied, that is, it is mapped within our sensory-motor system (Gallese 2003c). The same systems running our body in the world not only provide structure to conceptual content, but also contribute to the characterization of the semantic content of concepts in terms of the way we function with our bodies in the world. By means of metaphorical mappings, sensory-motor circuits in the brain may also be involved in characterizing the so-called “abstract” concepts that constitute the meanings of grammatical constructions and general inference patterns (see Lakoff & Johnson 1980, 1999; Gallese & Lakoff, 2005).

This proposal can be framed within the larger picture of an interactionist theory of meaning: the body is the main source of semantic content. This entails that the body not

only structures the experiential aspects of intersubjectivity, but also their linguistic representations. Its implications for psychoanalysis, and more generally for psychotherapy can be important. The aim of the present commentary is indeed to stimulate a potentially fruitful dialogue on these issues between our disciplines.

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