Original article

Mirroring and simulated intentionality

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SUMMARY: *Twenty years after their discovery, in spite of empirical evidence that points strongly towards the existence of mirror neurons in humans, not to mention the far-reaching implications of mirroring mechanisms in various branches of learning, the role of mirror systems in human cognition remains hotly disputed, particularly in Italy. Internationally, the discovery of mirror neurons appears to represent one of the greatest achievements in neuroscience, as it would overturn not only current knowledge on the structuring of cognitive working, but also epistemology itself in different branches of learning. Why is it so difficult for neuroscientists and psychologists to recognize the role of mirror mechanisms at a gnosiological level? Why are their implications so "difficult to digest" for some, and utterly convincing for others? Why is it so difficult to accept the existence of this basic mechanism, which is both elegantly simple and highly sophisticated? Is it because this would completely revolutionize our comprehension of the behaviour and intentions of other people without involving high-level actions of a symbolic-computational nature? In the attempt to provide answers to these questions, I will now present what neuroscientists have to say on the matter, and raise some merely speculative hypotheses in order to add grist to the mill. At the same time, I will try to develop the idea according to which "conceptual intentions" (theories) assigned to the others - i.e., neuroscientist proponents of mirrors - are to be assigned to "the intentions of those who watch" rather than the intentions of those who are watched. The results of research on the mirror neuron system tell us that it is through this particular class of neurons that we (as observers) grasp the intentions of others. While this seems to be a fact that contradicts the idea proposed, in this paper I will argue that this contradiction is only apparent, because the conceptual intentions attributed to others are formed on the basis of perceptual-motor patterns internalized by an observer (Buccino, Binkofski et al., 2004; Calvo-Merino et al., 2005; Rizzolatti and Sinigaglia, 2006) and therefore represent an interesting example of mirroring.*

KEY WORDS: *Mirror neuron, Neuro-conceptual configurations, Simulated intentionality.*

WHY IS IT SO DIFFICULT TO ACCEPT THE EXISTENCE OF A SENSORIMOTOR MECHANISM AT THE BASIS OF UNDERSTANDING?

Over the last fifteen years, the debate about the issue of a body-mind relationship has been raging anew. Though some last bastions of the Cartesian separation between mind and brain still survive, it is now widely accepted, not only by the scientific community, that thought has a biophysical rather than a 'mystical' basis. Although it is not yet entirely clear how thought can be generated through chemical-electrical processes, some of these mechanisms are now being unravelled, thanks to modern research techniques. Today, these techniques are allowing us glimpses into a world that was once unimaginable but is now not quite so mysterious.

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A major advance in this direction was made when the action of mirror neurons were recorded by a team of neurophysiologists in Parma led by G. Rizzolatti. The publication of their article set off an avalanche of related research and publications on an international scale. Despite this interest, in Italy a substantial number of researchers considered it "worthless nonsense". According to Haldane (1991)[25], this opinion is only to be expected, as it represents the first phase in the eventual acceptance of a revolutionary theory. This outright rejection is generally followed by the second and third stages of acceptance, from "It is an interesting but erroneous point of view," to "It is true but totally irrelevant," and, finally, the fourth stage of complete agreement: "I have said that all along!"

More and more frequently the prefix "neuro" appears in the titles of scientific (and other) publications, to convey their association with different branches of learning, e.g., neuroaesthetics, neuroethics, neuroeconomics, neurophenomenology, neuropedagogy, neuroteaching, etc. The fact that these fields are strongly connected with the implications of mirror working is clear, but as yet there is no consensus: some researchers stress the specificity and effects generated by mirrors, while others entirely reject their existence in man.

One of the most fascinating things to arise from this debate is that it is easier for many to accept the presence of this system in nonhuman primates than it is in human beings. Justifications for this standpoint include doubts regarding the instrumentation used and the difficulty in interpreting the results. As far as the instruments are concerned, the dispute centres around the kind of knowledge obtained through brain imaging techniques, and in particular functional magnetic resonance imaging, as this only allows indirect elucidation of what happens in a specific cerebral area[28]. As regards the interpretation of results, it is difficult to discern the involvement of the same class of neurons or groups of different and overlapping cells in response to motor and perceptive stimulations. In any case, accepting the presence of a motor mechanism at the basis of comprehension in nonhuman primates, but not in humans, means ascribing to the view that evolution, despite providing such an easy and efficient mechanism of understanding the surrounding environment in our ancestors, saw fit to interrupt this mechanism in humans, presumably to make way for something far more complex. From an evolutionary perspective, this theory does not seem very probable[11,37], and it is far more likely that we, as a species, still retain this mechanism.

So, accepting for a moment that mirror neurons do exist in humans, and in many more cerebral areas than previously thought[31], the more cautious may nevertheless question the ease and speed that some conclusions regarding the role of the mirror system in human cognition have been drawn in both the cognitive neurosciences and human sciences. The epistemological and anthropological study and theory of the implications of mirror mechanisms have, however, taken a long time to publish, suggesting that they are the fruit of careful consideration rather than excessive zeal. Indeed, mirror neurons were discovered at the beginning of 1990s, and it was not until 1998 that the first publications with the word "mirror" in the title started to appear[16]. Those by Rizzolatti were not published until 2004[33], and the first comprehensive review of experiments on the new role ascribed to the sensorimotor system is dated 2006[34].

So, why is there so much resistance to mirroring in humans? Is it because this particular class of neurons provides a simple explanation of some aspects of our mind that have been previously been considered too complex to explain in physical terms? Does the fact that neurophysiologists and neurobiologists are now encroaching on the territory once considered the preserve of psychologists (like Mind Reading, ego, memory, language, etc.) or philosophers (conscience, free will, etc.) create a barrier? Is it the idea that the mind, being capable of extraordinary creations, cannot share anything with something so humble as the sensorimotor system? Perhaps we are so used to making things difficult that we find it hard to believe that there is a neural mechanism so powerful to start, but not complete, the conditions granting us the skills to think, understand, learn, remember and relate to others. But the brain has taken thousands of years to 'learn' to work the way it does today! Evolution does not use theories to select the most effective mechanisms to produce adaptive answers, but instead tries and tests actions and tools to determine the most useful and economical means of survival.

According to proponents of mirroring, it is likely that evolution led to the development of a mechanism to allow primates (among other creatures) to perform the vital function of instrument/action relationship mapping. Indeed, mirror neurons are said to map the relationship that links an object or a tool with what we can do with it, its purpose[18]. In fact, research shows us that this special class of neurons does not activate itself in relation to the kind of object or its physical characteristics (an apple or a cup), but in relation to the

purpose of the action: eating an apple or putting it back in a box activates different mirror neurons because the purposes of the actions are different[10]. This mechanism enables the observer to immediately understand, at the neural level, the aim or intention of an action performed by somebody else as it is observed, because the mirror activated has in itself the object-purpose relationship that is being observed. Thanks to this anticipation, induced by the behaviour we have observed and the context of the action, things have an immediate, pre-reflexive and pre-linguistic meaning[27].
One of the most challenging aspects of this research is that comprehension of the action, i.e., understanding the intention of the action to which it is connected, is indissolubly linked with the contents of our sensorimotor system[34]. Indeed, research has demonstrated that the sight of acts performed by others will elicit different cerebral activity in the observer, depending on their prior motor knowledge[5]. For a subject who is learning, this could mean that the possibility of understanding a new concept will depend on the degree of sharing between the motor repertoire of the observer and that of the doer, or teacher.
Perhaps the reasons for the difficulty in understand a concept, a behaviour, or a theory when involving as yet unavailable neural pathways are starting to become clear. The absence of a suitable schematic for the comprehension of a stimulation-situation could be related to:

a) the lack of experience suited to the situation;
b) a different mapping of the experience in question;
c) the difficulty in finding a "structure" able to represent metaphorically the stimulation-situation to make it understandable.

Is one or more of these basic conditions at the heart of the difficulty in accept a theory that requires "neuro-conceptual configurations" too different from pre-existing configurations as valid or meaningful? I will discuss this in further detail later on (paragraph "Who does perceived intentionality belong to?"), but meanwhile, let us examine the main barriers to the full acceptance of the neuroscientific perspective in general, and the theory on the working of mirrors in particular.

☐ CRITIQUES OF THE NEUROSCIENTIFIC PERSPECTIVE

Neuroscientific explanations of mental processes are often thought of as:

a) "reductive", because they tend to reduce what is mental into physical terms;
b) "over-ambitious", because they claim to have discovered the unifying theory of social cognition;
c) "faddy" and "modish", thanks to the seductive power of the words, techniques, and images used to describe them; and, last but not least,
d) "self-referential", that is to say, they tend to ignore the body of knowledge acquired by human sciences over the last years.

Let us look at these criticisms one by one.

❒ The reductionism critique

Those who say cognitive neuroscientists are reductive believe they have the intention or conviction of explaining even mysterious and unexplainable phenomena like conscience, capacity of choice, motivation, and memory in corporeal terms. However, neuroscientists claim that believing that what is mental is the result of processes that happen in a physical system is not the same thing as believing that mental activity is solely the activity of the nervous system[38]. As Gallese[11] explains, claiming that mirror neurons enable basic aspects of intersubjectivity to be understood from both phylogenetic and ontogenetic perspectives does not mean that mirror neurons are thought to explain everything about social cognition since: "to make us what we are is not only the possession of a shared nervous mechanism, but also an historic path made of subjective experience which is unique and particular" (page 321). Boncinelli[2] also emphasizes that in humans genetic heritage, the absolute lord of life and behaviour in lower animals, has to all intents and purposes abdicated, leaving plenty of space for the action of the environment, learning and education. Considering the positive consequences of brain-based epistemology, as Edelman[8] states, is not the same thing as desiring a scientific explanation to reduce our "second nature", or its ethics and aesthetics. Iacoboni[25] also warns that it is too early to extend the discovery of mirrors to fields such as neuroethics and neuropolitics; in particular, it will be necessary to avoid the enthusiasm of neuroscientists ending up in neurobiological simplification, that is to say a new version of sociobiology. These are just a few of the many answers given by cognitive neuroscientists to the issue of the mind/body relationship, and since they are the first to distance them-

selves from this risk, it is not clear why they are still considered reductive.
Reductive could, however, be used to describe those who do not take into account new discoveries made in neurosciences, "reducing" its complexity to that which is already known. To whom can the reductive attitude, or any other attribution, be assigned? What is the "sharing space" between those who attribute something to somebody and the recipient of what has been attributed? Who has the reductive attitude or any other attribution? What direction does the action of attributing something to somebody take? From the outside in, or from the inside out? Or, could there be a "shared space", termed the share manifold by Gallese[14], referring to the state in which mutual intelligibility can occur?

❐ The universal theory critique

Theories based on empirical evidence produced by cognitive neurosciences have often been associated with the ambitious aim of providing a unifying explanation of human cognition. However, is it really the aim of cognitive neuroscientists to look for an explanation of the explanation, the principle of mechanisms capable of erasing the interpretations provided by all the branches of learning up to now? Does such interpretation mirror a human desire (not only that of cognitive neuroscientists) to look for the final solution to all mysteries, by identifying it according to a situation and phenomenon suited to this purpose? Although mirror neurons do seem to lend themselves to global explanations, neurophysiologists are the first to distance themselves from this temptation.
While it is true that Rizzolatti and Vozza[35] talk about a "unifying vision of the bases of social knowledge" and that Gallese, interviewed by Mozzoni for BrainFactor[30], refers to the presence in the human brain of a mechanism that represents a "unifying explanation that is more economical than a series of different behavioural and clinical data", it is also true that these Authors repeatedly stress the fact that their research is still in its infancy. They state that the huge overhaul that has been brewing since the discovery of mirror systems must be able to integrate with the disciplines that have thus far dealt with processes involved these systems, that is to say cognitive, emotional, social, creative and ethical processes.
To quote Gallese[15]: "Nowadays neurosciences are debated very much. They are often represented in a wrong way, that is as the instruments that will give us the final answers to unsolved matters that have been debated in philosophical terms for millenniums. This kind of attitude is not shared by the majority of my colleagues, but in our country it is the result of a sensationalistic and banal way of representing the results of scientific researches" (page 48). In "Descartes' error", Damasio also stresses that all matters concerning the mind-brain relation can be dealt with on several levels, from molecules to micro- and macro-circuits, to social and cultural spheres, without which an acceptable explanation of mental phenomena such as consciousness, opinions, decision and memory would not be possible[6]. Hence, although neuroscientists seek to distance themselves from all-embracing explanations, it is certain that the mirror mechanism, just for raising so much interest, must posses some unifying features! Indeed, a system that encompasses the memory of our perceptions, actions, cognition, and emotions, and one that gives rise to an extraordinary variety of human behaviours, at this point can be considered a good candidate for providing a common basis for such different phenomena as theatrical performance, perceptive classification, aesthetic judgment, learning, economy, etc.
But, why do we reject or shy away from such a basic mechanism potentially underpinning such a wide variety of different phenomena? What leads us to believe that a potential unifying mechanism is useless or even dangerous? Is it perhaps the desire to protect the borders of our respective disciplines, believing that this is the only way to survive in the competitive world of science? What if specificity and scientific acknowledgement were in fact connected to the contribution given, from a particular point of view, by the common growth of knowledge and research of the structure that links cognitive and biological processes?[1].

❐ The faddiness critique

Even though the popularity of applying the prefix "neuro" to every branch of learning (neuroeconomy, neuroaesthetics, neuroethics, neuropedagogy, neurodidactics, neuropolitics, neurophenomenology, etc.) is evident, it is equally clear that neuroscientists themselves are not to blame for this trend, rather those who exploit the results of the research and erroneously interpret them to suit their particular field.

The problem may lie in the translation process. It is very easy to be struck by sensational statements or original concepts, and to want to use them to further our own ends. Such appealing buzzwords as "mirror neurons" quickly become part of our vocabulary and the focus for a radical rethink, even though they are as yet far from fully understood. As Gallese states (when interviewed by Mozzoni in BrainFactor, 2009)[30] mirror neurons attract the attention of non-specialists because they deal with something we feel close to, even though we do not normally pay attention to it, and they are certainly far easier to understand than logic inferences or complicated symbolic processes. Who knows? Perhaps one day we will discover that mirror mechanisms - similar to those which enable imitation and active not only during socialization and learning - are behind even this, very human, attitude.

❒ The self-referentiality critique

Ascribing to cognitive neuroscientists a self-referential behaviour could represent another way through which mirror mechanisms are displayed at a phenomenological level. In other words, introducing my idea of "simulated intentionality", the perception of someone else's characteristics may mirror the use of a neuroconceptual configuration available to us, allowing us to use this as "pattern" to define the particular state we feel when observing or listening to someone's performance[29]. On the basis of the books we read for our research, I have never found anything resembling the scientific solipsism that is ascribed to some neuroscientists - quite the reverse! The attitude of most cognitive neuroscientists is easily recognisable in the following opinions.

For one, Damasio[6] claims that knowledge acquired at different levels cannot be excluded from the survey because no-one on his own can detect everything that goes into producing the mental phenomena we know today that can be studied thanks to brain imaging techniques. Dehaene[7] states the importance, in psychology and pedagogy, of knowing what neuroimages reveal about neural circuits that process graphemes and phonemes to understanding the complex process of reading. Iacoboni[26] shows that those who work in the neurosciences complement neural data with psychological data with no opposition. Gallese[13] advocates the need for a constant communication between cognitive neurosciences and human sciences to further knowledge of the workings of the mind. Practicing what he preaches, Gallese has worked with the most influential personalities from several diverse branches of learning, namely the linguist Lakoff[17], the science philosopher Sinigaglia[19,20,21,23] and psychologist Morelli[19]. Furthermore, among his interests are the relationships between neural correlates and various artistic forms (theatre, painting, cinema), psychoanalysis, psychopathology and narration. The fact that the first book to be published on mirror neurons was co-written by Rizzolatti and the philosopher Sinigaglia testifies to the need of cognitive neuroscientists to make use of the knowledge acquired by the human sciences over the years.

In summary, it seems that the external perception of self-reference is due more to things we have read than the positions taken by a particular class of scholars. Not being able to read everything in the copious scientific literature, it is clear that we select the Authors and publications of interest to us. Thus, our choice of reading matter, and hence our perspective, is not random, but it is strongly influenced by our epistemological affinities... or is it our motor repertoires?

□ WHO DOES PERCEIVED INTENTIONALITY BELONG TO?

In relation to the behaviours assigned to neuroscientists, and extrapolating from the examples shown, it looks as if when we assign a behaviour, intention or aim to others, these are not always felt as their own by the target subjects. How can this widespread and commonplace event, considered the function of reflecting mirrors, be explained? Interestingly, it may be used by those who argue for mirror function. Let us take embodied simulation, a theory through which Gallese[11] claims that assigning intentions to others comes about through the functional mechanism (embodied simulation) that makes comprehension of the action possible. Of course, Gallese is talking about simple intentions connected with the use of an object or the observation of a motor behaviour. However, through the results of experiments on sentence comprehension, we know that simulated mechanisms behind the comprehension of the actions observed are also responsible for the comprehension of statements referring to the actions in question, regardless of whether these statements are read, heard or simply thought[32,36].

Through research we also know that the degree of

comprehension of other people's behaviours depends on the motor repertoire of the observer, that is to say on chains of logically connected mirror neurons that work during observation, listening, reading, or also "just thinking" or imagining the behaviour in question[4,5]. By generalizing the implications of these results and extrapolating them to more complex intentions, following the principle of "family similarities"[39], one could speculate that assigning intentions to others is the result of the simulated processes themselves, which would activate to perform the behaviour in question, in this case, the neuroscientific theories. If in order to be understood, these theories required the presence of a specific motor-conceptual repertoire not yet available to those "who simulate"[24], the comprehension of the results and the theory itself would be hampered or even blocked. Indeed, sharing a particular motor-conceptual repertoire is necessary to understand other people's intentions and to imitate their actions correctly. If this condition is not fulfilled, according to this hypothesis, the brain/mind uses subsidiary circuits to arrive at comprehension.

It can be postulated that the selection of the kind of subsidiary circuit helping us in absence of appropriate conditions influences the shape of concept-target comprehension and its net of connections with other concepts. So, it is possible to assume that the comprehension of a theory, just as any other action that is removed from our schematics (which we now know have a motor basis) is the result of simulated accessory processes that produce the form of a reality which exists in the mind that perceives it. It must be clarified that according to this perspective, reality is formed in the mind of the observer, who draws on simulative mechanisms even when the conceptual repertoire of the simulator shares many neural maps with the target-repertoire. The difference between the condition in which a suitable sharing space is generated and that in which, in the absence of sharing, subsidiary repertoires come into play is that in the first case, in the presence of a base like that termed by Gallese[12] as "intentional consonance" (that is the comprehension of some nervous mechanisms that lead actions, emotions and sensations) it is more probable that the construction built acquires characteristics which are more suited to attribution of intentionality to the others. In contrast, when pre-existing knowledge is weak, it is possible that the shape produced, since it stands outside the neural sharing space, could hamper mutual intelligibility, losing subsidiary circuits that would assign our mental states (or motor schematics, depending on the level of description) to others.

□ CONCLUSION

The idea that assigning particular inclinations or intentions to somebody else (in this case to the theorists of the cognitive neurosciences) is seemingly the result of the activation of our conceptual repertoires, starting from logically connected neural chains, which act while we listen to or read the conceptual-linguistic repertoire of someone else. In other words, although it may in some ways seem counterintuitive, the intentionality assigned to the others, since it springs from simulative processes, would not necessarily belong to these others, rather it would take the shape of "simulated intentionality", that is mirrored by the observer, according to the meaning that the simulations have for them.

If a large part of the activated repertoire is shared by both the observer and the observed (in this case the researchers who make use of the results of neurosciences and the neuroscientists themselves) mirroring could produce a state of "intentional consonance" that may enable the comprehension of mutual motor representations. However, if certain theorists who assign intentions to other theorists have a very different structure from the latter, the two theories, or their respective perceptual-motor modelling, would not be easily compared if not "incommensurable", or not possessing a common "ground description"[9].

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