

**Editorial****□ Mirror neurons: still an open question?**

This edition of Progress in Neuroscience features contributions from scientists involved in the study of mirror neurons and related issues, including:

- Paolo Bartolomeo Pascolo (University of Udine) discusses mirror neurons from a challenging point of view. He argues that, twenty years after the discovery of a specific population of neurons, the mirror neurons, the debate as to their existence is still in full swing. Thus far there is no incontrovertible proof, and the doubts of sceptics have not yet been laid to rest.
- Alessandra Gilardini (BrainFactor) and Marco Mozzoni (University of Milan-Bicocca; BrainFactor Editor) provide a “reflection on mirrors” with a broad review aimed at giving voice to both proponents and doubters of the mirror neuron system.
- Andrea Lavazza (Centro Universitario Internazionale) and Luca Sammiceli (University of Bologna) discuss mirror neurons and free will, exploring the as yet speculative difference between free will in the “ontological” sense and that deriving from a broader “phenomenological” perspective of the perception of intentionality in human actions.
- Mauro Maldonato (University of Basilicata) and Silvia Dell’Orco discuss mirror neurons and the predictive mind, highlighting that our brain is not only a reactive mechanism, capable of providing a rapid response to the stimuli that arrive from the external environment, but is above all a pro-active mechanism that allows us to formulate hypotheses, anticipate the consequences of actions, and generate expectations.

- Daniela Mario (Ca’ Foscari University), after a short overview of the main critiques that are usually applied to neuroscientific explanations, introduces the idea that the mechanism by which specific intentions are ascribed to somebody else could be one of the ways through which mirroring mechanisms are manifest at a phenomenological level.
- Giancarlo Frigato, an independent researcher, speculates on mirror neurons and the eight parallel consciousnesses, enumerating brain areas whose damage causes the loss of consciousness without preventing unconscious perception, and, by delving into neglect analysis, defines a distinction between areas responsible for “access to consciousness” and areas responsible for “real consciousness”.

Autism, empathy and imitation are buzzwords often heard in this context, but any scientific evidence to date is purely indicative, being limited to qualitative evaluation (EMG, functional MRI, transcranial magnetic stimulation, etc.) rather than direct recording from the neurons themselves. This, understandably, leads scientists of the calibre of Csibra, Dinstein and Hickok, among many others, to cast considerable doubts on the consistency of the paradigm, and Pascolo points out that the only works in a position to back up the mirror system theory are those that have conducted direct measurements on simian neurons. However, he is also quick to mention that these, by now rather dated, studies were plagued by several methodological imprecisions *ab origine*, and therefore taking the conclusions they made as read has considerably muddied the waters.

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Progress in Neurosciences 2013; 1 (1-4): 27-28.

Article received: 20 October 2013.

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ISSN: 2240-5127

doi: 10.14588/PiN.2013.Zanotti.27

Indeed, it is important to remember that the mirror neuron hypothesis was based entirely on the inferred behaviour of certain neurons in the monkey and the (subjective) method of “observing” the behaviour of these monkeys in that experimental context. Specifically, when it is said that “the neuron fired both when the monkey observed the action of another grasping a nut and when the monkey performed the action of grasping the nut itself”, Pascolo wonders whether the monkey merely observed the action lying down or whether it was preparing the action. Nobody thought to ask the monkey and so we will never know. However we do know that mirror neurons have never been isolated histologically, and that the task the monkey was set was competitive in nature and involved food. The salivation that a tempting morsel being dangled in front of them will invariably generate in the mouth of an animal could be taken as a sign of desire and even preparation for the act, causing the neuron to fire.

Furthermore, as stated in the article by Paolo Bartolomeo Pascolo and Riccardo Budai<sup>(5)</sup>, the neuron examined was quicker than the hand of the nut grasper, further indication that the word “observation” used by the research team led by Giacomo Rizzolatti in 1996<sup>(8)</sup> should be interpreted with caution. Pascolo and Budai have already criticized the method that led to the enunciation of the existence of mirror neurons in 2008 in an Italian journal (*Rivista Medica*)<sup>(6)</sup>.

We know that in nature, exchange/confrontation between animals is competitive (for food and territory) and predatory, and this is mediated by understanding of the intention behind the other’s action rather than just comprehension of the action itself. The relationships that would need to develop to understand the action (mirror neuron paradigm) would be fatal for the survival of the species, as the response would be systematically delayed.

However, before we let you get on with reading these contributions and making up your own mind, we would just like to mention the article by Pascolo published in *Biomedical Sciences Instrumentation* (2013)<sup>(4)</sup>, which discusses the work by Roy Mukamel et al. appeared in 2010 in *Current Biology*<sup>(3)</sup>, and an earlier work, also published in *Biomedical Sciences Instrumentation* (2011)<sup>(7)</sup>, where Pascolo confutes the “measurements” performed on 3-8-day-old macaques by Pier Francesco Ferrari et al. (2008), whose video-clips can be accessed through the *La Repubblica*

website<sup>(2)</sup>. Pascolo maintains that in each of the works cited, little weight was given to the synchronization between executor and observer, i.e., between input and output, and this gives rise to several possible interpretations that contrast with the mirror neuron paradigm. Confirming these considerations by Pascolo, we can also mention the contribution by Miia-  
maaria V. Kujala et al. (2012)<sup>(1)</sup> regarding the danger in ascribing human meanings to actions performed by other animals, namely that “dog experts’ brains distinguish socially relevant body postures similarly in dogs and humans.”

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