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Research Focus

Failure to deactivate in autism: the co-constitution of self and other

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A new brain imaging study demonstrates that patients with autism have a strikingly different pattern of brain activity compared with control subjects. During cognitive tasks, cortical areas known as the 'default state' network – areas that have been implicated in both self-referential processing and processing of socially relevant information – typically reduce their brain activity. In patients with autism, such a reduction was not observed. This new finding indicates that a core deficit in autism might be related to the construal of a sense of self in its relationship with others and will certainly generate exciting new research on the neurobiology of autism.

Introduction

One of the most original cognitive neuroscience findings that came out from the brain imaging literature is the following: a set of cortical areas shows tonic, high metabolic activity at rest and typically reduces its activity while subjects are engaged in laboratory tasks designed to investigate classical cognitive functions [1]. Although the meaning of these surprising physiological properties is not entirely understood, extant data suggest that this 'default state' network might have to do with both self-oriented thoughts [1] and with the processing of socially relevant material [2]. A new study [3] demonstrates that patients with autism fail to show differential activity between rest and a cognitive task in the 'default state' network. This new finding not only reinforces the hypothesis that neural systems relevant to social cognition might be impaired in autism, but also expands on this notion by suggesting that a key functional aspect of social cognition that is altered in autism has to do with the processing of self and other.

The cognitive level: self and other as two sides of the same coin

The anterior [ventral medial prefrontal cortex (vmPFC)] and posterior (precuneus) midline structures that fail to deactivate in autistic patients during laboratory cognitive tasks have been associated with first person perspective (both areas) [4] and internally oriented thoughts (vmPFC) [1]. The main idea is that during rest, self-referential processing probably dominates and it is associated with high activity in these areas, whereas during a cognitive task, the 'engagement' required by the task shuts down the self-referential processes, leading to reduced activity in these areas. The new study [3] suggests that in patients with autism, the failure to reduce activity in midline structures during the cognitive task might originate from a lack or reduction of self-referential processing at rest. However, autism is mostly known for a condition affecting social behavior, not internally oriented thoughts. Indeed, previous studies have also shown increased activity in these midline structures in control subjects during the processing of socially relevant material, such as the observation of social interactions [5] and the use of social information for memory processes [2]. Self and other, similarly to two sides of a coin, are inextricably linked in these areas, especially the anterior ones. In fact, activity in vmPFC is substantially identical when control subjects are performing judgements of self and judgements of others that are similar to self [6], thus suggesting that to judge others similar to us, we simulate judging ourselves.

Such a simulation process provides a reminder of another simulation process that might be disrupted in autism. Recent functional magnetic resonance imaging (fMRI) data have shown a deficit in the mirror neuron system – a lateral premotor and parietal neural system that enables the simulation of the actions of others, thus leading to an understanding of the intentions and emotions associated with those actions [7] – in autistic children performing a social mirroring task [8]. Also, recent fMRI [9] and transcranial magnetic stimulation [10] data have associated mirror neuron areas with self-recognition processes. These recent data on mirror neuron areas and self suggest that the simulation process enabling the mapping of the other onto self provided by mirror neurons might be functionally equivalent to the mapping of the 'perceived self' onto the 'perceiving self' during self-recognition tasks. That is, when one (the 'perceiving self' or the self as the observer) is looking at one's own picture (the 'perceived self' or the self as the observed individual), mirror neurons probably support forms of internal simulation in the observer, similar to the simulation activated when the observer is looking at somebody else. Once again, it seems that – even in the mirror neuron system – self and other are inextricably linked as two sides of the same coin [11].

Although empirical data clearly show that midline structures belonging to the 'default state' network and mirror neuron areas have similar responses during the

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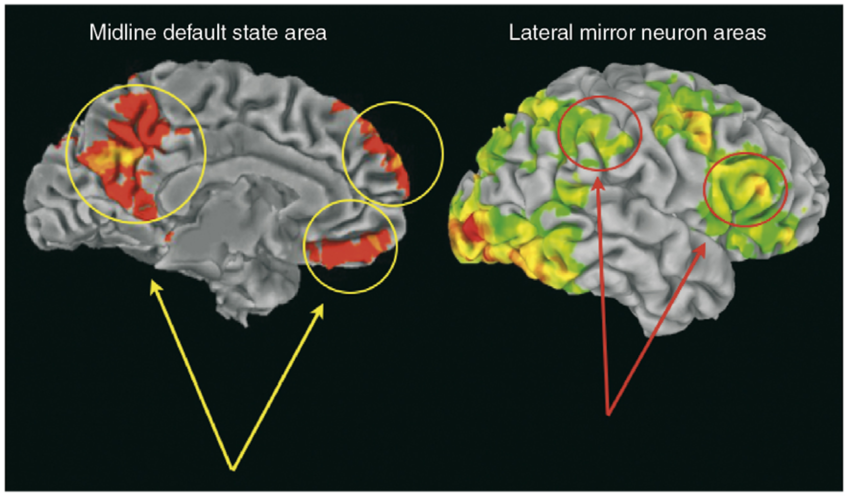

Figure 1. Midline default state structures typically encompass the precuneus and posterior cingulate posteriorly and the dorsal medial prefrontal cortex and the vmPFC anteriorly. By contrast, human mirror neuron areas are located on the lateral wall of the cerebral hemispheres, in the rostral part of the inferior parietal lobule and in the posterior part of the inferior frontal cortex and adjacent ventral premotor cortex. The activations in mirror neuron areas shown here were originally reported by Iacoboni *et al*. [17].

processing of social relations (5), it is also obvious that midline structures and mirror neuron areas have profound functional differences. To begin with, they are anatomically distinct (Figure 1). Furthermore, mirror neuron areas typically respond to the sight of actions of others [7], whereas midline structures do not. By contrast, midline structures are generally involved in evaluative judgement tasks [2,4,6], whereas mirror neuron areas typically are not. A unifying framework for these two neural systems might be conceptualized in these terms [12]: the midline structures belonging to the default state network are concerned with the internal aspects of self (and other), whereas the lateral mirror neuron areas are concerned with the external aspects of other (and self). This framework maps well onto the proposed division between an intrinsic and an extrinsic system in the human brain [13]. Thus, the new study on failing to deactivate in autism [3], together with the study showing mirror neuron deficits in autism during social mirroring [8], can be interpreted as suggesting a unifying principle of the social deficits in autism: what are disrupted are neural systems that support cognitive processes related to both internal and external aspects of self and other.

But why are self and other inextricably linked in different cortical neural systems such as the default state network and the mirror neuron system? One possibility is that – in cognitive terms – self and other are coconstituted, that one cannot exist without the other [11]. In support of this idea, developmental data show that there is higher imitative behavior (thus suggesting higher processing of the actions of others, probably facilitated by mirror neurons) in dyads of children who can self-recognize compared with children who cannot [14]. This coconstitution might be due to the fact that self and other are carved out of a more primary intersubjectivity [15]. Thus, the neural systems that deal with internal and external aspects of the self in the adult brain might be crucial for the coding of such intersubjectivity in the early developing brain.

The physiological level: The need for more data

The exciting new data [3], and also the data reported in the other studies discussed above, were obtained using blood oxygen level-dependent (BOLD) fMRI. However, one cannot forget that the 'default state' network has been largely defined by physiological parameters such as metabolism, blood flow and oxygen extraction fraction (OEF) [1] that were obtained using positron emission tomography, and cannot be obtained using BOLD fMRI. We know that the resting state does not 'activate' the default state areas because the OEF of these areas at rest is identical to the OEF of other cortical areas at rest [1]. We also know that baseline levels highly influence changes in brain activity associated with the coding of a particular function. For instance, under different levels of anesthesia – that yield different baseline levels of oxygen consumption and spike frequency – somatosensory stimulation produces similar maximum values of oxygen consumption and spike frequency, even though the starting baseline levels were different [16]. This suggests that what matters for brain coding might not be a relative change but the overall level of activity that must be achieved for a given functional aspect that needs to be coded. The new work [3] clearly calls for more data on resting metabolic rate and OEF in patients with autism. Without these data, a firm interpretation of signal changes in fMRI experiments might be difficult to achieve. For instance, the lack of signal decrease in the new study [3] might also reflect the normal amount of activity in default state areas that are not suppressed during the cognitive task by autistic subjects. Unfortunately, BOLD fMRI cannot disambiguate these alternative explanations.

Prospects for the future

To conclude, two lines of research need to be pursued in the future to understand better the implications of the new work on default state areas in autism [3]. On the one hand, social cognitive neuroscience-based research is required that focuses on the role of 'default state' areas and mirror neuron areas in processing self and other at both internally oriented and externally directed levels. On the other hand, we require a better understanding of the physiology of the 'default state' network in the autistic brain that will enable a firm grounding of the fMRI data collected by cognitive neuroscientists.

Acknowledgements

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Book Review

How well do you know yourself?

Subjectivity and Selfhood: Investigating the First-Person Perspective by Dan Zahavi. MIT Press 2006. US$36.00/£23.95 (hbk) (280 pp.) ISBN 0-262-24050-5

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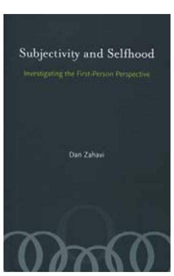

One of the great puzzles of consciousness concerns our knowledge of ourselves. On the one hand, it seems we have direct knowledge of our own experiences. On the other hand, numerous psychological experiments have served to undermine confidence in our self-knowledge. In the latest striking demonstration, subjects are asked to choose which of two faces, shown in separate pictures, is more attractive. Just a few seconds later, the experimenter tricks them by holding up the wrong picture and asking them why they chose it. Not only do subjects fail to realize the switch has been made, they proceed, quite unselfconsciously, to confabulate an explanation for their 'choice' [1]. How is it that we can so often be wrong about our own mental states, even while we have such a powerful sense of direct access?

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Phenomenology, defined by Dan Zahavi as the 'philosophical approach specifically interested in consciousness and experience inaugurated by Husserl', might have the answer. In his book, Zahavi conducts a painstaking examination of the development of ideas on subjectivity and self-awareness in the works of Sartre, Husserl, Heidigger, Merleau-Ponty, and others. His key claim is that there is a form of pre-reflective self-awareness that we can distinguish from reflective self-observation. This self-knowledge is both pre-theoretical and pre-conceptual and it is manifest in a first-personal 'givenness' that forms an essential part of every phenomenal experience. Each experience 'has two sides to it: "what is the object like for the subject" and "what is the experience of the object like for the subject." Although these two sides can be distinguished conceptually, they cannot be separated.' (p. 123). I got the best sense of this first-personal givenness from the discussion of the difference between vision and proprioception. Whereas vision takes the outside world as an object of perception, the phenomenology of proprioception appears to be somewhat different. We do not normally