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Visual neuroscience: A brain area tuned for processing social interactions

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Socialising with others is part of everyday life. A new study demonstrates that a brain area specialised for visual body perception is attuned to processing social interactions between two people. Intriguingly, this area is lateralised in the left hemisphere.

Imagine standing on the concourse of a busy railway station. The physical actions of the people around you signal the nature of their social relationships. Complex information about mood, familiarity and status can be understood from the physical posture and actions of others. These visual cues also convey the nature and intensity of the diverse range of social interactions you are witnessing. Fundamental to this understanding would be identifying which people were alone, and which formed a group. How do we do this so effortlessly? Studies of human visual perception have demonstrated that pairs of bodies are processed differently to single bodies[1,2]. Specifically, the visual system groups interacting bodies into holistic percepts in which the whole is greater than the sum of the parts. This suggests the existence of specialised cognitive mechanisms for processing social interactions. In a new study reported in this issue of *Current Biology*, Gandolfo, Abassi and colleagues[3] report experiments using different experimental methods that investigate the neural basis of these cognitive mechanisms. Their results comprehensively demonstrate that a brain area specialised for visual body processing is attuned to calculate the social interactions between two people.

Understanding the neural processes that support human interaction is a fundamental aim of social neuroscience. In pursuit of this goal scientists have mapped how the primate brain responds to images of visually presented bodies. Early work in macaques revealed neurons that responded to simple body parts such as hands[4]. Later studies in humans reported a region in the lateral occipital cortex that selectively responded to visual images of the human body[5,6]. While this region, known as the extrastriate body area (EBA), has been the subject of considerable study, the role it performs in social interaction is still poorly understood. This is (at least partly) because many studies have used stimuli depicting images of single bodies. By definition, a single body is not engaged in a face-to-face social interaction. Gandolfo, Abassi and colleagues[3] have addressed this prior omission using stimuli depicting two bodies, also called dyads.

The use of dyads is a methodological advance that has opened up new ways to investigate social cognition. For example, studies have demonstrated that dyads showing two bodies facing each other are processed differently than dyads showing two bodies facing away from each other[1,2]. This led to claims that two bodies facing each other are likely to be engaged in some form of social interaction. Humans are intensely social primates so attention to social interaction is necessary for survival. The difference in processing facing dyads is most clearly demonstrated when the stimuli are inverted. Inversion impairs the visual recognition of facing dyads to a significantly greater extent than non-facing dyads[1]. Importantly, this effect of inversion is also observed with other socially relevant visual stimuli (e.g., faces)[7] and is a demonstration of holistic processing. In psychology, holistic processing is a term used to suggest the existence of specialised mechanisms for performing specific cognitive tasks[7]. With respect to body perception, the greater inversion impairment for the facing compared to the non-facing dyads suggests specialised (and holistic) mechanisms for visually processing social interactions. The aim of the study reported by Gandolfo, Abassi and colleagues[3] was to study the neural mechanisms that underpin this dyad inversion effect. They did this using two experimental methods — neuroimaging and human brain stimulation.

In the neuroimaging study, participants were scanned using functional magnetic resonance imaging (fMRI) while viewing greyscale renderings of human bodies in various poses. These dyads were paired to be facing towards (facing dyads) or away from each other (non-facing dyads). Analysis focused on the EBA, a brain area that had previously been shown to respond to facing dyads more than non-facing dyads. Here[3], the results revealed a lateralised response. The EBA in the left hemisphere showed greater activity to the facing dyads than the EBA in the right hemisphere (Figure 1). This was unexpected. Prior data reported that the bilateral EBA responded to facing dyads[8]. The current study benefitted from increased statistical power, but the surprising nature of this lateralised result necessitated further empirical proof. Gandolfo, Abassi and colleagues provided this evidence using transcranial magnetic stimulation (TMS). TMS transiently disrupts neural functioning and is therefore able to causally demonstrate the role of a targeted brain area in a concurrently performed behavioural task. TMS was delivered over the left EBA and an adjacent brain region that selectively responds to visual scenes called the occipital place area (OPA)[9] (this acted as a control condition). Results showed that the inversion effect for facing dyads was effectively eliminated only after TMS to the left EBA and not to the left OPA. The TMS results therefore

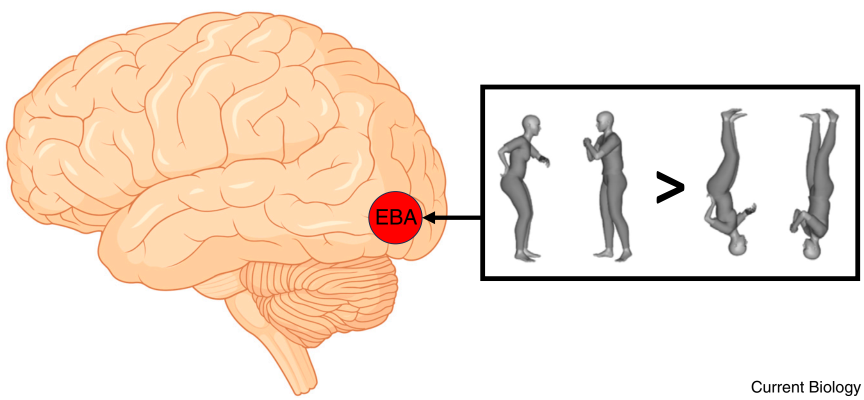

Figure 1. The left extrastriate body area (EBA) and the body inversion effect.
A schematic representation of the results reported by Gandolfo, Abassi and colleagues[3]. The authors studied how the brain processes visual images of two bodies, also called dyads. Dyads depicting bodies facing each other are thought to be processed using specialised cognitive mechanisms because social interactions typically occur face to face. This was demonstrated in a task where participants categorised dyads depicting facing bodies and dyads depicting non-facing bodies. These stimuli were presented either upright or inverted. The greater number of errors for inverted facing dyads is evidence for a holistic mechanism specialised for processing social interactions. Converging results from neuroimaging and brain stimulation experiments revealed that upright facing dyads are preferentially processed in the left extrastriate body area (EBA; shown in red).

comprehensively support the results of the fMRI study.

What makes the study from Gandolfo, Abassi and colleagues so compelling is this convincing demonstration of an unexpected finding using two approaches. An unexpected finding is more convincing if it is replicated using a different experimental method. This is especially true in human neuroscience in which the brain's neural response is related to models of cognitive function by measuring changes in cerebral blood flow[10]. fMRI has the precise spatial resolution (sub-millimetre)[11] to map the topographical organisation of the cortex, but the results are correlational. TMS can be used to disrupt the normal neural functioning, offering a causal link between brain activity and behaviour, but the spatial resolution is more diffuse (1 to 2 cm)[6]. The current study from Gandolfo, Abassi and colleagues[3] demonstrates the utility of using both methods, each compensating for the limitations of the other. But neuroscientists are not limited to these two approaches only. The neural basis of the dyad inversion effect can be further explored using methods with other strengths. For example, electroencephalography[12] and TMS chronometric studies[13] can establish the temporal dynamics of a cognitive effect (millisecond resolution) and human neuropsychology can explore the impact of brain lesions on behaviour[14]. Such studies would hopefully address the most interesting question raised by the current results — why should the perception of social interactions be preferentially processed in the left hemisphere?

Socially relevant biological stimuli typically show the opposite pattern. Face and body perception is more commonly lateralised to the right hemisphere[5,15], although this has been disputed[16]. To begin to resolve this question concerning laterality it is necessary to consider models of social perception that go beyond the visual processing of static body images. Social interactions are by their very nature dynamic and recent work has demonstrated that brain areas in the right hemisphere including the EBA and the superior temporal sulcus (STS) respond to dynamic depictions of dyads and social interactions[17,18]. This involvement of brain areas higher in the cortical hierarchy than the EBA (e.g., the STS) suggests that more complex assessments of social interaction may be processed across functionally connected brain areas. This is consistent with the recent proposal of an anatomically defined visual pathway specialised for social perception[19].

If the right hemisphere does preferentially process dynamic social interaction, this still leaves an important question. What is the role of the left hemisphere in social perception? One suggestion comes from models that seek to explain the role of the left visual cortex in action observation. For example, it has been suggested that the left hemisphere preferentially processes the meaning of body actions and action observation involving tool use[20]. Further empirical testing of these models is what makes the study reported by Gandolfo, Abassi and colleagues[3] so compelling. Why should facing dyads be preferentially processed in the left hemisphere? Their results open up many new and exciting questions for future studies on the neural and cognitive mechanisms that support the perception of social interaction.

DECLARATION OF INTERESTS

The authors declare no competing interests.

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Evolution: No end in sight for novel incredible (heterotrophic) protists

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The microbial eukaryotes known as protists are of immense importance for our understanding of eukaryotic biology. Although it is often difficult to convince funding bodies to sponsor research projects aimed at finding new protist lineages, such discoveries usually provide new and fundamental insights into cell and evolutionary biology, and ecology.

Probably more scientists study sparrows than all the free-living microbial eukaryotes (protists) combined. This is quite unfortunate, not because the former are unworthy, but because the latter not only contribute substantially to planetary health, but they also represent the majority of functional and evolutionary eukaryotic diversity on Earth[1]. This fact usually comes as a surprise to people studying macroscopic eukaryotes, yet the diversity of protists is bound to grow even further, as implied by the fact that 50% of eukaryotic genes expressed in the ocean do not have any match in public databases and/or lack any reliable phylogenetic affiliation[2]. Studies like the one on *Meteora sporadica* by Eglit, Shiratori *et al.*[3], published in this issue of *Current Biology*, superimpose intriguing protists over the unassigned sequences. This peculiar heterotrophic protist has a giant mitochondrial genome, unusual morphology and ultrastructure, and moves by use of bizarre 'swinging arms'. Surprisingly, however, sequences of its nuclear genes revealed that it belongs to the obscure and species-poor supergroup (kingdom) Hemimastigophora, with which it otherwise does not seem to have anything in common. First described by German protistologists in 2002[4], *Meteora* attracted attention mostly because of its unique rowing movement and by a failure to find its taxonomic home; it has remained in the *incertae sedis* category[5] until now.

Although the study by Eglit, Shiratori *et al.*[3] is exciting, it is not surprising that yet another free-living heterotroph is not closely related to any other known microbial eukaryote — a recurrent theme in the field! Indeed, completely unknown protists and/or those that have been described only morphologically seem to represent the biggest source of untapped eukaryotic diversity. Thanks to Eglit, Shiratori *et al.*[3], *Meteora* is no longer enigmatic, as it has now joined a disparate band that brings together deep-branching lineages, most of which have been discovered only recently, such as Picozoa, *Rhodelphis*, *Anaeramoeba*, *Barthelona*, *Microheliella*, and Provora[6–11]. Some of these organisms have been known for a very long time but remained mysterious until recently (for example, the morphologically