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COGNITIVE NEUROSCIENCE

COMMENTARY
Making mirrors: sensorimotor experience directs activation of the mirror system (Commentary on Catmur *et al.*)

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Watch your favorite athlete take a shot for the goal, or your favorite actor lean in for a kiss, and chances are that some of the same neurons that would be active if you were performing that action are firing as well. These mirror neurons – neurons in premotor and parietal cortex that fire both when an animal performs a goal-directed action and when observing such actions – provide a link between representations of the other and self-representations (di Pellegrino *et al.*, 1992). Along with their proximity to Broca's area, this has led to the suggestion that the mirror system is fundamental for the development of language and complex social-cognitive constructs including empathy and theory of mind (Iacoboni & Dapretto, 2006). But how does the mirror system acquire its reflective properties? Are the patterns it shows in response to observing a particular movement pre-set by evolution, or the product of experience?

In this issue, Catmur *et al.* address this question by using fMRI to assess activation patterns within the mirror system after sensorimotor training. They first trained participants to either flex their hand when they saw a picture of a flexed hand and flex their foot in response to the picture of a flexed foot (Compatible condition), or to reverse their responses (Incompatible condition; flex hand in response to foot picture and vice versa). Following training, participants were scanned while simply observing pictures of flexed hands or feet, while themselves remaining stationary.

The results show that the mirror system can be trained: Areas that showed greater activity to hand-action displays for the Compatible group showed greater reactivity to foot-action displays in the Incompatible group. Both groups showed stronger activations for the stimuli that predicted performance of the hand action, suggesting some pre-existing bias towards the representation of such actions. However, the critical finding is that the mirror system's mapping to which stimuli predicted such movements was flexible, showing a complete reversal after only 3 days of training. It appears that the representations linking others' actions and our own within the mirror system are not hardwired, but instead are easily changed.

Is the mirroring system truly unique, or more properly seen as a special case of experience-based associations? Is the urge to make a kick while watching a player do so during a televised game that different from 'feeling it in your bones' when you visit the soccer field you frequented in your youth? The results of Catmur *et al.* suggest that it may not be: In both cases mirror neurons may be responding to the experienced relationship between those cues and the motor programs you have used during a game.

The links between the mirror system and more traditional learning and memory principles have important implications. As described above, the mirror system is thought to be fundamental to empathy and social cognition, and disruptions in it may be related to autism, schizophrenia, and other disorders. The possibility of a trainable mirror system opens the door to treatments that 'iron out' such distortions.

References

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