

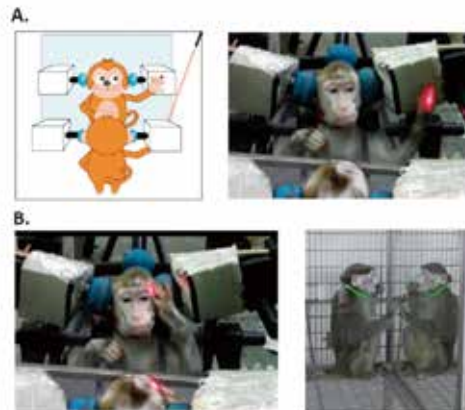
Monkeys that Use Mirrors

Monkeys showed spontaneous mirror self-recognition (MSR) behaviors after they learned precise visual-proprioceptive association for mirror images, demonstrated a recent study by researchers from the Institute of Neuroscience, Chinese Academy of Sciences in Shanghai.

Self-awareness is a form of higher intelligence that can be revealed by mirror self-recognition in humans. Testing MSR has become the main approach to examining the existence of self-recognition in animals, and only a few species have passed this test. In the standard face mark test for demonstrating MSR, an odorless nonirritant dye is placed on the face of the subject (without the subject's awareness) that can only be seen in the mirror. Humans and several species of great apes could pass the test by touching the dye mark after looking at themselves in the mirror. However, it remains controversial whether failing the MSR test is a result of the lack of an animal's self-recognition ability or the inadequacy of the mirror test.

In a study published in 2015, Dr. GONG Neng's team reported such MSR behaviors in monkeys after several weeks of visual-somatosensory association training, by applying an irritant laser light on the monkey's face in front of the mirror. However, this direct training on the monkey's face by the sensation-induced face-touching caused controversy and criticism as to whether the observed MSR behaviors were just a simple conditioned response.

For the current study, researchers designed a new training strategy in which the monkey was only trained to use the mirror as an instrument to find hidden objects. They trained head-fixed monkeys seated in front of a mirror to touch, with spatiotemporal precision, a laser pointer light spot on an adjacent board that could only be seen in the mirror. After several weeks of training, when the same laser pointer light spot was projected to the monkey's face, a location not used in training, all three trained monkeys successfully touched the face area marked by the light spot in front of a mirror. All



(A) Visual-proprioceptive association training. (B) Mirror-induced self-directed behaviors.

trained monkeys passed the standard face mark test for MSR both on the monkey chair and in their home cage. Importantly, distinct from untrained control monkeys, the trained monkeys showed typical mirror-induced self-directed behaviors in their home cage, such as using the mirror to explore normally unseen body parts.

In the research, visual-proprioceptive training of rhesus monkeys to precisely locate objects outside the body has resulted in self-directed behaviors in front of a mirror. This work may shed light on the neural basis of MSR and self-awareness. Furthermore, it suggests that the failure to demonstrate MSR in animals could be attributed to the lack of the ability in visual-proprioceptive association for the mirror images, rather than the absence of bodily self-consciousness. This work also stresses the importance of developing new experimental approaches in studying self-recognition and self-awareness, which may even exist in many non-primate species.

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