Mike or me? Self-recognition in a split-brain patient

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A split-brain patient (epileptic individual whose corpus callosum had been severed to minimize the spread of seizure activity) was asked to recognize morphed facial stimuli—presented separately to each hemisphere—as either himself or a familiar other. Both hemispheres were capable of face recognition, but the left hemisphere showed a recognition bias for self and the right hemisphere a bias for familiar others. These findings suggest a possible dissociation between self-recognition and more generalized face processing within the human brain.

The capacity to recognize oneself is central to a raft of higher-order cognitive capacities, such as self-consciousness, introspection and theory of mind[1]. To operate effectively in the world, people must be able to distinguish 'me' from 'not me'. Thus it is reasonable to assume that distinct neural mechanisms subserve the process of self-recognition. Despite the pivotal status of this process in human functioning, it is only in the last few decades that researchers have directed attention to the matter of how self-recognition is instantiated in the brain[2–5]. That this question requires empirical clarification is puzzling, as much is known about the processes and brain structures that support the recognition of familiar others (such as friends, family members or movie stars). Both functional imaging and patient studies show that face recognition typically relies on structures in the right cerebral hemisphere, such that damage to these cortical areas impairs people's ability to recognize others[6,7]. For example, split-brain patients perform significantly better on tests of face recognition when familiar faces are presented to the right, rather than the left, hemisphere[8].

But is the right hemisphere similarly specialized for self-recognition? Although some support has been garnered for this viewpoint[5,9,10], the available evidence is inconclusive. Patients undergoing sodium amytal (Wada) testing show a right-hemisphere advantage for the recognition of self[5]. In this previous study, a morphed facial photograph (combination of self plus a famous other) was presented to an anesthetized hemisphere. After the anesthesia had subsided, patients were shown two photographs (self and famous other) and asked to report which one they had seen before. Patients were more likely to report seeing themselves when the morphed face was presented to the right, rather than the left, hemisphere. It is unclear, however, the extent to which this effect reflects hemispheric specialization in self-recognition or memory components of the experimental task (that is, trying to commit a face to memory while a portion of one hemisphere in anesthetized).

To date, brain imaging studies have shown that highly self-relevant material (for example, autobiographical memories or one's own face) activates a range of cortical networks in the left hemisphere[4,11–13] that could potentially support self-recognition and a host of related cognitive functions (such as continuity of subjective experience or self-construal). Thus, whereas the recognition of familiar others relies primarily on structures in the right hemisphere, self-recognition may be supported by additional cognitive operations that reside in the left cerebral hemisphere. To investigate this possibility, we assessed the efficiency of the person recognition process (self versus familiar other) in a split-brain patient. Such an individual affords an ideal test of potential hemispheric differences in function, as information (photographs of self or of familiar others) can be presented separately to either the left or right hemisphere of the disconnected brain.

We tested JW, a 48 year-old right-handed male who, at the age of 25, underwent a two-stage callosal surgery with sparing of the anterior commissure. The surgery was undertaken as a treatment for pharmacologically intractable epilepsy. Written consent was obtained from JW and he was compensated for taking part in this study. Our experimental protocol was approved by the committee for the protection of human subjects at Dartmouth College. JW viewed a series of morphed facial photographs that ranged from 0% to 100% JW (self). The 0% self image was a photograph of Dr. Michael Gazzaniga (MG), a long-time associate of JW (a highly familiar other). The remaining nine images were generated using computer morphing software with each image representing a 10% incremental shift from JW to MG (**Fig. 1**). The images were presented laterally to each hemisphere for 250 ms in a random order. In one condition ('self-recognition'), JW was asked to indicate (by button press, yes or no) if the presented image was himself; in the other condition ('familiar other' recognition), he was asked to indicate whether or not the image was MG. The same morphed images were used for each judgment task. The only difference across the two conditions was the judgment that was required ("Is it me?" or "Is it Mike?"). Data were collected over six testing sessions. In each session, each of the 11 images (JW, Mike and 9 intermediate morphs) was presented four times to each cerebral hemisphere.

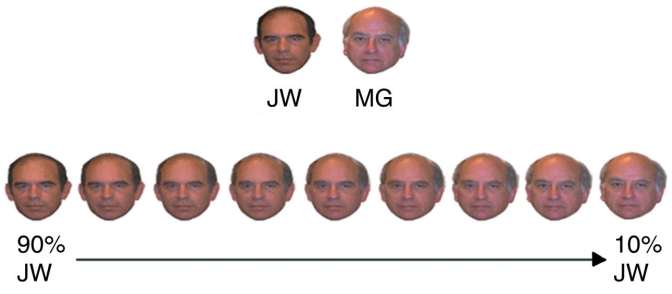

Fig. 1. A sequence of nine faces was created by morphing MG's face with JW's face in 10% incremental shifts. The initial image (left) contained 10% MG and 90% JW, and the final image (right) contained 90% MG and 10% JW. These nine morphed images together with the two original photographs of MG and JW were randomly presented to each hemisphere.

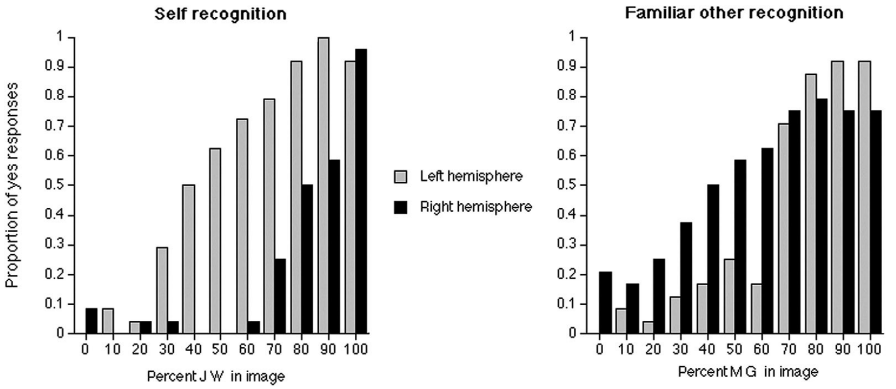

Fig. 2. Proportion of yes responses to recognition judgements as a function of the percentage of the individual contained in the image and the cerebral hemisphere to which the image was presented. In one condition (left), JW was asked to determine whether or not the image was self; in the other condition (right), JW was asked to determine whether or not the image was MG. JW showed a bias for self-recognition in the left hemisphere, and a bias for familiar other person recognition in the right hemisphere.

The results showed a double dissociation in JW's face recognition performance. Whereas JW's right hemisphere showed a bias toward recognizing morphed faces as a familiar other[8], his left hemisphere had the opposite pattern: biased recognition in favor of self (**Fig. 2**; $\chi^2_{(10)} = 52.34$, $P < 0.0001$). To ensure that this dissociation was not dependent on the identity of the familiar other (MG), we repeated the entire procedure (again across six testing sessions) using three additional targets (PC, a personally known individual, current U.S. President Bush and former U.S. President Clinton). Notably, the same dissociation was seen across all four targets ($\chi^2_{(10)} = 19.36$, $P < 0.0001$). Thus, while both hemispheres were capable of recognizing faces, JW's left hemisphere showed a recognition bias for self and his right hemisphere showed a recognition bias for familiar others.

Our results support the view that, although both hemispheres are capable of self-recognition[14], cortical networks in the left hemisphere have an important role in the execution of this process[2–4]. The double dissociation we found in JW's person recognition performance suggests that self-recognition may be functionally dissociable from general face processing, a finding that has important implications for contemporary models of social cognition. To chart a smooth passage through a complex social world, the human brain is believed to possess a self-memory system (SMS) that guides behavior in a purposive and meaningful manner[11,14]. Distributed across a discrete network of neural structures, the SMS comprises people's autobiographical knowledge, personal beliefs, currently active goal states and conceptions of self (both idealized and veridical)[11,12]. Through its enhanced ability to recognize the self, the left hemisphere may have a dominant role in the functioning of this system.

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Competing interests statement

The authors declare that they have no competing financial interests.

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