Components of a Social Brain

JASON P. MITCHELL AND TODD F. HEATHERTON

ABSTRACT Human ecology is radically different from that of other animals, despite the relatively short period of time that separates us phylogenetically from other primates. Recent commentators have suggested that the unique cognitive skills possessed by humans may, in fact, reduce to a small number of primary adaptations for one specialized ability: social cognition, the ability to interact effectively and safely with conspecifics. Emerging research from the neurosciences has begun to elucidate the component parts of these broad social skills. Here, we review evidence that suggests that human social cognition comprises four specialized abilities: a coherent sense of self, the ability to keep track of the mental states of others, control over socially inappropriate emotions and impulses, and sensitivity to threats of exclusion or aggression from other people. We conclude with a review of recent neuroimaging findings that support the view that social cognition has a privileged status in the human cognitive repertoire.

Surveying the problem posed by the enormous ecological gap between humans and chimpanzees, Tomasello (1999; Tomasello et al., 2005) has argued that many of the unique cognitive skills possessed by humans may, in fact, reduce to a small number of primary adaptations centered on one particularly specialized feature of the mind: the processes that give rise to social cognition. Critical for the development of many of our species-unique behavior—such as language, the use of handheld tools, the assembling of complex social systems—are the ability to learn from and the motivation to teach others. Unlike other primate species, which do not regularly engage in direct instruction, humans actively seek to impart their own knowledge to other humans, especially to young members of the species. Conversely, humans also seem to have a particular motivation to unlock the thoughts and knowledge of others around them, as evidenced by the never-ending "why?" questions asked by two-year-olds. In contrast, whereas apes may acquire new skills from others through imitation, they neither seek out pedagogic contexts nor appear inspired to aid the acquisition of knowledge by others, for example, by explicitly demonstrating a behavior, by repeating it for others to see more clearly, or by taking active steps to shape another's attempts at acquiring a new motor skill.

This species-unique proclivity for learning and teaching imbues humans with enormous behavioral advantages over other animals. Rather than each of us being required to discover facts about the world for ourselves, humans routinely capitalize on the accumulated knowledge of all the other people to whom they have some access. That is, whereas other apes can learn about only those objects and events with which they come into immediate contact, humans can avail themselves of what others, both past and present, have uncovered about the world. As such, we tend to add complexity to already existing knowledge rather than generating it from scratch—such as improving on the workings of already-existing tools and behaviors instead of creating them de novo. Unlike the knowledge of apes, which effectively remains trapped inside the mind of its possessor, human know-how spreads quickly through any population of humans who are in contact with each other, so if one person acquires a new bit of knowledge, all other humans in her group can generally make use of it as well.

What grants humans the ability to traffic so readily in the knowledge and beliefs of others? That is, starting with

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the basic primate mental algorithm, what additional cognitive software is needed to create a social animal of the human variety? Here, we expand on a model that attempts to identify the necessary basic components of the social brain (Heatherton, in press; Krendl & Heatherton, in press). From this perspective, building a social brain requires at least four distinct cognitive abilities. The first of these is a stable and coherent sense of self, the knowledge that one has mental states that are both idiosyncratic and private but that are in principle capable of being shared with others. The motivation to engage in teaching behavior is predicated on the assumption that one’s knowledge is idiosyncratic and not immediately apparent to others, that is, that one has knowledge that is unique to a self. In addition, teachers must assume that their learners are sufficiently similar to them that the teachers can impart their knowledge, that is, that learners are capable of thinking the same thoughts as oneself; the reason we do not routinely teach calculus to first-graders or lecture our pets about quantum physics is that we do not assume that their minds are sufficiently similar to our own to allow them to think the thoughts that we do.

Second, if one adaptive goal of the social brain is to foster the spread of knowledge from one mind to the next, humans require a mechanism for keeping track of the mental states of others. This skill, variously known as mentalizing or theory of mind, allows one person to intuit the beliefs, thoughts, feelings, goals, and desires of other people for the purposes of both predicting and influencing their behavior.

Third, human knowledge spreads only among individuals who are in contact with one another. As such, one requirement for human social life is the ability to live in close proximity with large numbers of other people. Although other primates may form groups as large as a few hundred individuals (Mare Hauser, personal communication, May 21, 2008), humans have developed the ability to live in close contact with a number of conspecifics that exceeds this by several orders of magnitude (witness New York City and Tokyo as examples). Living in large social groups, even relatively small human groups on the order of a rural village, poses cognitive challenges of considerable difficulty. Among the most substantial of these is the need to regulate one’s own desires and emotions to maintain social harmony. That is, maintaining cooperative relationships among large numbers of unrelated individuals requires a cognitive system with special abilities to inhibit potentially destructive emotional expression, a skill with which other primates (with the possible exception of bonobos) struggle.

Finally, the centrality of group living to human ecology generates two sources of special dangers that the social brain must have evolved to handle: threats from one’s own group and threats from other groups. Threats from one’s own group generally take the form of the potential for social exclusion, a fate that at many times in human history was equivalent to a death sentence. Conversely, because humans naturally form groups, one always faces the possibility of intergroup competition for resources or explicit conflict (group raids, war, etc.). Accordingly, the social brain should be expected to have developed mechanisms for anticipating and dealing with both sources of intraspecies threat.

In this chapter, we explore the functional neuroanatomy associated with these four components of social cognition: self-awareness, theory of mind, self-regulation, and threat detection. Unlike many other aspects of cognition, almost everything we know about the social brain has been uncovered in the last decade and a half. Fortunately, the emergence of social neuroscience has been both rapid and far-reaching; therefore, despite its infancy, this approach has netted a substantial number of reliable and surprising empirical findings about how the brain gives rise to human sociality. To this end, we conclude the chapter with a brief speculative review of some unexpected observations of the peculiar “specialness” of social thought within the human cognitive repertoire.

Components of the social brain

Self-Awareness Survival in human social groups requires that people monitor their behavior and thoughts and evaluate them against prevailing group (social) norms. Discussions of the importance of such introspective awareness have a long history in psychology. For example, William James (1890) devoted a chapter of his Principles of Psychology to issues of one’s own knowledge of self. More recently, Neisser (1988) has described a number of distinct ways in which one can think of selfhood, such as a “conceptual self” that represents our understanding of our own personality traits and dispositions, an “ecological self” that represents our sense of authoring our own actions in the environment, and a “narrative self” that maintains our sense of personal history and autobiographical memory (also see Boyer, Robbins, & Jack, 2005; S. Gallagher, 2000). S. Gallagher (1997) argues that this last sense of self is a widely shared human trait that leads to more efficient mental processing of personal and contextual information, thereby increasing the likelihood of survival and reproduction.

Cognitive neuroscience has made considerable progress in identifying the functional neuroanatomy underlying several of these different aspects of self-awareness. Of these, most is known about the brain regions subserving introspective knowledge of one’s own stable personality traits and dispositions. Specifically, both neuroimaging research and studies with neuropsychological patients have implicated ventral aspects of the medial prefrontal cortex (vMPFC) as contributing importantly to conceptual aspects of selfhood. For example, a considerable number of neuroimaging studies
have implicated this region in tasks that require participants to judge their own personality traits (Craik et al., 1999; Heatherton et al., 2006; Johnson et al., 2002; Kelley et al., 2002; Macrae, Moran, Heatherton, Banfield, & Kelley, 2004; Moran, Macrae, Heatherton, Wyland, & Kelley, 2006; Ochsner et al., 2004; Schmitz, Kawahara-Baccus, & Johnson, 2004; Zyss, Huber, Ferstl, & von Cramon, 2002) or report on their preferences and opinions (Ames, Jenkins, Banaji, & Mitchell, 2008; Jenkins, Macrae, & Mitchell, 2008; Mitchell, Macrae, & Banaji, 2006), compared to judging these characteristics in others.

The more an item is believed to be reflective of the self, the greater the activity in this area (Moran et al., 2006), and items that are inherently self-relevant (such as personal information) lead to vMPFC activity even during passive viewing when people are not asked to engage in self-referential processing (Moran, Heatherton, & Kelley, in press). Interestingly, damage to this region can lead to deficits in the organization of knowledge about one's preferences. Fellows and Farah (2007) have reported that, when asked to indicate how much they like/dislike various stimuli, patients with vMPFC lesions show unusually large discrepancies between testing sessions, suggesting that damage to this region leads either to failure to retrieve knowledge of one's preferences or to instability in otherwise stable aspects of selfhood.

In addition to knowledge about one's own personality and preferences, humans require a system for keeping track of the actions they perform (what Neisser referred to as an "ecological self"). In recent behavioral work, researchers have demonstrated enhanced memory performance for stimuli that a participant freely selects, compared to those that are selected by someone else (Cloutier & Macrae, 2007). Extending these results, Powell, Macrae, Cloutier, Metcalfe, and Mitchell (submitted) demonstrated that the sense of agentic free selection was associated with greater activity in the intraparietal sulcus (IPS), a region that was previously implicated in maintaining representations of one's goals and computing the motor commands needed to bring them about (Grafton & Hamilton, 2007; Hamilton & Grafton, 2006; Tunik, Rice, Hamilton, & Grafton, 2007). Moreover, activity in IPS correlated with the mnemonic fate of items—showing greater activity for items that were later remembered than for those that were later forgotten—but only for items that were freely chosen by the participant. In other words, much as the conceptual sense of who one is relative to others—that is, one's stable traits and preferences—relies on vMPFC, the agentic sense of what one has done relative to others draws on the activity of IPS.

Theorists have also pointed out the importance to the self of feeling continuity between one's present and past experiences, that is, of possessing a consistent autobiographical memory. Studies of autobiographical memory have implicated a wide range of brain areas, including retrosplenial cortex, parahippocampal gyrus, temporoparietal junction (TPJ), medial frontal cortex, temporal pole, cerebellum, and the hippocampus (for review, see Maguire, 2001). Of these, perhaps the most consistent finding is that of the MPFC, which has regularly been observed during tasks in which participants are asked to remember events from their own personal past.

Although there exists no specific "self" spot in the brain, this brief review of the cognitive neuroscience of self-awareness suggests that specific regions, such as MPFC and IPS, play an important role in distinguishing between self and other, a critical feature of the adaptive social brain. An important current goal in social neuroscience is further description of the precise cognitive processes that are subserved by these regions. For example, how exactly does the MPFC compute one's preferences or retrieve knowledge about one's stable personality traits? How does the IPS "tag" actions as having been performed by self rather than by another person? Elucidating the computations carried out by these regions and how they combine to give rise to our sense of self promises significant advances to our understanding of how the self contributes to social cognition.

Mentalizing One of the most critical components of social cognition is the ability to infer the mental states of other people, a skill that is alternately referred to as mentalizing, having a theory of mind, or adopting the intentional stance (Dennett, 1987). Mentalizing enables the ability to empathize and cooperate with others, accurately interpret other people's behavior, and even deceive others when necessary. A rapidly emerging neuroimaging literature on mentalizing has consistently implicated a small number of regions in making inferences about the mental characteristics of other people: MPFC, (TPJ), and medial parietal cortex (Amodio & Frith, 2006; Frith & Frith, 1999, 2001; H. L. Gallagher & Frith, 2003; Mitchell, 2006).

But how exactly does one make sense of the thoughts and feelings of other people, given that perceivers never have direct access to the inner workings of another person? Some cognitive scientists and philosophers have argued that one solution to this problem of mentalizing is suggested by the fact that, although one cannot directly perceive the mental states of another person, one does typically have immediate access to a decent proxy system: oneself. Simulationist (or projectionist) accounts of mentalizing posit that one way in which perceivers may infer others' goals, feelings, or preferences is to put themselves in the same situation as the target person, read off the feelings and thoughts that accompany that simulation, and then attribute (roughly) the same mental states to the target individual. However, this strategy for using oneself as a proxy for others works only when one can reasonably assume that another person will have similar responses to a situation; if a perceiver believes himself or
herself to be highly dissimilar from a target individual, the use of self-referential mentalizing can be inappropriate.

Interestingly, a series of neuroimaging studies has provided evidence in favor of this view by capitalizing on the well-characterized role of vMPFC in self-referential thought, as reviewed above (Jenkins et al., 2008; Mitchell, Banaji, & Macrae, 2005; Mitchell et al., 2006). Specifically, when perceivers mentalized about the preferences and opinions of a similar other (e.g., someone who shared the same social and political attitudes), a region of vMPFC was engaged; the same region was highly engaged when perceivers considered their own preferences. In contrast, a more dorsal region of MPFC was preferentially engaged when perceivers mentalized about dissimilar others. These results suggest that perceivers might indeed draw on their own knowledge about self in understanding the mental states of others, at least those others who are believed to be relevantly similar.

How does one go about inferring the mental states of those perceived to be dissimilar from self, that is, when simulation may be inappropriate? Although the exact mechanisms that support nonsimulationist mentalizing have yet to be detailed, the TPJ appears to augment the role of the MPFC in social cognition and may play an important role in non-self-referential theory of mind. Specifically, the TPJ is preferentially engaged during inferences about particular kinds of mental states, namely, others’ beliefs or knowledge about the world (Saxe, Carey, & Kanwisher, 2003; Saxe & Kanwisher, 2003; Saxe & Wexler, 2005), which may be inferred without reference to one’s own beliefs or knowledge. For example, many studies of inferences about others’ knowledge have used the classic false belief task, in which a character in a story believes that X is true, although the perceiver knows that X is false (e.g., the location of a hidden object). Here, perceivers cannot use their own self-referential knowledge (X is false) to make inferences about the target’s beliefs, and the TPJ may subserve some of the ancillary social-cognitive processes that allow this decoupling of one’s own knowledge of self from knowledge of others, perhaps by using a more rule-based approach to mentalizing.

**Self-Regulation** People who defy group norms—such as by cheating, lying, or being incompetent—often experience social emotions that indicate that something is wrong. We feel embarrassed when we goof, guilty when we harm, and ashamed when we get caught. Such social emotions serve as important guides for subsequent behavior (Baumeister, Stillwell, & Heatherton, 1994); for example, feeling embarrassed or ashamed motivates behavior to repair social relationships, and feeling guilty about considering cheating on one’s partner helps to rein in one’s response to temptation. In other words, social emotions promote self-regulation, which allows us to alter our behavior, make plans, choose from alternatives, focus attention on pursuit of goals, inhibit competing thoughts, and regulate social behavior (Baumeister, Heatherton, & Tice, 1994). Self-regulation refers not only to executive processes such as working memory, attention, memory, choice, and decision making, but also to the control of emotion (covering issues of affect, drive, and motivation). Although humans have the capacity to delay gratification, control appetites and impulses, and persevere to attain goals, failures of self-regulation are among the most important and perplexing problems facing society (e.g., drug abuse, domestic violence, binge eating).

The importance of self-regulation is that it helps people to control their behaviors and actions so that they remain in good standing within their groups. Throughout evolutionary history, people have faced the continuing struggle between satisfying personal desires and being a good member of the group. From a selfish hedonistic perspective, people should eat as much as they want, freeload on group resources, ignore restrictions on sexual conduct, use substances that induce euphoria, and so on. Essentially, strictly on the grounds of individual enjoyment, people should engage in activities that engage the mesolimbic dopamine system and produce rich feelings of reward. If it feels good, do it. But those who eat all the food, fail to be productive because they are incapacitated, or poach mates are bad group members; therefore most groups have shared norms and standards of conduct that discourage or place constraints on selfish, hedonistic activities. Religious doctrine, common to most cultural groups, places explicit rules on such behavior. Subcortical reward motives, then, are in constant battle with higher-level cognitive beliefs and values.

Neuroscience research indicates that various regions of PFC are responsible for the human capacity for self-regulation (see the review by Banfield, Wyland, Macrae, Munte, & Heatherton, 2004). For instance, functional neuroimaging studies have implicated the ACC in decision monitoring, initiating the selection of an appropriate novel response from several alternatives, performance monitoring, action monitoring, detection or processing of response conflict, and internal cognitive control (Wyland, Kelley, Macrae, Gordon, & Heatherton, 2003). More recently, we found an important role for the ACC in efforts to suppress unwanted thoughts (Mitchell et al., 2007), such that ACC was transiently engaged following the occurrence of unwanted thoughts, whereas dorsolateral PFC was more active during tonic efforts to suppress those thoughts. This finding is in keeping with the important role of prefrontal regions in executive functions more generally, all of which are necessary for successful self-regulation (Miller & Cohen, 2001). Since the case of Phineas Gage (Damasio, Grabowski, Frank, Galaburda, & Damasio, 1994; Macmillan, 2002), we have known that damage to certain prefrontal regions is associated with a lack of impulse control and self-regulatory difficulties more generally. The role of lateral PFC regions in
regulating social emotions appears to be among the most robust findings in social neuroscience.

How is brain activity related to self-regulatory behavior? Failures of self-regulation are commonplace, as can be confirmed by asking chronic dieters who are usually on a diet but seem to sabotage their diets with occasional, or not so occasional, bouts of overeating. In a series of classic studies, Herman and Polivy (1975) demonstrated that chronic dieters are prone to excessive eating in certain situations. In one of their first studies, chronic dieters (called restrained eaters) and nondieters were invited to the laboratory to engage in a supposed taste test, which was described as a test of perception (because the researchers did not want the subjects to know that eating was being monitored). Prior to the taste test, some of the participants were asked to drink one or two flavorful but obviously fattening milkshakes. The participants then were asked to taste and rate flavors of ice cream and were invited to help themselves to as much of the ice cream as they wanted. Nondieters ate sensibly; those who did not receive a preload ate a lot of the good-tasting (and free) ice cream, whereas those who had drunk one or two milkshakes ate much less of the ice cream. Restrained eaters, however, did just the opposite, eating much more if they had received a preload. This has been called the “what the hell effect,” the mindset of the dieter being “I’ve blown my diet, so I might as well just keep eating.” This finding of disinhibited eating has since been confirmed repeatedly (Heatherton & Baumeister, 1991) and serves as an excellent example of self-regulatory collapse.

In a recent imaging study, Demos, Kelley, and Heatherton (submitted) told dieters (N = 50) and nondieters (N = 50) that they were investigating the effect of nasal cavity temperature on BOLD signal artifact in orbitofrontal cortex. This cover story provided a rationale for requiring participants to drink either a large glass of cold water or a large glass of a high-calorie chocolate milkshake that would be forbidden in most diets and that had been associated with disinhibited eating by dieters. During scanning, subjects viewed images of animals, environmental scenes, people, and attractive food and made simple person perception judgments (i.e., “Is there a person present in the image?”). The person perception judgment was included to ensure that subjects attended to all images and to further disguise the primary goal of the study in examining cue reactivity to food images. A voxel-wise whole-brain ANOVA revealed that bilateral regions of the nucleus accumbens (NAcc) demonstrated a dietary status × preload interaction that mimicked the well-established behavioral pattern of disinhibited eating. Specifically, when participants received water prior to scanning, nondieters showed greater NAcc activity to food images than did dieters. This pattern was reversed in individuals who received the milkshake preload, such that dieters produced much greater NAcc activity than nondieters did.

Activity in the left amygdala revealed the reverse interaction: activity in the left amygdala was greater for dieters than for nondieters following the water and was greater for nondieters than for dieters following the milkshake preload. Importantly, the interactions in NAcc and amygdala were unique to food images; these patterns were not present when subjects viewed any of the nonfood images. This study demonstrates two important points. First, somehow dieters are able to view attractive food cues without activating reward circuitry while their diets are intact (although how they do this is currently unknown). In sharp contrast, following a large milkshake that should have induced satiety (and that eliminated a reward response among nondieters), dieters showed much greater reward-related food cue reactivity.

Studies such as these described begin to provide information relevant to people’s efforts to regulate their thoughts and actions. Coupled with research identifying brain regions involved in emotional regulation (Ochsner et al., 2004), social neuroscientists are tackling longstanding questions regarding the human capacity to control itself in order to obtain long term goals and be effective group members.

Detection of Threat Over the course of human evolution, a major adaptive challenge to survival was other people, both ingroup members and members of other groups. However, the nature of these threats is distinctly different. As was discussed above, the fundamental human need to belong makes social exclusion a potentially fatal sentence. In contrast, members of other groups pose a threat because they represent physical danger or competition for limited resources. As such, the social brain requires mechanisms not only to detect threats posed by both ingroup and outgroup members, but also to differentiate between the specific nature of each kind of social threat. A variety of brain regions have been identified as relevant to the detection of threat, including the amygdala and the anterior cingulate cortex (ACC), both of which have also been implicated in specifically social aspects of threat detection.

If humans have a fundamental need to belong, our system for social cognition must necessarily include mechanisms for detecting inclusionary status (Leary, Tambor, Terdal, & Downs, 1995; Macdonald & Leary, 2005). That is, given the dangers posed by exclusion from one’s group, humans must be capable of benchmarking their interpersonal relationships with others. A recent set of neuroimaging studies has examined the concomitants of a particular form of ingroup threat detection: social rejection. In the first of these studies, Eisenberger, Lieberman, and Williams (2003) engineered an experimental situation in which participants were unexpectedly excluded from a computer game by a virtual interaction partner, who simply started ignoring the participant. Participants reported experiencing social rejection under these circumstances, and the authors found that the depth of such
rejection feelings was positively correlated with activity in the dorsal ACC. Since this initial study, other studies have also implicated the ACC, although some of them find a more ventral rather than dorsal region (Somerville, Heatherton, & Kelley, 2006). Another recent study (Burkland, Eisenberger, & Lieberman, 2007) found a relationship between rejection sensitivity and activity in both dorsal ACC and the ventral ACC during emotional processing. The somewhat disparate findings of these studies indicate the need for further research to more clearly identify the neural correlates of states of social distress, especially in terms of the functional roles of ACC in processing and responding to threat cues.

Of course, social threats also come from outside one’s own group. The cognitive neuroscience of such external threats has burgeoned in recent years, the amygdala being the area most commonly identified as relevant to outgroup threat. For example, studies have associated amygdala activity with white perceivers’ negative responses to African-Americans (Cunningham et al., 2004; Phelps et al., 2000; Richeson et al., 2003). People who possess stigmatizing conditions that make them seem less than human, such as the homeless, also activate regions of the amygdala (Harris & Fiske, 2006). Krendl, Macrae, Kelley, Fugelsang, and Heatherton (2006) have found amygdala responses to physically unattractive individuals or people who are otherwise stigmatized by their appearance.

Considered together, these data strongly suggest that evaluations of outgroup members engage the amygdala. But what precisely does the amygdala do in the context of social cognition? One possibility derives from the longstanding notion that the amygdala may play a special role in responding to stimuli that elicit fear (Blanchard & Blanchard, 1972; Feldman-Barrett & Wager, 2006; LeDoux, 1996), suggesting that the amygdala may contribute to hard-wired circuits that have developed over the course of evolution to protect animals from danger. For example, the amygdala is robustly activated in response to primary biologically relevant stimuli (e.g., faces, odors, tastes), even when these stimuli remain below the subjects’ level of reported awareness (Morris, Ohman, & Dolan, 1998; Whalen et al., 1998).

However, many recent imaging studies have also observed amygdala activity in response to stimuli of positive valence, indicating that the amygdala is not solely concerned with fear. Indeed, some have argued that the amygdala is important for drawing attention to novel stimuli that have biological relevance. For instance, Stephan Hamann and colleagues (Hamann, Herman, Nolan, & Wallen, 2004) found that activity within the amygdala increased when both men and women viewed sexually arousing stimuli, such as short film clips of sexual activity or pictures of opposite-sex nudes. As such, the amygdala may play a role in processing social emotions more generally, because such affective states have direct relevance in maintaining long-term social relationships. Along these lines, Paul Whalen has argued that the amygdala is especially concerned with ambiguous stimuli that provide insufficient information to discern the nature of the threat (Whalen, 1998, 2007); since fear faces indicate an unspecified threat, they may engage the amygdala more than less ambiguous facial displays, such as anger (Whalen et al., 2001).

The “special” nature of social cognition

As was discussed above, a particular set of social-cognitive processes supporting our understanding of other minds has consistently been linked to a fairly small number of brain regions: specifically, the MPFC, TPJ, and medial parietal cortex. Interestingly, this set of brain regions is marked by an unusually high rate of resting metabolic activity. That is, different brain areas have overall higher or lower rates of metabolism when individuals rest passively without performing a specified task (Gusnard & Raichle, 2001), suggesting that some regions may chronically carry out cognitive processing even in the absence of explicit task demands. This observation suggests that, when allowed to relax to baseline, the human brain seems to persist in some kinds of social-cognitive processing, subserved by regions such as the MPFC and TPJ that have particularly high resting metabolic rates.

Perhaps even more speculatively, these brain regions demonstrate an unusual tendency to “deactivate” when perceivers engage in tasks that do not rely on social thought. When performing tasks that instead require consideration of nonsocial aspects of the world (e.g., visual search or semantic decision tasks), the human brain seems to suspend the otherwise high resting activity in the MPFC, TPJ, and medial parietal cortex. Suggestively, the tendency to deactivate during nonsocial tasks suggests that the processing in these regions may be in some way incompatible with nonsocial cognition; the brain regions that subserve other aspects of cognition (e.g., language or vision) do not share this feature of active inhibition when one performs a task that does not require those processes. Together, these observations suggest, albeit speculatively, that the human cognitive system may be in a state of continuous readiness to encounter other minds (hence the high resting metabolic rate evinced by these regions) and that this social default must be actively suspended to engage appropriately with nonsocial entities, such as inanimate objects.

Conclusion

Over the past two decades, the integration of cognitive neuroscience and social psychology has led to a spate of insights into the neural basis of human social cognition. In beginning to examine the neural underpinnings of social behavior,
researchers have begun the process of carving social cognition "at its joints," using the brain to identify the cognitive processes that allow humans to tap into the minds of others. We have learned that social thought relies on a suite of different mechanisms, some of which are quite distinct from the processes that subserves nonsocial aspects of human cognitive abilities, whereas others make use of more general-purpose computations. Here, we have specifically suggested that the social brain comprises at least four distinct mechanisms: awareness of self, understanding other minds, regulation of one's own behavior and emotions, and the detection and avoidance of social threat. But the field of social neuroscience is still very much in its infancy, and much remains to be added to this list. We look forward to such future insights with excitement.

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