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Research Report

Social cognition: A multi level analysis

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ABSTRACT

This paper investigates the construct of social cognition from an interdisciplinary perspective blending social psychology and cognitive neuroscience. This perspective argues for the inclusion of processes used to decode and encode the self, other people and interpersonal knowledge in the definition of social cognition. The neural modularity of social cognition is considered. The paper concludes by considering a number of challenges for social cognition research including questions of accuracy and the influence of motivation and bias in social cognitive processing.

The preference of newborn infants to attend to human faces as much or more than other objects (e.g., Mondloch et al., 1991) and studies showing that a large percentage of conversation is devoted to gossip (Dunbar, 2004) suggest that people have an early and persistent interest in themselves and other people. The processes by which people understand themselves and other people are referred to as social cognition. Social cognition has interested scientists from disciplines as varied as psychology, cognitive neuroscience, anthropology, and sociology. The purpose of this article is to define social cognition through an interdisciplinary lens bridging psychology and cognitive neuroscience. From this perspective, this paper addresses the definition of social cognition, the specificity of neural systems underlying social cognition, and the implications of this view for future research.

1. A definition social cognition and its core processes

1.1. *The domains of social cognition*

Social cognition broadly includes the cognitive processes used to decode and encode the social world. The most complete description of social cognition must include information processing about all people, including the self, and about the norms and procedures of the social world. These processes are likely to occur at the automatic and controlled levels of processing and will be influenced by a number of motivational biases.

The first component of social cognition includes the processes used to perceive other people. Questions concerning

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these processes have been a central topic of experimental research and a full consideration of this work is beyond the scope of the present article. Instead, two points regarding person-perception processes are highlighted. First, understanding other people likely involves multiple stages of processing. For example, we may use information from any number of sensory channels to process both verbal and nonverbal cues to understand others. These cues may be categorized or labeled in order to extract psychological meaning (i.e., a smile versus a frown). Once this initial assessment is formed, more information about the cues may be extracted from information gathered in the context or stored information derived from previous experience with the context and/or person involved. It is also important to note that as the process of person-perception unfolds, motivational biases may alter this process. In other words, if we know a person to always be grumpy, this expectation may make us quick to detect a frown or see one when it does not exist. Second, we are not arguing that the meaning extracted from a social cue is somehow fixed; social cues may be construed in a number of ways. For example, a furrowed brow may indicate anger or concentration. Again, information about the context and the person will be useful in construing cues on a situation by situation basis.

We include the self as a second component of social cognition because, like other people, the self is a social object that needs to be understood (e.g., Adolphs et al., 2001; Barone et al., 1997; Fiske and Taylor, 1991; Kihlstrom and Klein, 1994). Although researchers studying person-perception and researchers studying self-perception are often distinct groups, these two social-cognitive processes may be intrinsically intertwined in at least two ways. First, people are driven to understand themselves (e.g., Trope, 1982) and may partially accomplish this task by engaging in processes similar to those used for the perception of other people (Bem, 1972). For example, developmental research supports commonalities between self- and other-perception. Both self- and other-perception first manifest in physical activity and later become more complex as cognitive development progresses. Very young children indicate self-perception by pointing to themselves in a mirror or in a picture and similarly indicate other-perception by pointing to direct others' attention (e.g., Baron-Cohen, 1995; Lewis and Brooks-Gunn, 1979). Later on in development, both self- and other-perception are characterized by changes in the ability to represent mental states and the ability to infer differences between the self and other (e.g., Perner and Wimmer, 1985; Wellman and Woolley, 1990; Wimmer and Perner, 1983). Self-perception and other-perception both begin in a fairly egocentric fashion: children assume that other people always share their perspective. For example, a child may try to comfort a parent by offering up a cherished stuffed animal. As perception of self and others matures, individuals are able to recognize that their perspective is independent of others and may be fairly distinct at times. At this stage, individuals recognize that comfort can mean different things to different people.

Second, the self may serve as a cognitive filter through which other people are perceived. For example, introspections and personal experiences may be used to make inferences about the intentions and emotions of others, either consciously or unconsciously (e.g., Meltzoff and Brooks, 2001; Nickerson, 1999). Considering one's own feelings in a similar situation is one source of information for making inferences about others. Additionally, people might project their own beliefs onto others (Newman et al., 1997). Similarly, the self can be used as a reference to organize representations of other people (i.e., we are similar because we both like reading but we differ on extraversion). In all of these cases, self-beliefs serve as an anchor point for understanding others (Epley et al., 2004).

A final component of social cognition that has received less attention, particularly in neuroscience, is the fund of social knowledge that enables people to successfully manage life tasks (e.g., Kihlstrom and Cantor, 2000; Wood et al., 2003). This knowledge consists of both declarative and procedural processes that may be expressed and accessed both implicitly and explicitly. In social cognition, declarative knowledge is characterized by facts or abstract concepts (e.g., semantic memory) about social scripts, relations, and phenomena. In other words, this is a component of social cognition that has to do with what a person can state about the social world. For example, people can state norms about politeness even though they may differ across cultures. In contrast, the procedural knowledge component of social cognition is characterized by rules, skills, and strategies. This knowledge enables people to select responses or actions in social environments. For example, blowing one's nose is most politely done with a tissue rather than a shirt sleeve. These two types of knowledge are used in conjunction to accomplish tasks in the social world. For example, a person may want to befriend another person. The person's declarative knowledge may include the belief that friends are often people who share common interests. The person may then draw upon procedural knowledge to identify strategies for meeting like-minded people to befriend.

In summary, social cognition is defined as the perception of others, the perception of self, and interpersonal knowledge. The basic cognitive processes in social cognition involve the perception a social stimulus (the self, other people or the interaction of the two) in varying degrees of complexity. Later stages of elaboration integrate basic perceptions with contextual knowledge and, finally, involve representations of possible responses to the situation. The information sources may differ for the self- and other-perception and they may be interdependent. Finally, all of these processes may be operated upon implicitly and explicitly and may be subject to bias (see Problems section).

[1] Note that the issue is not whether there are specialized processing units at varied levels of analysis in the brain. It is well known that there are systems relatively specialized for processing object identity as compared to object location (the ;'what' vs. 'where' systems), for example, and that within a discrete sections a visual cortex there are columns specialize for processing lines or edges. The issue under consideration here is whether there are cortical systems dedicated for a specialized social cognitive function.

2. Social cognition: a neural module?

The interconnected and overlapping nature of the psychological processes involved in social cognition has often raised questions about whether there is a social cognitive module in the brain. Arguments in favor of brain modules often begin with the assumption that culture and social interaction give rise to benefits that are associated with the selection pressure necessary for developing specialized brain modules responsible for carrying out domain-specific social cognitive processes (e.g., Adolphs et al., 2001; Brothers, 1996; Cosmides and Tooby, 2004). With the possible exception of language, brain modules for specific higher-level abilities have almost always suffered under scientific scrutiny[1] (e.g., debates regarding the facial processing module, Gauthier et al., 1999; the emotional module of the limbic system, LeDoux, 1993). It is likely that any proposed social cognition module will experience the same fate for several reasons. Most generally, almost every brain function can be employed for social cognition; vision, language, hearing, memory, and more are likely to be recruited for social cognitive processing but are not unique to social cognition. The generality of the neural systems adopted for social cognition is exemplified in the various systems that are recruited for the different kinds of representations underlying social cognition outlined in the previous section. Perceptual encoding of inter- and intra-personal cues is likely supported by the visual, hearing, and visceral systems. The attribution of semantic meaning to these cues may recruit neural systems involved in semantic or declarative knowledge. Selection of actions is likely to draw on the neural systems involved in procedural knowledge. If almost everything can be used for social cognition but is not specific to social cognition, then the concept of a module becomes useless.

To the extent that there is a social cognitive brain system, it may involve additional neural areas recruited to perform these more general cognitive processes when the content is social in nature (i.e., self, other, interpersonal phenomena). For example, it is not easy to reduce representations of one's own mind or other people's minds to processes recruited for making inferences about non-intentional motion of non-social objects (e.g., Mason et al., 2004; Mitchell et al., 2002). Are special neural areas involved in self-perception, other-perception and interpersonal knowledge?

The extant research suggests that, for the most part, a host of interconnected and overlapping brain regions have been associated with self-perception (see Table 1), other-perception (see Table 2) and interpersonal knowledge (see Table 3) (see also Ochsner et al., 2005). The most common brain regions associated with social cognition include the frontal lobes (particularly the orbitofrontal and medial prefrontal subdivisions and the cingulate), the temporal lobes (both cortical and subcortical regions such as the amygdala), the fusiform gyrus, and the somatosensory cortices (e.g., Adolphs et al., 2001; Beer et al., 2004).

A second issue in the modularity of social cognition is whether or not there is neural specificity within the domain of social cognition. In other words, are there additional or different brain regions involved in the perception of one's self versus another? Some studies have reported the additional involvement of medial or right frontal areas for self-judgments when compared to other-judgments (e.g., Craik et al., 1999; Keenan et al., 2000; Kelley et al., 2002; Kircher et al., 2002) while other studies have not found differences (e.g., Fossati et al., 2003; Ochsner et al., in press). The mixed results from the neural studies mirror the studies conducted at the behavioral level. Initially, studies suggested that special cognitive processes were recruited for self-judgments because of superior memory for information encoded in relation to the self versus others (Markus, 1977; Rogers et al., 1977). Later studies provided strong evidence that the same types of processes (i.e., elaboration, organization) are engaged for self-perception and other-perception but in a more intense manner for the self and emotionally close others (e.g., Klein and Kihlstrom, 1986; Symons and Johnson, 1997). Specifically, information about the self and close others has superior elaboration because of the increased emotional intimacy and privileged experience in those two domain. Consistent with these studies, the neural studies comparing self- and other-perception have found differences in medial prefrontal activation when they

Table 1 – Brain areas associated with self-inferences and self-representations

Task	Brain structure/ area of damage	Citation
Anterior cingulate		
Self-reference	Anterior cingulate (BA 24)	Craik et al., 1999
Positive self- vs. negative self-judgments	Anterior cingulate (BA 32)	Fossati et al., 2003
Self vs. other person judgments	Anterior cingulate (BA 32)	Gusnard et al., 2001
Posterior cingulate		
Self-reference	Posterior cingulate (BA 31)	Fossati et al., 2003
		Kelley et al., 2002
		Kircher et al., 2000
		Kircher et al., 2002
Frontal Lobes		
Self-reference	Medial frontal lobe (BA 9/10)	Craik et al., 1999
		Fossati et al., 2003
		Kelley et al., 2002
		Ochsner et al., 2005
Self-reference	Inferior frontal gyrus (BA 47)	Craik et al., 1999
	Inferior frontal cortex	Kelley et al., 2002
	Inferior frontal gyrus (BA 44)	Kircher et al., 2002
Own face vs. unknown face	Inferior frontal gyrus (BA 45/46)	Kircher et al., 2000
Own face vs. partner's face	Middle frontal gyrus (BA 8/9)	Keenan et al., 2000
Own face vs. self-descriptions		
Impaired self-perception	Orbitofrontal cortex damage	Beer et al., in press
	Right frontal lobe damage	Keenan et al., 2000

Note. BA = Brodmann's area.

Table 2 – Brain areas associated with person-inferences and person-representation

Task	Brain structure/ area of damage	Citation
Amygdala		
Recognizing sadness vs. anger	Amygdala	Blair et al., 1999
Recognizing emotion vs. neutral (or age judgment)	Amygdala	Gur et al., 2002
Recognizing fear vs. happy	Amygdala	Morris et al., 1998
Recognizing fear vs. neutral	Amygdala	Breiter et al., 1996 Phillips et al., 1997 Sato et al., 2004
Recognizing happy vs. fear	Amygdala	Breiter et al., 1996
Impaired perception of emotion in others	Amygdala damage	Adolphs et al., 1994, 1995, 1999, 1998 Adolphs et al., 2002a Adolphs and Tranel, 2003, 2004 Anderson and Phelps, 2000 Broks et al., 1998 Glascher and Adolphs, 2003 Scott et al., 1997 Sprengelmeyer et al., 1999 Young et al., 1995, 1996
Impaired theory of mind	Amygdala damage	Shaw et al., 2004 Stone et al., 2003
Frontal Lobes		
Other reference	Medial prefrontal lobes	Ochsner et al., 2005
Inferences about people vs. dogs	Middle frontal gyrus (BA 9)	Mason et al., 2004
Empathic judgments	Orbitofrontal gyrus Superior frontal gyrus Inferior frontal gyrus	Farrow et al., 2001
Impaired empathy	Frontal lobe damage	Eslinger, 1998 Grattan and Eslinger, 1992 Grattan et al., 1994 Price et al., 1990 Shamay-Tsoory et al., 2003
Theory of mind	Medial frontal gyrus (BA 8/9)	Baron-Cohen et al., 1999 Fletcher et al., 1995 Goel et al., 1995
Impaired theory of mind	Orbitofrontal cortex damage	Stone et al., 1998
	Frontal lobe damage	Happe et al., 2001
Impaired perception of emotion in others	Orbitofrontal cortex damage	Adolphs et al., 2002b Beer et al., 2003 Hornak et al., 1996
Cingulate		
Empathy for physical pain	Rostral anterior cingulate	Singer et al., 2004
Fusiform gyrus		
Recognition of faces	Facial fusiform area	Kanwisher, 2000 for a review
Somatosensory cortices		
Impaired empathy	Somatosensory damage	Adolphs et al., 2000
Superior Temporal Sulcus/Gyrus		
Theory of mind	Superior temporal gyrus (BA 22/39) Anterior superior temporal sulcus	Fletcher et al., 1995 Rilling et al., 2004 Saxe et al., 2004
Impaired perception of emotion in others	Anteriomedial temporal lobe	Adolphs et al., 2001

Note. BA = Brodmann's area.

compared the self to non-close others (e.g., Craik et al., 1999; Kelley et al., 2002) and no differences in this region when they compared the self to a close other (e.g., Fossati et al., 2003; Ochsner et al., in press). These studies suggest that common neural systems will govern judgments about the self and others so long as emotionality/familiarity is held constant.

However, different information sources may be drawn upon to make judgments about the self in comparison to others. For example, the perception of emotion in one's self may include interoreceptive perception that is not available when perceiving another's emotion. These differences suggest that there may be additional brain areas recruited for judgments of the self and close others. For example, most representations of the self become abstracted over time and judgments are no longer tied to specific instances. In contrasts, a series of studies suggest that most judgments about others are derived from specific episodes (e.g., Klein et al., 1989, 1996). This difference has also been borne out in neural studies which have found increased hippocampal activity in relation to judgments of others in comparison to self-judgments (Ochsner et al., 2005). The hippocampus is a region that is thought to be involved in retrieval of episodic information. Therefore, while there are many commonalities between self- and other-perception at both the cognitive and neural level, there are certainly differences. These differences are most likely to result when different information is used to perceive the self versus other.

In summary, it is unlikely that there is a special neural system that handles social cognitive demands. Almost all neural systems can be recruited for social cognition and many of these systems perform similar functions when processing information from non-social domains. Similarly, arguments for modules specific to self-processing have not been robustly

Table 3 – Brain areas most commonly associated with social knowledge

Task	Brain structure/ area of damage	Citation
Amygdala		
Non-moral vs. neutral	Left amygdala	Moll et al., 2002
Untrustworthy vs. trustworthy	Right amygdala	Winston et al., 2002
Impaired social knowledge	Amygdala damage	Adolphs et al., 2000, 2002a,b, 1998 Bar-On et al., 2003
Frontal lobes		
Moral vs. non-moral judgments	Medial frontal (BA 9/10)	Greene et al., 2001
Person vs. object	Inferior frontal gyrus Superior frontal gyrus	Mitchell et al., 2002
Impression formation vs. sequencing	Dorsomedial prefrontal cortex	Mitchell et al., 2004
Moral vs. neutral	Medial frontal (BA 10/11)	Moll et al., 2002
Explicit vs. implicit trustworthiness	Superior frontal sulcus	Winston et al., 2002
Interpersonal knowledge	Prefrontal lobes	Wood et al., 2003
Impaired social knowledge	Orbitofrontal/ Ventromedial cortex damage	Bar-On et al., 2003 Cicerone and Tanenbaum, 1997 Saver and Damasio, 1991
	Prefrontal cortex damage	Anderson et al., 1999 Blair and Cipolotti, 2000 Goel et al., 1997 Gomez-Beldarrain et al., 2004 Grattan and Eslinger, 1992 Mah et al., 2004 Price et al., 1990
Superior temporal sulcus/gyrus		
Person vs. object	Superior temporal lobe	Mitchell et al., 2002
Untrustworthy vs. trustworthy judgment	Superior temporal sulcus/gyrus	Winston et al., 2002

Note. BA = Brodmann's area.

borne out in the research literature. Although neural differences have been found for self-processing, they appear to reflect the application of different strategies (e.g., drawing on abstract rather than episodic information) for perceiving one's self versus another. However, these same processes might be used for self-perception but much less frequently (e.g., draw on episodic knowledge in new domains for the self such as starting college).

3. Problems and challenges for future social cognition research

Although research on social cognition is probably at an all time high across a number of disciplines, there are a number of challenges that lie ahead. First, the most parsimonious explanation of social cognition remains an unanswered question. One of the simplest models suggests that social cognition depends upon motor representations that support understanding of one's own intentions as well as the intentions of other people. Self- and other-perception share a set of common underlying 'mirror neurons,' or 'shared representations' that connect perceptual displays of actions and their accompanying intentions. From this perspective, much of social cognition is accounted for by the perception of nonverbal cues that trigger shared motor representations (e.g., Blakemore and Decety, 2001; Gallese, 2003; Jeannerod and Jacob, 2005). If this account is correct, it raises a number of questions. For example, many actions are ambiguous and additional information may be needed to make attribution about intentions. Someone lifting a key may be using it to open a door, handing it to another person, or examining the key itself. If the observation of the movement occurs simultaneously with a representation of intention, then how are the multiple possibilities of intention sorted through? Additionally, a developmental perspective raises questions about the intrinsic relation between observation of movement and a mental category for that movement. How do representations of movement and intention become connected? Are they hardwired from birth or does the system begin with independent representations of movement and intention?

Second, research on social cognition has not been conducted equally across the domains of self-perception, other-perception, and interpersonal knowledge. An equal distribution of research will be beneficial for understanding the relation between basic and more complex social cognitive processing. For example, the most complete understanding of the role of automatic and controlled processing in social cognition will come from studies which examine these processes across all of the domains. Additionally, more communication between researchers interested in self- and other-perception will be beneficial for understanding the commonalities and distinctions between these two processes. Currently, researchers in psychology interested in person perception often treat self-perception as a completely distinct topic. At a neural level, most of the research has focused on differences between self and other and the modularity of social cognitive processes. Neither level of analyses has paid much attention to the component of social cognition in which contextual and procedural information is used to negotiate the social world.

Once these more basic issues have been resolved, at least two additional challenges lie ahead for social cognition research. The first will be to examine the general accuracy of social cognitive processing. How good are we at perceiving ourselves, perceiving others, and understanding social norms? Some theorists argue we are not very good at it (e.g., Funder, 1995; Nisbett and Wilson, 1977). If social

cognitive processing tends to be poor but is rooted in predictable neural systems that accomplish reasonable perception in non-social domains, then why is the social domain so problematic? It may be that we care more about the answers so that our motivations bias our perceptions and judgments in the social domain. For example, determining whether a shirt is red or blue is much less emotionally charged than determining whether one's self is a failure or a success. Do the motivational biases that have been demonstrated in relation to self- and other-perception such self-enhancement and self-verification (e.g., Murray et al., 1996; Plaks et al., 2001; Swann and Schroeder, 1995; Taylor et al., 1995; Robins and Beer, 2001) really compromise social cognition? Or should these biases be considered similar to the biases in the visual system (e.g., filling in the blind spot) which promote vision that is 'good enough' but comes at the cost of complete accuracy? Although social cognition has often been criticized as flawed because of the evidence of cognitive heuristics in the perception of self, people and social phenomenon, it is worth keeping in mind that 'short-cuts' in the visual system have often been lauded as demonstrations of the elegance and efficiency of visual perception.

A second challenge will be to understand how the brain represents the relationship between a person and their situational context. One of the primary messages of social psychological research has been that social situations are powerful influences on behavior. Cognitive neuroscientists often talk about task context as determining when and how particular behavioral responses are appropriate. It is not yet clear how a situational context is represented in the brain such that it affects social judgment and social action. Do situations provide a set of perceptual cues that activate the multiple types of person knowledge representations discussed earlier? If so, how do these different types of representations interact to guide us towards social judgments and socially appropriate behavior?

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