Theory of Mind and the Self

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ABSTRACT: This paper will discuss one aspect of the self, the ability to reflect on one's own inner states, in relation to recent work on the cognitive and neural basis of "theory of mind." Are the same representational resources required for "reading" one's own and other minds? Relevant literature from the study of normal development of theory of mind will be reviewed, along with research on a developmental disorder characterized by an apparent inability to think about thoughts: autism. Functional neuroimaging studies of theory of mind will be discussed as will studies that may tap the neural basis of self-reflection. From these different strands of evidence the speculative suggestion will be made that reflecting on one's own thoughts is not a privileged process, but rather relies on—and may have evolved from—the same cognitive and neural functions used for attributing thoughts to others.

KEYWORDS: theory of mind; autism; self-awareness; development; neuroimaging; brain

THEORY OF MIND AND THE SELF

"Theory of mind" refers to the everyday ability to attribute independent mental states to self and others in order to predict and explain behavior (Premack & Woodruff, 1978). This ability appears to be a prerequisite for normal social interaction: In everyday life we make sense of each other's behavior by appeal to a belief–desire psychology. For instance, it is trivially easy to explain why John will carry his umbrella with him: it is because he *believes* it will rain and he *wants* to stay dry. Attribution of mental states is vital for everyday social interaction (e.g., cooperation, lying, keeping secrets).

The cognitive processes that underlie the development of Theory of Mind (ToM) are still a matter of debate. The practitioners in the field can be divided

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into those who favor a more general explanation for ToM (e.g., simulation, general theory building) and those who argue for the necessity of a dedicated cognitive mechanism (for debate see, for example, chapters in Carruthers & Smith, 1996). Evidence in favor of a dedicated, innately specified cognitive mechanism underlying ToM includes the relative lack of normal individual difference or cross-cultural variation, the rapidity of acquisition in early childhood, and the case of autism, a biologically based disorder characterized by selective ToM impairment (see below). Of course, even with an innate predisposition underlying ToM, triggering input will be required, including experience of social interactions.

Despite the sometimes tortuous debate concerning the nature of ToM, paradigms for testing ToM are extremely simple. The litmus test for ToM has been the ability to attribute *false beliefs***,** where prediction and explanation of action cannot be based simply on own convictions or the state of the world. In other words, in order to pass the test, the particular beliefs held by another must be considered and held separate from own knowledge. Because of its relatively high verbal and executive task demands, this test can only be given to children from age 3 or 4 onwards. This is not to say that below that age children are not implicitly aware of others' mental states. There are plenty of signs that even in infancy the young child is capable of tracking another's intention (e.g., Gergely et al, 1995).

The two most frequently used false-belief tasks, both developed by Wimmer and Perner (1983), are location change and content change tasks. In the *Sally–Anne task*, a location-change task, Sally has a box and Anne has a basket. Sally puts her marble into her box, then goes out for a walk. While she is out, naughty Anne takes the marble from the box and puts it into her own basket. Now Sally comes back and wants to play with her marble. Where will she look for the marble—where does she think the marble is? The answer that seems obvious to a 4-year-old child is: Sally will look inside her box, where she *thinks* the marble is. Younger children have some difficulty with this task and often point to the basket, indicating that Sally will look where the marble really is.

In the *Smarties task* (Hogrefe, Wimmer & Perner, 1986), a content-change task, the experimenter shows a well-known sweet container, a tube, to the child and asks: What is in here? The child answers "Smarties," or sweets. The experimenter reveals that the tube contains a small pencil, and closes the tube again. Now the experimenter says: "Your friend John is going to come in now. He hasn't seen this tube. When John comes in, I'll show him this tube just like this and ask: 'What's in here?' What will John say?" The average 4-year-old will answer that John will say "Smarties." Younger children have trouble with this task and claim that John will say "a pencil." Furthermore, when asked what they themselves at first thought was in the tube, children under four will typically assert: "a pencil."

THEORY OF OWN MIND AND THEORY OF OTHER MINDS

A theoretically important question for philosophers and psychologists is whether the same cognitive mechanism required for attributing thoughts and feelings to others is also necessary for attribution of mental states to self. At first glance the two attributions seem entirely different: own mental states do not have to be inferred through observation, and might be expected to be more accurate. However, even though the input channels by which the relevant information is received may well be different, a crucial part of the process is to distinguish mental states, be they first person or other people's, from representations of the physical world. For example, it is necessary to distinguish the representation of the reality, that "there is a pencil in the tube," from the representation of the belief, I *thought* "there are sweets in the tube," and John *thinks* "there are sweets in the tube." It seems plausible that the mechanism that keeps separate representations of mental states from representations of physical states is the same whether the mental states in question are ascribed to self or others.

Leslie (1987) provided the first and most explicit description of the computational underpinnings required for ToM. He suggested that understanding of pretense in infancy demonstrates the availability of a special form of representation for mental states as mental states. Second-order or meta- representations are kept separate from first-order or primary representations of real states of affairs. Hence, the child observing his mother playfully using a banana as a telephone does not get confused about the normal use of phones and bananas. A meta-representation represents the attitude an agent takes to a description of a particular aspect of reality. In contrast, a primary representation describes a particular aspect of reality. Leslie postulates that meta-representation is necessary for attribution of any mental state, including (false) beliefs, and is necessary equally for self and other attribution.

Whether or not Leslie's general theory of ToM is accepted, it seems clear that underlying our social understanding must be representations that capture who is thinking what and in what sense they are thinking it. Are they believing it, desiring it, hoping it, fearing it? Without in some way tagging a representation with an agent marker, own and other's beliefs would be confused. Without marking an attitude, beliefs, desires, and pretense would be confused.

Despite the intuition that we know our own minds better than the minds of others, there is little evidence from the developmental literature to suggest that mental states are attributed to self before they are attributed to others. For instance, children do not systematically pass the self-question in the Smarties test ("What did *you* think was in the tube?") before passing the other's belief question ("What will John think…?"). Relevant studies are summarized by Gopnik and Meltzoff (1994), who conclude that when children are able to report their own mental states they are also able to report the mental states of others. Conversely, when they cannot report and understand the psychological states of others, they do not report those states of themselves. Lang and Perner (2002), too, found a strong relation between performance on standard (other) false-belief tasks and a test requiring insight into own reflexive (knee-jerk) versus intentional action—with the two tasks being of about equal difficulty for young children. If there is a common representational mechanism for attributing mental states to self and to others, then these findings make sense.

AUTISM—A DISORDER OF "THEORY OF MIND"

It is arguable whether we would ever have thought of such a thing as a neurologically specified theory of mind (ToM) mechanism, let alone a circumscribed brain system underlying this mechanism, were it not for the fact that individuals with autism appear to lack the ability to attribute mental states. Autism is a developmental disorder with a genetic basis and a prevalence of 0.1 to 0.6 %. It is diagnosed on the basis of early emerging qualitative abnormalities in social interaction, communication, and imagination (with restricted interests and activities). One striking feature of young children with autism is the lack of pretend play. It was this observation that originally suggested that, on Leslie's account, meta-representation and hence ToM might be impaired in autism. From this observation it was predicted that false-belief attribution might also be impaired, despite sufficient verbal and nonverbal ability to follow the Sally–Anne task (Baron-Cohen, Leslie & Frith, 1985).

There now exists ample experimental evidence that individuals with autism have difficulty in conceptualizing mental states, and thus fail to attribute (false) beliefs to others (Baron-Cohen, Tager-Flusberg & Cohen, 1993). This failure is extremely specific and cannot be reduced to a failure in more general cognitive processes. This is seen in a number of contrasts between assets and deficits in otherwise very similar behavior, distinguished only by the necessity to attribute mental states (for review see, e.g., Frith & Happé, 1994).

While it has been easy for many people to accept that the devastating social and communicative handicaps of autism may result from a failure to attribute mental states to others, the notion that this mind-blindness might also apply to the child's own mind has scarcely been acknowledged (but see Carruthers, 1996). However, if the mechanism that underlies the computation of mental states is dysfunctional, then it is possible that the ability to reflect on own mental states will also be impaired. The logical extension of the ToM deficit account of autism is that individuals with autism may know as little about their own minds as about the minds of other people. This is not to say that these individuals lack mental states, but that in an important sense they are unable to reflect on their mental states. Simply put, they may lack the cognitive machinery to represent their thoughts and feelings *as* thoughts and feelings.

What would a mind without introspective awareness be like? One important consequence of impaired self-consciousness might be impaired understanding of one's own actions. In other words, without self-awareness, an individual might not know how she is going to act until she acted, nor why she acted as she did. This is different from the usual experience of actions, where we take access to our own imagined or true motivations for granted. It is easy to believe that we know what we are going to do before we do it. A person who lacks self-consciousness, however, may be unable to distinguish her own willed and involuntary actions (c.f., Lang & Perner, 2002).

While the (in)ability to attribute mental states to others has been studied extensively in children with autism, there is little work on the ability to attribute mental states to self. However, some evidence is available to indicate that the latter may be just as impaired as the former. For instance, Perner et al. (1989) asked children with autism about what they knew and what the experimenter knew concerning the contents of a box, depending on whether they had been allowed to look inside. On some occasions only the child was allowed to look inside, and on other occasions only the experimenter. While it may seem obvious that only the person who has looked inside the box will know what it contains, this was not at all obvious to children with autism. Many failed this task of self-reflection, and there was no sign of better performance on the "self" versus "other" questions. A similar finding is reported by Kazak, Collis, and Lewis (1997), who asked young people with autism whether they/the experimenter knew or only guessed what was in a box, having on some trials seen inside. Again, the results showed no superiority in judging own knowledge versus judging other's knowledge, in any of the experimental groups (autism, Down Syndrome, typical development).

Other evidence suggesting deficits in self-reflection in autism includes relative difficulty in reporting back own past thoughts (despite verbal IQ in the normal range; Fisher, unpublished Ph.D. thesis), and inability to keep track of own prior intention, in the face of conflicting outcome information (in a rigged target-shooting game [Phillips et al., 1999]). Contrary evidence, however, has been reported recently by Russell and Hill (2001), who found no autism-specific impairment in three intention-tracking tasks. It may be worth noting that intention is, in some ways, an interesting mental attitude that appears to hover between a simple (nonpropositional) desire (akin to a tropism; e.g., intending to get the cake) and a fully-fledged propositional attitude (intending that I have the cake). People with autism appear to have a basic understanding of their own and other people's desires (Tan & Harris, 1991).

The often-observed executive function deficits in autism (problems in planning and monitoring goal-directed action [Pennington & Ozonoff, 1996]) may be indirect signs of an inability to reflect on own mental states. Carruthers (1996) and Perner (1998) have each argued that these impairments may result from an inability to represent one's own intended and imagined future behaviors. For example, planning ahead in a task such as the Tower of Hanoi, may require meta-representation of possible (not actual) moves and of the desired (but not yet realized) end goal state. In the normal case, monitoring of performance and correction of errors can occur even in the absence of external feedback, because of access to own action intentions—access which may be impaired in autism. It has also been argued, however, that executive function deficits may be the primary cause of impaired theory of mind (Russell, 1996).

FUNCTIONAL IMAGING STUDIES OF ToM AND SELF-REFLECTION

Functional brain imaging studies are attempting to identify brain pathways sufficient to support mental state attribution (i.e., ToM) in healthy volunteers. Studies to date are summarized in TABLE 1 (see also Siegal & Varley, 2002). All have identified regions of the frontal lobes, among others, as showing increased regional cerebral blood flow (rCBF) during ToM tasks. Seven of the eight studies published to date (using different modalities and types of tasks) implicate medial frontal regions in ToM, along with different regions of the temporal lobes. Our current hypothesis is that this region is a key part of a neural system also including temporo-parietal cortex (STS) and the temporal poles/amygdala complex (Castelli et al., 2000; Frith & Frith, 1999).

The key paracingulate region (BA 8/9) found to be specifically activated in normal subjects engaged in ToM tasks was not activated by individuals with Asperger syndrome (a form of high-functioning autism) during these tasks (Happé et al., 1996). This region shows decreased grey matter volume in adults with autism (Abell et al., 1999), and an association has been found between rCBF in this region and socio-communicative symptom scores in 23 children with autism (Ohnishi et al., 2000).

A number of imaging studies using tasks that might be considered to tap self-reflection suggest that medial frontal and cingulate regions are also activated when subjects reflect on their *own* inner states. Tasks include monitoring one's own intended speech (McGuire et al., 1996), reflecting on one's emotional reaction to stimuli (Lane et al., 1997; Gusnard et al., 2001), and judging whether trait adjectives apply to self (Kelly et al., 2002). Thus online monitoring of own mental states may engage the anterior cingulate cortex and neighboring medial frontal regions, regardless of the specific source of information.

Only one study to date has asked, specifically, whether self-reflection and ToM applied to reading other minds activate any distinct brain regions or pathways. Vogeley et al. (2001) asked volunteers to read short vignettes

TABLE 1. Functional neuroimaging studies of theory of mind

Authors	Task (technique)	Results (ToM-related activation)
Baron-Cohen et al. (1994)	Identify mind words (PET regions of interest)	R. orbito-frontal cortex
Fletcher et al. (1995)	Infer mental states in stories (PET)	L. medial frontal (BA 8/9), inferior temporal
Goel et al. (1995)	Infer other's knowledge of object uses (PET)	L. medial frontal, L. middle temporal lobe
Happé et al. (1996)	Asperger volunteers, Fletcher '95 task (PET)	Asperger Ss do not activate BA 8/9
Baron-Cohen et al. (1994)	Identify mind words (PET regions of interest)	R. orbito-frontal cortex
Baron-Cohen et al. (1999)	Infer inner state from photo of eye region (fMRI) normal and Asperger participants	L. medial frontal, L. dorsolateral, L. amygdala, bilateral temporo-parietal; Asperger Ss do not activate amygdala, activate frontal regions less than controls
Brunet et al. (2000)	Choose final scene for picture sequence (PET)	R. medial frontal, R. inferior prefrontal, R. inferior temporal gyrus, L. STG, bilateral anterior cingulate, middle temporal gyri
Gallagher et al. (2000)	Infer mental state in single-frame cartoons and in stories (fMRI)	Medial frontal, temporal poles, temporo-parietal junction
Castelli et al. (2000	Infer mental state in silent animation (geometric shapes) (PET)	Medial frontal, temporal poles, temporo-parietal junction

which either did or did not include self as a protagonist. In the ToM vignettes the test question was about a character's thoughts, while in the Self vignettes the question was about your own likely behavior or attitudes in the imagined situation. The Self condition activated a network of brain regions highlighted in other ToM imaging studies. However, on the basis of an interaction of conditions, the authors interpret their findings as suggesting non-overlapping neural circuits for self and other mind-reading. Given that studies of ToM using different materials do not lead to exactly the same activation patterns, it is also possible to interpret the very tiny region emerging in this interaction (in the right prefrontal cortex) as suggestive of strikingly overlapping brain substrates for reading own and other minds.

Recently, Raichle and colleagues have suggested that the relative increase in blood flow in portions of the medial prefrontal (MPF) cortex during resting baseline conditions indicates a default state of self-referential mental activity in this region. Judging images for pleasantness (versus whether they were indoor or outdoor scenes) was associated with increased activation in dorsal MPF cortex, whereas both tasks resulted in decreased activation in ventral MPF cortex compared with baseline (Gusnard et al., 2001; Lane et al., 1997). These findings appear compatible with the above results on ToM activity in proximal regions, along with other data, including studies showing a relation between number of "stimulus-independent thoughts" and level of activity in medial prefrontal cortex (BA 8, 9, and 10 [McGuire et al., 1996]). It may be that when our minds are not attending to external stimuli they naturally turn in upon themselves, reflecting upon internal states.

CONCLUSIONS AND SPECULATIONS

Data from typical development give little evidence, to date, of better performance on tasks requiring reflection on own mental states (as mental states) and attribution of mental states to another person. People with autism, who show striking deficits in ToM, may show parallel impairments in knowing their own minds, although this has as yet received little research attention. Finally, neuroimaging findings to date, appear to suggest a network of regions involved in attribution of mental states to others, which largely overlaps with areas of activity in self-reflection tasks. On the basis of this work, systematic investigations of the effects of acquired brain lesions on self- and other-mind-reading would seem warranted. While devising tasks to tap consciousness is a notoriously knotty problem, a first step would be investigation of insight in relation to social cognition. Is it possible to find individuals who can no longer judge what others may be thinking, but can reflect on and report without problem their own mental states? More intriguingly, is it possible that some patients might lose the ability to self-reflect while still being able to attribute mental states accurately to other people?

If reflection on own mental states uses the same cognitive and neural "machinery" as representing others' mental states, emerges no earlier in development, and is lost or impaired in conditions of ToM deficit, an intriguing possibility presents itself. The evolutionary function of self-reflection, or more broadly self-consciousness, has remained uncertain, despite much discussion. On the other hand, the fitness advantages of anticipating the thoughts of competitors (so called Machiavellian intelligence) or cooperators (collaboration and communication) are clear. Might, then, the ability to read others' minds have evolved first, with the turning inward of the metarepresentational spotlight upon our own inner states developing only later?

If so, self-reflection may be, in one sense, an epiphenomenon—an extraordinary side-effect of the crucial ability to read other minds.

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