# Theory of mind

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## Introduction

The way we perceive and describe each other is radically different from the way we perceive and describe stones and trees and the rest of the inanimate world. We see others and ourselves as persons, as rational agents with an inner life and a subjective view on the world. Rational agents enjoy sensations and feelings, they perceive the world around them, believe things to be true, desire things to be the case, intend to further their ends. Rational subjects do not just behave, but perform intentional actions based on reasons: They act in ways that they take to be conducive to bringing about what they desire. In explaining rational actions, we reconstruct the beliefs and desires that formed the agent's reasons (e.g., "He took a bite of the onion because he wanted to eat an apple and thought this was one.").

This conceptual scheme with which we describe and explain one another as subjective rational agents comes under various names. Sometimes it is called *folk psychology*, sometimes more specifically *belief-desire psychology* (because beliefs and desires are the fundamental mental states involved in rational action explanation), but in developmental psychology and related disciplines it goes under the rubric of *theory of mind* (ToM). This is a rather unfortunate term, actually, since it suggests that this conceptual scheme is somehow a theory, an issue that is very much contested, as we will see. Nevertheless, it has simply become the standard term in the field, and is widely used without any commitments concerning the question whether or not ToM is in fact a theory.

ToM is fundamental to virtually every aspect of our mature social life: We could not properly communicate, cooperate, compete, or engage in any other ways with other people if we did not constantly monitor how they view the world, what they know, want, and feel, and what they are up to. Due to this fundamental importance to our everyday life, ToM has become a topic of intensive research in many areas pertaining to psychology. For example, comparative psychology investigates how ToM might have evolved and in which respects it might be a uniquely human capacity that underlies uniquely human forms of social life and culture. Cognitive neuroscience studies the cognitive and neural underpinnings of ToM, and clinical psychology investigates the causes and consequences of disorders of ToM.

The focus of this entry will be on ToM from the point of view of developmental psychology. It will be structured as follows: The following section will give an overview of the emergence and the typical and atypical development of ToM in childhood and beyond. Next, the most important theoretical approaches to ToM development will be discussed, with open questions and an outlook for future directions taken up in the conclusions.

## Typical child development

### *The 4-year revolution*

When and how in development do ToM capacities emerge? In addressing this fundamental question, developmental ToM researchers have mainly focused on children's ascription of representational states such as beliefs and desires. Such states, for example believing that the sun is shining, desiring for the sun to shine etc., refer to objects and situations in the world and represent them as being a certain way. They differ in the kind of attitude (belief, desire etc.) and the propositional content ("that the sun shines" etc.), which is why they are also called 'propositional attitudes.' Two hallmarks of understanding representational states are (1) understanding that a certain state might misrepresent a situation, and (2) appreciating that the very same situation might be represented differently by two agents (or one agent at different times).

Tasks that involve demonstrating an understanding of misrepresentation and diverging representation have

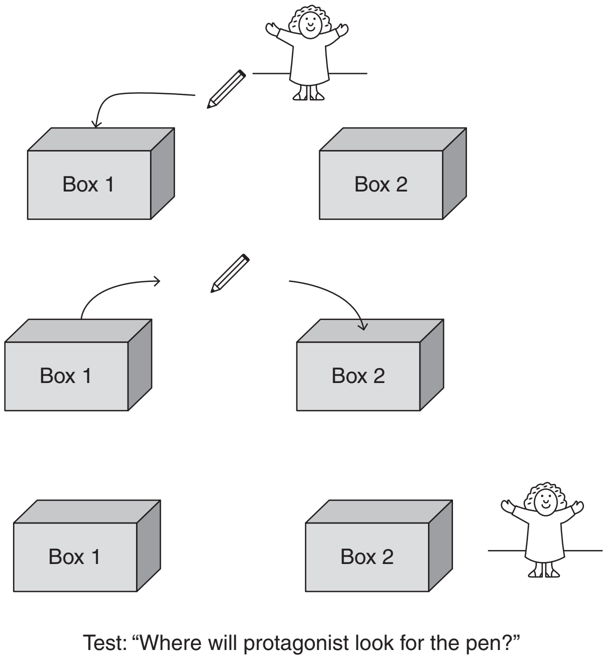


Figure 1. Typical narrative procedure of a standard change-of-location false-belief task after Wimmer and Perner (1983) (seen from the subject child's perspective). In step one, the child sees how the protagonist puts an object (here, a pen) into box 1 and leaves. In step 2, in the protagonist's absence, the child witnesses how the object is transferred to box 2. In step 3, after the protagonist's return, the test question is asked: "Where would the protagonist now look for the object?"

come to be considered litmus tests of ToM. A variety of now classical false-belief (FB) tasks require the child to ascribe to a protagonist a belief that diverges both from reality and the child's own belief and to explain or predict the subjectively rational action of the protagonist on this basis. In a typical *change-of-location* FB task, the protagonist puts an object O into box 1 and leaves. In her absence, someone else moves O to box 2. Upon the protagonist's return, the test question is then where will she look for O? (see Figure 1). In *unexpected content* FB tasks, the child is confronted with a familiar container, say a Smarties box, and asked what she thinks is inside (of course, children say "Smarties"). Then it is revealed that actually something else (e.g., a pen) is inside. The box is closed again immediately before the crucial test questions are asked: What would someone else not familiar with this box think was inside and what did the child herself initially think was inside. Hundreds of studies with such tasks from the last decades show a striking and consistent pattern of results.

- Children up to the age of approximately 4 tend to fail to grasp the agent's FB and thus systematically answer incorrectly (that the protagonist will act/answer on the basis of reality rather than their mistaken beliefs), whereas children from age 4 systematically answer correctly (Wellman, Cross, & Watson, 2001).
- There is an interesting symmetry between 3rd and 1st person FB ascription: In the unexpected content task, children younger than 4 usually answer incorrectly both that a naïve other person will think there is a pen in the box and that they themselves initially thought so, whereas older children tend to master both questions.
- Performance of children in these and conceptually related tasks that require understanding misrepresentation and diverging representations (e.g., visual perspective-taking tasks in which one has to grasp that the same thing looks different to different observers from different perspectives) emerges together and is very consistent, as indicated in strong inter-task correlations, even if the tasks differ in terms of surface structure, material etc. What this suggests is the emergence of a unitary novel conceptual capacity underlying all these tasks, namely, the acquisition of an understanding of representation (or 'meta-representation').
- This capacity seems to emerge around age 4 to 5 in children from various cultures all around the world, and has thus been discussed as a potential human universal (Callaghan *et al.*, 2005).
- All existing comparative studies suggest that this capacity is uniquely human. Various non-verbal adaptations of FB tasks have documented success in children from around the age of 4 years but consistent failure in chimpanzees and other great apes, and in any other non-human species, tested so far (Call & Tomasello, 2008).

### *Developments before the age of 4 years*

While children younger than the age of 4 years typically fail such explicit meta-representational tasks, some less complex forms of understanding mental states develop considerably earlier. Even in infancy, children begin to reveal some grasp of the fact that people perceive the world around them and are guided by goals and intentions.

Concerning an understanding of perception, from around 1 year of age, children follow the gaze of other people, even moving around barriers in order to align their vision with that of the other. While this could plausibly be interpreted as a sign of an understanding of the other person's perception, it might be more parsimoniously explained as mere following of another's head movement etc. But elegant research shows that gaze following is indeed cognitively richer. Twelve- to 18-month-olds were given experience with two sets of blindfolds, one of which was transparent and thus still could be seen through, while the other one was opaque (and the two merely differed in their color, but it could not be seen from the outside which one did or did not enable looking through). After experiencing these blindfolds, children followed the gaze of other agents with the transparent blindfold but not the gaze of agents with the opaque one. Around the same age, 20 to 24 months, children engage in so-called *level I perspective-taking*: They understand that others' and their own perspective at a given time might diverge in the sense that another person might see an object that the child herself cannot see, and vice versa.

Concerning an understanding of goal-directed action, children from around 1 year of age (or even earlier) indicate sensitivity to the intentional structure of action both in studies using habituation looking-time paradigms and in studies relying on more interactive paradigms. In looking-time studies, for example, when children see a ball jump over an obstacle on the way to another object, they seem to assume this has some rational means–ends structure (the ball jumps over the barrier in order to reach the other object). After being habituated to this scenario, and then confronted with a novel situation in which the barrier is absent, they look longer at the 'irrational' event in which the ball makes the same detour movement (unnecessary in this new situation) than at another novel, but rational, event in which the ball moves straight to the other object (Gergely, Knadasdy, Csibra, & Biro, 1995).

In more interactive measures, children's imitation reveals similar sensitivity to the intentional structure and rationality of others' actions: When confronted with an agent unsuccessfully trying to perform an action, what children then reproduce is not the superficial behavior of the agent but the action she unsuccessfully attempted, indicating an awareness of what she wanted to do yet failed to achieve. And when confronted with an agent performing a bizarre means to an end (e.g., operating a light switch with the head rather than the hand), children copy this action faithfully when the person had the more standard means available (her hands were free) but not when the model could not do otherwise since the standard means were not available as the hands were blocked (Gergely, Bekkering, & Kiraly, 2002). What this pattern of differential imitation suggests is that children considered the unusual means as just a means to an end in the latter case, but as an end in itself in the former.

Since these findings taken together suggest even infants have some grasp of perception and of goal-directed intentional action, such capacities have often been described as 'perception-goal psychology' that pre-dates (and possibly grounds) the later-developing belief-desire psychology. In contrast to belief-desire psychology with regard to which, as we have seen, there are fundamental cognitive differences between humans and other primates, perception-goal psychology seems to be a common cognitive capacity of humans and other great apes (and potentially other primates). Recent experimental studies with chimpanzees document analogous capacities to those of infants in keeping track of others' perceptions and intentional actions (Call & Tomasello, 2008). In human ontogeny, perception-goal psychology might be a developmental precursor of or foundation for the later-emerging belief-desire psychology. In longitudinal studies from the first to the fifth year, competence in early perception-goal psychology predicts later competence in belief-desire psychology.

Between ages 1 and 4, children gradually acquire more complex mental state concepts. For example, from the second year on, they develop some understanding of fictional mental states such as pretense and imagination. Soon afterwards, they ascribe simple desires to others and begin to distinguish between knowledge (in the sense of having had informational access) and ignorance (in the sense of lacking such access). Interestingly, the acquisition of these different mental state concepts usually follows a fixed, ordered sequence (Wellman & Liu, 2004).

### *New findings from implicit measures*

In the last decade, new studies have shown that in implicit looking-time tasks, even infants reveal some sensitivity to the false beliefs of other agents. When confronted with a typical change-of-location FB scenario in which an agent puts object O into box 1 from which it is transferred in her absence to box 2, upon the agent's return infants look in anticipation to box 1; and they look longer when the agent subsequently reaches toward box 2 than when she reaches toward box 1, but show the reverse pattern in true-belief control conditions in which the agents witnessed the object's transfer (Baillargeon, Scott, & He, 2010). What these studies clearly show is that infants are sensitive to some belief-involving situations. Beyond this, however, the interpretation of these findings has been very much contested. In particular, there have been deep controversies over the question whether these findings show that infants possess a concept of belief similar to the one assessed by explicit tasks years later (e.g., Apperly & Butterfill, 2009; Rakoczy, 2012; see below).

## Atypical development

Various clinical conditions and forms of atypical development go along with deviant developments in ToM. Most well known, autism is a developmental disorder that involves pervasive abnormalities in ToM. The typical autistic symptomology is characterized by deficits in social interaction and communication, and a tendency toward repetitive and stereotyped behavior. Soon after the beginnings of ToM research, it was discovered that children with autism are severely delayed in their ToM development compared to control groups (of typically developing children or children with other developmental disorders) matched in mental age. Some autistic children pass standard FB tests only years later than such controls, and others never succeed even though they do not show the same kinds of deficits on control tasks without any ToM elements (Baron-Cohen, Leslie, & Frith, 1985). And subsequent research found that autistic children also show social-cognitive deficits in infancy when they seem unable to ascribe intentions and perceptions to others in the same way as typically developing children.

These findings have led to the ToM account of autism according to which the ToM deficits (themselves biologically based) are the primary cause of autism (e.g., Baron-Cohen *et al.*, 1985). This hypothesis, however, is very much contested. First of all, even if there was an explanation of autism in terms of its underlying cognitive abnormalities, it is not clear that ToM would be the prime candidate. It is well known that autism is associated with fundamental deficits in executive functions and in the capacity to integrate information (sometimes called central coherence), and it could well be, and has been argued, that these deficits are responsible both for the ToM deficits and for many of the other symptoms. Second, and more fundamentally, it is not clear by any means that all cases on the autism spectrum can be accorded a single explanation based on one underlying causal factor. In summary, while a ToM deficit is well documented in autism, its role in the broader etiology of this developmental disorder is still not clear.

While the ToM deficits in autism seem to have a clear physiological basis, other conditions can produce similar developmental ToM delays and deficits in non-biological ways. Most strikingly, deaf children of hearing parents are massively delayed in their ToM development, mastering FB and related tasks only years later than control groups matched in terms of mental age (Peterson & Siegal, 1999). This contrasts with deaf children of deaf parents who show perfectly typical development of ToM capacities comparable to their hearing peers. Why is that? The crucial difference between the two groups of deaf children is their exposure to and acquisition of a native sign language: Deaf children of deaf parents learn sign language at home as their mother tongue and so show normal language acquisition, just in another modality. Deaf children of hearing parents, in contrast, lack such a native sign language and usually receive painstaking training in an oral language (e.g., lip-reading etc.), leading to a massive delay in language acquisition and a corresponding lack of communicative experience, factors deemed to be of crucial importance for normal ToM development (see below).

## Lifespan development

### *The growth of theory of mind*

Most developmental work on ToM has studied the emergence of this capacity in early childhood and has thus focused exclusively on the preschool years. More recently, however, a growing body of work has begun to investigate the functioning and development of ToM over the lifespan. First of all, it has been shown that children keep on acquiring novel, more complex conceptual capacities well into middle childhood and adolescence. In these periods, they come to acquire concepts of recursive higher-order beliefs ("She believes that he believes that I believe that she believes…"), and of more complicated emotions. Second, even in domains where young children have already acquired a basic competence in principle, like visual perspective-taking, their performance continues to develop until adolescence. For example, children gradually become faster and more accurate in putting their competence to work.

A very new field is experimental research on adult ToM in cognitive psychology and cognitive neuroscience. This field has begun to shed some light on the cognitive and neural underpinnings of ToM reasoning, and their relations to other cognitive processes and domains. One particularly exciting and controversial debate in this field is concerned with characterizing the development of ToM abilities from childhood to adulthood. The researchers interested in this topic are trying to understand whether the new, more complex competencies acquired in later years replace the older, less complex ones. Or, alternatively, is development to be seen as an amendment, such that the older capacities remain intact side by side with the new and more complex ones? Along the latter lines, some recent studies have argued that there is an initial form of automatic, unconscious, and implicit ToM that underlies infants' competence in implicit looking-time tasks, and that this initial form remains largely constant over the lifespan (beside adult conscious and explicit ToM capacities), revealing itself in processes of automatic perspective-taking even in adults (e.g., Kovács, Téglás, & Endress, 2010). In response, however, and along the former lines, other studies have doubted whether there is actually such a thing as automatic unconscious perspective-taking in adults. Much contemporary and future work will be dedicated to resolving this debate.

### *The decline of theory of mind*

How does theory of mind fare with aging? The findings so far are somewhat mixed. A few studies show no changes in old age, but the majority of findings suggest that some forms of ToM are in fact subject to age-related decline (see Henry, Phillips, Ruffman, & Bailey, 2013 for a recent meta-analysis). For example, older adults have been found to be less accurate than younger adults at ascribing complex higher-order mental states (such as double bluff, white lies etc.) to others, in particular when there are strong conflicts between others' and their own viewpoints. Older adults have also been found to be less accurate than younger adults at recognizing subtle emotions from pictures and movies presenting faces. What remains unclear so far is whether this decline, if it turns out to be a reliable and robust phenomenon, is a genuine and specific decline in ToM capacities, or whether it simply reflects age-related developments in other cognitive processes related to ToM. Evidence so far is mixed concerning the question whether ToM decline merely reflects the decay of executive function, processing speed, and other aspects of fluid intelligence in old age that has long been known. In some studies, differences in ToM between younger and older adults disappeared almost or completely once such cognitive factors were controlled for, whereas in other studies the differences remained despite such control analyses. Moreover, some recent research suggests that much of the age differences found so far might be due to motivational differences between the age groups. Once conditions were created to boost the older adults' task motivation (e.g., by using relatives rather than strangers as experimenters), there were again no age differences.

## Developmental determinants and correlates of theory of mind

### *Cognitive and social determinants and correlates*

What drives, underlies, and goes along with the development of ToM? Research over the last decades has identified a number of such correlates and determinants of ToM. First, language seems to play a crucial role in the development of explicit ToM capacities. There are many well-documented correlations between ToM and various aspects (syntax, semantic, pragmatics) of language experience and competence (Milligan, Astington, & Dack, 2007). And beyond mere correlation, there is clear causal evidence that language experience underlies or drives ToM development, both from experimental training studies, and from studies with deaf children in hearing families with oral language vs. deaf children from native signing deaf families (see above; Peterson & Siegal, 1999). Different aspects of language might contribute to its causal role in promoting ToM development. For example, acquiring the *semantics* of natural language expressions for mental states such as 'think' and 'want' might direct the child's attention to such states in the world. In terms of *pragmatics*, engaging in discourse with others highlights the need to take into account interlocutors' subjective perspectives potentially diverging from one's own. And the syntactic systematicity of most languages' complementation constructions ("He thinks that [the weather is fine]," in which propositions ["the weather is fine"] can be freely and flexibly embedded under mental state operators ["thinks," "hopes" etc.]) might constitute a medium for thinking in recursive ways about propositional contents embedded in other people's thoughts (deVilliers & deVilliers, 2000).

Second, executive functions are strongly related to ToM in development. Both in childhood and old age, numerous studies have found substantial correlations between ToM and executive function (EF) measures such as inhibition and working memory, even when controlling for extraneous factors such as age and verbal ability (e.g., Rakoczy, 2010). While such correlations leave open questions of causal directions, neuropsychological and lifespan studies speak for an influence of EF on ToM, showing that acquired deficits in EF lead to compromised ToM capacities. Similarly, longitudinal studies have shown that earlier EF predict later ToM, but not vice versa, suggesting a direct role for executive functioning in ToM development. Why might this be the case? Various accounts have speculated that EF such as inhibition and working memory may be the crucial domain-general cognitive foundations for ToM reasoning in that they enable the flexible coordination, embedding, and suppression of perspectives to be handled when ascribing subjective standpoints to others and oneself.

Third, ToM competence is associated in development with aspects of the family background such as maternal education and socioeconomic status. Most interestingly, a child's ToM development and the number of older siblings she has are positively correlated, suggesting experience in cooperative and competitive interactions with older brothers or sisters enhances one's social-cognitive development.

### *Neural correlates and foundations*

Neuropsychological studies with lesion patients and neuroimaging studies with healthy adults in the last decade have identified a network of cortical regions usually associated with ToM performance, including the medial prefrontal cortex, the temporo-partietal junction, the superior temporal sulcus and the temporal poles (see Schurz *et al.*, 2014 for a recent meta-analysis). What remains debated is whether or to what degree these regions are specific to representing others' mental states, or whether they function in more domain-general ways in representing states of affairs (including external symbols) with representational content.

More recent work in developmental cognitive neuroscience has begun to describe the neural basis not only of the adult ToM competence but also of developmental transitions. For example, children's increasing accuracy in more complex ToM tasks has been shown to correlate with an increasing specialization of those areas typically involved in the adult ToM network.

## Theoretical perspectives

Various theoretical perspectives and accounts of ToM development have been put forward, with many exciting and productive debates between different accounts. In what follows we will present some of these perspectives in asking the question 'Theory, simulation, or both?'

### *Theory theories*

The basic claims of theory theories are that our conceptual framework of propositional attitudes and other mental states is structured like a tacit theory and that conceptual development can be understood as theory change similar to historical changes in scientific theories (e.g., Gopnik & Wellman, 1994). According to such a framework, a given concept such as 'belief' is defined by its role in a bigger network of a tacit theory that specifies how this kind of state is related to (1) input from the world (e.g., typically, perception in normal circumstances yields belief), (2) other mental states (e.g., beliefs lead to other beliefs via inference; beliefs combine with desires to yield intentions, etc.), and (3) output (if a person believes she can bring about a desired goal by action X, and nothing speaks against X, she will typically do X etc.). Acquiring such a concept means coming to master these conceptual connections that constitute the concept, either by a process of more or less solitary theory formation and revision or by learning such conceptual connections from discourse and interaction with others. Crucially, the conceptual connections might not get mastered all in one package but in a rather piecemeal fashion. It is this phenomenon that can explain why children progress from simpler concepts of mental states (e.g., a concept of perception that does not yet admit of an understanding of misrepresentation) to more complex ones (e.g., a concept of belief that admits of misrepresentation and representational diversity). Another crucial aspect of the theory theory is that the very same concepts get used by a subject when ascribing beliefs and other mental states to themselves and to others, yielding, in principle, parallel developments of self- and other-understanding.

### *Simulation theories*

The basic assumption of simulation theories is that our own mental lives play a fundamental role in how we come to ascribe mental states to others and ourselves: We make use of our own processes of thinking and feeling in order to simulate what other people (or we at other times) might be thinking or feeling. There are two very different versions of simulation theories. Introspectionist accounts claim that simulation starts from introspection: We first introspect the kinds of mental states we are in and then use these in order to simulate what other people might be thinking (e.g., Goldman, 1993). Non-introspectionist accounts, in contrast, claim that in simulation we simply take our own cognitive processes offline and imagine what a given situation might look like from another perspective in order to determine what another agent perceives, for example. However, there is no need for introspection here (Gordon, 1986).

Simulation accounts have recently experienced a revival in light of neuroimaging findings of empathy and mirroring mechanisms that suggest that in many domains, the same kinds of neural processes are in play when a subject performs an action or has a feeling as when she observes someone else perform this action or express that feeling. Simulation theories account for conceptual progress in development by assuming that children's capacities of imagination and simulation get more refined over time. While, initially, children can only simulate situations much like their own, they get more and more sophisticated at adjusting the initial parameters of the simulation, taking into account differences, for example, in visual perspective, personal tastes etc.

Much of the initial theoretical debates in ToM research revolved around the question whether theory or simulation accounts were correct. Two things have become increasingly clear since then. First, it is not easy, perhaps even impossible, to conceptually and empirically differentiate elements of tacit theory and simulation. Second, both kinds of processes might well play together in our mental state ascription. For example, in order to ascribe visual perception to an agent, we need a theoretically integrated concept of 'perceiving,' while in order to determine how exactly a visual scene looks from a given angle, visual simulation might be indispensable. Therefore, many current accounts assume some theory–simulation mix.

## Infant theory of mind: nativism versus two-systems accounts?

### *Nativist modularity accounts*

The basic assumption of nativist modularity accounts is that our fundamental ToM capacities are realized by a module (sometimes called theory-of-mind module or ToMM) that operates automatically and swiftly, dedicated specifically to explaining others' behavior by mental state ascription, and that is basically innate (Leslie, 1994). In contrast to the assumptions of simulation and theory theory, this capacity should thus be working very early and without much learning experience. Empirically, proponents of the modularity theory interpret the new findings from implicit FB and related tasks with infants as evidence in this direction. But why then do children fail standard explicit FB tasks so much longer after they have mastered the implicit ones? According to modularity theories, the picture is the following: Implicit tasks involve the core conceptual ToM competence, but explicit tasks measure, in addition, all kinds of performance factors such as linguistic capacities or inhibition that mask the true competence. Such a nativist interpretation is opposed by two-systems accounts in the study of infant theory of mind.

### *Two-systems accounts*

The more recent theoretical developments have been the two-systems accounts of ToM (Apperly & Butterfill, 2009). Like modularity accounts, these theories assume that the new implicit FB tasks with infants require some form of ToM capacity, and that this capacity might be to some degree innate and modular. In contrast to modularity accounts, two-systems theories claim that these initial capacities are not the very same ones as those expressed later on in explicit tasks. Rather, the early implicit capacities are subserved by a simpler, evolutionarily and ontogenetically more ancient system (System 1) for tracking simple mental states. This system operates automatically yet inflexibly, keeping track of some basic mental states such as perception, but falls short of representing full-blown propositional attitudes such as belief. The later-developing System 2, in contrast, whose working is measured by standard explicit tasks, is flexible, dependent on central resources (language, executive functions), and allows for the proper ascription of beliefs and other propositional attitudes.

Based on these assumptions, the two-systems account makes a number of specific predictions that contrast with those of modularity accounts. One such prediction is that infants in implicit tasks, but also adults under circumstances that trigger System 1 processes (e.g., tasks without any instruction to engage in ToM reasoning; dual-task situations in which central cognitive resources such as executive functioning are less or not at all available), should show clear signature limits in their ToM capacities. They should be able to solve some FB and related tasks that can be mastered on the basis of tracking simpler mental states (such as perception and information registration), but should fail other FB tasks that strictly require the application of the concept of 'belief' and related propositional attitudes (in particular, FB tasks in which someone is mistaken about the identity of an object). Recent evidence suggests that indeed there might be such signature limits (Low & Watts, 2013), but much more systematic research will be needed to decide which account is correct.

## Conclusions

From systematic and interdisciplinary research in the last three decades we have gained deep insights into how our ToM, the capacity to ascribe mental states to others and ourselves, works, how it develops over the lifespan, what its cognitive and neural underpinnings are, and how it can be affected in clinical cases. Nevertheless, many exciting questions remain open for future inquiry, such as the following:

- What exactly do the findings with implicit tasks in infants show, and how can they be reconciled with the more traditional findings?
- How do we get developmentally from early implicit to later explicit ToM capacities?
- Is there such a thing as automatic, unconscious ToM in adults?
- In general, are there multiple systems or processes for ToM?
- What are the neurocognitive foundations of ToM reasoning in adults, and what are the neurocognitive bases for developmental change?

## See also

**Constructivist theories; Learning theories; Cross-cultural comparisons; Developmental testing; Cognitive development during infancy; Cognitive development beyond infancy; Executive functions; Intelligence; Language acquisition; Social development; Emotional development; Joint attention; Selfhood; Brain and behavioral development; Cognitive neuroscience; Social neuroscience; Autism; Hearing disorders; Primatology; Development of consciousness**

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