

Theory of Mind

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Theory of mind (ToM) is the intuitive understanding of one's own and other people's minds or mental states— including thoughts, beliefs, perceptions, knowledge, intentions, desires, and emotions—and of how those mental states influence behavior. Sometimes called intuitive psychology, folk psychology, or even mind-reading, ToM is an innate human ability. The understanding that others have mental states different from one's own makes it possible to infer what others are thinking and to predict their behavior. This ability to recognize one's own state of mind and those of others is central to human consciousness. The study of ToM and identification of the skills comprising ToM is a rapidly changing the field of developmental psychology.

THE THEORY OF TOM

The word *theory* in ToM refers to a person's tacit belief rather than to theory in the scientific sense. However, ToM is similar to a scientific theory in that it enables one to interpret and predict another's actions by evaluating their thoughts, beliefs, desires, or emotions. ToM also qualifies as a theory in the sense that the representations of reality generated by ToM are not directly observable. The ability to develop a ToM is a cognitive ability that develops by degrees from infancy through childhood and adolescence on into adulthood. It forms a basis for a child's acquisition of language and the development of appropriate social behavior and skills. ToM includes the ability to understand that the representations generated in one's mind do not necessarily reflect the real world and that other people may hold different representations. Empathy—the ability to understand another person's perceptions on a deep level without reference to one's own perceptions—may be a culminating feature of ToM development. ToM is involved in all aspects of daily living and social interactions. It underlies learning and teaching and the ability to follow directions and understand socially based information. ToM skills are essential for working cooperatively. They also underlie the ability to manipulate and deceive others. A lack of ToM skills is considered by many to be a core deficit in autism. and studies of autism have promoted research on the development and complex functioning of ToM.

As a basic component of human consciousness ToM has roots in philosophy, particularly in the groundwork for a science of the mind laid down by René Descartes (1596–1650). The Swiss psychologist Jean Piaget (1896– 1980) suggested that before the age of 3 or 4 egocentrism prevents children from understanding that other people's thoughts and viewpoints may differ from their own. In 1978 Nicholas Humphrey proposed that introspective consciousness has a specific function; it enables social animals to predict each other's behavior. Being aware of the effects of emotions on one's own behavior enables humans to predict the reactions of others to those same emotions.

FALSE BELIEF

In 1978 David Premack and Guy Woodruff coined the term *theory of mind* as it is now used in developmental psychology. They argued that chimpanzees and perhaps other nonhuman primates could

understand the intentions of others and therefore possessed ToM. Although that issue remains controversial, Premack and Woodruff's work was an inspiration for psychologists studying normal and abnormal child development. In 1983 Josef Perner and Heinz Wimmer applied Premack and Woodruff's false-belief test to children using an "unexpected location" task. In one version of this test a puppet named Maxi puts a chocolate in the cupboard and leaves the scene. The experimenter moves the chocolate to a new location and asks the child where Maxi will look for it. In another version called the "Sally-Anne" task, Sally and Anne put a marble in a box. Sally leaves and Anne takes the marble out and puts it in a different box. Up until about the age of 4 most children ascribe their own beliefs to Maxi and Sally and tell the experimenter that Maxi or Sally will look for the chocolate or marble in its new location. However, older children understand that Maxi will look for the chocolate where he last saw it in the cupboard, and Sally will look in the first box. The task requires that children understand that other people's beliefs may differ from their own and then predict how those people will react based on their differing beliefs.

Over the years many permutations of the false-belief test have been developed to ensure that it does not require advanced language skills. In the "unexpected contents" or "Smarties" task a child opens a candy box expecting to find a candy called Smarties and finds pencils instead. Until the age of 3 or 4 children assume that someone else will expect to find pencils in the candy box. Furthermore, children claim that they expected to find pencils when they first opened the box, a phenomenon called hindsight bias. The ability to pass the false-belief test is seen as a major milestone in the development of ToM in young children.

TOM IN INFANTS AND TODDLERS

Although children clearly begin to develop ToM at an earlier age than Piaget thought, researchers disagree as to which behaviors indicate a developing ToM in children younger than 3, and it has been very difficult to assess ToM in preverbal children. Some researchers argue that mimicking by infants is indicative of a developing ToM. Infants under 1 year expect hands and objects to move in ways that are goal oriented. Between 6 and 12 months infants develop "joint attention" — looking in the direction of someone else's gaze. Between 12 and 18 months babies will look in the direction that someone is pointing, rather than at the person's finger, and will themselves point to draw someone's attention to something. In 2000 Charman and colleagues found that children who showed the highest rates of joint attention at 20 months scored the highest on ToM tests at 44 months. Some researchers argue that as early as 14 months babies can understand intentional behavior and therefore understand that other people are intentional and mental beings. An 18-month-old who watches an adult try unsuccessfully to hang a loop on a hook will imitate the intended rather than the failed action, even though the baby has only seen the failed action. Toddlers begin to recognize that other people have desires and likes and dislikes that are different from their own. For example, a child can predict that another child who wants a cookie will go to the cookie jar. Two-year-olds understand and use words for their senses and their wants. They engage in pretend play and learn to distinguish between physical and mental events such as a real versus an imaginary playmate.

Three-year-olds begin to understand that other people's minds are distinct from their own but cannot yet clearly distinguish between what they know and what others know. Nevertheless, 3-year-olds have a fairly well-developed ToM. Most 3-year-olds can talk about mental states using words such as *think*, *know*, and *remember*. They can distinguish mental states such as dreams. They also understand that perception can lead to knowledge: Someone who looks inside a box will know what is in it, but someone who cannot see inside the box will not know.

TOM IN PRESCHOOLERS

At about age 4 children recognize that other people have minds and that their minds may hold different information. They also recognize that appearances may be deceptive and can mislead. The appearance-reality (A-R) task is used to assess a child's ability to distinguish between reality and representation. A child is given a sponge that is painted to look like a rock. When asked what the object looks like and what it is really, a 3-year-old will give the same answer to both questions—either a rock or a sponge. In contrast, a 4-year-old will correctly answer that it looks like a rock but is really a sponge. By the age of 5 children can understand that someone who appears happy may actually be sad. However, since the ability to recognize that others may have mistaken beliefs is central to ToM, the false-belief test remains the basic criterion for assessing ToM.

Although it is clear that the abilities to pass false-belief and A-R tasks at about age 4 represent important milestones in ToM development, the nature of these cognitive shifts is unclear. Simulation theory argues that children learn to understand other's beliefs through imagination—by imagining themselves in another person's situation. Other scientists believe that this milestone occurs through a process of conceptual change or through the maturing of structures in the brain that facilitate reasoning about the minds of others. Many psychologists believe that failure on false-belief and other ToM tasks is due to children's immature executive functioning. Although understanding false belief is universal in normal children over the age of 5, a number of factors appear to affect the exact age at which the skill is acquired. Success on false-belief tests correlates with short-term memory ability. Children with larger vocabularies and those from larger families pass false-belief tests at earlier ages. However, attempts to teach younger children about false-belief have been unsuccessful; the children may show improvement on the specific task that is taught, but not on other false-belief tasks.

ToM development in young children is strongly correlated with language ability. Bilingual preschoolers have increased understanding of both mental and non-mental representations. The acquisition of ToM is delayed in children with some specific language impairments. Both language and ToM skills predict later metamemory—knowledge and beliefs about one's own memory—and metacognition—knowledge and beliefs about one's own cognitive processes. ToM development appears to be advanced in children with older siblings, in children who participate in early pretend play, and in children whose families talk about mental states. Activities that seem to promote the development of ToM skills include:

- Pretend play and role playing
- Talking about past events
- Reading stories
- Discussing situations such as misunderstandings, teasing, and forgetfulness

- Imagining
- Discussing opinions and perspectives

Deaf children of deaf parents who are exposed to American Sign Language from birth perform similarly to hearing children on ToM tests. However, deaf children with hearing parents are significantly delayed in ToM development. A 2002 study by Schick and colleagues found that certain language skills of deaf children correlated with their ToM skills. For example, a deaf child who could understand the sentence “He thought his cake was in the cupboard” was more likely to pass ToM tests. It has been suggested that deaf children undergo normal ToM development but lack the language necessary to understand the stories that are generally used in ToM tests.

ToM IN SCHOOL-AGE CHILDREN

By age 6 children can pass second-order false-belief tests. In contrast to first-order belief tests (Sally believes the marble is in the first box when it is really in the second), second-order tests require a child to understand that Sally thinks Mary thinks the marble is in the first box, but both Sally and Mary are wrong. By the age of 6 children have acquired another ToM skill—the ability to deceive others. In a 2007 study Talwar and colleagues found that among elementary-school children the ability to maintain consistency between an initial lie and subsequent statements increases with age and correlates with the children's scores on second-order false-belief tests. ToM skills and knowledge about mental states and attitudes increase dramatically throughout childhood. Compared with younger children, 8-year-olds show more skill in first- and second-order false-belief tests involving physical facts and positive and negative emotions and have a much easier time explaining their responses. However, there are far fewer tests for evaluating ToM in children older than 6 and few ToM studies have focused on children older than about 7.

By elementary school children have gone from a state of self-recognition to a state of self-consciousness. At about age 7 they realize that thinking is an ongoing process or stream-of-consciousness, with each thought triggering a new thought. In contrast, preschoolers believe that mental activity starts and stops with each thought. Whereas very young children are unclear about what it means to know something and how they know it, and older preschoolers often insist that they have always known something that they learned just a few minutes ago, with middle childhood comes the realization that knowledge requires adequate information. Furthermore these children are starting to understand that interpretations of knowledge and situations can be influenced by expectations or biases. They are increasingly able to consider other people's points of view. ToM studies have shown that at about age 7 children come to understand that a person's facial expressions and thoughts do not necessarily coincide and they are increasingly able to link physical symptoms with anxiety. Researchers have found that sarcasm, irony, and bluffing are not well understood until about age 8.

Between the third and fifth grades children's understanding of the role of memory develops significantly. Although it has been both assumed and suggested by research that ToM is closely related to episodic memory—the ability to re-experience past events—recent research has suggested that ToM may function independently of episodic memory. Perner and colleagues reported in 2007 that episodic memory emerges later than false-belief skills, together with the ability to use imagery to solve visual

rotation tasks. A 1999 study by Simon Baron-Cohen and colleagues examined the ability of 7- to 11-year-olds to recognize a faux pas—saying something that is inappropriate or could be misconstrued—such as mistaking a boy for a girl or a customer in a restaurant for a waiter. The researchers found that the ability to recognize a faux pas developed by age 9 and that girls were better at it than boys.

ToM IN THE CLASSROOM

It is likely that ToM skills underlie a child's ability to understand and make up stories and therefore are important for developing reading skills. Astington and Pelletier (1996) have argued that there is a relationship between the degree of ToM development and the ability to learn by instruction and collaboration, and that ToM skills are linked to the development of scientific and critical thinking. In a 1998 study Perry Klein found that students' skills in predicting or explaining a doll or cartoon character's behavior correlated with their abilities to plan controlled experiments and explain the causes of events. He suggested that first through fifth graders use science strategies that are dependent on their ToM development. Most 6-year-olds understand the concept of evidence, and 8-year-olds can distinguish between ambiguous and unambiguous evidence. Younger children often hold on to prior beliefs despite evidence to the contrary, whereas older children can revise their beliefs. Likewise, younger children manipulate multiple variables when planning science experiments, failing to hold any factor constant, whereas older children and adults understand the concept of testing only one variable at a time and holding the other factors constant.

In school children need to be able to discuss mutual understandings and misunderstandings and their own beliefs and those of others and to make conceptual changes. These activities all require ToM skills. Helping students to reflect on and talk about their thinking may help improve ToM abilities. Teachers report that children with more advanced ToM skills have better social skills. However, advanced ToM skills can also be utilized for antisocial purposes such as bullying. The development of ToM may be particularly relevant to classroom learning during middle childhood and adolescence. Although all normal children develop ToM skills in basically the same sequence, the pace of ToM development may be different in different cultures, particularly among older children. This may be a function of the vocabularies about mental states in different languages or cultural differences in amount of thinking and talking about mental states. There also appear to be gender differences in the development of at least some aspects of ToM. In a 2000 study Bosacki found that 11-year-old girls scored higher than boys on tests of self-understanding and social understanding.

ToM development continues throughout adolescence and into adulthood. However, most research with adolescents has focused on metacognition rather than on ToM. Adolescents are well known for a particular type of ToM error—believing that those around them, especially peers, are thinking about them and judging them when there is no evidence that this is the case.

THE NEUROSCIENCE OF ToM

Brain imaging while performing ToM tasks has suggested the involvement of a patch of neurons above the eyes called the anterior paracingulate cortex. Some researchers believe that this region is responsible for the central ToM task of distinguishing between one's own mind and that of another

person. The frontal cortex is known to be important for both ToM and cognitive abilities and this region continues to develop during adolescence. Moriguchi and colleagues (2007) studied 9- to 16-year-olds and found that, as in adults, activation of the medial prefrontal cortex, the bilateral superior temporal sulcus (STS), and the temporal pole adjacent to the amygdala were associated with ToM, and that during late childhood and adolescence ToM activation of the medial prefrontal cortex switched from the ventral side to the dorsal. Researchers have found that the left medial prefrontal cortex is strongly activated when normal subjects read a story that requires understanding the mental states of characters, whereas this region is not activated when autistic subjects read the same story. The STS senses biological motion. It is activated by a moving hand but not a moving car and is particularly sensitive to eye and lip movements. The temporal pole is crucial for recalling memories. The amygdala, which is important for emotion, may also be involved in ToM.

Autism researchers have focused on the hypothesis that autistic children do not undergo normal ToM development. Autistic children who do manage to pass ToM tests usually have far more verbal knowledge than other 3- to 5-year-olds. They also laboriously explain their reasoning, whereas normal young children cannot explain their reasoning, suggesting that the autistic children use a different method to succeed on the test. In Baron-Cohen's 1999 study children with Asperger syndrome or high-functioning autism who passed false-belief tests were nonetheless unable to recognize faux pas or recognized them but continued to make them. Autistic children also have difficulty understanding and carrying out deception. Studies on autistic individuals have helped distinguish between ToM and cognition since autistics can have exceptional cognitive abilities while lacking ToM skills.