

Social Cognition and Theory of Mind

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ABSTRACT

For an individual to exist in a society, they must be receptive to not only signals from their natural environment but also to those from their social environment. Therefore, the human brain possesses a social cognition capable of processing, interpreting, and responding to various signals related to social interaction and relationships. Considering the prevalence of social dysfunction in neurological disorders, social cognition should now be recognized as a core area of function requiring clinical attention.

To fulfill the desire to understand the motives behind the behaviors and words of the individuals one interacts with, humans utilize simulation and Theory of Mind mechanisms. In simulation technique, one puts themselves in the shoes of another person and uses themselves as their reference point. Theory of Mind, on the other hand, is the mental mechanism that a person uses every day to explain a word or attitude of another or to predict a behavior of another. One attributes independent mental states to themselves and others and, accordingly, reaches certain opinions and judgments.

Theory of Mind problems occur in a plenty of neurodevelopmental disorders. Although it is encountered in almost all neurological diseases, it is generally overlooked within the general picture. It can also lead to various communication problems, misunderstandings, and serious problems between neurotypical people in daily life. In this context, Theory of Mind training under the title of social cognitive skills should be included in the curriculum not only in special education and neurorehabilitation but also in formal education.

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INTRODUCTION

As humans exist within society, being receptive to signals not only from their natural environment but also from their social environment is a fundamental skill. The human brain is therefore organized to process, interpret, and respond to various signals related to social interaction and relationships. This leads us to the concept of social cognition, a natural consequence of our social environment and the influence of our historical culture.

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With the use of language and utilization of tools, all cognition is transformed into social cognition. Social cognition undergoes a substantial developmental process spanning from infancy to adulthood. According to Vygotsky (1978, p. 46), 'Within a general developmental process, two qualitatively distinct lines of development from different roots can be distinguished: on one side, basic processes of biological origin, and the other, higher psychological functions of socio-cultural origin'.¹ Biological cognitive functions such as perception, attention, memory, and learning are transformed into cultural behavioral patterns via many intermediate steps through social interactions and life practices.

Both the transmission of oral-visual and written cultural knowledge across generations and the capacity to convey and retain this knowledge—such as through language—are primary factors that enable the advanced capability of humans to benefit from cultural learning, a trait seemingly unique to our species. Rather than learning solely through observation, the things prioritized are recognizing, and following instructions, and benefiting from the experiences and repertoires of others. One can seek and receive the support of competent individuals for possible solutions if necessary.

Considering the prevalence of social dysfunction in neurological disorders, social cognition should now be recognized as a core area of function requiring clinical attention and be a fundamental part of neurology education.

PHYLOGENESIS OF SOCIAL COGNITION: SOCIAL BRAIN

The roots of social cognition can be traced back to mammalian and avian behaviors. Evolutionarily, two distinct branches are notable, extending from the fish-amphibians and reptiles through to birds and mammals. From a behavioral viewpoint, birds and mammals are both endotherms. Some birds are almost intelligent enough to rival primates, their abilities to feed and nurture their young, capability to use advanced forms of communication, empathetic skills, possession of capacity for play, and courtship rituals are noteworthy. All of these demonstrate deep-rooted and diverse forms of social behavior.²

Brain development continues after birth in birds and mammals. However, the outcomes of this development significantly diverge from those in humans due to two main distinctions. First, humans uniquely experience the longest period of continued brain development in the extrauterine period, lasting up to 18 years of age. A newborn chimpanzee's brain weighs 60% of its adult form whereas a human newborn's brain is only about 24% of the size of an adult human brain. The second distinction lies in the fact that brain and mental development occur within a cultural environment that has accumulated over thousands of years and generations after generations. An extended childhood extrapolates both the neuroembryonic synaptogenesis process and the following synaptic pruning, especially in the prefrontal lobe, shaped by experience of life. This serves as evidence that neural development is occurring under social influences.³ During the extended childhood period, brain development is extensively exposed to external influences, fine-tuning the brain's sensitivity to its social environment. This process occurs through the active transmission of societal-historical culture in various forms after birth. Due to these two factors, the human brain is entirely a "social brain."

ONTOGENESIS OF SOCIAL COGNITION: THEORY OF MIND

Human relationships, becoming increasingly widespread throughout history, have taken on complex forms. We utilize certain mental mechanisms to effectuate our desire to understand the motives behind the behaviors and expressions of those we interact with. We do this through two interconnected mechanisms: a technique called Simulation and by forming a Theory of Mind. These two systems are not completely independent of each other. Many everyday tasks in our lives, but especially new and challenging tasks, can cause the simulation system and the Theory of Mind system to come into play together; it has been proposed that social behavior primarily proceeds through the interaction between these two processes.⁴

In the simulation technique, we put ourselves in someone else's place and use ourselves as a reference. We ascribe our feelings and thoughts to them. This way, we presumably read their minds or understand their experiences. What would I feel if I were in their place? They must be feeling the same way, right? It is thought that mirror neurons form the basis of simulation.⁵

In the 1990s, two Italian scientists, Vittorio Gallese and Giacomo Rizzolatti discovered a unique functional characteristic in certain neurons during their experiments on macaque monkeys.^{6,7} These neurons were firing during a specific grasping action. However, the same neurons were also activated when the same action was performed by another monkey or even the human experimenter. These motor neurons, called mirror neurons, were crucial for perceiving and understanding the intention behind actions.

There are a great number of studies on mirror neurons and the body of research currently keeps on growing. Located in different cortical areas, mirror neurons perform different functions depending on their location. For instance, the frontal and parietal areas are crucial for detecting the purpose and intention of the observed motor actions. Mirror neurons operate on two distinct levels: one identifies what the action is, and the other discerns why it was done, based on a sequence of actions (chain of events). For example, in children with autism, the mechanism for understanding the intention behind an action, rather than just what the action is, is impaired. It has been shown that the anterior cingulate cortex is activated both in individuals experiencing pain and those observing the person experiencing pain.⁸ Similarly, the anterior insula is activated both in individuals smelling a bad odor and in those observing this individual, even though they do not smell the odor themselves.⁹

Development of Theory of Mind

A person forming a Theory of Mind (using the mechanism of mentalization) needs to know that others have minds different from their own; therefore, they may have different experiences, desires, beliefs, and knowledge, and, in order to understand these, the individual must develop a cognitive structure, partly spontaneously and partly through effort.

Theory of Mind is the mental mechanism that enables a person to attribute independent mental states to themselves and others daily, allowing them to predict someone else's behavior or explain their words or demeanor, also providing the means to one to reach certain beliefs and judgments based on these attributions. Almost everyone predicts, interprets, and explains the behaviors of others, expressing this through a logical sequence and on an intuitive basis, in both their attitudes and actions. This leads to certain moral judgments.

These assumed causal relationships fall under the category of folk psychology.

The construction of the Theory of Mind involves a series of processes. Its initial stage includes social perception but extends beyond it, requiring the ability to reason and conceptualize others' mental/emotional states. It involves forming *theories* connected to a broad range of human understanding that agents have purposes, desires, beliefs, and thoughts. This demonstrates our everyday ability to attribute independent mental states to ourselves and others. It encompasses a specific cognitive ability to perceive others as intentional agents. Theory of Mind is an act of prediction, interpretation, projection, and rationalization. It is a logical endeavor to create a causal map of what happens in the intersubjective space. Once formulated, it can serve as the cause of an action in the form of a decision, judgment, belief, or plan.

PRECURSORS OF THE THEORY OF MIND

Normal developing children around the ages of 3-4 years old can understand that other people may hold false beliefs and act according to these false beliefs, sincerely thinking they are true. This means that a child of 3-4 years is expected to be able to distinguish their own mental state (intentions, beliefs, desires, and knowledge) from the mental states of others. This situation signifies the child's introduction as an active individual into the network of social relations. The Theory of Mind becomes functional, marking a turning point in the child's life. However, this does not happen suddenly.

First of all, all normal developing infants are born with a genetic predisposition towards developing the Theory of Mind. Provided that minimal social and environmental conditions are met, some precursor skills that will aid in its establishment begin to be cultivated immediately after birth. The components of the Theory of Mind continue to show developmental changes up until late adolescence.

The presence of certain key mental functions is essential for the completion of the development of the Theory of Mind. For example, linguistic/conceptual development needs to reach a certain level. Additionally, executive functions (attention, working memory, and inhibitory control) and memory, particularly working memory, source memory, and auto-noetic episodic memory, should function properly.

There are also a series of social and environmental factors that precede the development of the Theory of Mind, some of which will become a part of its structure in later stages. These factors can be examined under headings such as "Parental engagement and attachment, interactive communication, proxemics and body posture, reciprocity, and affect attunement" (for more detailed information, see Korkmaz, Njiokiktjien & Verschoor, 2013).¹³

Parental Engagement and Attachment

Mutual bonding is established under conditions of close physical and emotional contact after birth. It is a complex, multi-component state of the relationship. Attachment encompasses affective components (reward, dependence, pleasure), cognitive components (memory), behavioral components (proximity, touch), and intentional components (seeking security).

Mothers begin attempting to communicate with their babies even before birth, and almost all engage with motherhood and continue with their pregnancy; because their unborn babies are potential

conversational partners, capable of thought and emotion, with whom they can communicate.

Development of Body Perception and Theory of Body

In the first three months, infants gain an understanding of their caregivers' gestures, referred to as the Theory of Body. It is the perceptual experience of a being's bodily behavior and, more importantly, is consistent with affect. Theory of Body is an implicit, non-verbal 'theory' about the actions of others and leads to the development of one's own body schema.¹⁴

Empathy

Mirror neurons are believed to play a role in imitation, gestures, and also, empathy. Empathy is the ability to feel the emotions of others as if experiencing them oneself. Empathy lies at the heart of any interaction between a mother and her baby. In empathetic interactions, merely observing an emotion, whether through its subtle or overt manifestations, can spontaneously trigger the same feeling, thereby causing the observer to resonate with the other.

Imitation

Imitation is an advanced behavior where an individual observes and replicates another's actions. Infants communicate with others by imitating them. They mimic adults' facial and hand movements and emotional expressions;¹⁰ they also respond with interest when adults mimic them. Gestures serve communicative purposes. A typically developing child begins to use pointing as an invitation to share attention to an object between 9 to 14 months of age¹⁵ and later starts employing other conventionally significant gestures.¹¹ There is evidence that by nine months, infants use pointing to convey their requests.¹² When imitating, our brain becomes active in areas that would be active if we were performing the action ourselves. This occurs thanks to our mirror neurons.

Social Perception

It includes components such as eye contact, face recognition, recognizing emotions in faces and gazes, gaze direction, and the meaning of a gaze. Recognizing facial emotions begins at a very early stage. Immediately after birth, newborns respond differently to human eyes and faces.¹⁵ They are sensitive to emotional information on faces; even newborns can distinguish and mimic facial expressions of emotions.¹⁶

Interactive Communication

When parents predictably talk to their babies about recurring events, it helps the child to structure their world, segment events, differentiate between types of activities, and predict future events.¹⁷

Development of the Self-concept, the Distinction Between Self and Other

This is observed to evolve throughout infancy. By the time infants are 5-6 months old, they preferentially watch a video of another baby over their own video.¹⁸ Around 18 months of age, babies begin to recognize themselves in the mirror.¹⁹

Relationship Between Theory of Mind and Emotion

While Theory of Mind is a cognitive structure, it is intertwined with sensory processes. It includes subcomponents such as emotional awareness, perception of emotions, understanding of emotions, and expression of emotions.²⁷ Facial mimicking of the basic emotional expressions begins at about 10 weeks of age.²⁹ Affect attunement (affect regulation and behavioral synchronicity) is the ability of the

mother and baby to resonate emotionally with each other. It is the capacity for two individuals to resonate emotionally with each other before cognitive understanding. Affect attunement lays the basis for the development of shared emotional meanings between the baby and the mother. These processes are rapid, automatic, and provide a direct way to understand other people's emotions.²¹ However, they are not sufficient for mature empathetic understanding and sympathetic concern.

Social Smiling

It is observed even in visually impaired infants, suggesting an innate origin for this mechanism.²² The mutual exchange of smiles between mother and child marks the beginning of reciprocal empathic communication.²³

Reciprocity (Dyadic Relationship)

This means the mother and baby immediately mimic the same actions as imitative behaviors or display complementary behaviors to each other. If a mother, who is playfully interacting with her baby, suddenly stops, even a 2-month-old baby will attempt to continue the interaction. If this fails, the baby will protest.²⁴

The Detection of Gaze Direction and Gaze Following

Initially, children learn to follow gazes without understanding their social significance. Following gazes is the ability to respond to others' shared attention tendencies. Gaze following has been reported in 30% of 2-month-olds and increases with age to encompass all by the time they reach 14 months.²⁵

Newborns are already sensitive to the direction of gaze and prefer looking directly at faces. While some infants can distinguish between direct and averted gazes by day 5,²⁶ others only begin to do so at around 4 months of age.²⁷ Between five and six months of age, infants can follow the gaze of another person toward an object of shared interest.

We pay particular attention to others' eyes. We can detect very subtle movements while observing someone's eyes. It is easier for humans to detect others' gazes and signal with gazes because the white sclera is prominently visible in humans, and the rotation of our eye causes the pupil to move to one side. We can detect eye movements smaller than 2 millimeters from a distance of 1 meter from the face of interest. This sensitivity to eye movements allows us to take the first step into someone else's mental world. We can accurately tell where a person is looking based on the position of their eyes. If we know where someone is looking, we can discover what they are interested in.

Direction of the Head Movement

Since most mammals do not move their heads and eyes independently,³⁷ the direction of head movement is as useful as the direction of eye movement as it is easier to detect. Foveal and binocular (depth perception) vision require primates to turn their eyes in the direction that they want to look at. Sometimes turning the eyes independently of the head either provides a wider field of visual angle or gives misleading impressions about the intent. If a person moves their eyes without turning their head, it is particularly difficult to determine what they are looking at by observing the direction of the head.

Intentionality

Starting around three months of age, infants can distinguish animate-biological movements from random or mechanical ones.²⁸

Infants have different expectations from people and physical objects. For instance, around about six months of age, infants perceive living beings as entities with intentionality. In intentionality, behaviors are represented as volitional states (purpose and desire).

Social Relatedness

Social relationship involves feeling connected with others and having a sense of belonging within a group. To develop this, students need opportunities to know each other not just as acquaintances or classmates but also on a deeper level as individuals with diverse interests and beliefs.

Central Coherence

It is the extraction of the whole's meaning from details.²⁹ For example, individuals with autism often have weak central coherence, leading them to remember details instead of the overarching meaning of the whole.

Pretend Play and Imagination

Pretend Play, also known as fantasy, dramatic, or symbolic play in developmental psychology, emerges between 18 to 24 months.³⁰ Separating meanings from objects is a strong stimulus for the development of the Theory of Mind. Pretend Play begins with the substitution of imaginary situations for real ones. It is almost always a reproduction of a real situation: a child playing with a toy doll tries to replicate the mother's behavior as closely as possible.

Joint Attention

It is one of the most critical precursors to the development of the Theory of Mind and later becomes an integral part of it. We refer to the behavior as "joint attention" when a person intentionally coordinates their focus of attention with that of another person. Joint attention is the purposeful and simultaneous focusing of interest by two individuals on the same thing (object, event, etc.), whether it is on a volitional or an instinctual basis. Many infants demonstrate all these skills by the age of 12 months,³¹ and some exhibit aspects of joint attention (e.g., following the direction of the mother's head turn towards a visible target) as early as 6 months.³² There are three forms of joint attention development: responding to joint attention, inviting joint attention, and sharing joint attention.

Social Referencing

This process refers to infants using an adult's emotional expressions to regulate their behaviors towards environmental objects, people, and situations. They follow gazes to interpret references. Social referencing comes into play in complex situations when assistance is needed. An infant requires social referencing when encountering an emotionally ambiguous object or event.³³ The baby looks at a parent's emotional expression to find a way to manage the situation and then responds accordingly. This involves directing attention to the relevant object or event.

Perspective Taking

The ability to understand how a situation appears to another person and how that person cognitively and emotionally responds to that situation. Perspective taking occurs when an individual sees a situation from another's viewpoint. It is a fundamental social skill underlying human empathy. It facilitates understanding of what another person thinks and feels in a distressing scenario. Perspective taking is defined in two dimensions: perceptual and conceptual. Perceptual

perspective taking is the ability to understand how another person experiences events through their senses (i.e., visually or auditorily).³⁴ Conceptual perspective taking is the ability to comprehend and adopt the viewpoint of another person's psychological experience (i.e., thoughts, feelings, and attitudes).³⁴

THEORY OF MIND AND SOCIAL RELATIONS

In modern society, personal conflicts (e.g., in marriage) often stem from misunderstandings or misinterpretations. Therefore, Theory of Mind training can play a significant positive role in addressing communication issues between spouses. Theory of Mind training can provide a positive enhancement in the workplace, allowing for healthier collaborations. Theory of Mind is generally necessary for success in life within a society, but it is never sufficient on its own.⁷⁰ Social cognition primarily functions in the realms of social perception and cognition. It is comprised of many elements beyond the Theory of Mind. For example, "social adaptation" refers to people's understanding of social behaviors and developing appropriate responses, while "social competence" refers to responding with adequate skill.

However, being empathetic and successfully reading minds does not directly guarantee moral reasoning (another component of social cognition) and the realization of behavior with ethical concerns. A successful Theory of Mind does not always result in honest, smooth, and cooperative social interactions. It can be used to predict possible behaviors and therefore manipulate the behaviors of others. Typical manipulations such as persuasion, deception, concealment, bafflement, trickery, and lying are common. Therefore, some of these skills are known in popular culture as Machiavellian intelligence, emotional intelligence, or charismatic intelligence.

Moreover, mind reading often falls short in real-life conditions for smooth social interaction since the interaction process is characterized more by participants collectively making sense of the situation together rather than continuously attempting to understand each other's mental states. This sense-making also occurs according to current conditions and social norms.

The interpretation and conclusions drawn from the Theory of Mind tests used in scientific research are contentious. The scientific study of Theory of Mind is conducted from a third-person observer perspective, approximating the stance of a scientist in experimental research. However, this approach is prone to a series of errors. The observer is always involved in the event as a variable in real life. Otherwise, it would not have been possible to speak of a mutual interaction. Different results are obtained under real-life conditions or in tests where the child is directly involved.

Theory of Mind issues emerge in a multitude of developmental disorders. The incidence of autism is high. In fact, the group known as Asperger's syndrome is even more common. Issues in Theory of Mind is seen in almost all neurological diseases but often go unnoticed or are disregarded in the general picture. Moreover, it can lead to various communication problems, misunderstandings, and serious issues among neurotypical individuals in everyday life (Table 1). In this context, it is necessary to include Theory of Mind training under the umbrella of social cognitive skills not only in special education and neurorehabilitation but also within the formal education curriculum.

Table 1. Difficulties Encountered in the Daily Life by Individuals Without Any Clinical Diagnosis but with Disruptions in Theory of Mind development

They may end up alone, due to multiple reasons / Forced to choose loneliness / Left alone (isolated). Because they are prone to misunderstanding
They may not care about what others think and/or say. This situation can even affect their dressing and eating habits.
Cleaning perception may vary. They can be both very messy and very clean.
They may end up in a harassing position. They may invite harassment.
They may not receive their share of social learning.
They may be considered rude.
They may not realize they are becoming or are boring
They cannot grasp that they are not welcome in a certain environment.
They do not realize they are giving unnecessary or incomplete information.
They do not check whether the other person understands them.
They realize they are misunderstood but do not give feedback.
They do not realize they are being hurtful.
They do not offer consolation.
They give off a selfish impression.

Korkmaz B., Yüksek İşlevli Otizm: Asperger Sendromu, ABA Yayınevi, İstanbul, 2019

AUTISM AND THEORY OF MIND

Autism is a disorder characterized by impairments in the Theory of Mind. When standard false belief tests, which require inferences about how people with false information will behave, are used, very few 3-year-olds understand the Theory of Mind, but by the age of 5, most children with typical development would succeed in these tests. 80% of children with autism struggle with the most commonly administered false belief tasks, even though their verbal mental ages are well above the 4-5 year level. The tests used in Theory of Mind studies involve a type of task where children must deduce that another person does not have the same information they possess. For example, children are shown that a candy box contains coins instead of candy and then are asked what another person would expect to find in the box. Approximately 3-year-old or younger children will say coins, while older children will correctly answer as candy.

Although some individuals with autism may succeed in first-order false belief tasks, they fail in more challenging second-order false belief tasks. This indicates that in autism, the development of the Theory of Mind is not entirely absent but delayed in specific ways.

The core symptoms of autism spectrum disorders affect socialization, communication, and behavior areas. The diagnostic criteria according to DSM-5-TR are provided in Table 2.³⁵ While clinical findings can be observed from the age of 3, some studies in babies considered at risk have shown that even infants aged 6-12 months may exhibit deficiencies in social responsiveness, communication, and play.³⁶

Issues with the Theory of Mind are not unique to autism. Although it is most characteristically seen in autism, it is observed in many different conditions (Table 3). This tells us that the ability for Theory of Mind relies on a widespread neural network.

Table 2. DSM 5-TR Autism Spectrum Disorder Diagnostic Criteria Group A

<p>A. Persistent deficits in social communication and social interaction across multiple contexts, as manifested by all of the following, currently or by history</p> <ol style="list-style-type: none"> 1. Deficits in social-emotional reciprocity, ranging, for example, from abnormal social approach and failure of normal back-and-forth conversation; to reduced sharing of interests, emotions, or affect; to failure to initiate or respond to social interactions. 2. Deficits in nonverbal communicative behaviors used for social interaction, ranging, for example, from poorly integrated verbal and nonverbal communication; to abnormalities in eye contact and body language or deficits in understanding and use of gestures; to a total lack of facial expressions and nonverbal communication. 3. Deficits in developing, maintaining, and understanding relationships, ranging, for example, from difficulties adjusting behavior to suit various social contexts; to difficulties in sharing imaginative play or in making friends; to absence of interest in peers.

The characteristics listed in Section A of the DSM 5-TR criteria for Autism Spectrum Disorder fully reflect the consequences of a lack of Theory of Mind. The presence of symptoms in the early stages of development, remaining unnoticed until they exceed the boundaries of social expectations, are additional supporting features. The symptoms must lead to clinically significant impairment in social, occupational, or other important areas of functioning. However, strategies learned later in life by the individual may mask these deficiencies.

According to Baron-Cohen, individuals with autism understand behavior in terms of desires and goals.³⁷ They can differentiate between animate and inanimate objects. They understand that desires lead to emotions. They can spontaneously use the word “seeing” in their conversations. They can discern whether someone is looking at them or elsewhere. They can deduce where someone is looking. However, individuals with autism cannot confirm that they are paying attention to the same object or event as someone else, because shared attention is impaired. They cannot engage in joint attention behaviors. They cannot follow a gaze. They cannot point or use gestures. They cannot infer that seeing expresses a desire.

NEUROLOGICAL BASIS OF THEORY OF MIND

Like all human intellectual functions, the Theory of Mind depends on a coordinated operation of various neural systems and pathways. These are complex and dynamic systems formed in the

Table 3. Conditions with Theory of Mind Impairment

Autism Spectrum Disorder
Attention Deficit Hyperactivity Disorder
Learning Disabilities
Dyslexia / Nonverbal Learning Difficulties
Schizophrenia and Related Conditions
Affective Disorders
Borderline Personality Disorder
Antisocial Personality Disorder
Congenital Blindness
Congenital Deafness
Gilles de la Tourette Syndrome
Obsessive Compulsive Disorder
Trauma, neglect, abuse

brain via the interaction of environmental/experiential inputs with developmental/maturation changes. Two main groups are identified within these systems. The first group consists of a series of structures located in the posterior cerebral region, including key nodes such as the fusiform gyrus, superior temporal sulcus, and temporoparietal junction. The second group is comprised of structures in the anterior cerebral region, the medial prefrontal cortex (MPFC), and the anterior cingulate cortex (ACC) (Figure 1). The MPFC is the primary assessment module where the Theory of Mind is realized.³⁸

The constant features of the human face (eye color, basic positions of facial features, etc.) are processed in the right fusiform face area and the inferior temporal lobe. The fusiform face area responds to three distinct facial features: the classical front face configuration (arrangement of two parts placed horizontally and symmetrically above the two vertical parts), the presence of specific facial sections (eyes, nose, and mouth), and the bounding contour of a roughly oval face with hair on top and sides. However, it has been shown that the identity information of the face is largely processed in the right anterior temporal lobe.³⁹ Identity information is also processed in the lateral fusiform gyrus, which is interconnected with the temporal lobe.

Data from the inferior visual cortex including the variable features of the face (e.g., eye movements), is sent to the superior temporal sulcus (STS) to be processed, providing information about the eyes, including gaze direction. Information from the STS then goes to the amygdala, where social and emotional meanings are added, and to the auditory cortex, where lip movements are recorded. Studies have shown that the STS region is functionally divided into two areas: a frontal area primarily associated with processing speech and to a lesser extent with Theory of Mind functions, and a posterior area involved in processing faces, visual-auditory integration, motion processing, and related to the Theory of Mind.⁴⁰

It has been shown that the posterior superior temporal sulcus responds to all social features while not responding to any non-social features (places, objects, rigid movements, people not in social interaction, actions not directed towards a goal, and non-human sounds).⁴¹ It is the main region for visual-auditory integration.

The Temporo-Parietal Junction (TPJ) is a very specific brain region, formed by the posterior superior temporal sulcus, the inferior parietal lobule, and the lateral occipital cortex. It is known that this junction, especially on the right side, plays significant roles in the distinction processes of self from others and in the Theory of Mind. The left part of this junction (Wernicke’s area and angular gyrus) consists of crucial anatomical structures of the brain involved in language cognition, processing, and the understanding of both written and spoken language.

The second group, located in the anterior cerebral region, is the MPFC which is the place where the Theory of Mind is substantiated. It has dorsal and ventral parts; the dorsal MPFC is more involved with complex cognitive mechanisms like evaluating stimuli and information; while the ventral MPFC is concerned with emotional processes. The relationship between the two is contradictory; when one is activated (tasks requiring attention), the other is inhibited (emotional activity).⁴²

The connections of the ventral MPFC with different brain regions lead to diverse functions. The Ventral MPFC is critically important

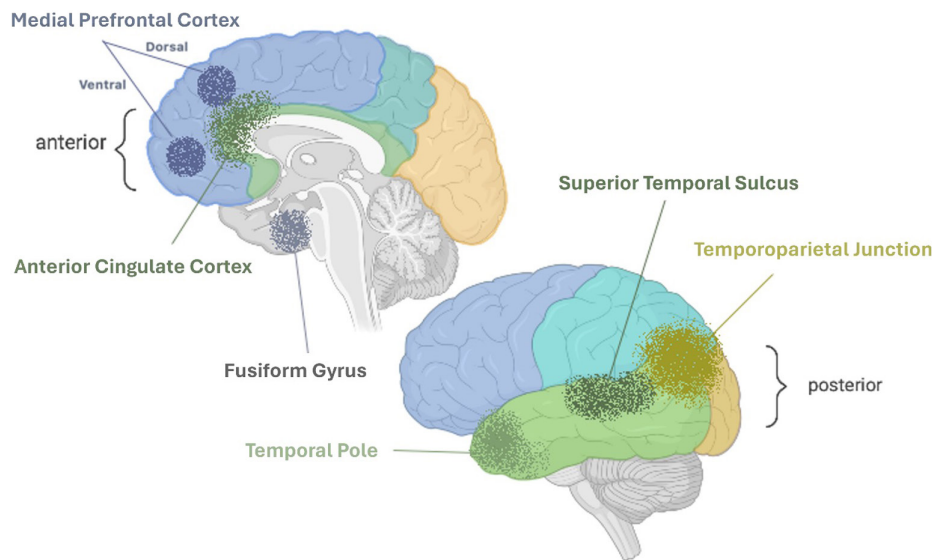


Figure 1. Brain areas involved in the Theory of Mind.

in reward and value-based decision-making processes through its interactions with the ventral striatum and amygdala. Along with the orbital prefrontal cortex (OPFC), the ventral MPFC functions in the integration of social and emotional signals guiding our behaviors. Perceptual information related to social events is interpreted, moral events are emotionally labeled by the ventral MPFC, and bodily sensations are contextualized.⁴³ Together with the OPFC, the ventral MPFC facilitates the amalgamation of social scenarios with their emotional responses. Perceptual data of social events are animated with their emotional dimensions. Social issues are also related to emotional expectations and decision-making. Bodily data is likewise utilized.

Anatomically, the ventral (MPFC) is extensively connected with limbic structures such as the amygdala, ventral striatum, hypothalamus, midbrain periaqueductal gray area, and brainstem autonomic nuclei through the OPFC.⁴⁴ Such anatomical connections suggest the role of these medial areas in the integration of the visceromotor aspects of the emotional process with information gathered from both the internal and external environments. The ventral MPFC inhibits the raphe nuclei, thereby enhancing alertness and regulating the stress response. It plays a critical role in regulating aversive responses, depression, and post-traumatic stress disorder. The locus coeruleus has an important role in the stress-induced modulation of MPFC function.⁴⁵

The ACC, anatomically tightly connected with the ventral MPFC, is crucial for coordinating between executive functions (dorsolateral) and social cognition networks (ventromedial).⁴⁶ It procures social orientation. The ACC takes control when the need to focus on the external world arises. It encodes information about the mental effort to be expended during a task. It reflects on conflicting situations. By integrating information about past actions' outcomes, it guides action selection based on cost-benefit analysis. Actions that yield positive results are learned, and behavior is organized accordingly.

Akinetic mutism, a syndrome that emerges in lesions affecting both the MPFC and ACC, indicates the critical role these regions play in motivation (being energized). The term abulia generally refers to a decrease in the initiation of cognitive responses, and lack of will or

initiative, and can be seen as a manifestation of reduced motivation. Apathy is the absence of motivation that is necessary to do things or a lack of concern about what is happening around one.⁴⁷

The emotional evaluation of faces in uncertain situations is associated with the activation of networks that include the dorsal MPFC.⁴⁸ Furthermore, activation of the medial Brodmann area 8 shows a negative correlation with the degree of subjects' intolerance to uncertainty ("intolerance of uncertainty").⁴⁹

The dorsal MPFC is activated during tasks involving generating, expressing, and tracking the ideas to talk or think about emotions and intentions, which are processes of the individual's mental state and internal dialogue.

Inhibitory control, one of the fundamental executive functions, involves an individual's ability to override a strong internal predisposition or external allure by controlling their attention, behavior, thoughts, and/or emotions, to instead do what is more appropriate or needed. Without inhibitory control, we are all at the mercy of impulses, old thoughts, action habits (conditioned responses), and/or stimuli in our environment that pull us in one direction or another. Our behaviors are often much more under the control of environmental stimuli than we realize, but possessing the skill to utilize inhibitory control creates a possibility for change and choice. The dorsal MPFC shows increased activation during complex decision-making tasks, in addition to social judgments.⁵⁰ The dorsal MPFC is active when people attempt to understand others' perspectives, beliefs, and thoughts.

The dorsal MPFC is also a part of the Resting Network (Default Mode) along with the medial temporal lobe, posterior cingulate cortex, ventral precuneus, and parts of the parietal cortex. This network is activated when a person is not focused on the external world, during wakeful rest, such as daydreaming, thinking about others or themselves, reminiscing, planning for the future, or engaging in thoughts and plans unrelated to a task.⁵¹ The resting state is the scientific term given to the moments when the subconscious mind is not involved in any activity or operation focusing on oneself and one's relationships.

CONCLUSION

Social cognition defines the individual's cognitive processes such as processing, interpreting, and reacting to signals coming from society. The social dysfunctions, which can be commonly detected in neurological diseases, can sometimes be overlooked or clinicians may be insufficient in this area. Therefore, social cognition should now be recognized as a core area of function requiring clinical attention and be a fundamental part of neurology education.

The development of the Theory of Mind can begin from birth and continue until late adolescence. For the infant to be included in the network of social relations as an active individual, the Theory of Mind must become functional. A certain degree of linguistic and conceptual development, as well as the integration of executive process and memory, are necessary for the complete development of the Theory of Mind. A disturbance in the theory of mind's development can lead to various communication issues, misunderstandings, and serious problems in daily life. In this context, it is necessary to include Theory of Mind training under the umbrella of social cognitive skills not only in special education and neurorehabilitation but also within the formal education curriculum.

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