Theory of Mind: Going to the Heart of ASD and Social Communication Disorders

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Theory of mind (ToM) in Pinnochio

Geppetto displays ToM. He wished and daydreamed that Pinocchio were a real boy.

Ubuntu

Development of theory of mind is dependent on attuned interactions with others

An ideology that highlights the unity of humanity and emphasizes the importance of constantly referring to the principles of empathy, sharing, and cooperation in our efforts to resolve our common problems.

Classic Definition of Theory of Mind

• The ability to attribute mental states—beliefs, intents, desires, pretending, knowledge, etc.—to oneself and others and to understand that others have beliefs, desires, and intentions that are different from one’s own

Cognitive Theory of Mind

Classic Assessment of Cognitive ToM
False Beliefs Contents (pass)


Classic Assessment of Cognitive ToM
Sally-Anne False Belief Location (fail)


Pinocchio needs ToM to be human

Pinocchio becomes sentient: The blue fairy gives Pinocchio the ability to feel, perceive, be conscious and to experience subjectivity. The Blue Fairy gave Pinocchio cognitive ToM

BUT to become fully human, he must be brave, truthful, and unselfish, and he must learn to choose from right and wrong; his conscience will be his guide. He must develop affective ToM

Affective Theory of Mind

- Affective cognitive ToM: awareness and reflection on one’s own emotions; ability to recognize or infer what others are feeling (understanding the emotions of others cognitively)
- Affective empathy: drive to respond appropriately to others’ emotions


Cognitive ToM

<table>
<thead>
<tr>
<th>First Order</th>
<th>Second Order - directed toward picture</th>
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<tbody>
<tr>
<td>Cognitive ToM (24 trials)</td>
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<tr>
<td>Cop 1-2 trials</td>
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<tr>
<td>Cop 2-6 trials</td>
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<tr>
<td>You are thinking of:</td>
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Affective ToM

<table>
<thead>
<tr>
<th>First Order</th>
<th>Second Order - directed toward picture</th>
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<tbody>
<tr>
<td>Affective ToM (24 trials)</td>
<td></td>
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<tr>
<td>with 12 trials</td>
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<tr>
<td>and 6 trials</td>
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<td>You hear:</td>
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Cognitive False Belief

Joe and Anna are setting the table for a festive dinner at the dining room. Anna pours Joe a glass of water, but some water spills on his new shirt. Joe says: “It’s nothing, I will change the shirt later.” Anna puts the glass on the table and goes to look for a paper towel to dry Joe’s shirt. When she leaves the dining room, Joe takes his handkerchief and dries the shirt and the table. Anna peers into the dining room, sees what Joe is doing, and so she doesn’t bring a paper towel. Anna returns to the dining room.

1. What does Joe think that Anna thinks about the shirt’s condition, when she returns to the dining room? (2nd order ToM)
2. What does Anna think of the shirt’s condition? (1st order ToM)
3. What is the shirt’s condition?
4. What were Joe and Anna doing?

Affective False Belief


Joe and Anna are setting the table for a festive dinner at the dining room. Anna pours Joe a glass of water, but some water spills on his new shirt. Joe says: “It’s nothing, I will change the shirt later.” Anna puts the glass on the table and goes to look for a paper towel to dry Joe’s shirt. When she leaves the dining room, Joe gets furious about the wet shirt and kicks the table. Anna peeks into the dining room, sees what Joe is doing, and so she feels guilty. Anna comes back to the dining room.

1. What does Joe think that Anna feels about the wet shirt, when she returns? (2nd order ToM)
2. What does Anna think Joe feels about the wet shirt? (1st order ToM)
3. How does Joe feel?
4. What were Joe and Anna preparing for?

Interpersonal Cogni,ve ToM


Intrapersonal Cogni,ve ToM


Types of theory of mind


Metacognition: Intrapersonal Cognitive ToM

ToM in Star Trek

Friendship involves all aspects of ToM

Sheldon tries to approach friendship using his intrapersonal cognitive ToM

Cognitive intrapersonal ToM:
I know that in books, foxes are usually bad.

Cognitive interpersonal ToM:
The goose doesn’t know the fox is there but we do. We know fox’s intention is to eat a goose and duck.

Affective interpersonal ToM:
We realize that goose is nervous/worried.

Affective empathy:
We might feel worried/frightened for goose and duck.

Mirror Neurons

A mirror neuron is a neuron that fires both when an animal acts and when the animal observes or hears the same action performed by another. Thus, the neuron “mirrors” the behavior of the other, as though the observer were itself acting.

• Visual mirror neurons
• Auditory mirror neurons

Neural Networks Subserving ToM

Cognitive ToM
- Temporoparietal junction (particularly right)
- Dorsal lateral prefrontal
- Superior temporal sulci (STS)
- Temporal poles
- Dorsal medial prefrontal cortex (mPFC)
- Precuneus/posterior medial cortex


Affective ToM
- Dorsal lateral prefrontal
- Temporoparietal junction (particularly right)
- Superior temporal sulci (STS)
- Medial prefrontal cortex (PFC)
- Temporal poles
- Precuneus


Affective Empathy

Limbic system


Facial Processing

Core System
- Visual Analysis
  - Superior temporal sulci: spatially directed attention
  - Auditory cortex: prefrontal speech perception
  - Amygdala-insula-limbic system: emotion
  - Fusiform gyrus: invariant aspects of faces and objects
  - Anterior temporal poles: personal identity, name information


Face Scanning


Social-Emotional Foundations of Communicative Competence

- Inferring mental states of others
- Recognize emotions of others & infer cause; empathy
- Awareness of my own knowledge & use of this to learn & plan
- Metacognition
- Cognitive: interpersonal & social
- Affective: interpersonal & social
- Cognitive: intrapersonal & reflective
- Affective: intrapersonal & reflective
- Recognize & regulate my own emotions

Neurochemistry & ToM

- Higher dopamine levels predict better ToM performance;
- lower dopamine levels predict lower ToM performance
- Intranasal oxytocin improves ability to infer mental state
- Long-term elevated cortisol levels (response to stress) charge brain architecture
  - Smaller orbitofrontal cortex


Genotypes and ToM/empathy

- Children with these genotypes who are reared in negative social environments (abuse/neglect) are likely to have lower levels of ToM/empathy.
  - Short form of DRD4 (dopamine receptor gene)
  - Low-activity MAOA genotype (monoamine oxidase A—metabolizes stress hormones)
  - AA or AG allele of OXTR gene (oxytocin receptor)


Epigenetics and ToM

- “epi” means above; “genome” refers to all of an individual’s genetic information.
  - Thus, the epigenome is information about us that is stored outside of our DNA
  - Special chemicals called tags can become attached to the nucleotides of our DNA or to our histone proteins, and, depending on the nature of these tags, specific genes can either be silenced (prevented from being expressed as protein) or pushed to become more active (so that the abundance of a particular protein in our cells will rise).

ToM in Communication Disorders

- Autism
  - All aspects of ToM significantly affected
  - Cognitive ToM tends to develop in children with high-functioning autism or Asperger
- Language impairment
  - Delays in development of most aspects of ToM
  - Fewer mental state & emotional words than typical children
- Attention deficit-hyperactivity disorder
  - May have delays in ToM development
  - Higher levels of inter- and intrapersonal ToM affected
  - Particular deficits in intrapersonal ToM for self-regulation of behavior and emotions

ToM in Communication Disorders

- Deafness
  - Delays in ToM (particularly for Deaf of hearing parents)
  - Delays associated with language but greater than expected from language levels
  - Poor identification of emotions and recognizing causes of emotions
- Blindness
  - Delays in cognitive ToM
  - Difficulties identifying emotion in tone of voice
- Children who experience abuse/neglect
  - ToM deficits in affective empathy often most marked

ToM in Communication Disorders

- Children involved as bullies, victims, & bully-victims
  - Likely deficits primarily in affective empathy in bullies
  - Others may have ToM deficits in any or all areas
- Children & adolescents with disruptive behavior disorders
  - Callous/unemotional traits
    - Callousness; lack of empathy,
    - Lack of personal affect
    - Remorselessness
  - Machiavellian traits

ToM in Communication Disorders

- Persons with traumatic brain injury (TBI)
- Persons with degenerative brain conditions
  - Alzheimer’s disease
  - Frontotemporal dementia
  - Amotrophic lateral sclerosis
  - Parkinson’s disease
- Persons with psychiatric diagnoses
  - Psychopaths
  - Borderline personality disorders
  - Narcissists