

Theory of Mind Development: An Overview

Peter de Villiers
Smith College

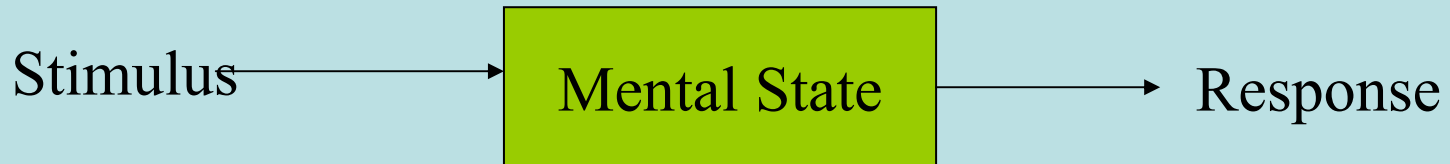
Winter Institute, PUC
Rio de Janeiro, August 2007

Outline

- What is a theory of mind and why is it important?
- How does it develop from infancy to age 5?
- General theories of theory of mind development
- Process theories of theory of mind development
 - The role of executive functions
 - The role of language
- The challenge of new infancy research

Introduction: What is it to have a Theory of Mind?

- Being able to infer and use information from other people about their emotions, intentions, desires, beliefs (true or false), and knowledge or ignorance.
- Understanding that their behavior is a reaction not just to the environment, but also to those mental states.
- A “theory” because the child infers people’s mental states from their behavior (they are typically not directly observable) and uses those concepts to predict and explain behavior (Astington & Gopnik, 1991)



Why have a Theory of Mind?

- Important for **social interaction**: to explain and predict others' actions.
- Important for **communication**: to read the speaker's communicative intent, to assess our listener's knowledge state, and to tailor messages to that state (Grice, 1975; Sperber & Wilson, 1986 -- Relevance Theory).
- Important for **narrative**: to understand motives, intentions, desires, beliefs of characters -- what Bruner (1986) called the "landscape of consciousness".
- Therefore crucial for **literacy and success at school**.

ToM and Social Outcomes

- Lalonde and Chandler (1995) found that ToM was related to social skills that arguably involve mental states (e.g., following rules in simple games without being reminded) but was not related to social skills that only involve routine social conventions (e.g., saying “thank you”).
- Jenkins and Astington (2000) report a significant impact of ToM understanding on children’s success at complex pretend play, particularly joint role taking and explicit communication of roles.
- Astington and Pelletier (2003) found that children’s ToM understanding accounted for unique variance in a teacher rating of the children’s social competence, even after accounting for age and language ability. There was no evidence of the reverse effect.

At first...

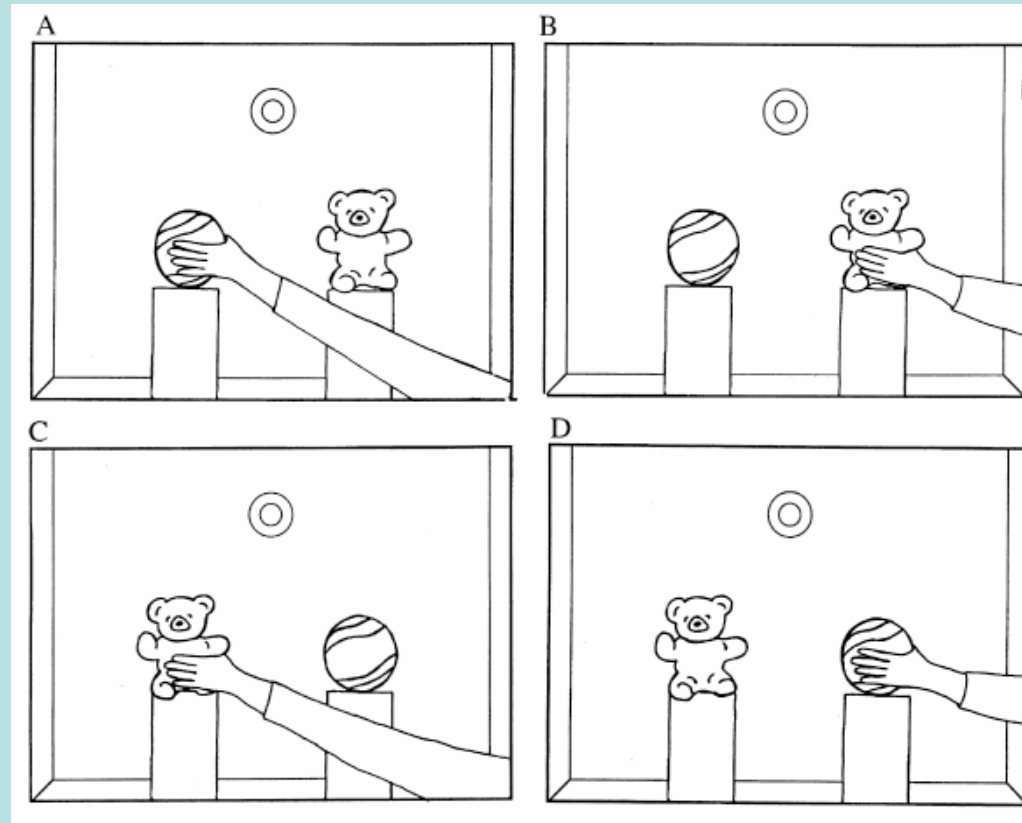
- Infants are sensitive to eye-gaze as a signal of what someone is **interested** in.
- They follow eye-gaze to **share attention** on an object or event.
- As toddlers, they come to use eye-gaze and pointing as signals of what a person is **referring** to by a word.
- So shared attention is a basic prerequisite for early **word learning**.

In addition...

- Infants seem to understand that behavior of humans is **intentional**.
- Amanda Woodward's work (Woodward, 1998) shows that 6-9month old infants expect a hand that reaches for object A will **continue to reach** for A when objects are switched. They don't have the same expectation for a stick with a sponge on it.
- 14-18month olds imitate intended actions (taking the goal into account) rather than exact behavior (Meltzoff, 2000; Gergely et al, 2001)

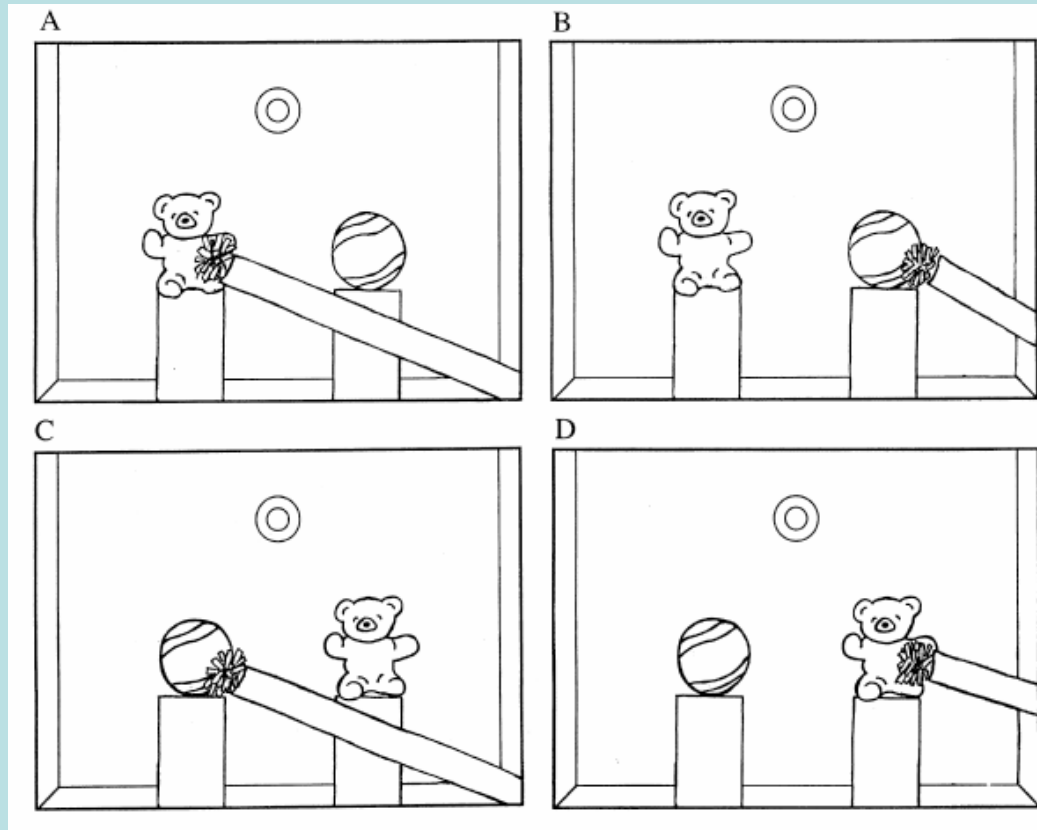
6 to 9 month olds Infer Human Intentions (Woodward)

- Infants habituated to an arm that grabs the ball are surprised and look longer when it reaches for the Teddy.
- Habituated to the arm grabbing the Teddy are surprised when it reaches for the ball.



Infants don't Read Intention into the Actions of an Inanimate Object

- When the arm is replaced by a pole with a sponge on the end, the infants don't show any expectation of what the pole "wants".



Gergely et al, 2001



Hands free



Hands occupied

Reading Communicative Intentions

- The young child's ability to read both action and communicative intentions is also critical for word learning.
- Bloom (2003) and Tomasello (2001) both show that in learning words, toddlers are highly attentive to **whether a person's intention was achieved.**

And Emotions...

- Infants are sensitive to emotional expressions, and from the first months are disturbed by negative or unresponsive emotional expressions.
- They expect “happy” voices to come from “happy” expressions” and sad voices from sad faces, by the end of the first year.
- By the second year of life if something unexpected happens they “check” the response of an adult with them to see how to respond.

By two years...

- Children seem to understand that **desires** are individual: they may prefer crackers, but an adult might like broccoli better.
- Having seen this preference, they hand broccoli but not crackers to the adult when asked “can I have some?” (Gopnik& Repacholi)
- This shows they are beginning to understand **different** desires.

Pretense

- **In the third year of life** children begin to distinguish between the world of **pretense** and the real world.
- For example, pretend cereal is poured from a familiar cereal box into one of two distinctively different bowls. The child is asked to feed a puppet his cereal.
- Which bowl does the child use? Two-and-a-half year olds reliably choose the one that has pretend cereal in it, not the one that is still “empty”.
(Harris, 2000)

Labeling Emotions

- **By three**, children know the words for and can label simple emotional expressions.
- And they can predict what emotion someone will have if they experience a commonplace event e.g. drop their ice-cream, or get a new toy.
- They also understand that emotions relate to people's desires. We are happy when we get what we want, and sad when we don't.

Beliefs

- **By three-and-a-half**, children can understand that someone will act according to his beliefs.
- For example, child is asked which of two closed boxes a character should look in to find an object. Then the child is told the character thinks it's in the other box.
- Children from around 3 1/2 can predict that the character will look in the box he thinks the object is in, not the box the child thought it was in.

By three and a half...

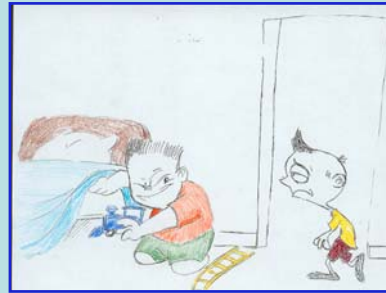
- Children understand that if one character has seen in a box, and another character has not seen in the box, they have different knowledge.
- They also understand that if someone has left a room, that person may need to be shown where something has been placed in their absence.
- In other words, that **seeing leads to knowing.**

False Beliefs

A critical development in ToM comes:

- When the child can differentiate his/her own mental states from those of others (i.e., can think about other people's thoughts).
- Is aware that people can differ in their beliefs and knowledge, and comes to understand that his/her own or other people's beliefs **may be false**.
- Can represent the contents of mental states, the truth or falsity of that content in relation to shared "reality", and different people's **point of view** on events.

Tests of False Belief Understanding



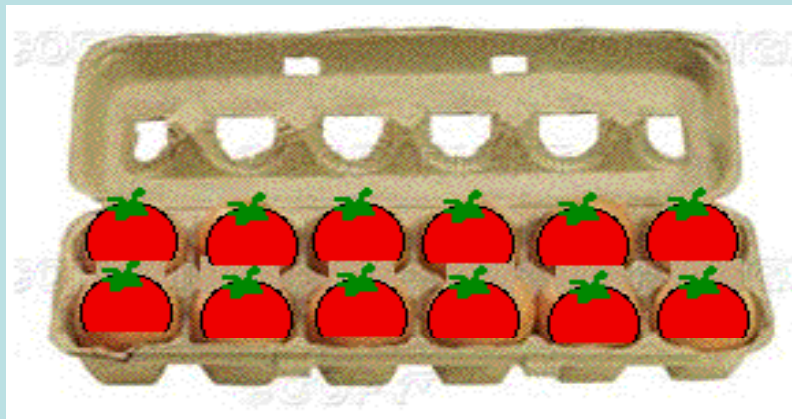
Unseen change of location

- A character puts an object in one of two or three possible locations and then leaves the scene. While he is away, a second character moves the object to a new location. The first character then returns to the scene and wants the object. Following memory check questions, the child is asked where the character will look (or “first look”) for the object.
- **The 3 year old says the character will look where the object now is.**
- **The 4 year old says he will look where he last saw it.**

Unexpected Contents: Other's Belief?



- What do you think is in this box?



If we close it up again and ask your friend, what will she think is in the box?

Unexpected Contents

- In *unexpected-contents* tasks, the child is shown a familiar container such as an M&M candy box, an egg carton, or a CRAYOLA crayon box, that leads them to expect particular contents.
- However, when they look inside, the box turns out to contain something unexpected -- for example, a plastic spoon in the crayon box. The box is then closed up again and the child is asked either what they thought (or “first thought”) was in the box before they looked inside or what a friend would think was in the box before they looked inside.
- **The 3-year-old says he will think there’s a spoon in the box.**
- **The 4-year-old says he will think there are crayons in the box.**

Some common real-life scenarios that involve theory of mind

- Hide-and-seek
- Explanation of mistaken actions
- Predicting what characters in a story will do
- Understanding familiar nursery tales - they often depend on false appearance, trickery, deception: Cinderella, Sleeping Beauty, Little Red Riding Hood.

Explaining strange actions

QuickTime™ and a
H.263 decompressor
are needed to see this picture.

Why did the girl drink the flowers?

- **Three years olds:**

“She was silly”

“She likes flowers”

“ I don’t know”

- **Four year olds:**

“She didn’t know her coke was moved”

“She thought it was her drink”

“She didn’t see her move it”

Steps in Theory of Mind

Understanding false beliefs; emotions, and desires based on belief **4-5 yrs**

Understanding the relationship of seeing to knowledge; conflicting emotions **3.5-4 yrs**

Understanding desires; simple “scripted” emotions; pretense **2.5-3.5 yrs**

Basic ToMM: shared attention, directed eye gaze, monitoring intent of others. **9mos-2.5 yrs**

Theory of Mind: Explanations for Development

General Theories about ToM Development

Process Theories of False Belief Reasoning

- The Role of Executive Functions
- The Role of Language

Theories of ToM Change

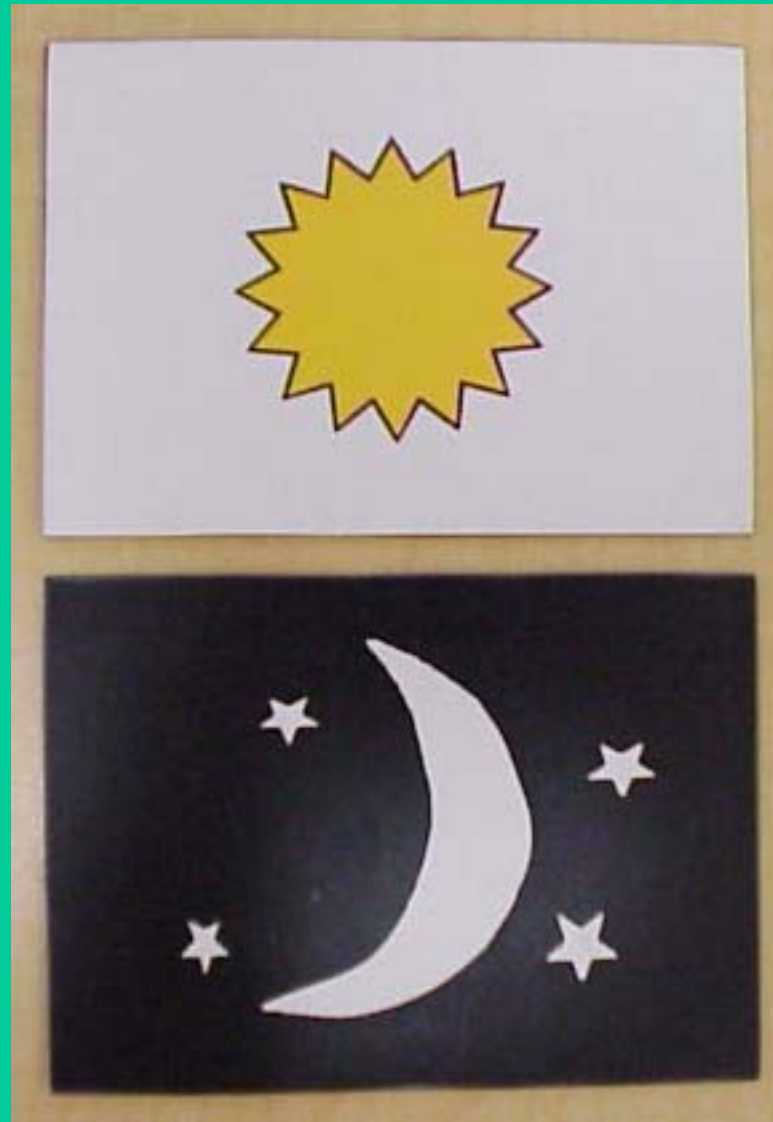
- **Innate Theory of Mind Module in the Brain** (Leslie, 1994)
 - Primary developmental process = maturation
 - Pretense ---> Belief Understanding
- **Simulation Theory** (Harris, 1988)
 - Primary developmental process = empathy
 - Emotion ---> Belief Understanding
- **Theory-Theory** (Wellman, 1990; Gopnik & Astington, 1991)
 - Primary developmental process = child as little scientist building a theory about the social and psychological world
 - Desire ---> Belief Understanding

Process Theories of False Belief

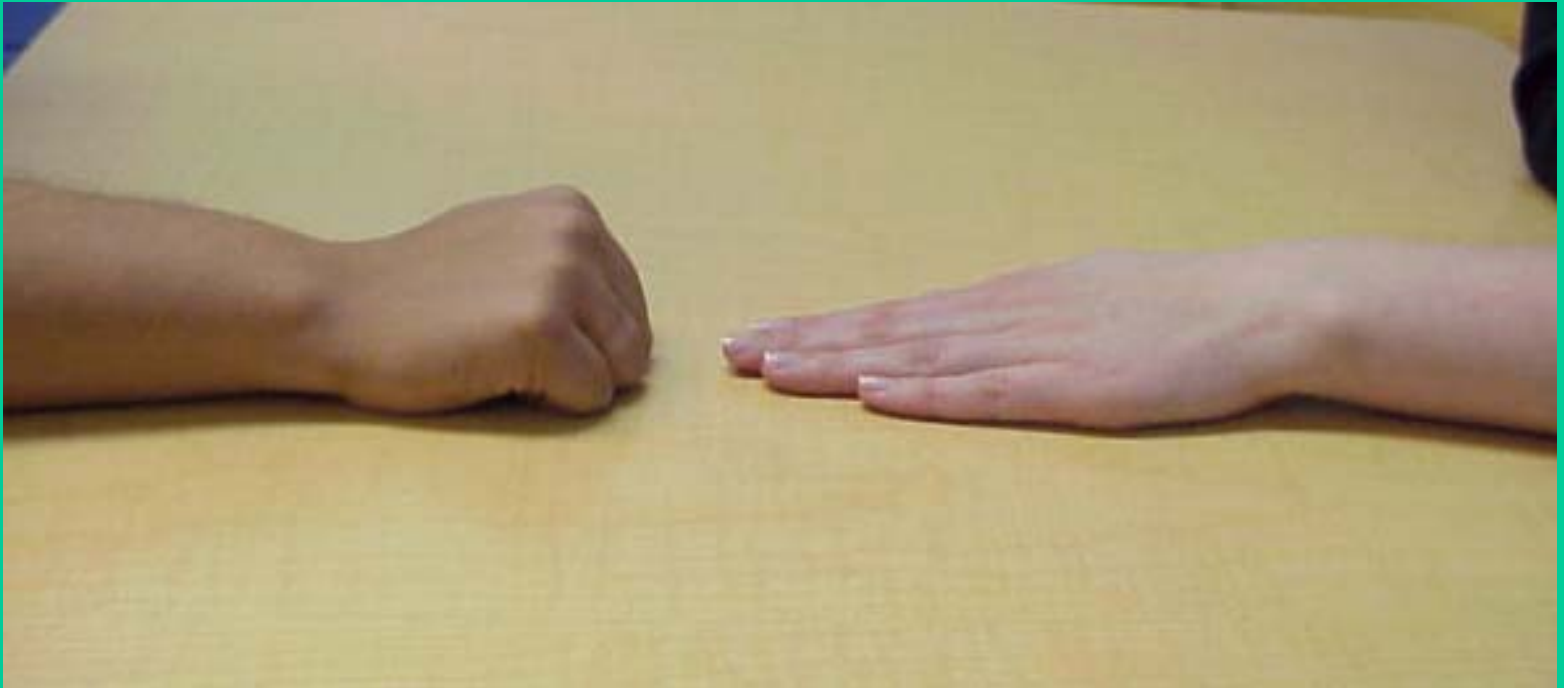
Understanding: Executive Functions

- Executive Functions = maturation of frontal lobe of brain
 - **Inhibitory Control of Behavior**
 - “Think before you act” -- inhibit impulsive responses
 - Day-night STROOP task
 - Luria hand games -- e.g., knock vs tap task
 - **Working Memory**
 - Updating of short term memory
 - Manipulation of information
 - Exhaustive search task
 - **Planful, Flexible Problem Solving**
 - Combination of working memory and inhibitory control
 - Dimensional Card Sorting task
- **All of these correlate with success on false belief tasks**
e.g. unseen object displacement and unexpected contents

Day-Night Stroop



Knock-Tap



Two Roles for Language in Theory of Mind Development:

- *Language input to the child:*
 - Conversational role and points of view
 - Language about mental states
- *Language skills of the child:*
 - Labels for mental concepts
 - Pragmatic skills
 - Syntax for representing mental state contents

How might language input affect ToM?

Four models with different implications:

1. Language input provides a major source of evidence for the culturally specific Theory about minds that the child comes to share.
 - Assumption: the theory is directly transmitted as a cultural theory - like a theory of folk biology, or folk physics. The richer the input, the better the match to the cultural theory.
 - Children from cultures or groups that don't talk much about mental states as explanations for behavior will be slower to master false belief tasks (e.g., Vinden, 2000; but see Lillard, 2004)
 - **Child joins cultural discourse.**

Second model

2. Language input provides a major source of evidence for the child to build a Theory about minds.
- The way people interact and the things they say about themselves and each other provides the raw data for the child's formulation of a Theory about minds and behavior.
 - **Child as cognitive scientist.**

Third model

3. Language input provides the vocabulary about minds that reifies concepts that the child might not otherwise notice.
- Linguistic input includes abstract terminology: believe, want, think, know.. that causes the child to actively search for meanings, extending his grasp beyond behavior to its hidden causes.
 - **Child as semanticist.**

Fourth model

4. Language input provides linguistic structures that enhance representational capacity in specific ways relevant to representing the content of other minds.
- The child learns the syntax and semantics for differentiating between his own reality and the contents of other minds.
 - **Child as linguist.**

Differences?

- For the first, good mental explanations of behavior, real mind-mindedness, is paramount.
- For the second, general discourse and conversation is as significant, e.g. communicative misunderstanding and clarification adds to the evidence.
- For the third, vocabulary is most significant.
- On all of them, the more mind talk, the better for false belief understanding, i.e. a mature ToM.

The fourth

- On the last model what is most important about input is how it builds the child's own language structures.
- Mental vocabulary without syntax of complements is of little use for understanding false beliefs. So saying lots of "I don't know" or "I think so" or "What do you want?" is no real help.
- But saying, "He said he fell down but he didn't." = perfect! So on the fourth model, it's not "the more the better", it's exposure to ENOUGH input of a specific sort, at least for the breakthrough to representing the contents of false beliefs.

What Evidence for Role of Input?

- Dunn (1994, 2005) noted a correlation between aspects of family conversation and the child's performance on measures of emotion understanding and false belief reasoning.
- Families that talked a lot about the psychological causes of behavior, especially emotions, desires, and states of knowledge/ignorance, had children who were more likely to pass tests of ToM.
- But could the child be leading the caregiver?

Mothers' Mind-Mindedness

- Meins et al (2002, 2003) found the best predictor of their children's later ToM was the mother's tendency to talk **about** her infant at **six months** in mentalistic terms.
- They called this “maternal mind-mindedness”, e.g. “He wants me to do that again.” “She thinks that’s funny.”
- Mothers who use a lot of mental descriptions rather than trait or behavioral descriptions had children who learned ToM faster.

The Role of the Language Input (Ruffman et al., 2002, 2003)

Ruffman et al assessed:

- Children's language competence (on a standardized test of grammar and vocabulary -- the CELF)
- Their Theory of Mind skills on standard tasks
- The mother's use of mental state-talk during discussion with the child of the characters in a picture book.
- Each of these three measures was taken at three different time points (t1, t2 and t3) over the course of approximately 1 year.
- Mothers' mental state language during the picture book task (at t1 and t2) predicted children's later ToM performance (at t2 and t3) even with children's prior language ability and ToM performance (at t1 or t2) partialled out.

So clearly, language input has an effect.

Child's own Language as Key

- *Semantic/Pragmatic Theory*. (e.g. Astington, 2001; Bartsch & Wellman, 1995; Dunn, 2005; Harris, 1996; Peterson & Siegal, 1995, 1999)
 - ToM is facilitated by:
 - -- references to mental states in explanations of behavior (focus on mental causes, labels for concepts)
 - -- conversational dialogue (reading communicative intent, presuppositions, and state of knowledge)
- *Syntactic Theory*. (e.g. J. de Villiers, 1995; Tager-Flusberg, 2002)
 - Acquisition of the underlying syntactic structure of complement clauses with verbs of communication (“say”, “tell”) enable the representation of false beliefs.

What special syntax might be involved?

- Verbs of communication and mental state uniquely take **complement clauses**, for example,

Bill said *that he caught a unicorn*

Bill thought *that he caught a unicorn*

Notice the complement clause “he caught a unicorn” is false, but the whole sentence is not false.

- This is unlike other subordinate clauses e.g. an **adjunct adverbial clause**

Bill left *because he caught a unicorn*

Bill left *after he caught a unicorn*

in which if the adjunct clause is false, the whole is also false.

What do complements allow?

- They allow the representation of truth and falsity in a world in **someone else's mind** that is distinct from the world as represented in our own mind.
- From that representation, reasoning can proceed about what the person might do, based on such a representation, or to explain what they have done.
- The syntax and meaning of complement clauses can be **learned first from verbs of communication** (saying and telling), where the truth and falsity is more obvious than in cases of thinking or believing.

Test for complement mastery



- The woman said the girl had a bug in her hair.



But it was only a leaf.

What did the woman say the girl had in her hair?

What did she say the girl had in her hair?

Claim:

- To get the right answer to the wh-question the child has to know that the complement clause is **embedded** and applies to BOTH verbs
- Not just **what did the girl have**, but **what the woman said the girl had**.
- 3 year olds answer “ a leaf” = what the girl had
- 4 year olds answer “a bug”.

What role is played by a child's own language skills?

- Longitudinal studies of preschoolers
- Training studies
- Studies of autistic children
- Studies of children with specific language impairment (SLI)
- Studies of deaf children -- oral and signing

Longitudinal Studies

(Astington & Jenkins, 1999;
J. de Villiers & Pyers, 2002)

- Tested language acquisition and development of false belief understanding between age 3 and 4 in preschoolers.
- **Language predicted later false belief reasoning, not vice versa.**
- Processing of false complement clauses with verbs of communication was a better predictor of later theory of mind development than were other measures of general language skills (e.g. Mean Length of Utterance or other complex clause production).

Training studies

- Two separate training studies (Hale and Tager-Flusberg, 2002; Lohmann & Tomasello, 2003) have shown that **teaching the syntactic structures** relevant for language about the mind can have a significant effect on children's performance on false belief tasks.
- The studies used communication verbs (e.g. *say, tell*) which have the same syntax as verbs like *think, believe* in that they take embedded complement clauses:

“She said *that it was an apple*, but it was really an orange”.
- **Training on these false communication complement structures accelerated later false belief reasoning more than direct training on the standard false belief tasks or on appearance/reality tasks themselves.**
- Training on other complex sentence forms, such as relative clauses had no effect on theory of mind development.

Language and ToM are reciprocally related:

- Early ToM drives language development -- toddlers reading communicative intentions.
- Around age 3 to 4 language acquisition (of mental state vocabulary and complement clauses) drives ToM development. Both the input and the child's own language seem to be important.
- Both ToM and the language of the mind then drive later development of discourse and communication skills.

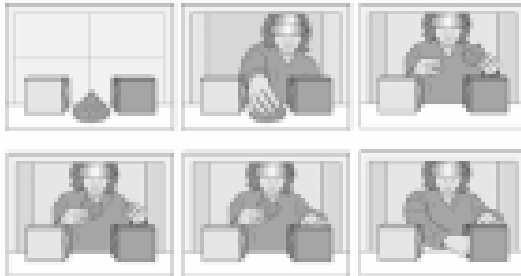
Challenges to this Picture:

New Infant Research

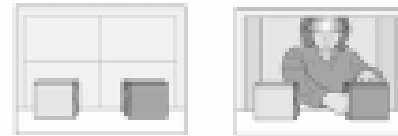
- Onishi & Baillargeon (2005)
 - 15 month olds watched as an object moved from A to B, either in sight or out of sight of a character.
 - They stared longer if the character then reached for the object in the right place if they had not seen it move there.
- Southgate et al (2007)
 - 25 month olds looked in anticipation at where a person's hand would emerge depending on whether they knew where an object was (it had not been moved) or if they had a false belief (it had been moved while they were not watching).

Onishi & Baillargeon, 2005

Familiarization Event 1



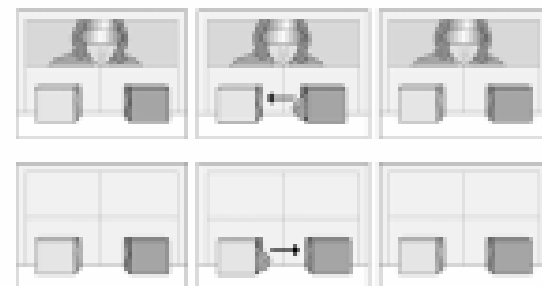
Familiarization Events 2 and 3



Belief-induction Event:
False-belief:Green-box Condition



Belief-induction Event:
False-belief:Yellow-box Condition



Onishi & Baillargeon, 2005

Test Events

Green-box event



Yellow-box event

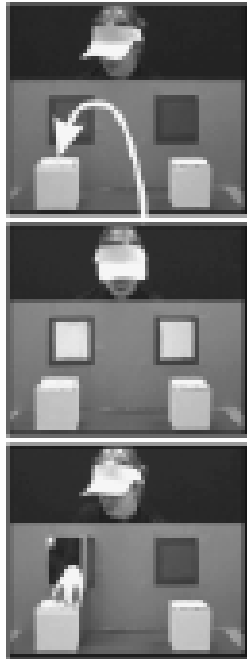


Southgate et al, 2007

Familiarization

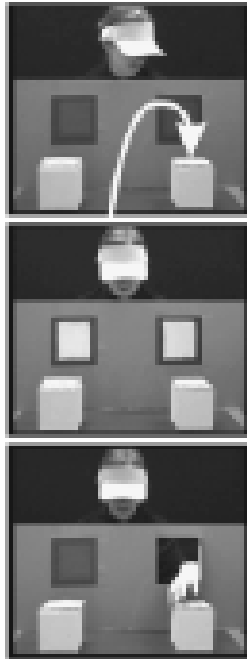
a

First



b

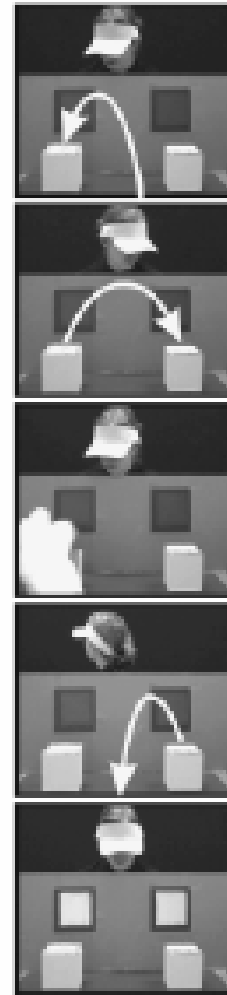
Second



Test

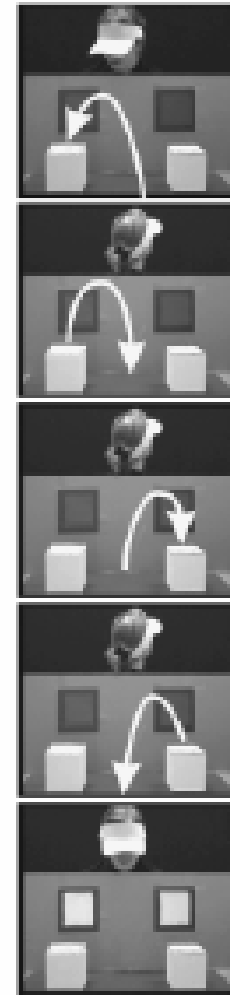
c

False Belief 1



d

False Belief 2



Questions raised?

Why do infants show sensitivity to what people do and don't know, but 3 year olds still fail false belief reasoning tasks?

- Is it just the cognitive and linguistic demands of the tasks? (e.g., executive functions)

What is the difference between what the infants and toddlers understand about false beliefs and what 5 year olds and adults understand?

- Implicit vs Explicit reasoning? (Clements & Perner, 1994; Perner & Dienes, 1999)
- Behavioral rules vs cognitive rules? (Povinelli & Vonk, 2004; Penn & Povinelli, 2007).