A young child with blonde hair and a large insect on their head, wearing a muddy coat on a beach. The child is looking directly at the camera with a neutral expression. The background is a rocky, pebbly beach with some wet sand and small puddles. The text is overlaid on the right side of the image.

Two Systems & Two Theories of Mind

Ian A. Apperly
& Stephen A. Butterfill

automatic

Are human adults' abilities to represent beliefs automatic?

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Infants' false-belief tracking abilities

Violation of expectations

- with change of location
- with deceptive contents
- observing verbal commⁿ

(Onishi & Baillargeon 2005)

(He et al 2011)

(Song et al 2008; Scott et al 2012)

Anticipating action

- looking
- pointing

(Southgate et al 2007)

(Clements et al 1994)

(Knudsen & Liszkowski 2011)

Helping

(Buttleman et al 2009)

Communicating

(Southgate et al 2010)

Altercentric interference

(Kovacs et al 2010)

Infants' false-belief tracking abilities

Violation of expectations

- with change of location
- with deceptive contents
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(Song et al 2008; Scott et al 2012)

Anticipating action

- looking
- pointing

(Southgate et al 2007)
(Golan et al 1994)
A-tasks (Golan & Liszkowski 2011)

Helping

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Communicating

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Altercentric interference

(Kovacs et al 2010)

1. There are subjects who can pass A-tasks

2. These subjects' success on A-tasks is explained by the fact that they **can** represent (false) beliefs

3-year-olds fail false belief tasks

prediction

- action

- desire

(Wimmer & Perner 1983)

(Astington & Gopnik 1991)

retrodiction or explanation

(Wimmer & Mayringer 1998)

select a suitable argument

(Bartsch & London 2000)

own beliefs (first person)

(Gopnik & Slaughter 1991)

involvement (deception)

(Chandler et al 1989)

nonverbal response

(Call et al 1999; Low 2010 exp.2)

test questions word-for-word
identical to desire and pretence
tasks

(Gopnik et al 1994;
Cluster 1996)

3-year-olds fail false belief tasks

prediction

- action
- desire

retrodiction or explanation

select a suitable argument

own beliefs (first person)

involvement (deception)

nonverbal response

test questions word-for-word

identical to desire and pretence

tasks

Perner 1983)

(Gopnik 1991)

Mayringer 1998)

London 2000)

B-tasks

Wimmer 1981)

Wimmer 1989)

1999; Low 2010 exp.2)

Wimmer 1994;

1996)

1. There are subjects who cannot pass B-tasks.

3. These subjects' failure on B-tasks is explained by the fact that they **cannot** represent (false) beliefs

1. There are subjects who can pass A-tasks but cannot pass B-tasks.
2. These subjects' success on A-tasks is explained by the fact that they **can** represent (false) beliefs
3. These subjects' failure on B-tasks is explained by the fact that they **cannot** represent (false) beliefs

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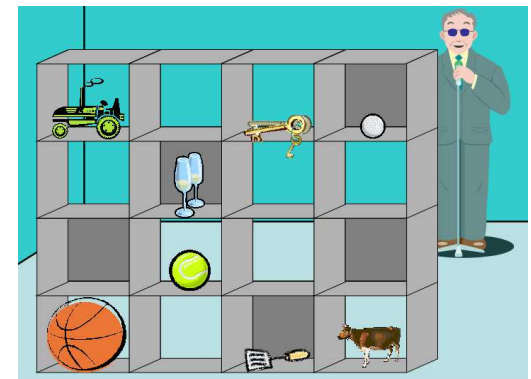
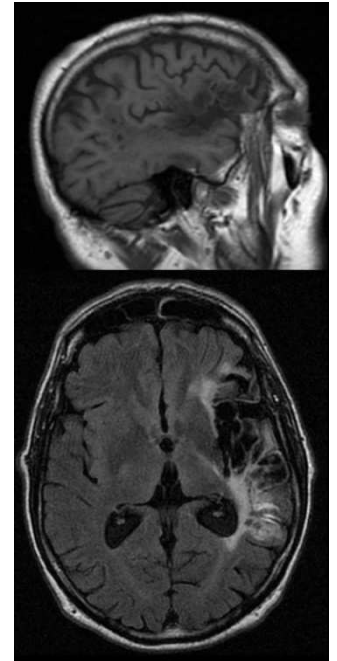
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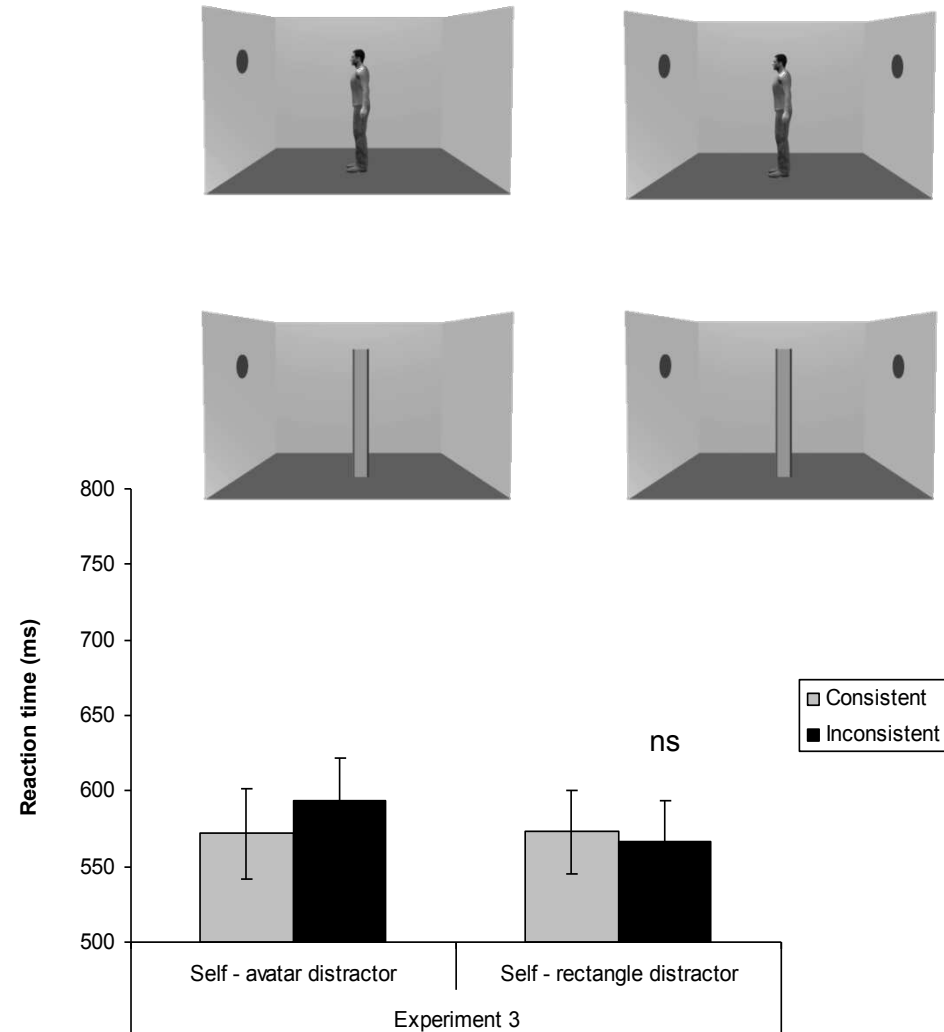
--- **yes:** Kovács et al (2010), Schneider et al (2011).

Evidence that mindreading is a flexible but demanding ability

- **In Adults....**
- Belief reasoning requires cognitive control
 - (e.g., Bull, Philips & Conway, 2007)
- Impaired executive processes can lead to severe egocentrism
 - (e.g., Samson, Apperly, Kathirgamanathan & Humphreys, 2005)
- Belief inferences are not *made* automatically
 - (Apperly, Samson, Riggs, Simpson & Chiavarino, 2006; Back & Apperly, 2010)
- Belief inferences are not *used* automatically
 - (e.g., Keysar, Lin & Barr, 2003; Apperly et al., 2010)
- Holding false beliefs briefly in mind has a measurable processing cost
 - (Apperly, Back et al., 2008)
- Recursion (e.g., beliefs about beliefs) remains challenging
 - E.g., Mckinnon & Moscovitch (2007)
- **And of course in children...**

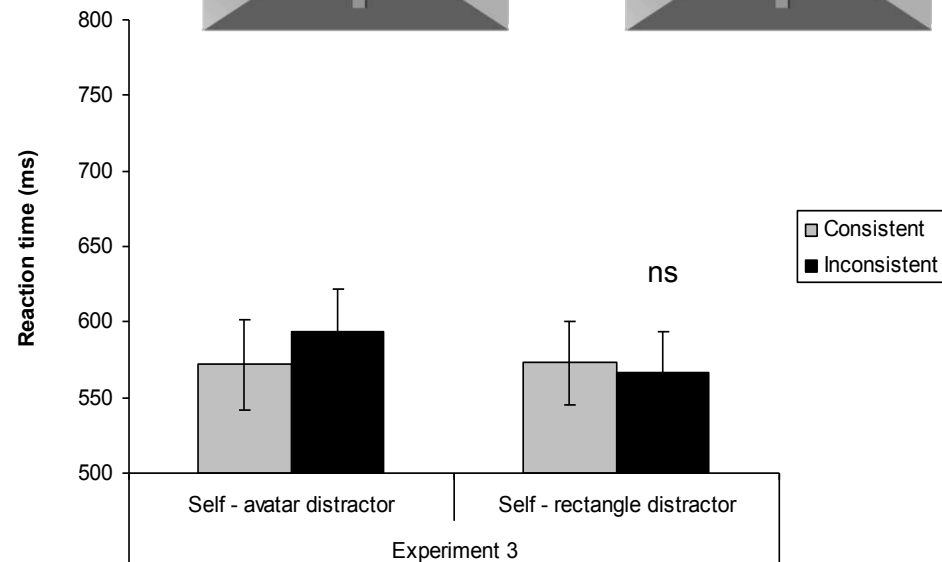
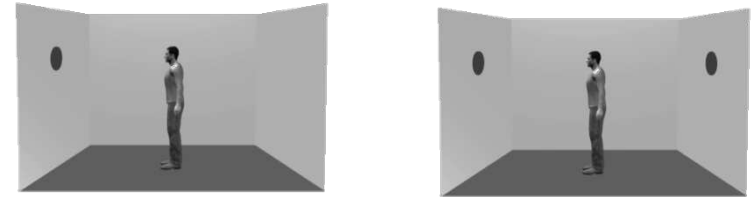


Evidence that mindreading is an efficient processes?



Evidence that mindreading is an efficient processes?

- Evidence of involuntary inference of:
 - Simple visual perspective (Samson et al., 2010)
 - Agent's spatial frame of reference (Zwicker, 2011)
 - Agent's "false belief" (Kovacs et al., 2010)
- Sometimes without explicit awareness
 - Schneider et al. (2011)
- Without need for "executive control"
 - Qureshi et al. (2010)



Mindreading makes contradictory demands

Apperly & Butterfill (2009) *Psych. Rev.*

ToM must be flexible
- An archetypal “central process”



ToM must be fast and efficient
- An archetypal “modular process”



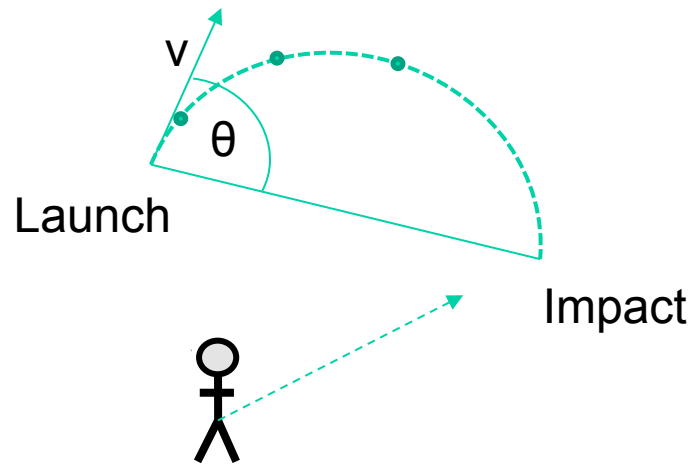
Fast &
Flexible?



But how could mindreading be efficient?

An analogy with practical physics

Examples from the psychology of trajectories



What Newton would have done.....

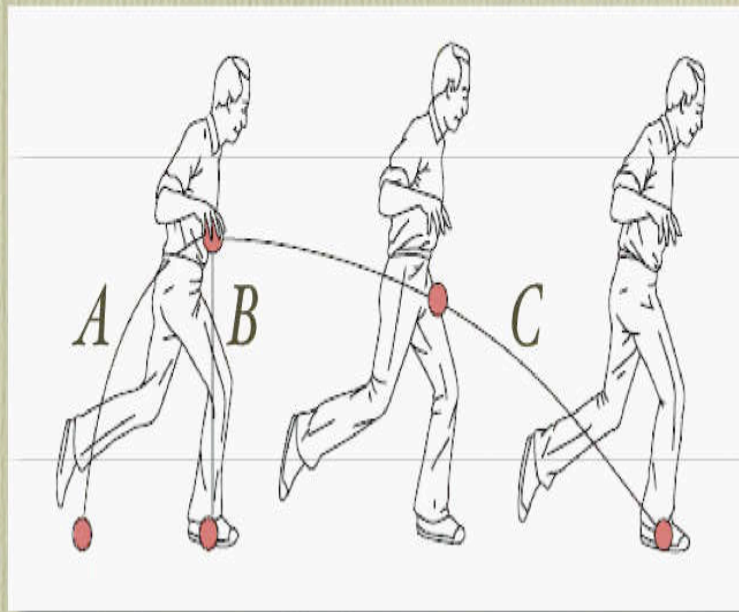
A) Derive equation for trajectory of ball.

B) Derive equation for one's own capacity to move.

Solve A and B simultaneously

Examples from the psychology of trajectories

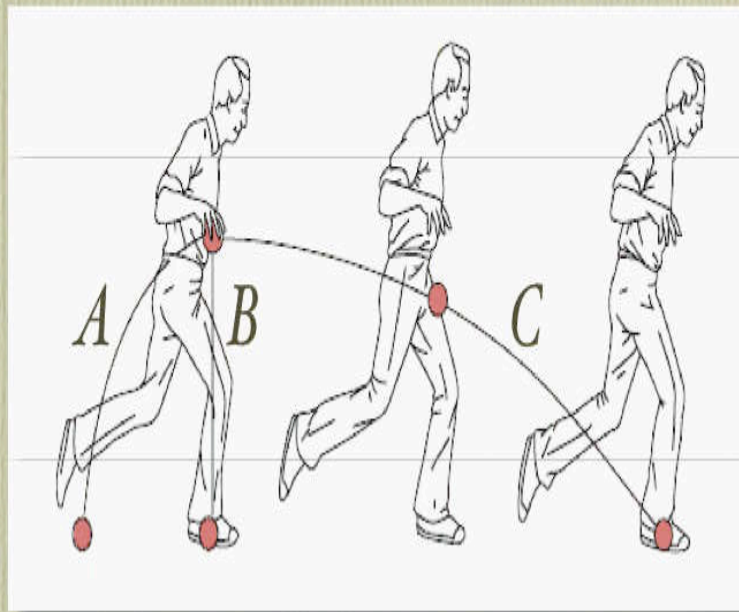
Which of the three paths shown (A-C) most closely resembles the path taken by the ball?



McCloskey, Intuitive Physics, Scientific American 248 (1983),

Examples from the psychology of trajectories

Which of the three paths shown (A-C) most closely resembles the path taken by the ball?



This naïve theory will often give the correct answer, and is much easier to use

McCloskey, Intuitive Physics, Scientific American 248 (1983),

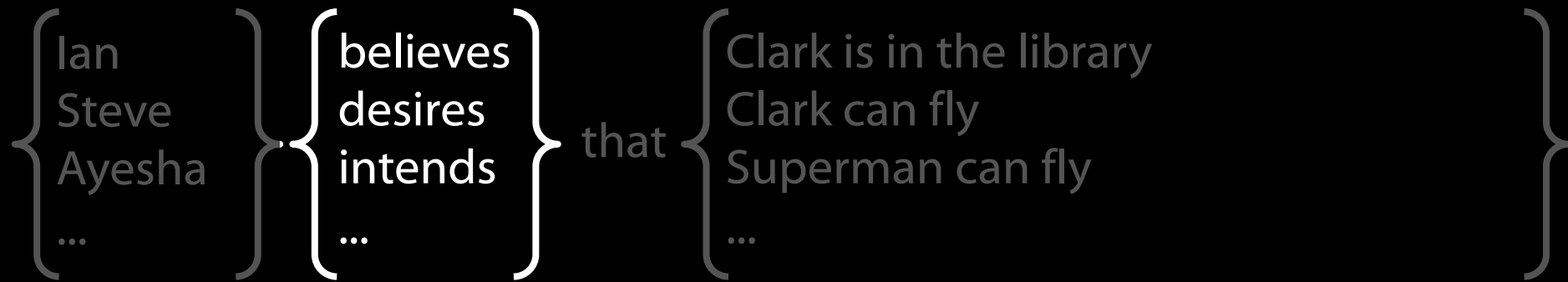
Is there an unsophisticated but useful model of the ^{mind}~~physical~~?

{
Ian
Steve
Ayesha
...
}
{
believes
desires
intends
...
}
that {
Clark is in the library
Clark can fly
Superman can fly
...
}

Subject

Attitude

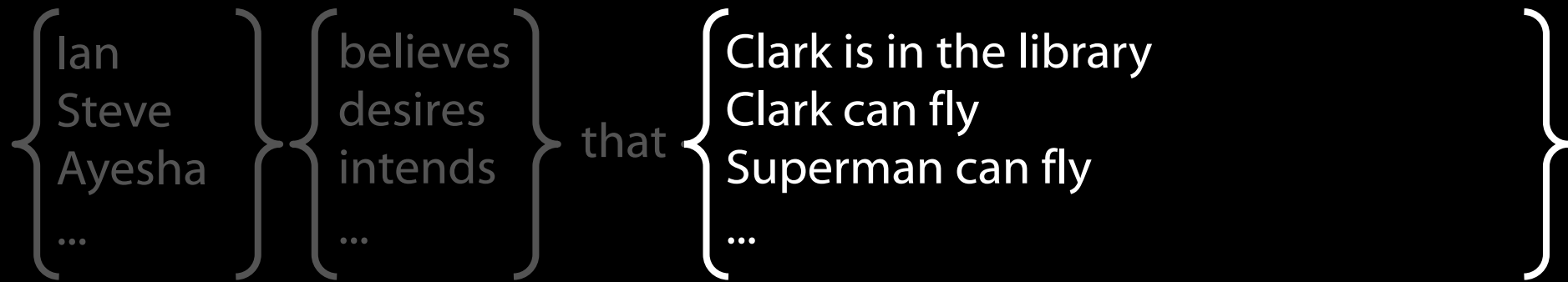
Content



Subject

Attitude

Content



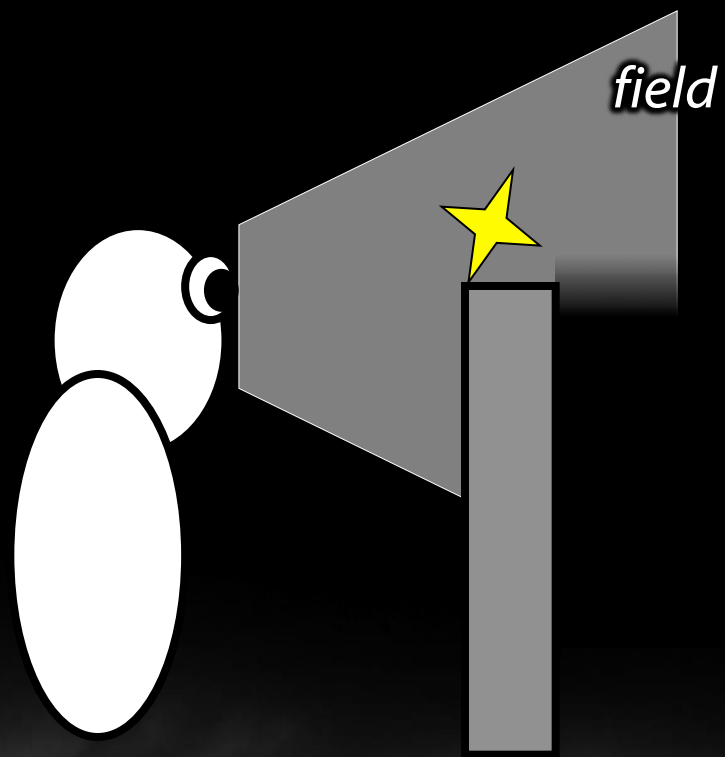
Subject

Attitude

Content

minimal theory of mind





But can we test how mindreaders model minds?

Ian believes:

Superman is here

Clark Kent is here

Propositional
attitude

Ian believes:

Superman is here

Clark Kent is here

Propositional
attitude

Ian registers:

<Superman, here>

<Clark Kent, here>

Relational
attitude

Distinct propositions

Ian believes:

Superman is here
Clark Kent is here

Propositional
attitude

Ian registers:

<Superman, here>
<Clark Kent, here>

Relational
attitude

Same relata



Propositional
attitude

Relational
attitude

false beliefs about location

Y

Y

false beliefs about identity

Y

N

Propositional
attitude

Relational
attitude

false beliefs about non-
existence

Y

N

false beliefs about location

Y

Y

false beliefs about identity

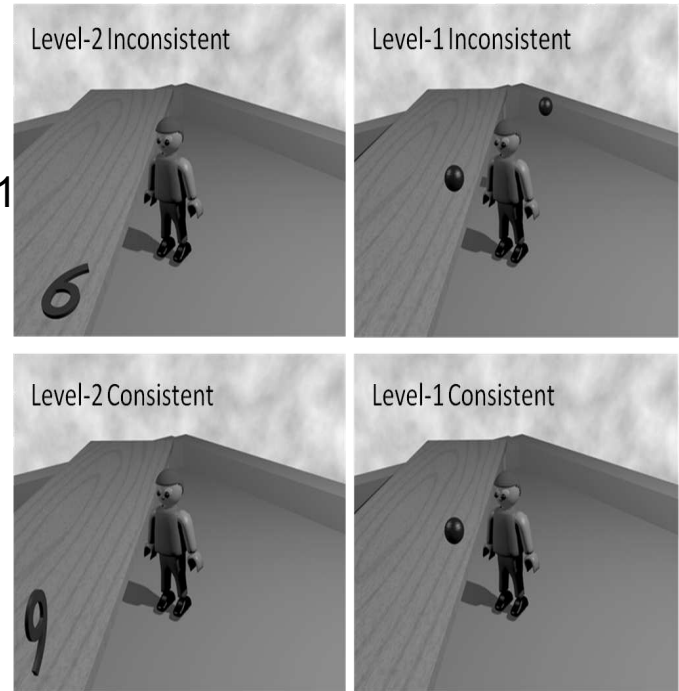
Y

N

	Propositional attitude	Relational attitude
level-1 perspective taking	Y	Y
level-2 perspective taking	Y	N
false beliefs about non-existence	Y	N
false beliefs about location	Y	Y
false beliefs about identity	Y	N

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 - Schneider et al. (2011)
- Without need for "executive control"
 - Qureshi et al. (2010)
- **Limited to simple cases**
 - Level 1 but not Level 2 visual perspectives (Surtees, Butterfill & Apperly, 2012)
 - "False beliefs" about location but not identity (Low & Watts, in press)



Comparing limits



Who is a mindreader?

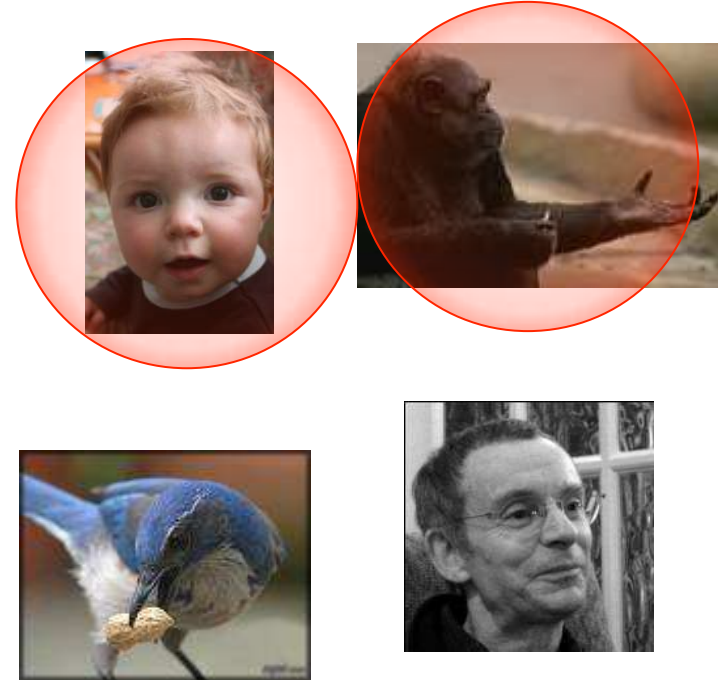
Comparing limits



Who is a mindreader?

How does the
mindreader model
minds?

Comparing limits



Suppose neither could track FB about identity?

Who is a mindreader?

How does the
mindreader model
minds?

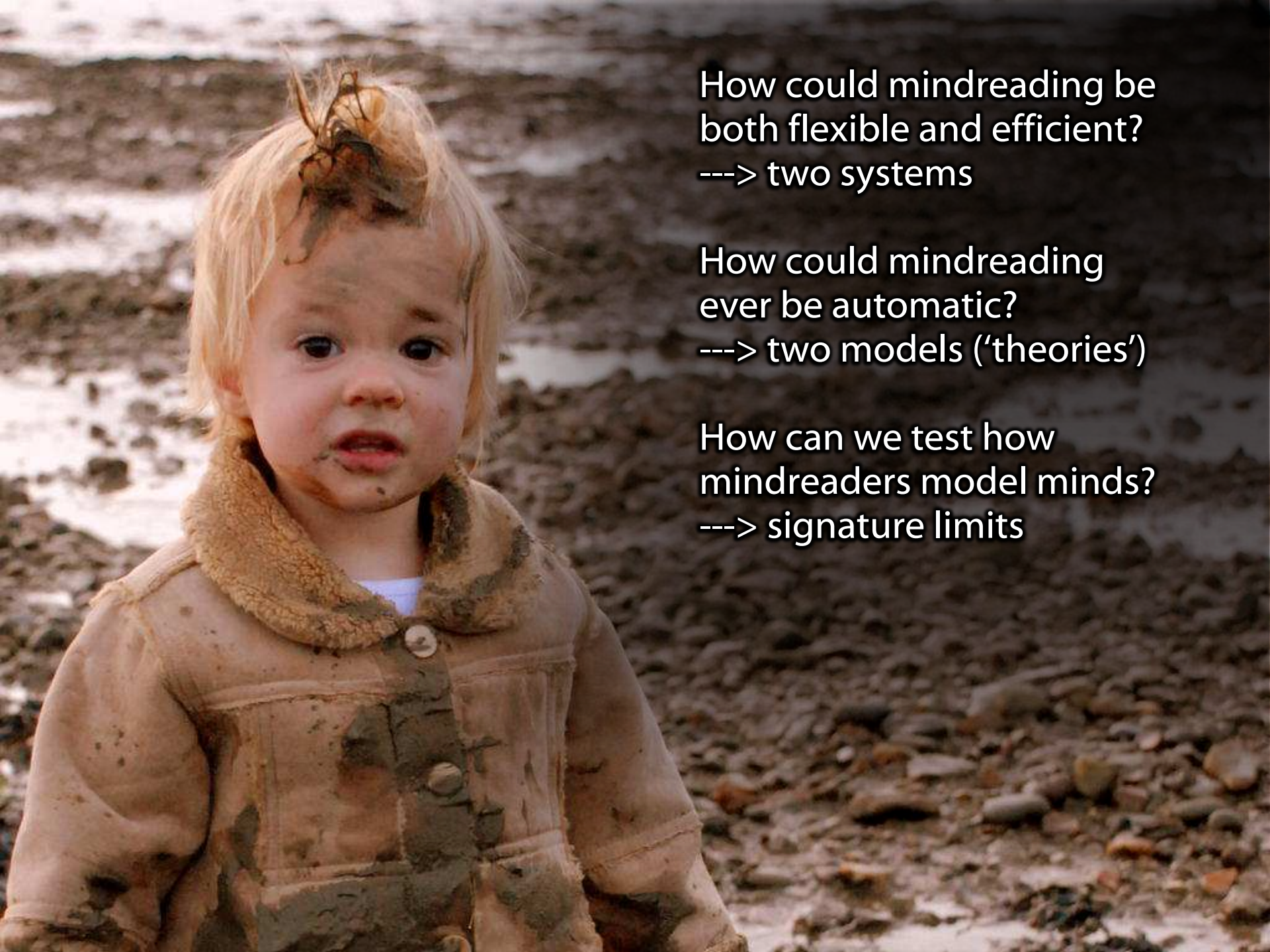
Comparing limits



Understanding the *limits* on a given capacity can act as signatures for identifying the operation of a given capacity, across contexts and across types of participant

Who is a mindreader?

How does the mindreader model minds?



How could mindreading be both flexible and efficient?

---> two systems

How could mindreading ever be automatic?

---> two models ('theories')

How can we test how mindreaders model minds?

---> signature limits

