

# How to construct a Minimal Theory of Mind

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A black and white photograph of two young children, a boy and a girl, standing close together against a dark background. The boy, on the left, has light-colored hair and is wearing a patterned long-sleeved shirt under dark overalls. He is smiling and looking towards the camera. The girl, on the right, also has light-colored hair and is wearing a dark top with small patterns. She is also smiling and looking towards the camera. They appear to be in a playful or happy mood.

# challenge

Explain the emergence, in evolution or development, of full-blown theory of mind cognition.

A black and white photograph of two young children, a boy and a girl, standing close together and smiling. The boy is in the foreground, wearing overalls, and the girl is behind him, wearing a patterned dress. They appear to be in a playful or happy mood.

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Explain the emergence, in evolution or development, of full-blown theory of mind cognition.

# conjecture

We need to understand how theory of mind cognition could come in degrees.

“chimpanzees understand ... intentions ... perception and knowledge ... Moreover, they understand how these psychological states work together to produce intentional action”

(Call & Tomasello 2008:191)



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“chimpanzees probably do not understand others in terms of a fully human-like belief–desire psychology”

(Call and Tomasello 2008)

A black and white photograph of two young children, a boy and a girl, standing close together and smiling. The boy is in the foreground, wearing overalls, and the girl is behind him, wearing a patterned dress. They appear to be in a bright, possibly outdoor setting.

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“our [typical adult humans’ ] fundamental conception of what it is to know that P is itself an explanatory conception [...] we think of S’s knowledge that P as something that can properly be explained by reference to what S has perceived or remembered or proved or ...”

(Cassam 2007:356)



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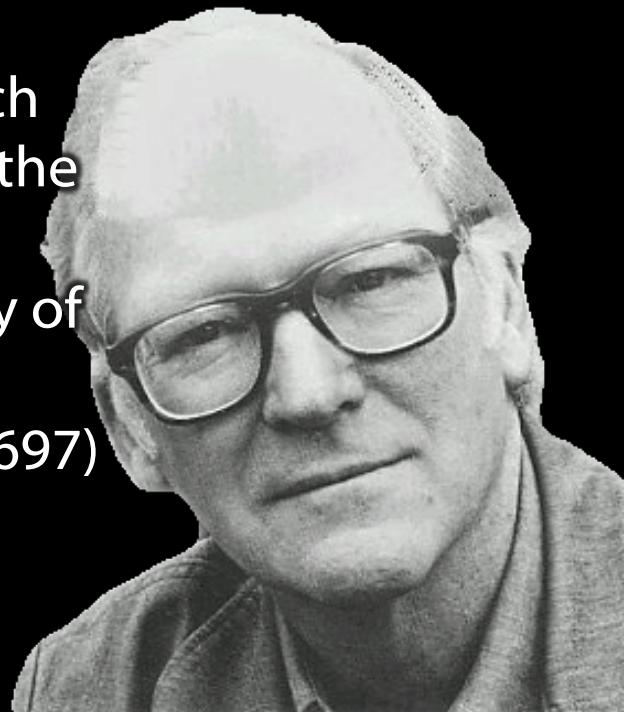
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# obstacle

Grasp of everyday psychological concepts like belief, desire, knowledge and intention is all-or-nothing.

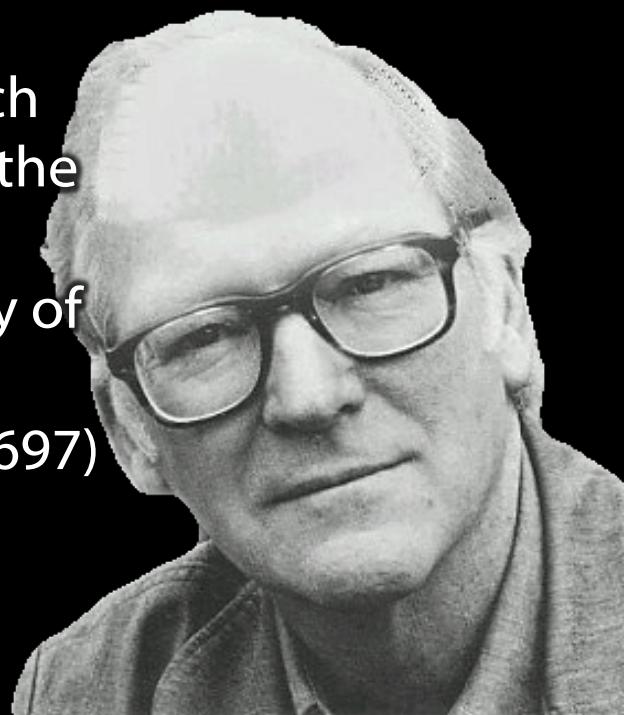
“We are stuck with our two main ways of describing and explaining things, one which treats objects and events as mindless, and the other which treats objects and events as having propositional attitudes. I see no way of bridging the gap”

(Davidson 2003:697)



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puzzle

Theory of mind *abilities* are widespread



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**18-month-olds** point to inform, and predict actions based on false beliefs

(Liszkowski et al 2006)

(Onishi & Baillargeon 2005;  
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(b) scarce cognitive resources

- attention
- working memory

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Propositional attitudes ...

cause actions

resemble “intervening variables” linking environment to behaviour

have contents which may be true or false

have contents which may refer to non-existent entities

are involved in uncodifiably complex causal interactions

have contents which are individuated by senses, not only by referents

are associated with normative requirements

are individuated in terms of their interlocking roles in causal and normative explanations of thought and action

...

# puzzle

What could infants, chimps and scrub-jays represent that would enable them, within limits, to track others' perceptions, knowledge, beliefs and other propositional attitudes?

# puzzle

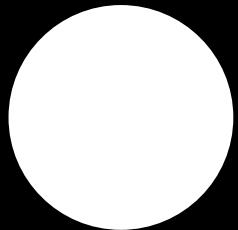
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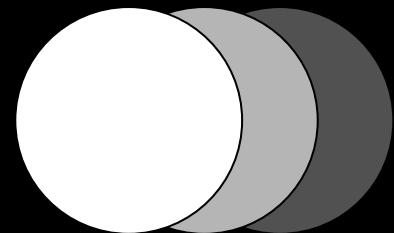
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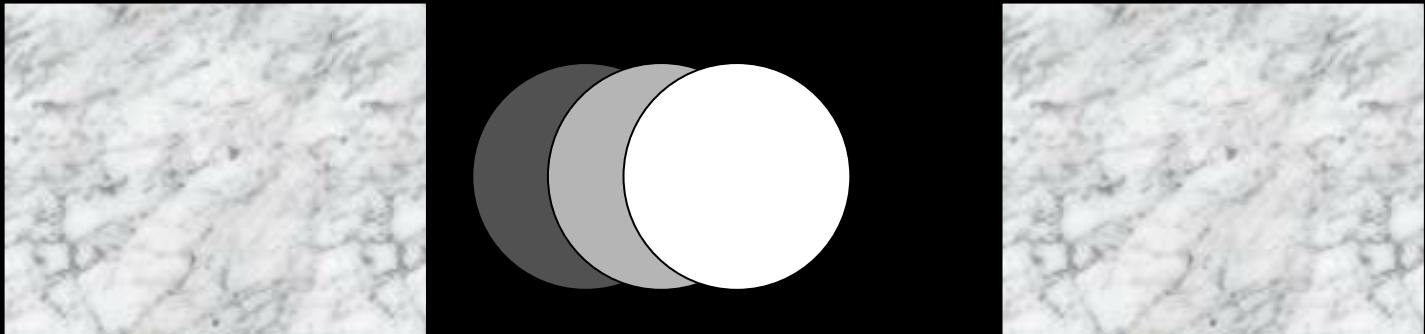
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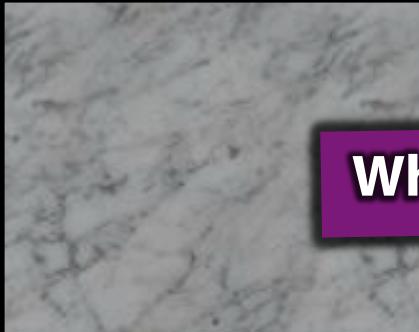
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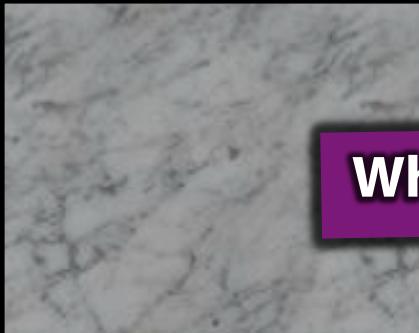
**Where is the ball?**



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Where is the ball?



puzzles  
What could be  
would enable  
knowledge

RT / looking time



Other's belief

True

Other's belief

False

adapted from Kovács, Téglás & Endress (2010)

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# puzzle

What could infants, chimps and scrub-jays represent that would enable them, within limits, to track others' perceptions, knowledge, beliefs and other propositional attitudes?

# challenge

Explain the empirical evidence for evolution or development of the capacity of mind cognition.

# puzzle

What could infants, chimps and other primates know about the world? What would enable them, within limits, to learn about the world? How do they learn about the world? What are the limitations, if any, on what they can learn?





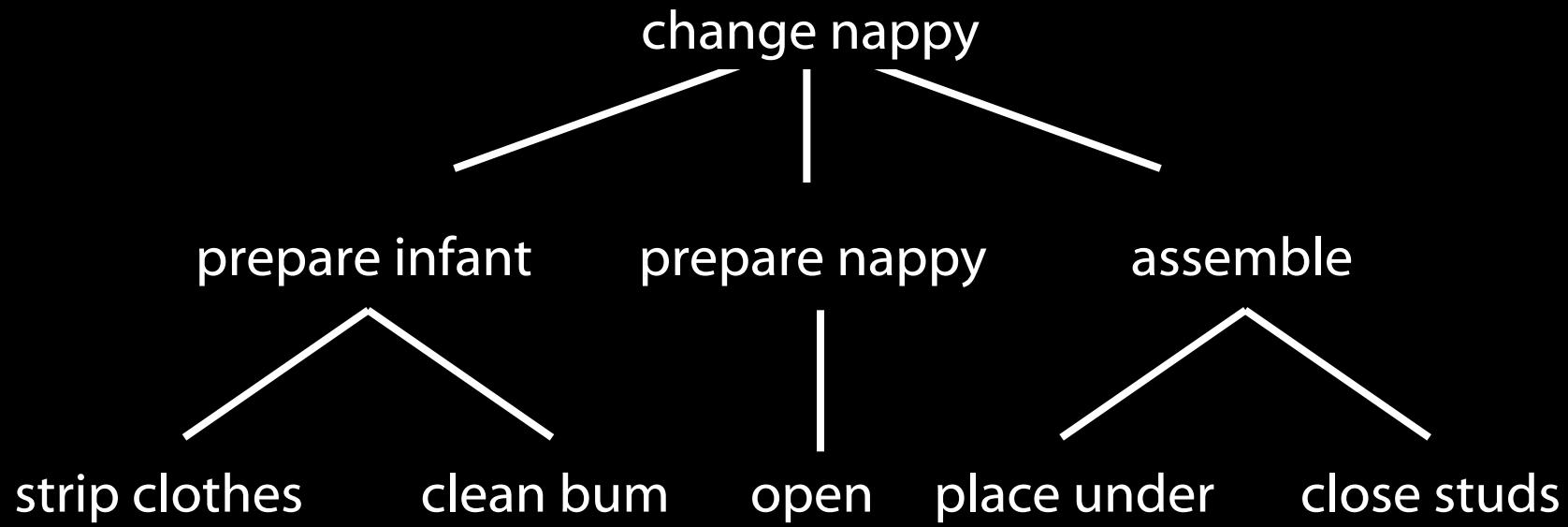
change nappy

plans

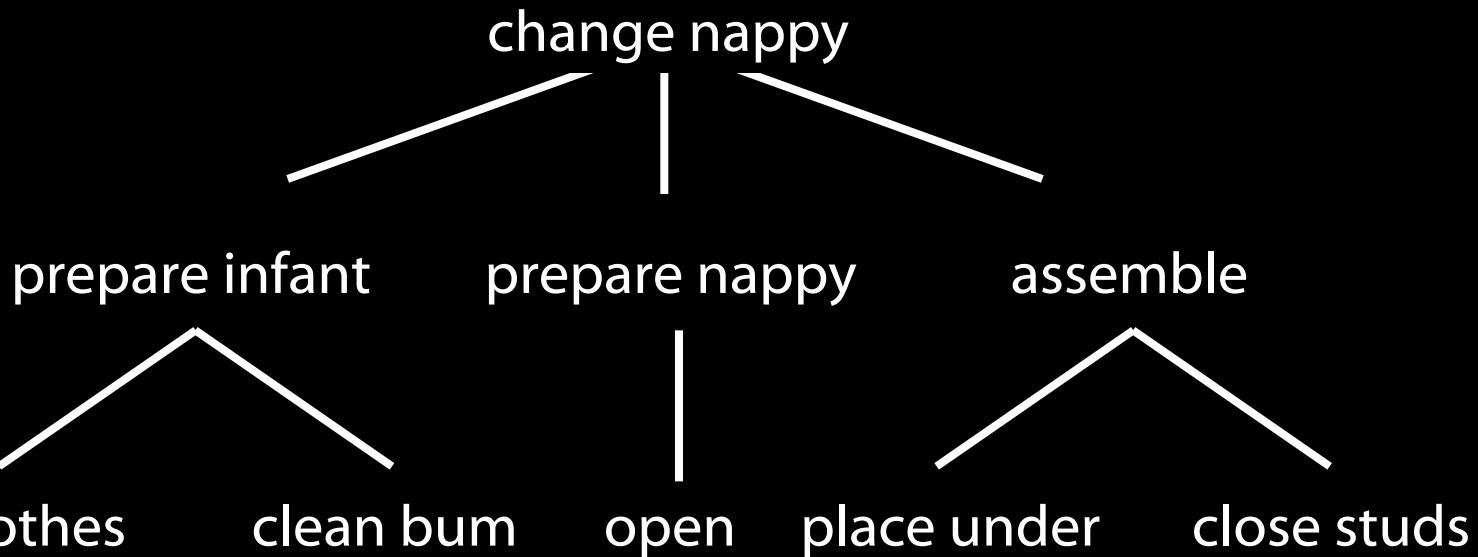


plans

goals



plans



goals

motor action

. /reach X/ /grasp X/ /grasp Y/ /pull Y/ /scoop X/ /Y out of X/ ...

plans



goals

strip clothes      clean bum      open      place under      close studs

motor action

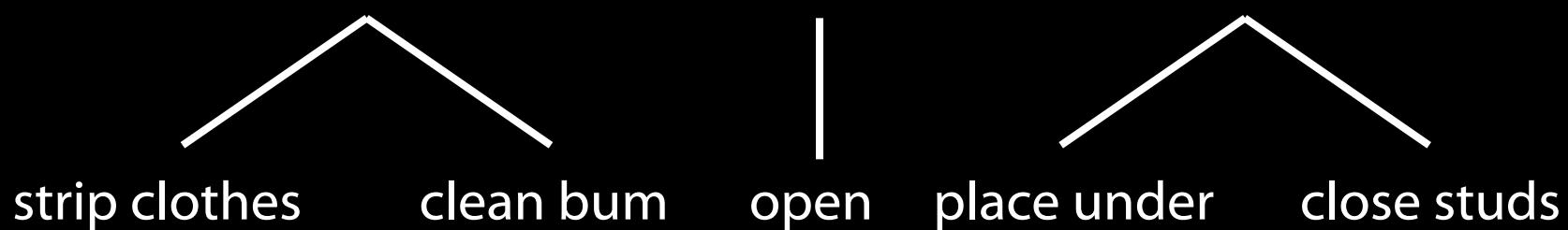
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[reach-left-hand X] [left-wholehand-grasp X] [right-wholehand-grasp ...]

plans



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motion



plans

goals

motor action

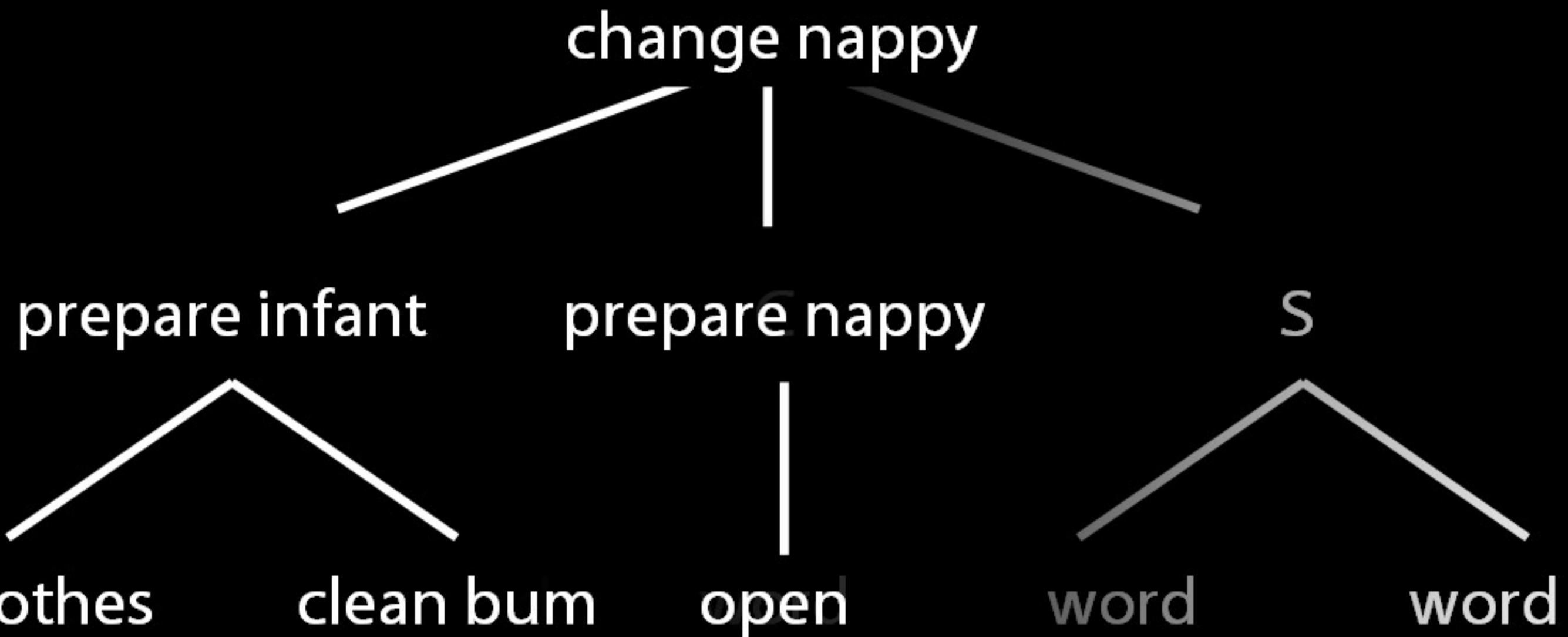
motion

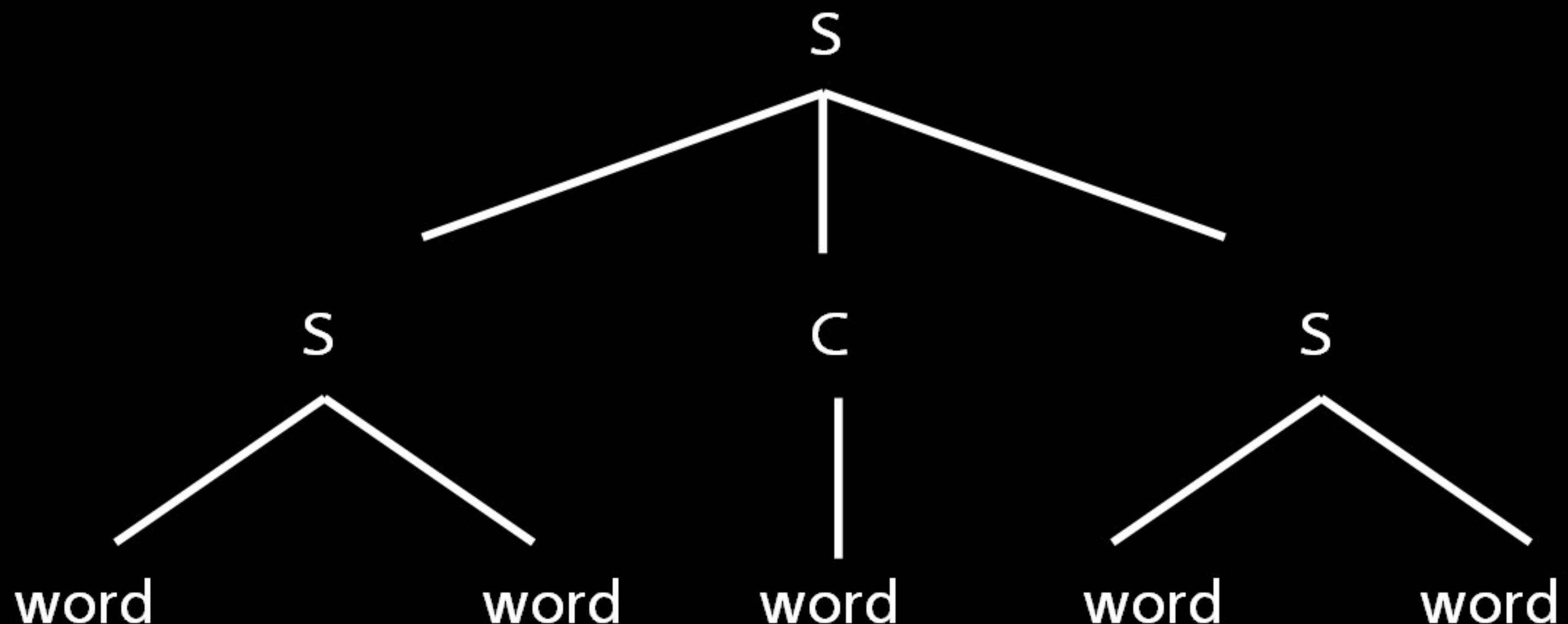
clauses

words

motor action

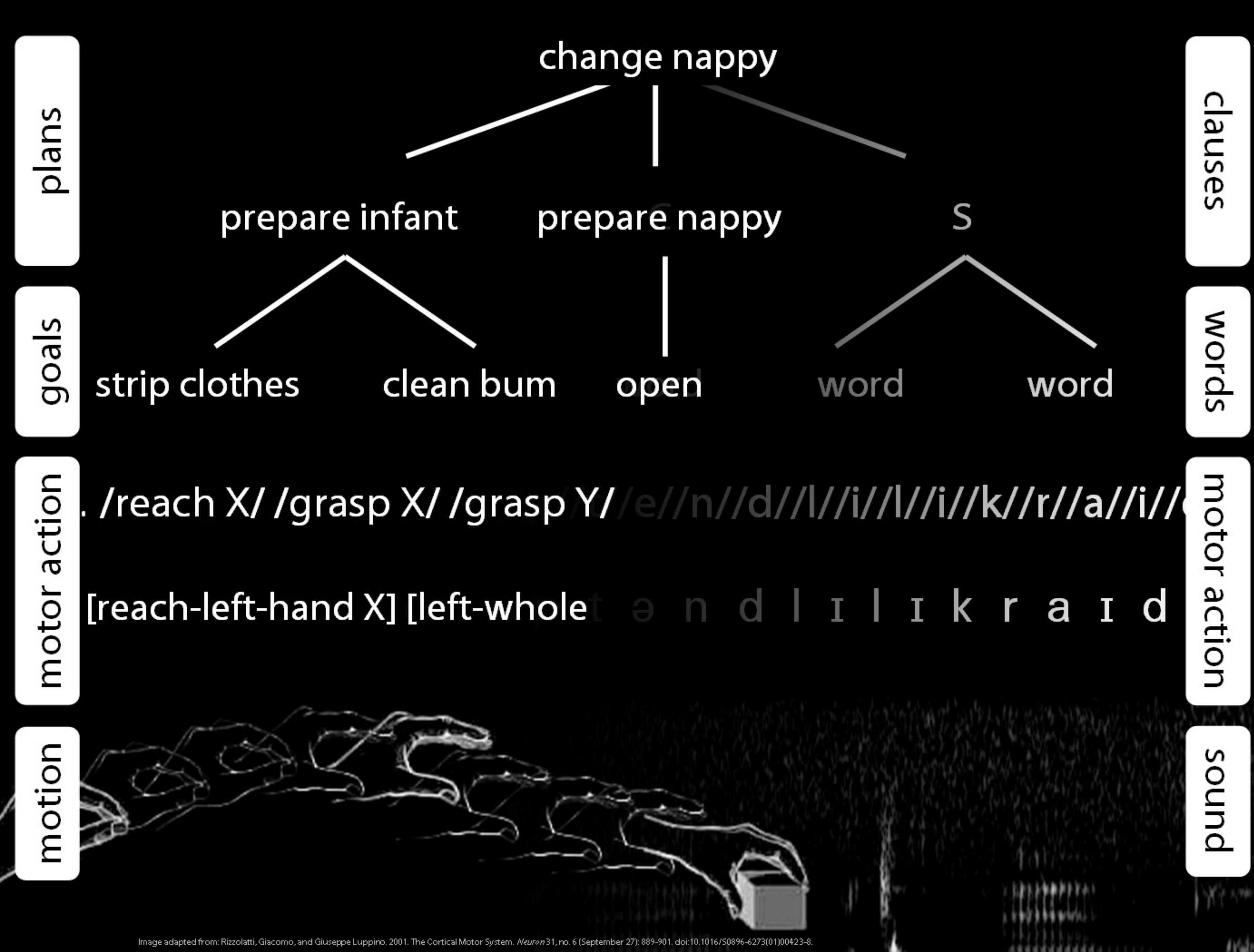
sound





/i//z//e//b//e//l//s//l//e//p//t//e//n//d//l//i//l//i//k//r//a//i//d//

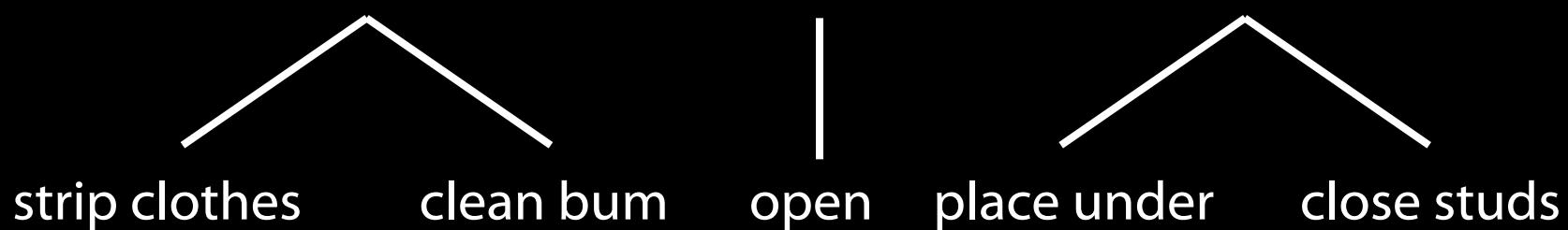
| i z e b e l s l e p t e n d l i l i k r a i d



plans



goals



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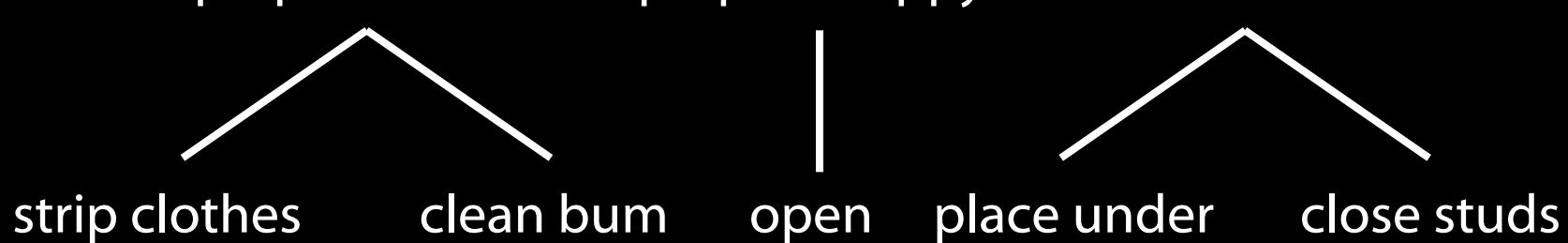
motion



plans



goals



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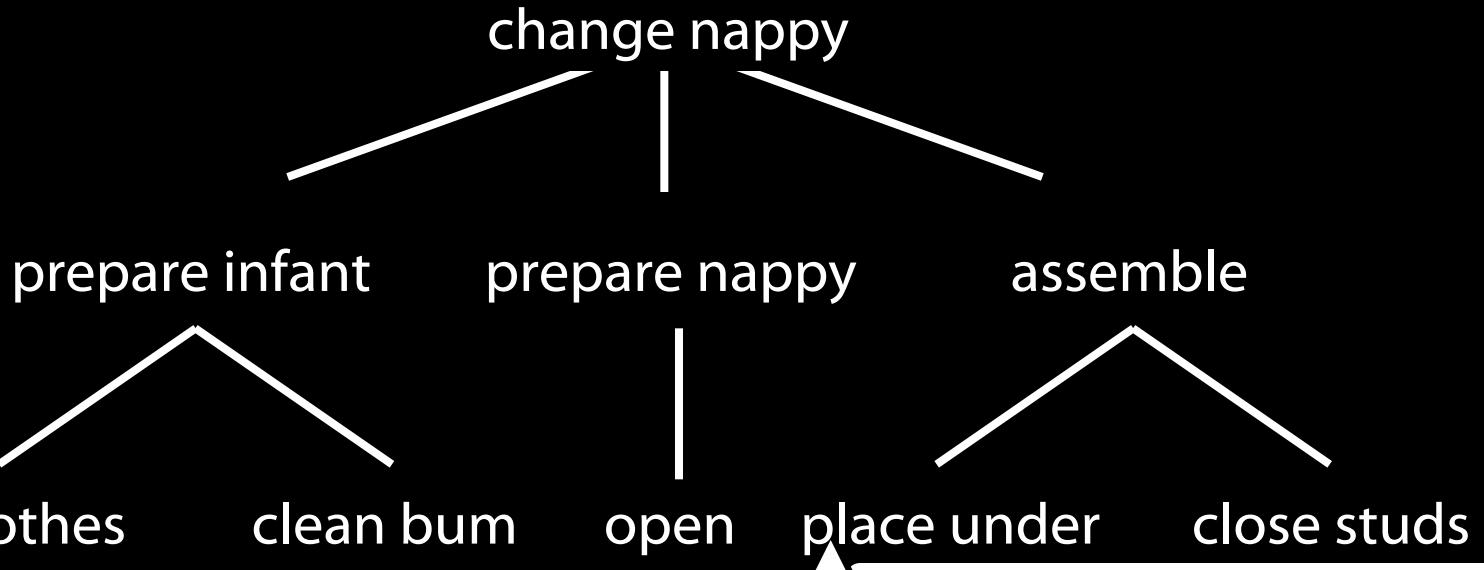
[reach-left-hand X] [left-wholehand-grasp X1] [right-wholehand-grasp ...]

motor emulation

motion



plans



goals

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motor action

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motion

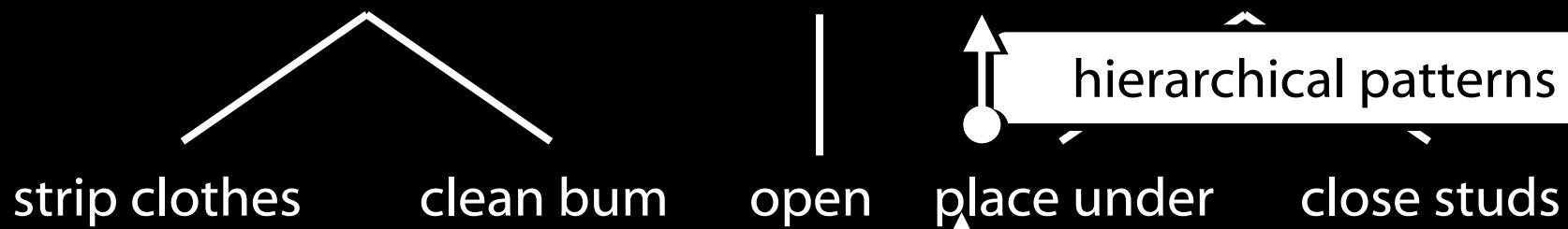
motor emulation



plans



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motion



plans



goals

strip clothes      clean bum      open      place under      close studs

object-directed actions

/reach X/ /grasp X/ /grasp Y/ /pull Y/ /scoop X/ /Y out of X/ ...

motor action

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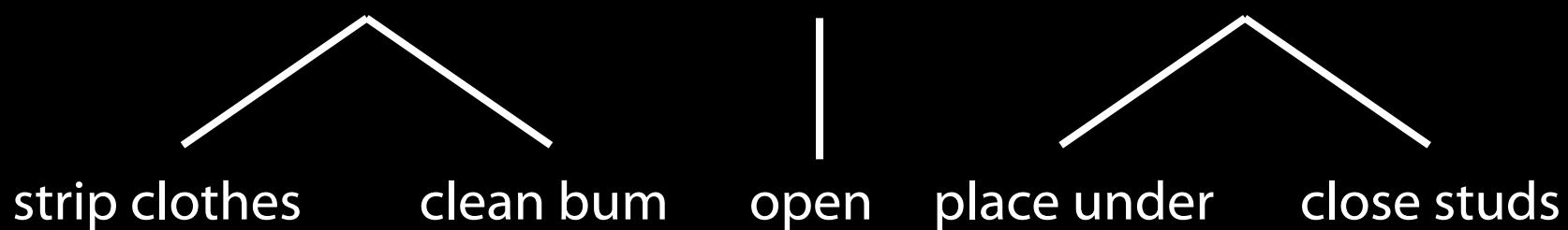
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motion





Your *field* = a set of  
objects related to you by  
proximity, orientation,  
lighting and other factors



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proximity

orientation

lighting

barriers

trajectory

Your *field* = a set of objects related to you by proximity, orientation, lighting and other factors

You *encounter* an object = it is in your field



*proximity*

*orientation*

*lighting*

*barriers*

*trajectory*

Detour  
Goals are not intentions

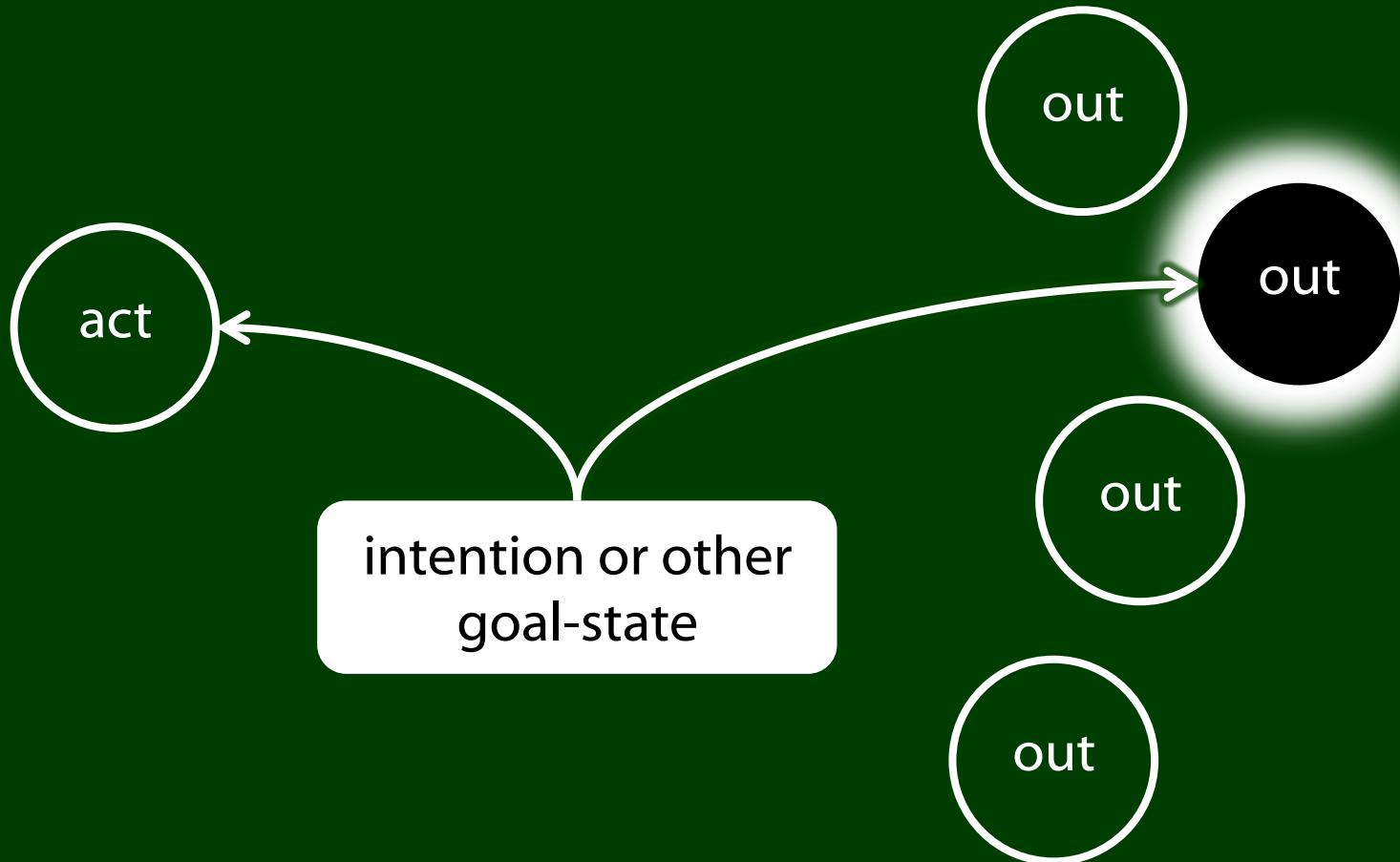
What is the relation between an action and the goal (or goals) to which it is directed?



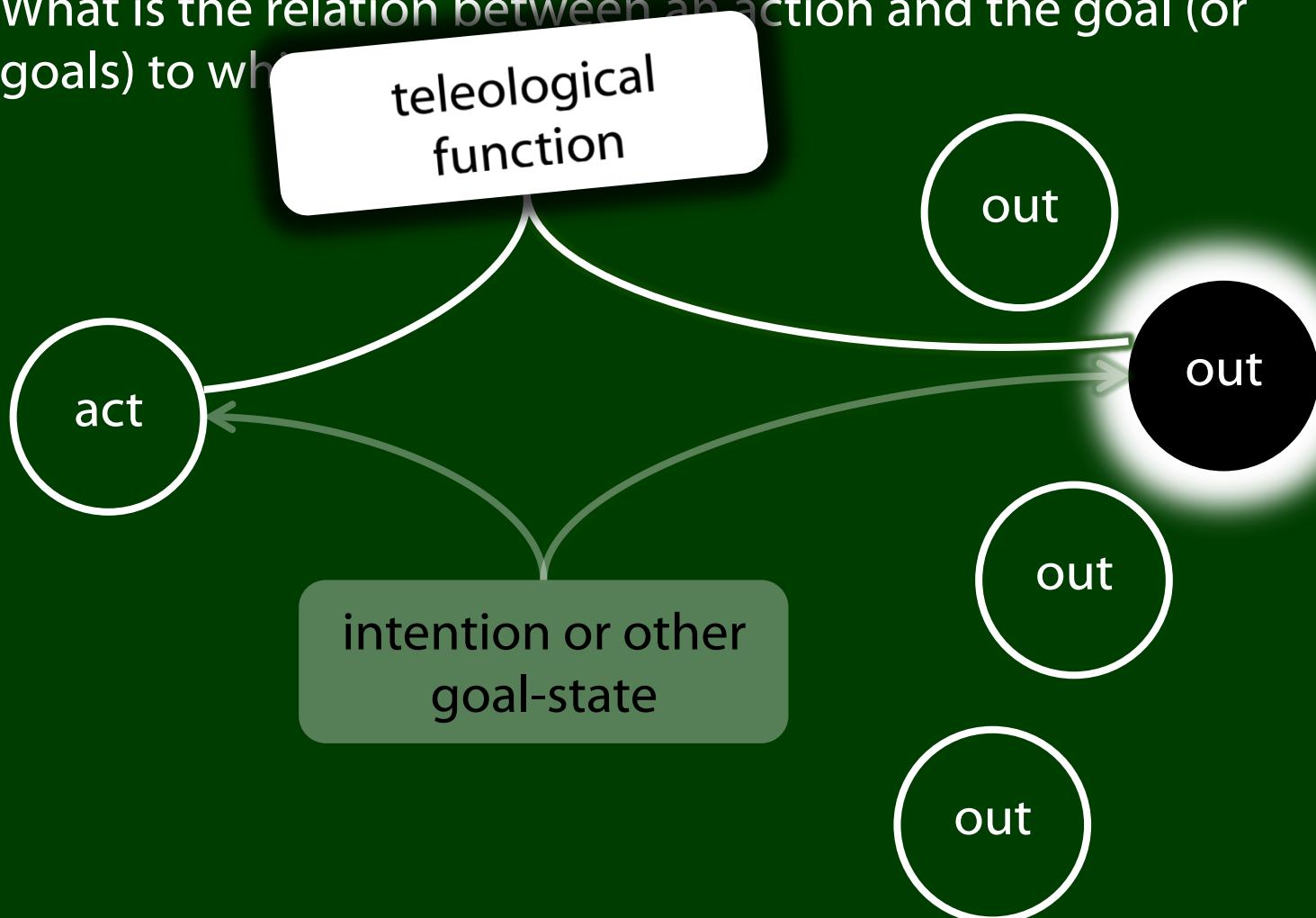
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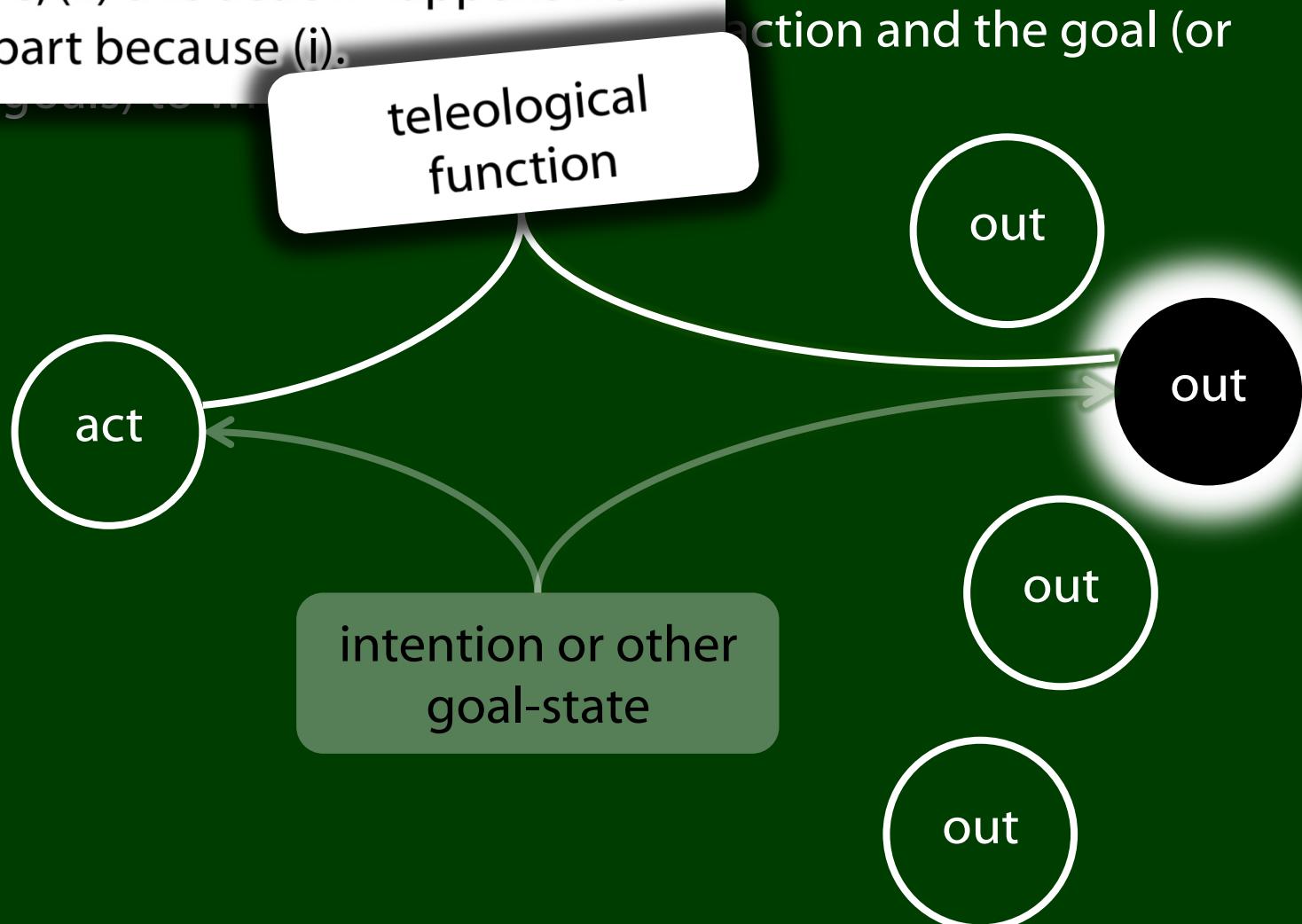
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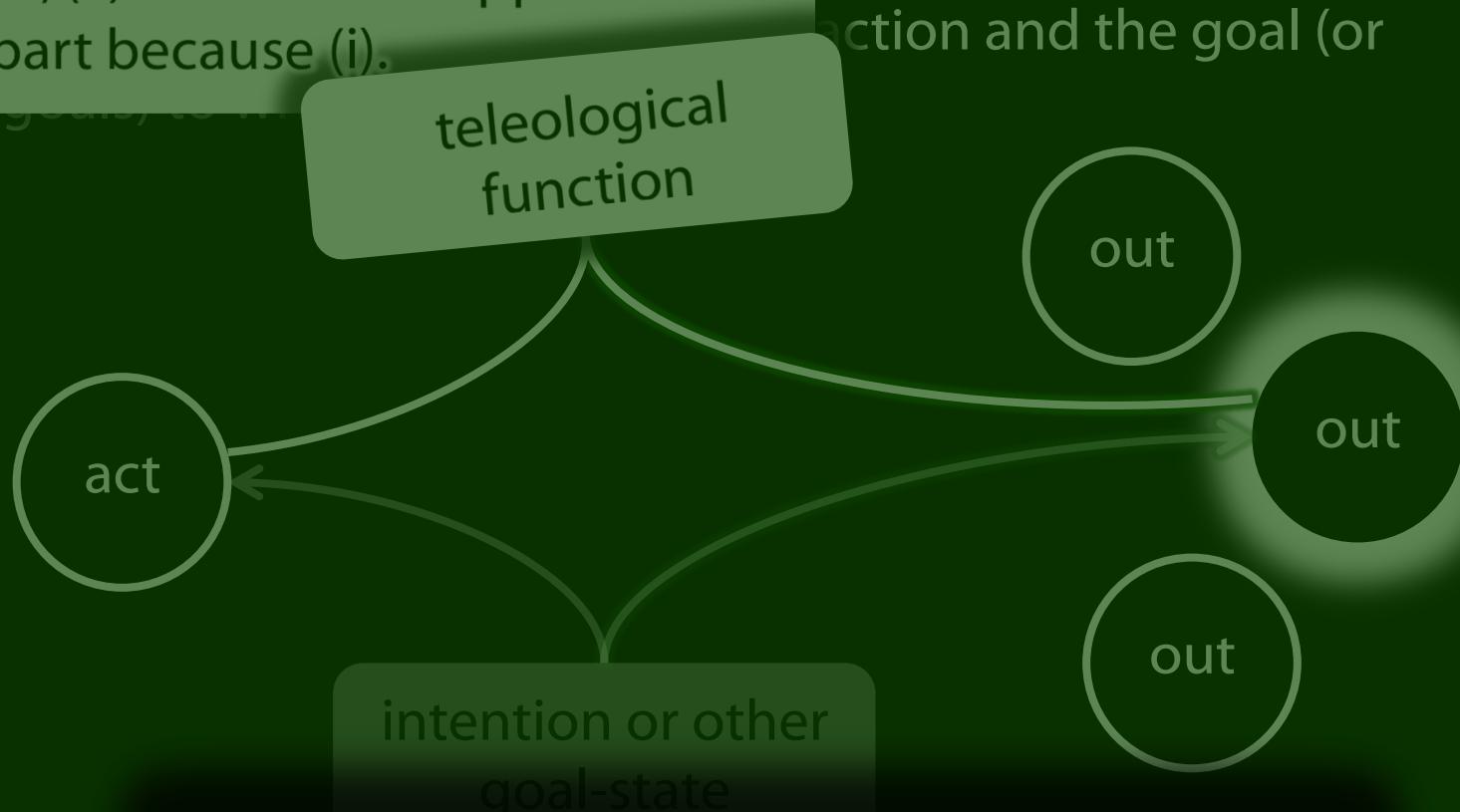
What is the relation between an action and the goal (or goals) to which it is related?



(i) in the past, actions of this type have caused outcomes of this type; (ii) this action happens now in part because (i).



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It is possible to represent goal-directed actions without representing intentions.

End Detour

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*proximity*

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*lighting*

*barriers*

*trajectory*

Your *field* = a set of objects related to you by proximity, orientation, lighting and other factors

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Principle 3: one can't goal-directedly act on an object unless one has encountered it.



proximity

orientation

lighting

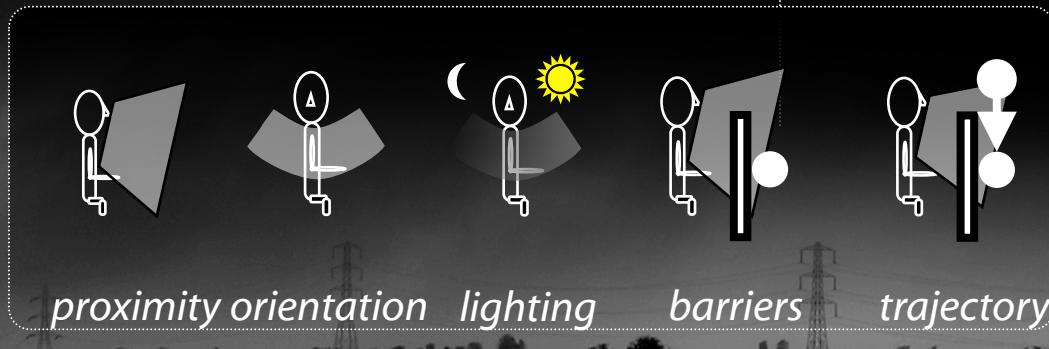
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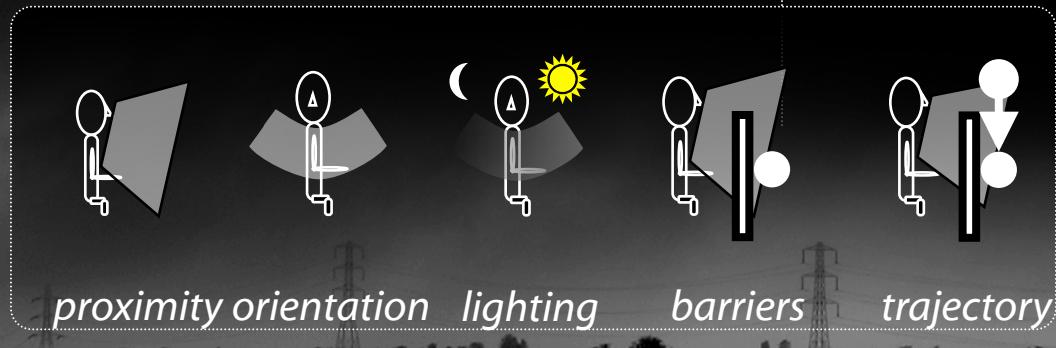


Your *field* = a set of objects related to you by proximity, orientation, lighting and other factors

“children could ... think about what the other person saw rather than what they saw”

(Flavell, Shipstead & Croft 1978: 1210)

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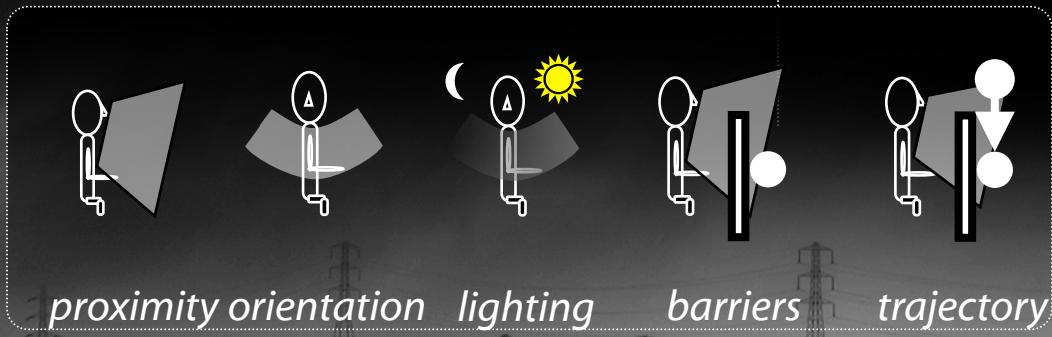


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You *register* an object at a location  $\leq$  you most recently encountered the object at that location

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Principle 4: correct registration is a condition of *successful* action.



*proximity*

*orientation*

*barriers*

*trajectory*



source: Liszkowski et al (2008)





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orientation



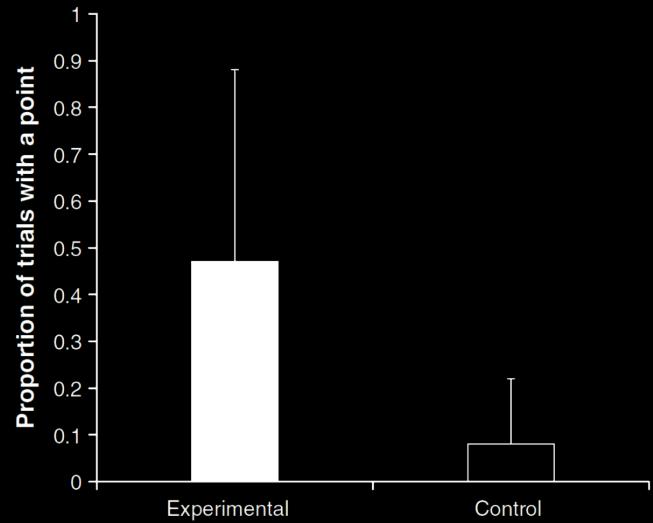
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barriers

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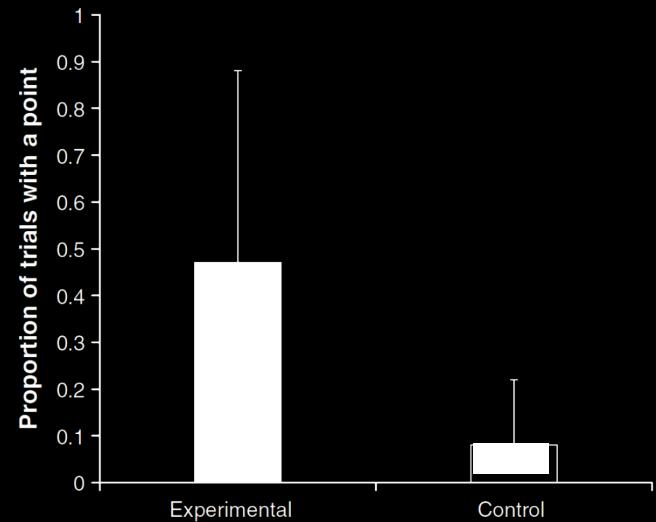
*proximity orientation lighting*

*barriers*

*trajectory*

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“Helping by informing inextricably involves ... an understanding of others’ goals and ... of others’ ignorance.”

(Liszowski, Carpenter & Tomasello 2008: 738-9)



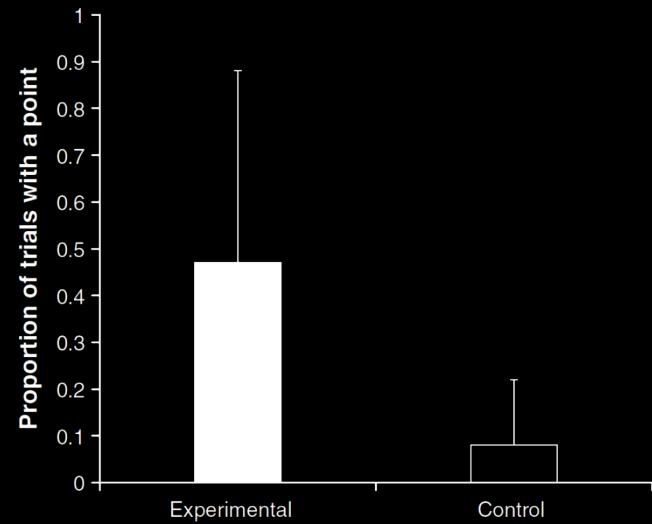
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“Helping by informing inextricably involves ... an understanding of others’ goals and ... of others’ **ignorance**.”

(Liszkowski, Carpenter & Tomasello 2008: 738-9)



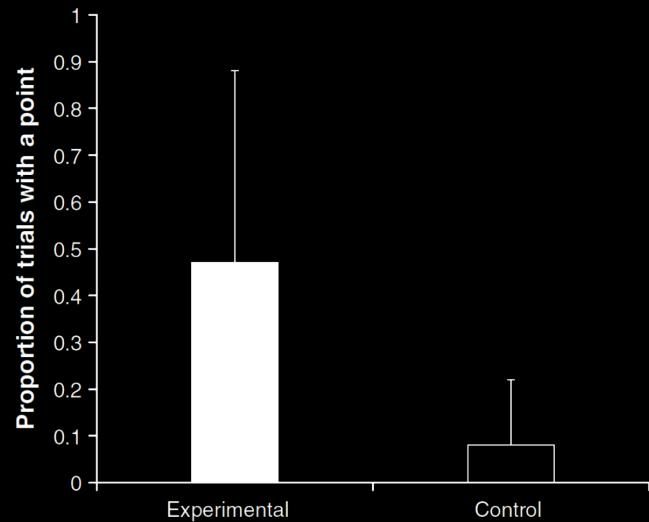
*proximity orientation lighting*

*barriers*

*trajectory*

Principle 3: one can’t goal-directedly act on an object unless one has encountered it.

Principle 4: correct registration is a condition of *successful* action.



source: Liszkowski et al (2008)



Your *field* = a set of objects related to you by proximity, orientation, lighting and other factors

You *encounter* an object = it is in your field

You *register* an object at a location <= you most recently encountered the object at that location

Principle 3: one can't goal-directedly act on an object unless one has encountered it.

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proximity orientation



lighting



barriers



trajectory

Your *field* = a set of objects related to you by proximity, orientation, lighting and other factors

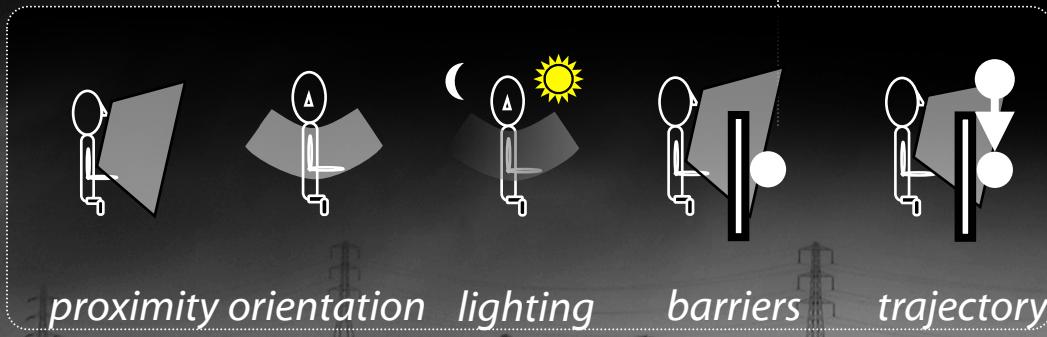
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Principle 4: correct registration is a condition of *successful* action.

Principle 5



Your *field* = a set of objects related to you by proximity, orientation, lighting and other factors

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You *register* an object at a location <= you most recently encountered the object at that location

Principle 3: one can't goal-directedly act on an object unless one has encountered it.

Principle 4: correct registration is a condition of *successful* action.

Principle 5: when an agent performs a goal-directed action and the goal specifies an object, the agent will act as if the object were actually in the location she registers it at.



proximity



orientation



lighting



barriers



trajectory

# puzzle

What could infants, chimps and scrub-jays represent that would enable them, within limits, to track others' perceptions, knowledge, beliefs and other propositional attitudes?



Propositional attitudes ...

cause actions

resemble “intervening variables” linking environment to behaviour

have contents which may be true or false

have contents which may refer to non-existent entities

are involved in uncodifiably complex causal interactions

have contents which are individuated by senses, not only by referents

are associated with normative requirements

are individuated in terms of their interlocking roles in causal and normative explanations of thought and action

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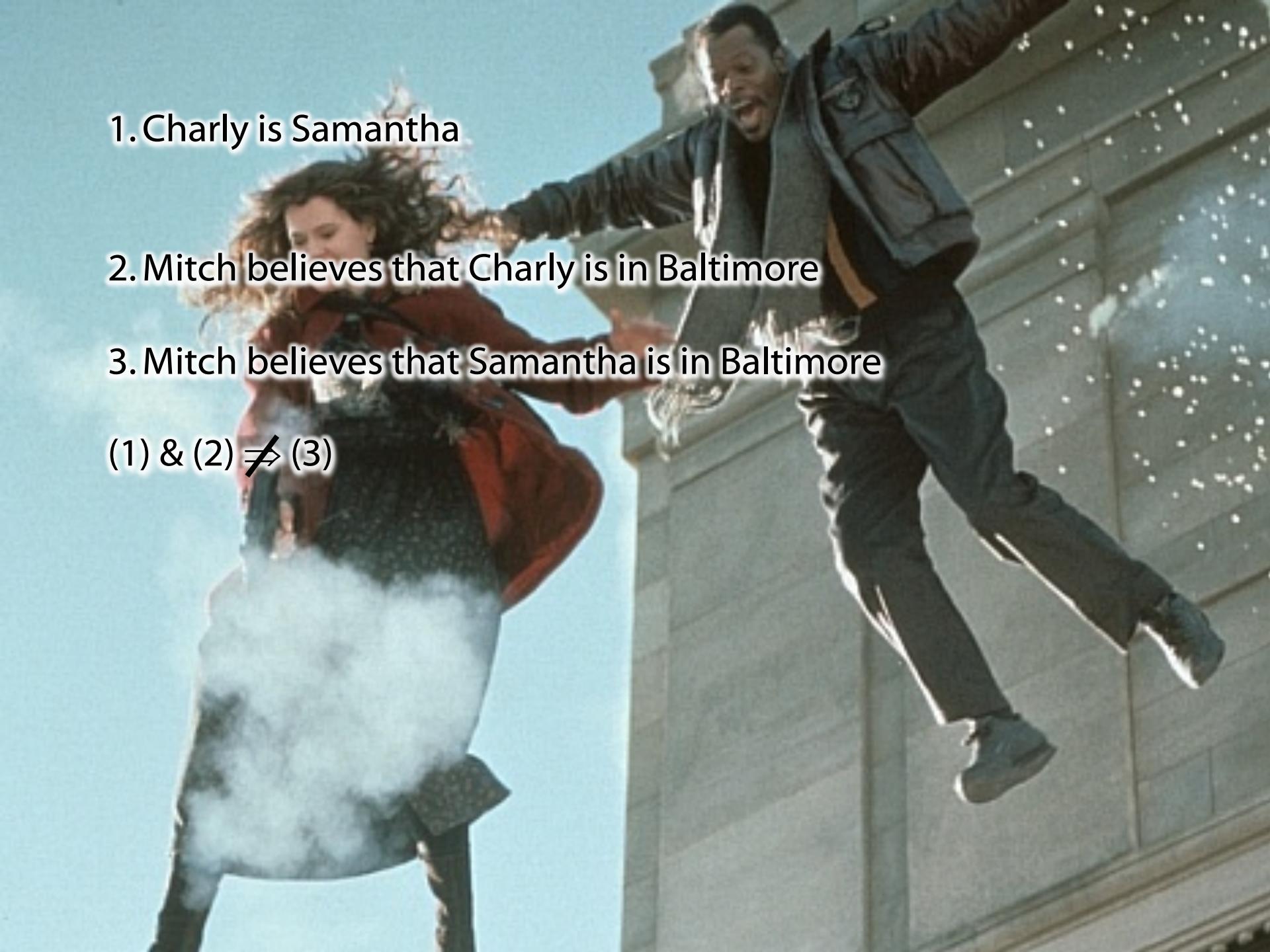
signature limits

1. Charly is Samantha

2. Mitch believes that Charly is in Baltimore

3. Mitch believes that Samantha is in Baltimore

(1) & (2)  $\not\Rightarrow$  (3)



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(1) & (2)  $\not\Rightarrow$  (3)

1. Charly is Samantha
  2. Mitch believes that Charly is in Baltimore
  3. Mitch believes that Samantha is in Baltimore
- (1) & (2)  $\not\Rightarrow$  (3)
4. Mitch registers <Charly, Baltimore>
  5. Mitch registers <Samantha, Baltimore>
- (1) & (4)  $\Rightarrow$  (5)

Subjects represent  
registration only

*pass*

*fail*

Subjects represent  
beliefs

*pass*

*pass*

False belief  
about location

False belief  
about identity











Subjects represent  
registration only

*pass*

*fail*

Subjects represent  
beliefs

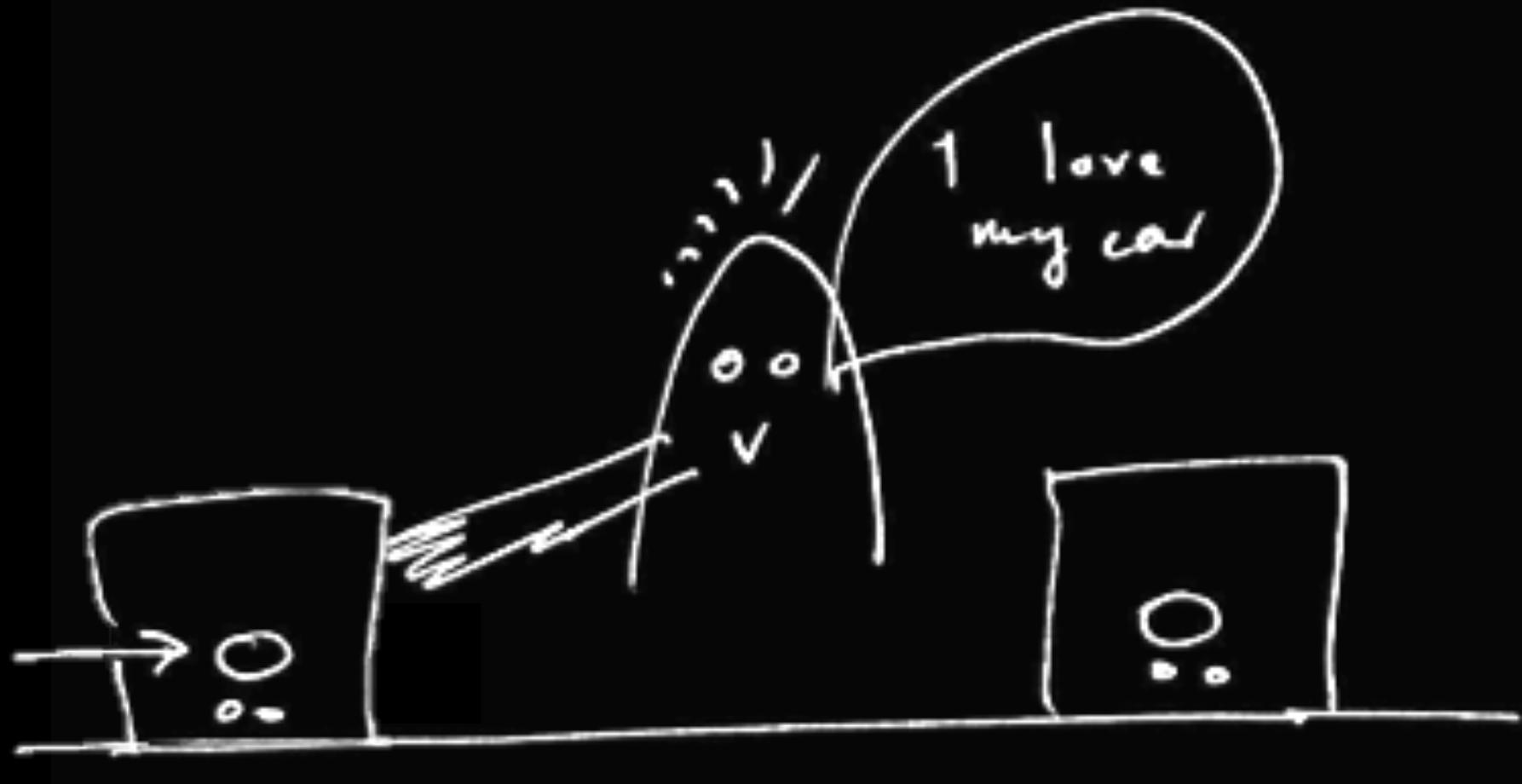
*pass*

*pass*

False belief  
about location

False belief  
about identity

Rubio, Richardson & Butterfill



Rubio, Richardson & Butterfill



Rubio, Richardson & Butterfill



Rubio, Richardson & Butterfill



Rubio, Richardson & Butterfill



Rubio, Richardson & Butterfill



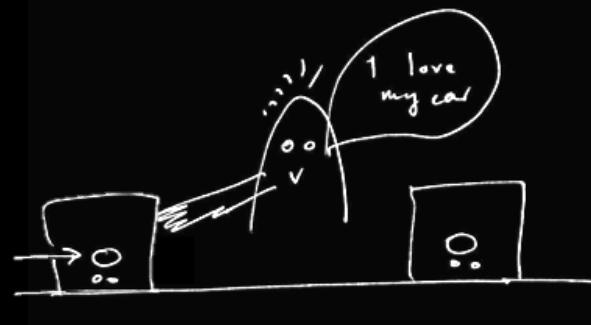
Rubio, Richardson & Butterfill

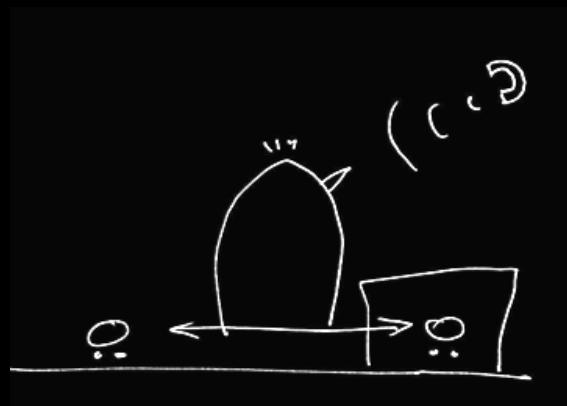
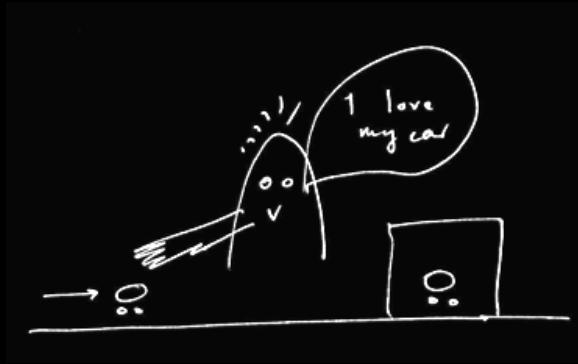
we predict Ss  
will look here  
she believes  
her car is here

I want  
my car

her car is here

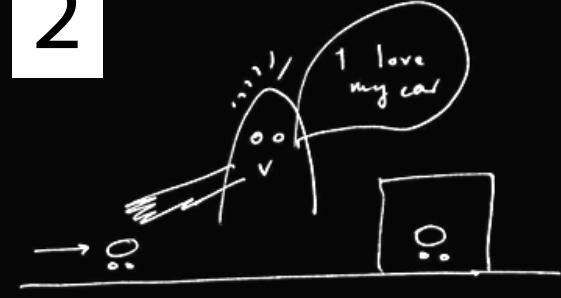
Rubio, Richardson & Butterfill



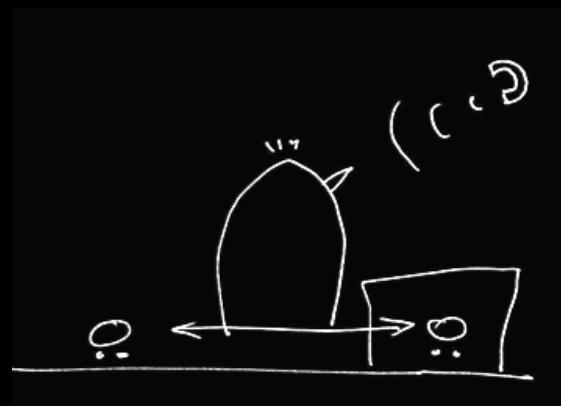
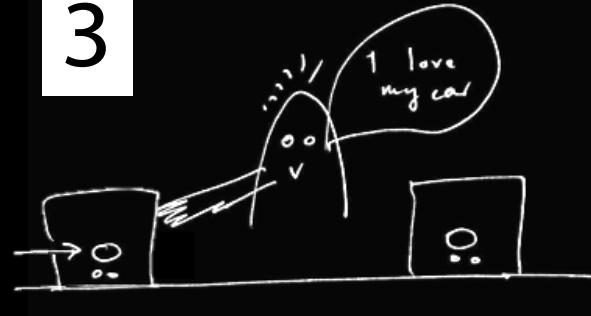


Rubio, Richardson & Butterfill

2



3



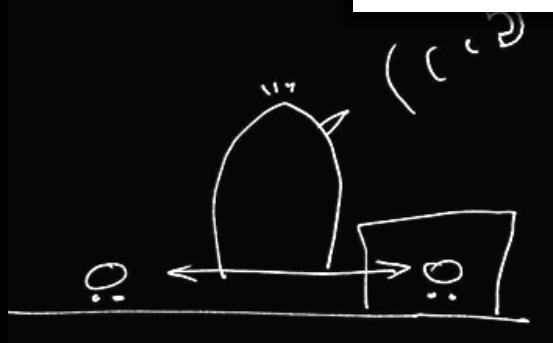
2



3



belief:  $2 \approx 3$



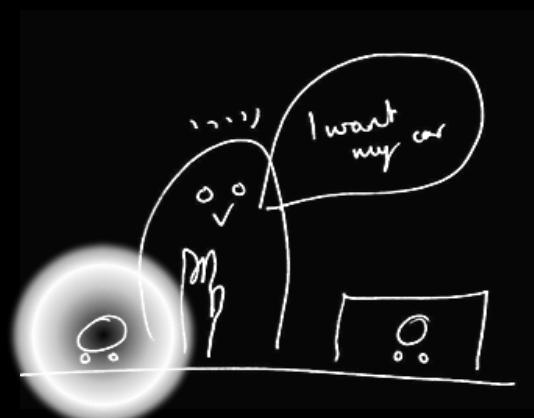
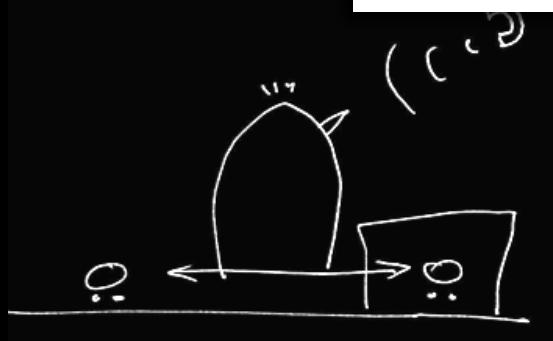
2



3

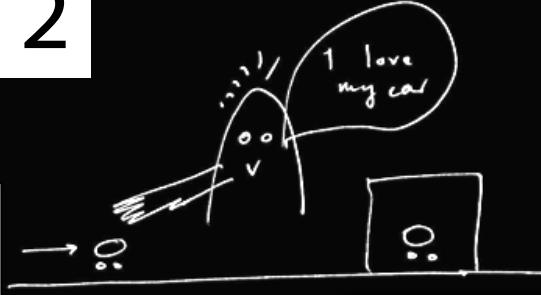


belief:  $2 \approx 3$





2



3



left right

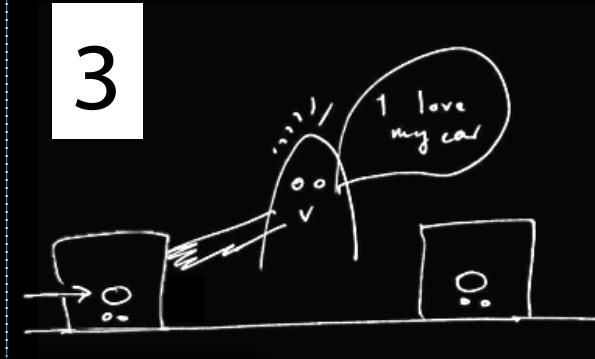
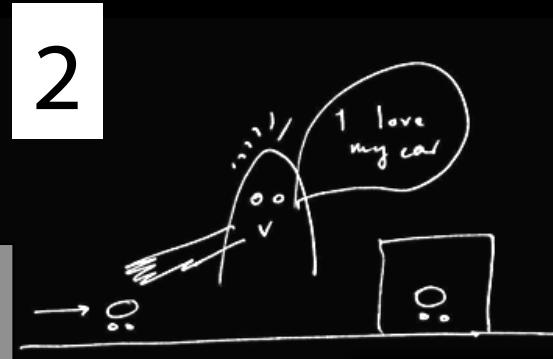
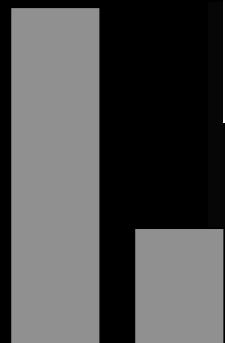
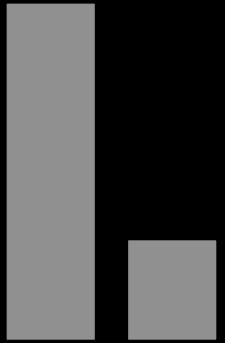
left right

2

3

belief:  $2 \approx 3$ 

Rubio, Richardson &amp; Butterfill



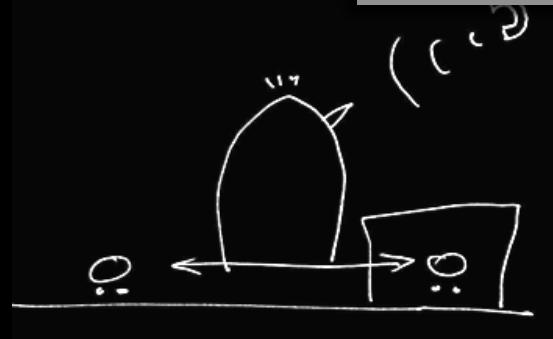
left right

2

left right

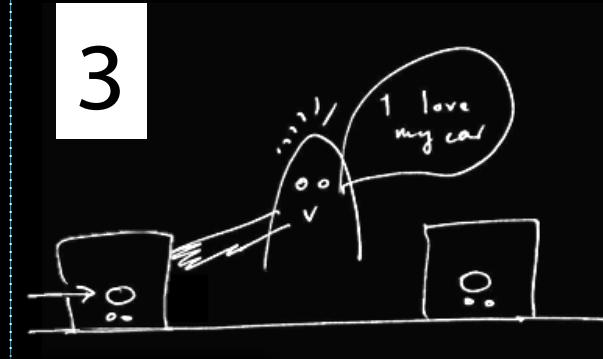
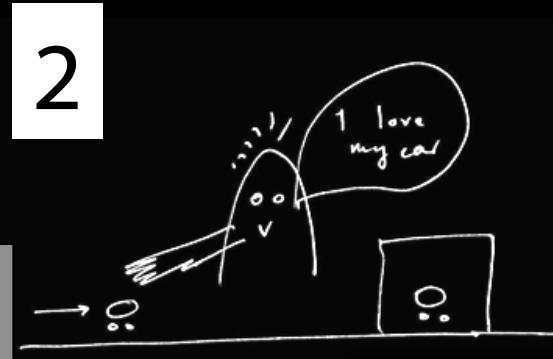
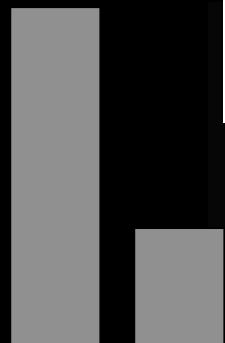
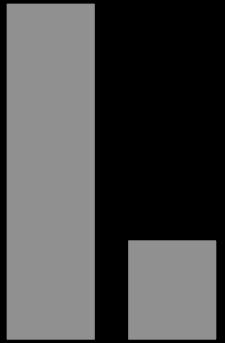
3

belief:  $2 \approx 3$



registration:  $2 \not\approx 3$





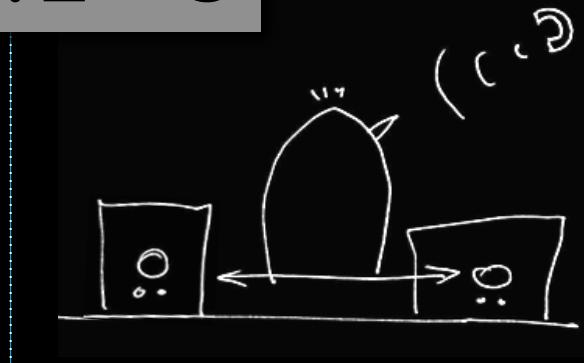
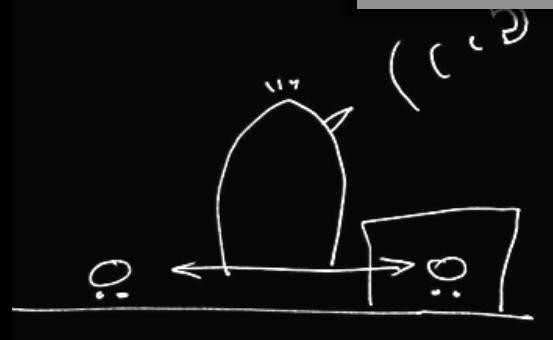
left right

2

left right

3

belief:  $2 \approx 3$



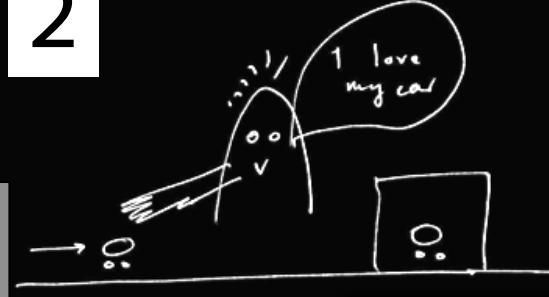
registration:  $2 \not\approx 3$



Rubio, Richardson & Butterfill



2



3



left right

2

left right

3

belief:  $2 \approx 3$



registration:  $2 \not\approx 3$



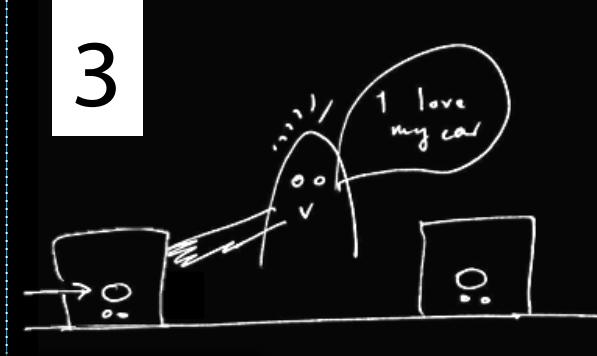
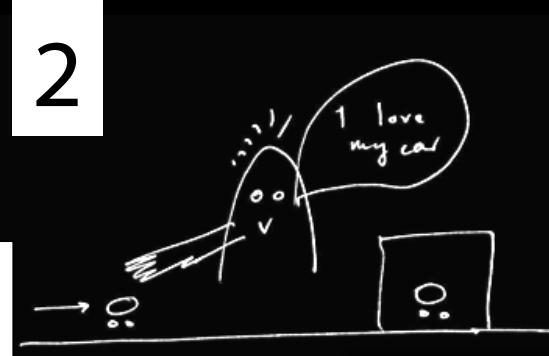
left right

2

left right

3

Rubio, Richardson & Butterfill



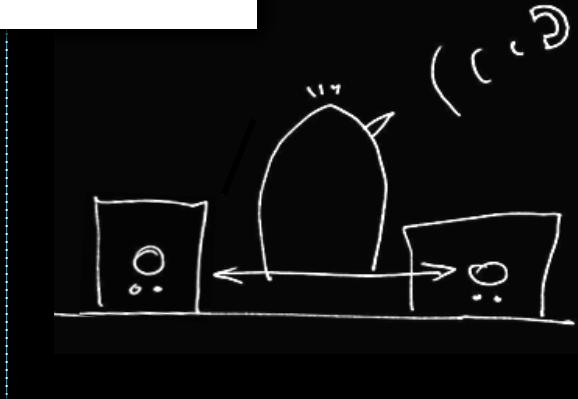
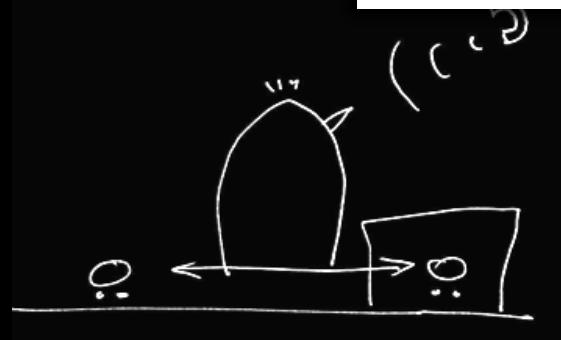
left right

left right

2

3

belief:  $2 \approx 3$



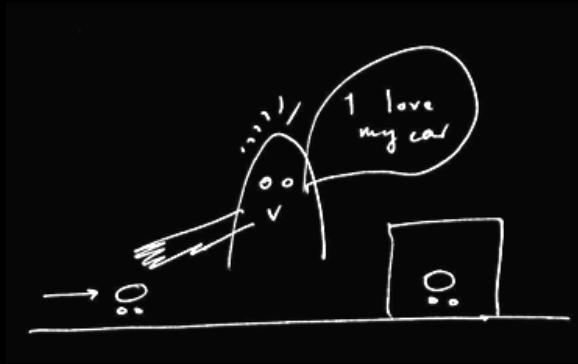
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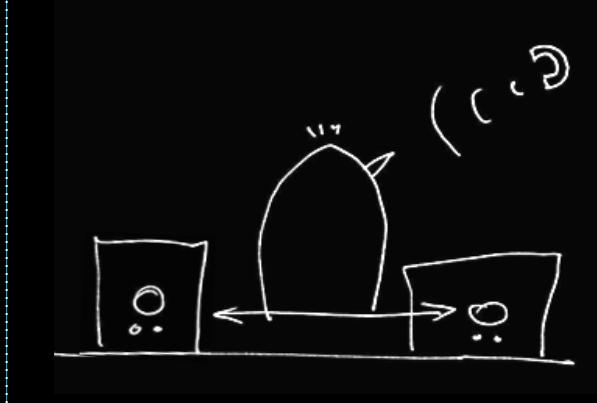
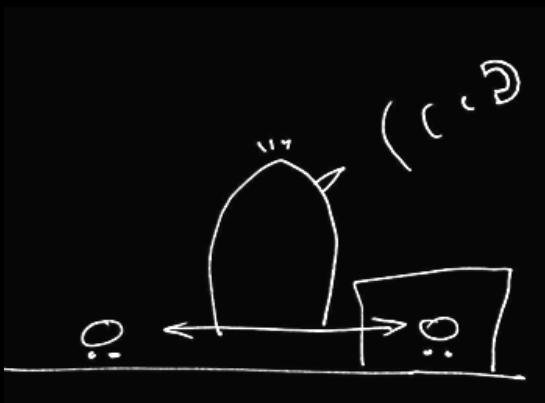
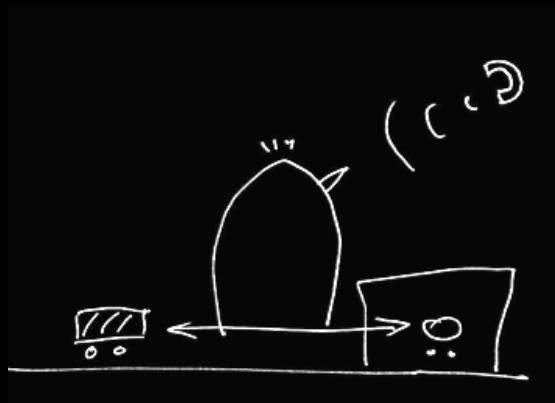
2

3

registration:  $2 \not\approx 3$



Rubio, Richardson & Butterfill



Rubio, Richardson & Butterfill

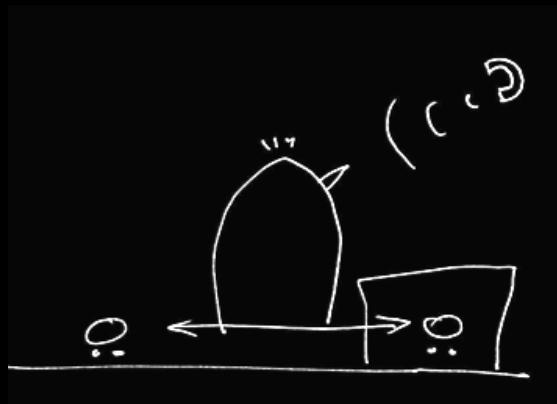
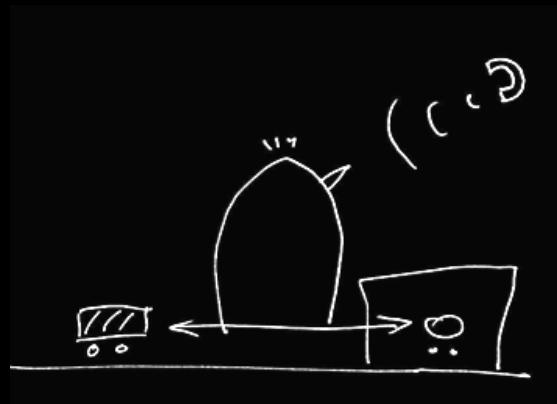
1



2



3



1



2



3



belief:  $2 \approx 3$

registration:  $2 \not\approx 3$

belief:  $1 \not\approx 2$

registration:  $1 \approx 2$





# challenge

Explain the emergence, in evolution or development, of full-blown theory of mind cognition.

# puzzle

What could infants, chimps and scrub-jays represent that would enable them, within limits, to track others' perceptions, knowledge, beliefs and other propositional attitudes?

# challenge

Explain the emergence, in evolution or development, of full-blown theory of mind cognition.

# puzzle

What could infants, chimps and scrub-jays represent that would enable them, within limits, to track others' perceptions, knowledge, beliefs and other propositional attitudes?

joint action (ability  
to share goals)

minimal theory of  
mind cognition

understanding  
communicative intent

communication by  
language

full-blown theory of  
mind cognition

other stuff

other stuff



"We ... use the acronym ToM, to refer to any cognitive system, whether theory-like or not, that predicts or explains the behaviour of another agent by postulating that unobservable inner states particular to the cognitive perspective of that agent causally modulate that agent's behaviour."

(Penn & Povinelli 2007:732)

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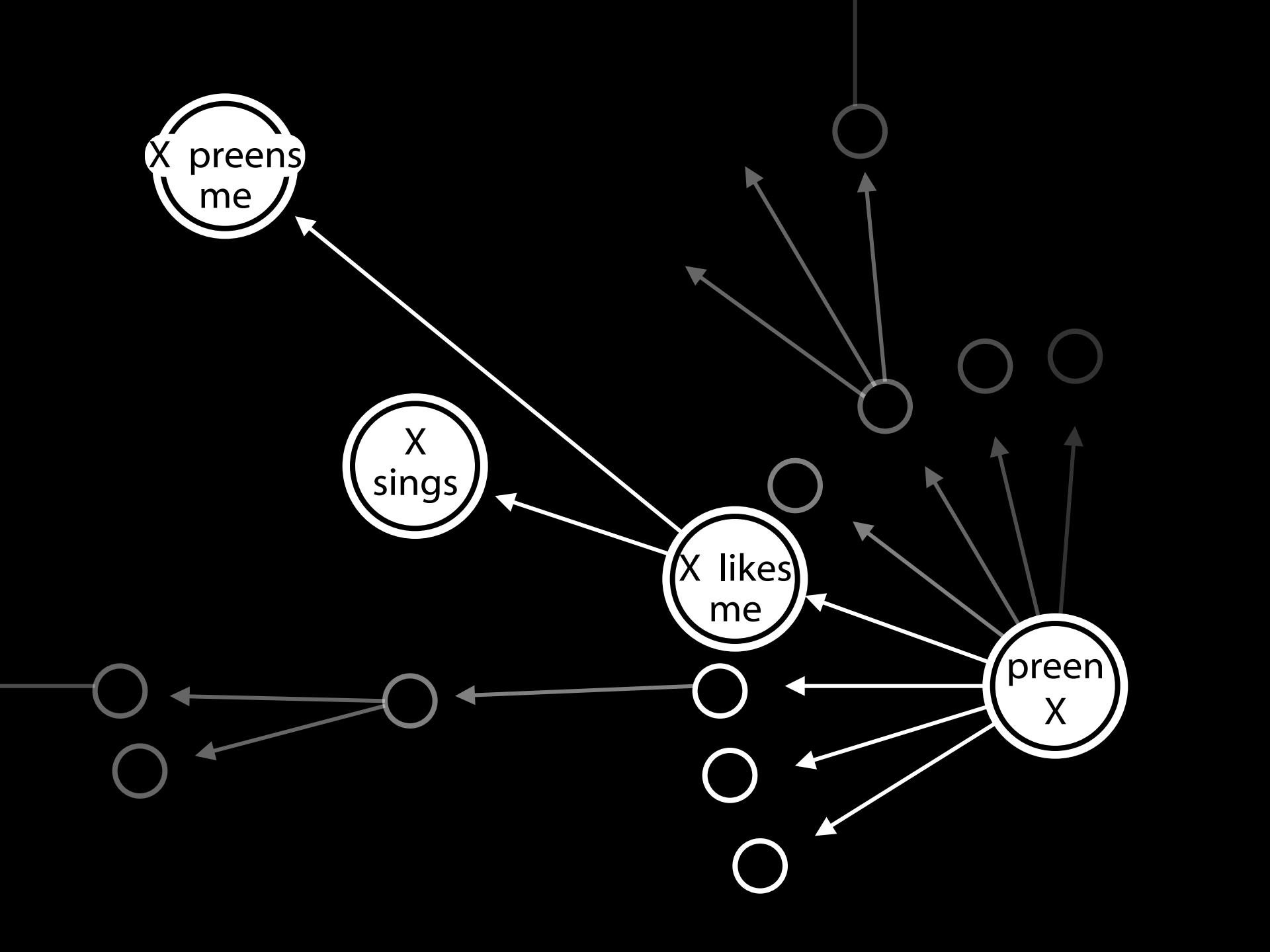
(Penn & Povinelli 2007:732)

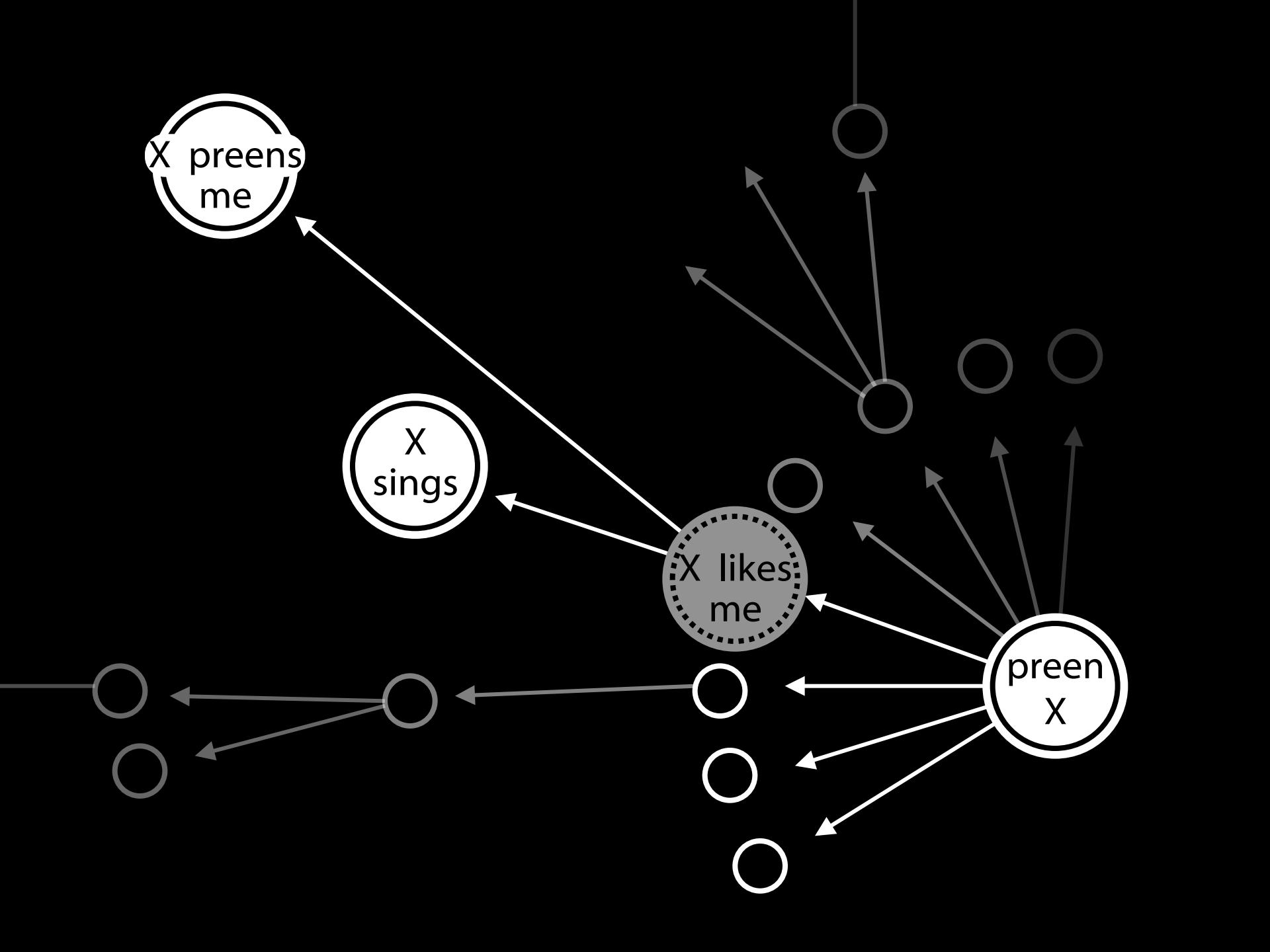
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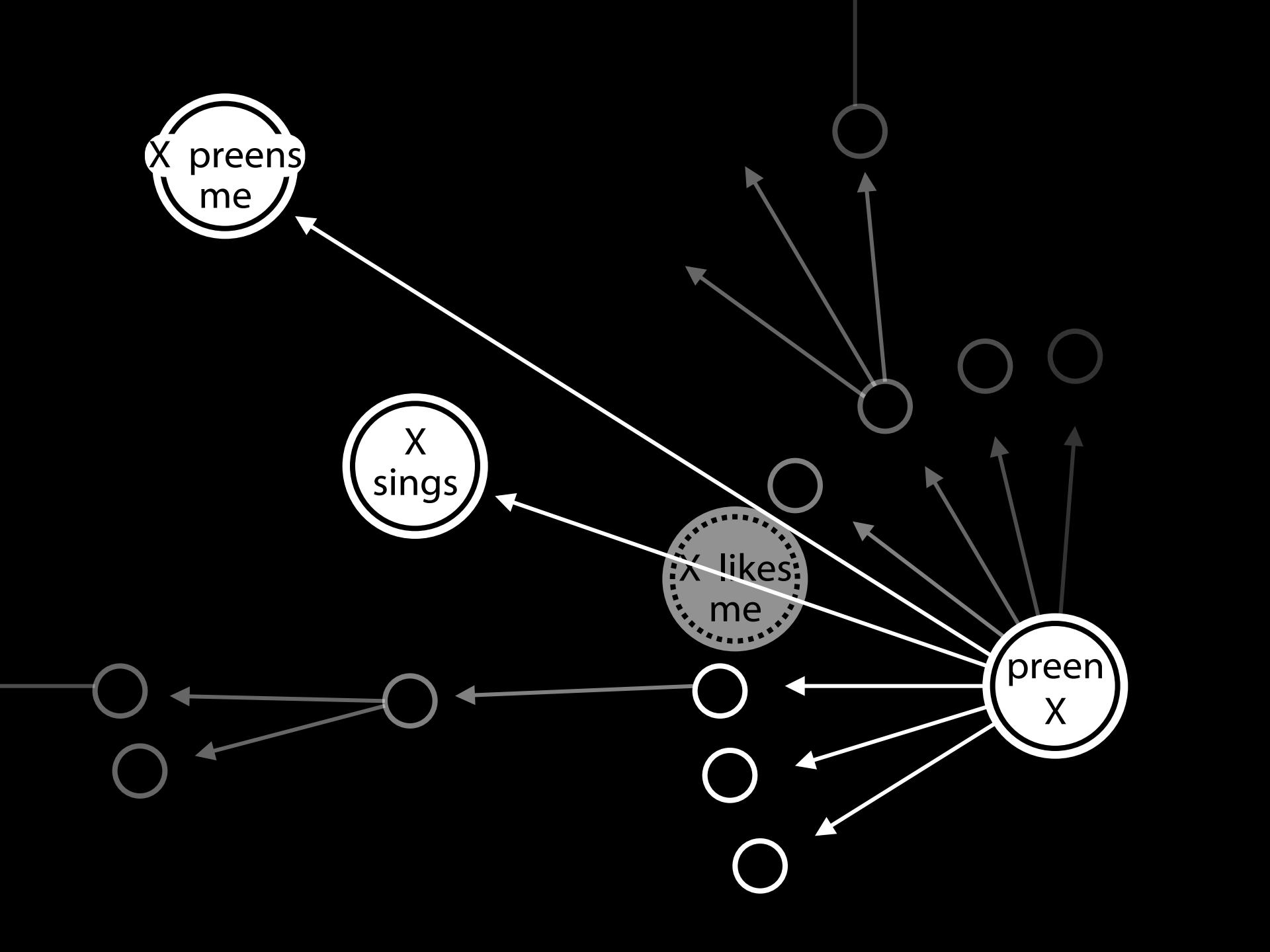
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“chimpanzees understand ... intentions ... perception and knowledge ... Moreover, they understand how these psychological states work together to produce intentional action”

(Call & Tomasello 2008:191)



“our fundamental understanding of [...] knowledge is that it is something whose possession by an individual can properly be explained by reference to [...] ways of coming to know.”

(Cassam “What is Knowledge?”, forthcoming)

