



Joint Action and the Emergence of Mindreading  
**Intention and Motor Representation  
in Joint Action**

s.butterfill@warwick.ac.uk & corrado.sinigaglia@unimi.it

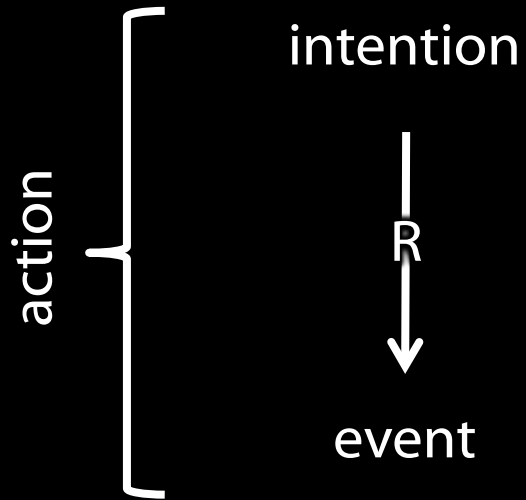


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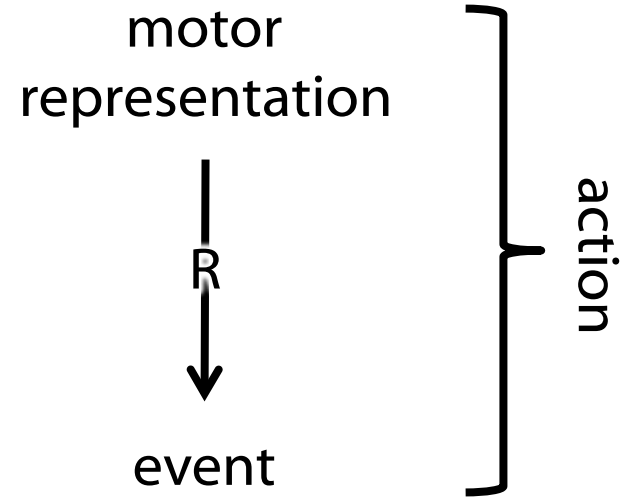
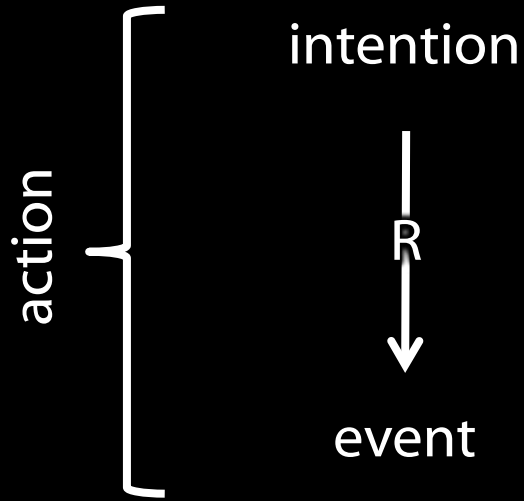
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Which events are actions?

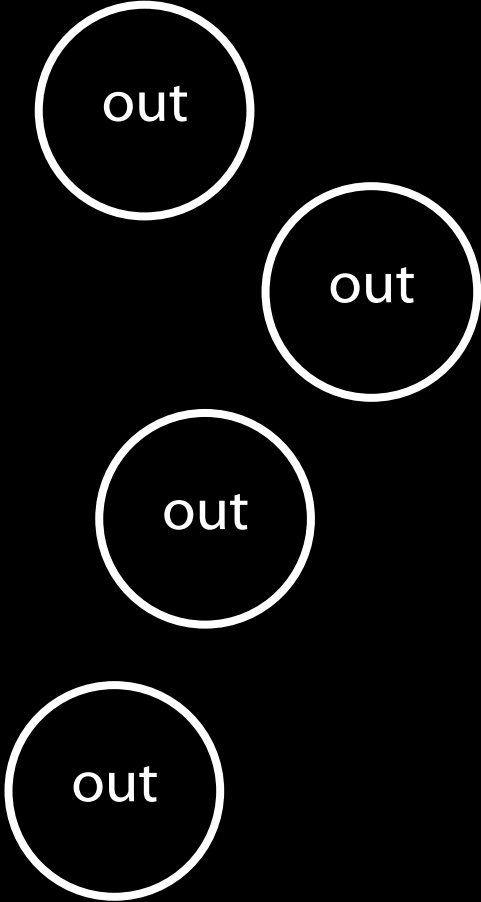
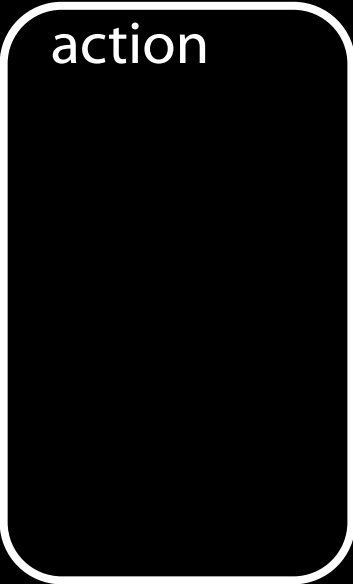
Which events are actions?



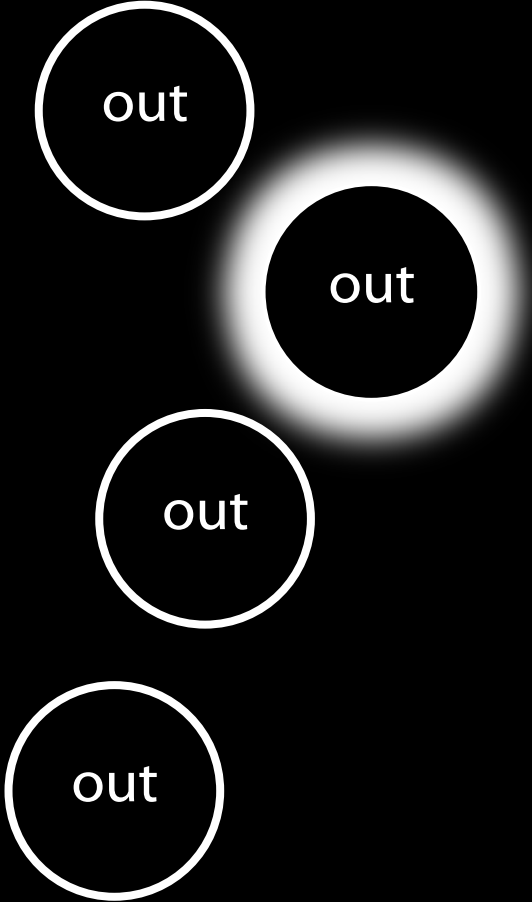
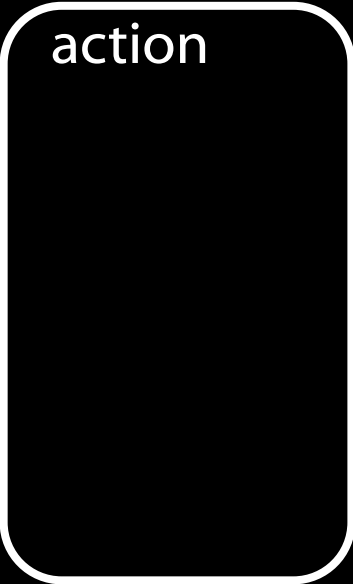
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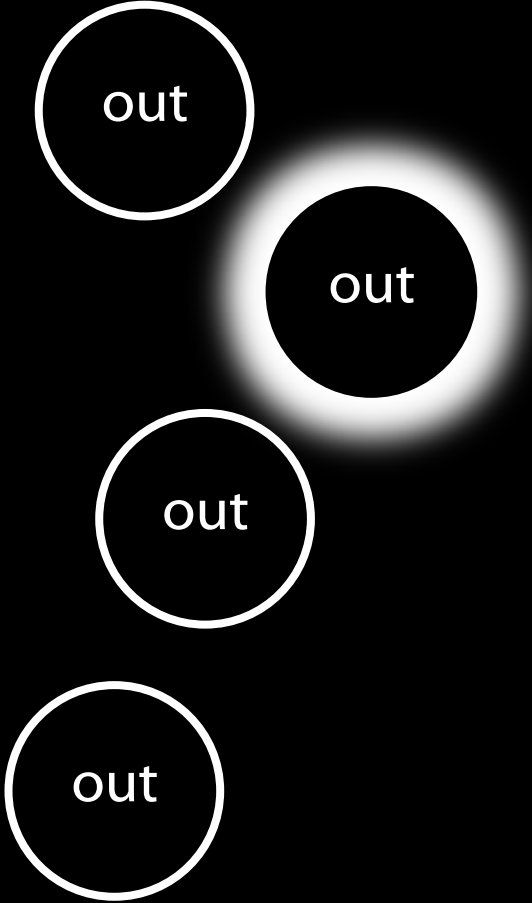
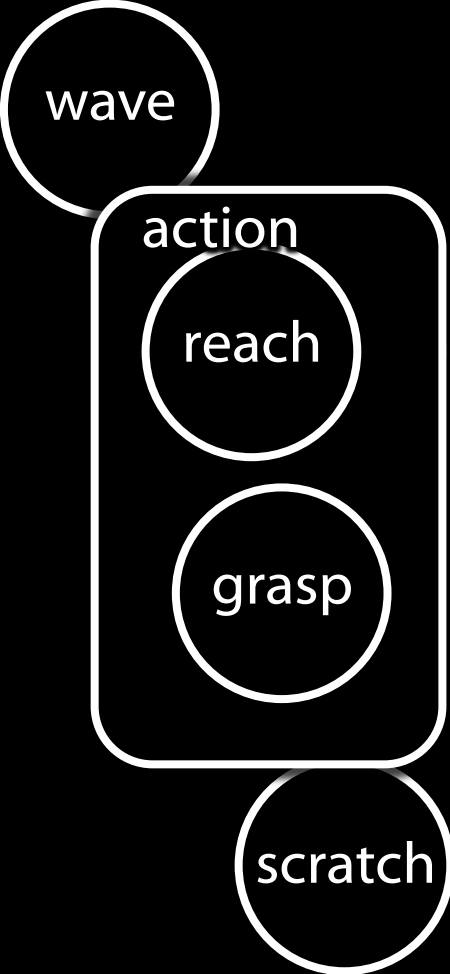
What is the relation between a purposive action and the outcome or outcomes to which it is directed?



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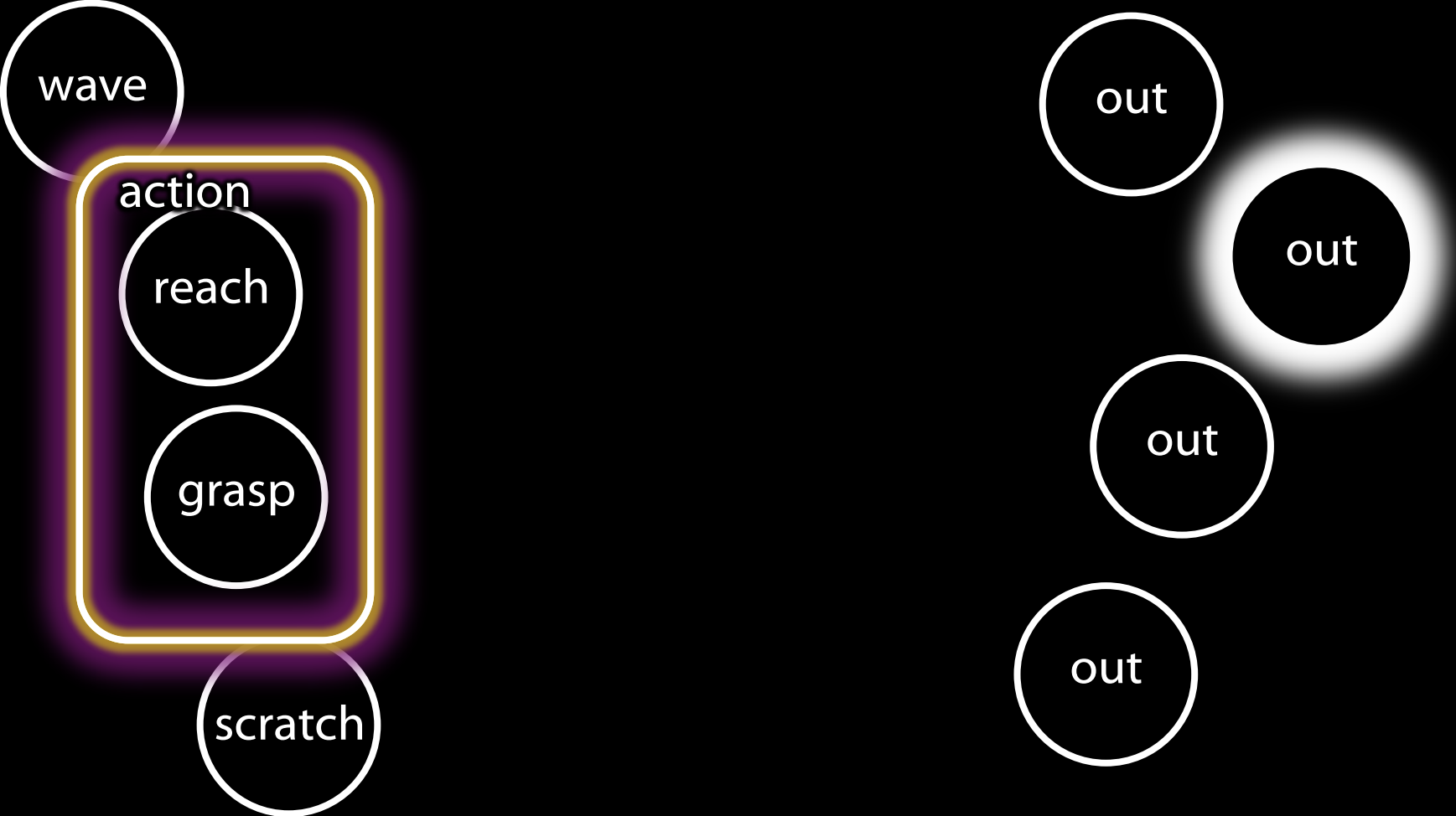


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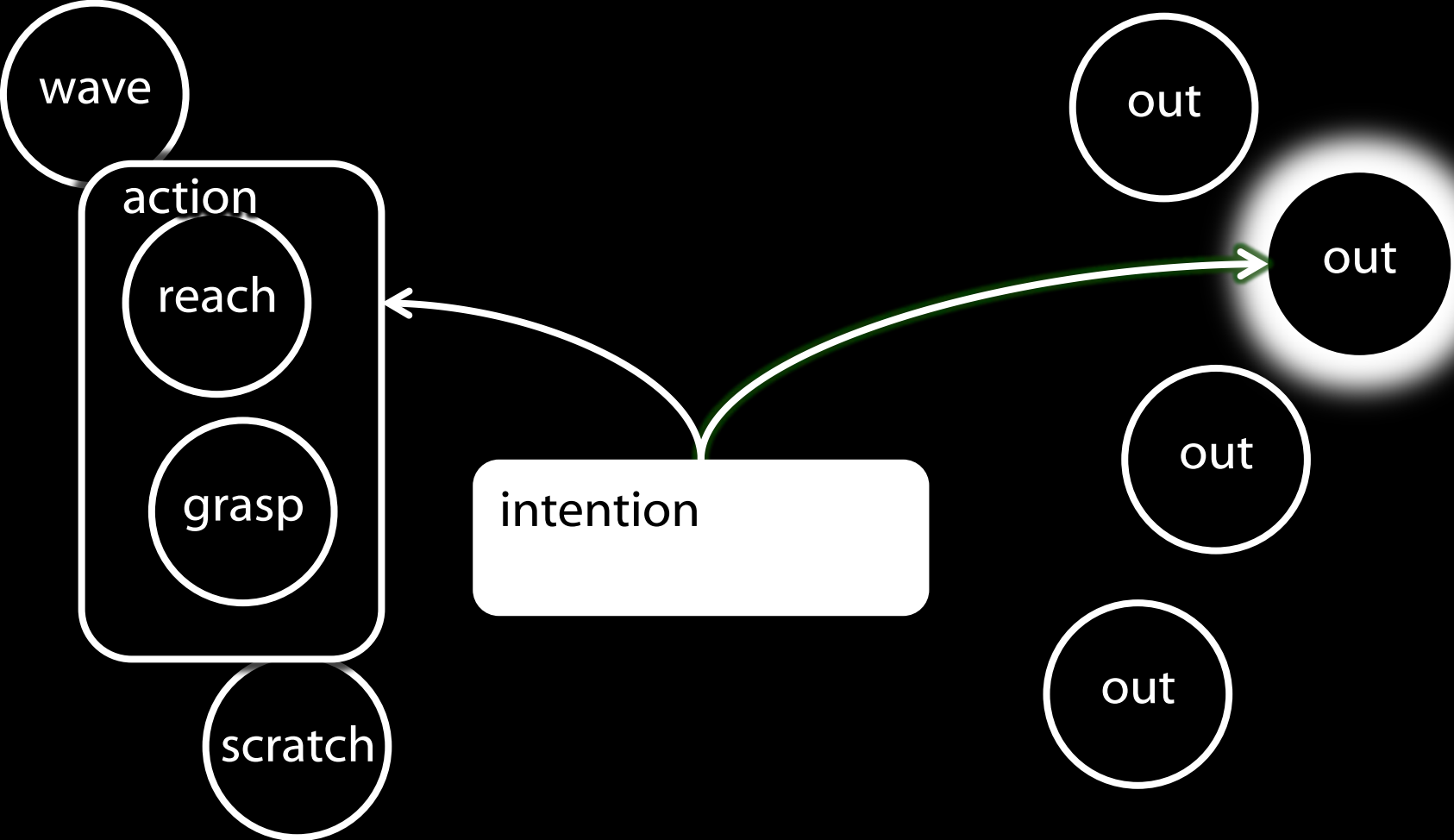




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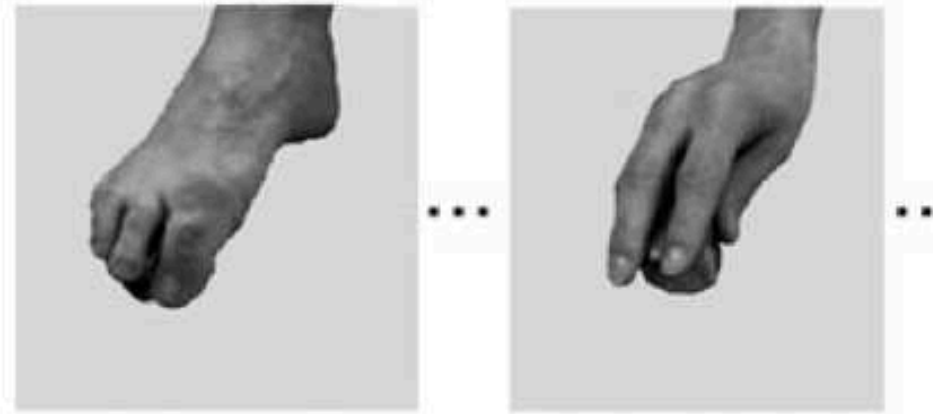


What is the relation between a purposive action and the outcome or outcomes to which it is directed?



Some motor representations carry information about outcomes.

Some motor representations carry information about outcomes.



same  
effector

different  
effector



same outcome

Cattaneo et al (2010)

Some motor representations carry information about outcomes.



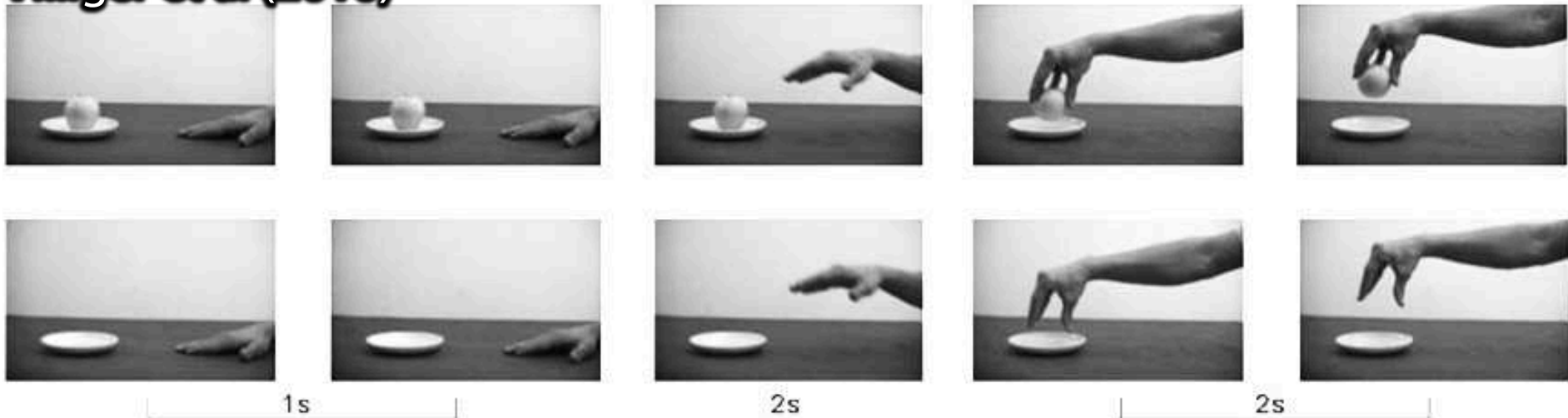
same effector

different effector

same outcome

Cattaneo et al (2010)

Villiger et al (2010)



Some motor representations carry information about outcomes.



same  
effector

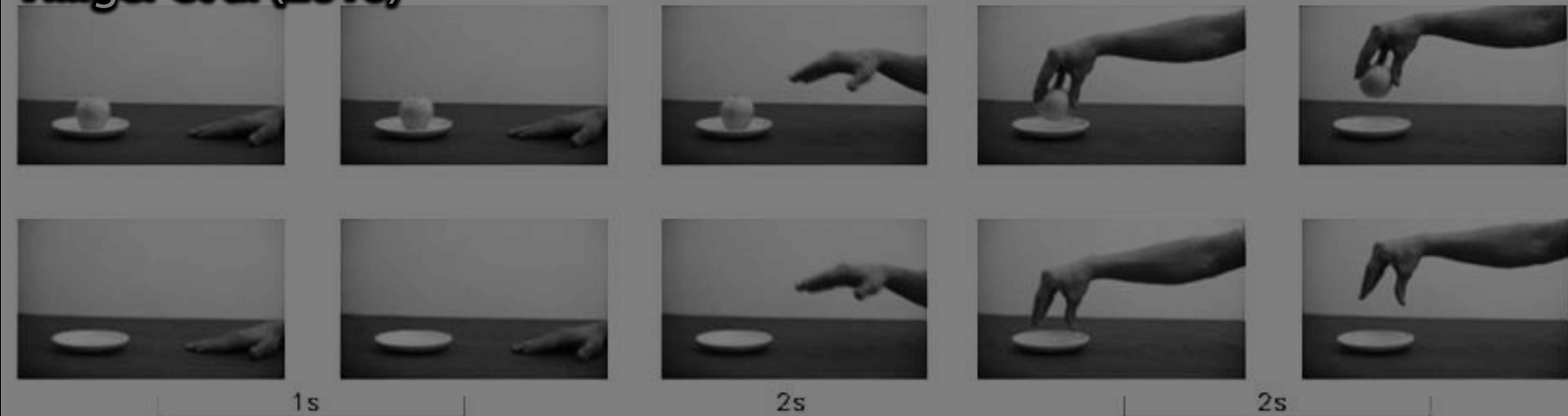
different  
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same outcome

Cattaneo et al (2010)

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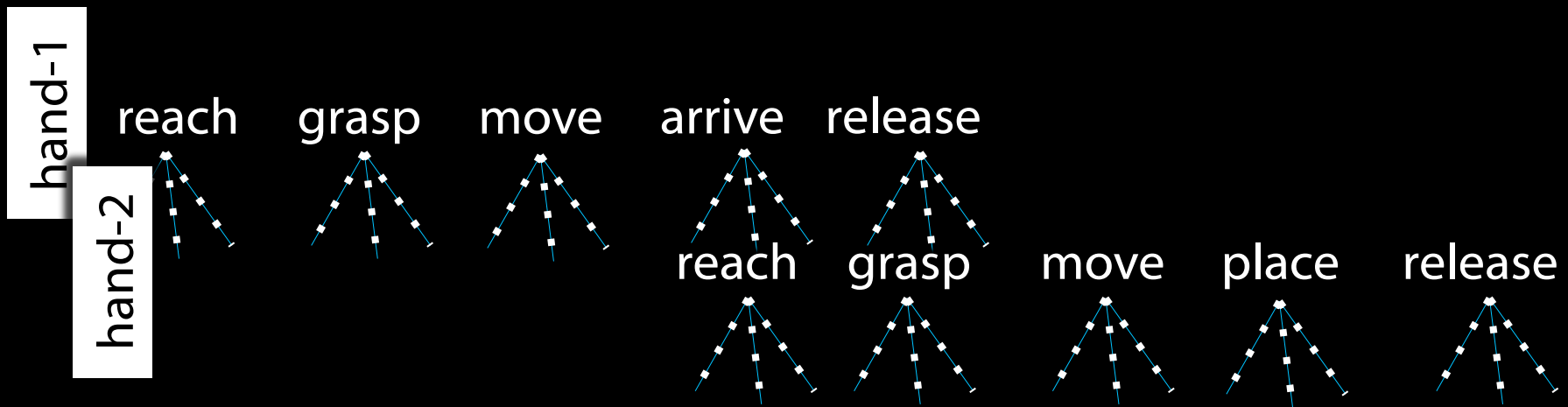


Some motor representations carry information about outcomes.

Information about outcomes guides planning.

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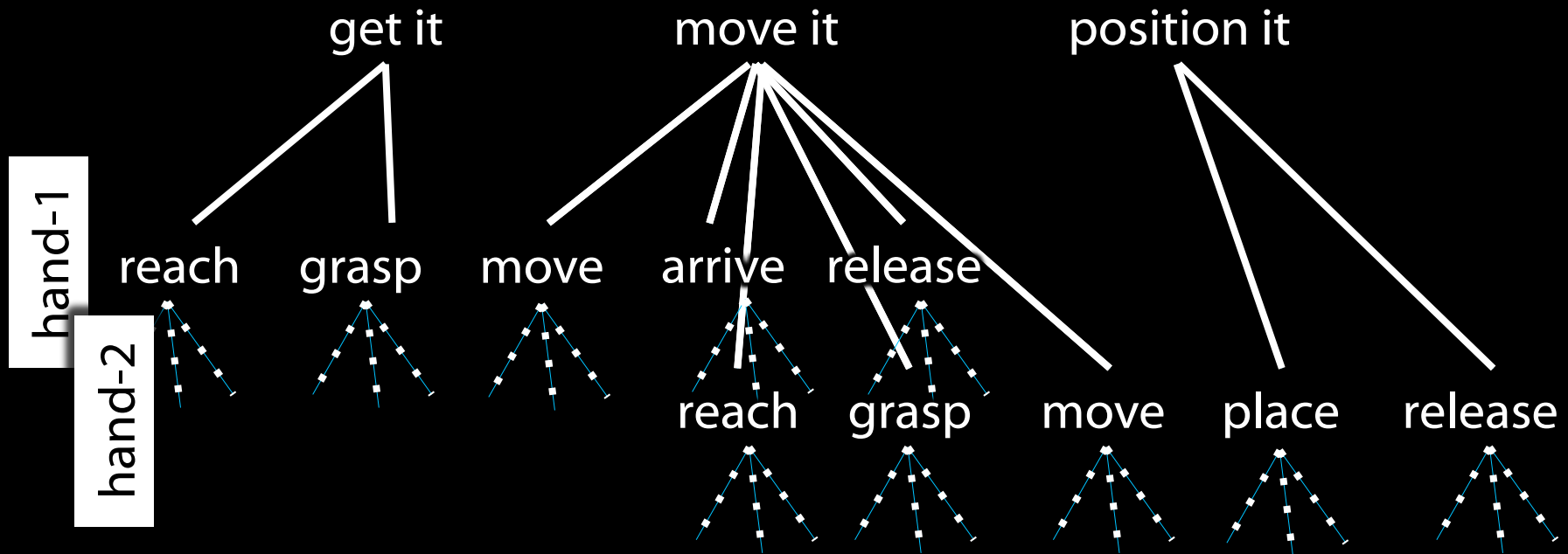
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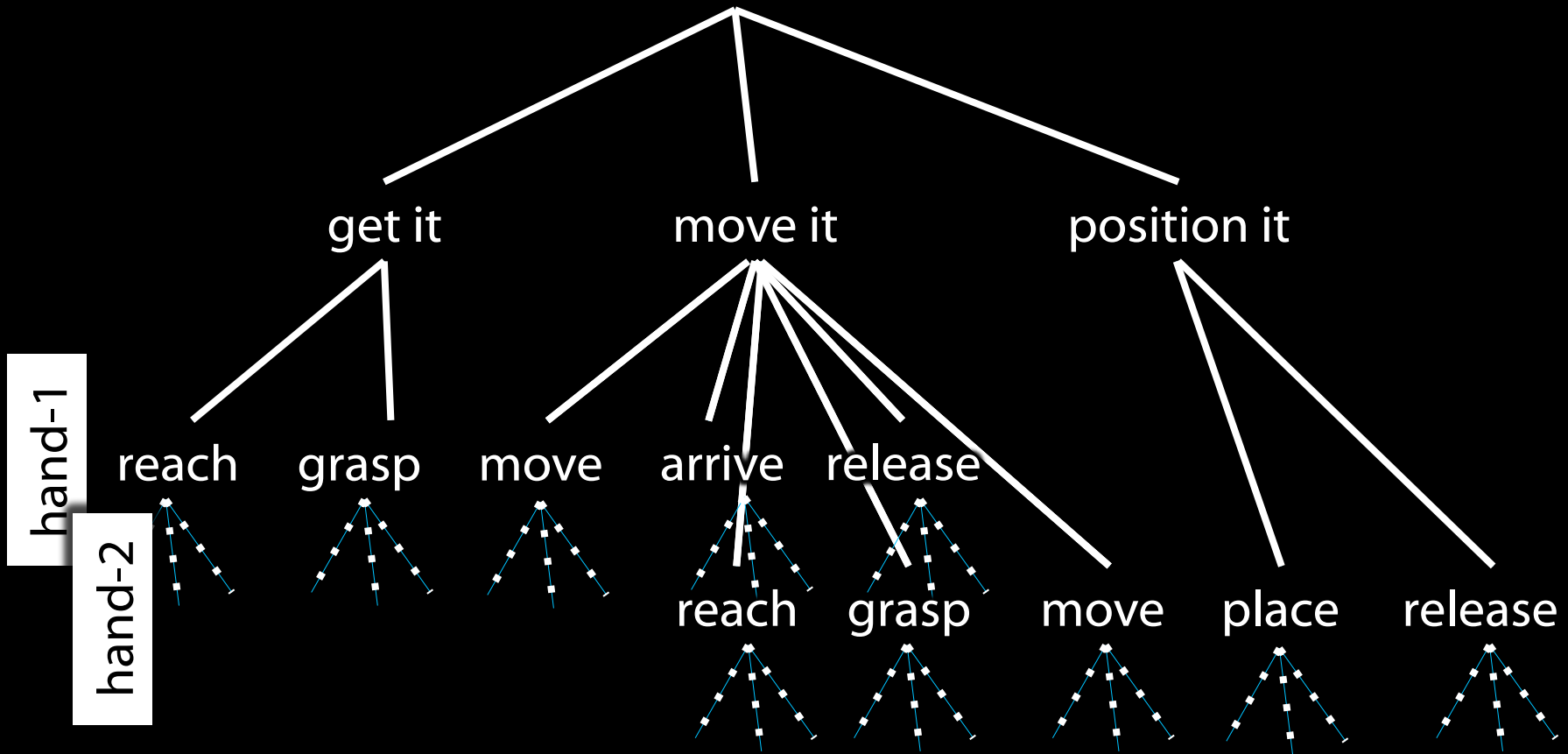
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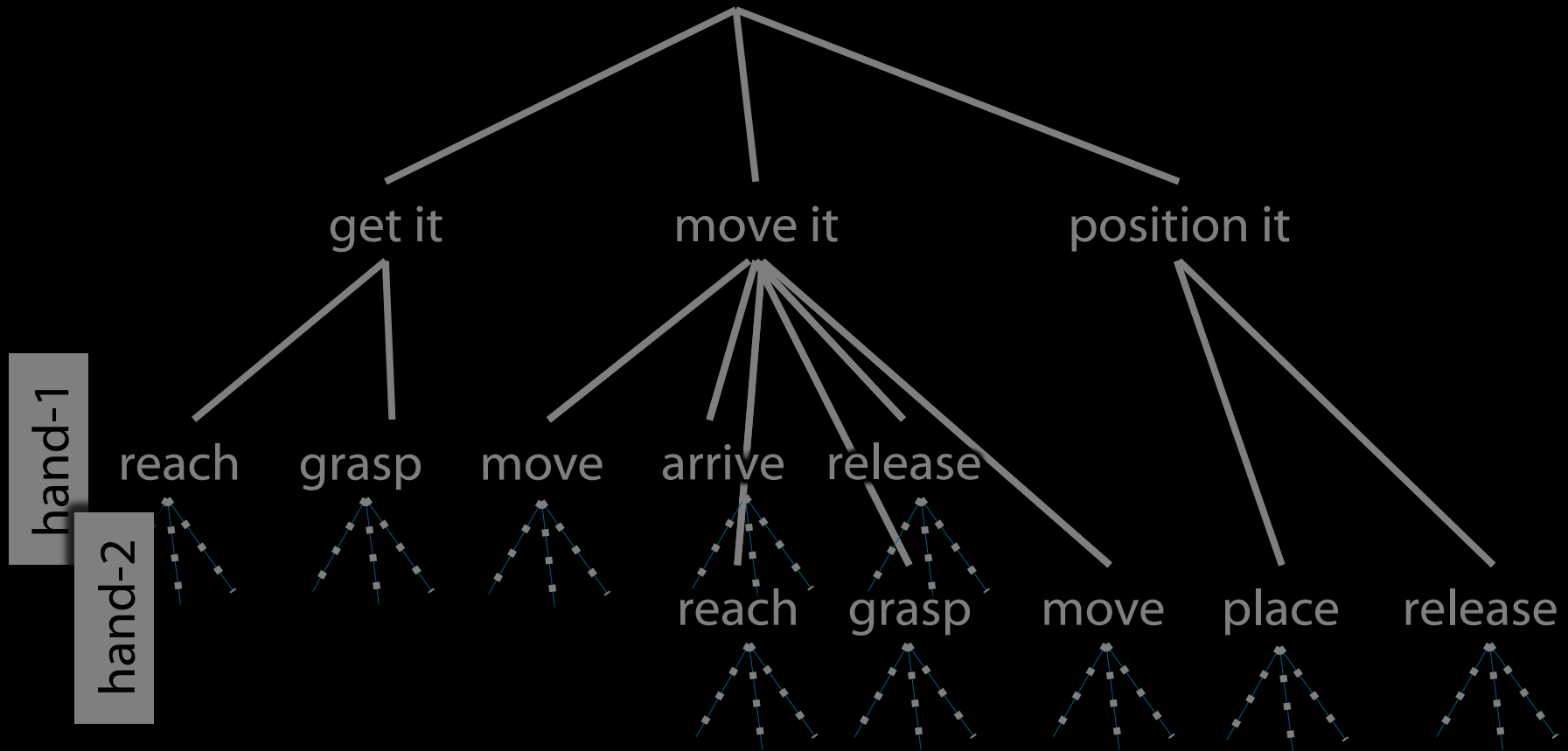
Move it from there to here



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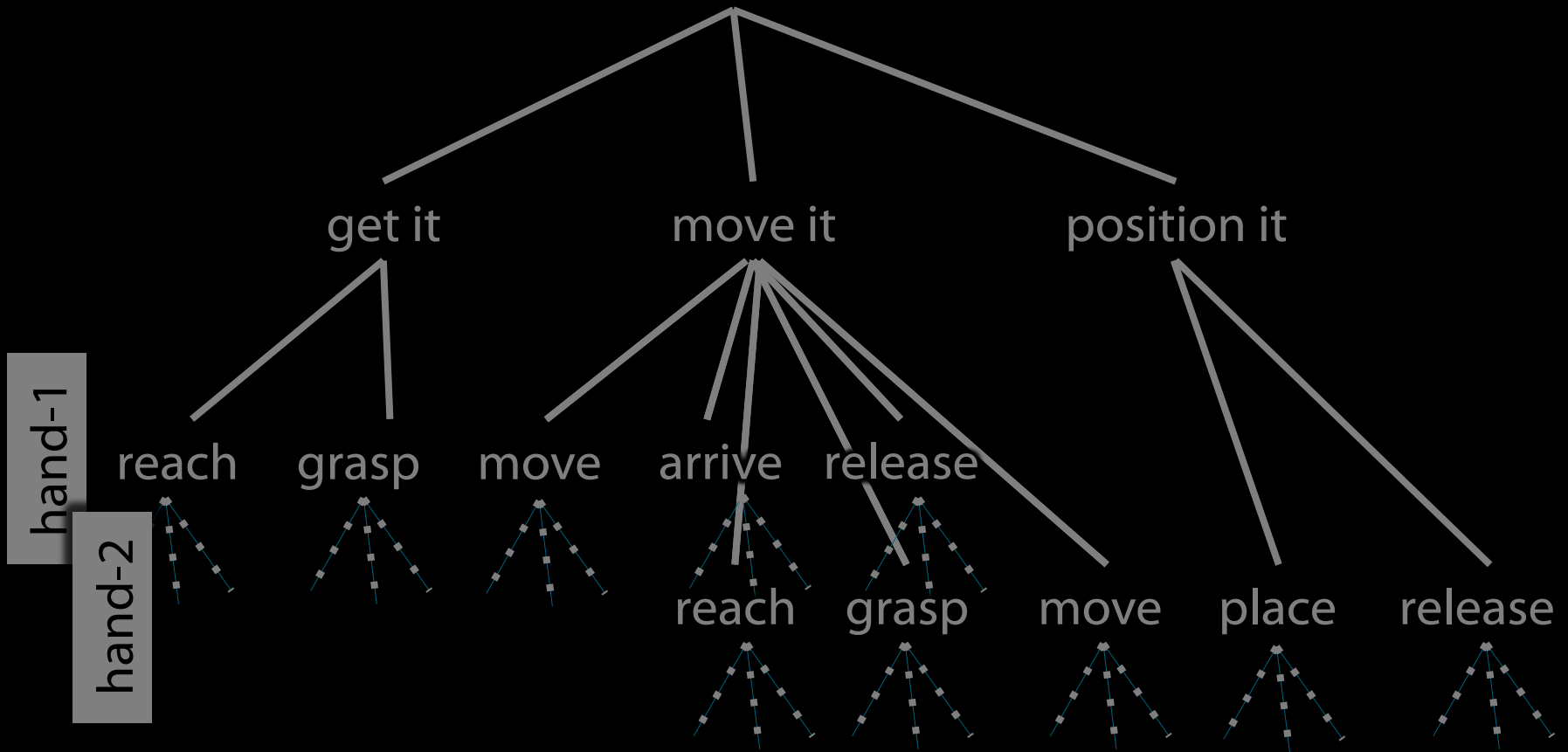


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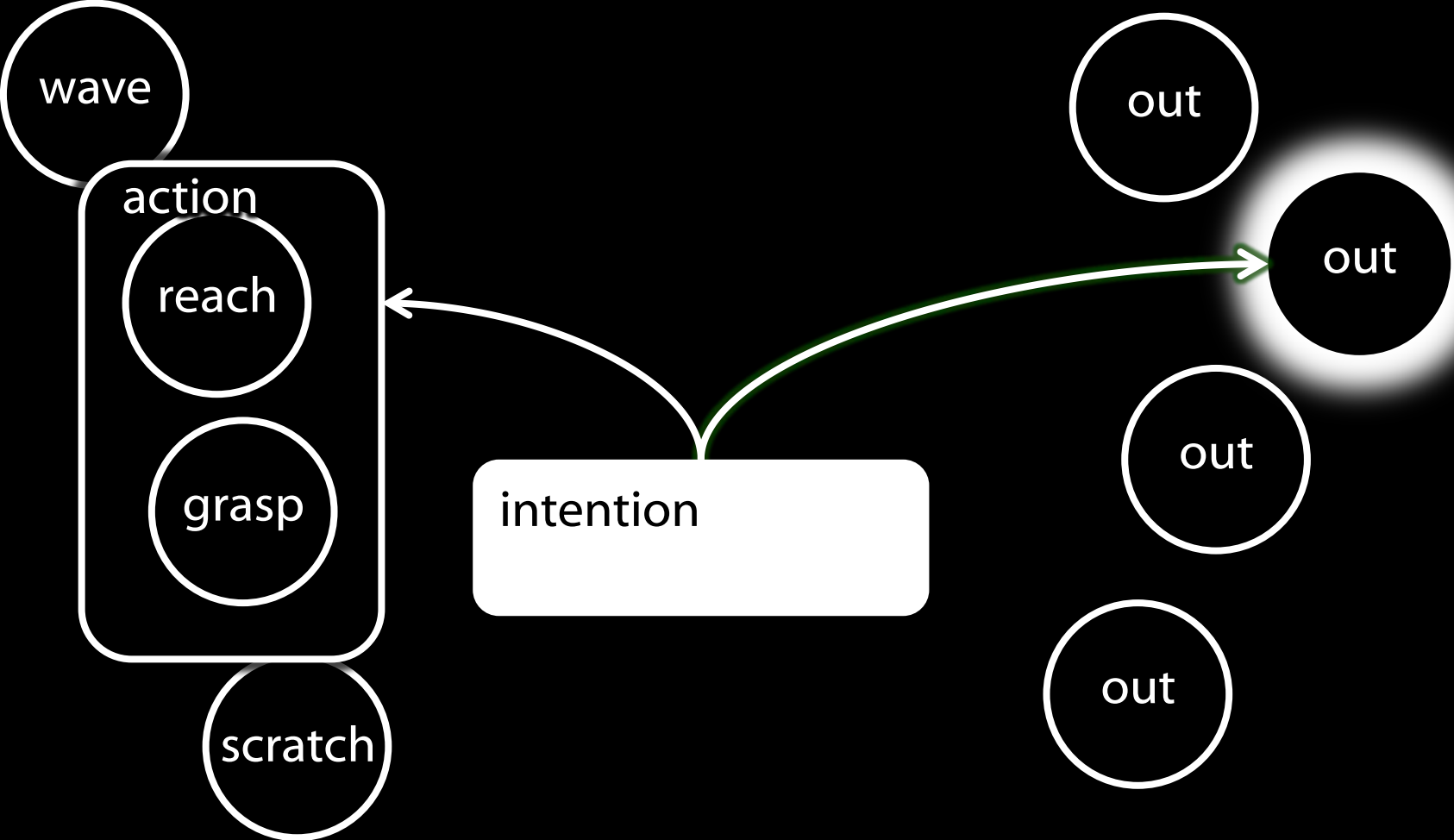
Information about outcomes guides planning.

Some motor representations represent outcomes

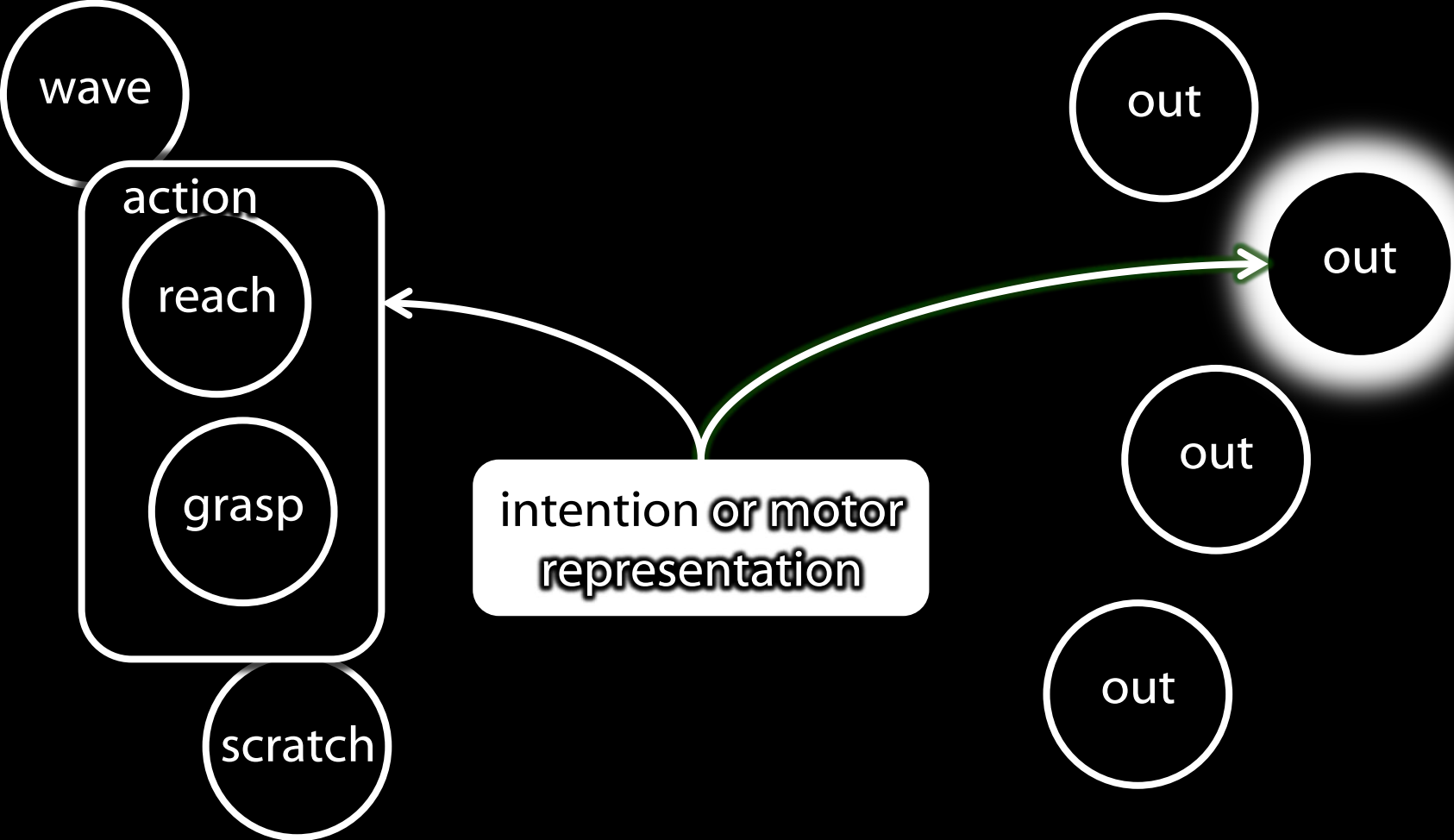
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What is the relation between a purposive action and the outcome or outcomes to which it is directed?



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# **Intention and Motor Representation in Joint Action**

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premise:

Reciprocal agent-neutral motor representation  
enables some joint actions



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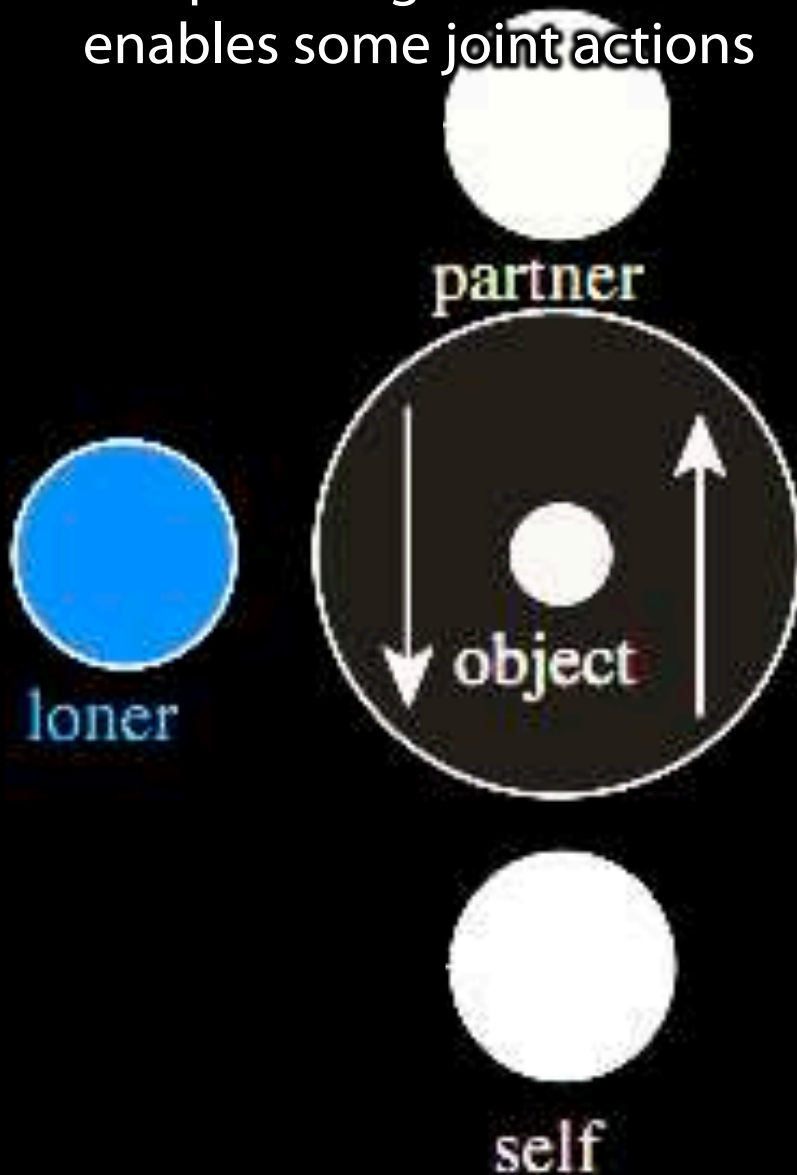
“Simulation of another person’s action, as reflected  
in the activation of motor cortices, gets stronger the  
more the other is perceived as an interaction  
partner.”

--- Kourtis, Sebanz & Knoblich (2010, p. 4)



premise:

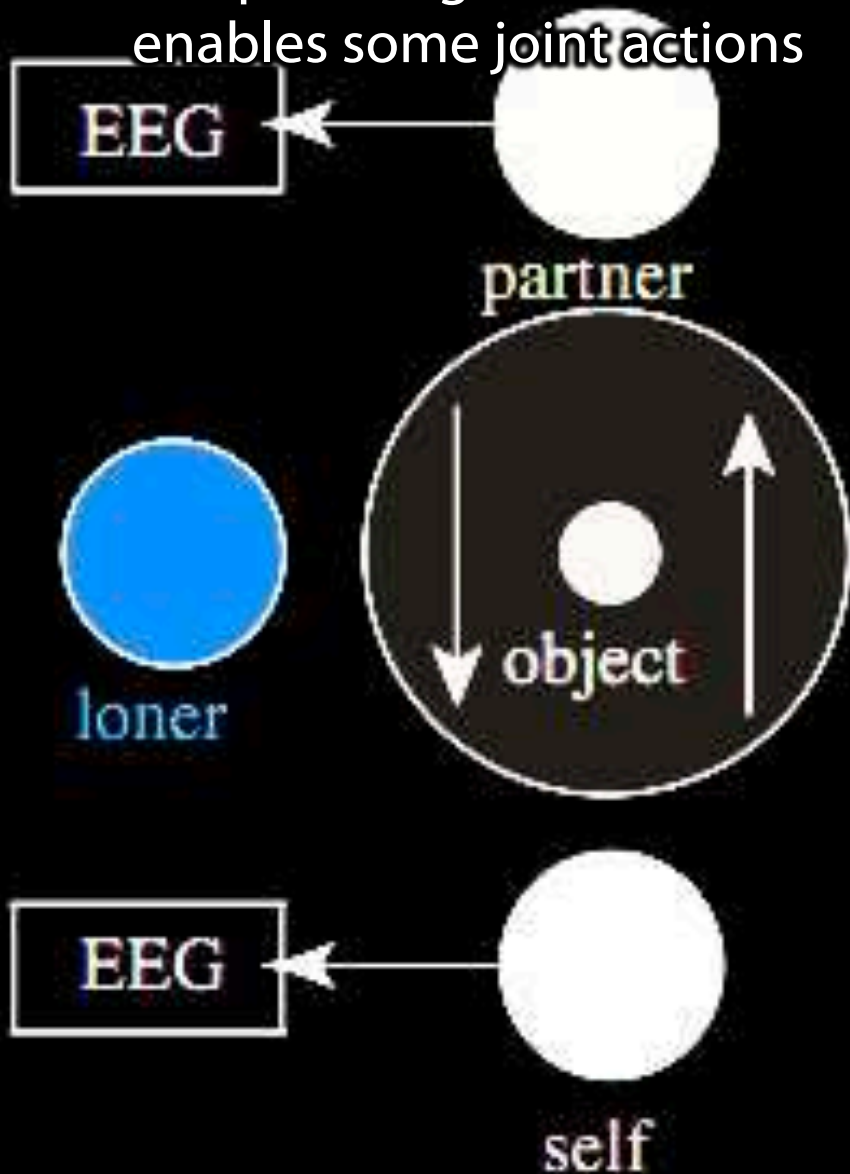
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Kourtis, Sebanz & Knoblich (2010)

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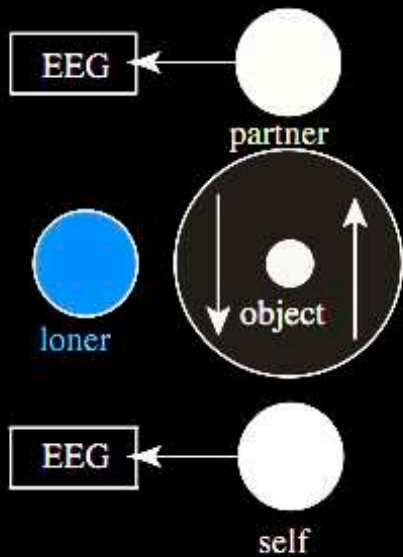
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premise:  
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(a)

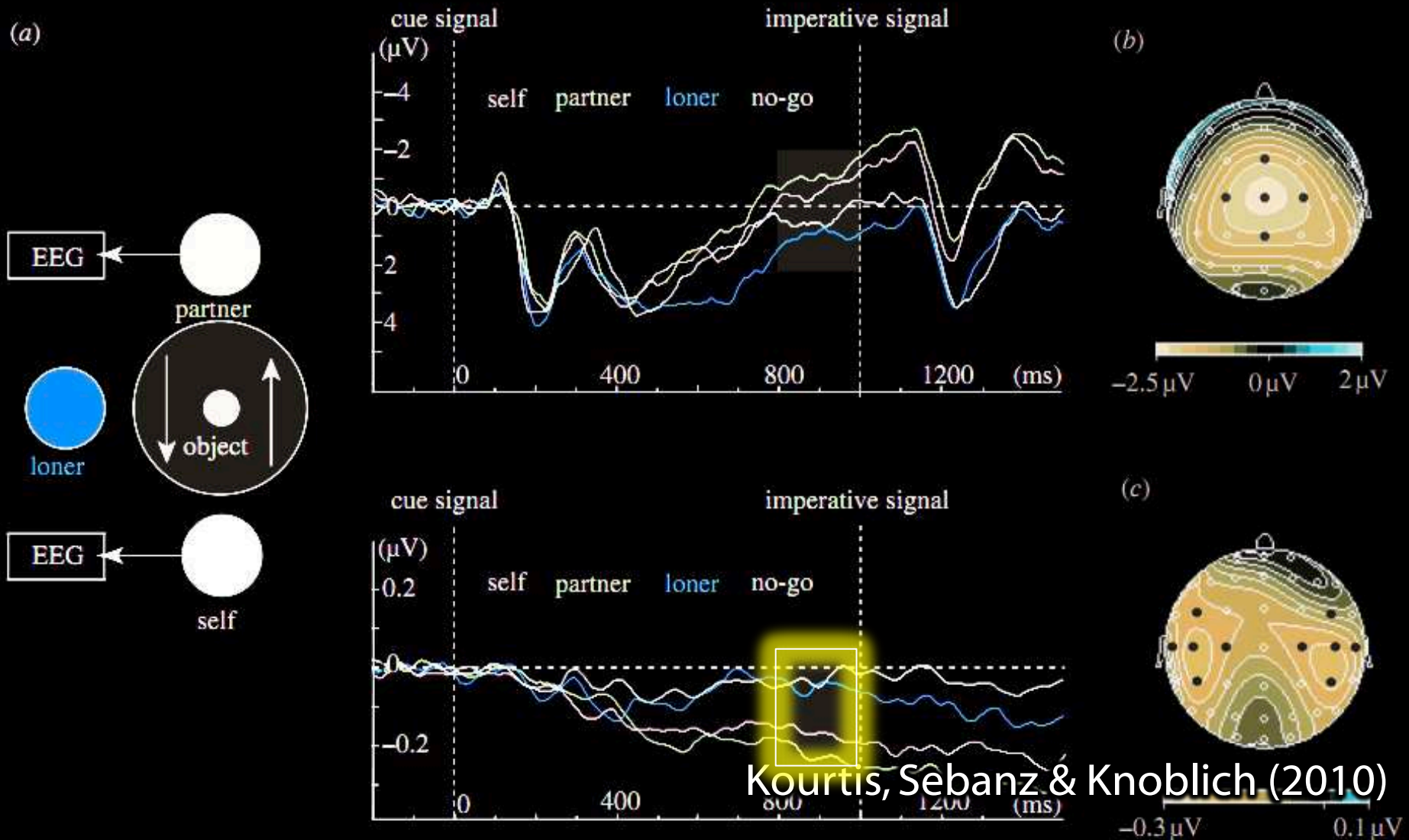


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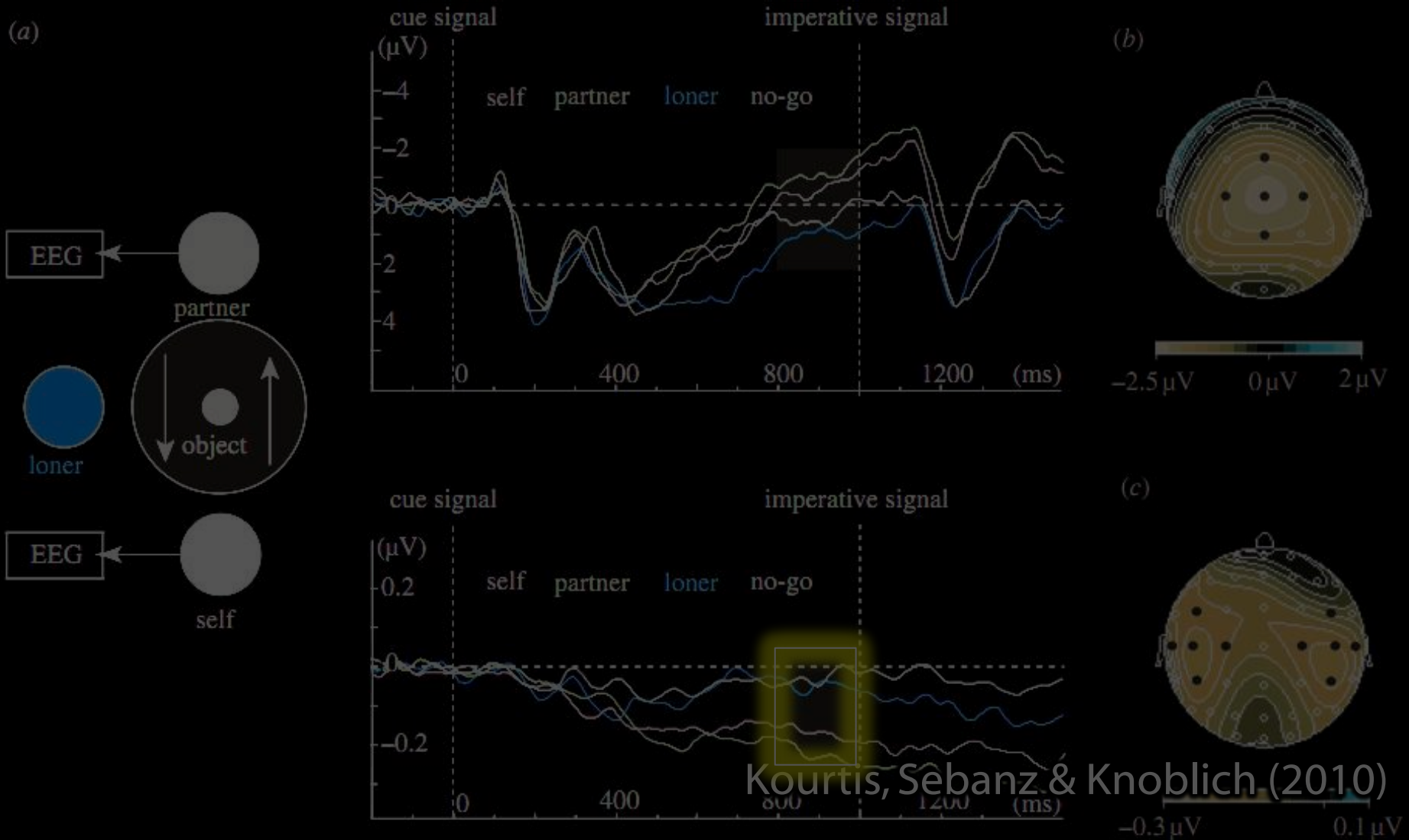




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*Kourtis et al., subm.*



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*Kourtis et al., subm.*



**Cue Stimulus**



200 ms



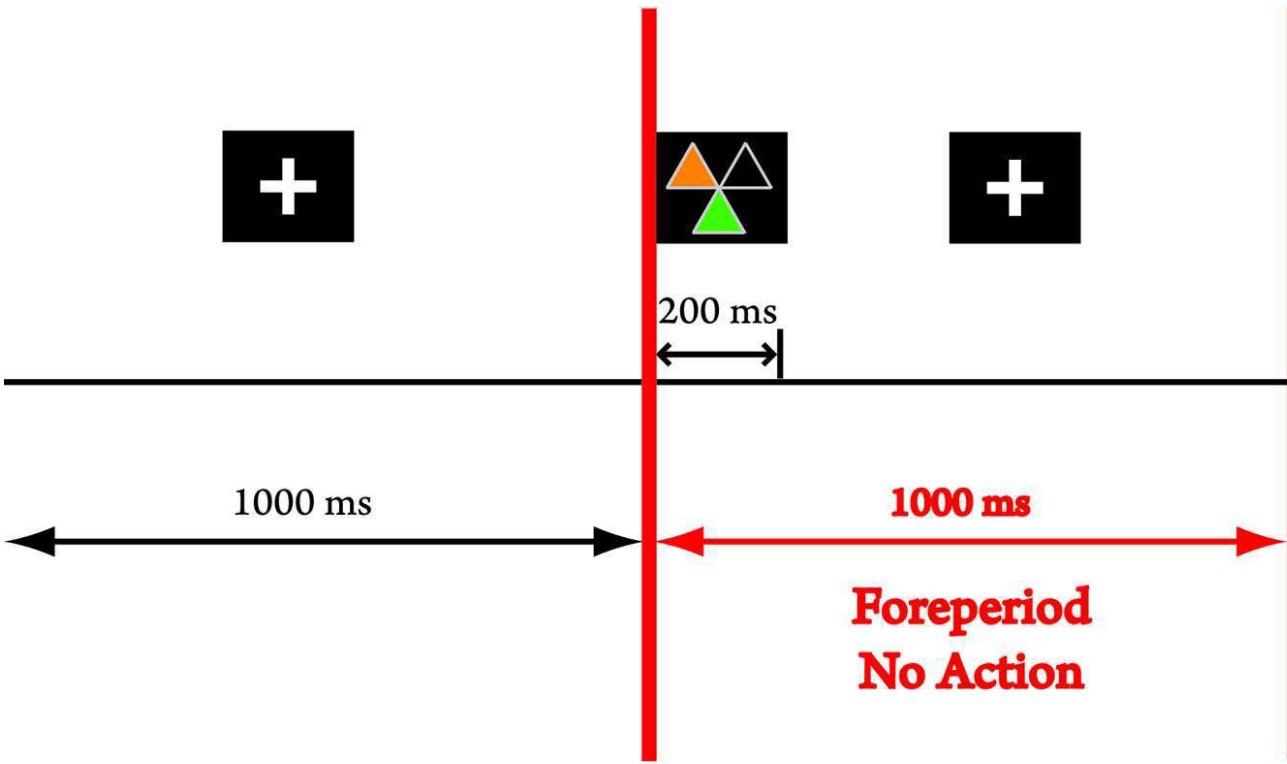
1000 ms



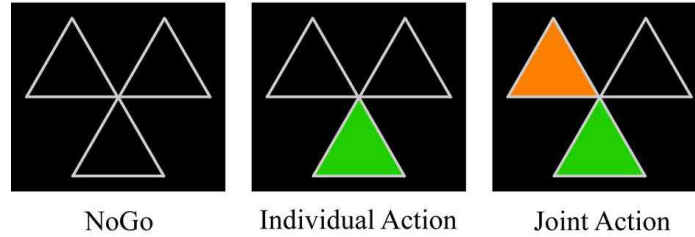
*Kourtis et al., subm.*



**Cue Stimulus**



*Kourtis et al., subm.*



**Cue Stimulus**

**Imperative Stimulus**



200 ms

200 ms

1000 ms

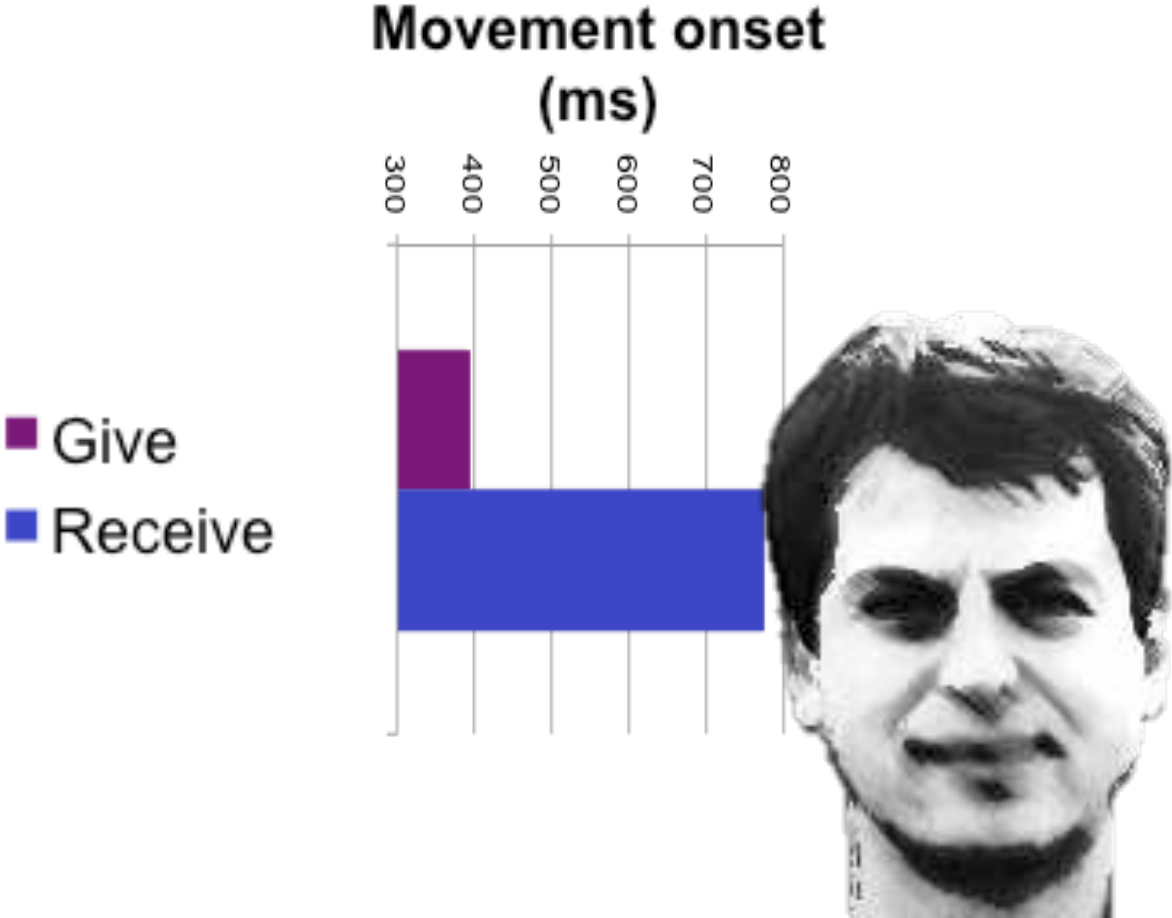
1000 ms

**Foreperiod  
No Action**

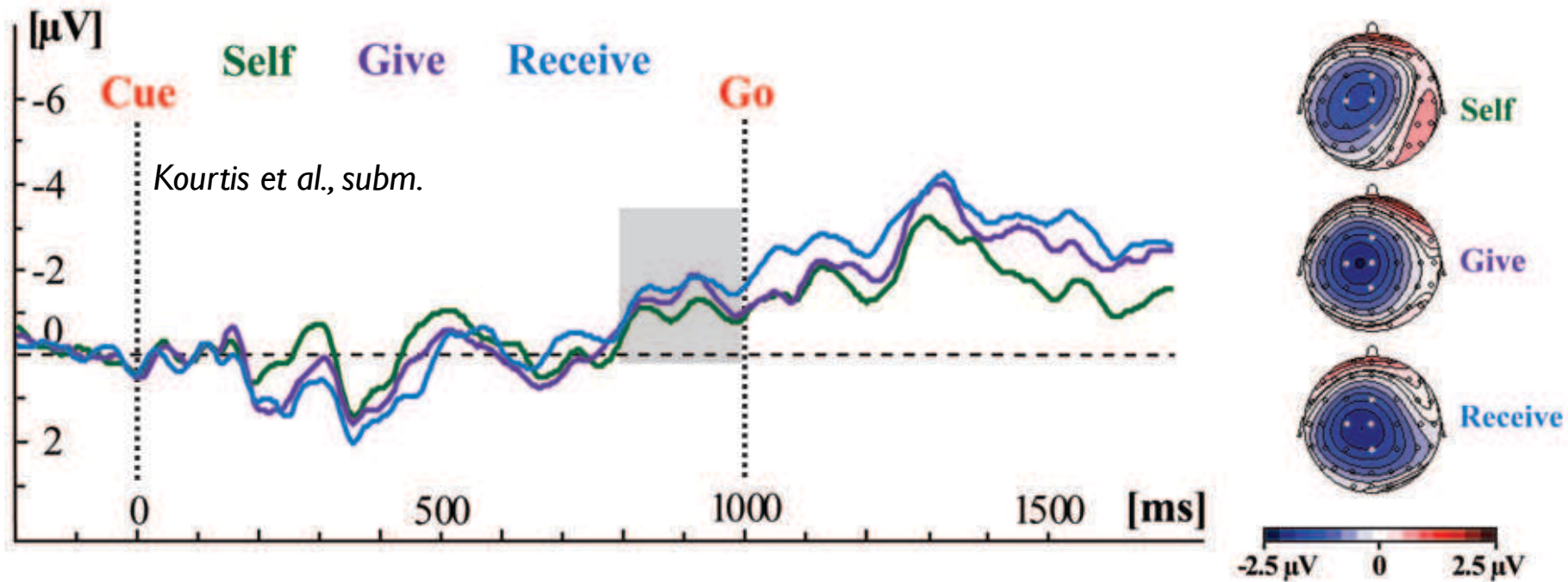
**Response**



*Kourtis et al., subm.*

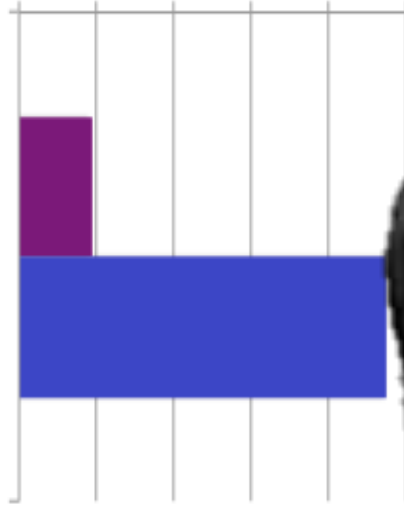






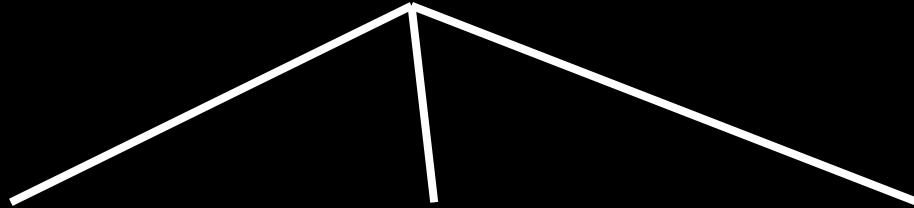
■ Give

■ Receive

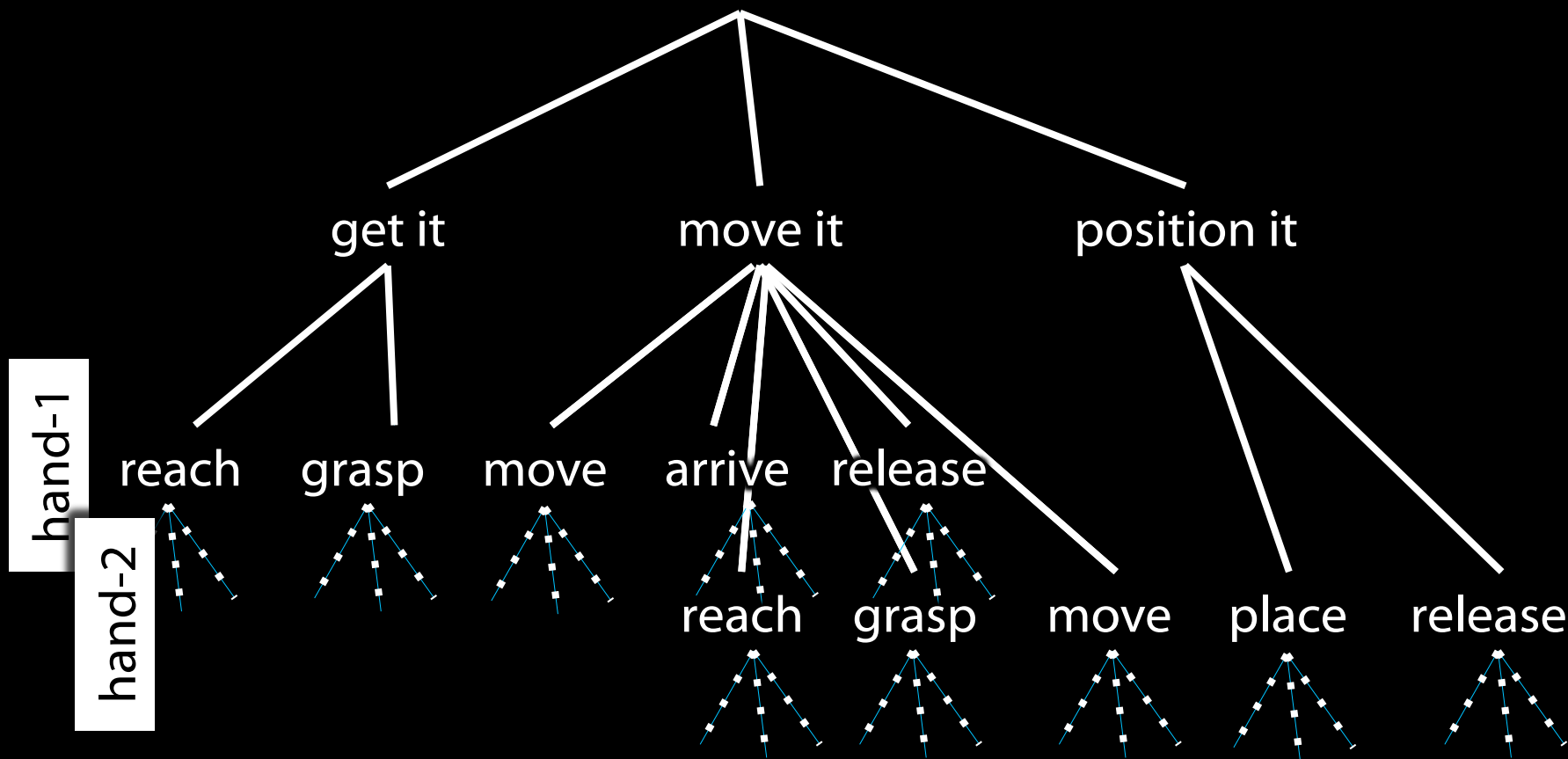


How could reciprocal agent-neutral motor representation ever enable any joint action?

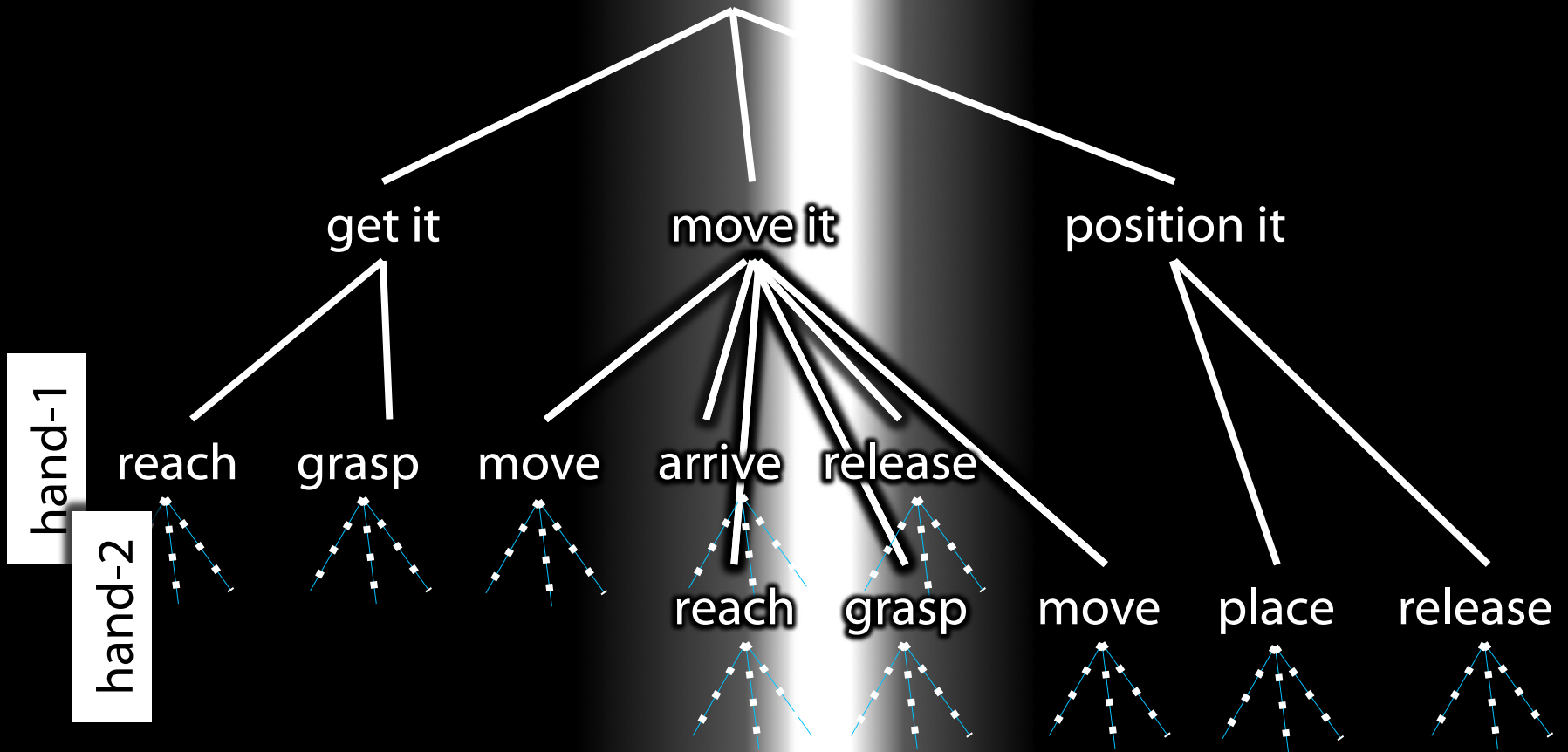
Move it from there to here



Move it from there to here

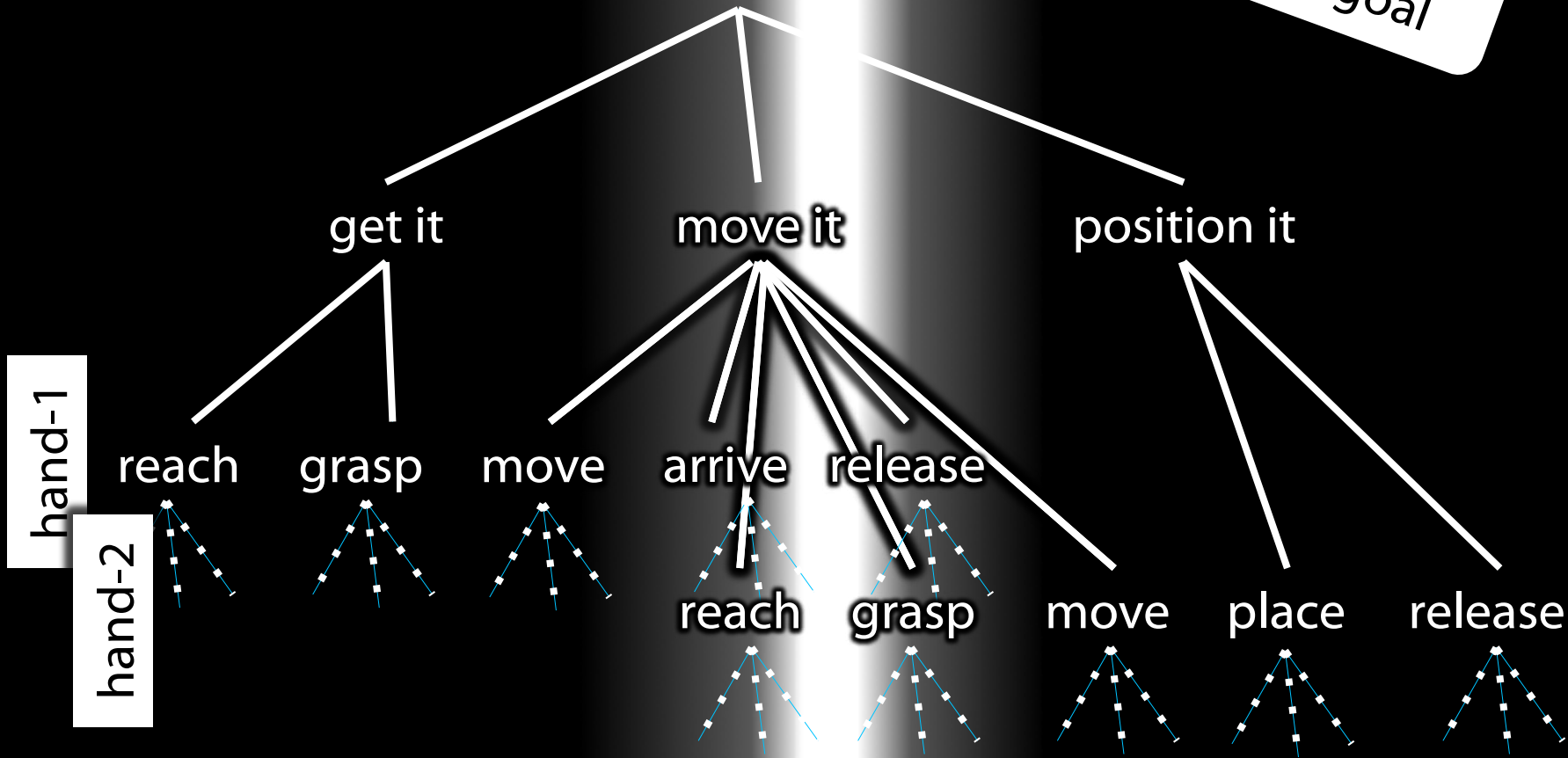


Move it from there to here



Move it from there to here

joint action:  
same goal



Move it from there to here

joint action:  
same goal

get it

move it

position it

hand-1

hand-2

reach

grasp

move

arrive

release

reach

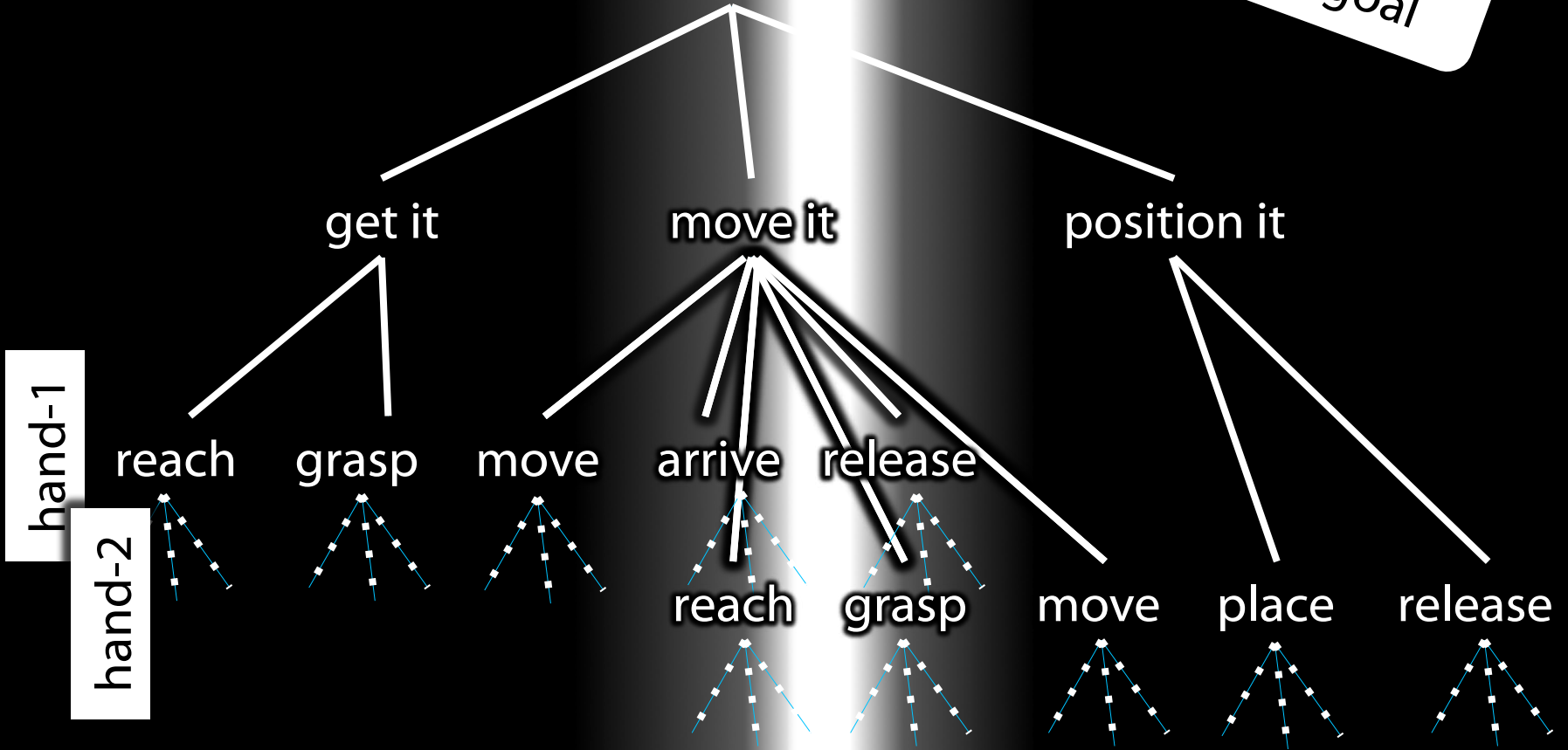
grasp

move

place

release

similar timing  
problem



Move it from there to here

joint action:  
same goal

get it

move it

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same  
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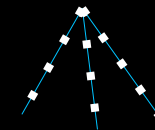
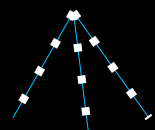
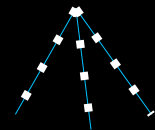
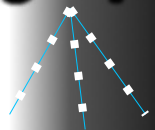
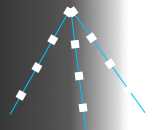
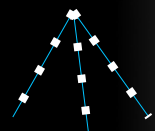
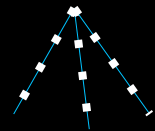
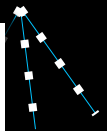
grasp

move

place

release

similar timing  
problem





Move it from there to here

joint action:  
same goal

get it

move it

position it

same  
planning

hand-1

hand-2

reach

grasp

move

arrive

release

reach

grasp

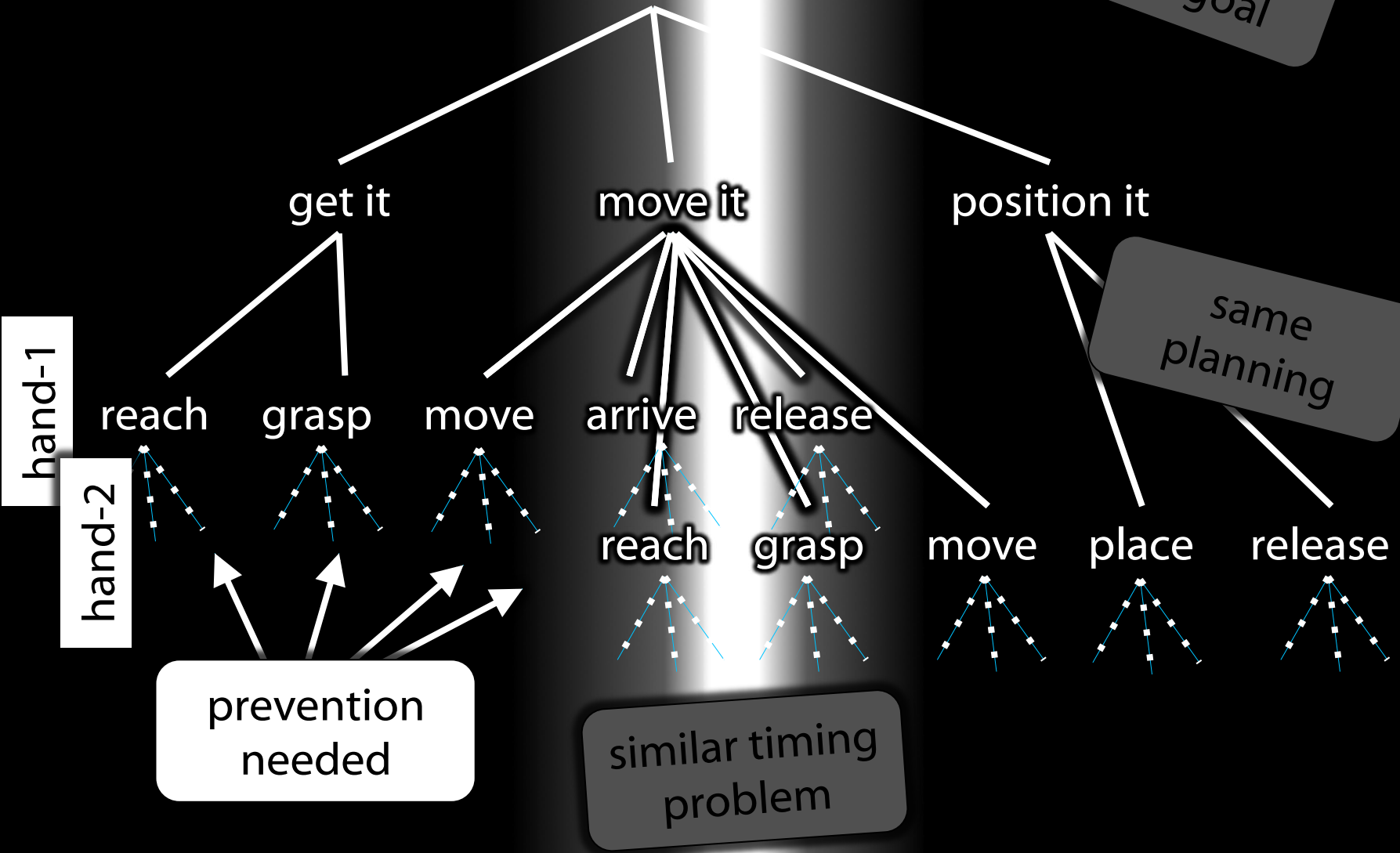
move

place

release

prevention  
needed

similar timing  
problem



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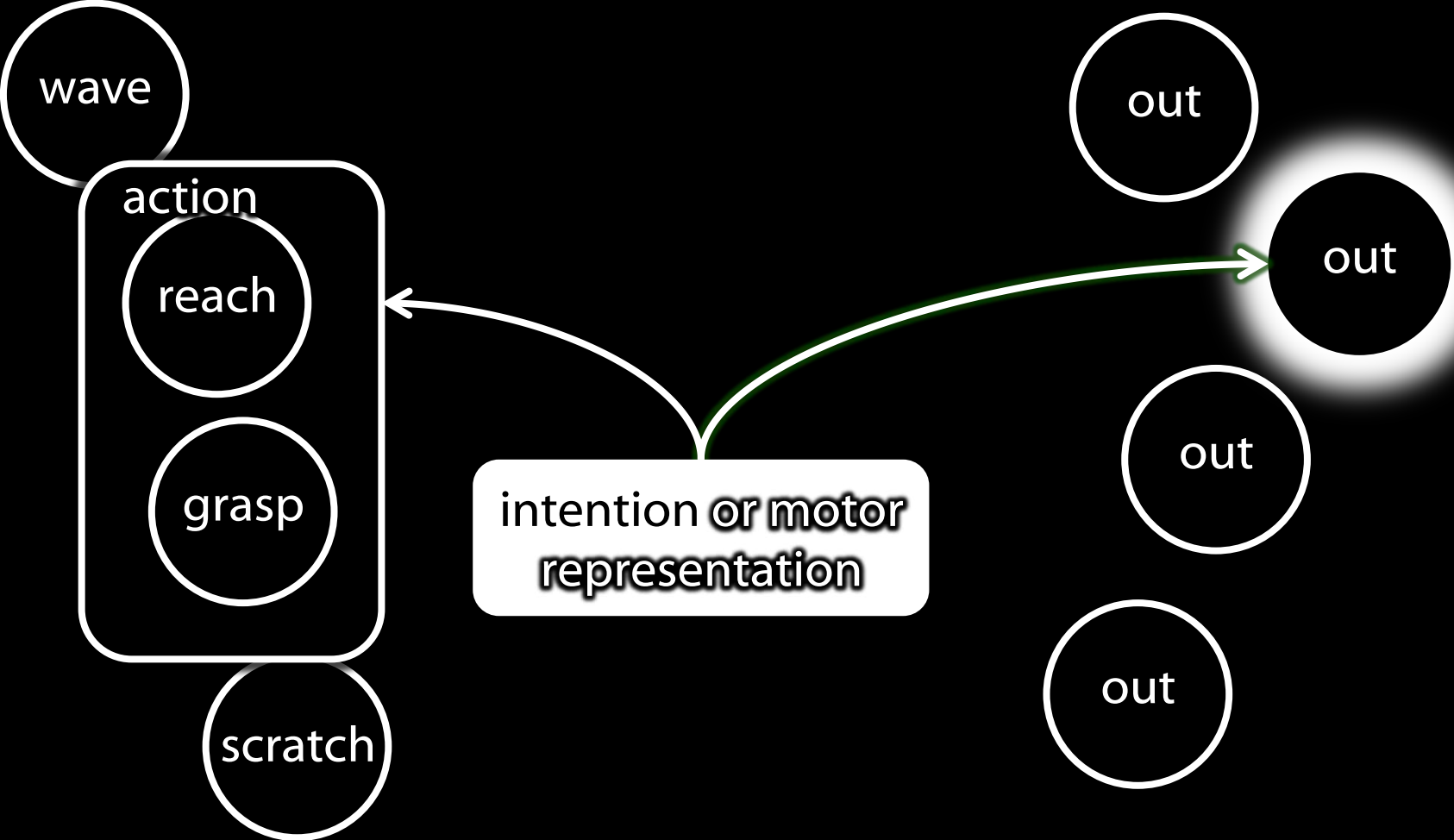
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Does reciprocal agent-  
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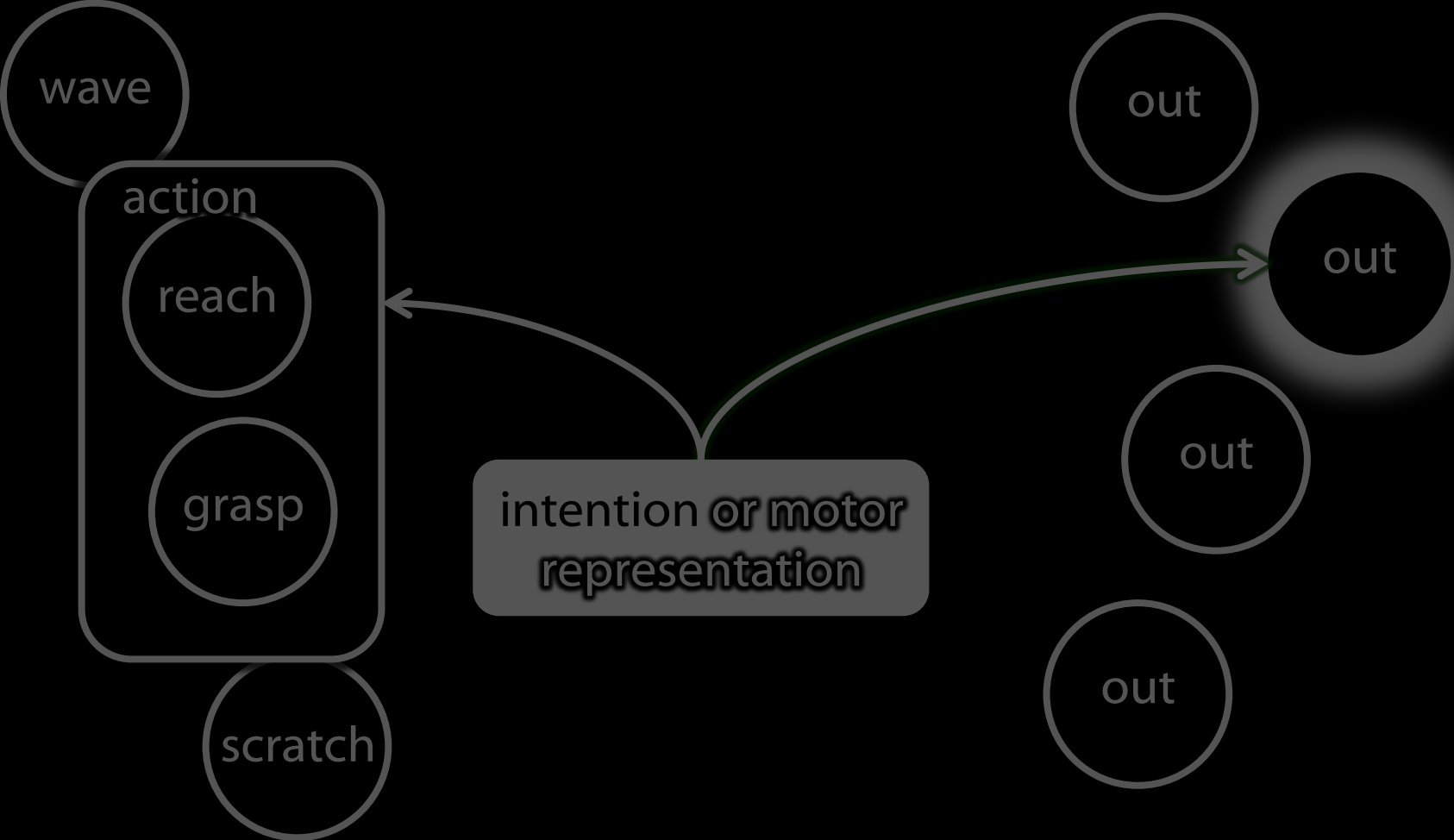
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How could social motor  
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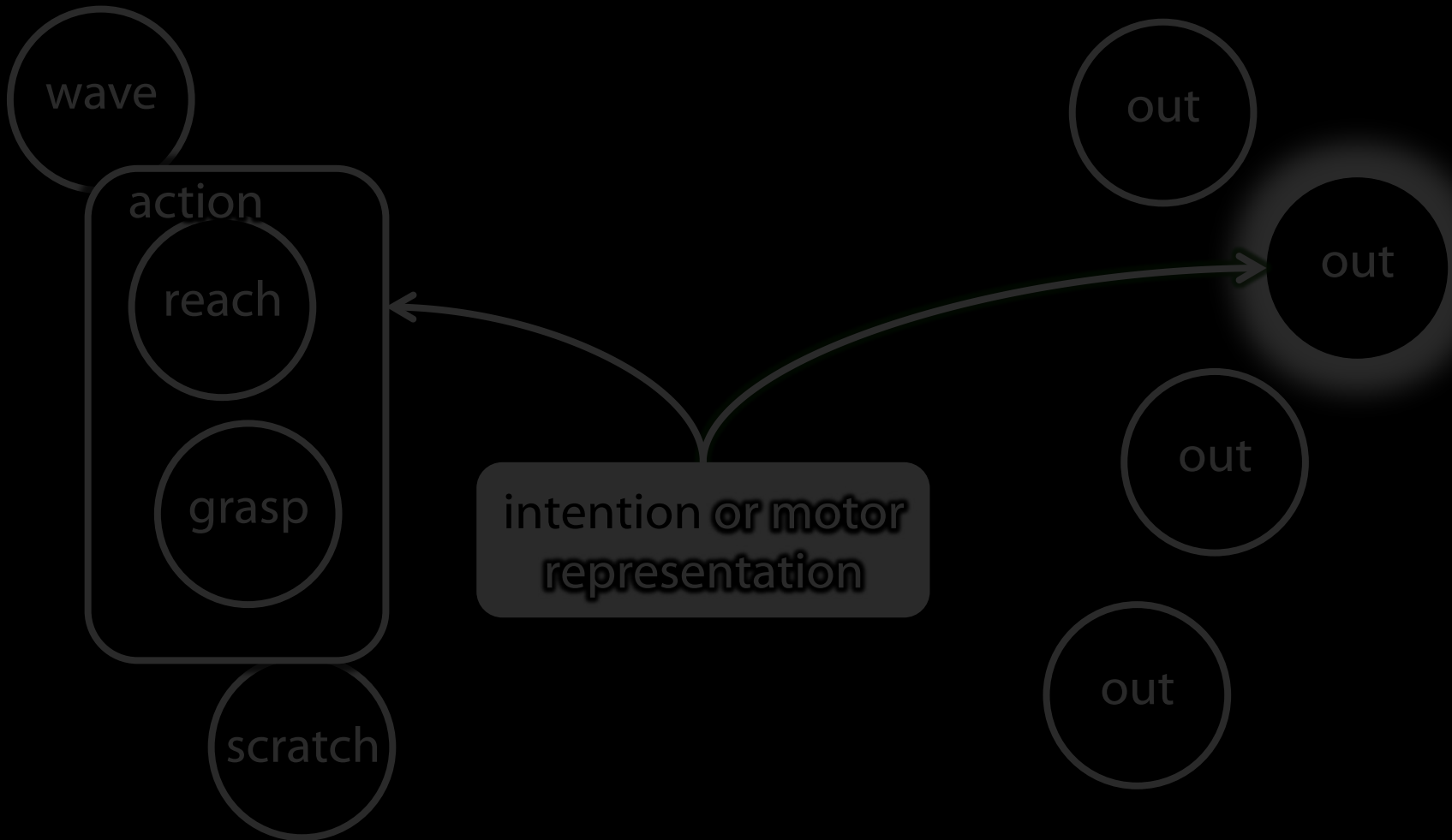
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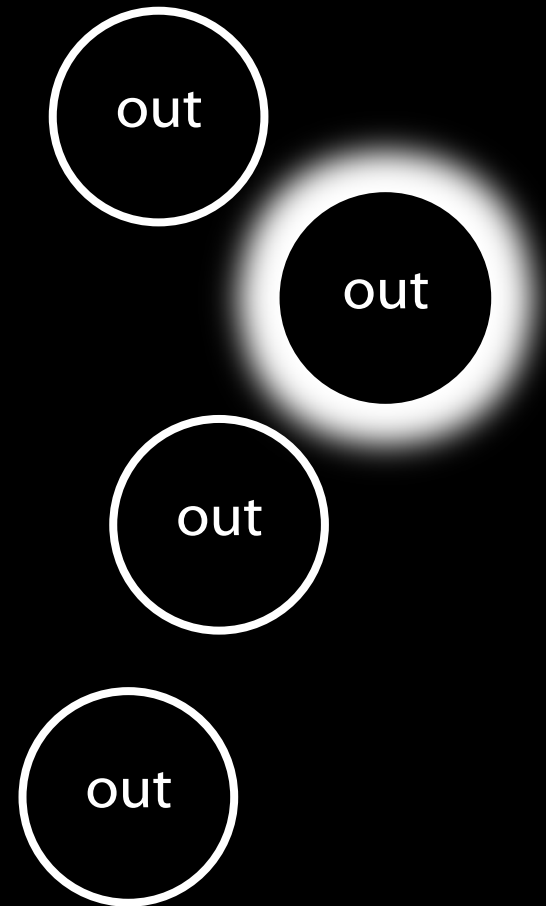
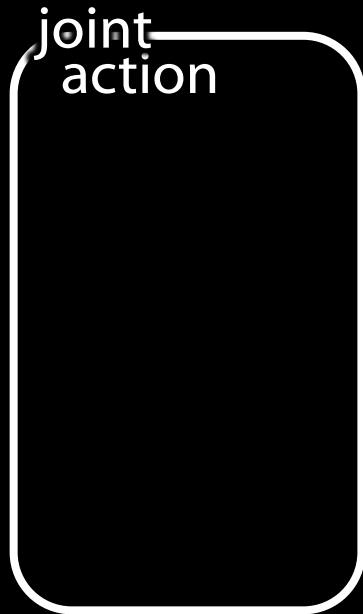
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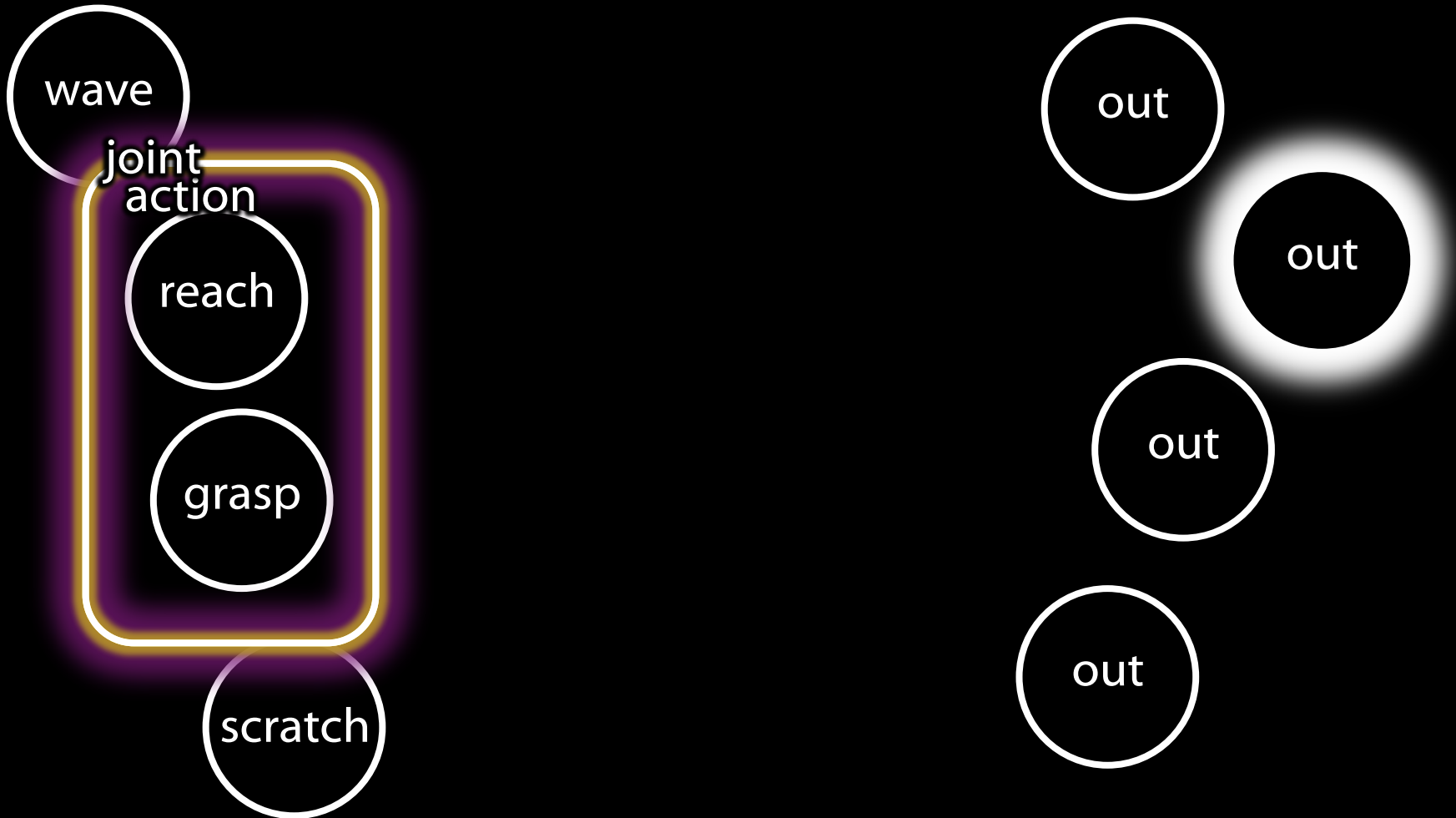
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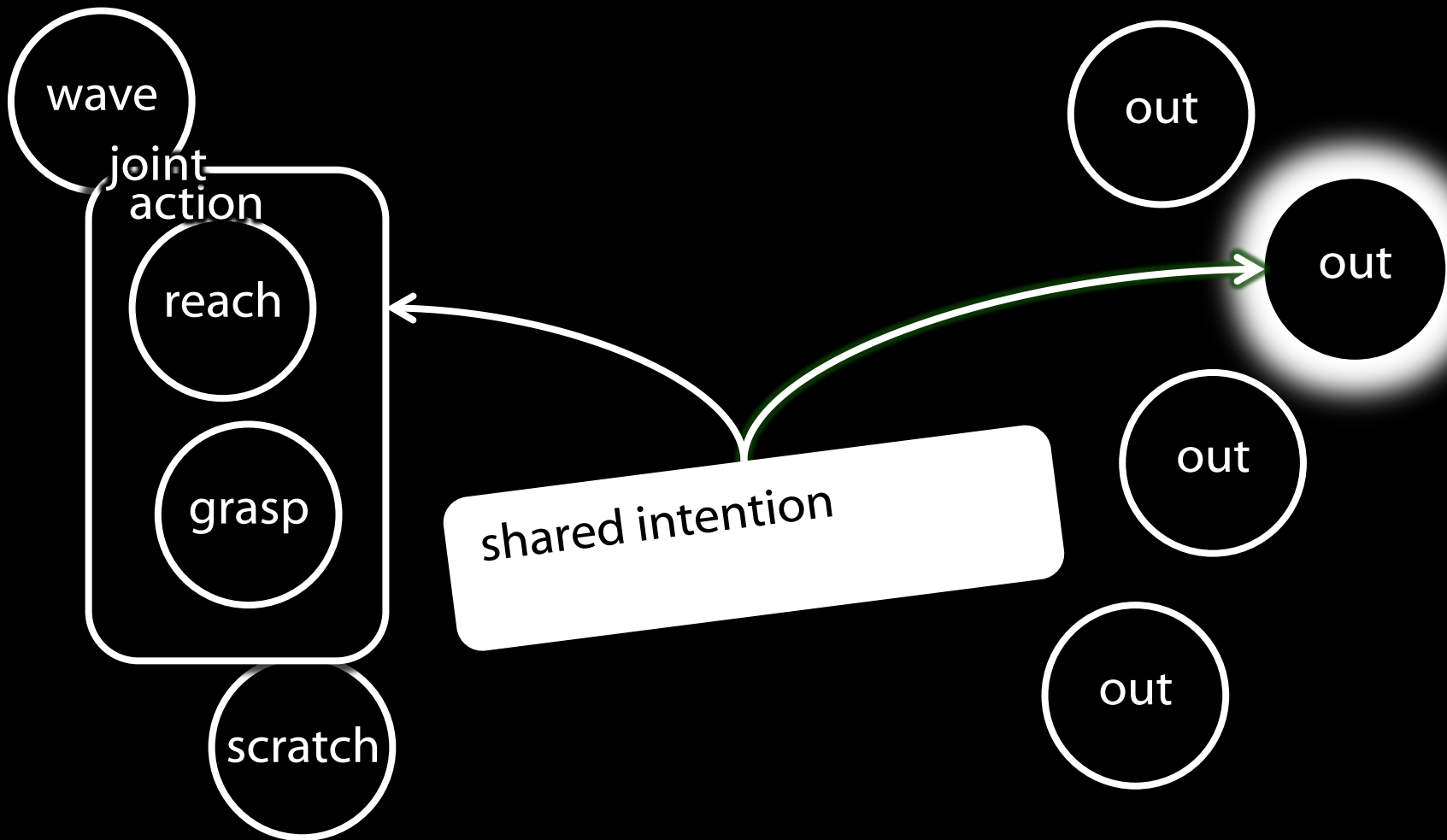


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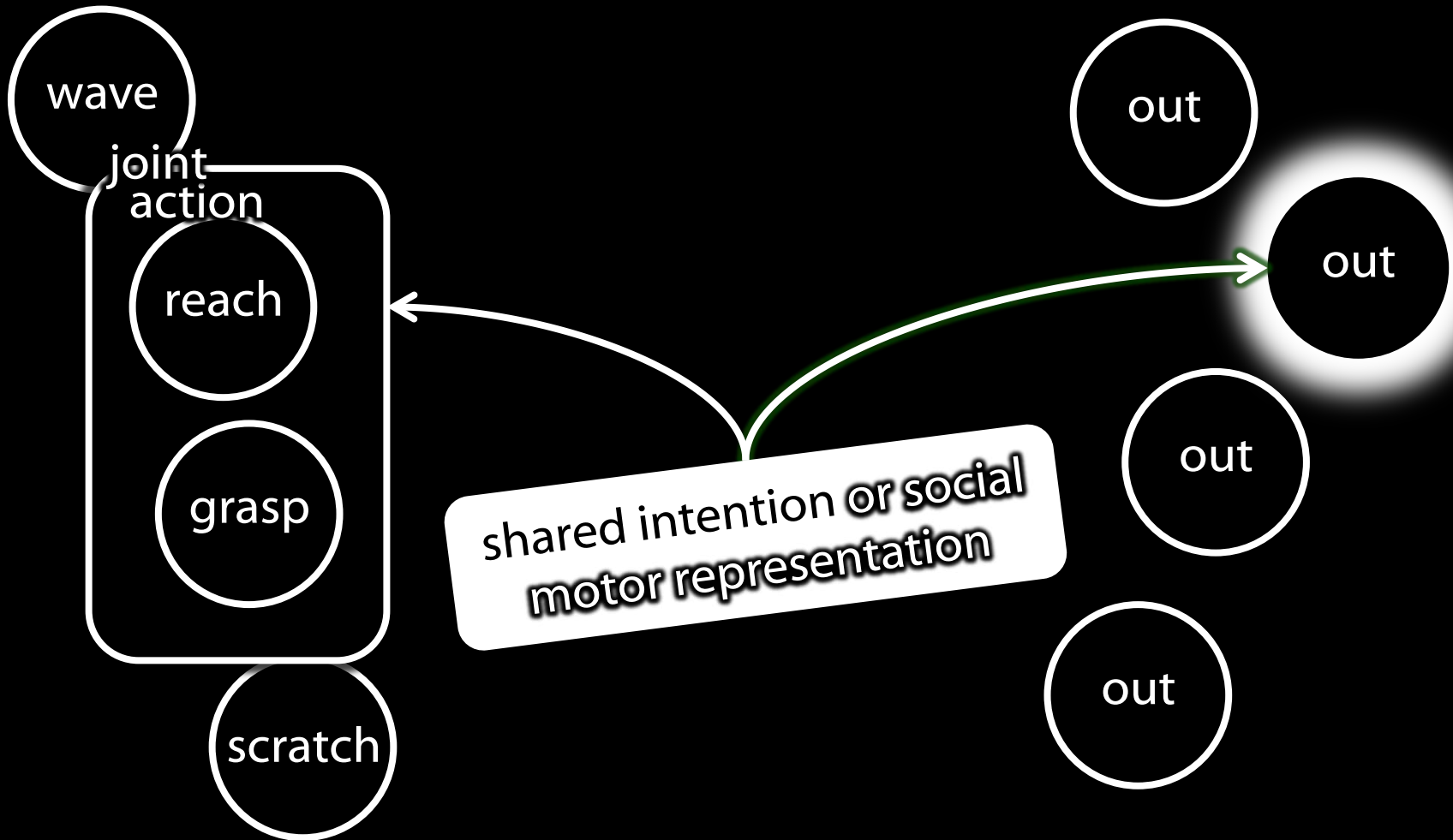




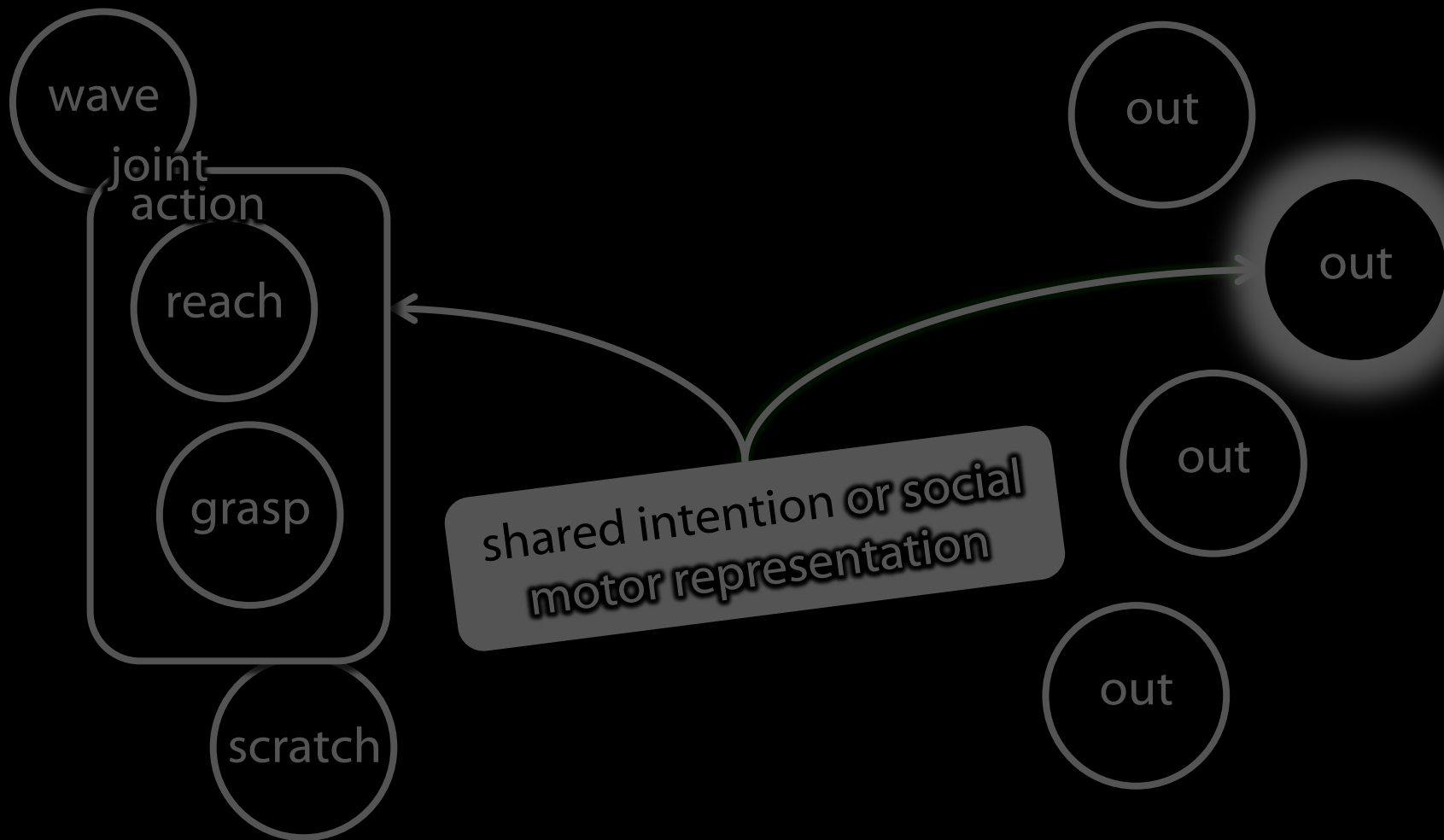
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Goal-directed joint action: an event with two or more agents which, taken as a whole, is directed to a goal.

G is a distributive goal: it is an outcome to which each agent's actions are individually directed and it is possible that: all actions succeed relative to this outcome.

G is a collective goal

- (a) it is a distributive goal;
- (b) the actions are coordinated; and
- (c) coordination of this type would normally facilitate occurrences of outcomes of this type.

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G is a collective goal

(a) it is a distributive goal;

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(c) coordination of this type would normally facilitate occurrences of outcomes of this type.

The agents have reciprocal, agent-neutral motor representations of the outcome which is the distributive goal.

Each expects the other to do part of the action.

## Sufficient conditions

We have a shared intention that we J if

“1. (a) I intend that we J and  
(b) you intend that we J

“2. I intend that we J in accordance with and because of Ia, Ib, and meshing subplans of Ia and Ib; you intend [likewise] ...

“3. 1 and 2 are common knowledge between us”

(Bratman 1993:View 4)



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“it seems reasonable to suppose that in shared intention the fact that each has the relevant attitudes is itself out in the open, is public.”

(Bratman 1993 [1999], p. 117)



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question:

Does reciprocal agent-  
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representation also play a  
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challenge:

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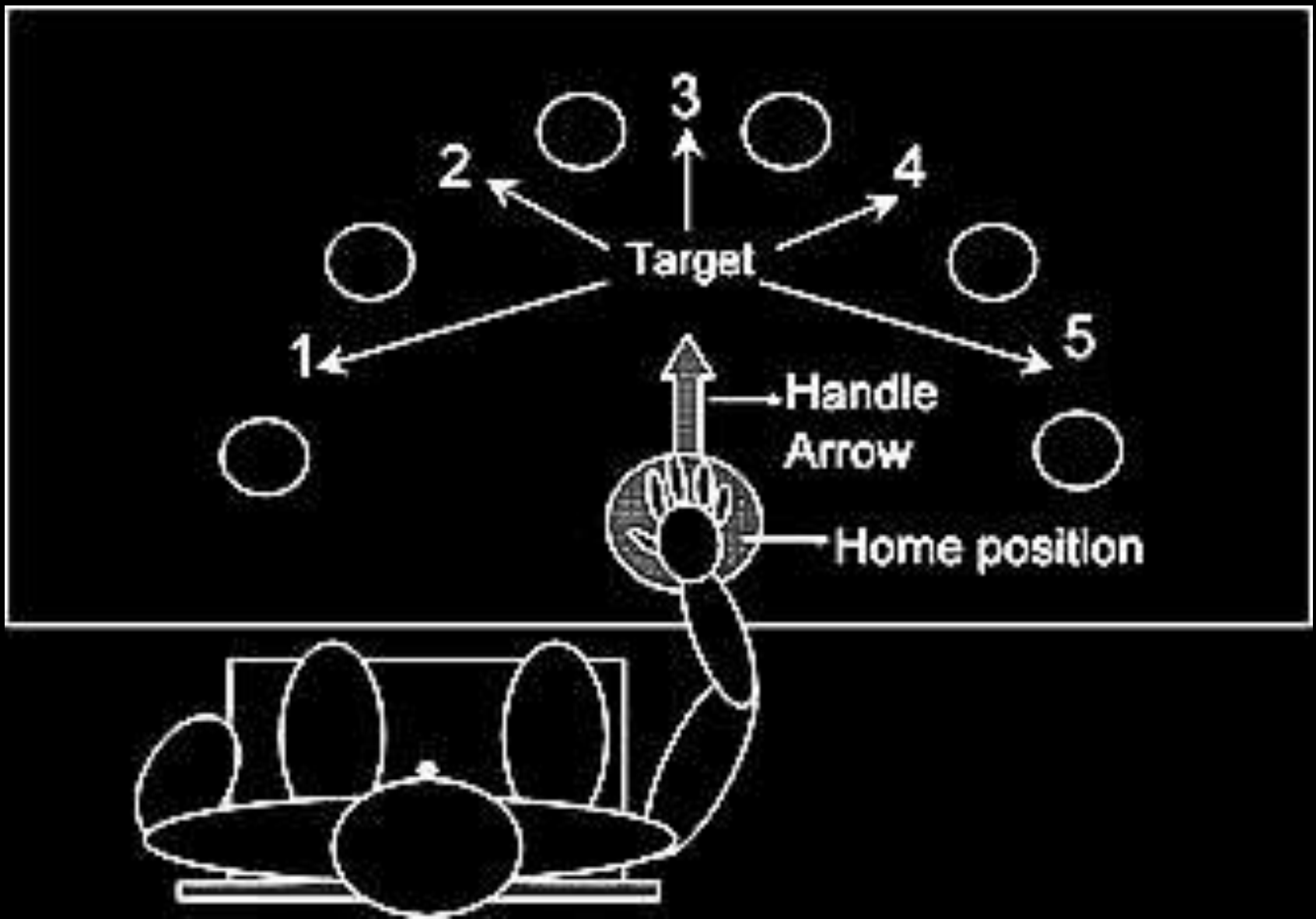
How could social motor  
representation and  
shared intention

reciprocal agent-neutral  
motor representation  
= shared intention?

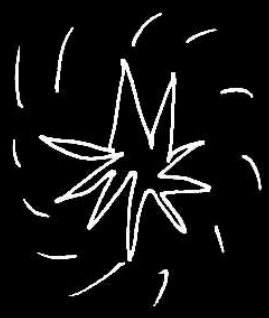


What are intentions for?

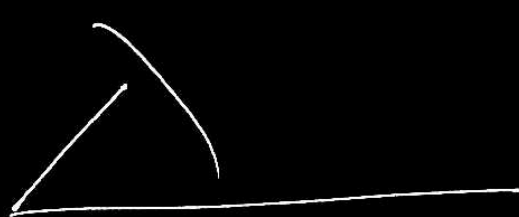
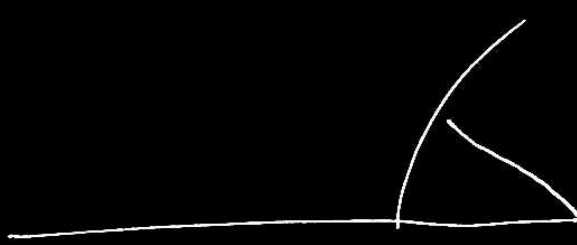




(Zhang and Rosenbaum 2007)



(big reward)



↑  
ONE WAY

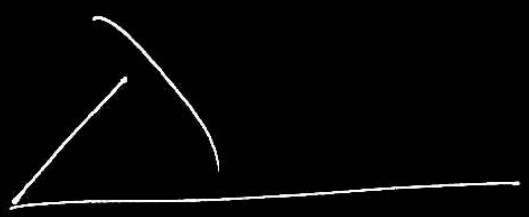
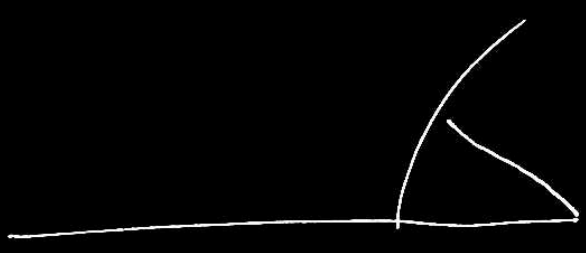


x start here

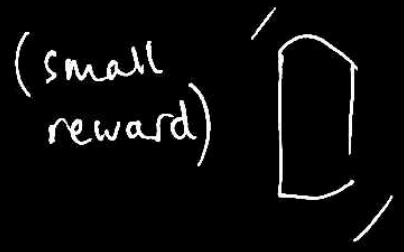
shared  
What are intentions for?  
人



(big reward)



↑  
ONE WAY



x start here

moving an object together

(Kourtis et al 2010)

tidying up the toys together

(Behne et al 2005)

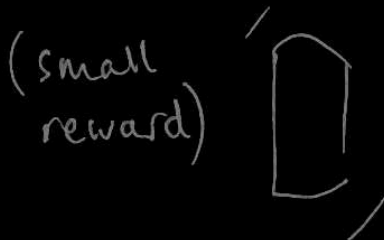
cooperatively pulling  
handles in sequence to  
make a dog-puppet sing

(Brownell et al 2006)

bouncing a cube on a large  
trampoline together

(Tomasello & Carpenter 2007)

pretending to row a boat  
together



ONE  
WAY

X

start here

premise:

Reciprocal agent-neutral motor representation  
enables some joint actions

question:

Does reciprocal agent-  
neutral motor  
representation also play a  
role in explaining what  
joint action is? [Yes]

challenge:

How could social motor  
representation and  
shared intention

reciprocal agent-neutral  
motor representation  
= shared intention?



< different content >



< different content >

< different format >

Head southeast on Rue Cujas toward Rue Victor Cousin. Turn right onto Rue Saint-Jacques...



Take RER B and get out at the Luxembourg station, from there it's less than 5 minutes walk.





Head southeast on Rue Cujas toward Rue Victor Cousin. Turn right onto Rue Saint-Jacques...



Only representations with a common format can be inferentially integrated.


Any two intentions can be inferentially integrated in practical reasoning.

My intention that I visit Paris on Friday is a propositional attitude.

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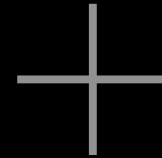
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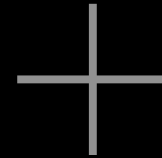
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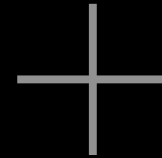
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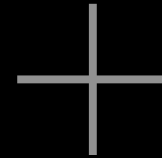
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# The Interface Problem

# The Interface Problem

Some joint actions involve both shared intention and reciprocal agent-neutral motor representation

# The Interface Problem

Reciprocal agent-neutral  
motor representations:

i. represent outcomes;

ii. ground the  
purposiveness of some  
joint actions

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## The Interface Problem

Reciprocal agent-neutral motor representations:

i. represent outcomes;

ii. ground the purposiveness of some joint actions

Two outcomes, A and B, *match* in a particular context just if, in that context, either the occurrence of A would normally constitute or cause, at least partially, the occurrence of B or vice versa.

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## The Interface Problem: How are non-accidental matches possible?

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Reciprocal agent-neutral  
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(the constituent attitudes  
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Head southeast on Rue Cujas toward Rue Victor Cousin. Turn right onto Rue Saint-Jacques...



Follow *that* route

=



?

Follow *that* route

=



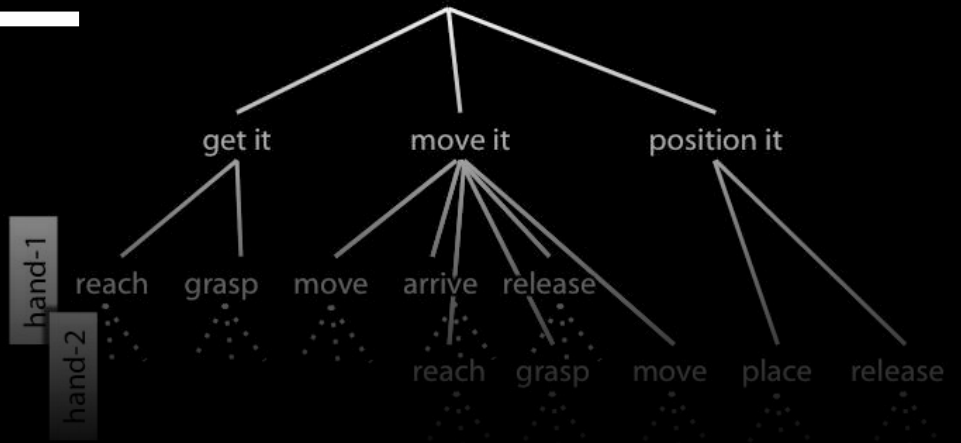
?

Do that

==

Move it from there to here

?



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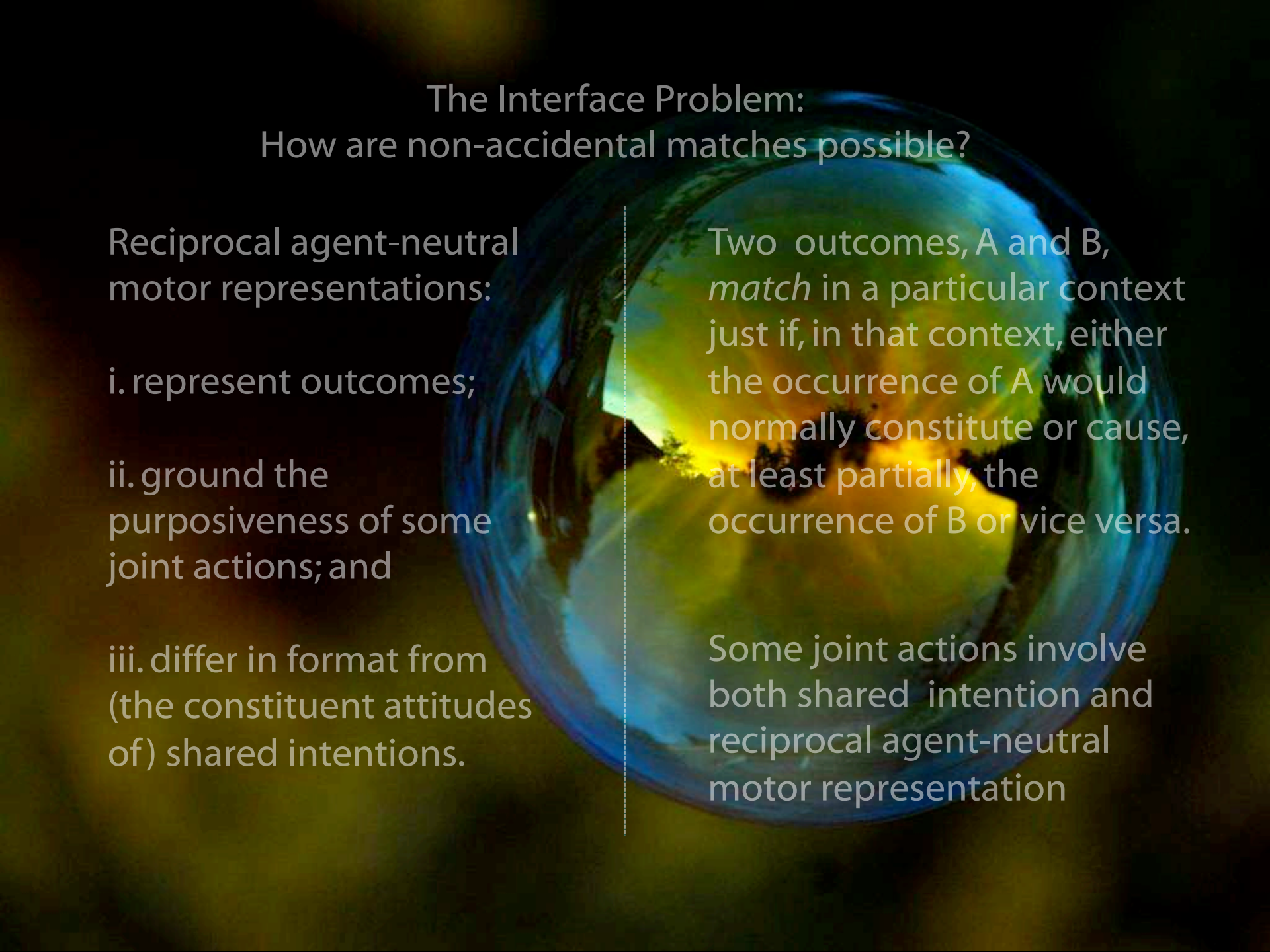
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# challenge

Explain the emergence, in evolution or development, of sophisticated forms of theory of mind cognition.

# conjecture

The existence of abilities to engage in joint action partially explains how sophisticated forms of theory of mind cognition emerge in evolution or development (or both)

# 2<sup>nd</sup> objection

Joint action presupposes sophisticated theory of mind cognition