

Ingredients of Joint Action: A View from Cognitive Psychology

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European Research Council
Established by the European Commission

Views of Joint Action

Prominent philosophical theories addressing joint action focus on shared intentions (Bratman, 2015) and postulate that common knowledge of our individual intentions to perform a joint action is a prerequisite for joint action (1993).



Such theories have provided a useful 'benchmark' in developmental and comparative research that sought to establish what makes human joint action special compared to social interactions in other species (Tomasello, 2008).



Philosophical theories of joint action also have the advantage of providing a sound conceptual system that connects to normative and ethical issues.

This is not a Joint Action



Views of Joint Action

Solely focusing on shared intentions may be problematic for HRI research

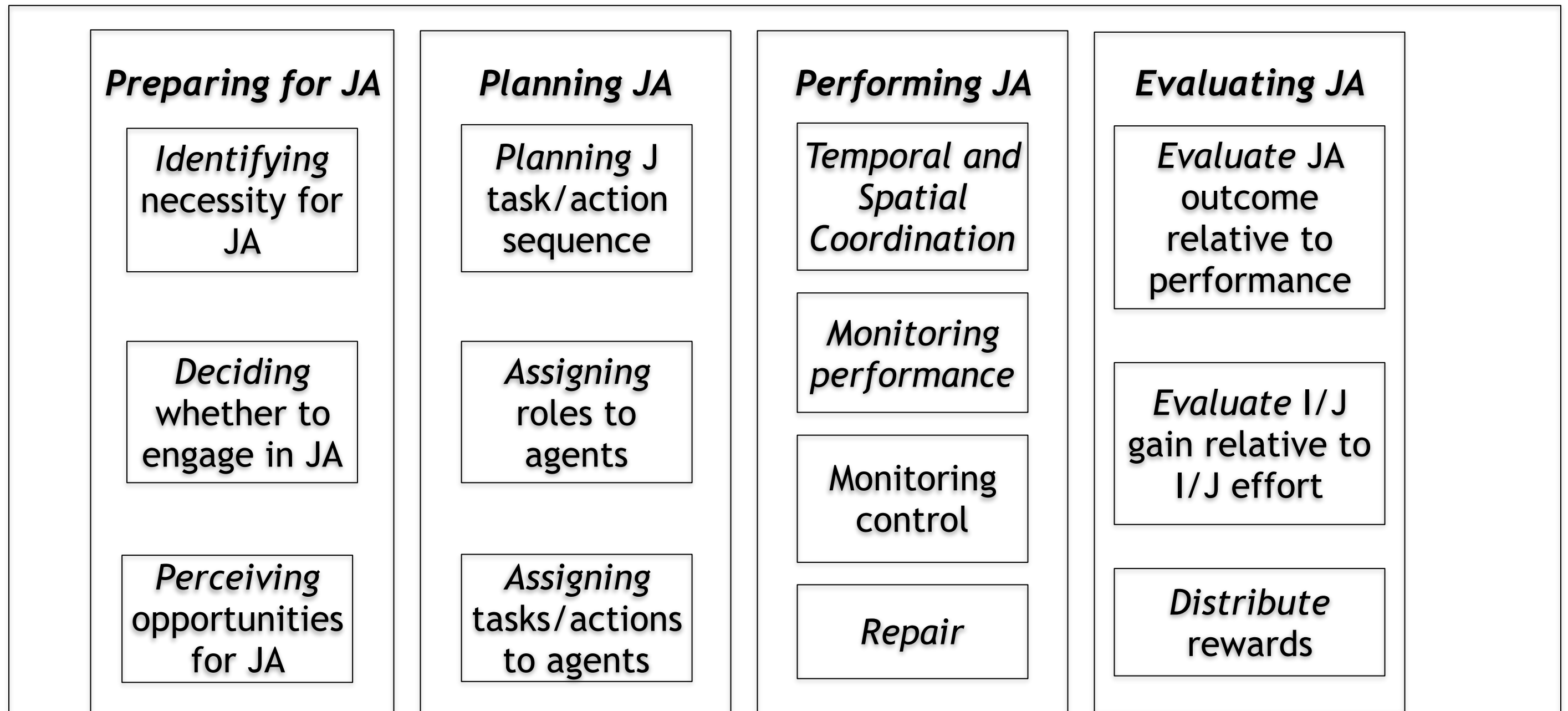
Such a focus provides few clues to the processes involved in preparing, planning, performing, remembering, learning... joint actions

It may be useful for HRI to work with a wider definition of joint action that focuses on coordination: *A joint action is a social interaction whereby two or more individuals coordinate their actions in space and time to bring about a change in the environment* (Knoblich, Butterfill, & Sebanz, 2011).

This shifts the focus to questions such as:

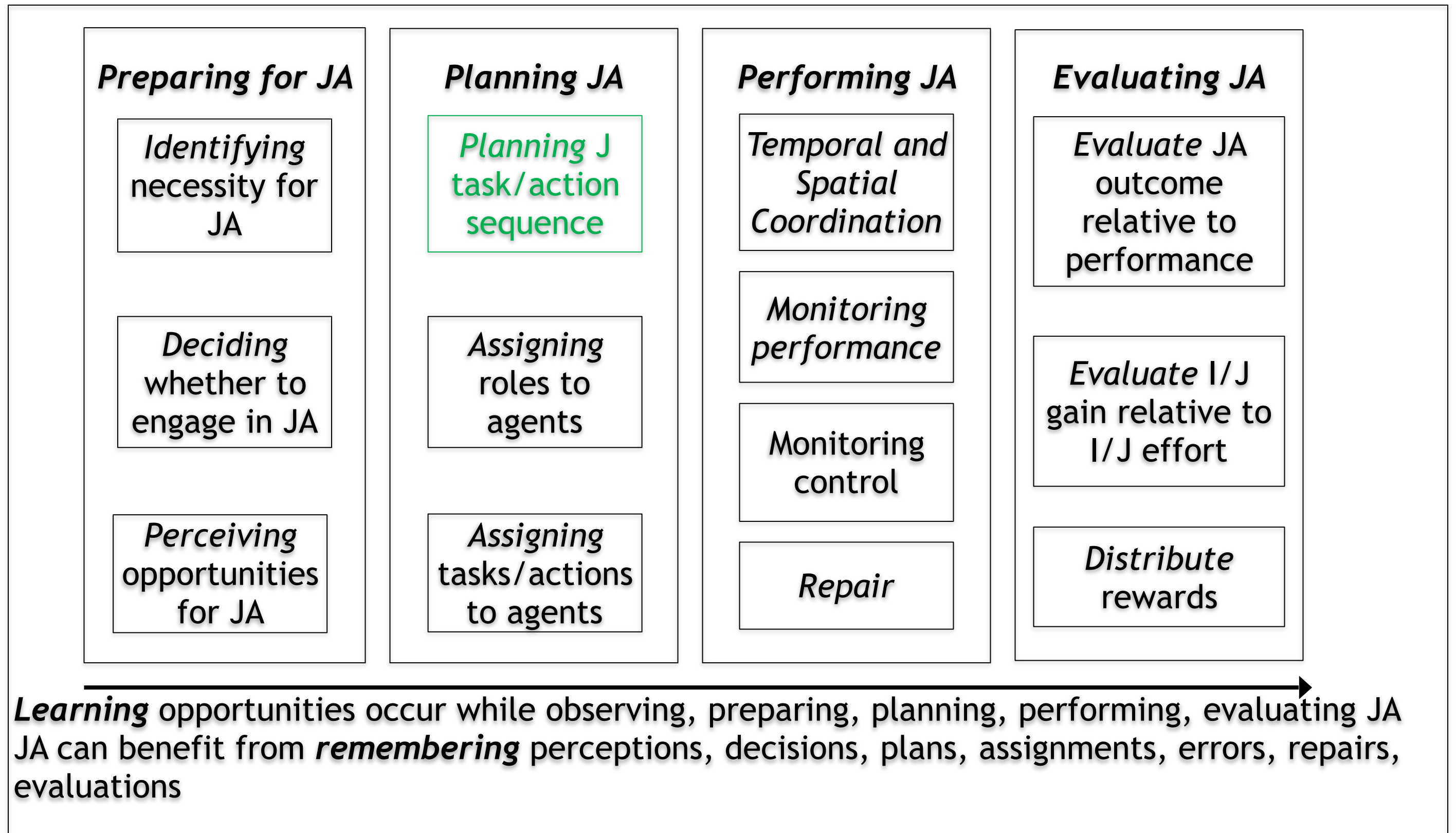
- What are the cognitive and brain processes that enable individual humans to engage in joint action?
- Are there cognitive processes that are specifically dedicated to perceiving, preparing, planning, controlling, performing joint actions?

Overview of Some Relevant Processes



Learning opportunities occur while observing, preparing, planning, performing, evaluating JA
JA can benefit from **remembering** perceptions, decisions, plans, assignments, errors, repairs, evaluations

Some Examples of Our Current Research



Relational Planning in Joint Action?

(Kourtis, Knoblich, Sebanz, submitted)



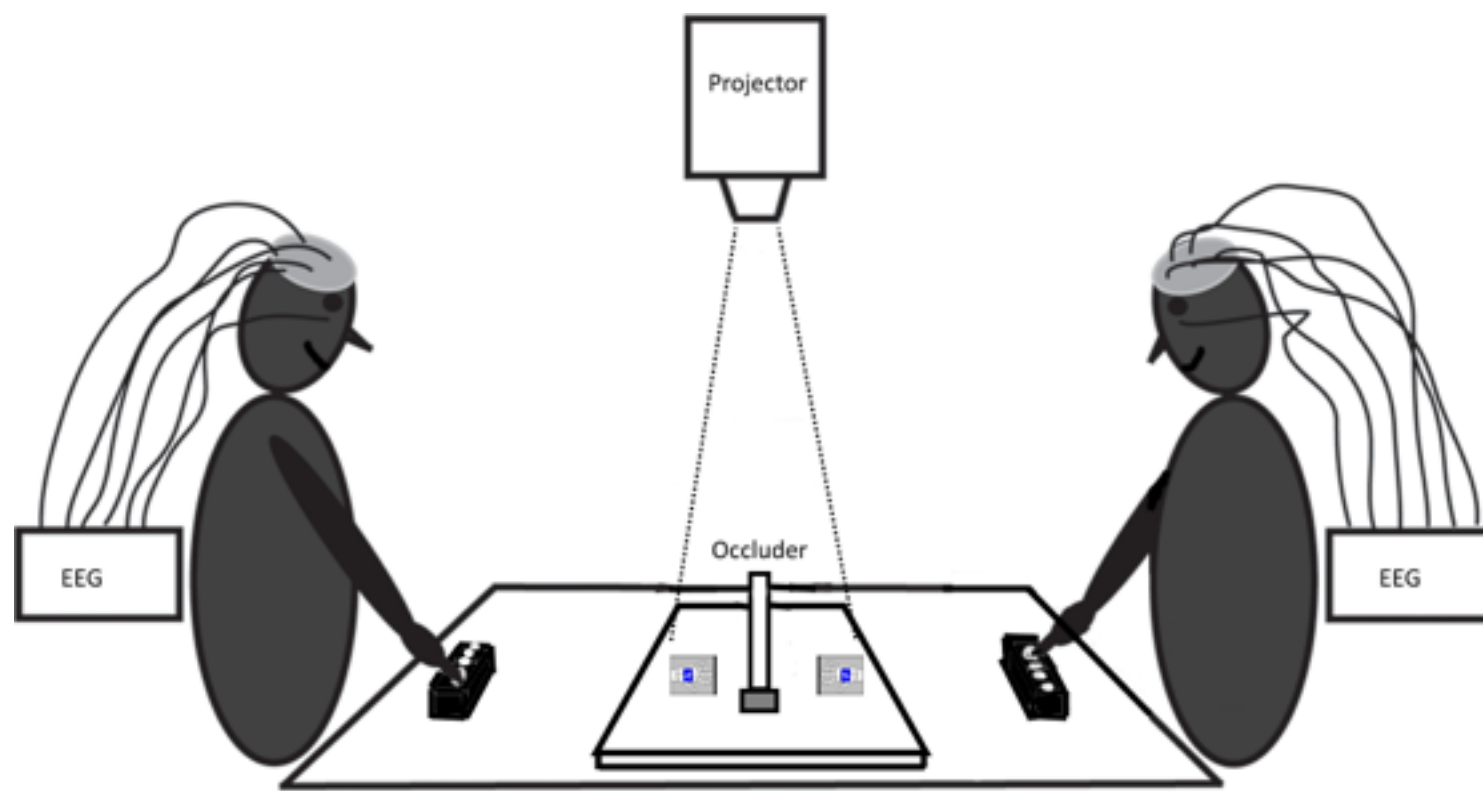
It is known that humans tend to co-represent each other's actions and tasks even if they don't need to (Sebanz et al., 2003; 2005)

It is also known that co-actors represent others' actions in a similar way to their own while preparing for joint action (Kourtis et al., 2013; 2014)

Do co-actors form action plans that reflect the action capabilities of the team and the relation between their own and their partners' actions?

Relational Planning in Joint Action?

(Kourtis, Knoblich, Sebanz, submitted)

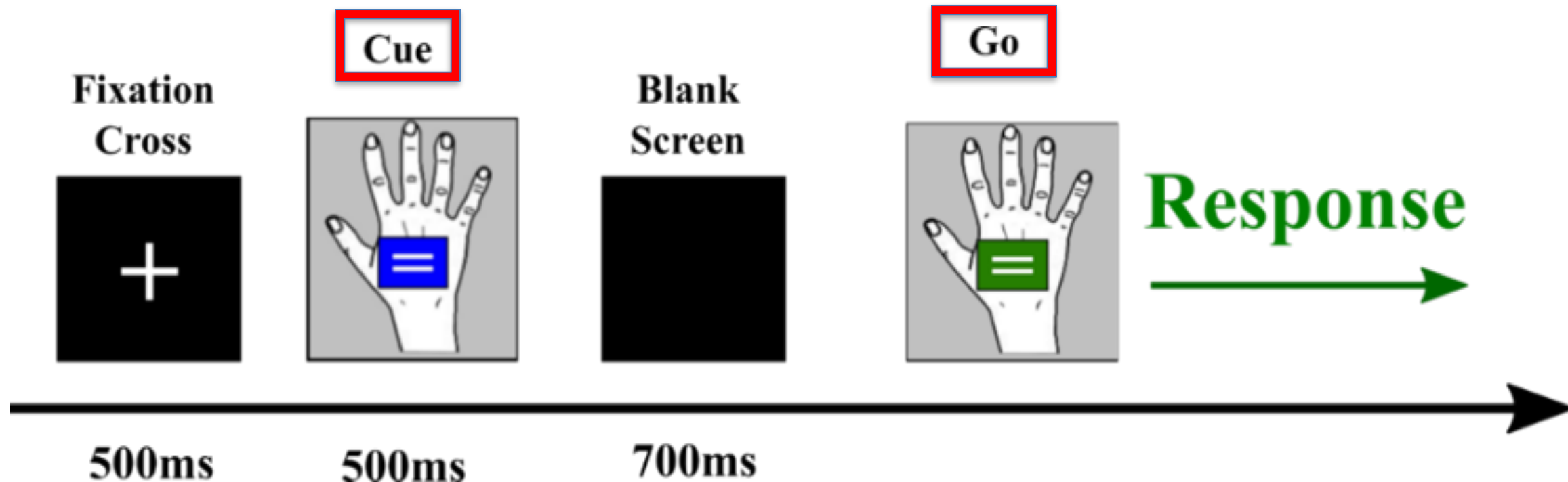


Task: Form a hand gesture (palm in or palm out) at the same time as your partner.

This produced joint configurations involving the same or a different gesture from each partner

Cueing Procedure

(Kourtis, Knoblich, Sebanz, submitted)



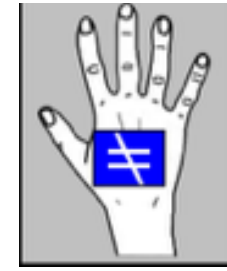
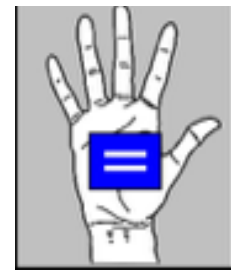
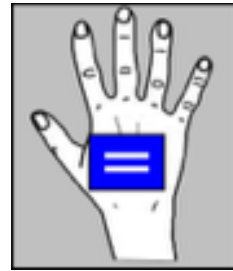
Cue provided advance info about joint configuration and/or individual action

Go Signal provided full info about configuration and individual action

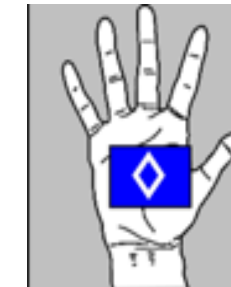
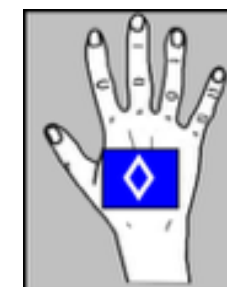
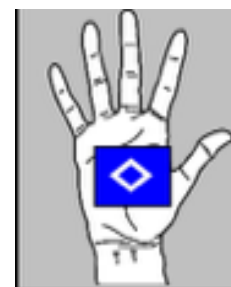
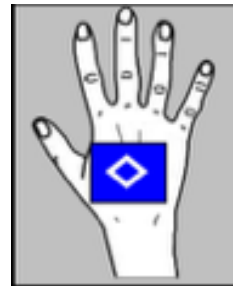
2x2 Design Varying Cue

(Kourtis, Knoblich, Sebanz, submitted)

J+ I+



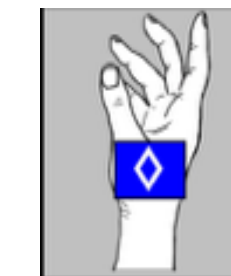
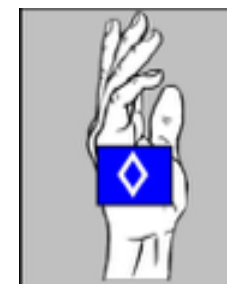
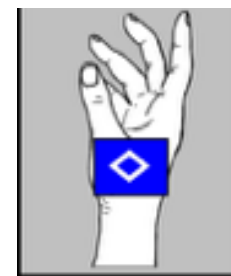
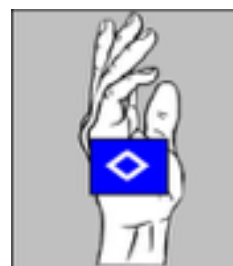
J- I+



J+ I-

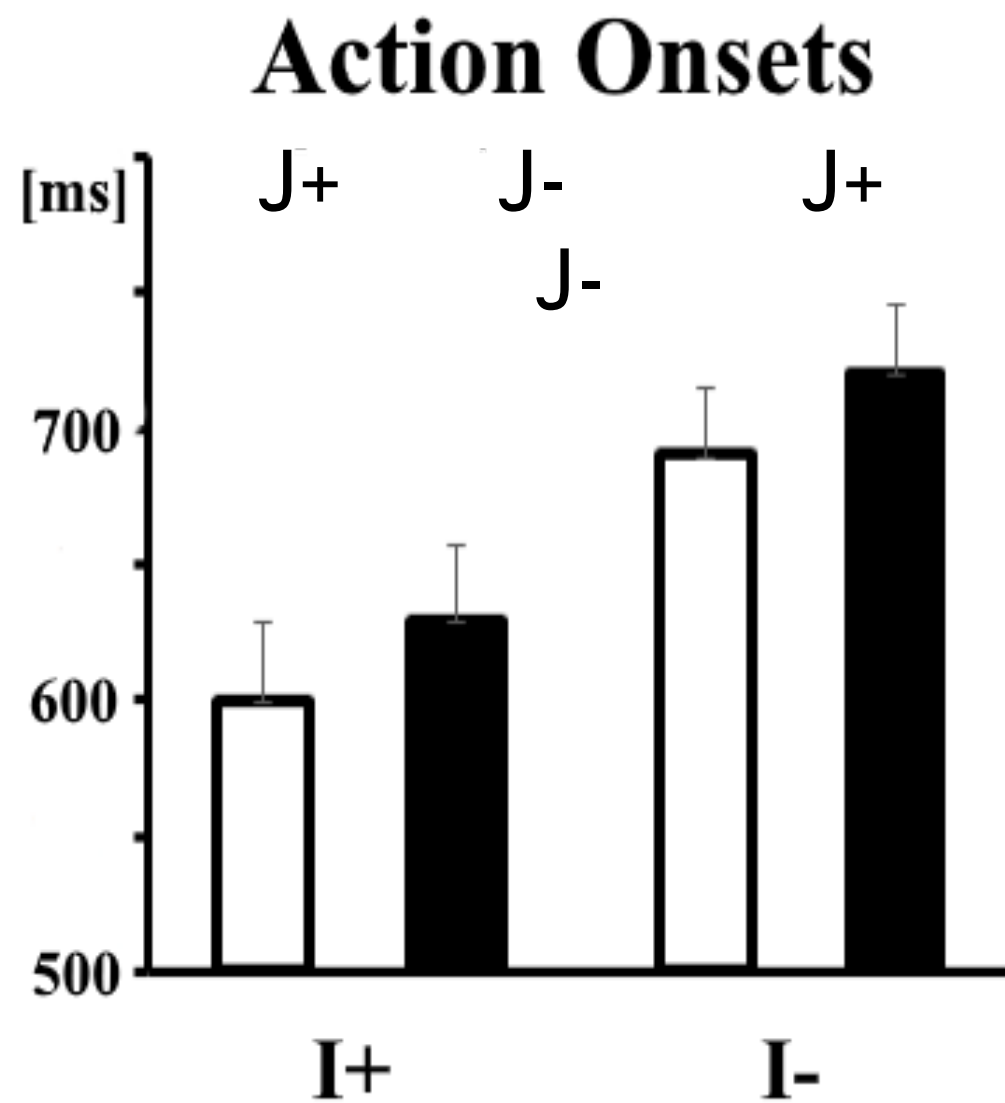


J- I-

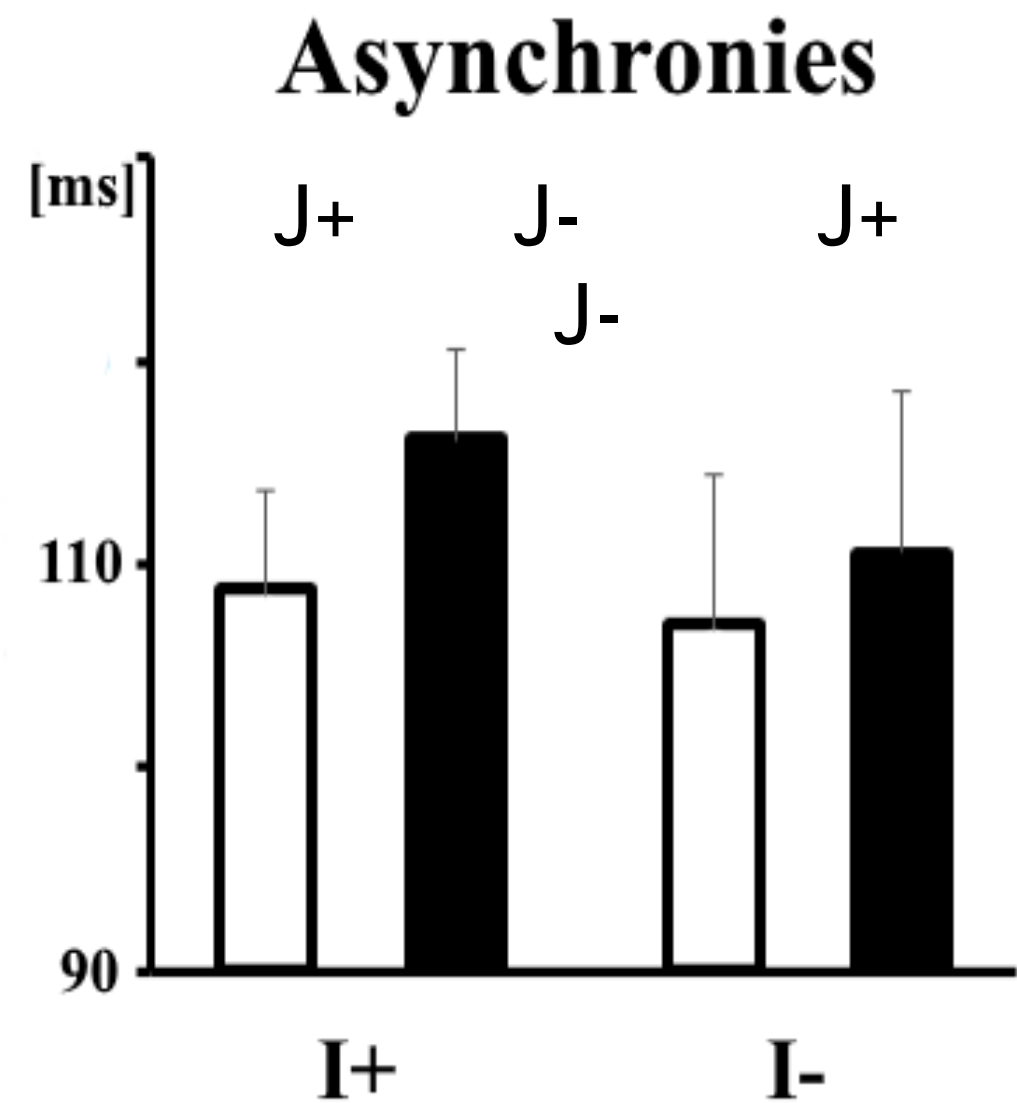


Behavioral Results

(Kourtis, Knoblich, Sebanz, submitted)



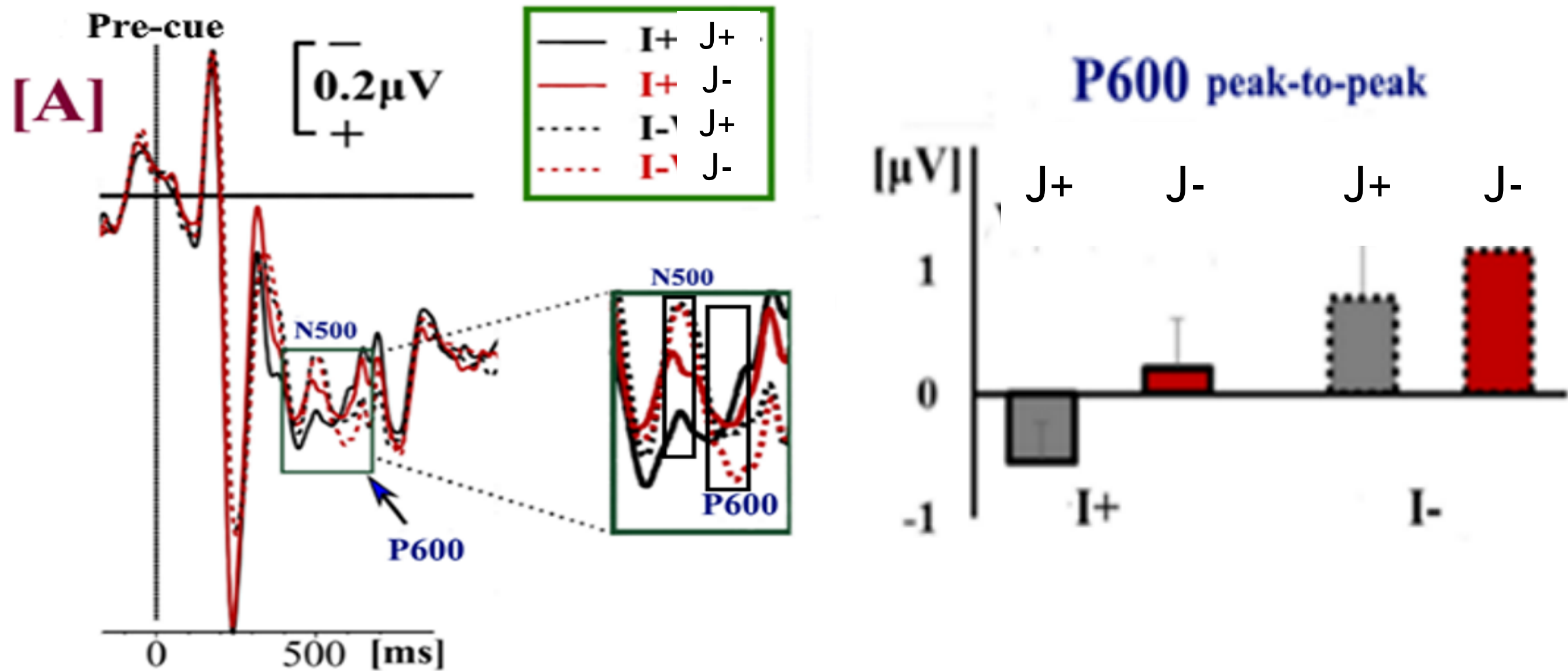
Cueing the joint configuration alone speeds up the action onset



Asynchronies in action onset slightly smaller if joint configuration cued

ERP Results: P600

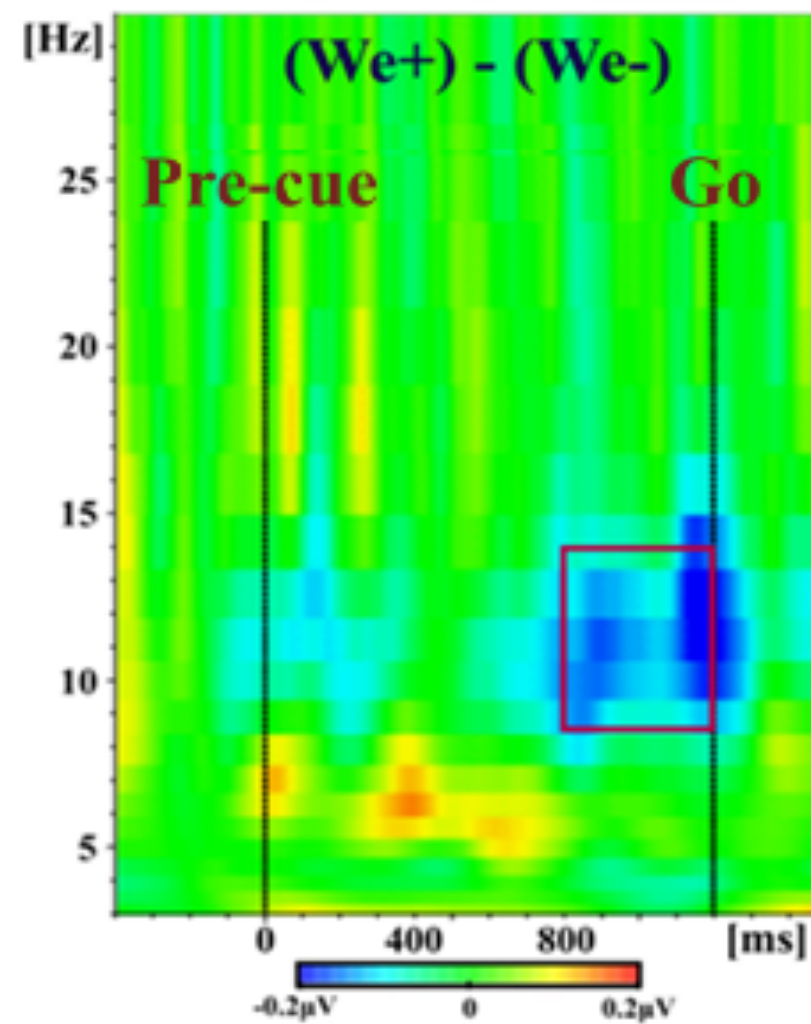
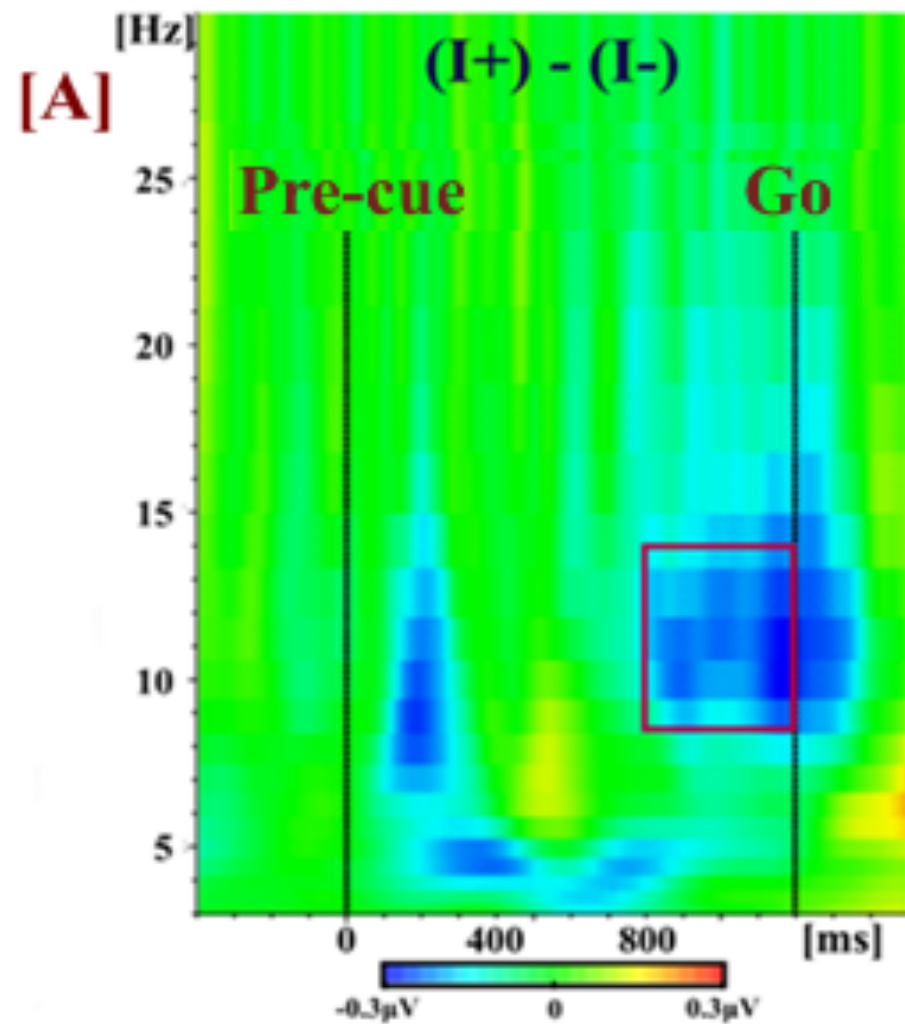
(Kourtis, Knoblich, Sebanz, submitted)



Specifying joint configuration reduces planning uncertainty. This indicates that all possible joint configurations are considered during planning. Otherwise a cue to joint configuration could not reduce uncertainty.

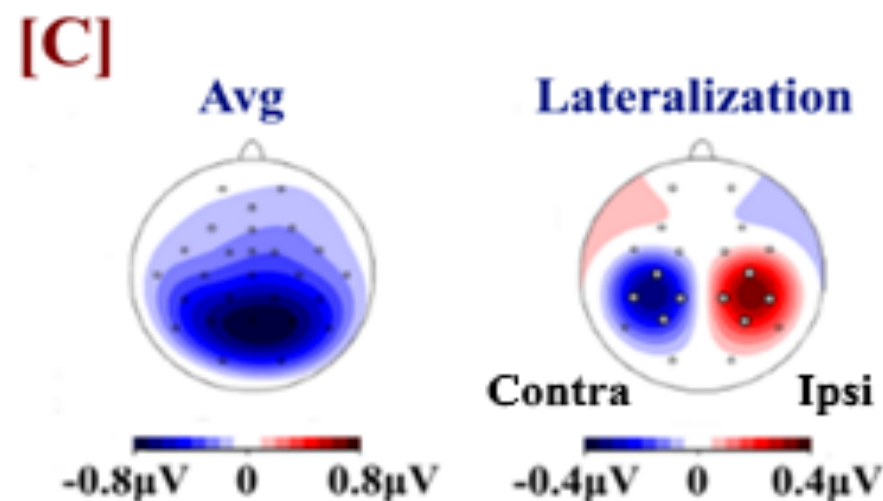
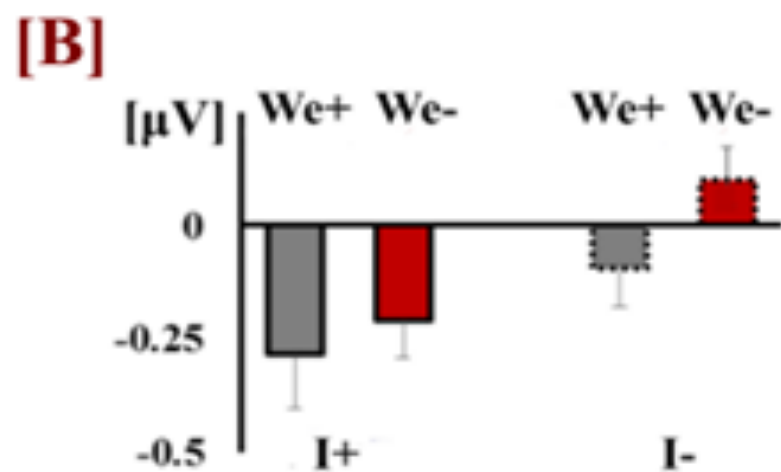
Mu suppression (We = J)

(Kourtis, Knoblich, Sebanz, submitted)



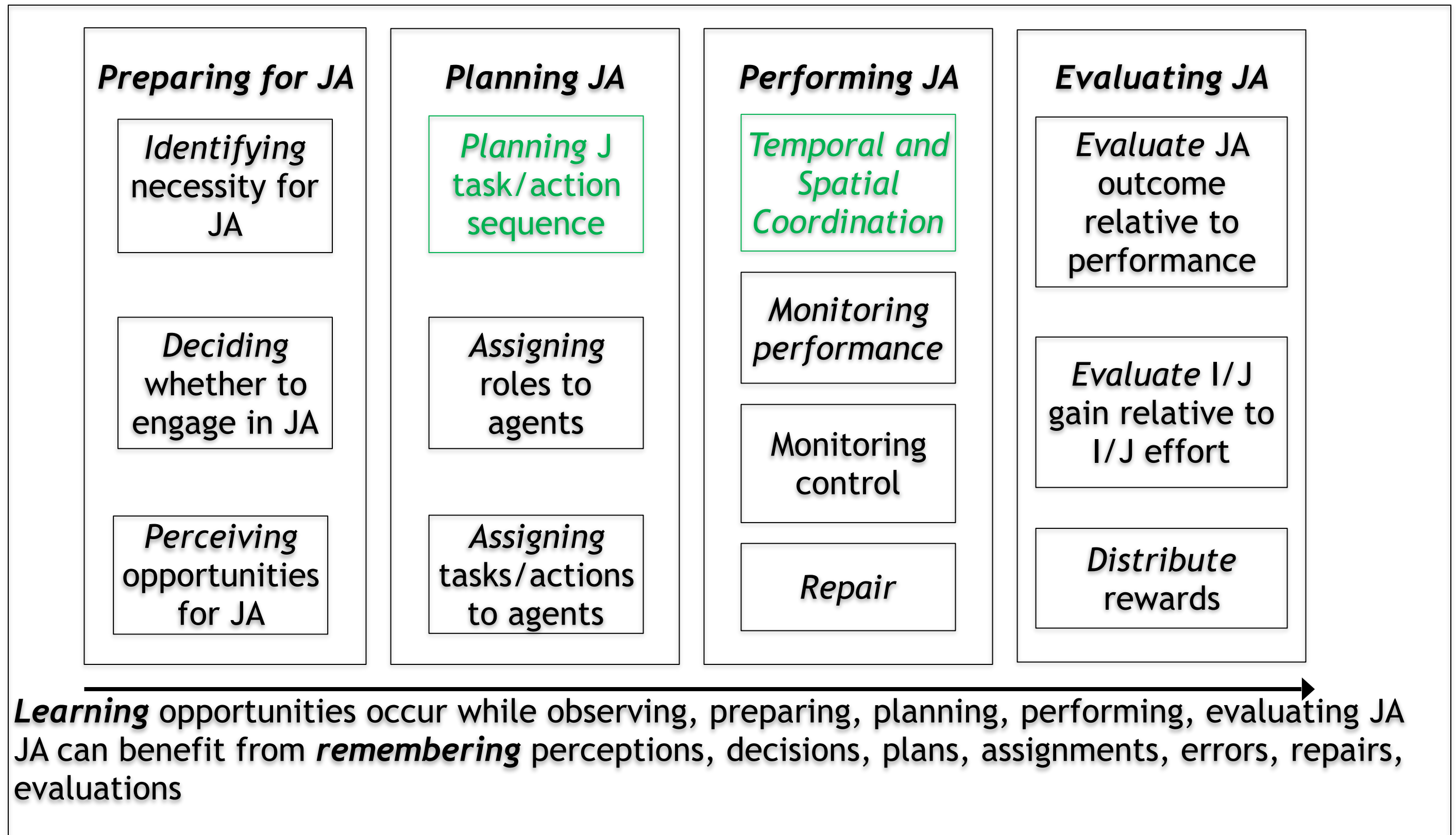
Cueing joint configuration led to enhanced mu suppression.

Specification of the joint configuration helped co-actors to prepare their motor system for action (A)



This was true even when individual actions were not specified (B)

Some Examples of Our Current Research



Leadership vs Reciprocity in JA Coordination

Previous research indicates that reciprocal information flow between equal co-actors enhances the quality of interpersonal coordination

This has been demonstrated for rhythmic finger tapping (Konvalinka et al., 2011)

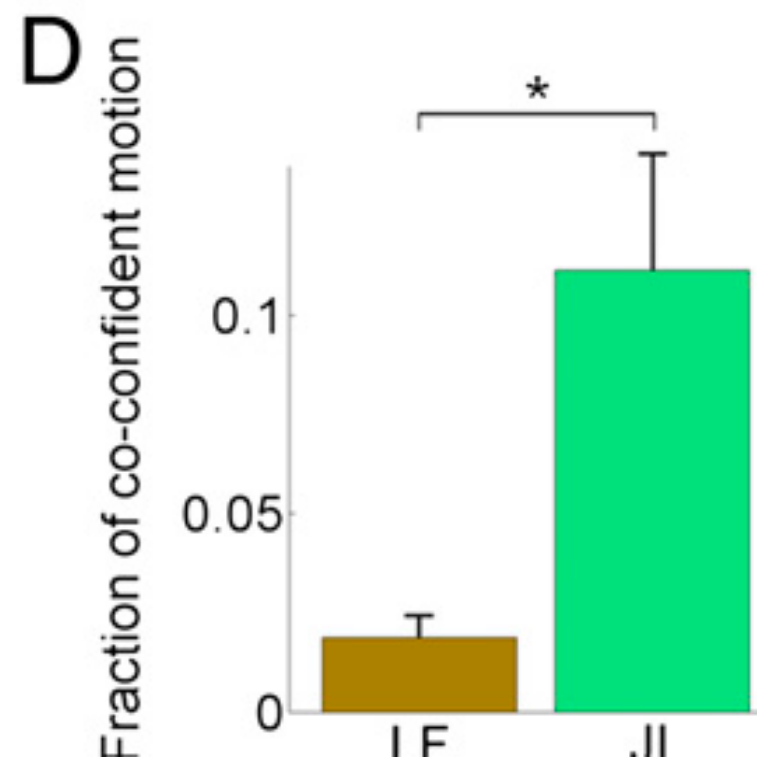
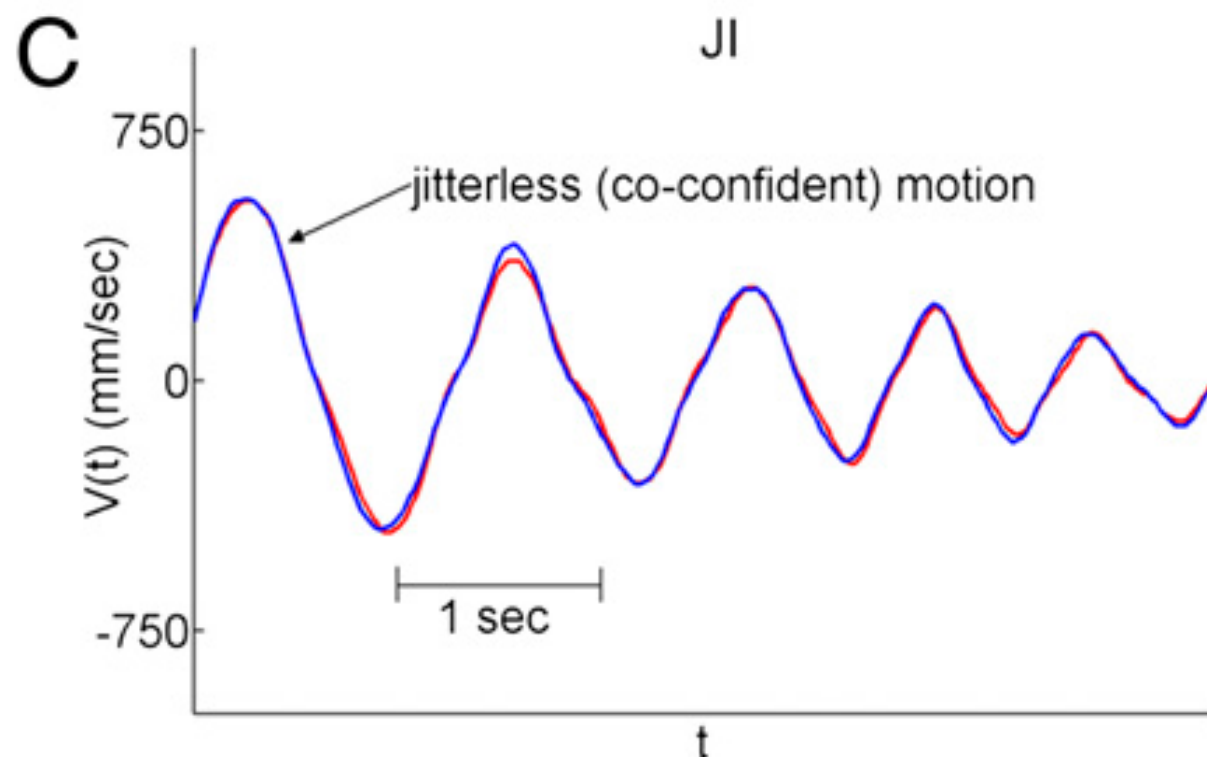
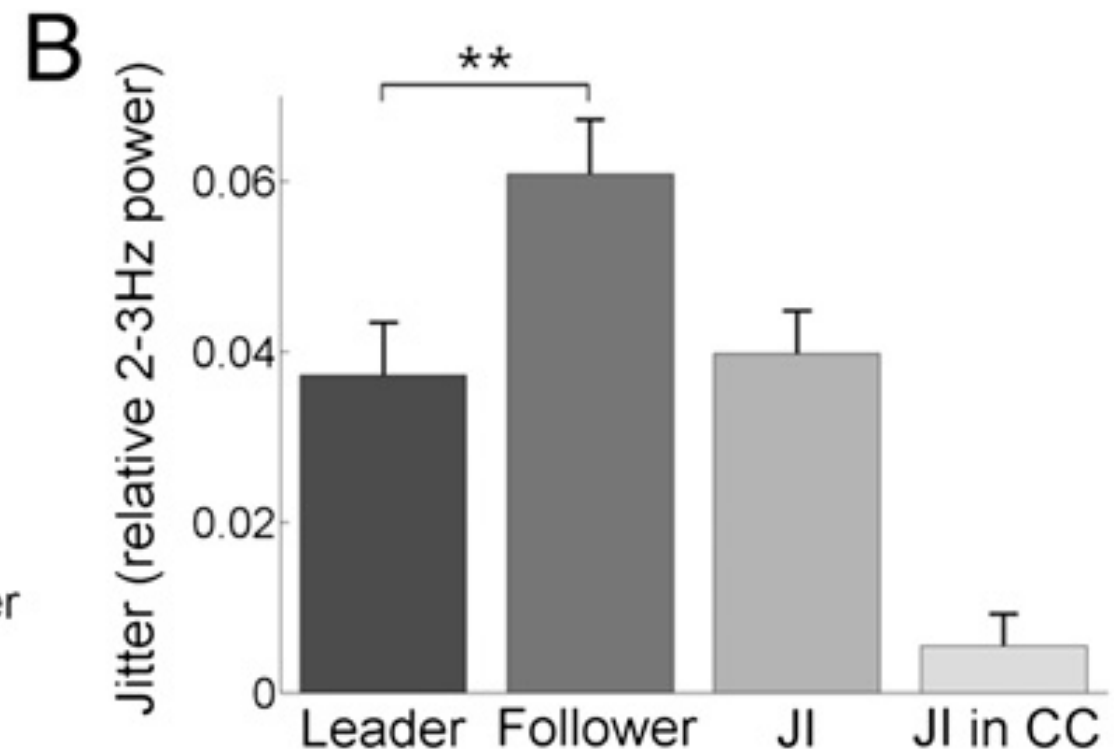
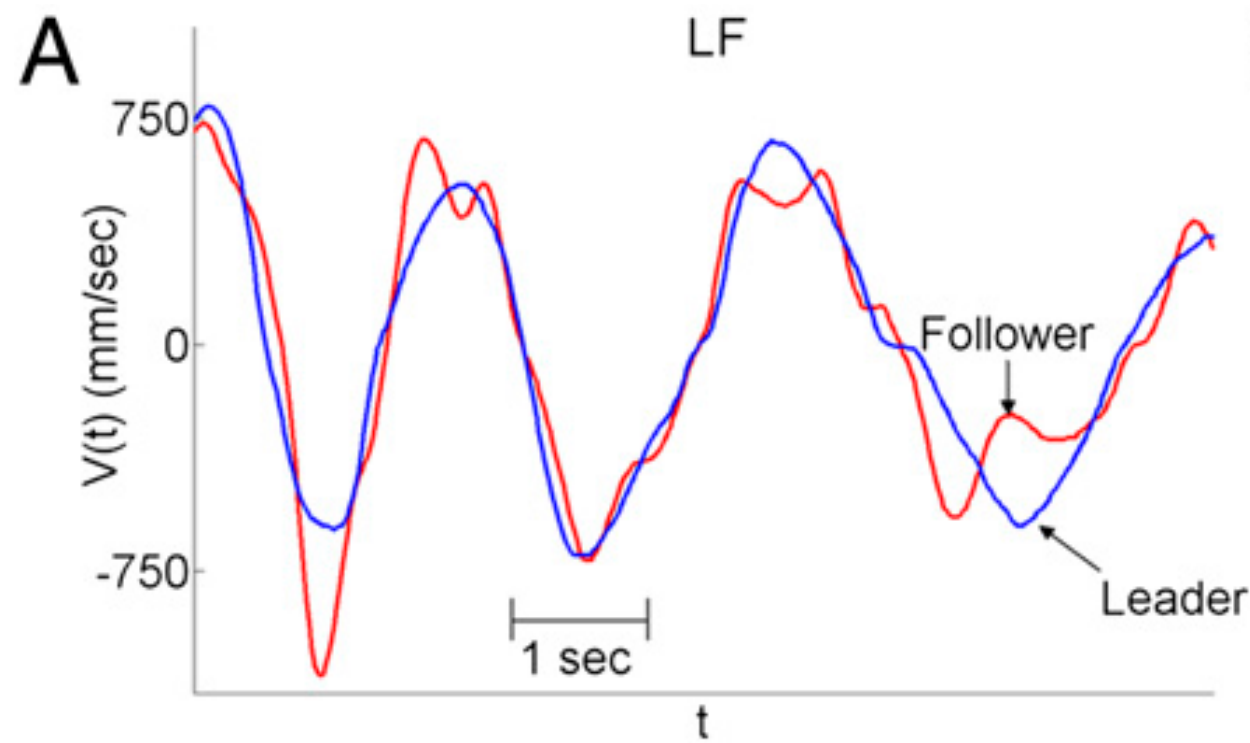
and

in the mirror game where two co-actors are asked to create interesting and synchronized motion together



Detrimental Effects of Role Distribution

Noy et al., 2011

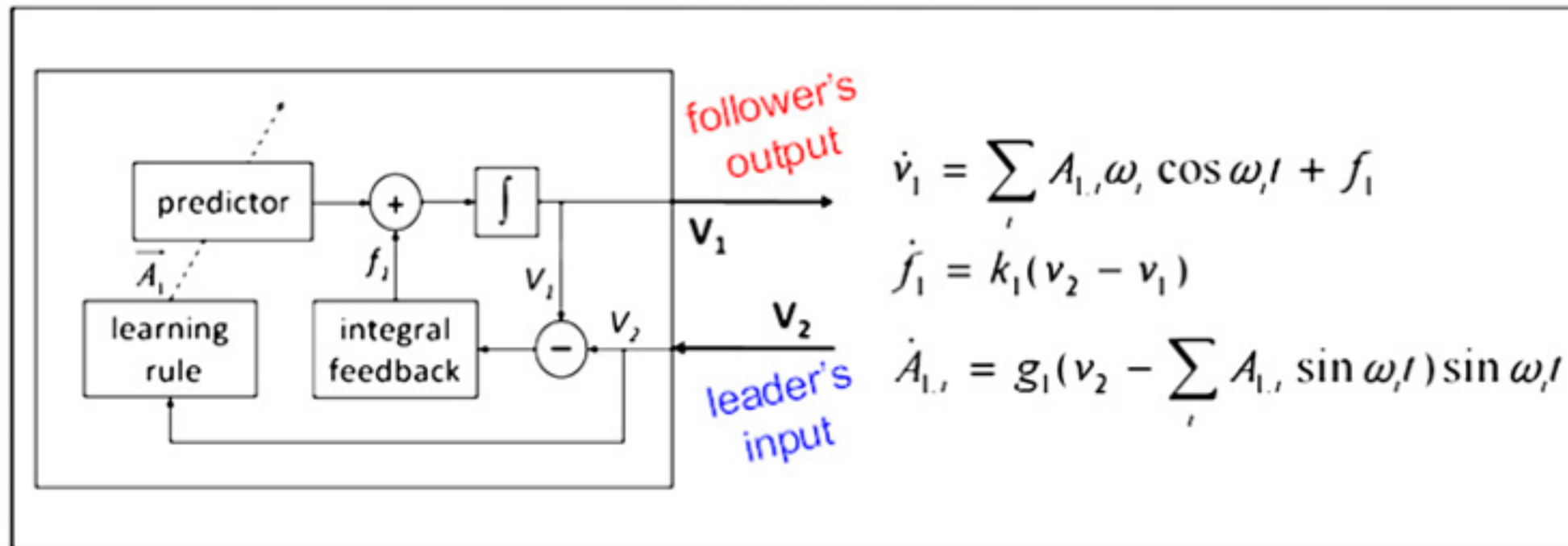


Coupled Predictors Improve Coordination

Noy et al., 2011

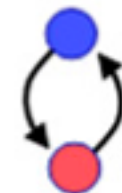
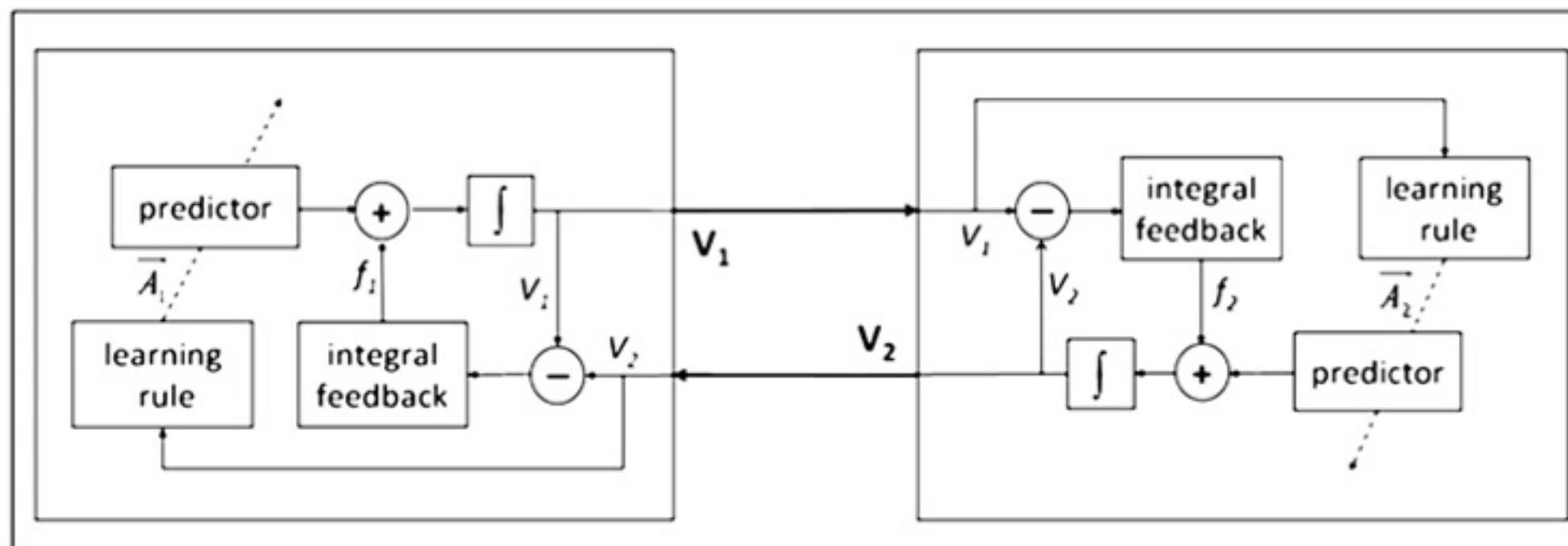
A

LF model



B

J1 model (mirror configuration)



Reciprocity and Role Distribution in JA Coordination

Curioni, Knoblich, & Sebanz (in revision)

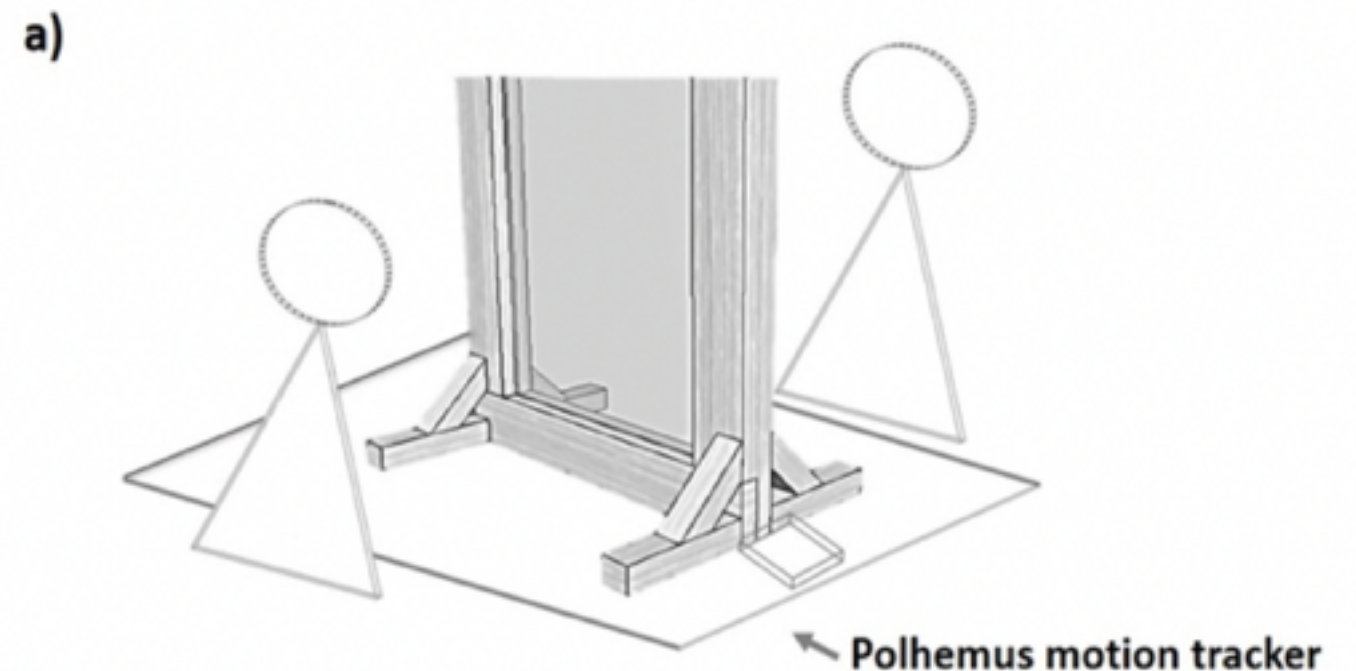


Is reciprocity of information flow really the key in enabling successful coordination?

Or can clear role distributions also support successful coordination

Are the effects of reciprocity and role distribution modulated by how difficult it is to coordinate?

New joint drawing task. Screen can be transparent or opaque



Reciprocity and Role Distribution in JA Coordination

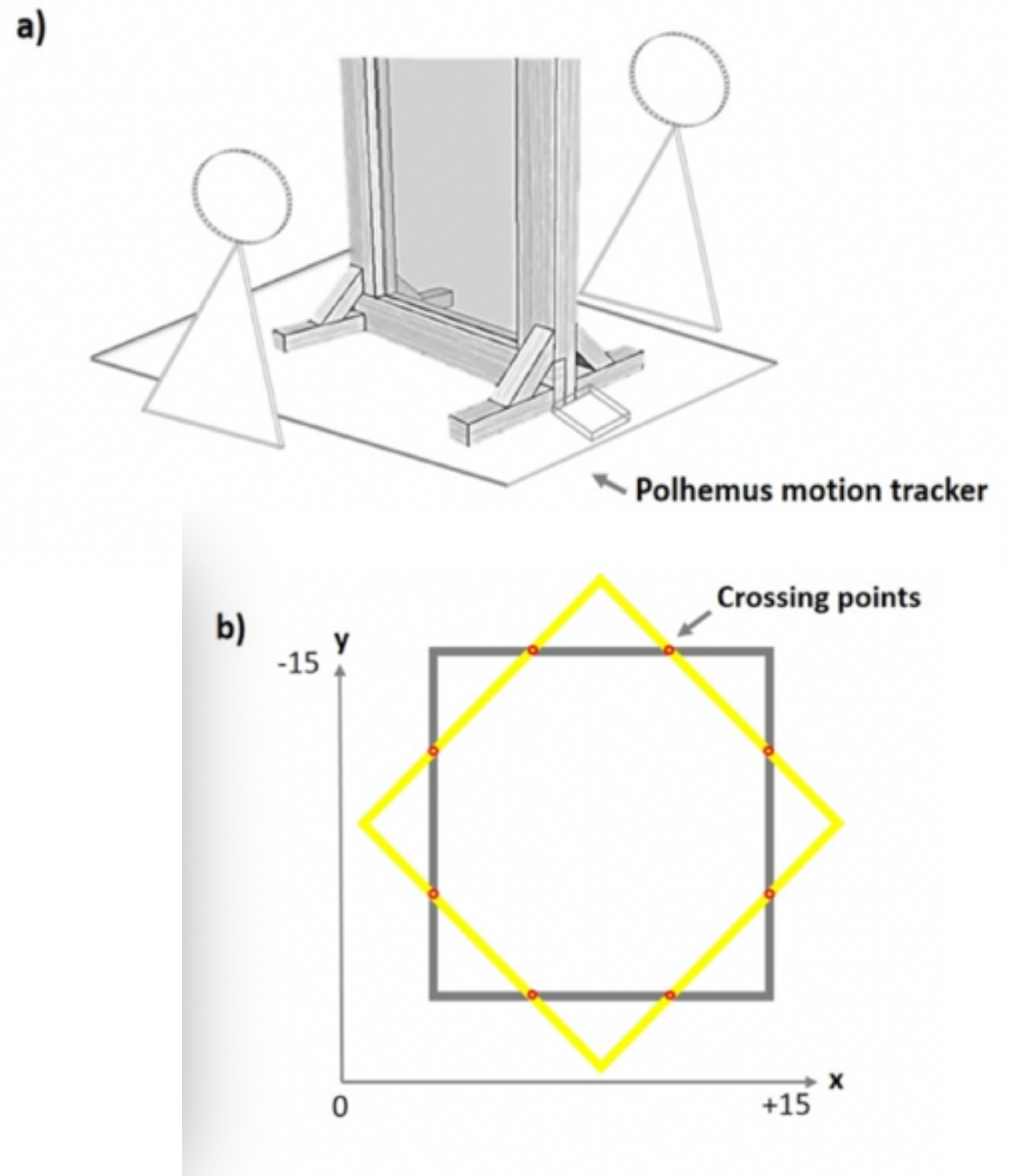
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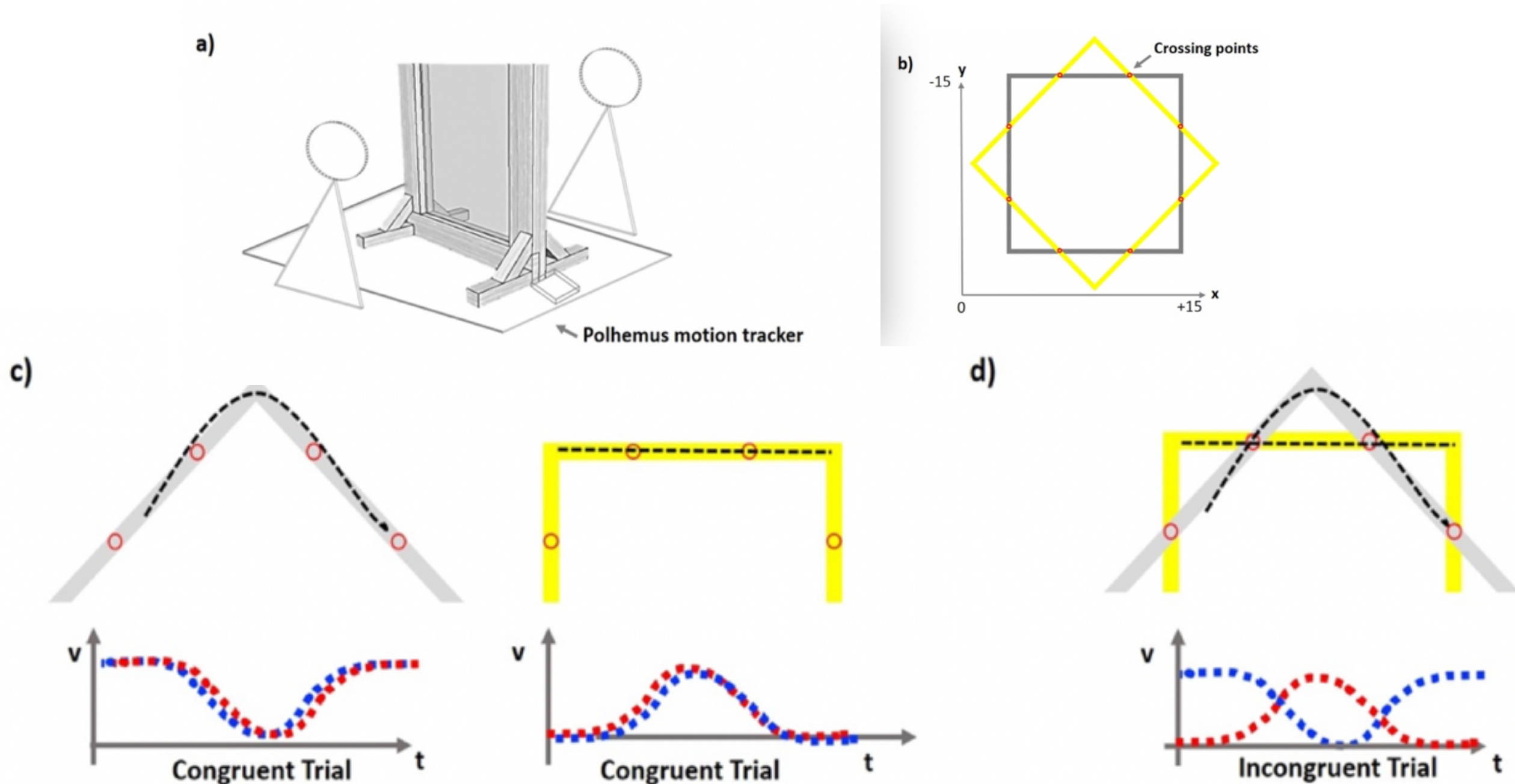
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New joint drawing task. Screen can be transparent or opaque.



Reciprocity and Role Distribution in JA Coordination

Curioni, Knoblich, & Sebanz (in revision)



Partners trace same square (congruent) or different square (incongruent). Blue and red lines show velocity profiles produced by each partner.

Reciprocity and Role Distribution in JA Coordination

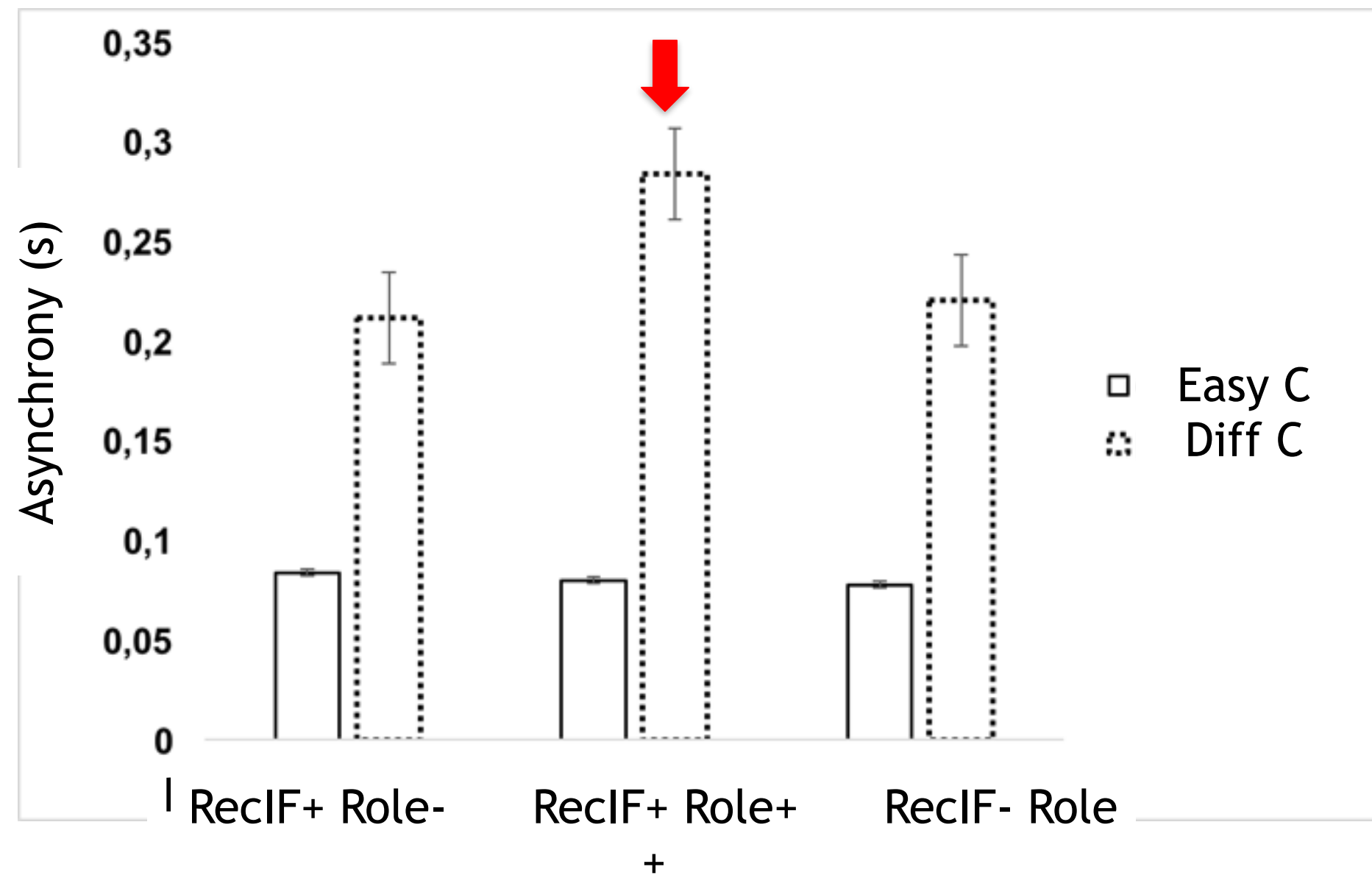
Curioni, Knoblich, & Sebanz (in revision)

Three conditions
(between subjects):

1) Reciprocal
information flow
without role
assignment

2) Reciprocal
information flow with
role assignment

3) Role assignment
without reciprocal
information flow



Spatial Deviation from Prescribed Path

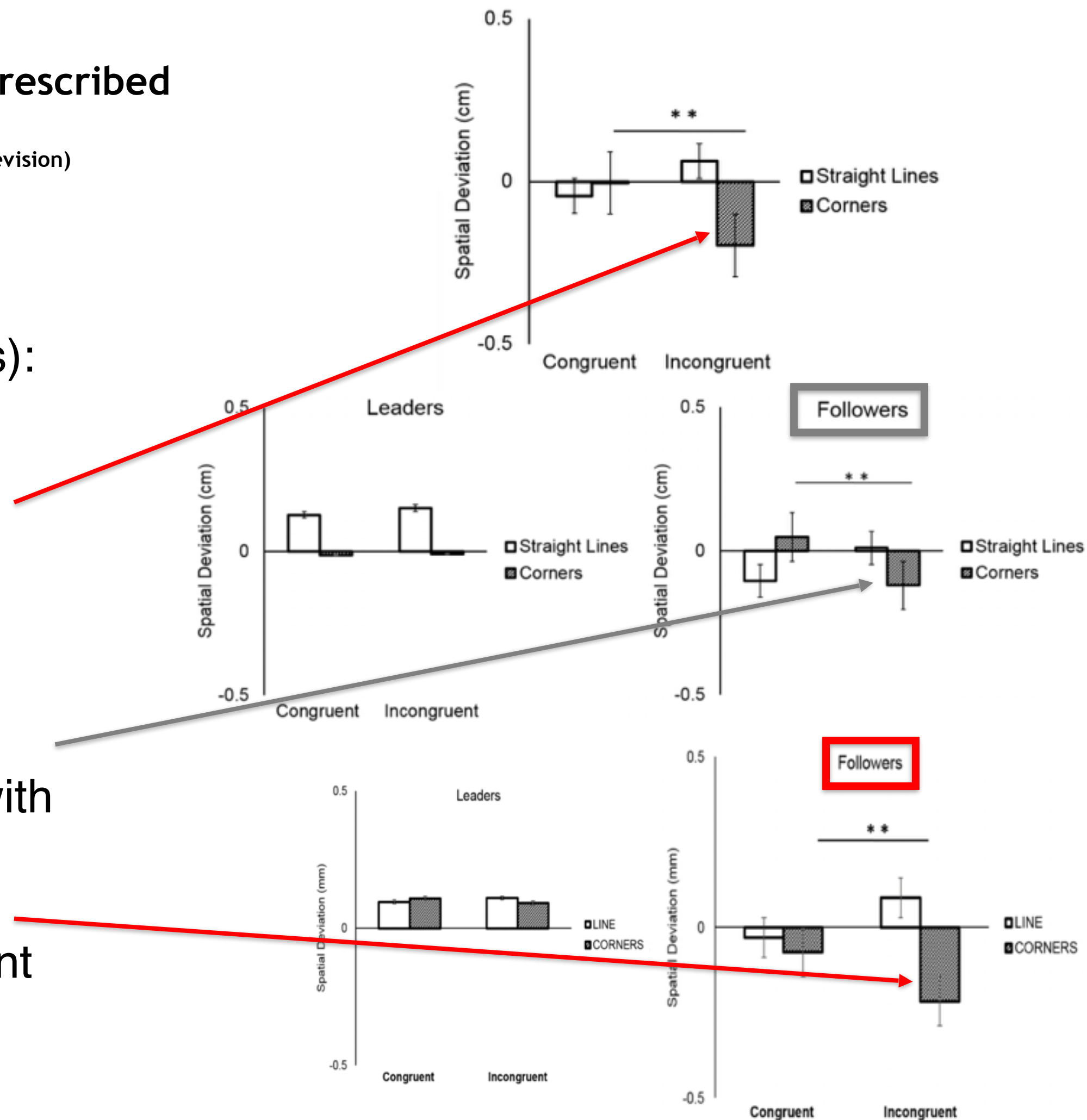
Curioni, Knoblich, & Sebanz (in revision)

Three conditions
(between subjects):

1) Reciprocal information flow without role assignment

2) Reciprocal information flow with role assignment

3) Role assignment without reciprocal information flow



Reciprocity and Role Distribution in JA Coordination

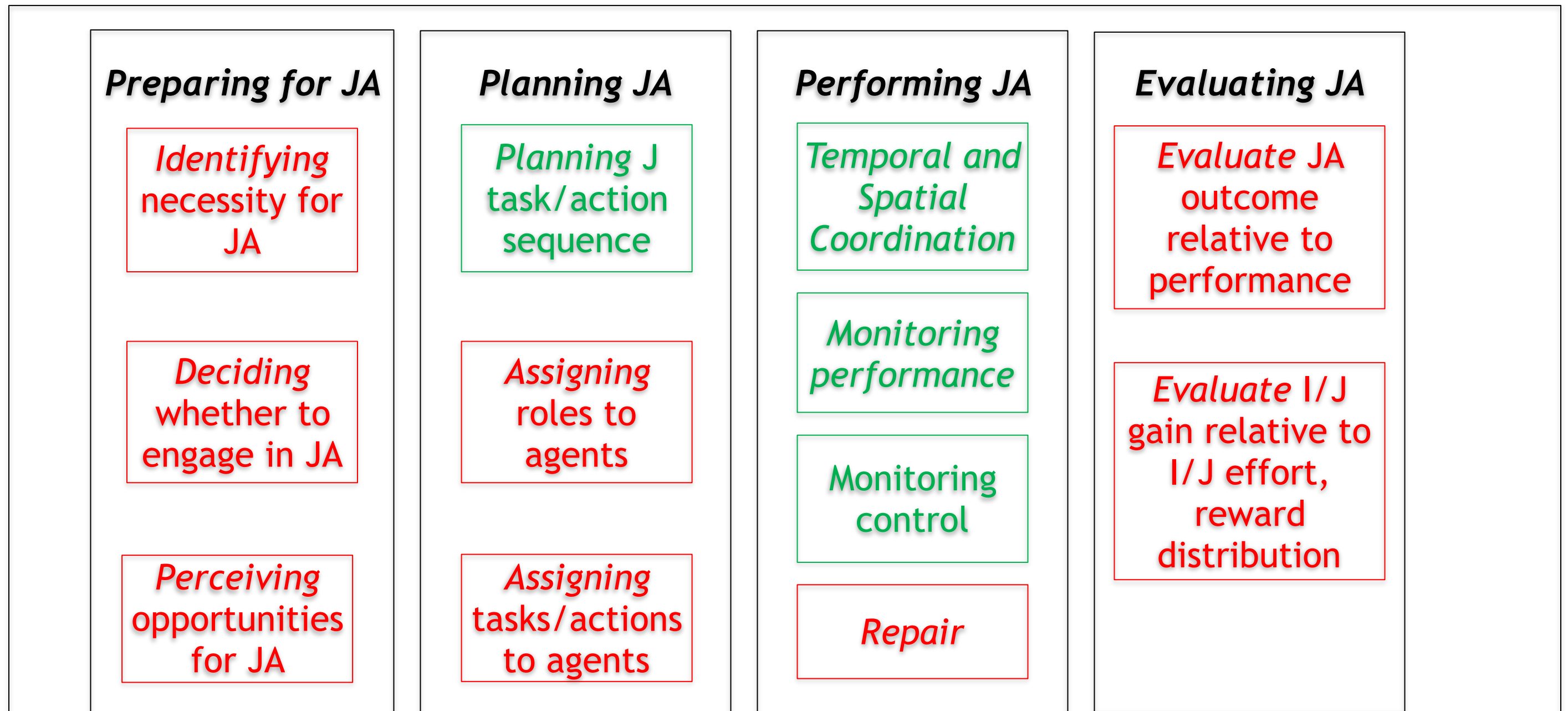
Curioni, Knoblich, & Sebanz (in revision)

There are different ways of effectively achieving coordination during joint action:

Role distribution is beneficial when information flow is unidirectional from leader to follower

Reciprocal information is only beneficial when no role distribution is prescribed

KNOWLEDGE GAPS



Learning opportunities occur while observing, preparing, planning, performing, evaluating JA
JA can benefit from **remembering** perceptions, decisions, plans, assignments, errors, repairs, evaluations