Donders Institute
for Brain, Cognition and Behaviour

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The social interaction challenge for CS:

Why Adam needs Eve

Radboud University Nijmegen

Traditional Cognitive Science: Talking

We sat together at
one summer's end,
That beautiful mild woman,
your close friend,
And you and I,
and talked of poetry.
I said, "A line will take us
hours maybe;…

Problem:

Cognitive scientists tend to ignore or downplay the influences of social interaction on individual cognition except, perhaps, the shared knowledge that is needed for verbal communication.

Thesis:

The main purpose of human perception, action, and cognition is to support social interaction.

Individual cognition is best understood as a device for enabling and controlling sophisticated bodily and mental coordination between individuals.

The social is not a specific knowledge domain within individual minds, it is the key for understanding how individual minds work.

(Stephen Butterfill will have a more balanced proposal…)

Biologically inspired AI/Evolutionary robotics?

Main social interaction is sex
Individuals who are well-adapted to the environment pass on traits
Cooperative mechanisms ensure group survival or survival of close kin
No talking, no cognition

Joint action as the key paradigm

Substantiate the challenge with better understanding how people perform actions together

Joint action: Any form of social interaction whereby two or more individuals coordinate their actions in space and time to bring about a change in the environment.

Joint action in the service of culture…

Joint action: Hot…

… and cold

Joint action: Young…

… and old

Joint action as the key paradigm

Sebanz, Bekkering, & Knoblich, Cognition, 2006 TiCS

Joint action: Any form of social interaction whereby two or more individuals coordinate their actions in space and time to bring about a change in the environment.

Two separate aspects:

- Sharing actions and tasks
- Coordination of actions in real time

Sharing actions and tasks

Starting Point:
Shared Action Representations

There is ample evidence that observing others' actions activates action representations that are also involved in performing the observed action (Prinz, 1997, Rizolatti & Craighero, 2004)

This match between perception and action is based on spatial and temporal aspects of actions and their consequences that remain invariant across self and other

The match may allow recruitment of anticipatory motor mechanisms for perception (Wilson & Knoblich, 2005)

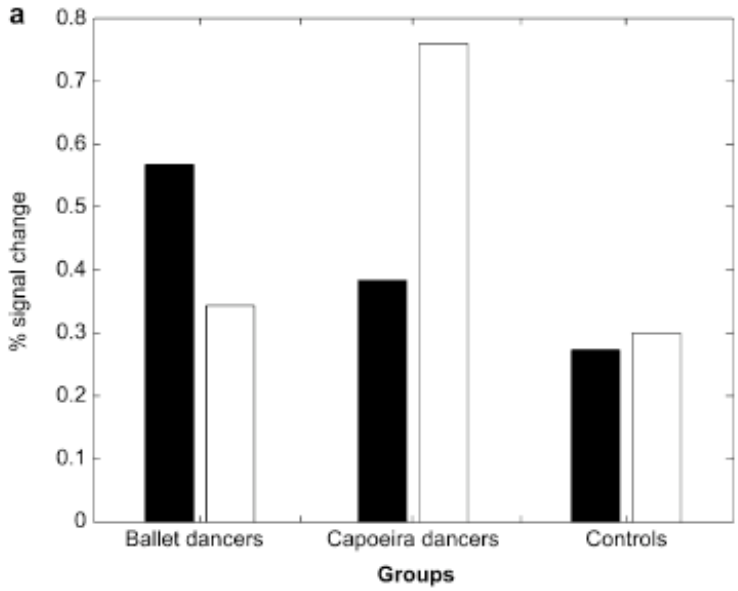
Starting Point:
Shared Action Representations

Behavioral Evidence:
Experiments on Mimicry

e.g., Chartrand & Bargh, 1999; van Baaren et al., 2003

Neural Evidence:
Mirror Neurons/fMRI

Rizolatti & Craighero, 2004, Calvo-Merino et al., 2005



Shared Representations for Complimentary Actions?

Are shared action representations also involved when people take turns in performing complementary actions?

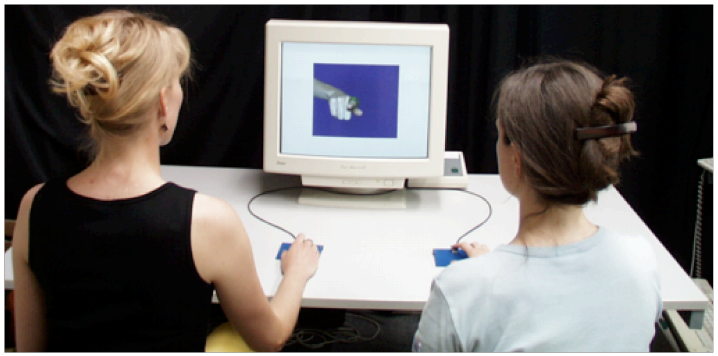
Do we represent the potential actions of others in a similar way as the actions at our command?

This could be useful for joint action because it would create a representational domain for integrating the potential actions of self and other to obtain joint goals

Co-representation of complimentary actions: Experimental approach

A task with two action alternatives is divided up into two go-nogo tasks.

Each go-nogo task is assigned to one of two actors and is carried out alone and taking turns with another participant.

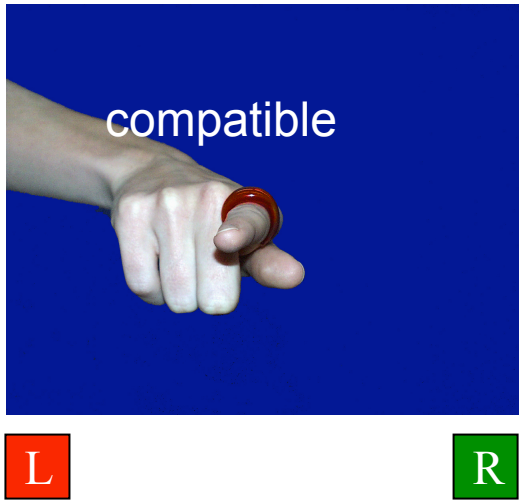


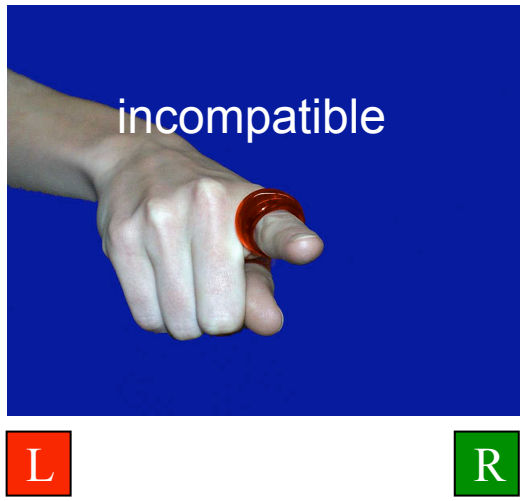
Differences in performance must be due to acting together.

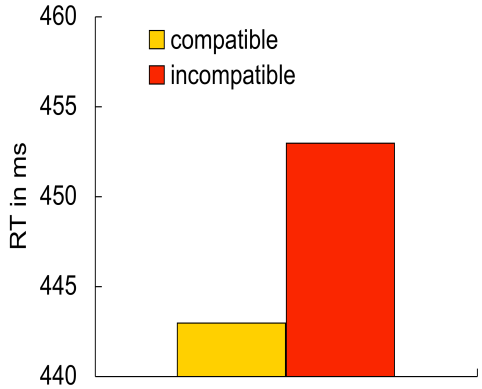
Paradigm: Simon Effect

Set of 2 stimuli and 2 corresponding responses

Relevant Dimension: Colour (red, green)
Irrelevant Dimension: Spatial (pointing direction)







Social Simon:
Two Complimentary Go-Nogo Tasks

Each person responds to one of two colours.

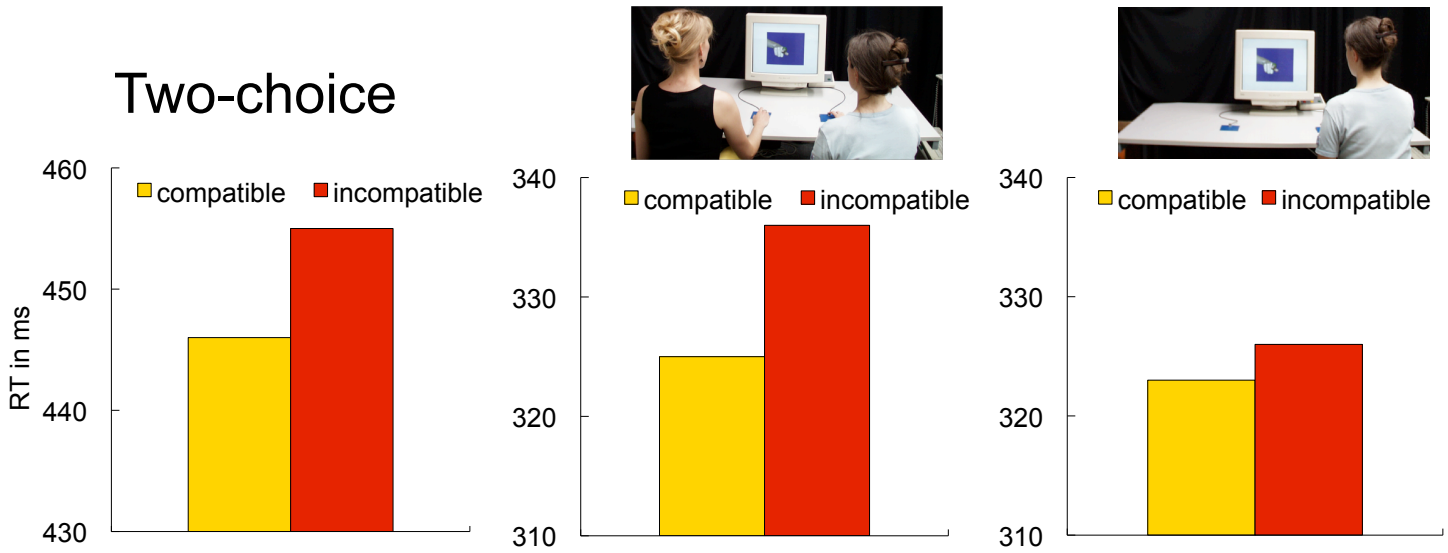
Pointing direction again irrelevant

P1 P2

P1 P2

Results

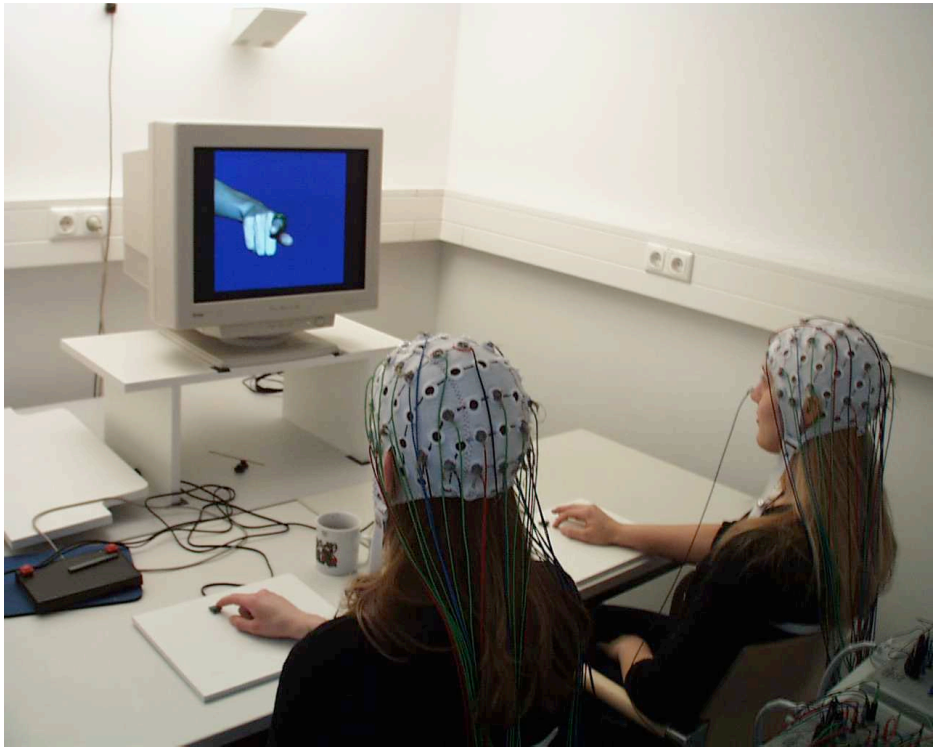
Sebanz, Knoblich, & Prinz, Cognition, 2003



Does not occur when other does not act
Does occur when the other's actions cannot be observed
Does occur in individuals with autism (Sebanz et al., *Cogn. Neuropsych.*, 2006)

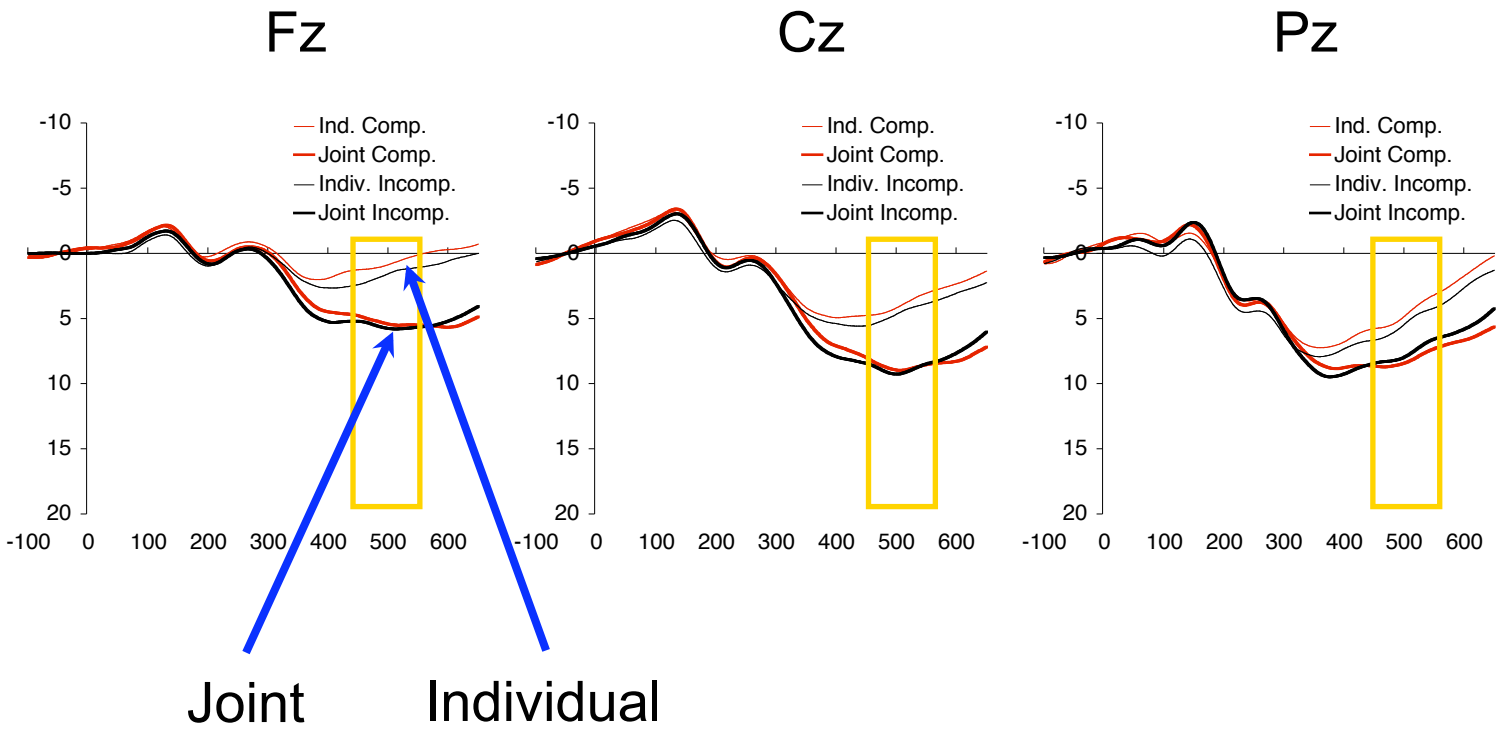
What happens when it‘s not your turn?

Sebanz et al., *Journal of Cognitive Neuroscience*, 2006



Inhibition: NoGo P3

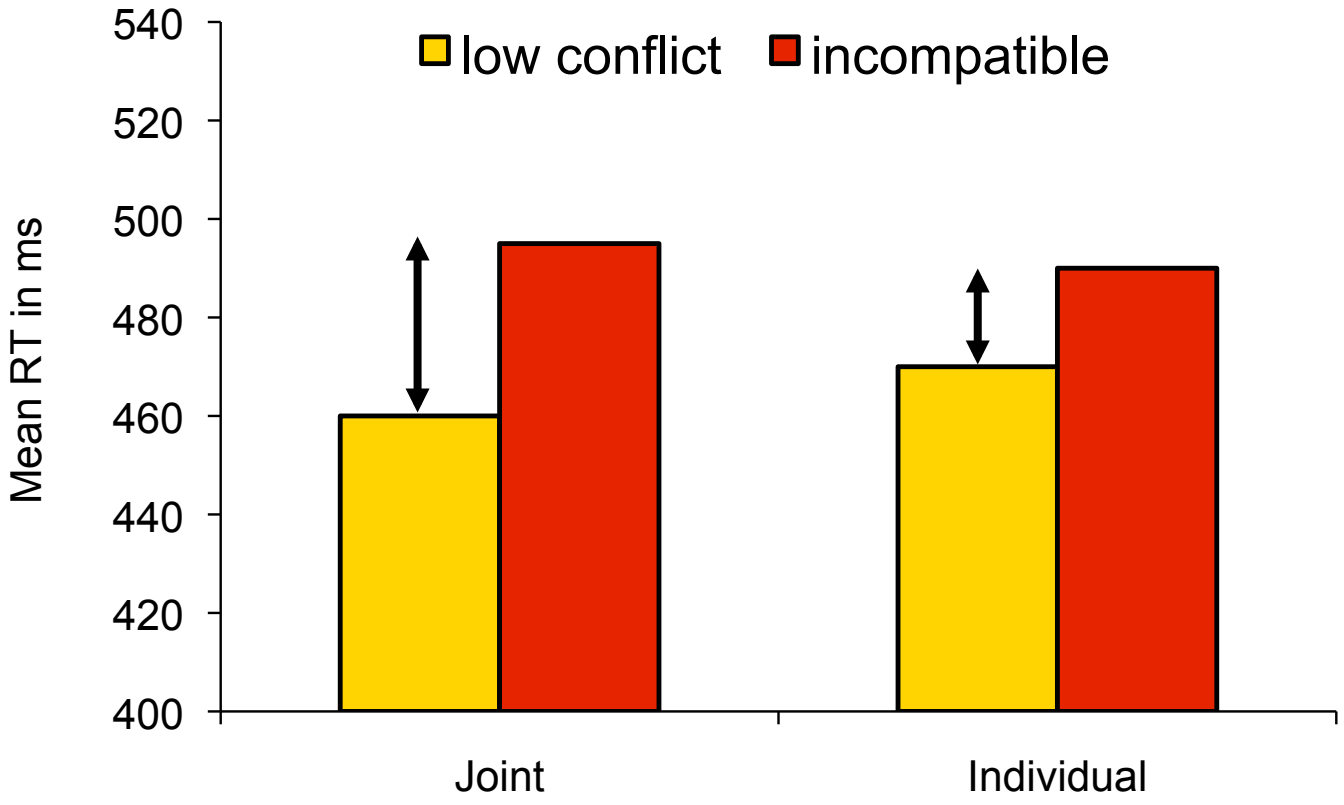
Sebanz, Knoblich, Prinz, & Wascher, *JoCN*, 2006



What if people don‘t see each other?

Results

Atmaca et al. (submitted)

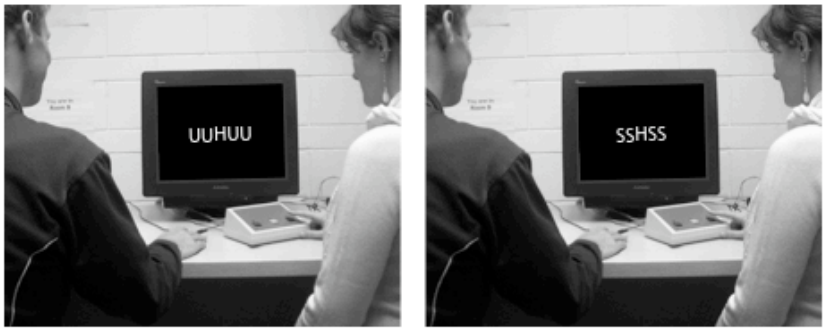


What if the other does not act intentionally?

Atmaca et al, submitted

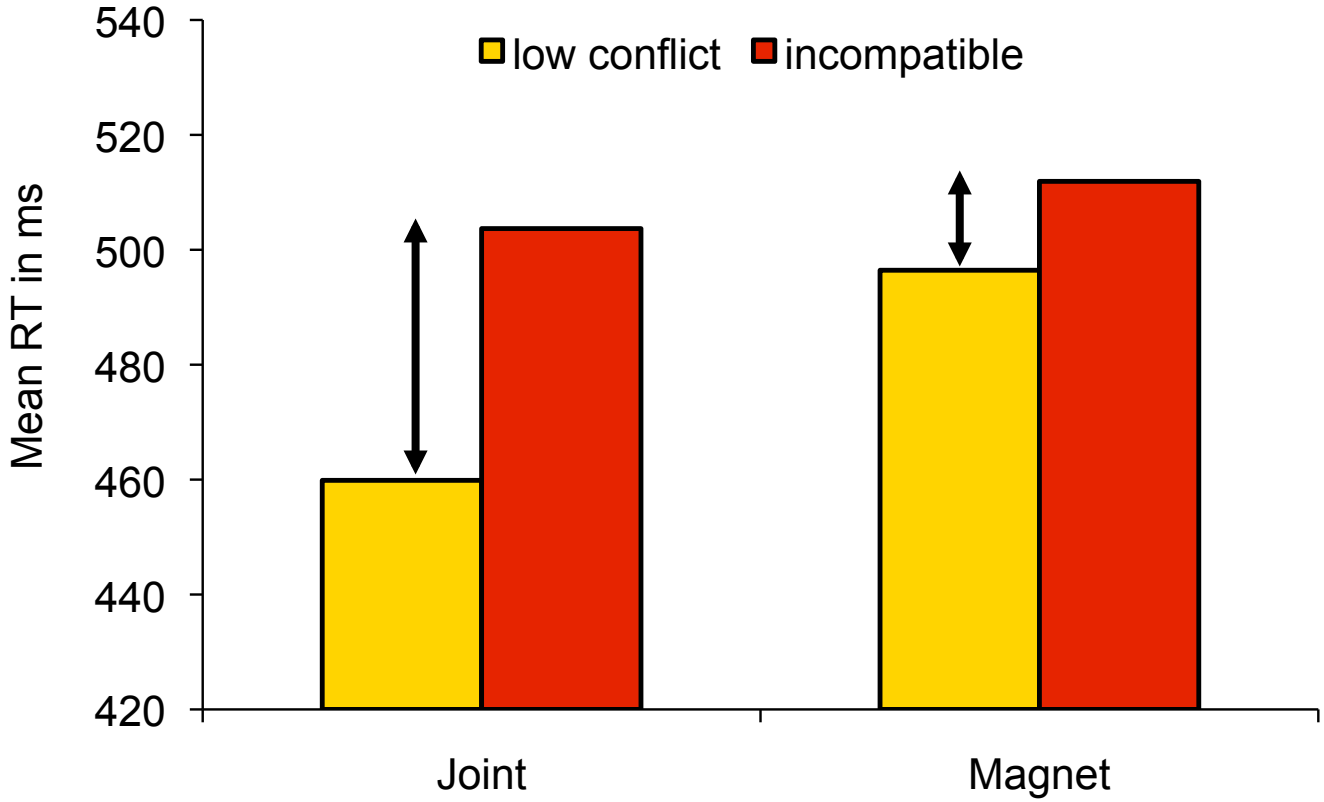
Unintentional Co-Actor

Intentional Co-Actor

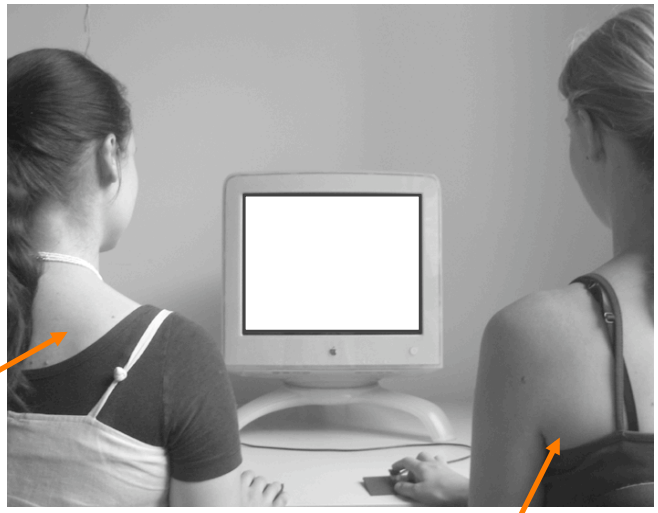


Results

Atmaca et al. (submitted)



Does co-representation influence memory encoding?



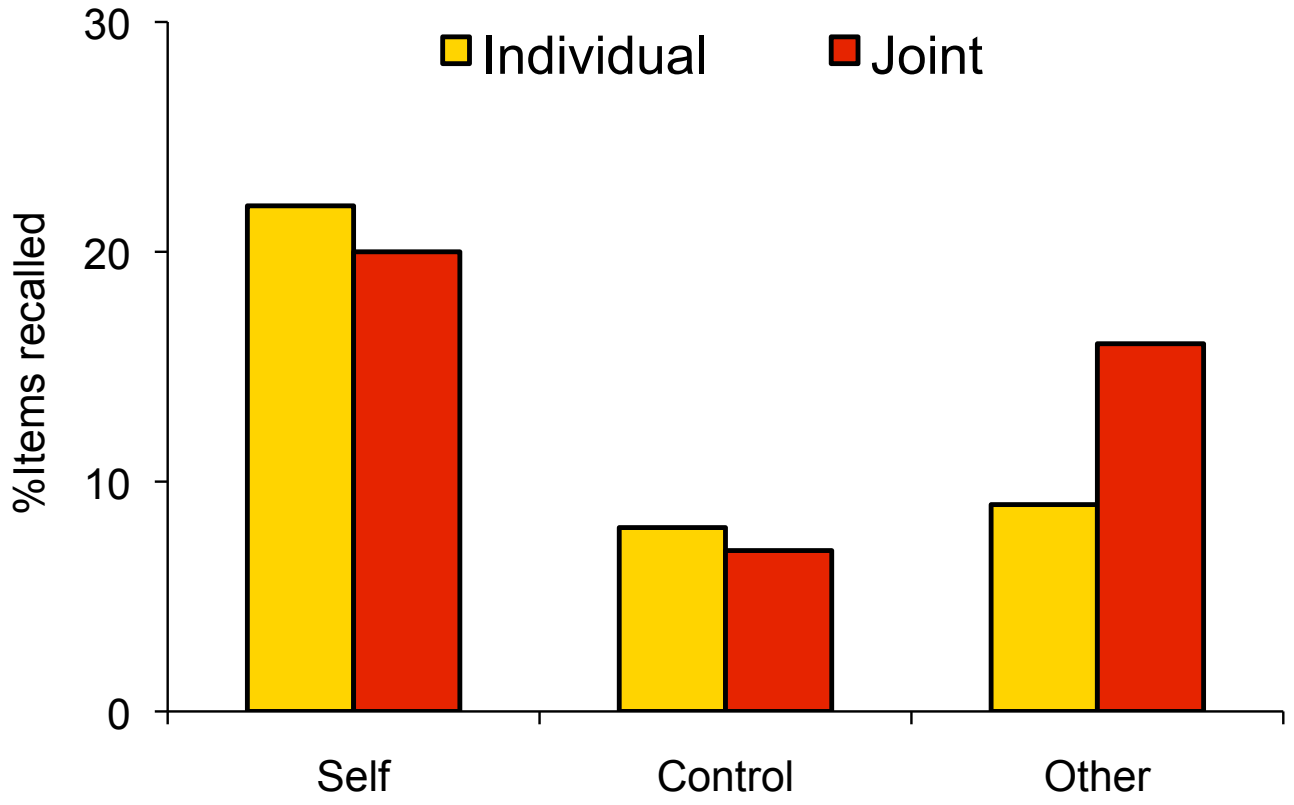
fruits & vegetables

animals

fruits & vegetables

Control category: household items

Does co-representation influence memory encoding?

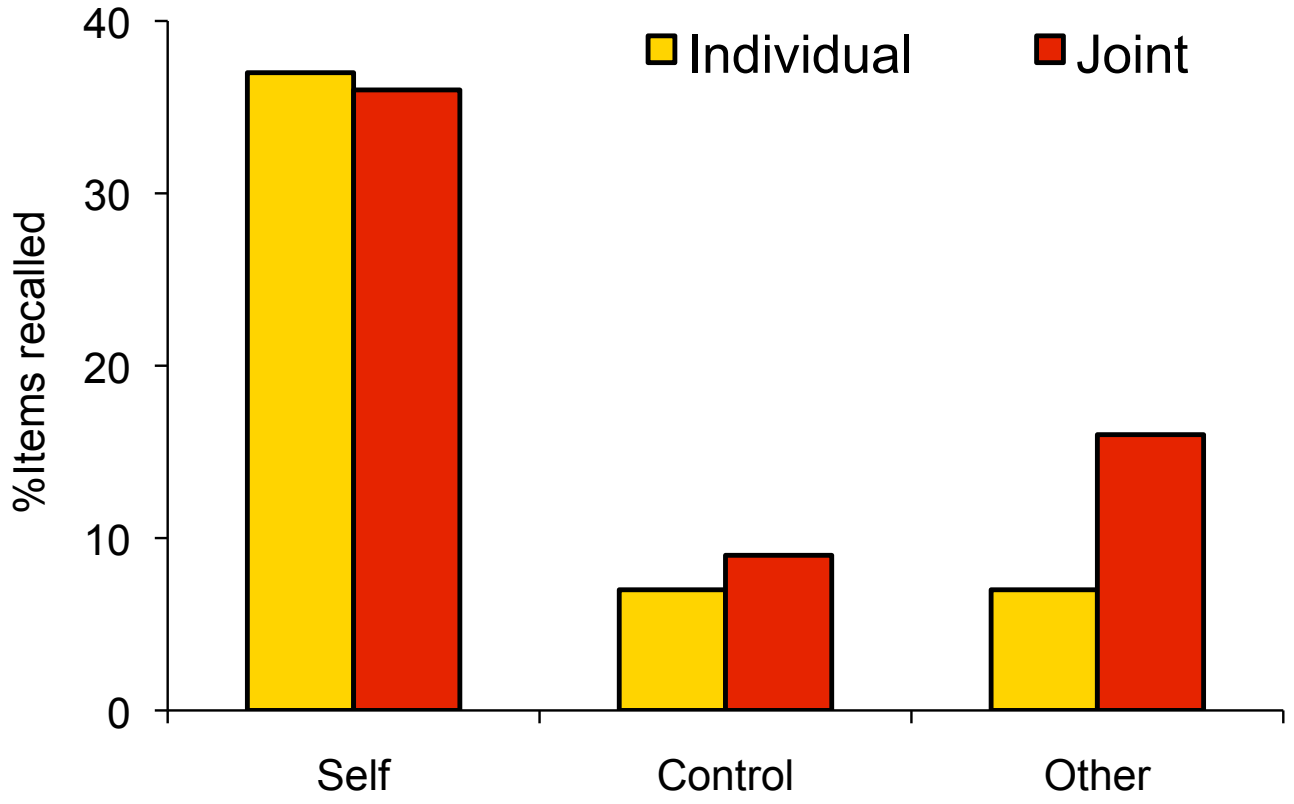


What happens if encoding others' items becomes more costly?

Monetary incentive for items recalled in own category but not in other's category

However, later asked to recall items in all conditions

Does co-representation influence memory encoding?



Interim Summary

Even when coordinated action is not required, people form shared task representations.

This is suggested by behavioral results (RTs) as well as ERP results (Nogo-P3).

The belief that another person performs a complimentary task is sufficient for co-representation to occur

No co-representation of unintended actions

Co-representation improves memory

Coordinating actions in real time

Coordination vs. co-representation

Sebanz & Knoblich, in press, Topics in Cognitive Science

Co-representation is not sufficient for joint action

Additional temporal coordination is required. This can be achieved through entrainment and/or predictive timing mechanisms

Joint action implies coordination between minds (brains) rather than within minds (brains)

Temporal Entrainment

Schmidt, Carello , & Turvey, 1990

People tend to move in the same rhythm.

Similar mechanisms are present in fish

However, we inherited this tendency to synchronize

Note that entrainment is different from mimicry!

Entrainment: Rocking together

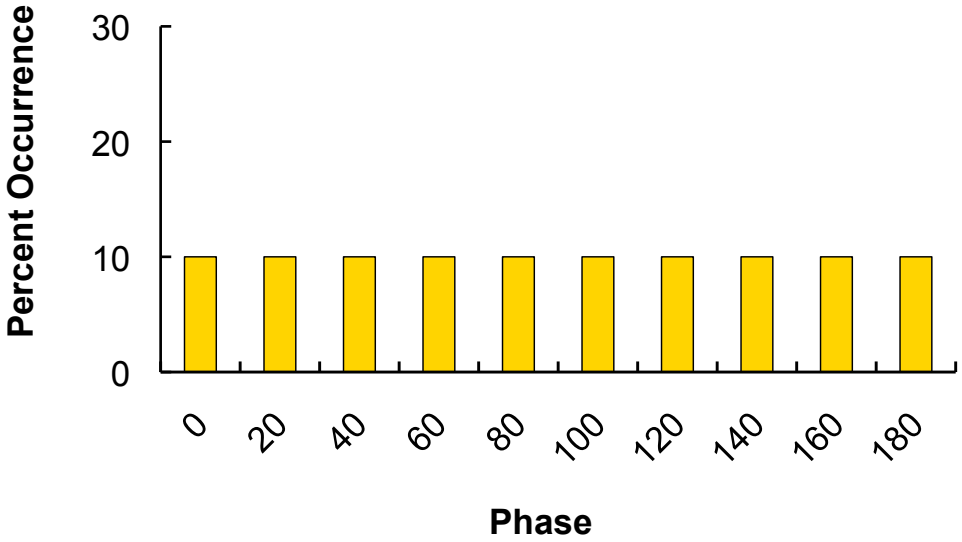
M. Richardson et al.(2007), Human Movement Science

Do people entrain automatically?

If so they should spontaneously act against the “natural frequency“ of rocking chairs in order to rock in synchrony

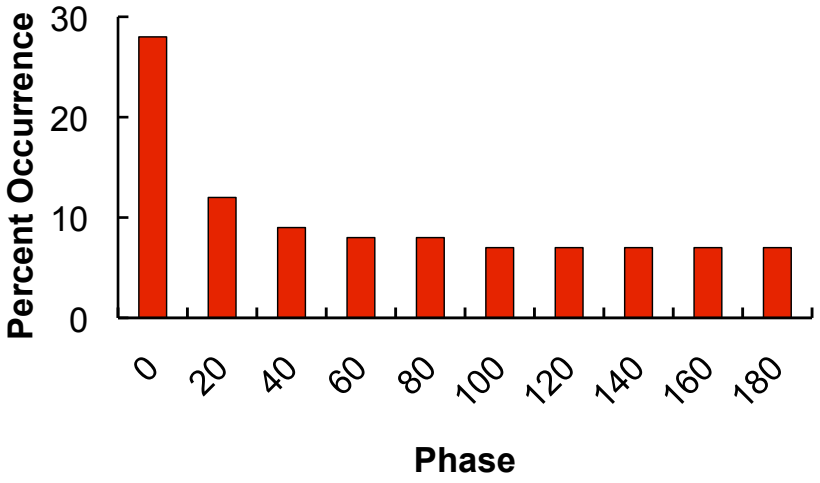
Entrainment: Rocking together

M. Richardson et al. (2007)

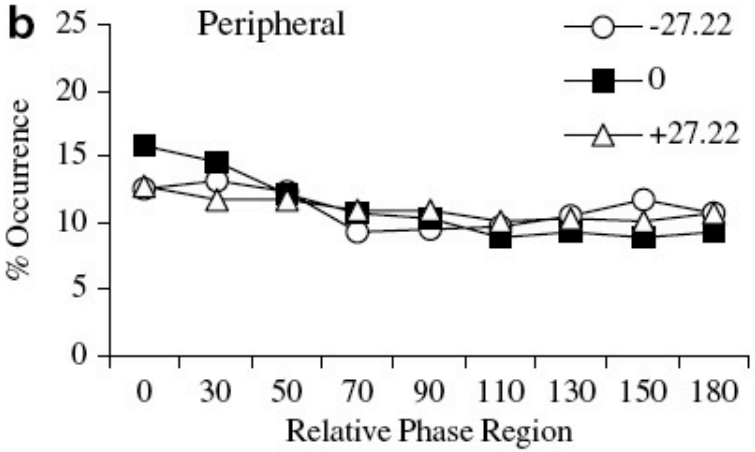


Entrainment: Rocking together

M. Richardson et al. (2007)



Results


b
Peripheral
-27.22
0
+27.22
% Occurrence
25
20
15
10
5
0
0
30
50
70
90
110
130
150
180
Relative Phase Region

Individual and Joint Action Planning

Knoblich & Sebanz, 2008, Philosophical Transactions of the Royal Society B

Entrainment is a “passive” mechanism and may contribute to coordination during joint action

However, it is far from clear how entrainment mechanisms can support intentionally controlled joint action

Are there other mechanisms that support temporal coordination during joint action?

In particular, how can co-actors coordinate complimentary actions in real time?

E.g., how can we learn to paddle a canoe together?

Timing of potentially conflicting actions

Knoblich & Jordan, 2003, JEP:LMC

During individual action one can time actions internally to avoid carrying out conflicting actions at the same time.

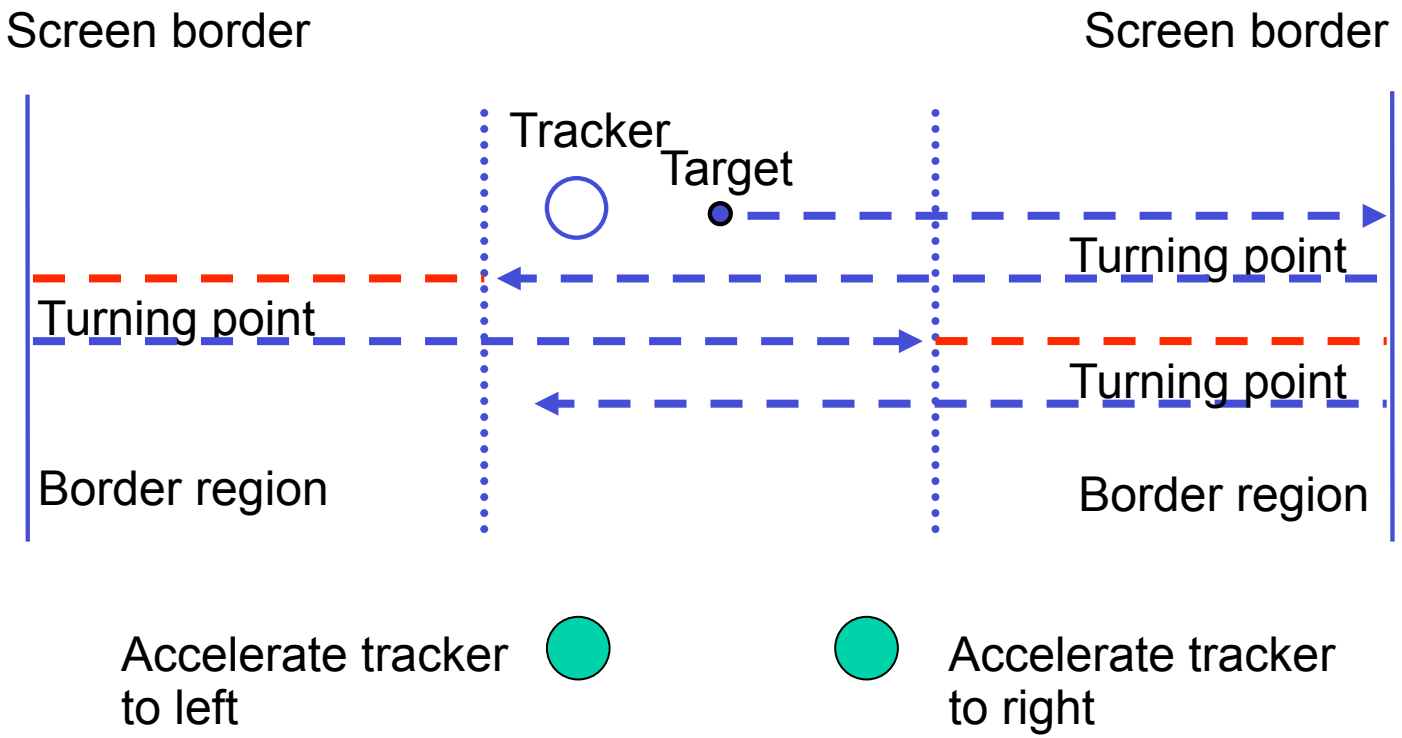
Groups need to use the environment to schedule actions at the right moment in time to avoid conflict.

Thus joint action creates additional demands on temporal coordination, especially under time pressure.

These demands could be met by predicting when others will act and by adjusting one's own timing accordingly.

Accurate information about the timing of others' actions should help with this adjustment and thus improve temporal coordination during joint action.

Tracking task



Compensation & Anticipation

a) Compensation: Reduces immediate error (tracker-target-distance)
Produces large error after turn

Before button press After button press

b) Anticipation: Creates small immediate error (tracker-target-distance)
Greatly reduces future error after turn

Before button press After button press

Button presses increasing immediate error to avoid future error indicate that individuals/groups have acquired the required anticipatory strategy

Experimental manipulations

Factor 1: Individual or joint

Individuals control both buttons

In the joint condition each co-actor controls one button

Factor 2: Timing signal/no timing signal

Co-actors get or don't get auditory signals that specify timing of each button press (different pitches for the two buttons)

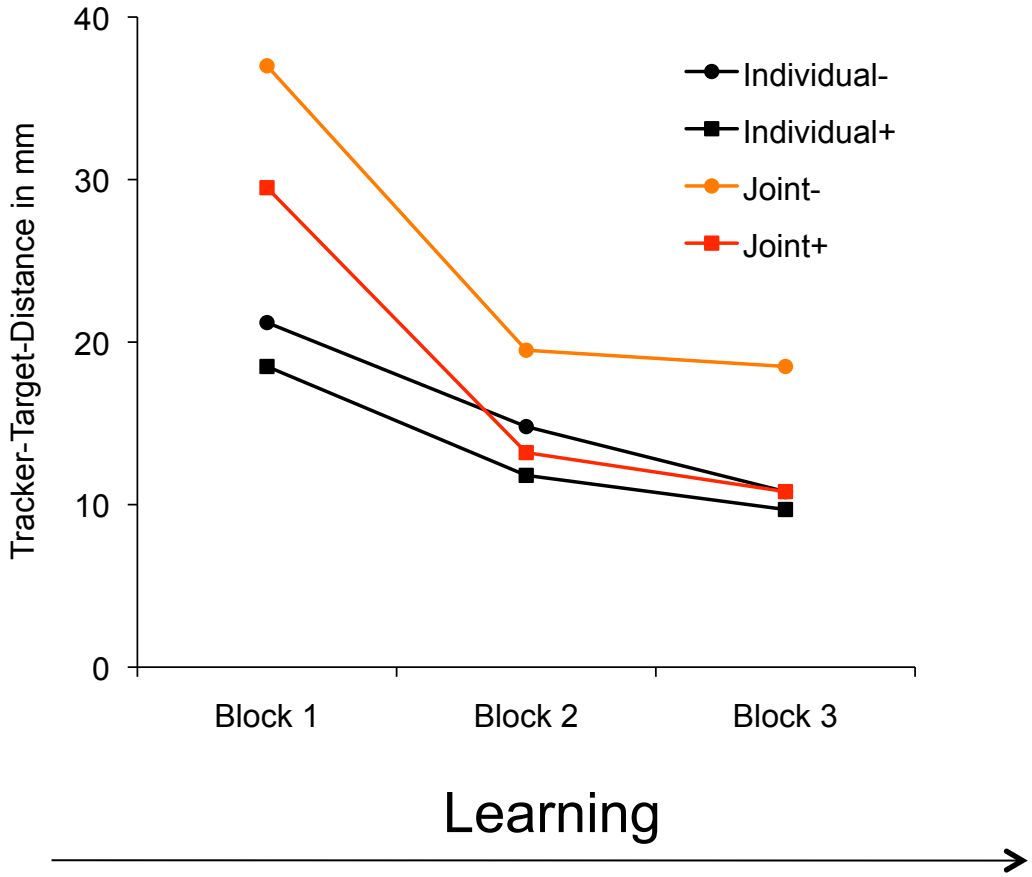
Dependent Variables:

Tracking errors (performance)

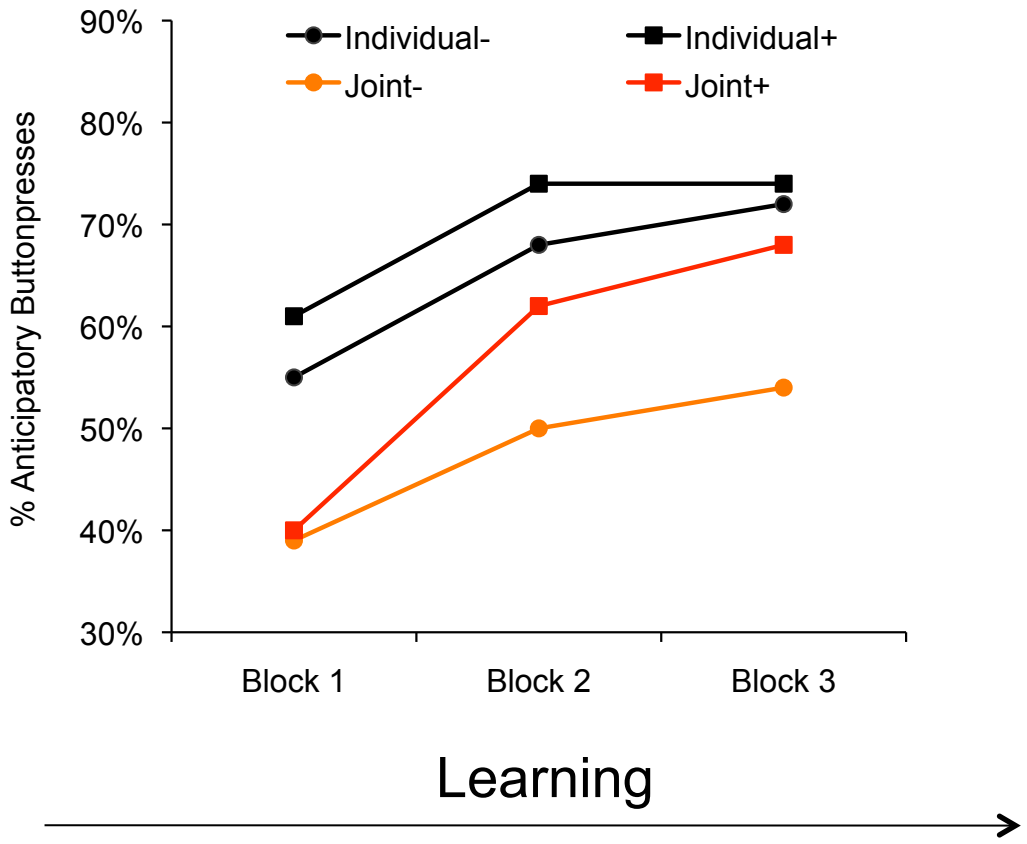
Anticipatory button presses (increase tracking error)

Time between button presses

Performance



Anticipatory Button Presses



Is predictive timing supported by the motor system?

Predictive timing may use internal models that predict when action consequences occur

Such models may be used to predict the timing of others' actions while they are matched to one's action repertoire (Wilson & Knoblich, 2005)

The match is best when receiving one's own actions as input (maximal similarity between perception and action)

Thus one should be most accurate at predicting the timing of one's own actions.

Do pianists duet better when they play with themselves?

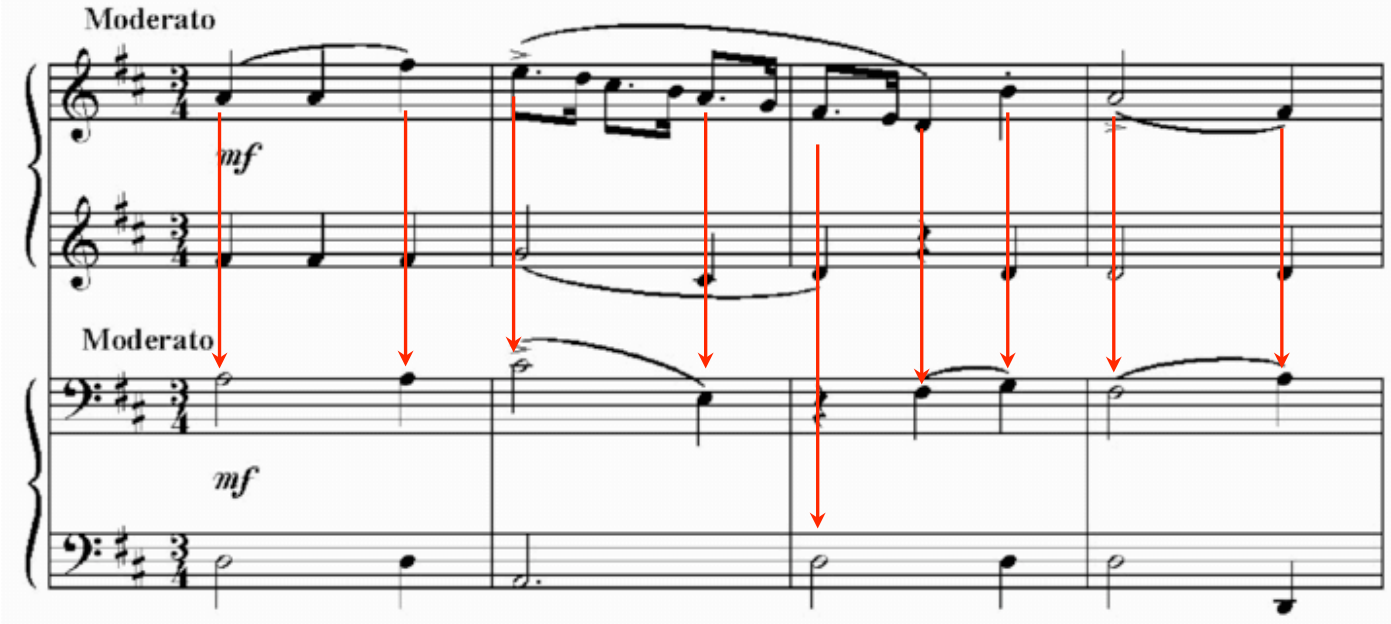
Keller, Knoblich & Repp, Consciousness and Cognition, 2007

Nine pianists of the Yale school of music recorded one part of several piano duets.

Two months later they performed the second part, either to a recording of their own performance or to a recording of another pianist's performance.

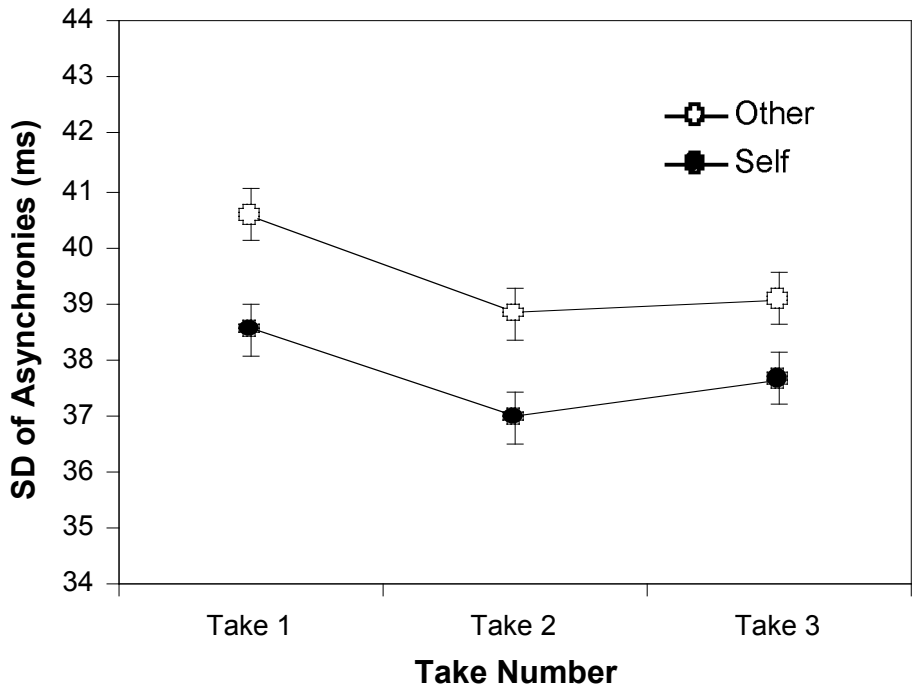
Better synchronization accuracy for self?

Alignment



Are synchronous notes in the score also synchronous in the performances of the two parts of the duet?

Results



Significantly lower SD of asynchronies for self. The SD of asynchronies describes the average temporal deviation between two notes that should be synchronous.

What do people experience when performing joint actions?

Loss of agency through sync

Synchronous action creates ambiguity with respect to temporal cues to agency. Reduction in the experience of individual agency?

Increase of agency
Defining the rhythm of joint action

Individuals may experience heightened control when they dictate the rhythm of group action

Feeling we-agency?

Is there a genuine experience of we-agency that is qualitatively different from the experience of me-agency?

We-agency?

We both intend/expect
a joint outcome that we
cannot produce alone and
it happens as intended/
predicted

We-agency?

Or is we-agency only in the eye of the observer?

Conclusions

Joint planning relies on shared action and task representations that provide a basis for integrating actions across self and other.

Temporal coordination (partly) relies on predictive timing mechanisms that may use internal models residing in the motor system.

Studies of joint action are likely to provide a fresh perspective on individual cognitive processing

Joint action may shape experience

They can help to generate new ideas about what individual minds need to achieve in order to be able to flexibly engage in social interaction

Take home message:

There are many social interactions apart from sex and talking about it.

These have likely shaped your thinking even before you started to babble...