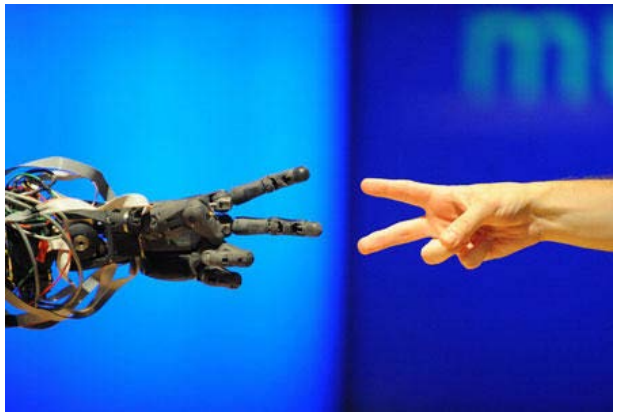
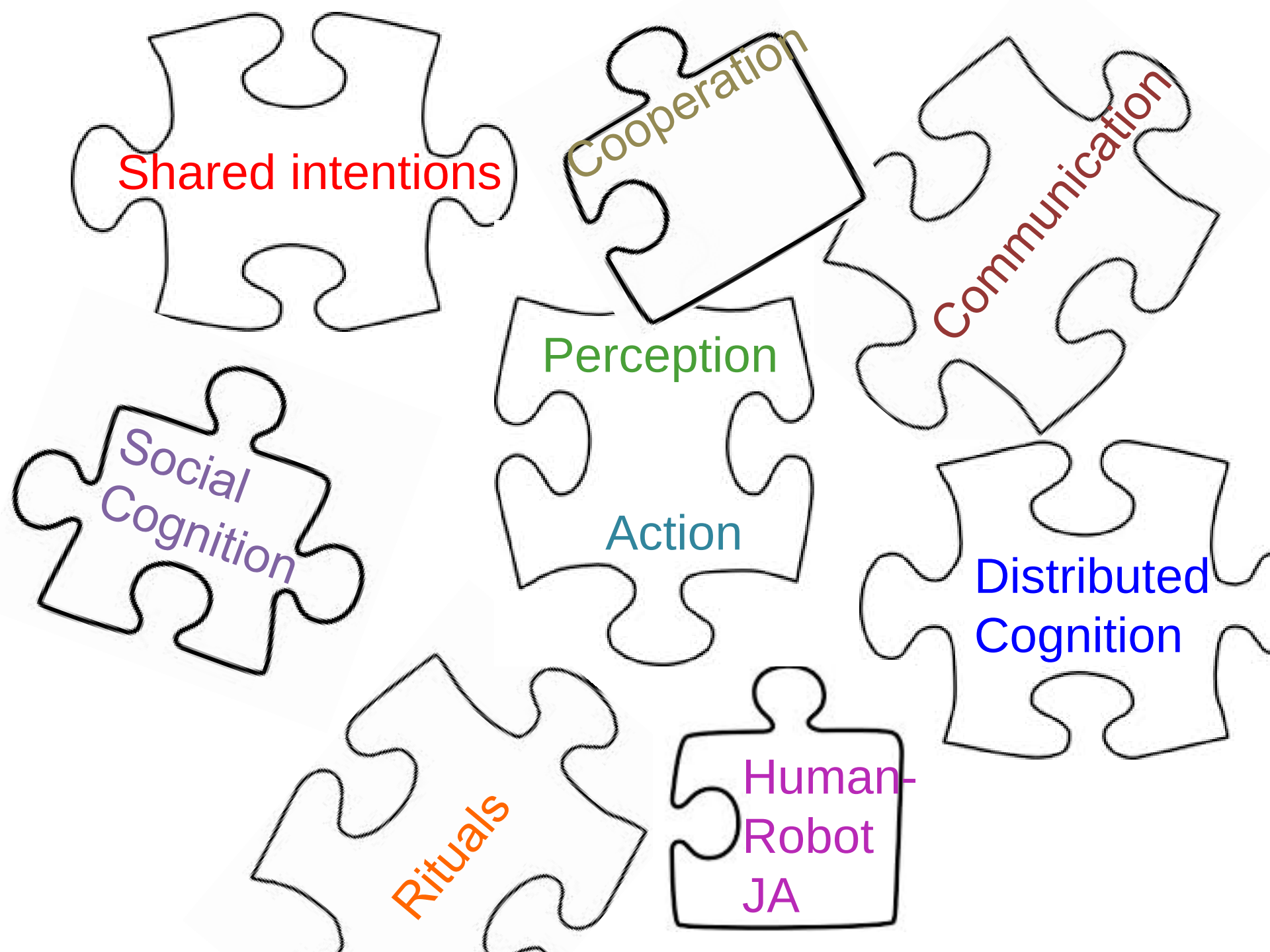
How t(w)o act together

Natalie Sebanz

CEU CENTRAL EUROPEAN UNIVERSITY




Shared intentions
Cooperation
Communication
Perception
Social Cognition
Action
Distributed Cognition
Rituals
Human-Robot JA

Falling into Sync

People have a tendency to synchronize their actions, e.g., while walking, running or clapping.

Explained in terms of coupled oscillators (Schmidt & Richardson, 2008)

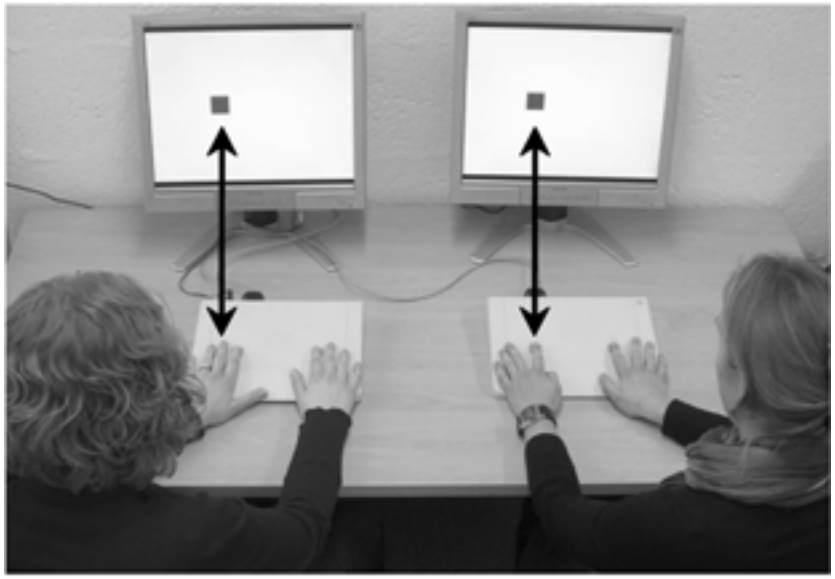
Effects on liking and cooperation

CEU Department of Cognitive Science
CENTRAL EUROPEAN UNIVERSITY

Overview

1. **Making oneself predictable**
2. Planning each other´s actions
3. Learning through joint action
4. Human-robot interaction

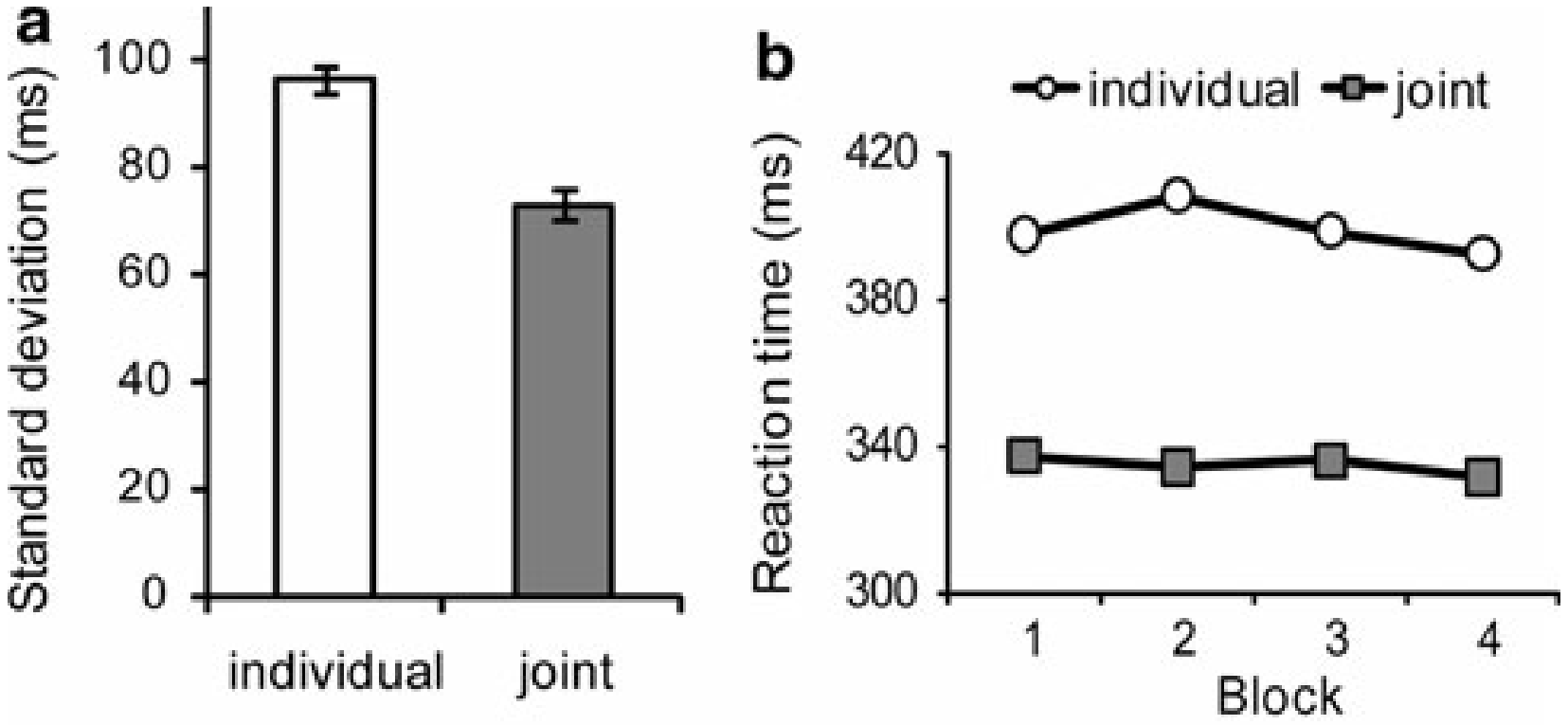
Making oneself predictable



Task: Respond as synchronously as possible

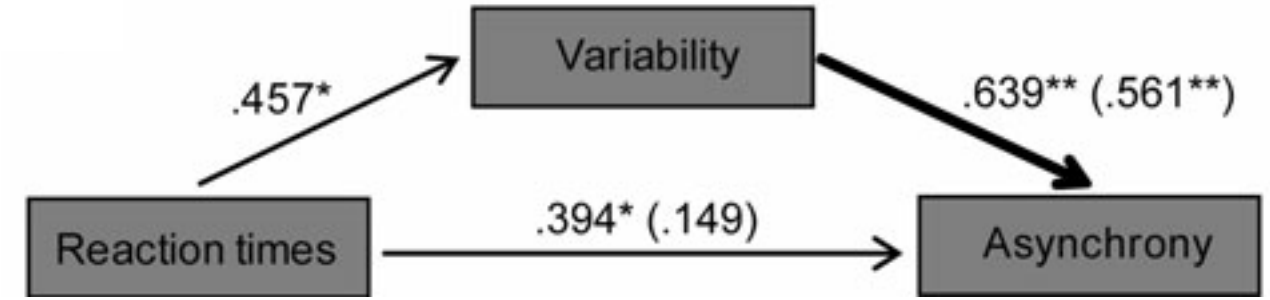
Reducing variability

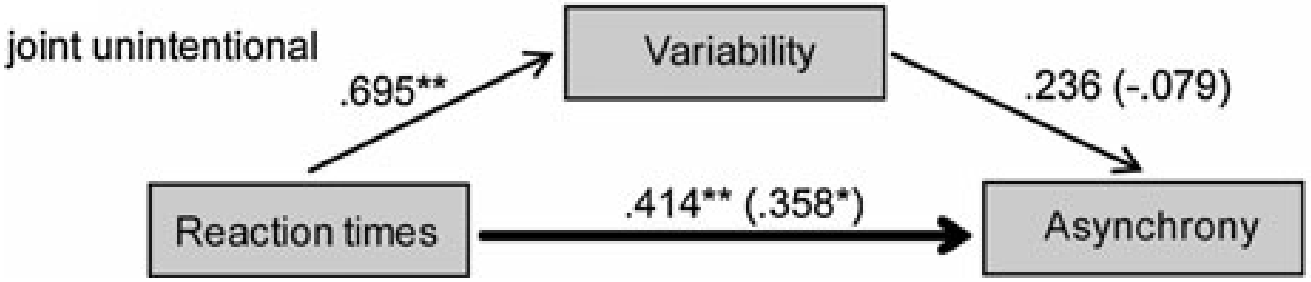
Vesper et al., EBR, 2011



Reducing variability

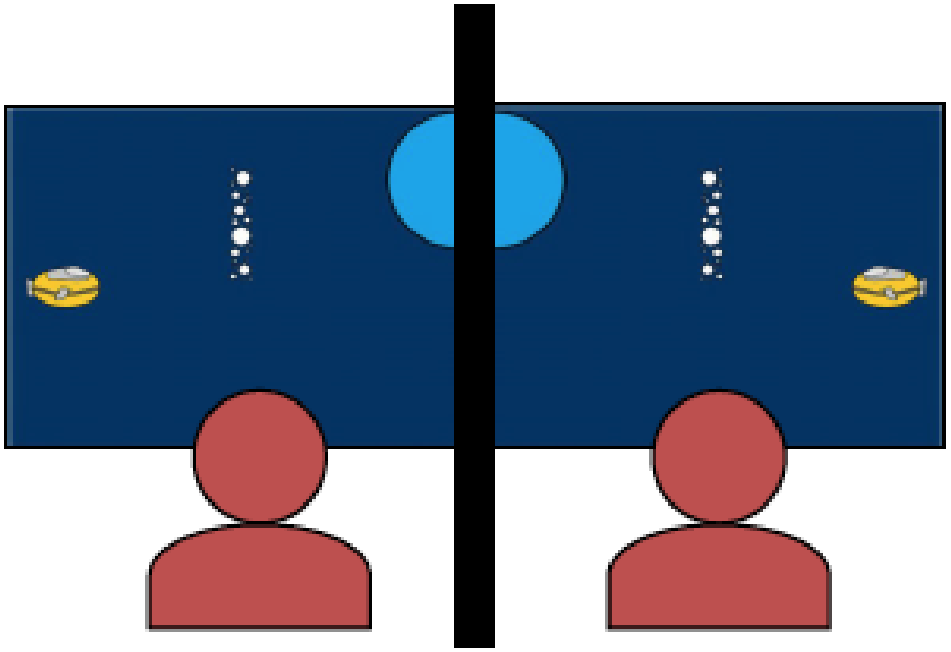
Vesper et al., EBR, 2011





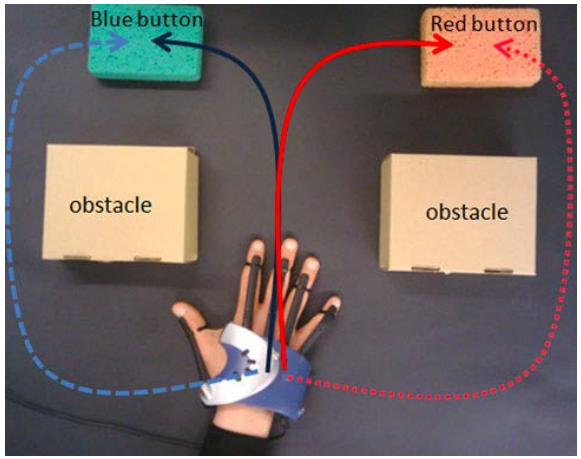
Reducing variability

Also works in space!
See poster by Vesper et al. (52)



Making oneself predictable: Signaling

…a way of making actions "speak":



Modifying instrumental actions in the service of communication, e.g., deviating from movement path to disambiguate target object

Pezzulo & Dindo, EBR, 2011

Signaling

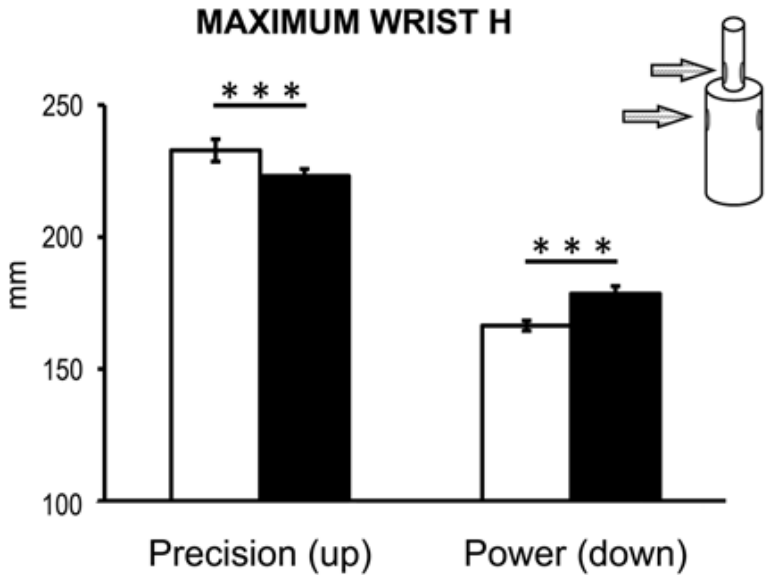
Joint task: grasp object synchronously using complementary grip

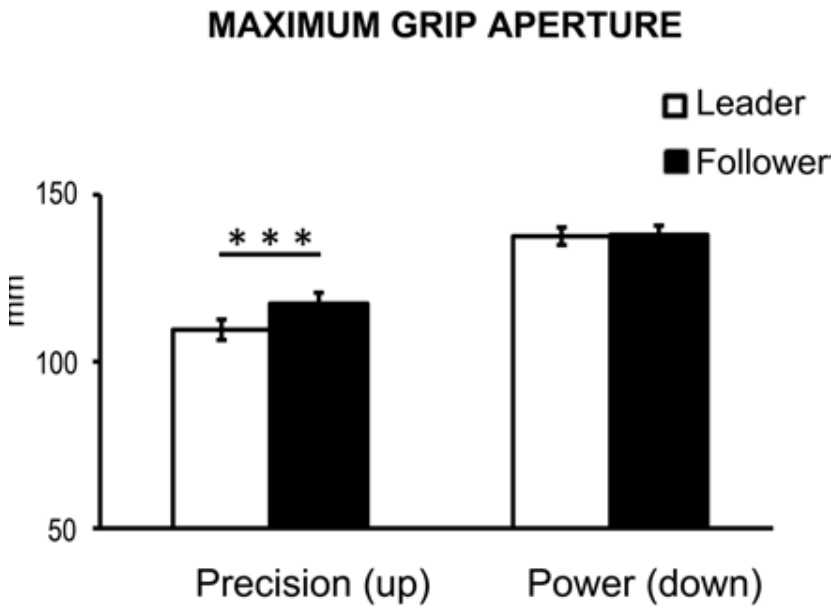
One person knows where to grasp the object, the other does not

Sacheli et al., 2013

Signaling

The knowledgeable person amplifies her movement (amplitude, grip aperture) to signal her action goal





Sacheli et al., 2013

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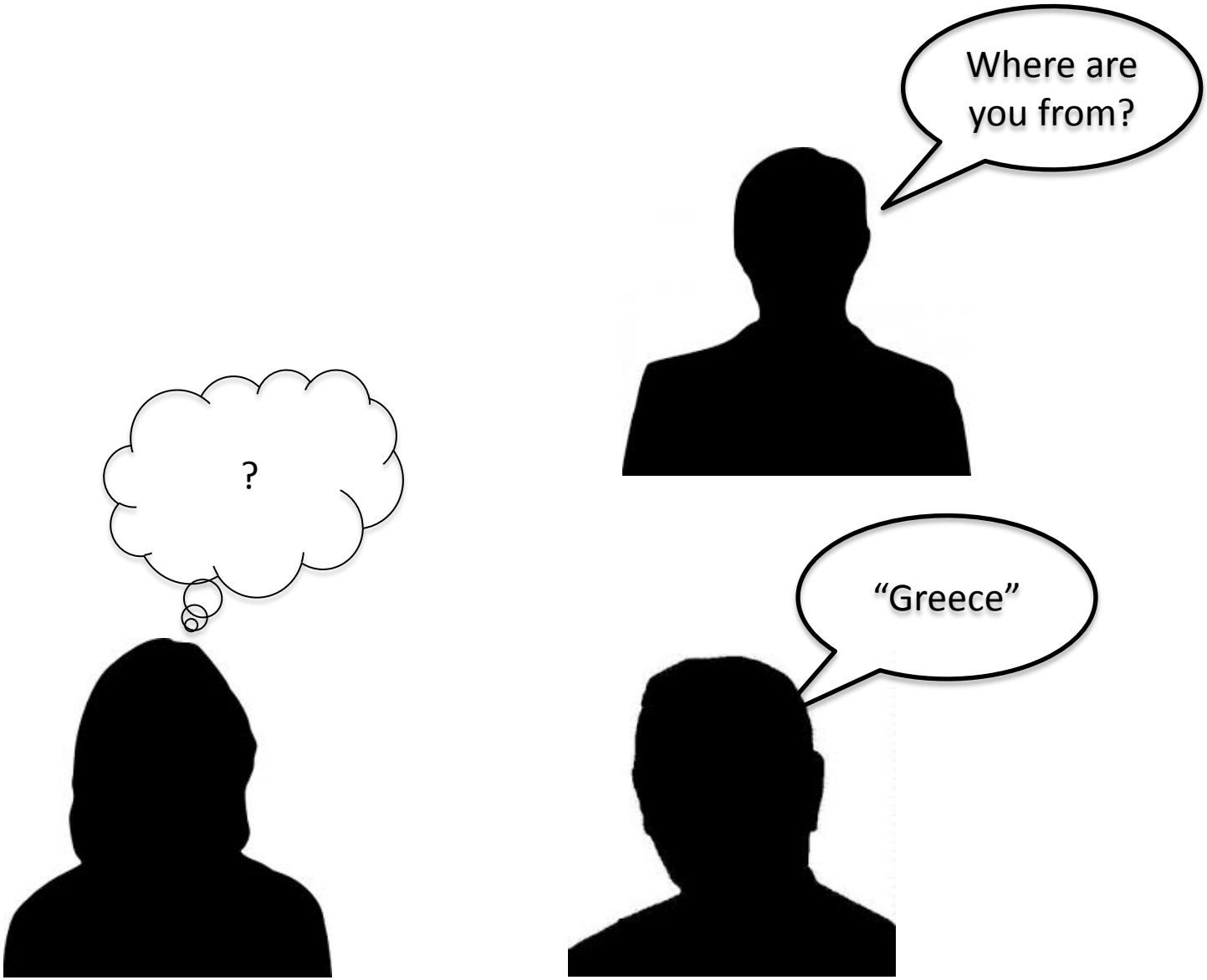
Is your task my task?



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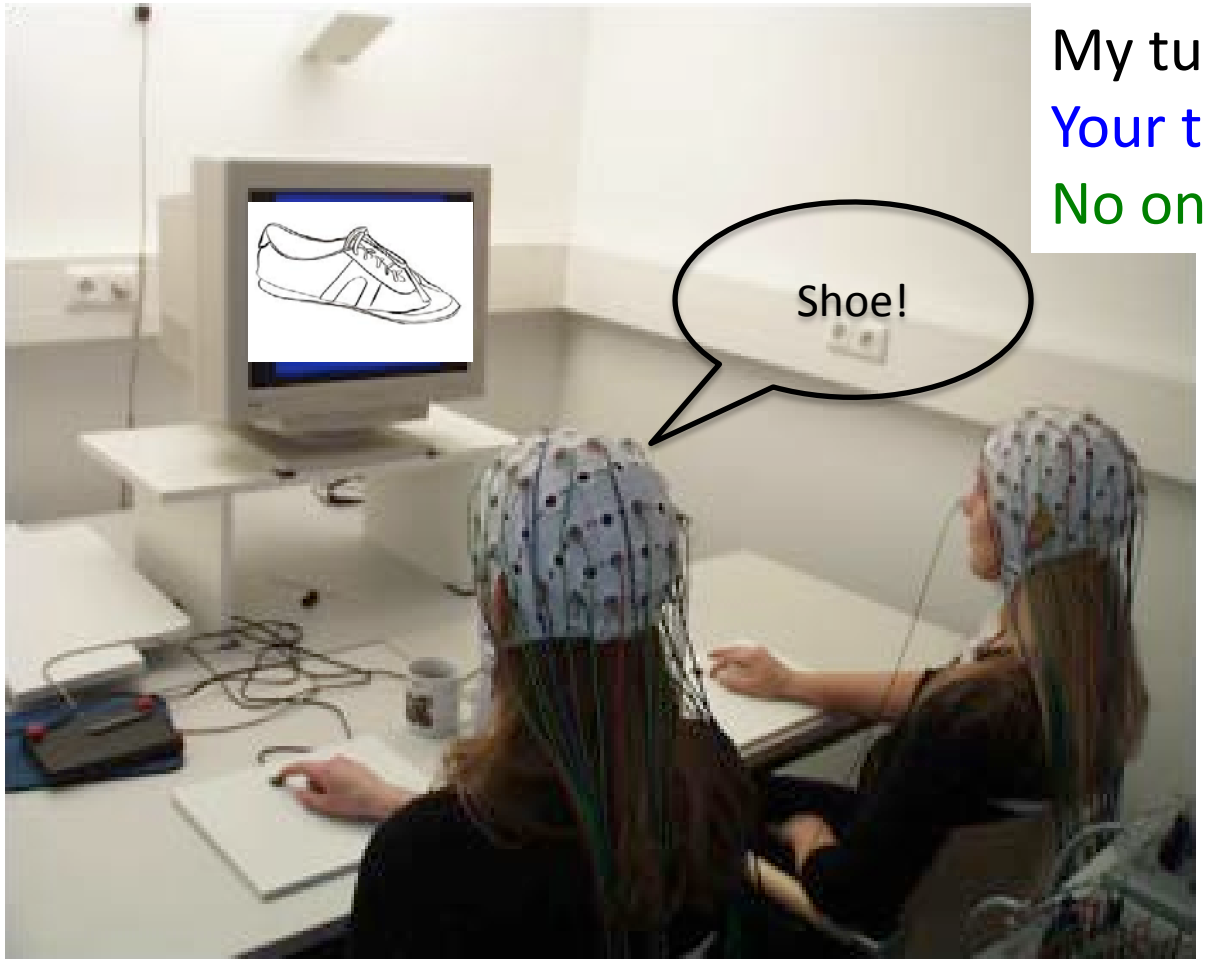


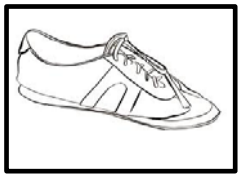
My turn (go)

Your turn (no-go)

No one´s turn (no-go)

Baus et al., Cognition 201

Is your task my task?

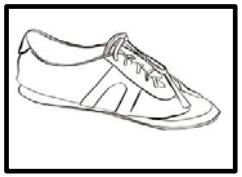


Effect of lexical frequency on naming:

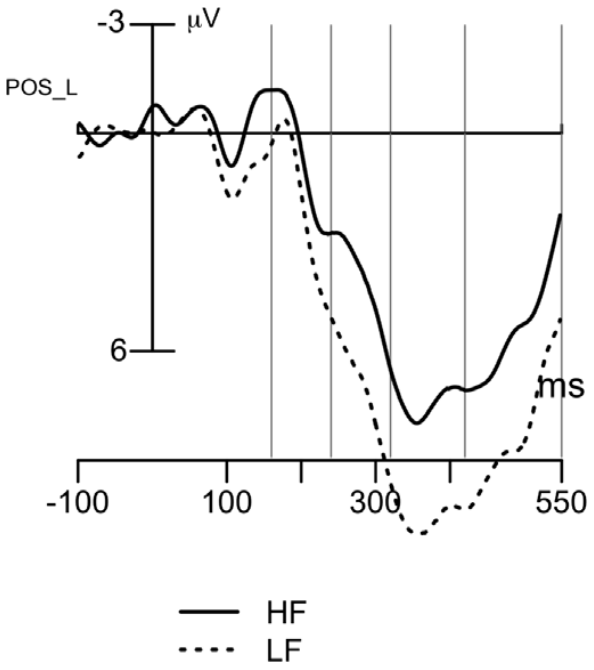
Naming **low frequency** words elicits a **larger positivity at posterior electrodes** than naming high frequency words

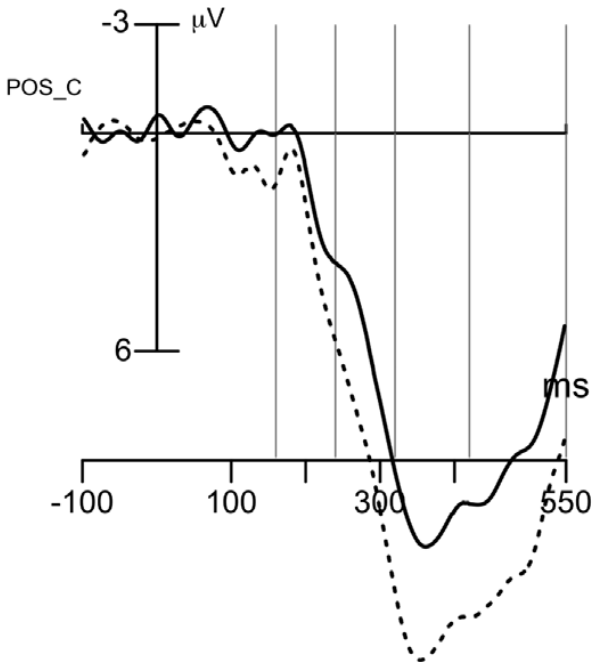
Effect of frequency on no-go trials?

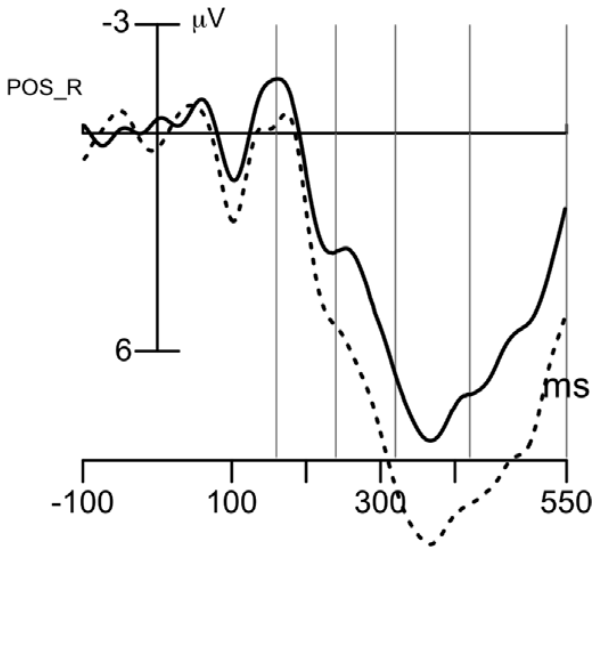
Is your task my task?



Go trials (my turn)

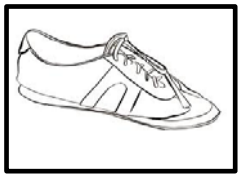




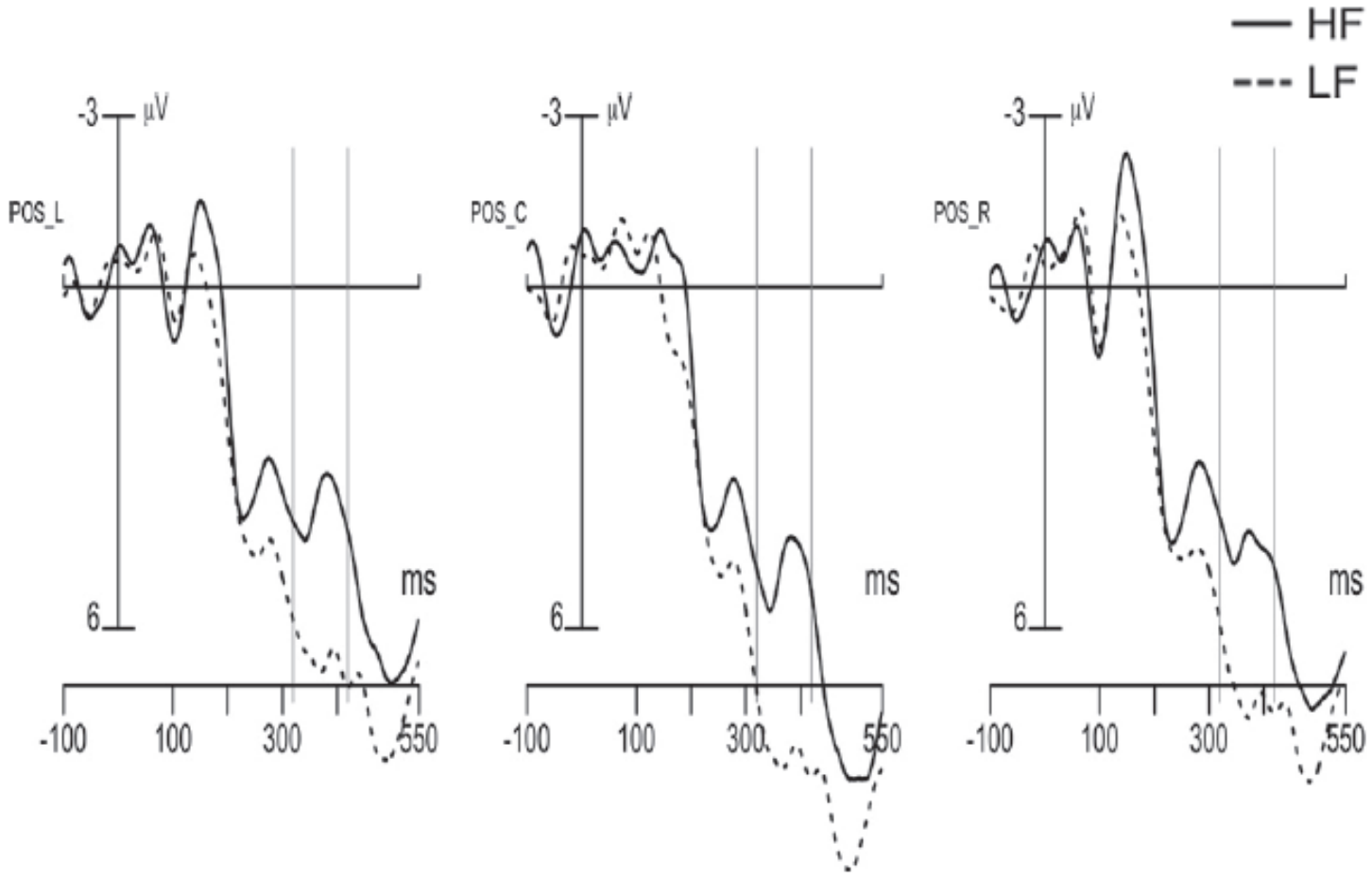


Baus et al., Cognition 201

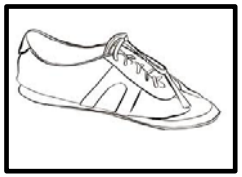
Is your task my task?



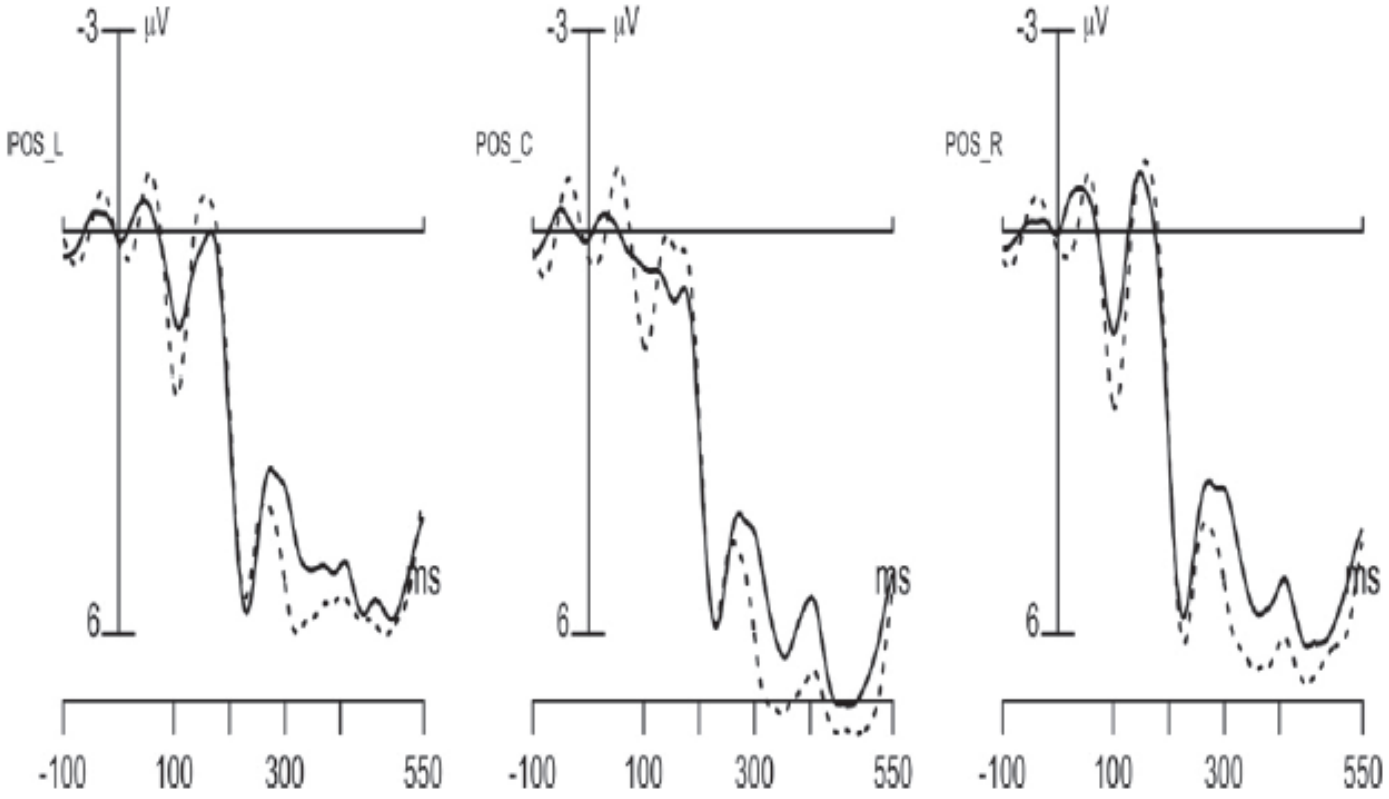
No-Go trials (you turn)



Is your task my task?



No-Go trials (nobody´s turn)



Baus et al., Cognition 201

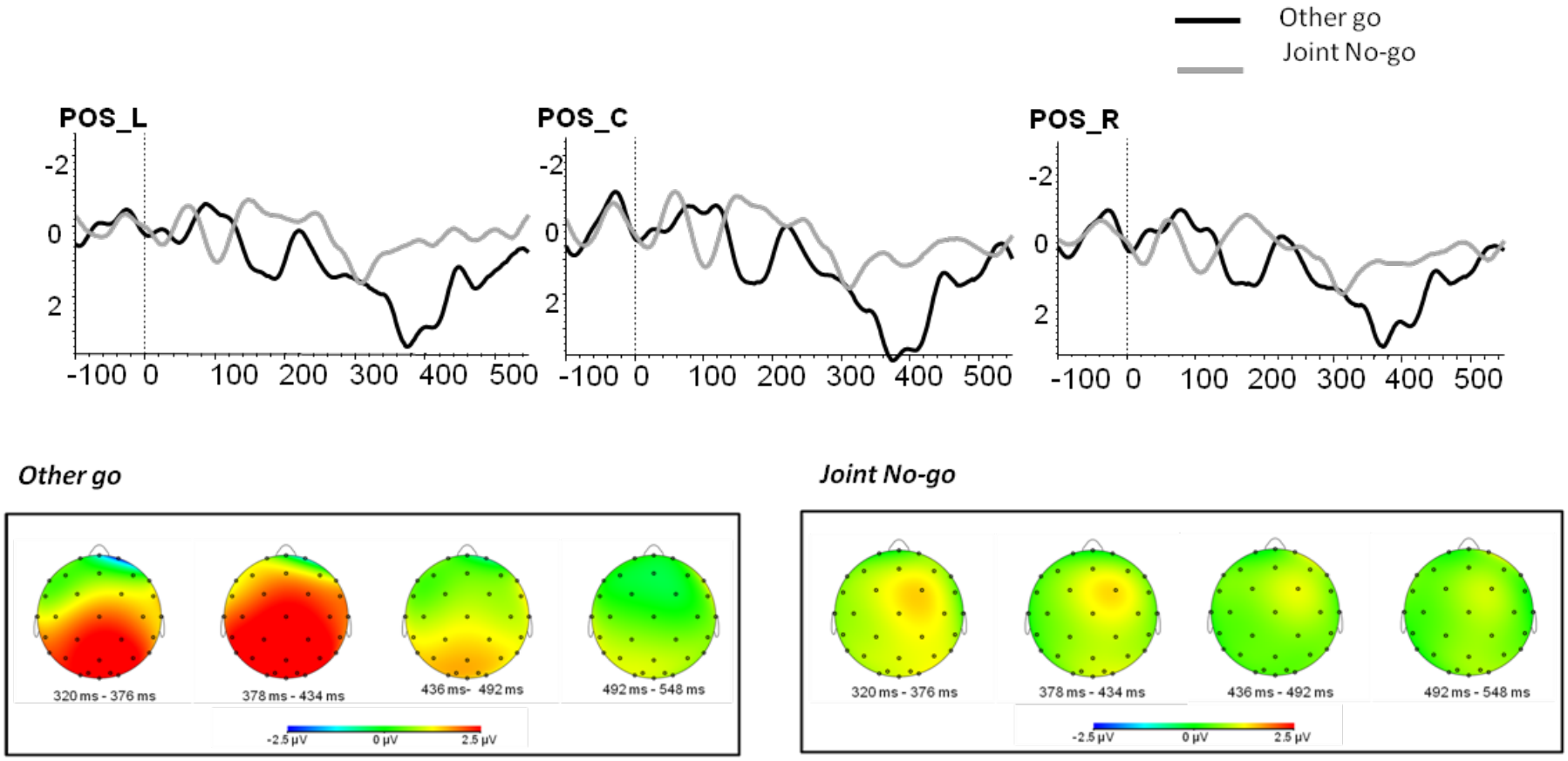
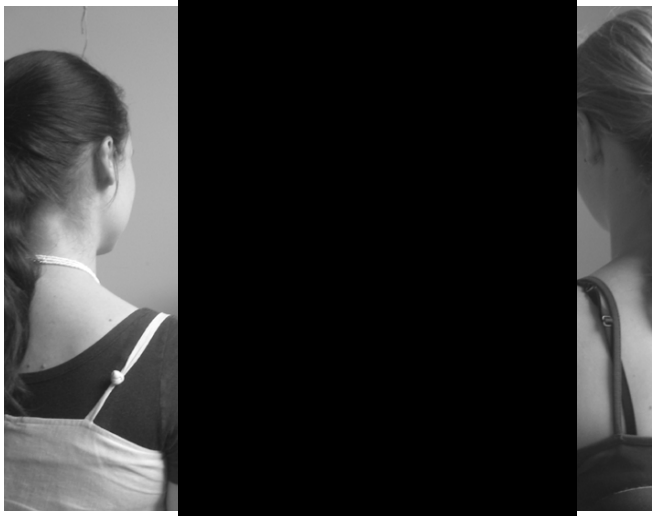


Fig. 5. Upper panel: Difference waves obtained by subtracting grand-average ERPs to high frequency words from ERPs to low-frequency words for other go (black line) and joint No-go trials (gray line) in the Joint Condition. Recording sites are posterior left POS_L (posterior left: T5, P3 and O1), Posterior central POS_C (posterior central: Pz, PO1 and PO2) and posterior right POS_R (posterior right: T6, P4 and O2). Lower panel: Topographical maps representing the frequency effect in the P300 time-window (low frequency words minus high frequency ones). Positive differences (red colors) correspond to low frequency words being more positive than high-frequency ones. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article.)

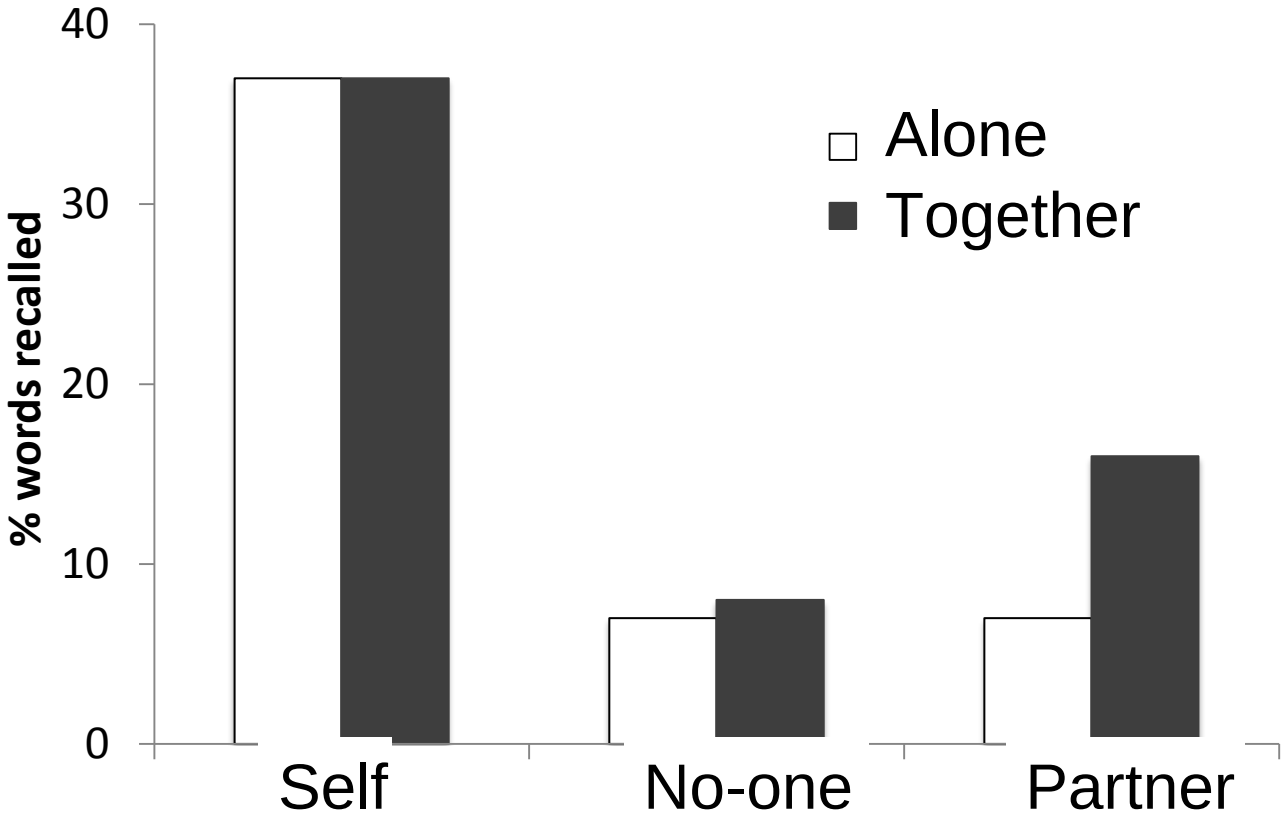
W[redacted]ys in m[redacted]



FOOD[redacted]AL?

FOOD[redacted]

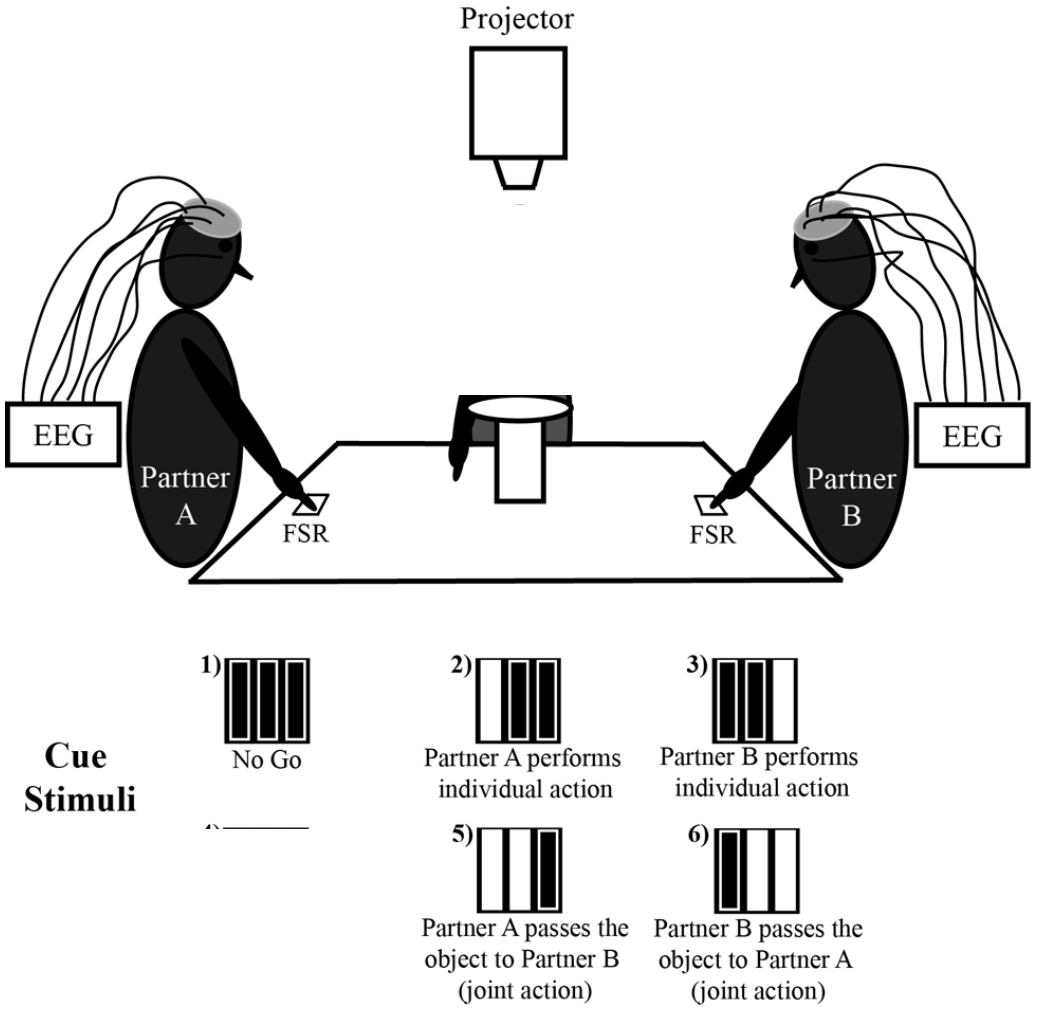
What stays in memory?



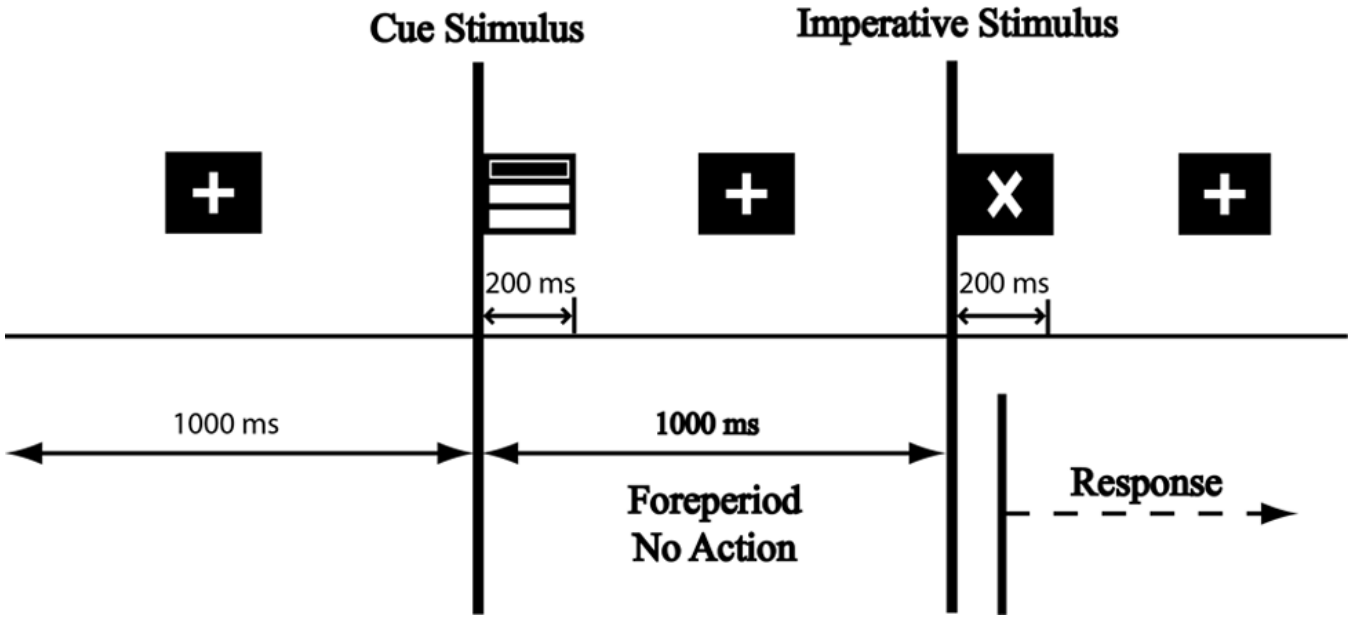
Eskenazi et al, PBR, 2013

Planning your action?

Planning partner´s action?



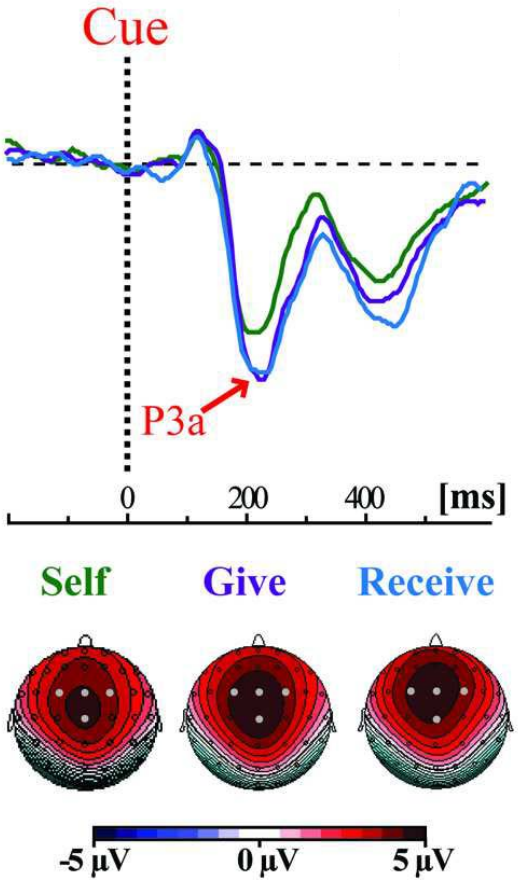
Kourtis, Sebanz, & Knoblich, Social Neurosci, 2013


Cue Stimulus
Imperative Stimulus
200 ms
200 ms
1000 ms
1000 ms
Foreperiod
No Action
Response

Planning partner´s action?

The P3a amplitude is larger when participants prepare for joint action.

This likely reflects a more complex task representation, where the other's part is specified in addition to one's own.



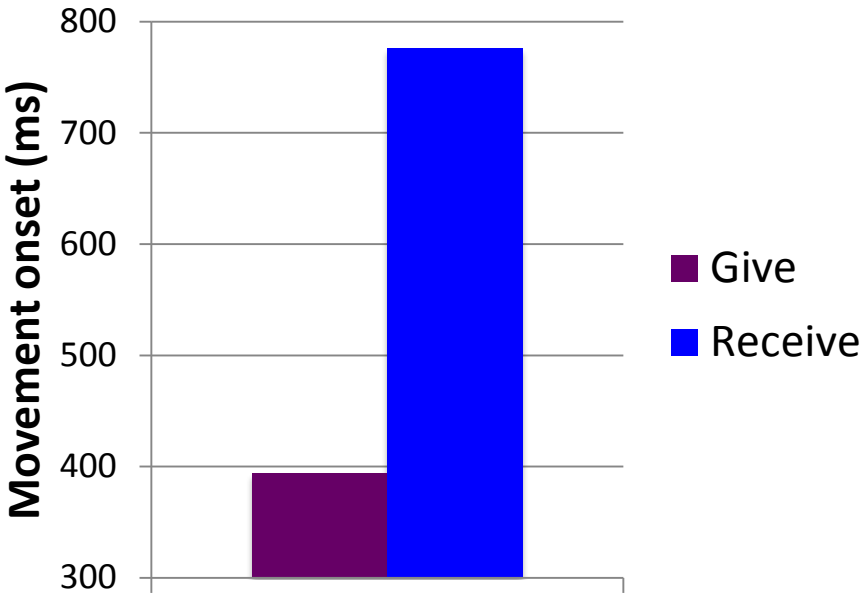
Kourtis, Sebanz, & Knoblich, Social Neurosci, 2013

Predicting other´s timing?

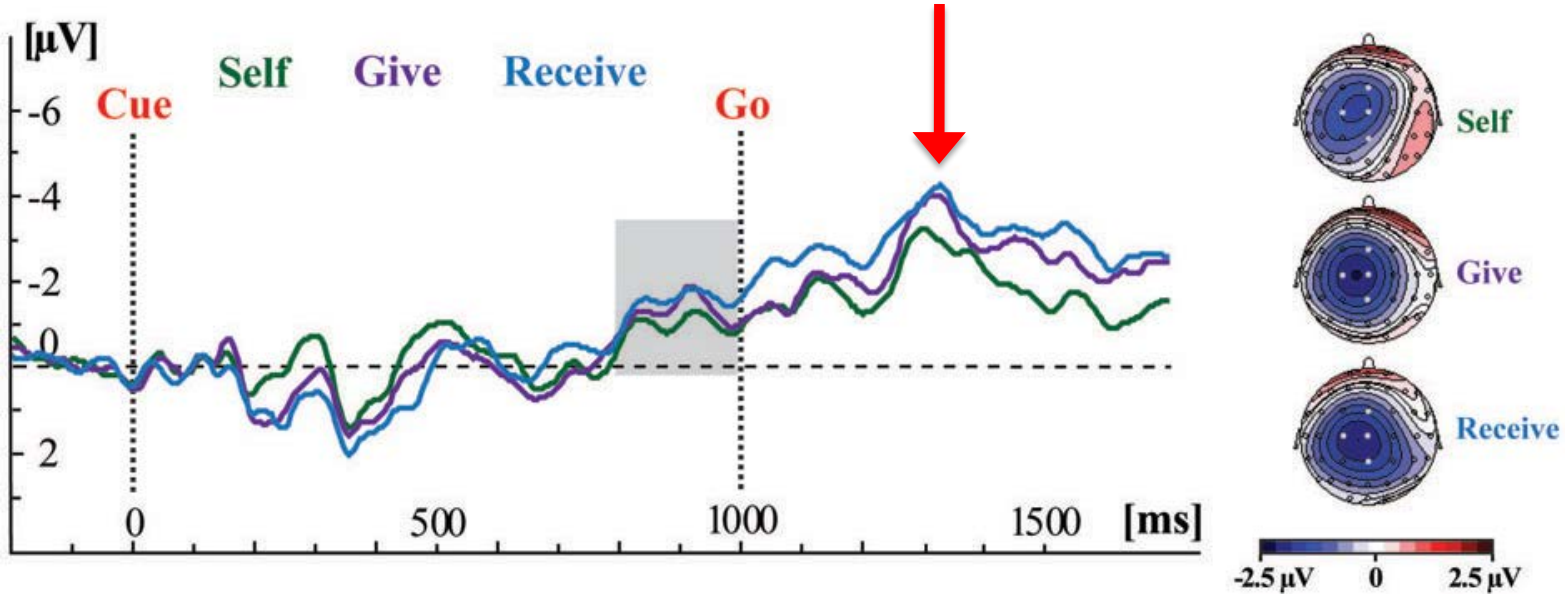
Giving actions are initiated much faster than receiving actions.

The late CNV is a neural marker of motor planning - peaks when people start to act.

If the receiver simulates the giver´s action, the CNV should peak at the onset of the giver´s action.

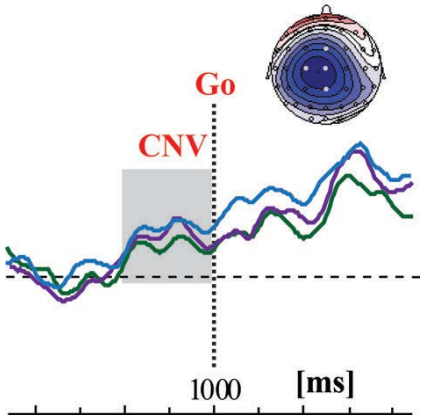


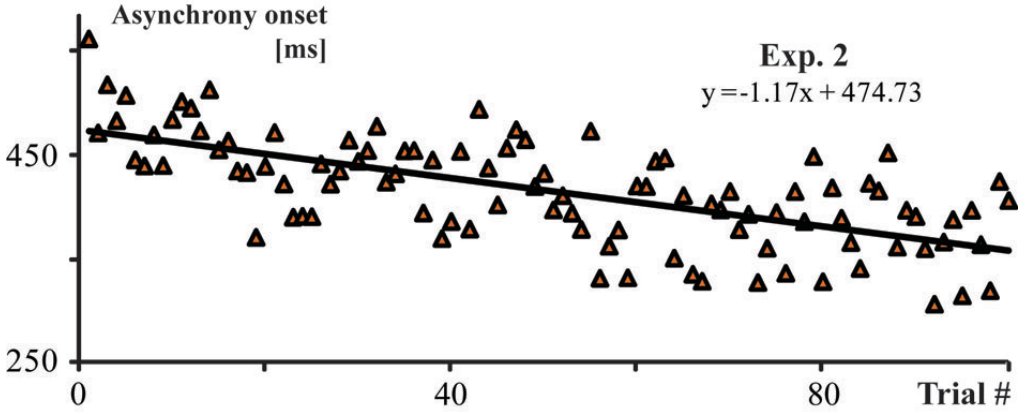
Predicting other´s timing?



The **motor CNV** in the receiver **peaked** around the time of the **giver's action** onset even though the receiver's response onset occurred much later.

Correlation with Joint Performance





The amplitude of the motor CNV in the receiver was correlated with the improvement in coordination performance ($r = 0.585$, $p = 0.022$).

Planning your action like my own?

How similar is solo and joint planning?

Kourtis, Knoblich, & Sebanz, JoCN, 2014

Bimanual Action

How similar is solo and joint planning?

Kourtis, Knoblich, & Sebanz, JoCN, 2014

Bimanual Action

Joint (Unimanual) Action

How similar is solo and joint planning?

Kourtis, Knoblich, & Sebanz, JoCN, 2014

Bimanual Action

Joint (Unimanual) Action

Unimanual Action

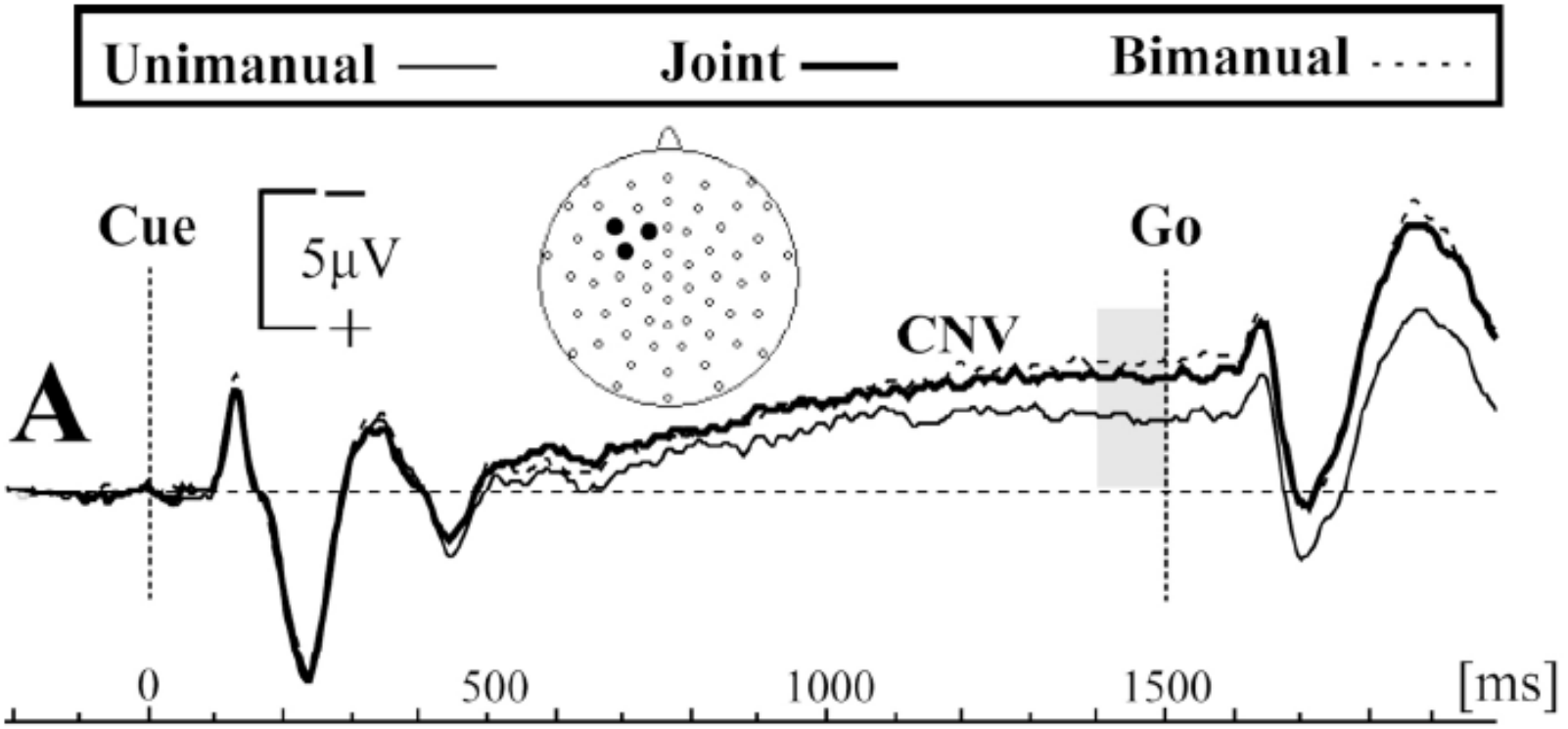
Predictions

Focus on marker of motor activation: CNV

Higher CNV in bimanual than in unimanual condition

Is CNV in joint action condition like bimanual or like unimanual?

Action Representation: CNV



Kourtis, Knoblich, & Sebanz, JoCN, 20

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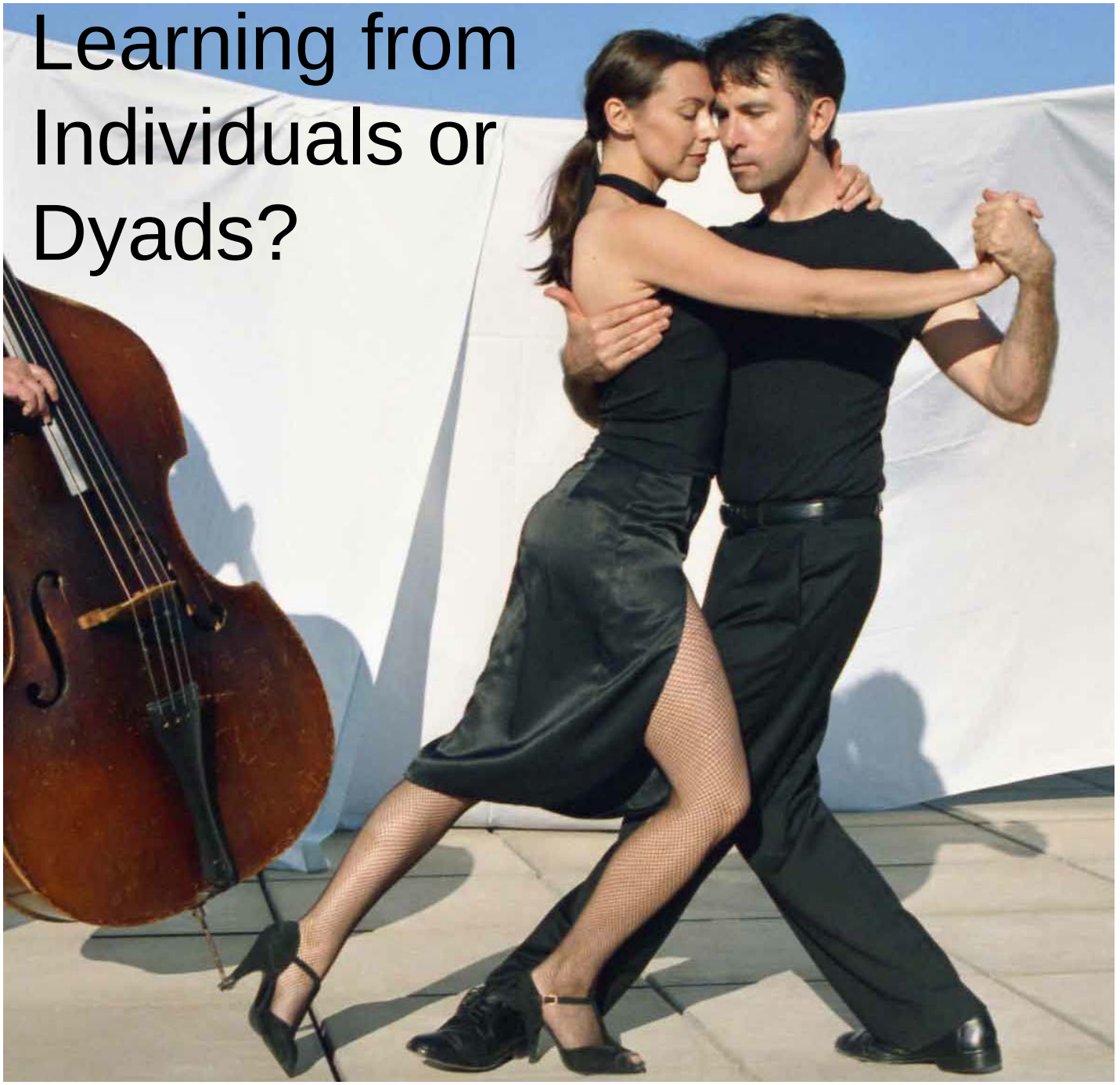
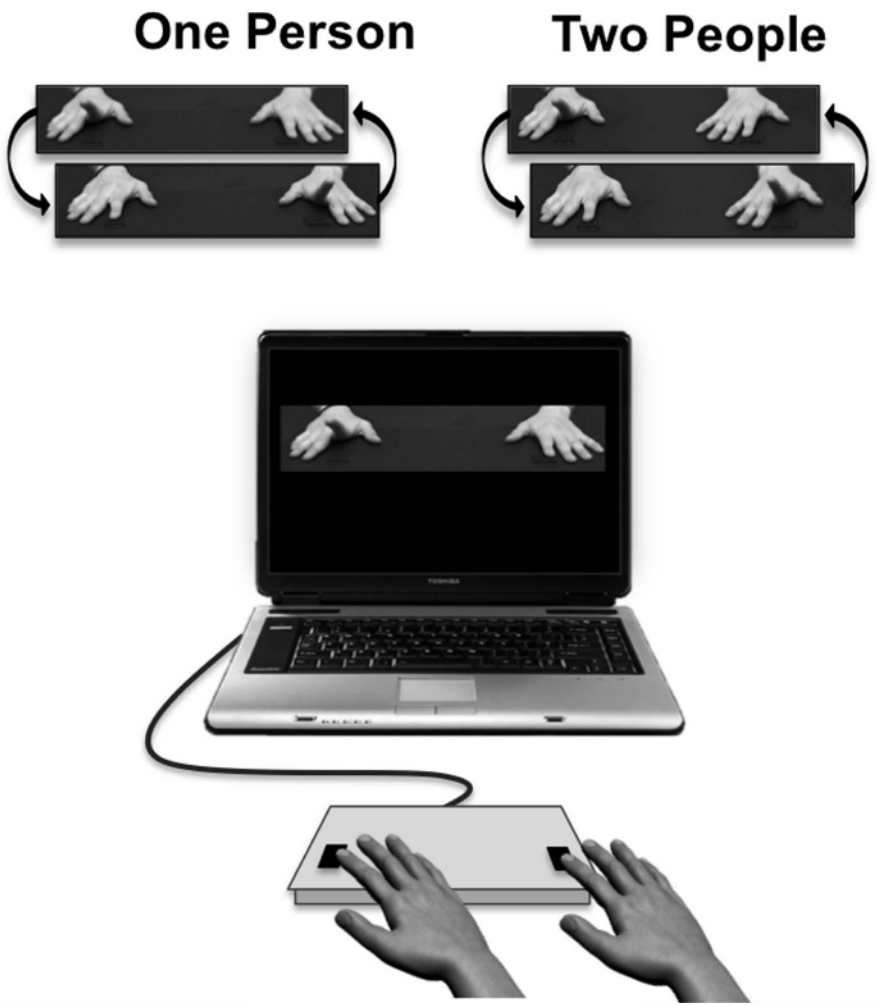
Learning from Individuals or Dyads?



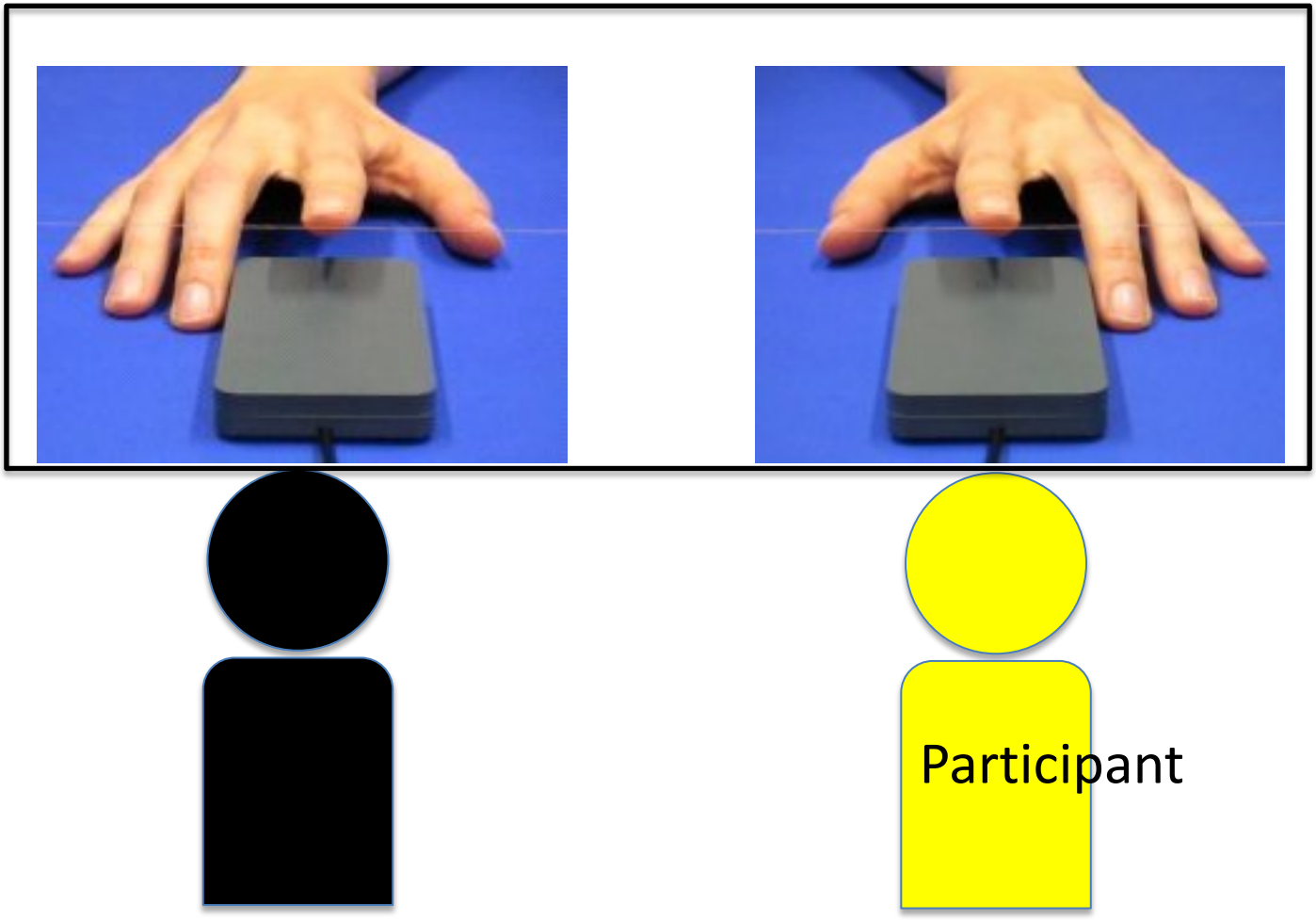
Learning from Individuals or Dyads?

Acting together, we mimic joint actions more than actions of one person.

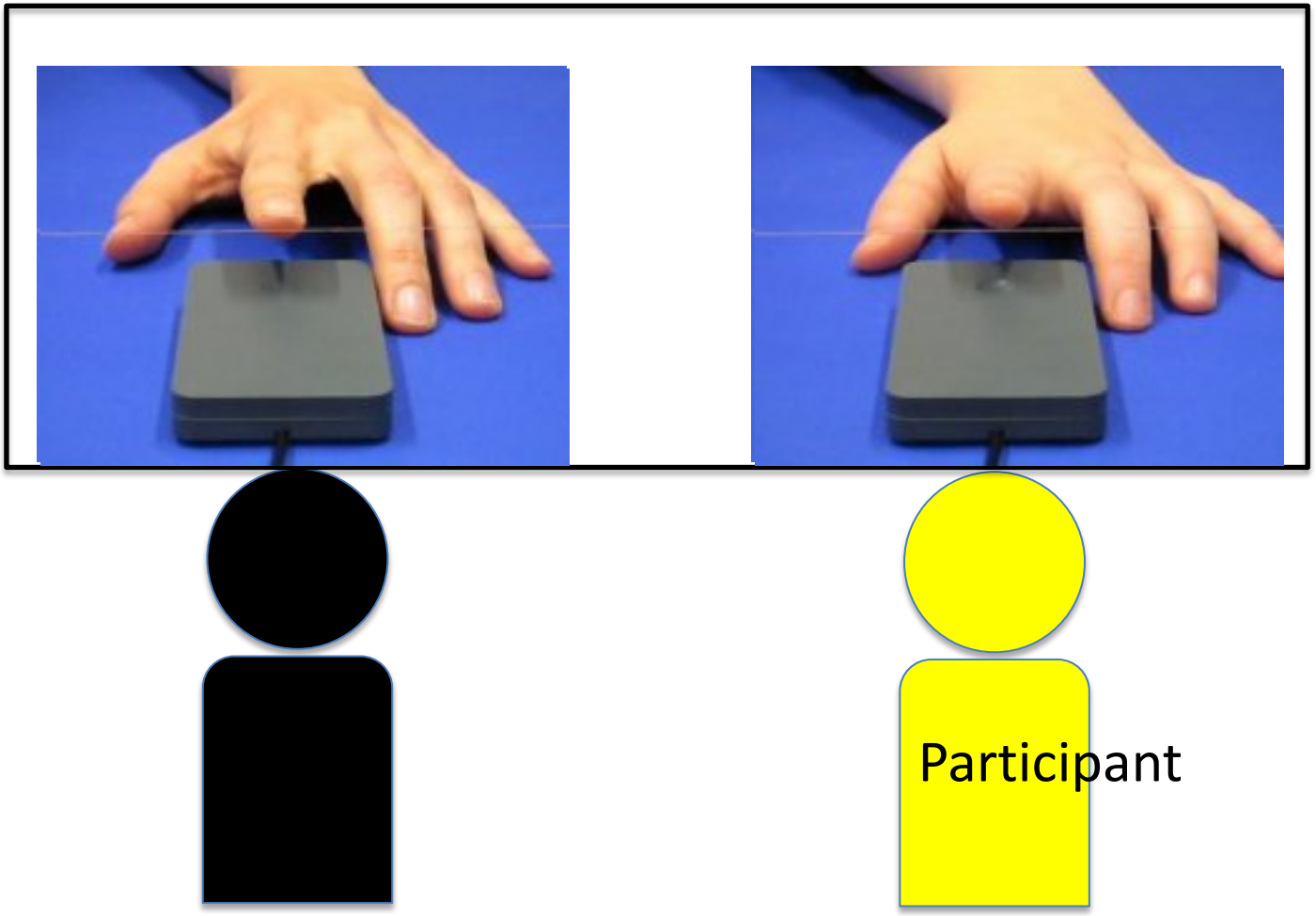
Acting alone, we mimic actions of one person more than joint actions.



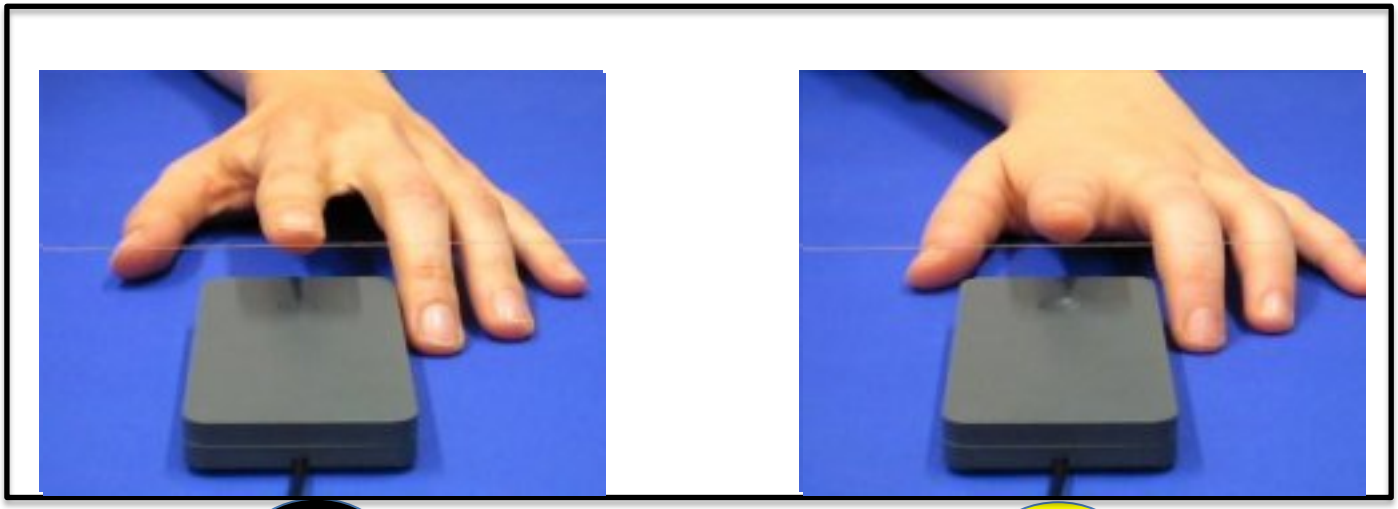
Observed: SOLO ACTION

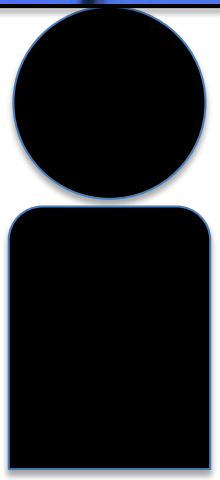


Observed: JOINT ACTION

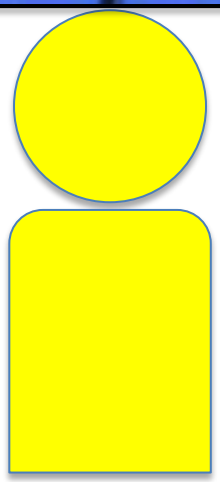


Compatible Condition





Press the key when the left hand is moving.



Press the key when the right hand is moving.

C

P

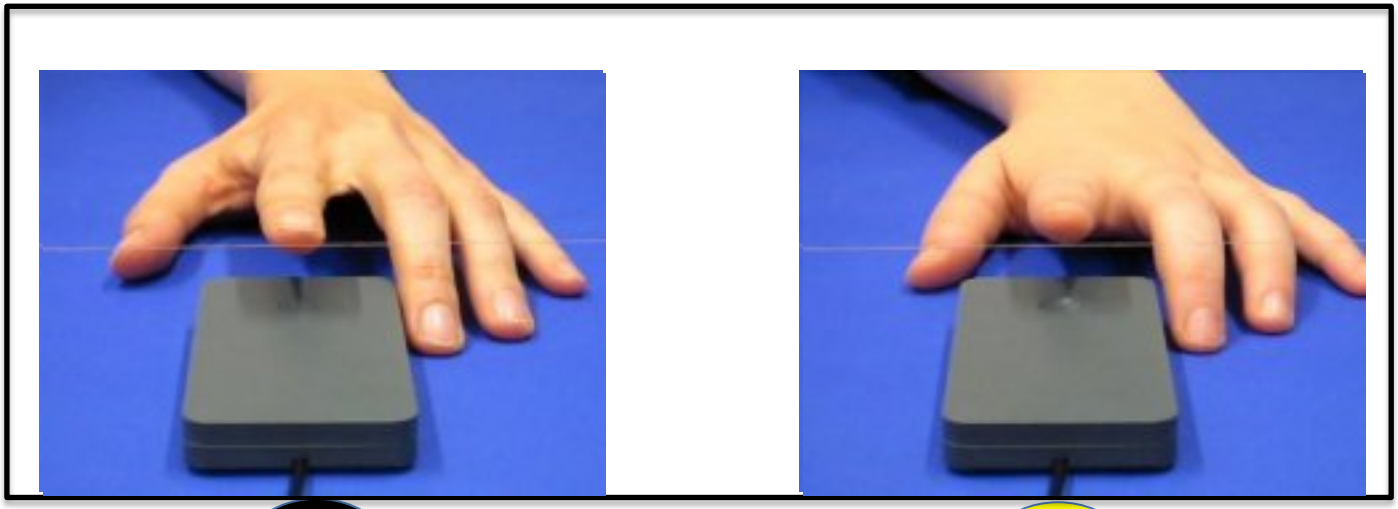
C

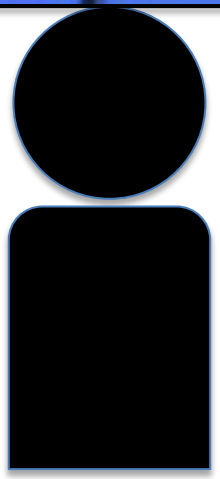
P

C

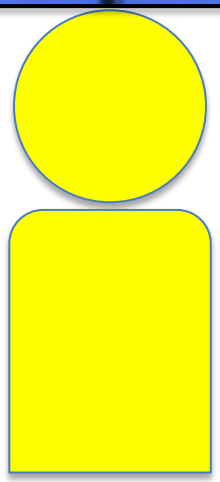
P

Incompatible Condition





Press the key when one hand is moving.



Press the key when the right hand is moving.

C

P

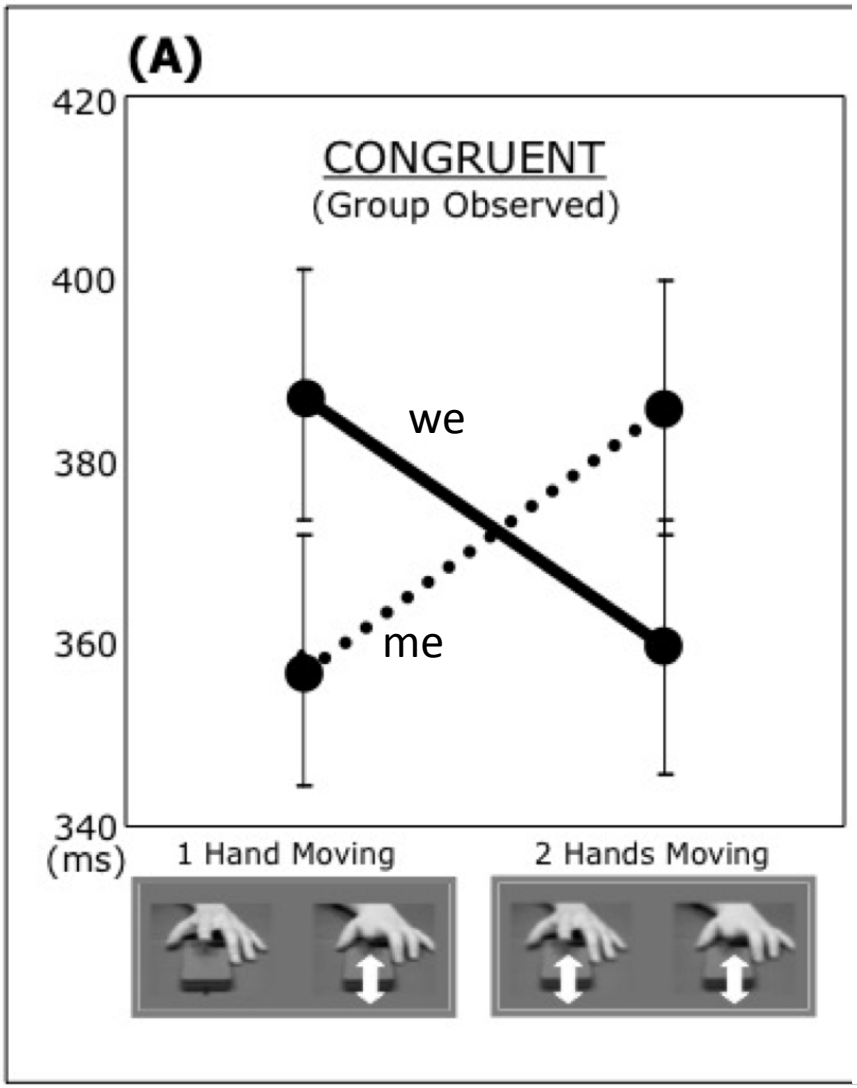
C

C

P

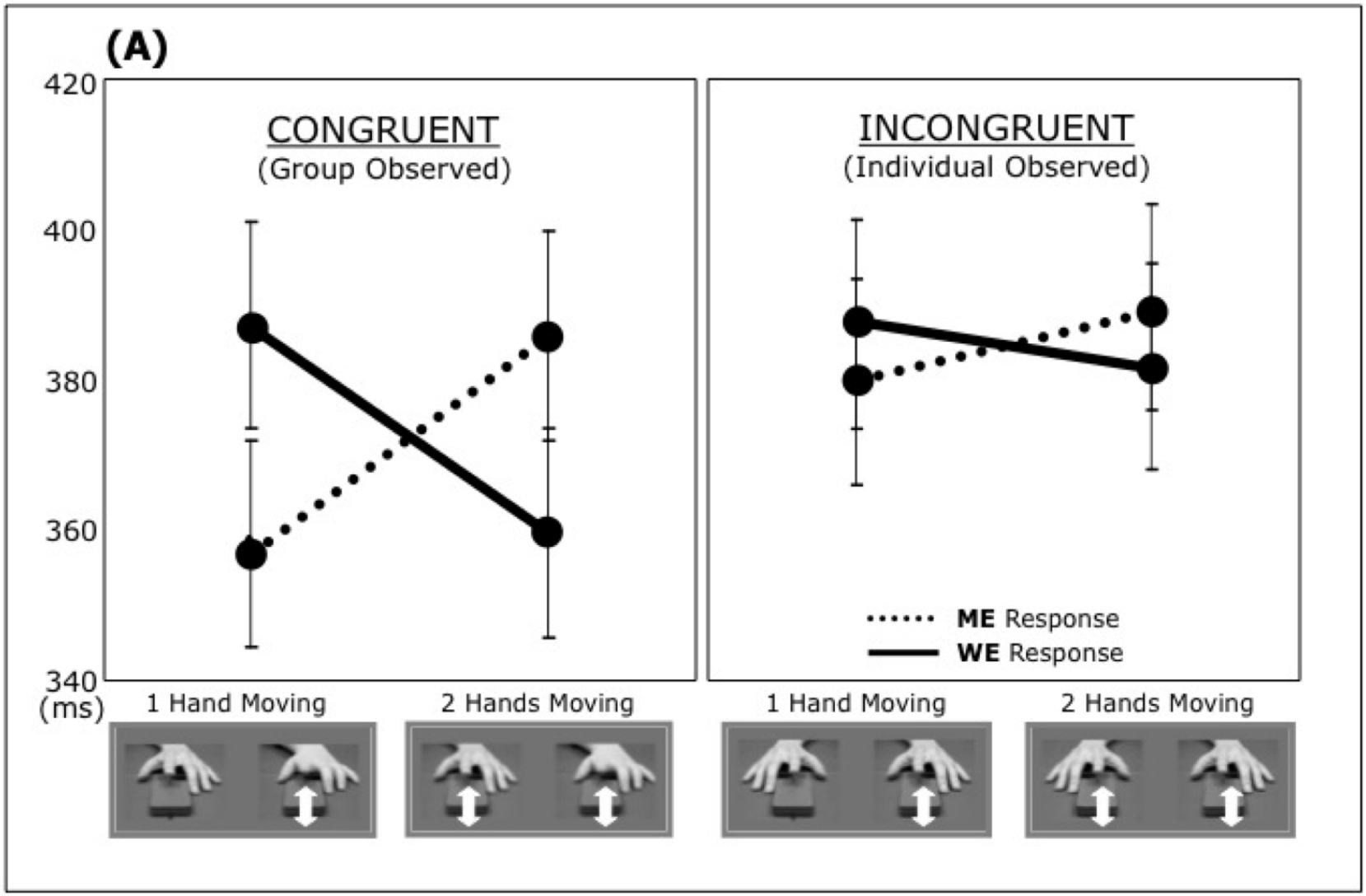
P

Tsai et al. 2011, Cognition



JOINT

Tsai et al. 2011, Cognition



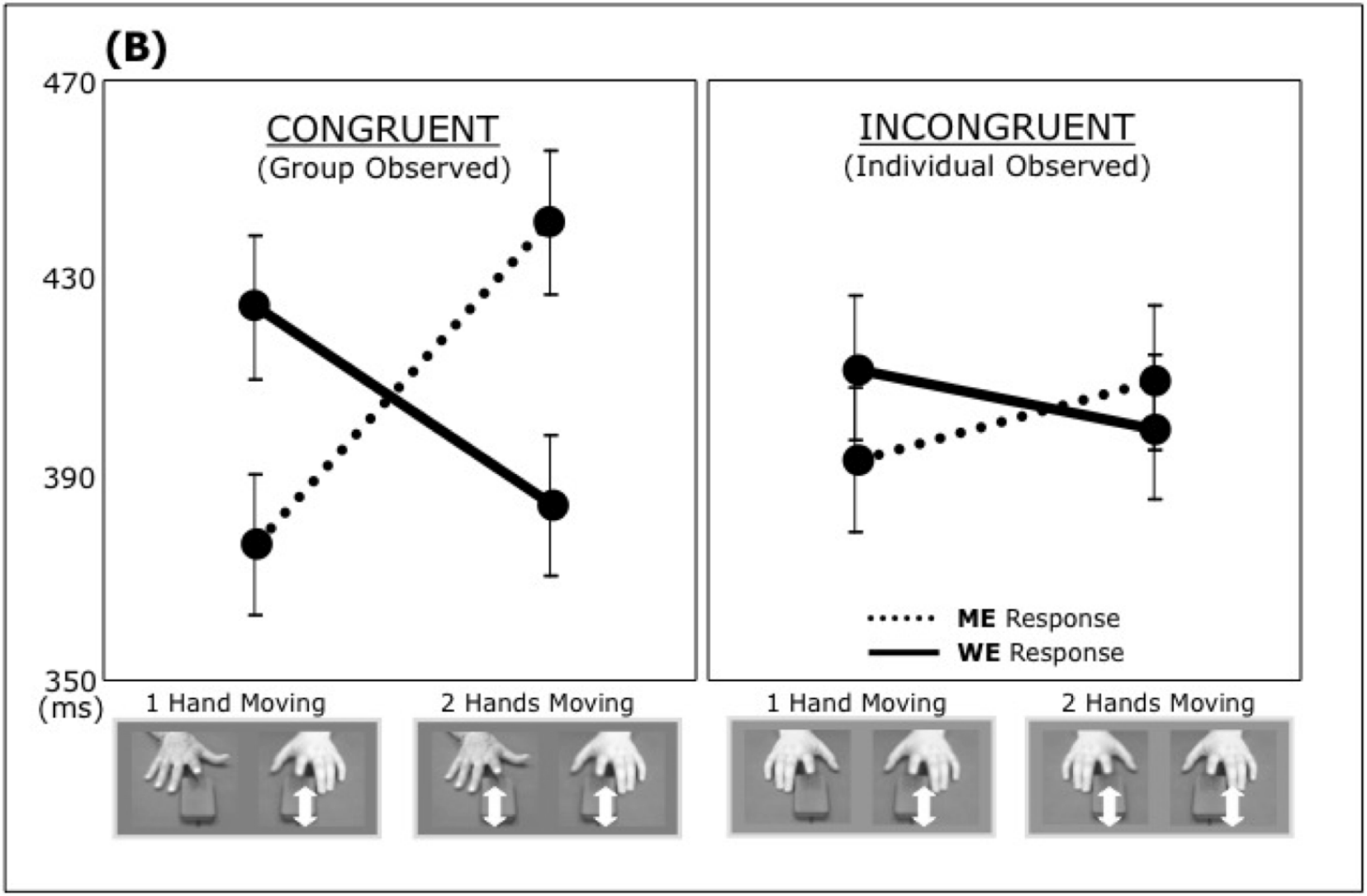
JOINT **SOLO**

Tsai et al. 2011, Cognition

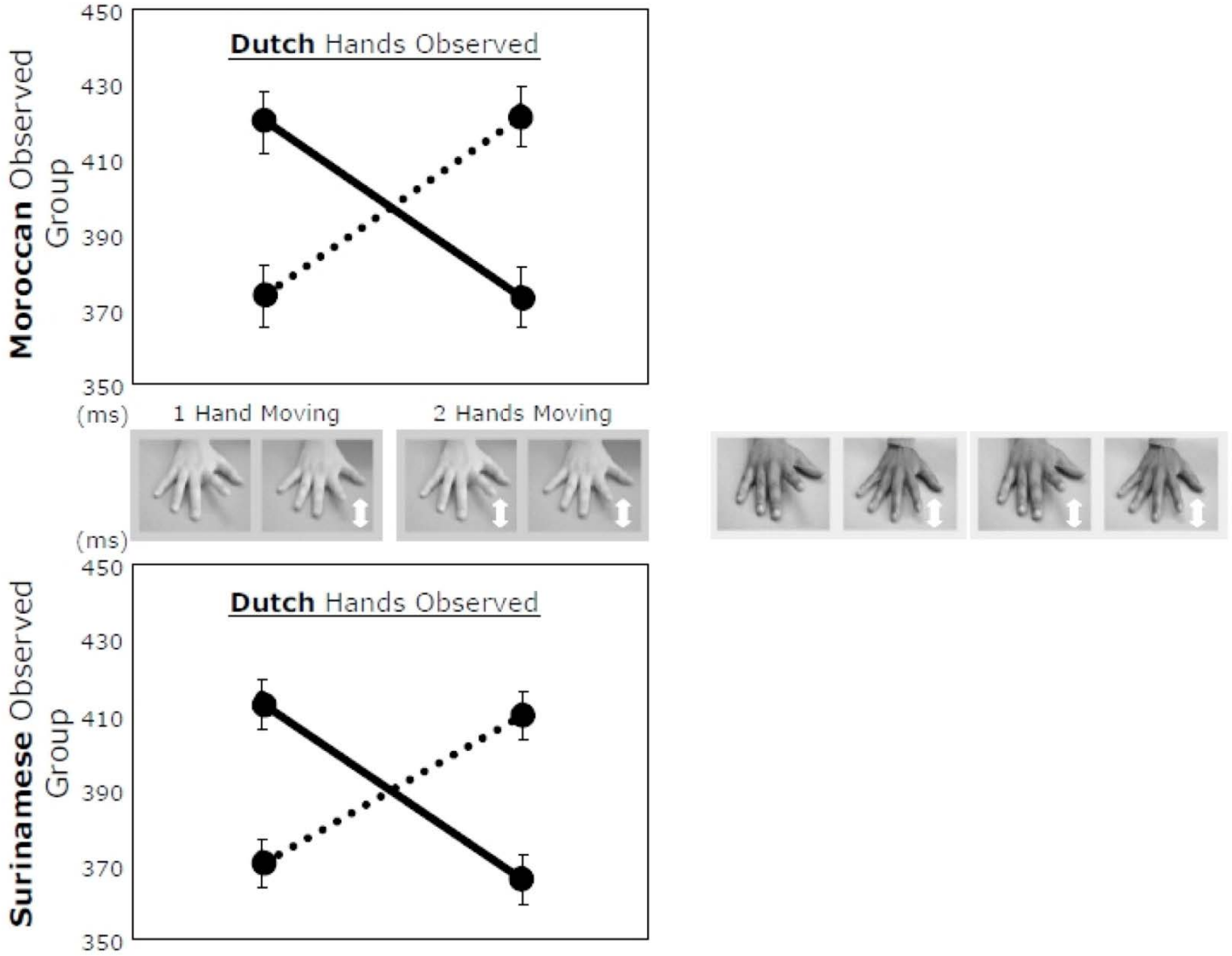
Control for Hand Arrangement

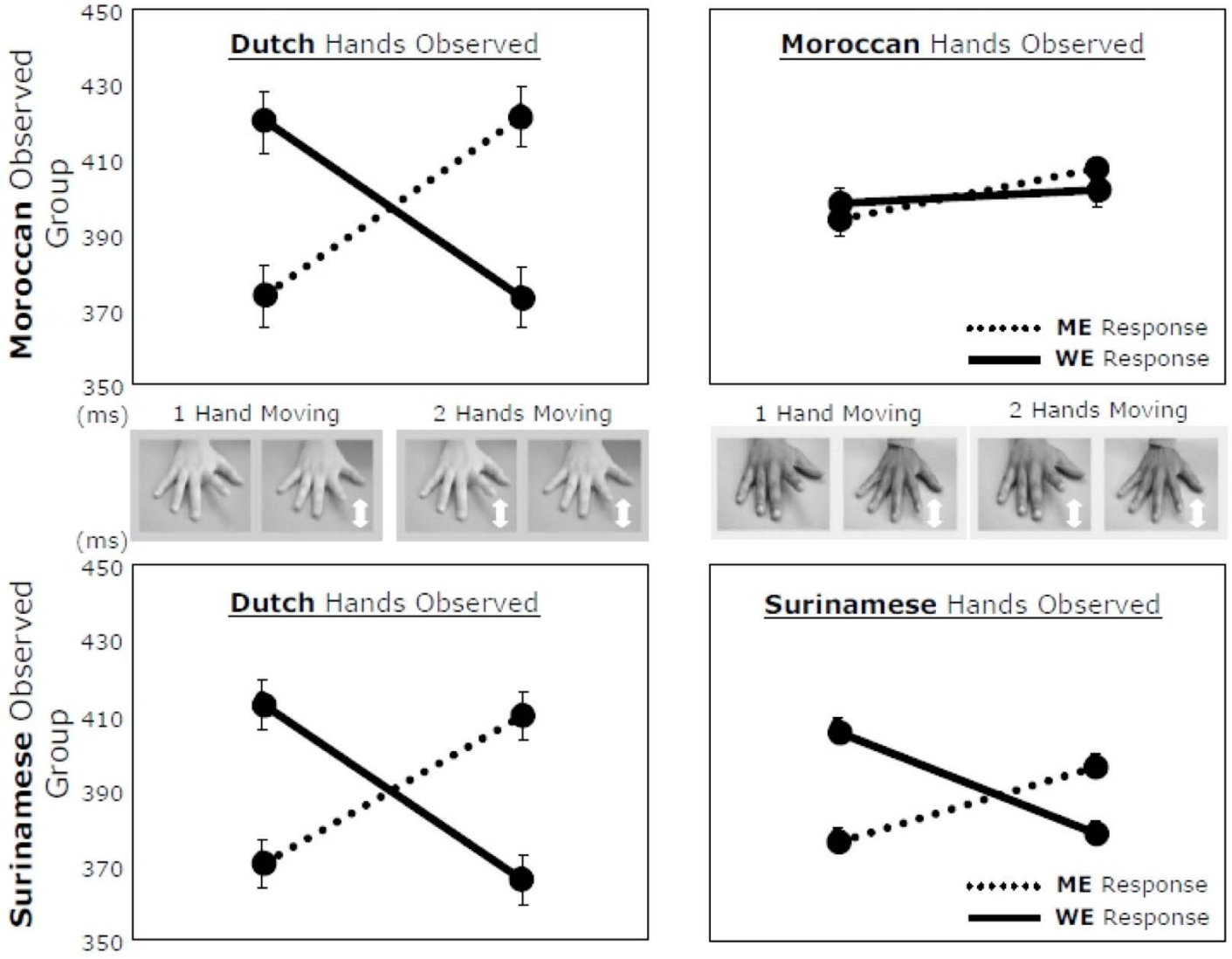
JOINT **SOLO**

Tsai et al. 2011, Cognition



JOINT **SOLO**


Moroccan Observed Group
Dutch Hands Observed
450
430
410
390
370
350
(ms)
1 Hand Moving
2 Hands Moving
(ms)
Surinamese Observed Group
Dutch Hands Observed
450
430
410
390
370
350


Moroccan Observed Group
Surinamese Observed Group
450
430
410
390
370
350
(ms)
Dutch Hands Observed
Moroccan Hands Observed
Surinamese Hands Observed
ME Response
WE Response
1 Hand Moving
2 Hands Moving

Overview

1. Making oneself predictable
2. Planning each other´s actions
3. Learning through joint action
4. **Human-robot interaction**

Robots as JA Partners?

Role of looks vs. motion

Anticipation (e.g., Hoffman & Breazeal, 2007)

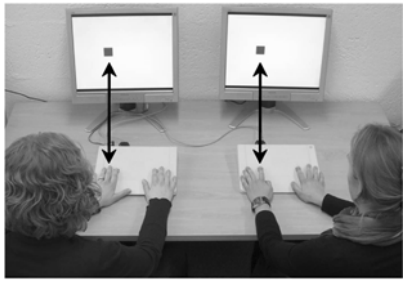
Fluency (e.g., Hoffman, 2013)

Robots as JA Partners?

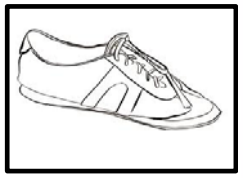
1) https://www.youtube.com/watch?v=0YpZnVCiMiU
2) https://www.youtube.com/watch?v=IJbfE2AtlSk

Conclusions

People modify their own actions to make themselves predictable: reducing variance and signaling



They plan task partner´s actions as if they were their own.



Conclusions

Joint action can be a motor for learning; dyads more faithfully imitate actions of other dyads than actions of single individuals

For robots to be valuable JA partners, getting the timing right is important.

THANKS!

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