Planning, Coordination, and Control in Joint Action

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Shared Intentions
Social Physics

Coordination through informational coupling (direct perception-action links; e.g., Marsh et al. 2006)

Explains why people naturally fall into synchrony, e.g., rocking in synchrony even against chair eigenfrequency (Richardson et al. 2007)
There is not only high-level long-term planning and low-level entrainment....

How do people plan and coordinate joint actions?

Which factors affect how much individuals feel in control during joint action?
1. Making oneself predictable
Task: Act in synchrony
Task: Act in synchrony
Task: Act in synchrony
Reducing variability

Vesper et al., EBR, 2011: **Synchronous action coordination**
Reducing variability

Vesper et al., EBR, 2011: Synchronous action coordination
Reducing variability

Vesper et al., EBR, 2011: Intentional vs. unintentional synchronous coordination
Task: Act in quick succession
Reducing variability

Vesper et al., EBR, 2011: **Sequential coordination (leader-follower)**

[Graph showing standard deviation and reaction time across individual and joint conditions.]

- **Standard deviation (ms):**
  - Individual: 80 ms
  - Joint: 100 ms

- **Reaction time (ms):**
  - Individual: 300 ms
  - Joint: 420 ms (increasing across blocks)

[Diagram illustrating variability and its relationship with reaction times and asynchrony.]

- Variability: 0.854** \( (0.188) \)
- Reaction times: 0.709** \( (0.188) \)
- Asynchrony: 0.755** \( (0.409** \)
Reducing variability

Also works in space!
Reduced variability in macaque monkeys

Visco-Comandini et al., Cortex, 2015
Reduced variability in macaque monkeys

Visco-Comandini et al., Cortex, 2015
A principle that could scale up...
2. Planning and predicting other’s actions
Planning partner’s action?

1) Cue Stimuli: No Go
2) Partner A performs individual action
3) Partner B performs individual action
4) Partner A passes the object to Partner B (joint action)
5) Partner B passes the object to Partner A (joint action)

Kourtis, Sebanz, & Knoblich, Social Neurosci, 2013
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
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.
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.
The amplitude of the motor CNV in the receiver was correlated with the improvement in coordination performance ($r = 0.585$, $p = 0.022$).
How similar is solo and joint planning?

Kourtis, Knoblich, & Sebanz, JoCN, 2014
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Kourtis, Knoblich, & Sebanz, JoCN, 2014
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, 2014
Conclusions

Reducing variability of one’s own actions is a basic and useful coordination mechanism.

A further key process is predicting task partners’ actions through motor simulation.

Planning and coordination processes are often tightly linked.