# The Role of Body and Tool Based Information on Joint Action Performance

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## Research question:

What are the underlying mechanisms governing collaborative behavior in humans? Is cooperative behavior guided by immediate sensory feedback (online control) or by representing the actions of the interaction partner (e.g. simulation)? We investigated this question in a collaborative/competitive table tennis task.

## Predictions:

|  | online control of action | simulating interaction partner |
|---|---|---|
| Seeing ball | most important | least important |
| Seeing interaction partner's tool | less important | less important |
| Seeing interaction partner's body | least important | most important |

**Table 1:** Online control theories (OCT) suggest that humans are able to extract task relevant information (e.g. information about the ball trajectory) online from a visual stimulus in order to guide one's own actions in real time via feedback loops. Thus, for increasing performance in a ball hitting task, it should be most important to see the ball, less important to see the interaction partner's racket and least important to see the interaction partner's body movements. However, simulation theories (e.g. direct matching) suggest that collaborative behavior relies on predicting the other's action by internally simulating observed behavior (body movements). Thus simulation theory suggests that it is most important to see the interaction partner's body movements, less important to see the interaction partner's racket and least important to see the ball.

## Experimental Paradigm:



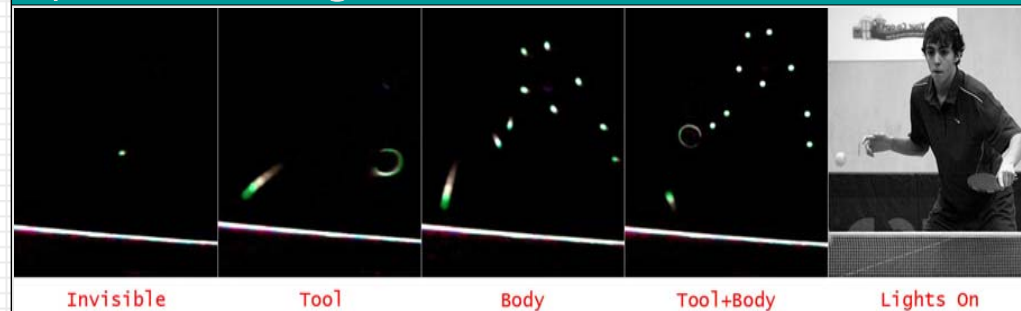Invisible    Tool    Body    Tool+Body    Lights On

**Figure 1:** Two participants played a table tennis game in complete darkness. The ball and the outline of the table was painted with "glow in the dark color". In the experimental conditions we manipulated visual information about the tools (rackets on or off) and the bodies (body markers on or off) of both players by attaching self-glowing paint on the paddle or on the upper body joints of the participants. The task was to play the ball back and forth without making errors. We expected that the availability of visual information about the tools and/or the body markers would affect the error rate of the dyad. If tool or body information is important, participants should make fewer errors if this information is available. We measured the performance of each player in terms of their **individual error rate (%)** which is the percentage of invalid returns.
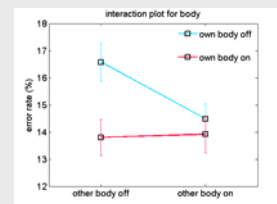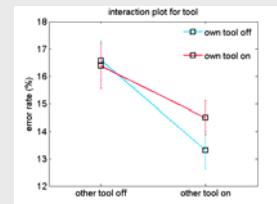
## Experiment 1 (cooperative table tennis):

- We measured the effect of seeing the one's own and the interaction partner's tool (racket on vs. off) and seeing one's own and the interaction partner's body movements (markers on vs. off) on individual error rate (%).

- 14 pairs of participants (students)

- Results:
  - **sign. effect of other tool** (p<0.01)
  - no sign. effect of other body
  - sign. effect of own body (p<0.01)
  - no sign. effect of own tool



## Experiment 2 (competitive table tennis):

- Using individual error rate, we measured the effect of seeing one's own tool and the interaction partner's tool (racket on vs. off) as well as seeing one's own body and the interaction partner's body (markers on vs. off).

- 14 pairs of participants (students)

- Results:
  - **sign. effect of other tool** (p=0.03)
  - **sign. effect of other body** (p<0.001)
  - no sign. effect of own tool
  - no sign. effect of own body
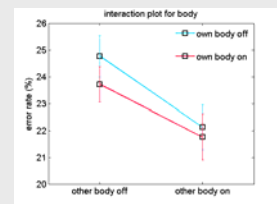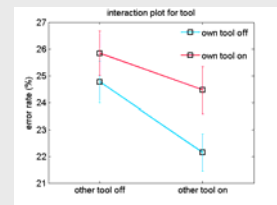


## Conclusions:

- Seeing interaction partner's **tool** is important independently from the social context
- Seeing the interaction partner's **body** is only important in competitive TT. Why?
  - Simulation occurs/helps only in competitive play?
- 2 different processes might be involved:
  - one process to predict the ball trajectory (online control)
  - one process to predict the interaction partner's actions (simulation in competition)