

"If you go, I don't care"

The role of co-representation in response inhibition and error detection

Stephan Miedl, Ellen R. A. de Bruijn, and Harold Bekkering

Nijmegen Institute for Cognition and Information (NICI), Radboud University Nijmegen, The Netherlands

JAST
Joint Action
Science and Technology

nicl
Nijmegen Institute for Cognition and Information
Radboud University Nijmegen

Background

Until recently, action-monitoring studies solely focused on single-actor settings while in daily life humans often work together on tasks. Consequently, the monitoring processes involved in joint action have not been investigated thoroughly.

- Efficient behaviour requires inhibitions of incorrect responses and fast detection of errors. These action-monitoring processes can be investigated by examining event-related potentials (ERPs) and reaction-time measurements.
- When performing a task together, humans often divide subtasks among the actors involved. As a result, people form a representation of their own and the others' tasks. However, the possible effects of this so-called co-representation on action monitoring are not yet known.
- In addition, competitive elements in a joint task create different response strategies depending on the performance of the partner.

In the current study, we wanted to investigate...

- (1) ...how the formation of a co-representation affects response inhibition
- (2) ...whether this influences performance levels and error-detection processes, and
- (3) ...what role competitive response strategies may play in these processes.

Methods and design

- Joint Go-NoGo task (14 pairs, 1600 trials)



Stimuli	Actor 1 (EEG)	Actor 2 (RT)	Condition
S1 (55 %)	Go	Go	Both Go
S2 (15 %)	Go	NoGo	Self Go
S3 (15 %)	NoGo	Go	Self NoGo
S4 (15 %)	NoGo	NoGo	Both NoGo

Measures of interest

- Response inhibition as reflected in the NoGo P3
- Behavioural results: overall performance and effects of competition
- Error-related activity as reflected in the error-related negativity (ERN)

ERP results: NoGo P3

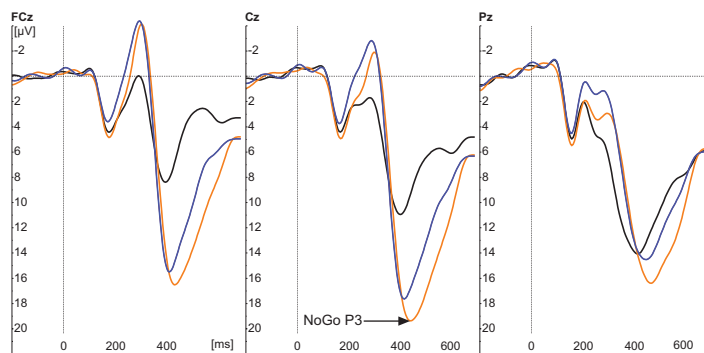


Figure 1. Grand average stimulus-locked ERP waveforms for correct **Self Go**, **Self NoGo**, and **Both NoGo**.

- The NoGo P3 is smaller on Self NoGo stimuli compared to Both NoGo trials ($p = .001$).

Behavioural results

Table 1. Mean reaction times and proportions for correct and incorrect responses

Type of response	Condition	Reaction time (proportion)
Correct	Both Go (Go / Go)	313 (96.4)
	Self Go (Go / NoGo)	348 (63.3)
Incorrect	Self NoGo (NoGo / Go)	276 (25.3)
	Both NoGo (NoGo / NoGo)	282 (16.0)

- Incorrect responses were faster than correct responses ($p < .001$).
- Participants made more errors on Self NoGo stimuli than on Both NoGo stimuli ($p = .030$).

ERP results: Error-related negativity (ERN)

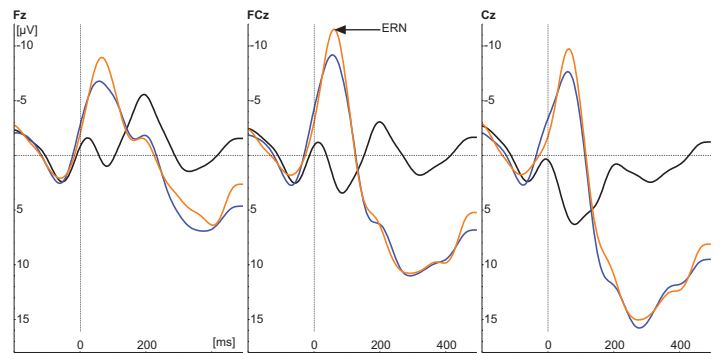


Figure 2. Grand average response-locked ERP waveforms for **correct Self Go**, **Incorrect Self NoGo**, and **Incorrect Both NoGo**.

- The ERN is smaller for incorrect Self NoGo than for incorrect Both NoGo ($p = .030$).

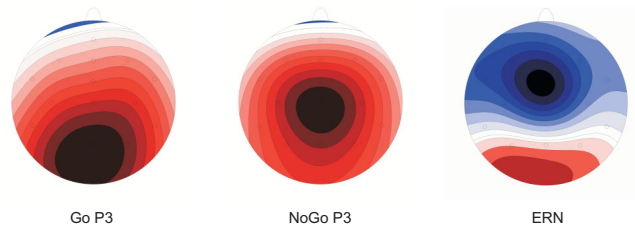


Figure 3. Topography of ERP components

Effects of competition

- The EEG participants who had more fast responses than their partner in the Both Go condition were assigned to the subgroup of 'Fast responders' ($N = 7$).

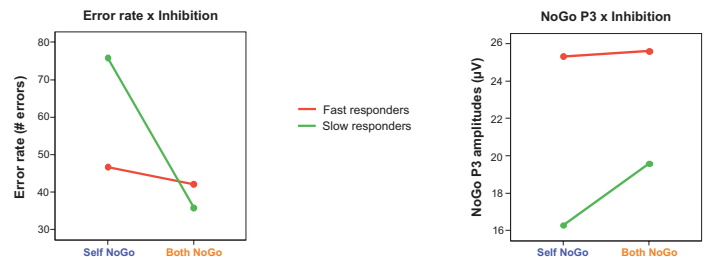


Figure 4. Left panel: Error rate x Inhibition interaction, Right panel: NoGo P3 x Inhibition interaction

- The subgroup of Slow responders was mainly responsible for the increased error rate in the Self NoGo condition (interaction: $p = .047$).
- Similarly, the Slow responders mainly caused the reduced NoGo P3 on Self NoGo stimuli (interaction: $p = .004$).

Conclusions

- Co-representing the other persons task leads to less response inhibition on stimuli that require a response of the other person, compared to stimuli that required inhibition of both actors. These differences in response inhibition result in...
 - (1)...decreased performance on stimuli that require a response of the other person. This finding suggests that co-representation results in conflict at the task level, namely the representation of your own task is in conflict with the task of the other person.
 - (2)...increased error detection on stimuli that require inhibition of both actors. This outcome indicates that the impact of the error is larger when the erroneous response is in conflict with the task of the other person.

The existence of a co-representation in a joint task leads to specific modulations of action-monitoring processes. Interestingly, these effects may also depend on the response strategies people employ in a competitive setting.

Task knowledge of a co-actor's behavioral patterns may help deciding when to respond and when not. Co-representation provides an additional source of information that may be used to support a robot's decisions whether to act or to refrain from acting.