

# The faster one has blinkers on: The role of co-representation in response inhibition and error detection

Stephan Miedl<sup>1</sup>

Supervisors: Ellen de Bruijn<sup>1</sup>, and Harold Bekkering<sup>1</sup>

<sup>1</sup>*Nijmegen Institute for Cognition and Information, Nijmegen, The Netherlands*

Earlier experiments have shown that the formation of a co-representation of the task of others influences one's own action behaviour. The aim of the present study was to investigate how differences in co-representation, while doing a go-nogo task together with a second participant, influence one's own action-monitoring processes. The results showed a smaller NoGo P3, more errors and a reduced ERN on stimuli requiring only the response of the other participant compared to stimuli requiring the inhibition of both participants. Moreover, significant interactions with competitive response strategy revealed that the monitoring processes of fast responders were least affected by shared action representations. These results create evidence that 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.

*Keywords: ERN, response inhibition, error detection, co-representation*

## 1. Introduction

Until recently, action-monitoring studies focused solely on single-actor settings while in daily life humans often work together on tasks. Consequently, action-monitoring processes like response inhibition and error detection have not been investigated thoroughly in joint action. When performing a task together, humans often divide subtasks among the actors involved. As a result, people form not only a representation of their own tasks, but also of the others' tasks. However, the possible effects of this shared action representation or 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 individual speed-accuracy trade-off. In the current study, we want to investigate (1) how differences in co-representation affect response inhibition, (2) whether differences in co-representation influence performance levels and error-detection processes, and (3) what role competitive response strategies may play in these processes.

### 1.1 Joint action

When approaching a green traffic light that is about to turn red, while having a car in front of you, the chance is high that the driver in the car in front of you will stop. This makes you slow down, to prevent an accident. Therefore successful driving means dealing with the appropriate behaviour of your own as well as the behaviour of other traffic participants.

The concept of joint action is related to mentally representing the task, acting together with other people, and being part of a group. One of the basic assumptions in joint-action research was proposed by Prinz (1995), who created a new framework to understand the functional relationship between perception and action. He raised two principles. First, the common-coding principle states that perception and action share a common representational domain. Second, the action-effect principle indicates that the outcome of actions influences planning and control of these actions. These two principles play a crucial role in joint action. The common-coding principle enables integrating information of the other person's behaviour in one's own representation system. The action-effect principle is responsible for using this integrated information in a goal-directed manner.

This means observing another person grasping a cup should not only activate my own motor system for grasping, but also activate part of the motor system to bring the cup to my mouth. Support for this came from Ramnani & Miall (2004), who conclude that predicting the actions of others activates brain areas engaged in mental state attribution, reflecting a formed representation of an intentional relation. Therefore, we define joint action broadly, which means not only situations where people work together physically, but also mentally, in situations where people have to achieve a common goal in mind. Action representations become shared as soon as people are aware that they are part of a group and tasks are distributed within this group (Sebanz, Knoblich, and Prinz, 2005). This means that any member of a group forms, along with one's own task representation a co-representation of the tasks of other members. There is evidence that own actions and other's actions are represented in a functionally similar way. Sebanz et al. (2003) demonstrated an action-selection conflict for stimuli requiring an action from both actors in a "Go-NoGo" task, where participants were sitting next to each other. Interestingly, each actor integrated the co-actor's action alternative in his/her action planning, even when it was not possible to observe the other's actions. Additional support comes from an experiment by van Schie et al. (2004) where subjects had to observe actions performed by another person. Importantly, motor activation of the observer continued to develop for observed correct responses and decreased for incorrect ones, suggesting that similar neural mechanisms are responsible for monitoring one's own and others' task performance. In addition Sebanz et al. (2005) showed an action-selection conflict in participants, when a response was required to a stimulus to which the partner had to respond. Furthermore, task representations are not static with respect to a moment in time, obviously people realize goals by using own and other's past experiences, own and other's consequences of actions, and own and other's desired outcomes of actions for action prediction (Sebanz, Bekkering, and Knoblich, 2006). All above mentioned studies focused on the more general effects of joint-action settings on aspects of action control, in a way that one actor's performance is influenced by the other's task. Up to now joint-action experiments always clearly discriminated between a solo condition, where participants had to act alone and a joint condition, where participants

performed the task together. There is clear evidence that forming a co-representation of the task of the second participant influences one's own behaviour. However, until now no study has investigated how differences within the formed co-representation might influence action-monitoring processes.

## 1.2 Action monitoring

In daily traffic situations, people have to continuously monitor their actions to prevent errors or to detect them as fast as possible. While waiting in front of a red traffic light that turns to green one may immediately start to accelerate. However the exact time when one accelerates depends on the fact whether or not there is a car in front of you waiting for a green light. Having a car in front of you implies that you must withhold your tendency to accelerate until the other car starts moving. When you do start too early, or when the car in front of you accelerates slower than expected, you will immediately have to hit the brakes to avoid an accident.

An appropriate method to measure joint-action monitoring is to record electrical activity of the brain by means of EEG while doing a joint-action task. In the current study, we will focus on two specific action-monitoring processes. First, pre-response inhibition on correct trials, as reflected in the stimulus-locked NoGo P3 potential (Pfefferbaum et al., 1984, Falkenstein et al., 1995). The NoGo P3 is maximal at frontocentral locations and a valuable electrophysiological indicator for inhibitory function, related to the frontal lobe (Bokura et al., 2005). It is assumed that frontocentral NoGo P3 is a better candidate for response inhibition than the N2 component (Donkers et al., 2004), which is recently found to be a correlate of response conflict rather than response inhibition (Nieuwenhuis and Yeung, 2003). A recent study of Sebanz et al. (2006) showed a higher NoGo P3 in joint-action conditions compared to single conditions. The authors concluded that increased response inhibition was necessary to withhold subjects from responding on NoGo trials in the group condition.

Second, the process of error detection can be measured electrophysiologically by the response-locked error negativity (Falkenstein et al., 1991) or error-related negativity (ERN; Gehring et al., 1993) with maximal amplitude within 100 ms after an error has been made. The ERN has a common neural source within the medial frontal cortex

and is seen as the product of action monitoring, used to enhance future performance. Humans' anterior cingulate cortex (ACC) is thought to be the generator of the ERN; it has connections to the limbic system, the motor system, and to prefrontal regions (Ridderinkhof et al., 2004). Originally, the ERN was taken to be a result of a mismatch of the comparison between the representation of the correct response and the representation of the actual response (Falkenstein et al. 1991; Gehring et al., 1993; Coles, Scheffers, and Holroyd, 2001). More recently, the ERN has also been linked to the emotional response to an error or to the affective evaluation of actions (Gehring and Willoughby, 2002). So far no experiments have investigated error monitoring while two participants performing a task together at the same time. **Consequently, relatively little is known about how a co-representation of another person's action modulates the process of error monitoring.** A study by Hajcak et al. (2005) investigated the more general effect of being observed. They showed that ERN amplitude was larger on error trials in a condition where subjects were told that they were being evaluated by an observer sitting next to them compared to a solo condition performing the task alone. The authors concluded that the ERN was sensitive to affective and motivational factors, but the experiment is not able to provide further insight into co-representational effects on action monitoring. In the current study, we want to investigate whether and how differences in co-representation influence the action-monitoring processes of response inhibition and error detection.

## 1.3 Predictions

In the current study we investigated three different questions. First, although Sebanz and co-authors (2006) suggest that co-representation may affect response inhibition at a general level, it is unknown whether differences in co-representation within a joint-action setting affect response inhibition. In joint action, response inhibition as reflected in the NoGo P3 should be different in behavioural identical situations of one subject, dependent on the task of the second subject.

Second, no studies have examined whether differences in co-representation influence performance levels and error-detection processes. This was investigated by reaction times and response-locked ERN recording. If differences in co-representation affect performance levels and

error-detection, accuracy rates and the ERN would be different in behavioural identical situations of one subject, dependent on the task of the second subject.

Third, we investigated the role competitive response strategies may play in these processes. With respect to applied response strategies, there are two different basic modes of social cognition, which are possible when two or more people are working together on one task: cooperation among group members or competition between members of the group (Decety et al., 2004). In our experiment we wanted to look more closely to the modulatory effects within a competitive mode. This was reflected in situations where both participants had to be active and applied a competitive response strategy in order to be faster than the other. To optimise performance in a competitive setting it may be advantageous to concentrate on your own performance and disregard the other person to a maximum. If competitive response strategy affected co-representational differences in action monitoring, differences due to deviant co-representations within response inhibition, reaction times, and error detection should be modulated by the extent to which a participant adheres to a competitive strategy or not.

## 2. Methods

### 2.1 Participants

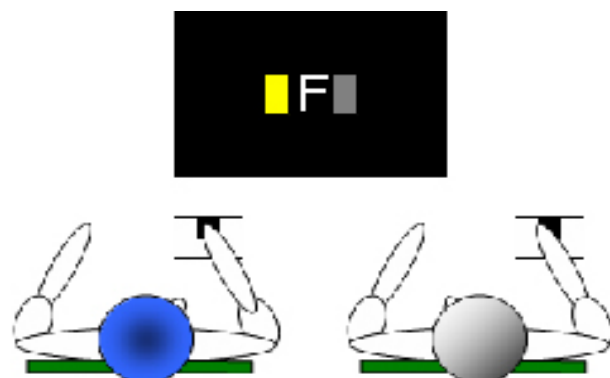
Fourteen pairs, each comprised of one EEG subject and one behavioural subject (see Figure 1B) participated in the experiment. All were right-handed and had normal or corrected-to-normal vision. Only the data from the EEG participants were analysed (13 females, 1 male; mean age 21.9

years SD 2.1 years). All participants were paid 6 euro per hour for participation.

### 2.2 Design and procedure

Participants sat next to each other and performed a joint Go-NoGo task in which they responded with their dominant index finger to the presentation of single letters. The stimuli were presented in white against a black background in the centre of a computer screen between two grey boxes, placed at a distance of roughly 70 cm from the subjects. The stimuli (the letters P, F, E, or T in an Arial uppercase font; font size 16) were presented for 100 ms. The left grey box coloured yellow when the left subject responded – the right grey box coloured yellow when the right subject responded (see Figure 1B). The inter trial interval was random between 1000 and 2000 ms. Participants were instructed to press the response button “as fast as possible” on Go trials and to avoid errors, i.e. responding on NoGo trials. An experimental session was composed of eight blocks of 200 trials, during which both EEG and behavioural data was obtained from one participant (EEG participant) and only behavioural data from the other participant (RT participant). As we will only report the data obtained from the EEG participant, the naming of the different stimuli is done from the perspective of this participant. Both participants had to respond to Go stimuli that were presented in 70% of the trials. The remaining 30% were NoGo stimuli to which both participants had to withhold their response. The Go stimuli were comprised of ‘Both Go’ trials (55%; both participants need to respond) and of ‘Self Go’ trials (15%; EEG participant responds, while RT participant inhibits). Similarly, the NoGo stimuli were composed of ‘Self NoGo’ (15%; EEG

Condition	EEG-participant	RT-participant
BothGo (55%)	Go	Go
Self Go (15%)	Go	NoGo
Self NoGo (15%)	NoGo	Go
Both NoGo (15%)	NoGo	NoGo



**Figure 1.** Left: Experimental paradigm and frequency distribution of the stimuli. Right: Experimental session with response of EEG participant (left; blue head) and no response of RT participant (right).

participant inhibits, while RT participant responds) and of ‘Both NoGo’ (15%; both participants need to inhibit their response). Half of the EEG participants were assigned to the left sitting-position and half of them to the right sitting-position. Reaction-time feedback (averaged over correct responses) per participant was presented after each block and at the end of the experiment (total average over all eight blocks). There was a short break between the blocks. The total experiment lasted 120 minutes, including preparation and breaks.

### 2.3 Electrophysiological Recording and Data Analysis

The EEG-signal was recorded from 27 locations on the scalp. Electrodes were placed at locations in accordance with the international 10-20 system. All signals were referenced to the left mastoid, but were later offline re-referenced to the average of both mastoids. The vertical electro-oculogram (EOG) was recorded bipolarly from electrodes placed above and below the right eye. The horizontal EOG was also recorded bipolarly from electrodes lateral to both eyes. All electrode impedances were kept below 5 k $\Omega$ . The EEG and EOG signals were amplified using a time-constant of 8 s and were filtered off-line low-pass at 15 Hz. All signals were digitised with a sampling rate of 200 Hz.

EOG artefact correction was carried out using the procedure by Gratton, Coles, and Donchin (1983). For both behavioural and ERP analyses all

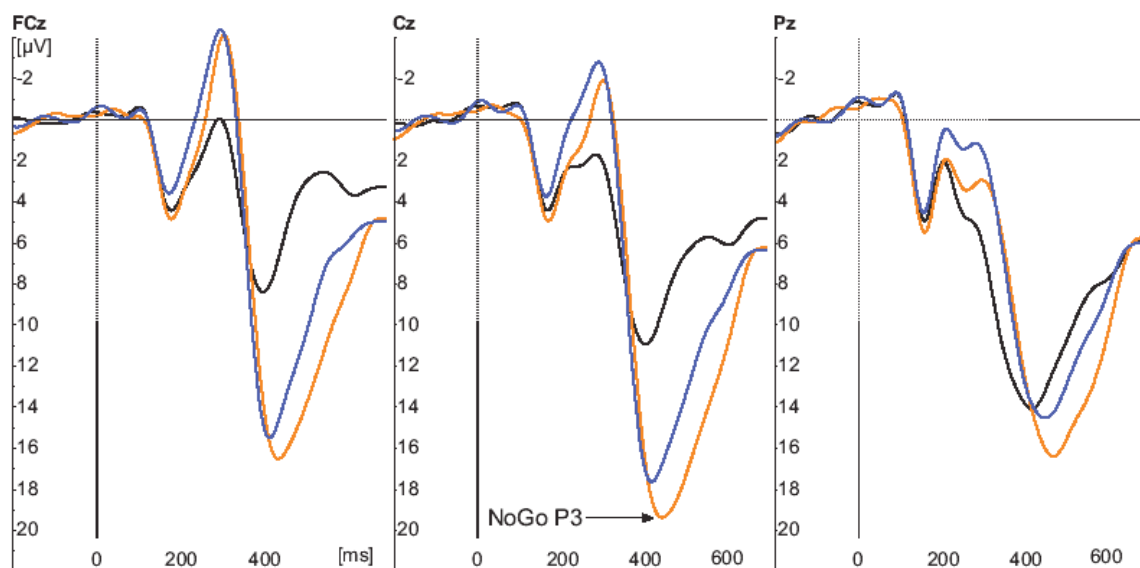
responses with reaction times faster than 150 ms (1.1%) were removed from the data sets. Trials were averaged to ERPs separately for each condition and each subject, relative to a 200 ms pre-stimulus or pre-response baseline.

ERN amplitude was determined on incorrect response-locked subject ERP averages by subtracting the most negative peak in the 0-150 ms time-window after response onset from the most positive peak in the time-window starting 80 ms before and ending 80 ms after response onset at electrodes Fz, FCz, and Cz.

NoGo P3 amplitude was determined on correct stimulus-locked ERPs as the most positive peak in the 250 - 800 ms time window at electrode FCz, Cz, and Pz.

Individual averages for RTs, amplitudes, and number of responses were entered in a repeated measures General Linear Model (GLM) with inhibition (2 levels: Self NoGo vs. Both NoGo) as within-subject factor. The analyses on ERN and NoGo P3 amplitude also included the within-subject factor electrode (3 levels: Fz, FCz, and Cz for ERN – FCz, Cz, and Pz for NoGo P3).

To control for the influence of competitive response strategies, EEG participants were divided into two groups depending on the number of faster responses in the Both Go condition. The EEG participants who had more fast responses than their RT partners in the Both Go condition were assigned to the subgroup of ‘Fast Responders’ (N = 7). Similarly, EEG participants who had more slow responses than their RT partners in the Both



**Figure 2.** Grand average stimulus-locked NoGo P3 waveforms for correct Both Go, Self NoGo, and Both NoGo.



Go condition were assigned to the subgroup of “Slow Responders” ( $N = 7$ ). Individual averages for RTs, amplitudes (electrode FCz for ERN and Cz for NoGo P3), and number of responses were entered in a repeated measures General Linear Model (GLM) with response strategy (2 levels: Fast Responders vs. Slow Responders) as between-subject factor and inhibition (2 levels: Self NoGo vs. Both NoGo) as a within-subject factor.

### 3. Results

#### 3.1 Response inhibition: NoGo P3

Figure 2 depicts the grand-average of the stimulus-locked ERP. The analyses demonstrated that NoGo P3 amplitude for the Both NoGo condition (20.47  $\mu\text{V}$ ) was significantly higher compared to the Self NoGo condition [18.87  $\mu\text{V}$ ;  $F(1,13) = 9.65$ ,  $p = 0.008$ ]. There was also a main effect of electrode [ $F(2,12) = 18.30$ ,  $p < 0.001$ ]. Repeated contrasts showed that NoGo P3 amplitude was largest at electrode Cz [Figure 2 centre; Figure 4 centre; (FCz vs. Cz:  $p < 0.001$ ; FCz vs. Pz:  $p = 0.634$ ; Cz vs. Pz:  $p = 0.027$ )]. The interaction between electrode and inhibition (Self NoGo vs. Both NoGo) was not significant [ $F(2,12) = 2.65$ ,  $p = 0.112$ ].

#### 3.2 Behavioural analyses

For an overview of mean reaction times and proportion of responses see Table 1. Reaction times were faster for incorrect responses (279 ms) than for correct responses [330 ms;  $F(1,13) = 100.77$ ,  $p < 0.001$ ]. More errors were made in the Self NoGo

condition (25.3%) compared to the Both NoGo condition [16.0%;  $F(1,13) = 5.98$ ,  $p = 0.030$ ].

#### 3.3 Error monitoring: ERN

Figure 3 indicates that ERN amplitude was higher for incorrect Both NoGo (-12.63) than for incorrect Self NoGo [-11.03  $\mu\text{V}$ ;  $F(1,13) = 5.99$ ,  $p = 0.029$ ]. There was a main effect of electrode [ $F(2,12) = 14.09$ ,  $p = 0.001$ ]. Repeated contrasts showed that ERN amplitude was largest at electrode FCz [Figure 3 centre; Figure 4 right; (Fz vs. Cz:  $p = 0.889$ ; Fz vs. FCz:  $p = 0.002$ ; FCz vs. Cz:  $p < 0.001$ )]. The interaction between electrode and inhibition (Incorrect Self NoGo vs. Incorrect Both NoGo) was not significant [ $F(2,12) = 2.377$ ,  $p = 0.135$ ].

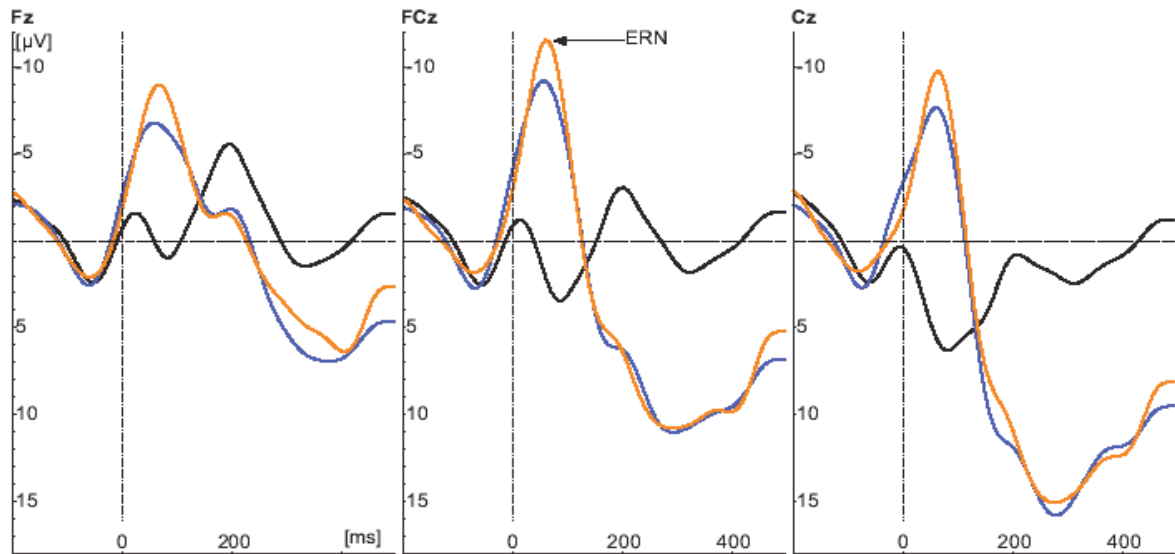
#### 3.4 Competitive strategy

The EEG participants who had more fast responses than their partner in the Both Go condition were assigned to the subgroup of “Fast Responders” ( $N = 7$ ). Similarly, the EEG participants who had more slow responses than their partner in the Both Go condition were assigned to the subgroup of “Slow Responders” ( $N = 7$ ). The subgroup of fast responders was on average in 62% of the Both Go trials faster than the behavioural subject. Slow responders were on average in 38% of the Both Go trials faster than the behavioural subject.

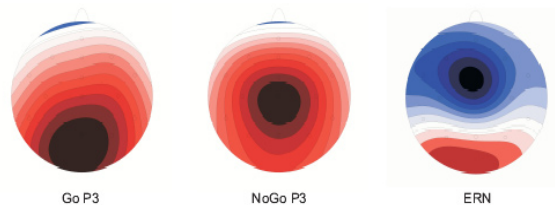
With respect to the analysis for error rate we found a main effect of inhibition [ $F(1,12) = 7.78$ ,  $p = 0.016$ ]. The factor response strategy did not reach significance [ $F(1,12) = 1.658$ ,  $p = 0.222$ ]. Crucially, the inhibition x response strategy interaction was significant [Figure 5 left;  $F(1,12) = 4.912$ ,  $p = 0.047$ ].

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)

**Table 1.** Mean reaction times and proportions for correct and incorrect responses from the perspective of the EEG subject (“Self” corresponds to the EEG subject).



**Figure 3.** Grand average response-locked ERN waveforms for Correct Both Go, Incorrect Self NoGo, and Incorrect Both NoGo.



**Figure 4.** Topography of ERP components averaged over 14 subjects.

The subgroup of Slow Responders made more errors in the Self NoGo condition [75.86 errors (31.6%)] compared to the Both NoGo condition [35.86 errors (14.9%)], while Fast Responders did not differ in number of errors between the two conditions [46.71 errors (19.5%) in the Self NoGo condition vs. 42.14 errors (17.6%) in the Both NoGo condition].

Similarly, once more for the NoGo P3 analysis there was a main effect of inhibition [ $F(1,12) = 18.04$ ,  $p = 0.001$ ]. The factor response strategy was marginal significant [ $F(1,12) = 4.65$ ,  $p = 0.052$ ]. Fast Responders showed a higher amplitude of response inhibition (25.47  $\mu\text{V}$ ) than Slow Responders (17.92  $\mu\text{V}$ ). Importantly, the inhibition  $\times$  response strategy interaction was significant [Figure 5 right;  $F(1,12) = 12.80$ ,  $p = 0.004$ ]. The subgroup of Slow Responders had a lower NoGo P3 in the Self NoGo condition (16.27  $\mu\text{V}$ ) compared to the Both NoGo condition (19.58  $\mu\text{V}$ ), while Fast Responders did not differ in NoGo P3 between the two conditions (25.33  $\mu\text{V}$  in the Self NoGo condition vs. 25.61  $\mu\text{V}$  in the Both NoGo condition).

Apparently, again for the analysis of the ERN

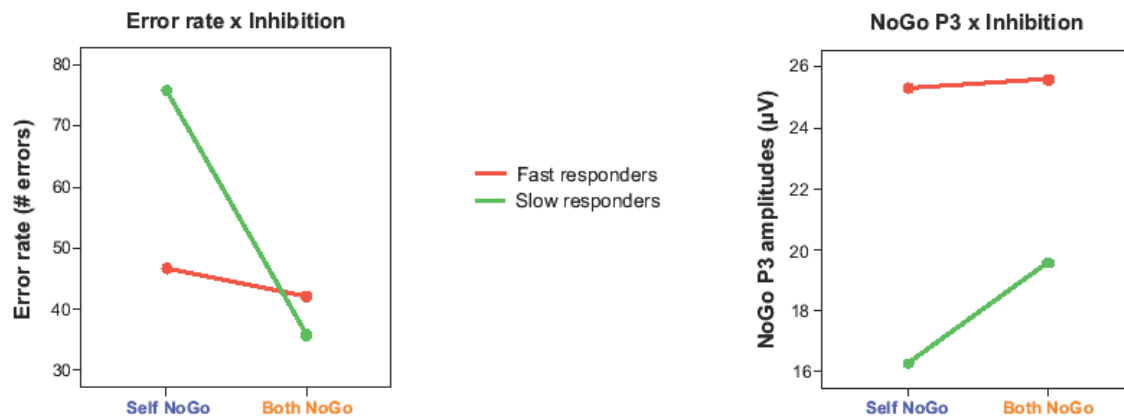
we observed a main effect of inhibition [ $F(1,12) = 8.45$ ,  $p = 0.013$ ]. The main effect of response strategy was not significant [ $F(1,12) = 0.004$ ,  $p = 0.948$ ]. Interestingly, the ERN difference in response inhibition (Self NoGo vs. Both NoGo) was not modulated by response strategy (Fast vs. Slow Responders) [ $F(1,12) = 1.85$ ,  $p = 0.199$ ].

## 4. Discussion

In the present study we investigated how differences in co-representation influence the processes of response inhibition and error detection, as reflected in the NoGo P3, behavioural measures, and the ERN. The results showed a smaller NoGo P3 on Self NoGo stimuli, requiring only a response of the other participant compared to Both NoGo stimuli requiring withholding the response by both participants. Also, more errors and a reduced ERN were present on erroneous responses in situations, where only the other participant had to respond, compared to the situation, where both participants had to inhibit. Moreover, significant interactions with competitive response strategy revealed that response inhibition and the error rate of fast responders were least affected by shared action representations. We will first discuss these results separately and then later integrate them into an overall conclusion.

### 4.1 Response inhibition: NoGo P3

The smaller NoGo P3 on Self NoGo stimuli



**Figure 5.** Left panel: Error rate x inhibition interaction effect, Right panel: NoGo P3 x inhibition interaction effect.

compared to Both NoGo stimuli provides evidence that differences in co-representation modulate the process of response inhibition. The NoGo P3 was maximal at central electrodes, which is in line with the more frontal orientation of the component (Pfefferbaum et al., 1984, Falkenstein et al., 1995). Apparently, participants issue less response inhibition on trials that require a response of the other person compared to trials that require an inhibition of both participants. Since the own task representation is the same in both conditions, viz. to inhibit a response, the current outcome can only be explained by the difference in task of the other person. This result indicates that along with the own task representation, the co-representation of the other participant's task affects the process of response inhibition, as reflected in the NoGo P3. This finding is in line with Sebanz et al. (2006) who recently showed a more general increase in NoGo P3 when comparing a joint condition to a single condition. The current study demonstrates that differences in co-representation even affect response-inhibition processes within a joint condition.

#### 4.2 Error monitoring: behavioural results and ERN

The finding that participants make less errors on stimuli that require an inhibition of both participants is probably directly related to the higher amount of response inhibition that is issued in this condition, thus less frequently leading to incorrect responses. The finding of an increased ERN after an error on Both NoGo trials compared to an error on Self NoGo trials shows that co-representation also affects the process of error detection as

reflected in the ERN. Although Hajcak et al. (2005) demonstrated a more general ERN effect caused by observation, until now no studies have demonstrated influences of co-representational differences on error detection. Apparently, the impact of an error was higher when an error is made in the situation where both participants had to withhold their response. Two possible explanations exist for the higher impact of an error in the situation that requires the inhibition of both participants. First, according to the mismatch theory of the ERN (Coles, Scheffers, and Holroyd, 2001; Falkenstein et al., 1991; 1995; Gehring et al., 1993), making an erroneous response in the Both NoGo situation the error could reflect a mismatch to the own task representation (to inhibit) and a mismatch to the co-representation of the other person's task (other has to inhibit). An error in the Self NoGo situation mismatches only with the own task representation (to inhibit), but matches with the co-representation of the other person's task (the other has to respond). The higher amplitude of the ERN in the Both NoGo situation could thus reflect this larger mismatch between the representation of your own action and that of the other person. Second, our results are in line with an affective interpretation of the ERN (Gehring & Willoughby, 2002) stating that the ERN reflects an emotional response to an error. In the current experiment, inhibiting a response was obviously more difficult than responding. Thus, erroneous responding in the situation that required the inhibition of both participants could lead to a higher affective response associated with the committed error, because participants are aware that the other person did succeed in performing the same difficult job of inhibiting. An error in the condition that requires



only a response of the other participant may be associated with a lower emotional impact, due to the knowledge that the other participant had an easy task to perform. Responding erroneously while knowing that the other participant will probably succeed in a difficult situation may lead to an enhancement of the emotional response associated with the error, compared to committing an error while knowing that the other participant will probably do well in an easy situation.

We would like to point out that the higher amplitude of the ERN in the Both NoGo condition might be caused by the higher error rate in the Self NoGo condition compared to the Both NoGo condition. However, the significant interaction with competitive response strategies shows that only slow responders were responsible for the higher error rate in the Self NoGo condition. Therefore we would expect differences in ERN between the Self NoGo and Both NoGo condition also to be modulated by slow vs. fast responders – but this was not the case.

### 4.3 Competitive response strategies

The outcome that response inhibition and the accuracy of fast responders were least affected by shared action representations shows that employing a more competitive response strategy implies ignoring the other participant's task. This is also shown in a study of Georgiou et al. (2006), who found different action patterns for cooperative and competitive task settings. Kinematic patterns were different in tasks where two participants had to cooperate to join two objects in the middle of a working surface compared to tasks where participants had to compete to place the object first in the middle of a working surface. The authors argue that actions are planned differently depending on their underlying global intention, such as cooperation and competition. With respect to our study the argument that different sensory events in fast and slow responders related to response processing cause the inhibition x response strategy interaction can be ruled out because the NoGo P3 component was measured with respect to the moment of stimulus onset. This means that sensory events related to responses of subjects occur at different time points after stimulus onset and averaged to zero while calculating the NoGo P3 component.

Interestingly, in our experiment the error-detection process reflected by the ERN was not

modulated by the extent of competitive response strategy. This means that when an error was made fast responders and slow responders did not differ in the process of error detection. The current results strongly suggest that a clear dissociation exists between the influence of response strategies on error prevention, reflected in response inhibition, and error detection. The dissociation can be interpreted in the way that a level of competition is set as a goal and influence the process of error prevention but not the process of error detection. An explanation could be that only perfect behaviour was planned in terms of a response strategy, but making an error could have had disrupted such a global intention – the error was there, not expected and people, regardless of their response strategy, had to deal with it in the same way.

## 5. Conclusion

We conclude that different co-representations in a joint task lead to specific modulations of action-monitoring processes. Interestingly, due to the goal-directed nature of response strategies, the response strategies people employ in a competitive setting only affect the process of error prevention. In everyday life, co-representation of the co-actor's task provides an additional source of information that may be used to support human's decisions whether to act or to refrain from acting. Future research on joint action monitoring will be necessary to provide a deeper understanding of the neuronal correlates underlying the extent the faster one has blinkers on.

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