Combined EEG-EMG-TMS study on the modulation of response inhibition by proactive control

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INTRODUCTION

The suppression of an initiated movement has a broad effect on the motor system, resulting in reduced excitation of both task-relevant and -irrelevant effectors (Badry et al. 2009). More specific inhibition may be achieved by activating proactive control in advance (Aron et al. 2011, Greenhouse et al. 2012). These reactive and proactive inhibitory influences may depend on distinct neural mechanisms.

Aim: Compare motor preparation, inhibition latency and extent in uni- and bimanual stop signal tasks with proactive cues.

Expectations:
1. The possibility of future stopping activates proactive control during motor preparation.
2. Inhibition in the unimanual task has a broad effect on the motor system. In the bimanual task with selective stopping requirements, inhibition is more effect-specific and therefore slower.

GO & CUE RESULTS

 Longer reaction times in the MS than in the CG condition indicate the activation of proactive control due to the possibility of future stopping.

This effect is similar in both tasks.

STOP RESULTS

Partial EMG suppression occurs later in the bi- than in the unimanual task (170 and 148ms, respectively). SSRTs are similar in both tasks (around 229 and 221ms).

The EMG time-course of the responding hand in the bimanual stop trials reveals that the ongoing response is affected by the stopping process. At the single trial level, later EMG suppression latency is associated with less interference to the ongoing response (bimanual task).

EFFECTS OF PROACTIVE CUE PREPARATION ON MOTOR RESPONSES

Response preparation is affected by the task context, where the possibility of future stopping activates proactive control. In the continousgo task, response preparation can be quantified from continuous EMG activity.

There are traces of EMG activity in the successfully stopped hand in both tasks. This activity is suppressed relatively early in both tasks, while it is still earlier in the unimanual than in the bimanual task. The latency differences are paralleled by the P3 EEG component, which is lower in amplitude and peaks earlier in the unimanual than in the bimanual task.

There is broad motor suppression in the unimanual task and differential facilitation of the responding hand in the bimanual task. However, the continuous EMG of the responding hand in the bimanual still reflects inhibitory interference at the time of stopping. At the single trial level, slower inhibition was associated with less interference to the ongoing response.

GENERAL CONCLUSIONS

Response inhibition is fast, reaching periphery at around 140-170 ms.

Inhibition latency is associated with inhibition extent. The broad inhibition in the unimanual task is faster than more specific inhibition in the selective stop signal task. This speed-selectivity trade-off is evident at the single trial level, where interference on ongoing responses can be quantified from continuous EMG activity.

The hand-specific modulation of the motor response is evident already in the motor preparation period prior to the presentation of the go or stop signal.

References: