Sub-threshold TMS applied over primary motor cortex does not facilitate startle reaction time even when controlling for timing of TMS application

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Background

- Presentation of a startling acoustic stimulus (SAS) during a simple reaction time (RT) task significantly reduces RT, termed the StartReact effect[1]
- The involvement of the cortex in the storage and release of early responses by SAS is widely debated[2], leading to two proposed neural mechanisms (Figure 1)
- Sub-threshold TMS applied over motor cortex (M1) increases cortical excitability for 6-30ms following a TMS pulse, termed intracortical facilitation (ICF)[3]
- Sub-threshold TMS early in the RT interval also leads to significant reductions in RT[4]

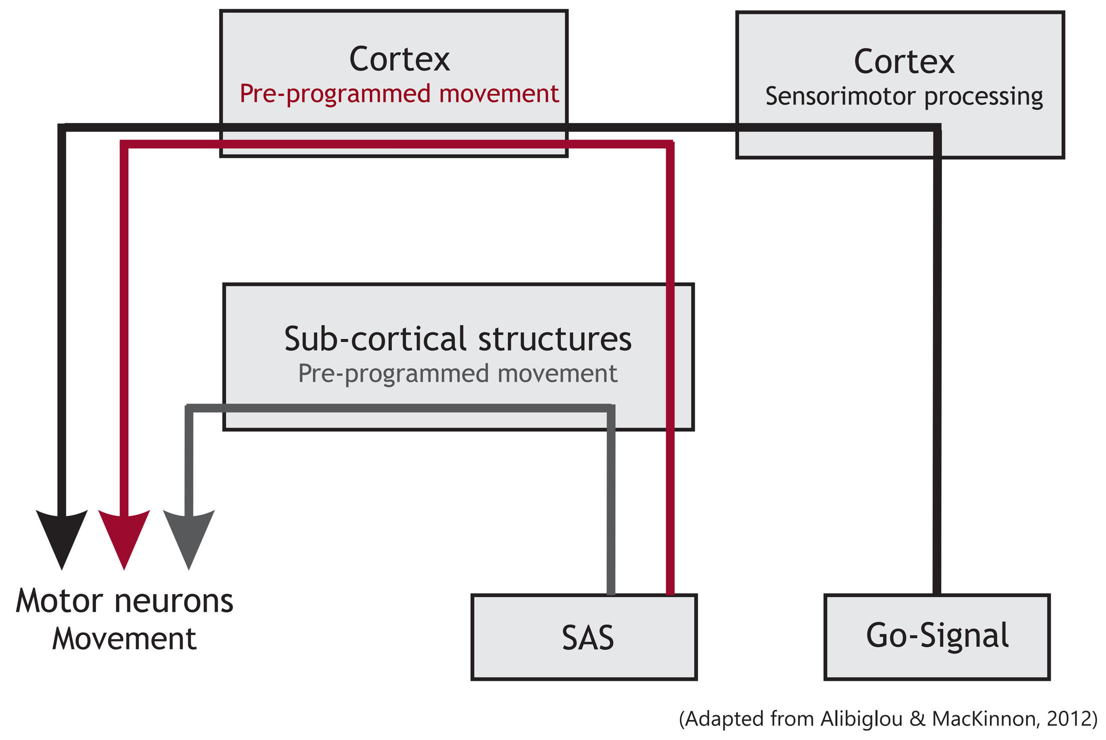

Figure 1. Proposed mechanisms underlying startle-induced RT shortening. Red arrow represents the cortical storage hypothesis[1], grey arrow represents the sub-cortical storage hypothesis[5] and black arrow represents a non-startle mechanism. Can ICF delineate between these mechanisms?

Question: Can the application of sub-threshold TMS over M1 early in the RT interval lead to facilitation of startle RT?

Methods

- **Experiment 1**: Participants (n=14) completed 120 trials of a wrist extension simple RT task in response to an auditory go-signal (82dB), which was replaced by a SAS (120 dB) on 30 trials.
- In 20 trials TMS was applied over the M1 representation of the wrist extensors (80% of RMT, posterior-anterior current direction).
- In 20 trials sham-TMS was applied, consisting of a "click" noise of the same sound intensity as a TMS pulse delivered by the auditory speaker.
- **Experiment 2**: Participants (n=10) completed a second experiment to control for possible RT differences due to timing of TMS application. Experiment 2 was identical to Experiment 1 except:
  - TMS was applied 30 ms following the go-signal or SAS in both control and startle trials, respectively
  - Sham TMS consisted of TMS applied at 80% resting motor threshold, using a coil orientation eliciting a latero-medial current direction, which does not lead to ICF[6]

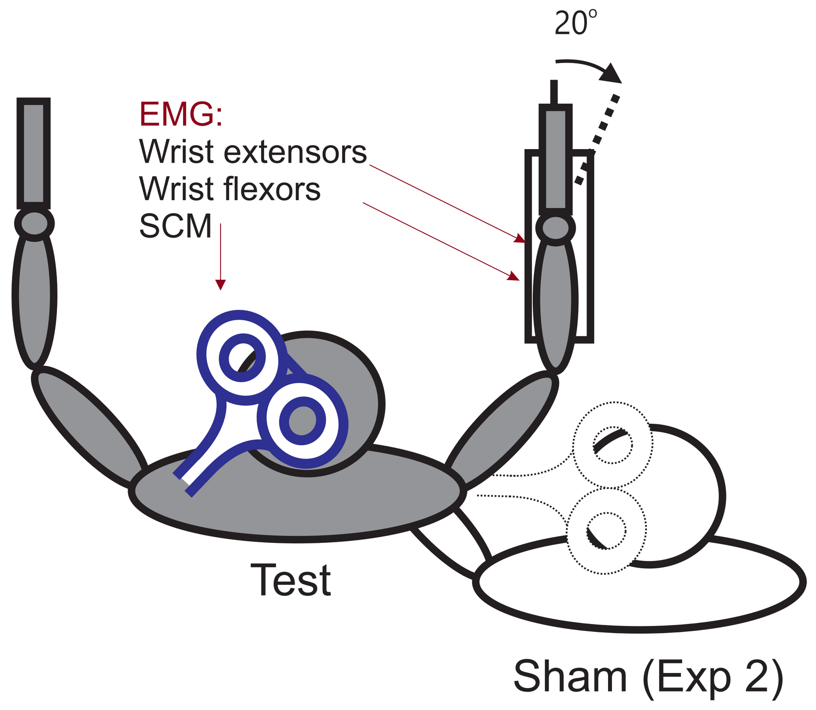

Figure 2. Experimental set-up of participants in blocks with application of real TMS (left) and sham TMS (right, Experiment 2 only). Note: a frequency and intensity matched auditory "click" was used for sham in Experiment 1.

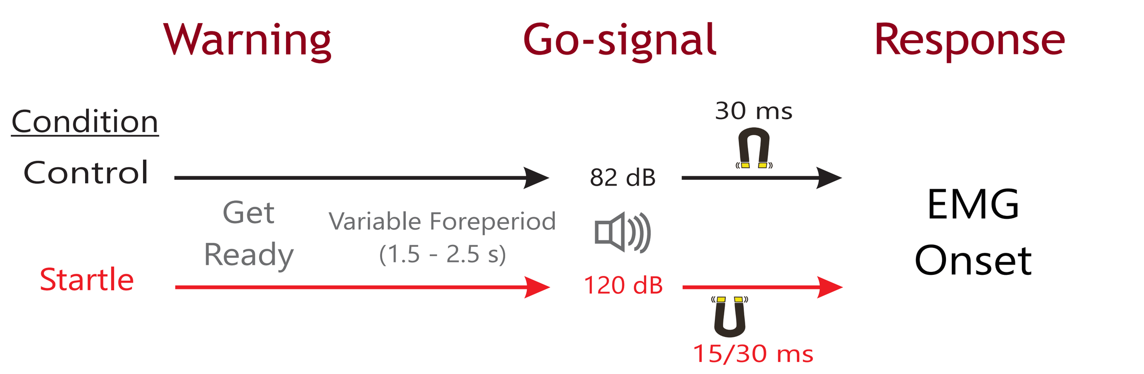

Figure 3. Time-course of trials in Experiment 1: A warning cue was given followed by the go-signal (82 dB or 120 dB) after a variable foreperiod. TMS was applied 15 or 30 ms after the "go".

Results

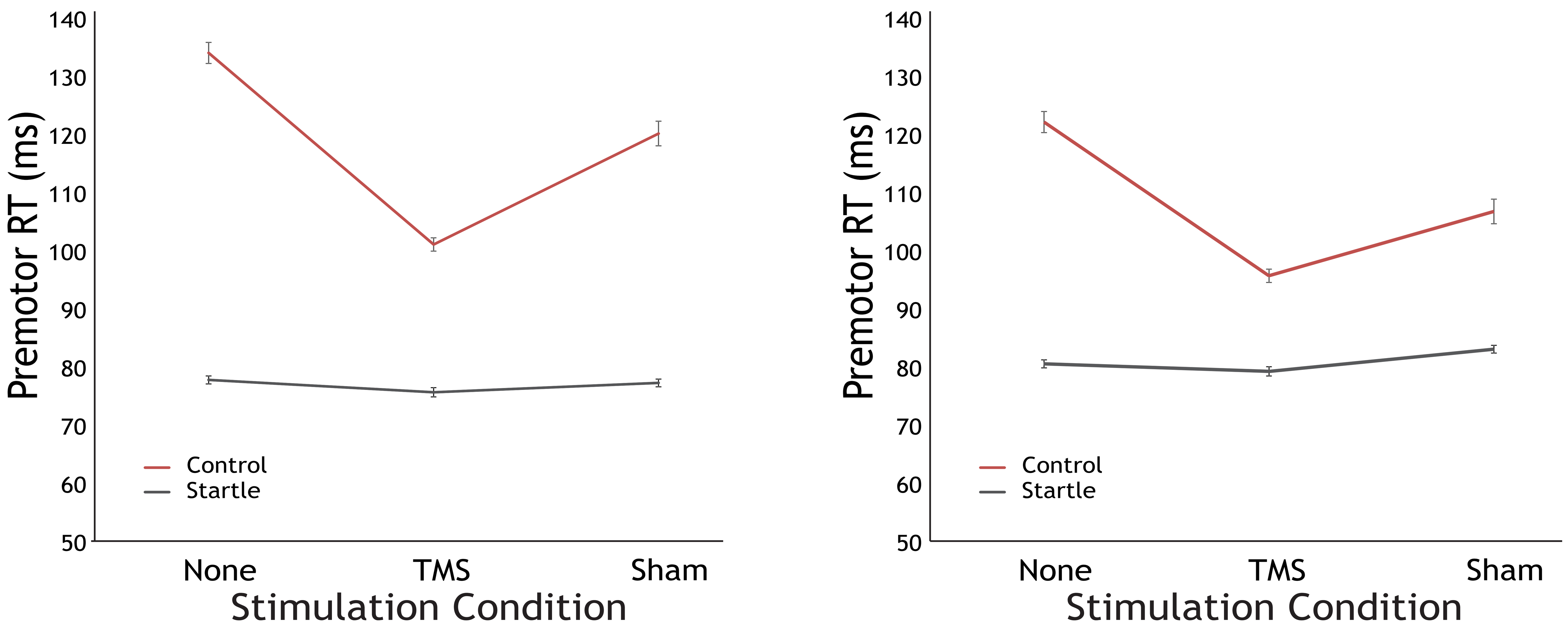

Figure 4. Mean premotor RT (with SE bars) for each go-stimulus condition (control vs. startle) across TMS stimulation conditions for Experiment 1 (left) and Experiment 2 (right).

Discussion

- The control RT results of Experiments 1 & 2 support previous research suggesting that TMS reduces RT through both intersensory facilitation, and speeding up the motor processes involved in responding[4].
- In SAS trials there were no RT differences between no-TMS, sham-TMS or TMS conditions in either experiment (Figure 4), suggesting ICF adds limited to no additional RT speeding following a SAS regardless of the timing of TMS application.
- This suggests that either 1) cortex has limited involvement in the StartReact effect or 2) that StartReact responses exhibit a floor effect in terms of the fastest RTs humans are capable of producing.

References

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