

Variability in cortical excitability – a TMS-EMG study with stimulus-response curves

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Introduction

- The general rule of thumb in TMS studies is to use an interstimulus interval (ISI) of at least 5s to avoid any cumulative effects on the responses.
- The 5s rule is based on studies in which TMS has been applied with a constant stimulation intensity (SI).
- A previous study by Mathias et al., 2014 [1] found that using varying stimulation intensities would allow shorter ISIs than 5s, without the any effects on the responses. However, these results were presented only on the group level, and thus, in this study, we aimed to evaluate the individual level results.

Methods

- The study included 12 healthy subjects (8 females, 22-60 years, one subject excluded due to miscalculated rMT_{guess}).
- At the optimal representation site of the right APB, the rMT_{guess} was calculated by using 3 pulses according to the following formula [2]:

$$rMT_{guess} = \frac{SI + 8.83e^{-3} * (A - 50)}{1 + 0.363e^{-3} * (A - 50)}$$
 (A=median MEP amplitude of the 3 repeated single-pulses in microvolts).

- rMT_{guess} did not differ from rMTs estimated with conventional methods (data not shown).
- Thereafter, 3 single-pulse TMS sequences were applied with varying ISI (1–2s, 2–3s, 3–4s) in a random order. The SI was varied randomly between 0.75 and 1.25 of the rMT_{guess} at 0.05 intervals (total 108 pulses/sequence).
- The rMT for each sequence was calculated from the stimulus-response curves formed from the data [2].
- The effect of ISI on the resulting rMT and on the MEP amplitudes was evaluated with repeated measures ANOVA.

References:

1. Mathias JP, et al. Rapid acquisition of the transcranial magnetic stimulation stimulus response curve. *Brain Stimul* 2014;7:59–65.
2. Julkunen P, et al. Threshold curves for transcranial magnetic stimulation to improve reliability of motor pathway status assessment. *Clin Neurophysiol* 2011;122:975–83.

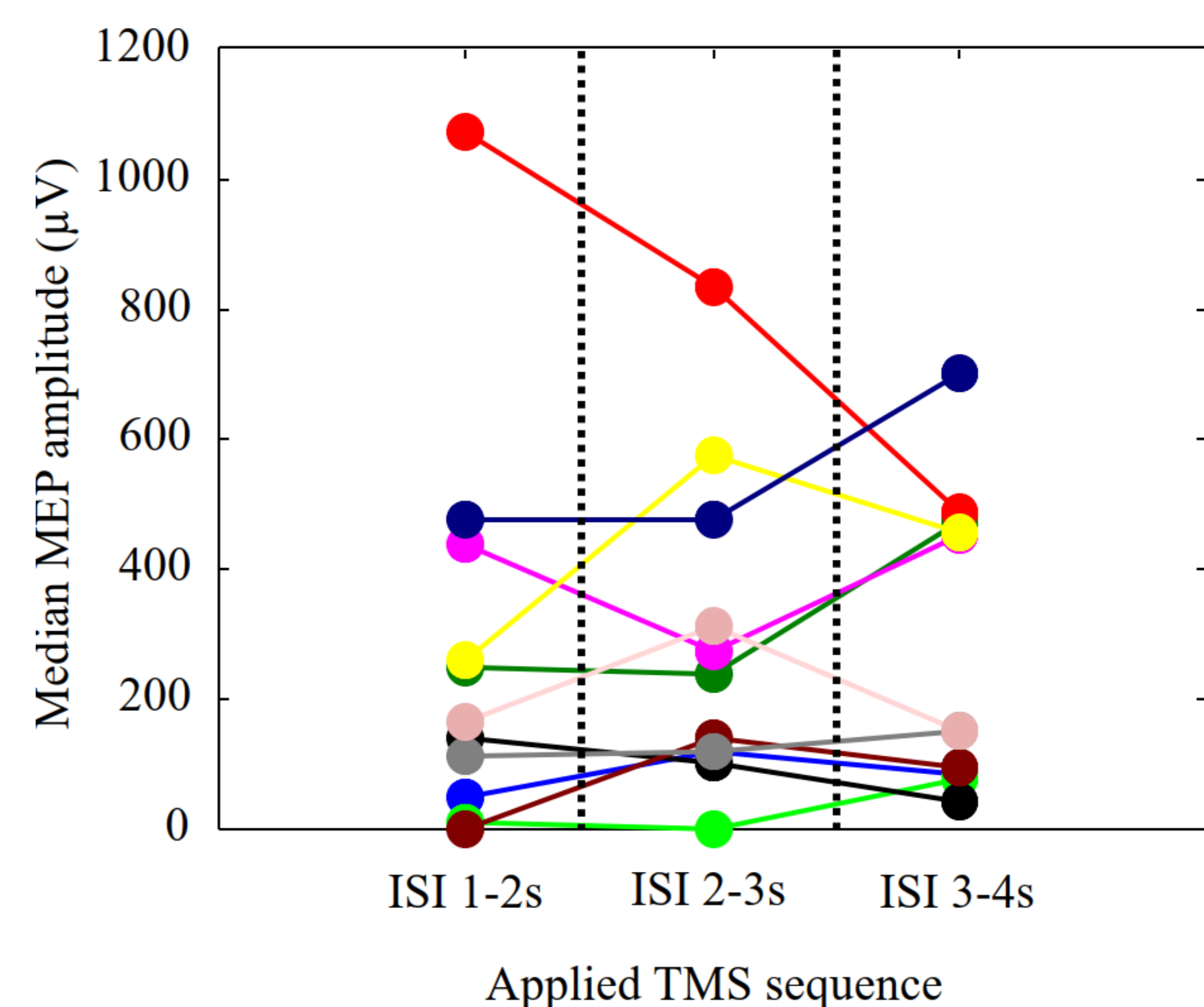


Figure 1. Median MEP amplitudes over all SIs at different ISIs. The different colors represent different subjects.

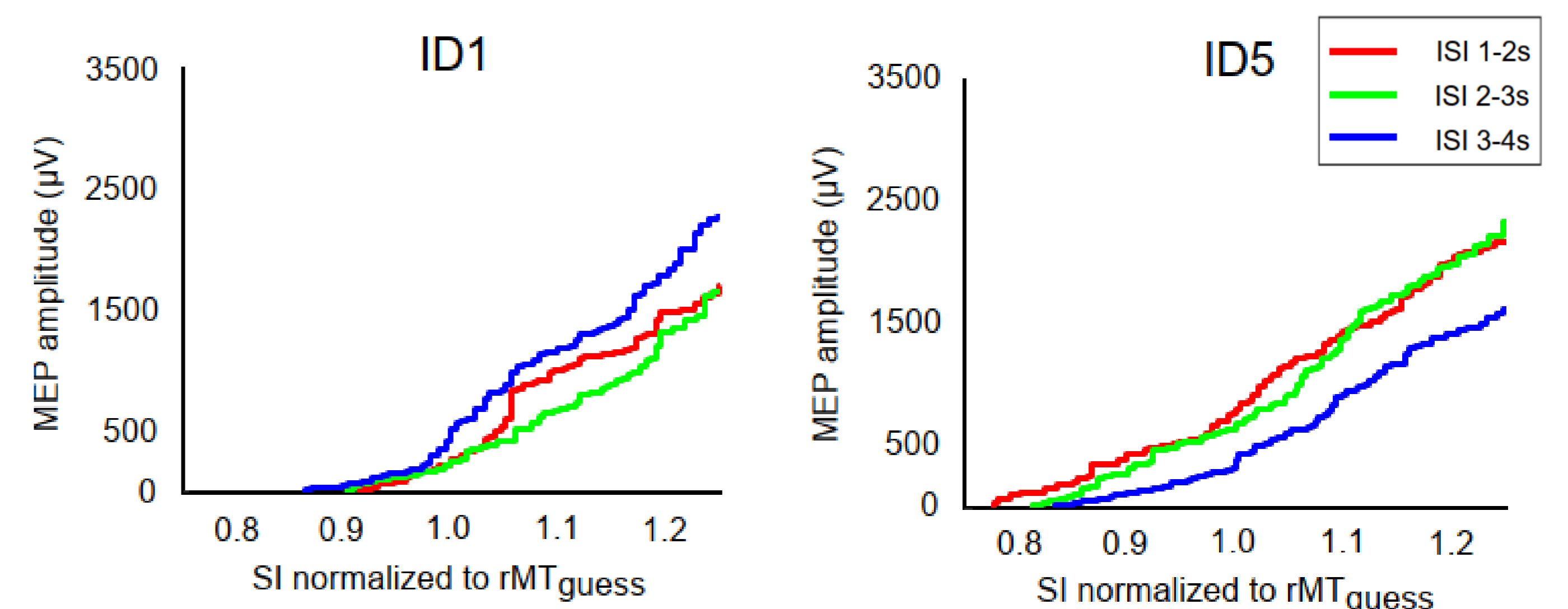


Figure 2. Threshold curves for two subjects (ID1 and ID5) showing different ISI behavior.

Results

- The ISI had no effect on the rMT estimated from the curves ($F=0.24$, $p=0.683$) nor single-trial MEP amplitudes ($F=0.90$, $p=0.405$), but a significant subject by ISI interaction ($F=3.64$; $p<0.001$) was observed in MEP amplitudes (**Figures 1 & 2**).

Conclusions

- On the group level, the ISI seems to have no clear effect on the rMT or MEP amplitudes.
- On the individual level, the ISI affects the MEP amplitudes differently between subjects and therefore, **the rMT or stimulus-response curves cannot be reliably estimated with short ISIs.**