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Investigating the Reliability of a Double-Coil TMS Method to Assess Corticospinal Excitability

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Abstract

Transcranial magnetic stimulation (TMS) applied over the primary motor cortex (M1) elicits motor-evoked potentials (MEPs) which provide a temporally precise and muscle-specific readout of the state-changes in the motor output system. For more than twenty years, many studies have used this method to investigate corticospinal excitability (CSE) changes in various contexts. Amplitudes can be compared for MEPs elicited at different times within a given condition and/or between different states. For example, in studies on hand choice, MEPs have been elicited during the reaction time period preceding left and right hand responses. This procedure has allowed to characterize CSE changes associated with a selected or non-selected response (e.g. left MEPs preceding a left or right hand response, respectively).

Habitually, these studies have used single-coil TMS eliciting MEPs in the contralateral hand. However, in many situations, it would be useful to obtain MEPs in both hands at once, to track CSE bilaterally. For example, in the hand choice example mentioned above, this would allow obtaining markers of CSE changes associated with selected and non-selected hands within each trial, whether the left or right hand is chosen for the response. Such a method requires to use a double-coil approach where both M1 are stimulated concurrently whilst avoiding electromagnetic interference between the two stimulating coils.

Here, we evaluated the reliability of a double-coil TMS method where both M1 are stimulated with a 1ms inter-pulse interval to avoid direct interference between the two pulses (double-coil_{1ms}). In a first experiment, we compared the amplitude of left and right hand MEPs elicited at rest using double-coil_{1ms} TMS or single-coil TMS over the right or left M1, at 100, 115, 130, 145 or 160 % of the resting motor threshold (rMT). In a second experiment, we compared MEPs elicited at 115% of the rMT during a choice reaction time task using the single- or double-coil_{1ms} technique. Importantly, in both studies, all conditions were intermingled within the same blocks and tested within each subject, allowing controlled comparisons of MEPs elicited using double-coil_{1ms} and single-coil TMS. Because the pulses were separated by a 1 ms inter-pulse interval when using double-coil_{1ms}, TMS was either applied over the left M1 first or the right M1 first in separate trials in the two experiments.

When elicited at rest (Exp. 1), the amplitude of MEPs increased with the intensity of stimulation, reaching the highest value at 160% of rMT. Besides that, in both studies, MEPs were equivalent whether they were elicited in the left or right hand using single- or double-Coil_{1ms} TMS, or preceding movements of the left or right hand (Exp. 2). These results suggest that double-coil_{1ms} TMS is a reliable method to assess CSE in both hands at once.