



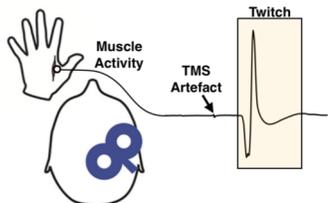
Introduction

Transcranial Magnetic Stimulation (TMS) uses electromagnetic induction to non-invasively stimulate the brain. TMS to primary motor cortex above a threshold intensity can elicit muscle twitches, called motor evoked potentials (MEPs), in targeted muscles.

A conditioning subthreshold TMS pulse delivered 3 ms before a suprathreshold TMS pulse can influence the size of the MEP. This project used a non-traditional paired-pulse TMS protocol to study the effects of two subthreshold pulses on the size and likelihood of MEPs. Previous studies showed subthreshold paired TMS pulses can influence MEPs (Du, 2014). Here, we examined whether paired subthreshold pulses increase the likelihood of MEPs.

Methods

- 7 healthy subjects (4 male 25.5yrs+/-3.7yr, AMT=41+/-9.62), (3 female 20.3+/-1.2 years, AMT=45+/-5) were tested.
- Surface electromyography (EMG) was recorded from the left first dorsal interosseus (FDI) and C7 on the neck. A ground electrode was also placed on the wrist above the head of the ulna.
- TMS was administered at five different intensities relative to the subject's active motor threshold (AMT), the threshold needed to elicit MEPs consistently 50% of the time while maintaining a tonic contraction.
- The conditioning pulse was randomly administered at 50%, 65%, 80%, 95%, 110% AMT and separated by 3ms from the test pulse at 115% AMT.



TMS = Transcranial Magnetic Stimulation

MEP Amplitudes Increase At Higher Conditioning Pulse Intensities

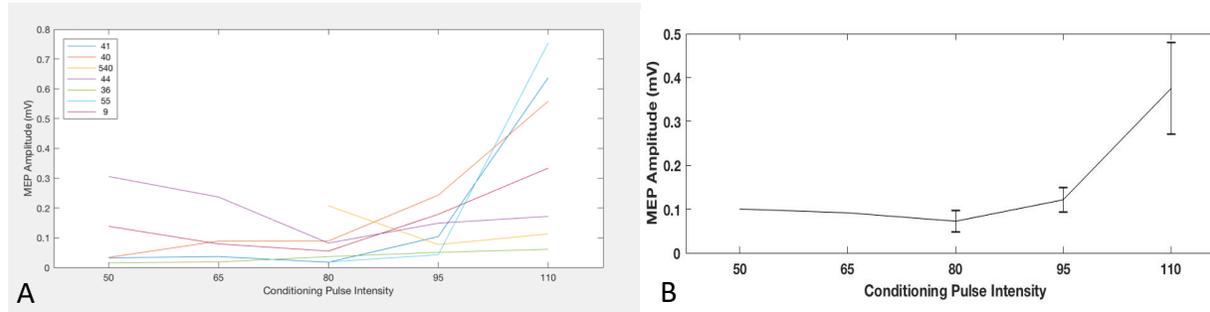


Figure 1A shows MEP amplitudes vs. conditioning pulse intensity by subject. Figure 1B is the mean across subjects. A one-way repeated measures ANOVA revealed a significant effect of conditioning pulse intensity on MEP Amplitude, $[F(4, 27) F = 4.81, p = .005]$. Post hoc Tukey tests revealed that 110% conditioning pulse ($M = 0.37mV, SD = 0.27$) had significantly larger MEP amplitudes than the 4 other lower intensities. $** = p < .01$

MEP Likelihood Increases At Higher Conditioning Pulse Intensities

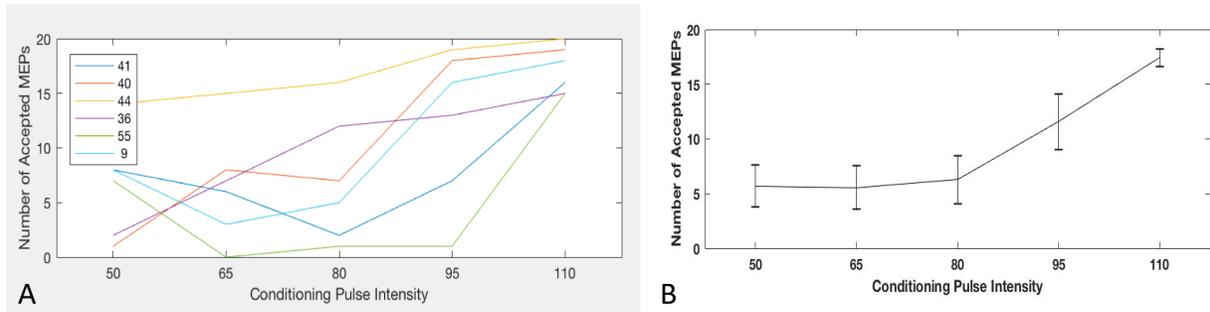
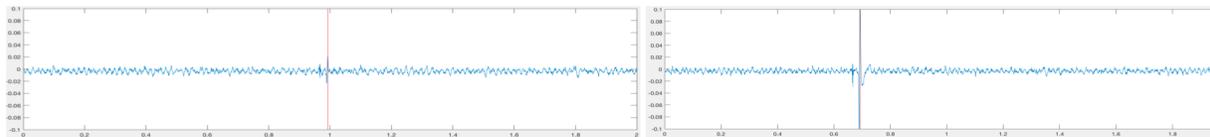


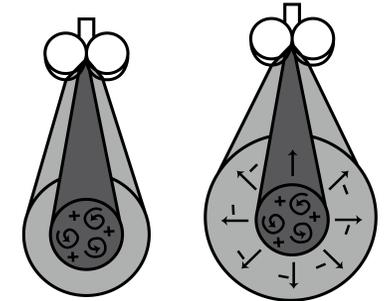
Figure 2A shows number of accepted MEPs vs. conditioning pulse intensity per subject. A one-way repeated measures ANOVA revealed a significant effect of conditioning pulse intensity on likelihood of MEPs as well, $[F(4, 30) F = 6.89, p < .001]$. Post hoc Tukey tests revealed that 110% intensity ($M = 17.42, SD = 2.07$) had significantly more MEPs than the 4 other levels. $*** = p < .001$



Small MEP at 65% Intensity

Large MEP at 110% Intensity

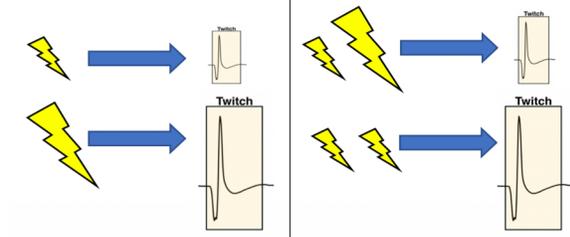
Discussion



Protocol used in this experiment

Traditional paired-pulse protocol

- Our results replicate and extend a previous study (Du, 2014)
- The increased MEP likelihood and MEP amplitudes at higher conditioning pulse intensities may reflect a particular instance of a **center-surround mechanism** within primary motor cortex.
- If both pulses are subthreshold, they may induce **temporal summation** within the same population of M1 cells driving them above a threshold for producing an MEP.
- At the same time, surrounding cells may be indirectly inhibited by short latency intracortical GABA-ergic mechanisms (Kujirai, 1993)
- In classic paired pulse experiments, the second pulse is of a larger suprathreshold intensity which would have a larger field of stimulation to activate surrounding cells.
- Thus, a center-surround mechanism could explain the results we observe here along with the observed overall relative reduction in the MEP amplitude traditionally seen in previous studies.



References

- Du, Xiaoming, et al. "Neural summation in human motor cortex by subthreshold transcranial magnetic stimulations." *Experimental brain research* 233.2 (2015): 671-677.
- Kujirai, T., et al. "Corticocortical inhibition in human motor cortex." *The Journal of physiology* 471.1 (1993): 501-519.