SOMATOSENSORY CORTEX ACTIVITY IN RESPONSE TO FINGERTIP STIMULATION CAN INCREASE WITH REMOTE SUBTHRESHOLD VIBROTACTILE NOISE: AN EEG STUDY

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INTRODUCTION

Motivation and Significance

- Stochastic resonance improves tactile sensation [1].
- Subthreshold vibrotactile noise at the wrist and dorsal hand improved fingertip touch sensation in stroke survivors, as measured by the monofilament test [2].
- The mechanism of the remote vibrotactile noise improving touch sensation is unknown.
- Understanding of the mechanism behind sensory enhancement with remote subthreshold noise may help guide its clinical applications.

Objective

- To examine the effect of remote vibrotactile noise on the brain activity in response to monofilament touches at the fingertip.

Hypothesis

- Hypothesis: Electroencephalography (EEG) activity increases with remote subthreshold, but not suprathreshold, vibrotactile noise during the monofilament touches on the fingertip pad.

METHODS

Subject

- 1 right-handed healthy young adult

Procedure

- The 64 channel EEG data were collected at 1kHz in the international 10-20 system during 150 monofilament touches (Fig. 1a).
- Monofilament touched (stimulated) the index fingertip pad (Fig. 1b), while vibrotactile noise was applied on the dorsal skin over the 2nd metacarpal bone (Fig. 1c).
- Vibrotactile noise intensity:
  - subthreshold (60% of the sensory threshold)
  - suprathreshold (120% of the sensory threshold)
  - no vibrotactile noise

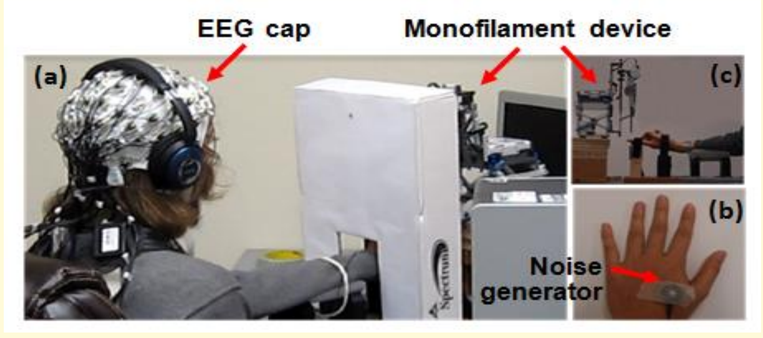

Fig. 1: Experimental setup.

Data Analysis

- Artifacts were removed via independent component analysis [3].
- Event-related potential (ERP) and power spectral densities (PSDs) were analyzed for the C4 electrode depicting the contralateral hand sensorimotor area (Fig. 2).
- ERP peak to peak amplitude and PSD at 5, 10 and 23 Hz were compared between the subthreshold vs. no noise and the suprathreshold vs. no noise using two-sample t-tests. The false discovery rate (FDR) correction was used.

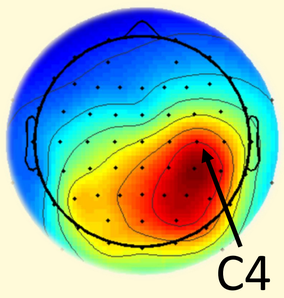

Fig. 2: Independent component reflecting somatosensory cortex activity with the fingertip stimulation via monofilament.

RESULTS

ERP Peak to Peak Amplitude

- The subthreshold vibrotactile noise resulted in a larger ERP peak to peak amplitude compared to no noise in response to the monofilament stimulation (Fig. 3a; p<0.001).
- The suprathreshold noise did not affect ERP peak to peak amplitude compared to no noise (Fig. 3b) .

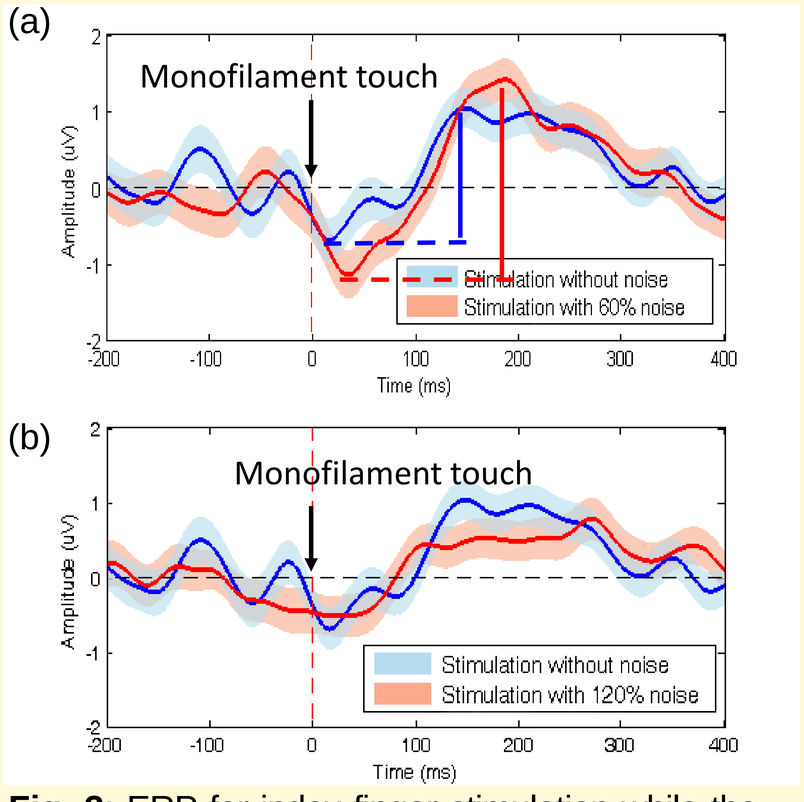

Fig. 3: ERP for index finger stimulation while the dorsal hand received the sub- (a) and supra-threshold (b) noise compared to no noise.

PSD

- The subthreshold noise resulted in (Fig. 4a):
  - increased β band activity (around 23 Hz) (p_{FDR}=0.01)
  - decreased α band activity (around 10 Hz) (p_{FDR}=0.05)
- The suprathreshold noise did not significantly affect PSD (Fig. 4b).

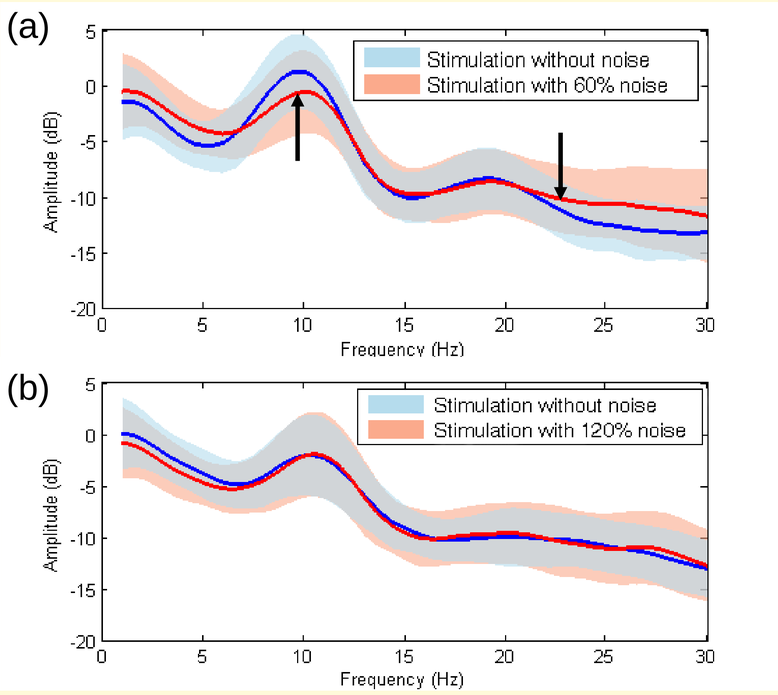

Fig. 4: PSD when the dorsal hand received the sub- (a) and supra-threshold (b) vibrotactile noise compared to no noise.

CONCLUSIONS

- The subthreshold, but not suprathreshold, vibrotactile noise at the dorsum hand increased the brain activity of the somatosensory cortex hand area in response to fingertip stimulation, as evidenced in the increased event-related potentials.
- The subthreshold noise increased β and decreased α band activities, indicating strengthened sensation/sensory feedback and sensorimotor information processing [4-5].
- Remote subthreshold noise may enhance touch sensation at the fingertip via cortical influence.
- Elucidation of this mechanism may lead to a novel rehabilitation engineering technique for sensory enhancement in patients and older adults.

REFERENCE

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