Short-latency somatosensory evoked potentials following vibrotactile stimulation

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I. Introduction

Somatosensory evoked potentials (SSEPs) are typically elicited using electrical nerve stimulation yielding short- (P9, N9, P11, N11, P13/P14, N18, P20, N20, N30, P40) and long-latency (P100, N150, P250, P350) components [1]. However, for some experimental paradigms more naturalistic, vibrotactile stimuli may be preferred. While long-latency SSEPs can be reliably evoked using vibrotactile stimulations [2], little is reported on short-latency SSEPs since they are much smaller. To facilitate future SSEP research we characterize the short-latency potentials following brief vibrotactile stimulations. We expect the SSEP amplitudes to scale with the stimulation amplitudes.

II. Methods

Twenty-two right-handed participants (13 female, mean age = 24.4 years) received informed consent and were compensated with either course credit or 10 €/hour. A vibrotactile stimulation device (PiezoTac tactor; Engineering Acoustics, Inc., USA) was attached to the proximal phalanx of participant's right index finger. Participants sat in an EEG cabin with their hands resting on a table while fixating a cross in the middle of a computer screen. Each participant received 200 repetitions each of sinusoidal vibrotactile stimulations (20 ms, 280 Hz) at four supra-threshold amplitudes (peak-to-peak displacements of 42, 97, 134, 190 µm) in randomized order with an inter-stimulus interval of 2200 ms. EEG signals were recorded using a 64 active Ag/ACl electrodes (actiCap) and a BrainAmp system (BrainProducts, Germany) at 1 kHz with two reference electrodes on the earlobes and electrodes on the outer canthi of both eyes and one electrode underneath the right eye to monitor eye movements. EEG data were preprocessed using BrainVision Analyzer (Brain Products, Germany) by downsampling to 500 Hz, applying a low-cut-off filter at 0.1 Hz, a high-cut-off filter at 40 Hz, and a notch filter at 50 Hz. All electrodes were re-referenced offline to the average of the linked earlobes. Epochs were created for each trial, time-locked to the onset of the vibrotactile stimulation, and baseline-corrected using a period of 200 ms before the stimulation. Trials with blinks exceeding ±60 µV, eye movements exceeding ±30 µV, or muscle artifacts exceeding ±80 µV were excluded. Two participants were excluded due to rejection of 40% or more trials. The analysis included an average of 171 trials per stimulation amplitude per participant.

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III. Results and Discussion

We found a centro-parietal short-latency (44 - 48 ms) positive peak corresponding to a P45 at the CP3 electrode close to the somatosensory cortex contralateral to the stimulation (Fig. 1). The P45 latency did not differ among the four stimulation amplitudes (F [3,57] = 0.616, p = .607, η_G^2 = 0.016). A preliminary analysis of the averaged signal around the P45 peak (36 to 56 ms) showed a significant difference in SSEP amplitude between stimulation amplitudes at CP3 (F [3,57] = 7.89, p < .001, η_G^2 = 0.178). Bonferroni-corrected post-hoc tests (α = .008) showed a significantly higher peak amplitude after the highest compared to the lowest (t [19] = 4.88, p < .0001, d = 1.09) and second lowest (t [19] = 3.15, p = .003, d = .71) stimulation amplitudes. To better contrast short-latency SSEPs of electrical and vibrotactile stimulations we will re-test participants using electrical stimulations. We also plan further detailed analyses of all components and their topographies.

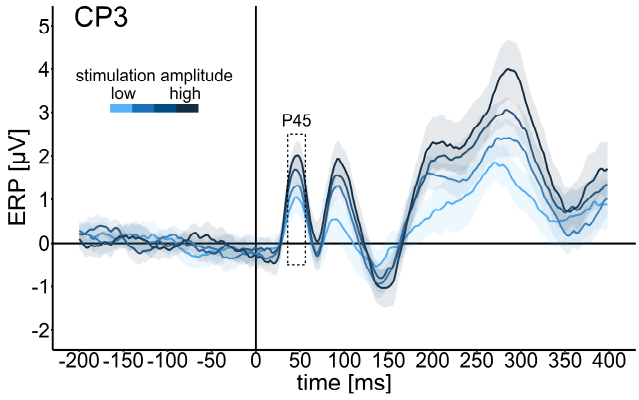

Figure 1. *Grand-averaged ERP at CP3 for the four stimulation amplitudes. The shaded error bars represent 95% Cosineau-Morey confidence intervals.*

References

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