Neural correlates of Mechanical versus Electrical Somatosensory Detection

Rosa Großmann[1,4], Sangjoon Woo[1], Thomas Knösche[1], Arno Villringer[1,2,3]

1Max-Planck-Institut für Kognitions- und Neurowissenschaften, Leipzig, Germany | 2Charité – Universitätsmedizin Berlin, corporate member of Freie Universität Berlin and Humboldt-Universität zu Berlin, Berlin, Germany | 3MindBrainBody Institute, Berlin School of Mind and Brain, Humboldt-Universität zu Berlin, Berlin, Germany |4 University of Leipzig, Leipzig, Germany

grossmannr@cbs.mpg.de

MAX PLANCK INSTITUTE
FOR HUMAN COGNITIVE AND BRAIN SCIENCES

Introduction

- **Somatosensory processing** in the brain entails a pathway through the brainstem, the thalamus the somatosensory cortices and higher order cortices.
- At what stage the stimulus is perceived is a long standing question.
- **Perceived** near-threshold stimuli elicit the mid-latency event-related potential (ERP) **N140**, which is absent when the stimulus was not perceived. Earlier ERPs such as the **P50**, on the other hand, seem to encode **physical features** of the stimulus (Forschack et al., 2020; Schröder et al., 2021).
- A recent study shows that the neural correlates of mechanical and electrical stimulus perception might differ. The **P60** seems to encode **perception** itself instead of stimulus intensity and an additional neural correlate was found: the **N80** (Förster et al., 2025).
- Are these results replicable? What role does the individual subject play in this result?

Methods

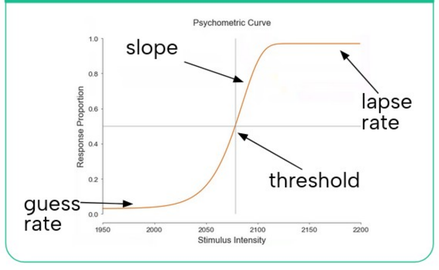
EEG Recording of Near-threshold detection paradigm
Two sessions per participant: one with mechanical, one with electrical stimulation
8 blocks per session, per block: 1. Threshold assessment, 2. Test block
7 intensity levels per test block

1. Threshold assessment

1. Up-Down Method

- Searches for prior boundaries for the parameters of the Psi-method

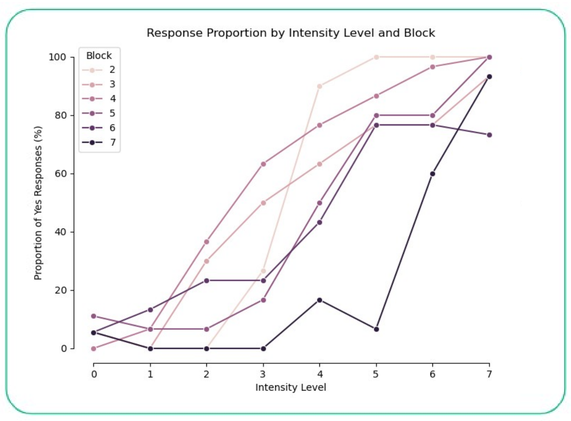
2. PSI Method



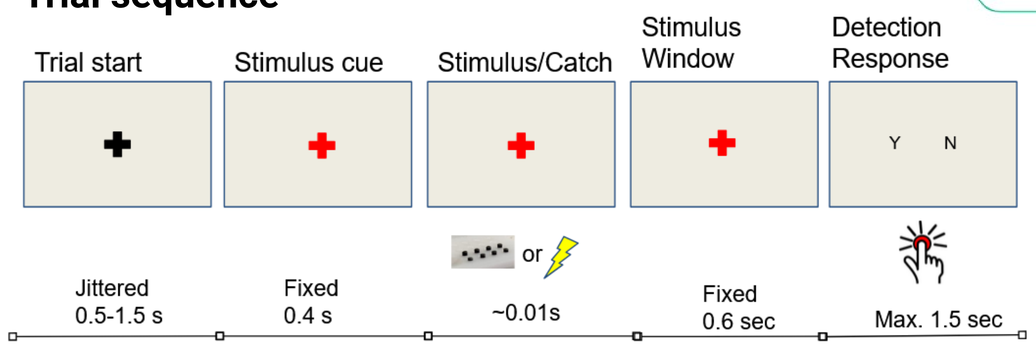
3. Test Trials

- 10 trials + 10% catch trials to test the computed threshold

2. Main block



Trial sequence



Additional Measurements

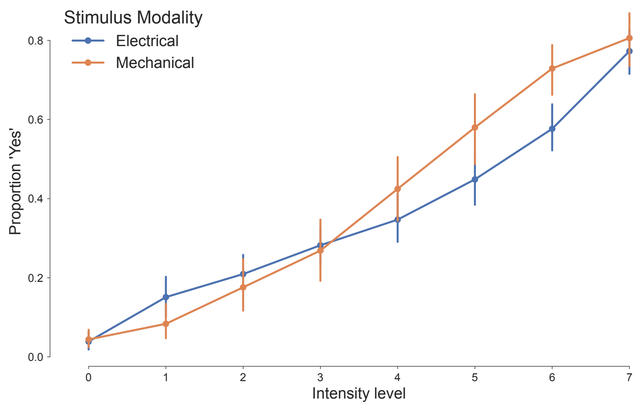
- Electrocardiography
- Respiration
- Finger weight on stimulator

Results

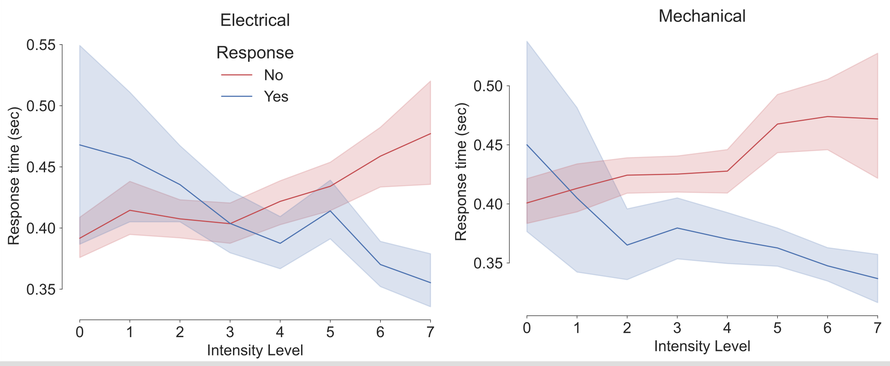
- Recorded, preprocesses and analyzed 6 Pilot data sets.
- 2 subjects had to be excluded from the ERP analysis due to strong noise in the EEG signal
- Signal was average per subject, block and intensity level separately

1 Behavioural

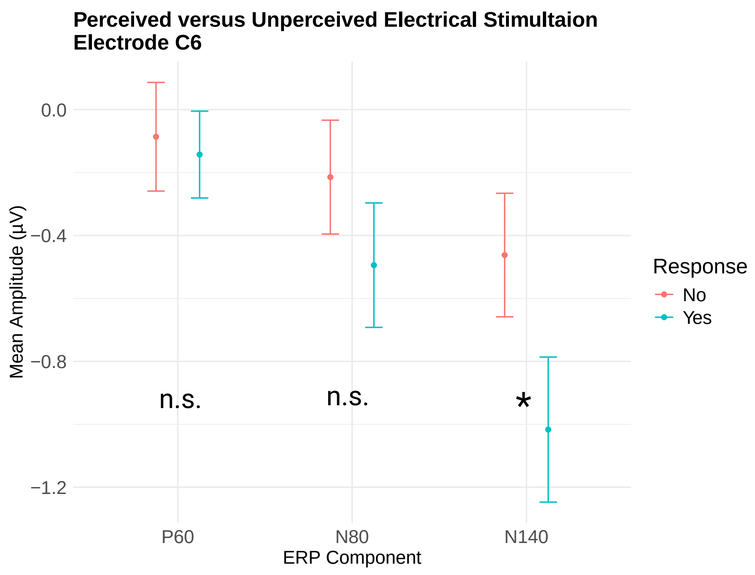
Response Proportions

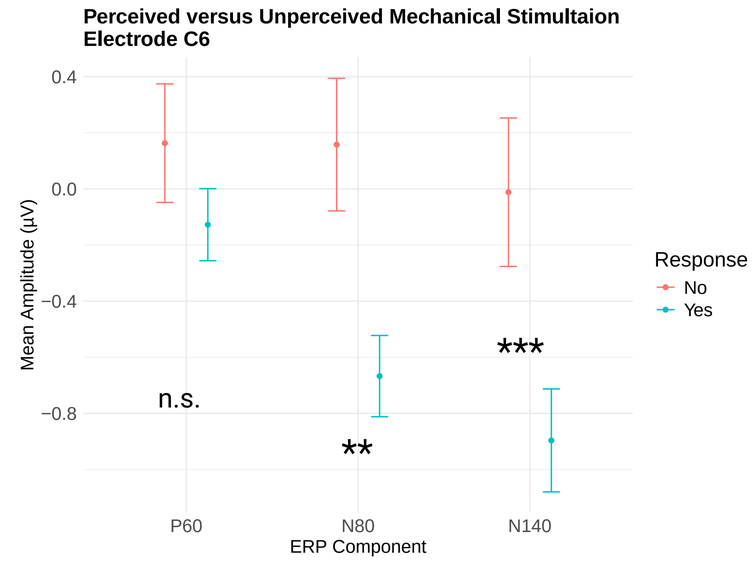


Response times per intensity

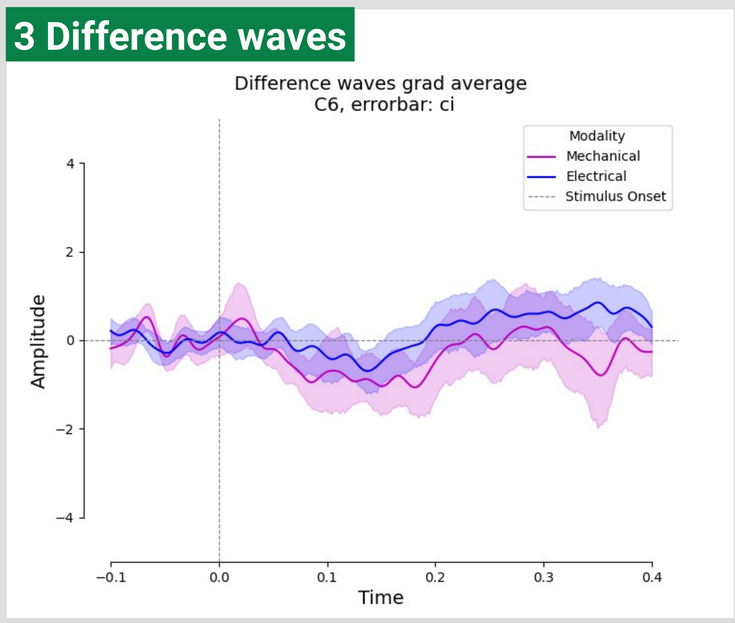


2 ERPs





3 Difference waves



- The difference between mechanical and electrical stimulation is not significant.
- The difference between perceived and unperceived stimuli is significant within the N140 time window for mechanical (t=3.58, p<.001, df=142.24) and electrical (t=2.79, p=0.0057, df=176.18) stimulation.
- The N80 is only significantly different in the mechanical condition (t=2.84, p=0.0051, df=131.49).
- In both mechanical and electrical stimulation, the difference in P60 amplitude for felt versus unfelt stimulation was not significant.

Discussion

The results of the pilot analysis show that there is a difference between perceived and unperceived stimuli for mechanical stimulation in the midlatency components N80 and N140, similar to Förster et al. (2025).

Perceived electrical stimuli indicate an elecited N140, but no N80 compontent.

Unexpectedly, electrode C6 does not show a clear P60 in the electrical stimulation, neither for the detected nor for the undetected stimuli. For the mechanical stimulus, the perceived stimulus shows an even lower P60 amplitude than the unperceived stimulus, which is unusual and might be due to the low sample size.

Limitations
Due to the low sample size, the interpretation should be done with caution. Recordings of at least n=35 total subjects is currently in progress.

References

Förster, J., Vardiero, G., Nierhaus, T., Blankenburg, F. (2025). The P50 predicts conscious perception under tactile but not electrical somatosensory stimulation in human EEG. bioRxiv

Forschack, N., Nierhaus, T., Müller, M. M., & Villringer, A. (2020). Dissociable neural correlates of stimulation intensity and detection in somatosensation. *NeuroImage, 217.*

Schröder, P., Nierhaus, T., & Blankenburg, F. (2021). Dissociating perceptual awareness and postperceptual processing: The P300 is not a reliable marker of somatosensory target detection. *The Journal of Neuroscience: The Official Journal of the Society for Neuroscience, 41(21).*

MBB Symposium, 2025