OBSERVING ELECTRICAL BRAIN RESPONSES AROUND THE NOCICEPTIVE DETECTION THRESHOLD

T. Berfelo[1], B. van den Berg[2], I.P. Krabbenbos[1], J.R. Buitenweg[2]

1 Dept. of Anesthesiology, Intensive Care and Pain Medicine, St. Antonius Hospital, Nieuwegein, the Netherlands

2 Biomedical Signals and Systems group, Technical Medical Center, University of Twente, the Netherlands

Introduction

There is a lack of objective measures providing insight into key neural mechanisms underlying chronic pain, such as central sensitization and deficient descending inhibition.

- Recently, we combined psychophysical Multiple Threshold Tracking (MTT) around the Nociceptive Detection Threshold with brain Evoked Potentials (NDT-EP method) to study neurophysiological activity related to processing of single and double pulse electrical Intra Epidermal Stimuli (IES)[1].
- NDT-EP results from pain-free subjects measured at the University of Twente demonstrate that EPs can be measured around the detection threshold, and correlate with stimulus properties and subjective responses, which warrants further exploration of diagnostic potential[1].

Study objectives

1. Explore the replicability and feasibility of the NDT-EP method in pain-free subjects and chronic pain patients at a hospital environment.
2. Observe the behavior of neurophysiological and psychophysical measures (detection thresholds and cortical activity in response to stimuli) in failed back surgery syndrome (FBSS) patients.

Methods

Quantitative assessment of nociceptive sensitivity

- Pain-free subjects (n=17), and chronic low back pain patients diagnosed with FBSS (n=14) and indicated for spinal cord stimulation, underwent test and retest measurements in a single session using the NDT-EP method at St. Antonius Hospital.
- Nociceptive Detection Thresholds (NDTs) and Evoked Potentials (EPs) were observed to describe central sensitization.

NDT-EP method

1. Activating specific nociceptive (Aδ) fibers using IES-5 electrodes.
2. Tracking detection probability and thresholds using an adaptive stimulus sequence (MTT paradigm).
3. Measurement of subjective response to every stimulus (NDTs).
4. Measurement of stimulus-related response in the EEG-signal with respect to every stimulus (EPs).

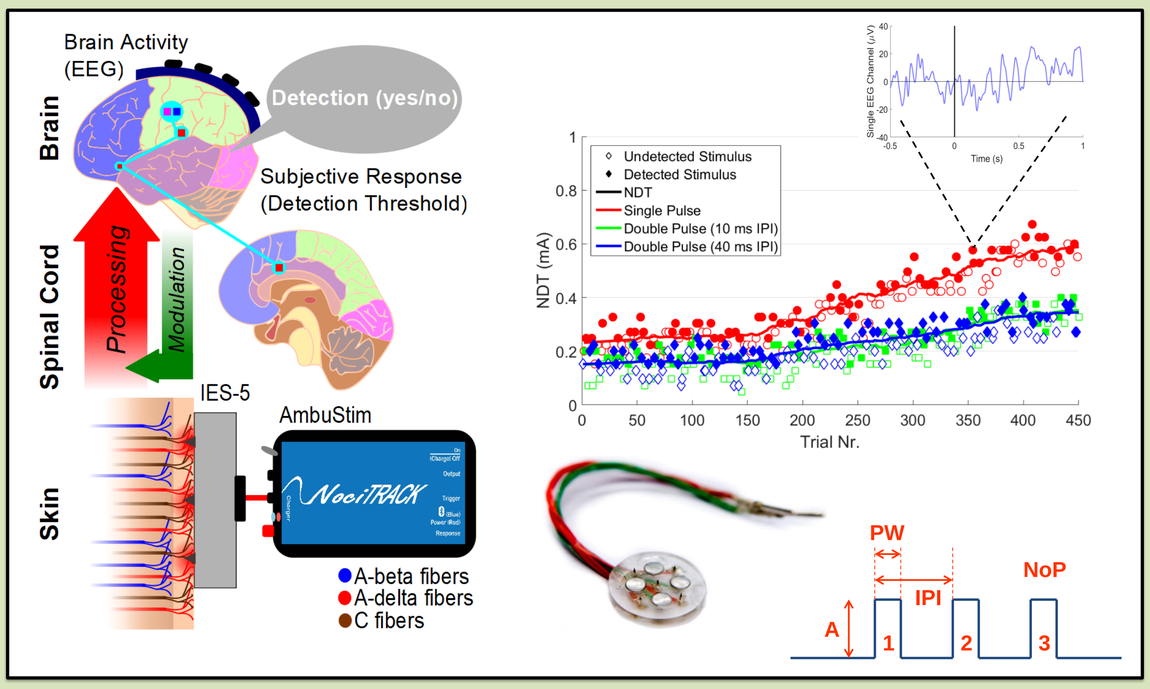

Figure 1. In total 450 stimuli, consisting of three different stimulus types, were randomly applied to the subjects by intra-epidermal stimulation (IES-5) electrodes using the MTT paradigm. Subsequently, the nociceptive function is assessed by stimulus-response pairs (NDTs) and stimulus-related brain activity (EPs).

Results

Replicability of results in pain-free subjects

- Similar values of (initial) NDTs and phenomena (habituation and paired-pulse facilitation) in pain-free subjects.
- Similar EP profiles which are modulated by stimulus detection, amplitudes and number of stimuli.

Altered behavior in FBSS patients

- Higher (initial) NDTs.
- EPs modulated by stimulus detection and single-pulse amplitude, not by double-pulse amplitudes and number of stimuli.

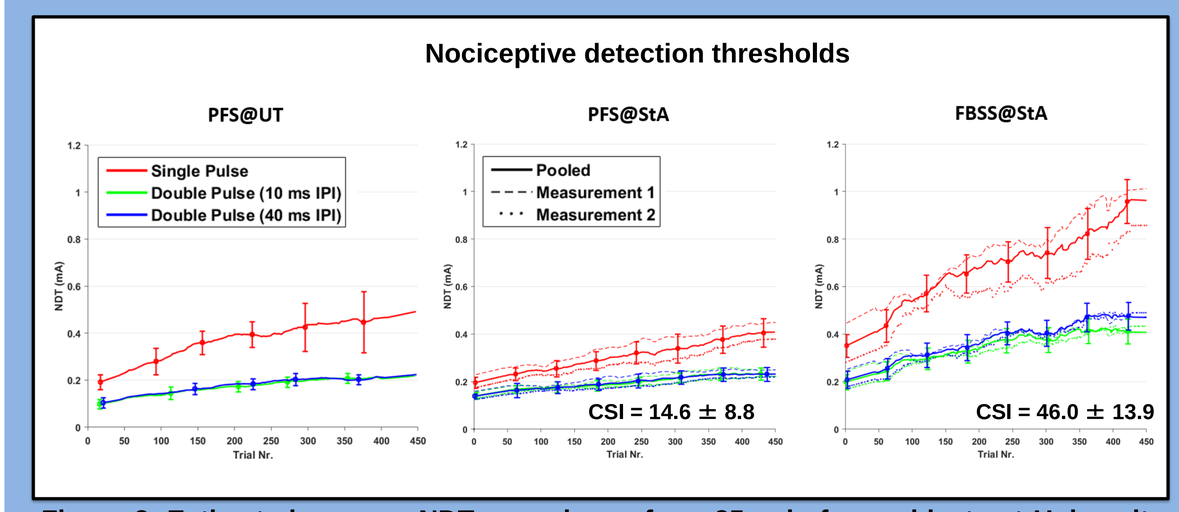

Figure 2. Estimated average NDTs are shown from 25 pain-free subjects at University of Twente (left), and 17 pain-free subjects (middle) and 14 FBSS patients at St. Antonius Hospital (right). Similar values of thresholds and phenomena (habituation) are seen in pain-free subjects. Higher (initial) NDTs are found in FBSS patients.

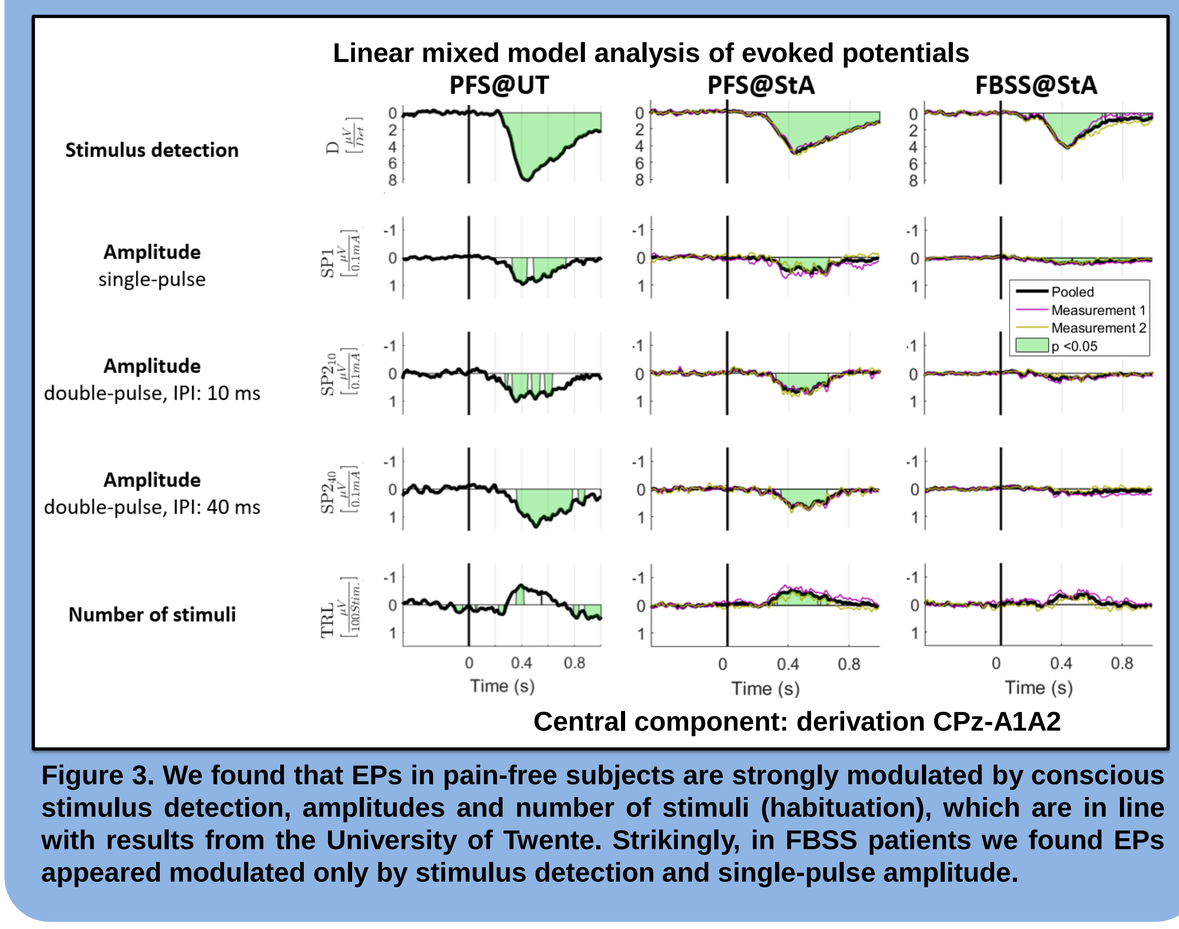

Figure 3. We found that EPs in pain-free subjects are strongly modulated by conscious stimulus detection, amplitudes and number of stimuli (habituation), which are in line with results from the University of Twente. Strikingly, in FBSS patients we found EPs appeared modulated only by stimulus detection and single-pulse amplitude.

Conclusion

- **Results of the NDT-EP method can be replicated in a hospital environment since similar phenomena in NDTs and EPs are observed in pain-free subjects at St. Antonius Hospital.**
- **Behavior of NDTs and EPs seems to be altered in FBSS patients.**

References 1. Van den Berg, B., Buitenweg, J.R., Analysis of Nociceptive Evoked Potentials during Multi-Stimulus Experiments using Linear Mixed Models, IEEE EMBC2018, Honolulu, US.

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