Expectation effects on repetition suppression in nociception

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Introduction

- **Repetition suppression**, a reduced neural response to the repeated presentation of a stimulus, is a consistently reported phenomenon in perception (Grill-Spector et al., 2006)
- **Different explanatory frameworks**

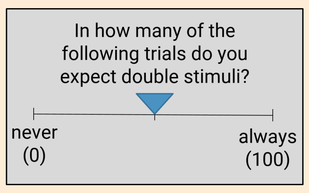
Receptor habituation, neuronal fatigue → independent of expectations

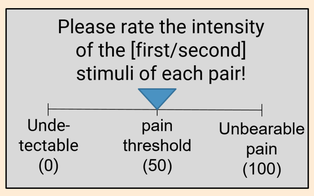
Predictive processing accounts → modulated by expectations

- Evidence for predictive processing accounts in auditory and visual domain, **in nociception currently unclear** (Valentini et al., 2011, Wang et al., 2010).
- **Goal: Adaptation of a repetition suppression paradigm from the auditory domain (Todorovic et al., 2011) to the nociceptive domain.**

Methods

Block type 8 blocks á 24 trials	Repetition Trials	Omission trials
High repetition probability	**75%** (expected repetitions)	**25%** (unexpected omissions)
Low repetition probability	**25%** (unexpected repetitions)	**75%** (expected omissions)





- **Manipulation check**: expectancy rating before each block
- **Average pain ratings** acquired after each block
- **Forced choice task** (1 block before and after main experiment): participants should indicate after each trial whether they received one or two stimuli (P = 0.5)

- **N = 36** (female, age 18 - 35)
- Acquired 57 participants, exclusion of 11 (stimuli unbearable) + 3 (incomplete dataset) + 4 (stimuli not painful) + 3 (stimulus discriminability too bad)
- block order balanced across participants

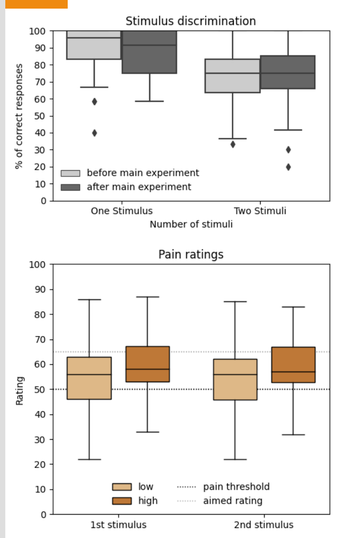
- **Nociceptive stimulation** using CO_2 laser (Laser Stimulation Device, SIFEC, Belgium)
- **Acquisition** of
  - 32-channel EEG, nose reference
  - Skin conductance responses, Pupil dilation, ECG, Respiration

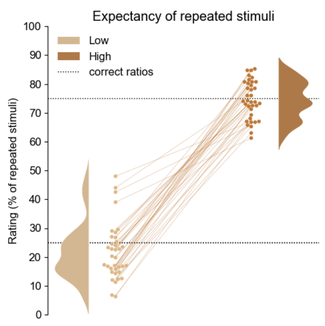
- **Preprocessing** of EEG data (MNE-Python)
  - High-pass filter 1 Hz (zero-phase, FIR)
  - Notch filter around 50 Hz (width 5 Hz)
  - Epoch data, manual rejection
  - Extended infomax ICA, reject eye + muscle components
  - Automated rejection of remaining artefacts
  - Re-reference to average reference *(Fz for N1)*
  - *For ERPs: low-pass filter 30 Hz*

- **Time-frequency analysis** (FieldTrip) using fast Fourier transform of Hanning-tapered data
  - for f <= 30 Hz window length 500 ms
  - for f > 30 Hz window length 250 ms

Results

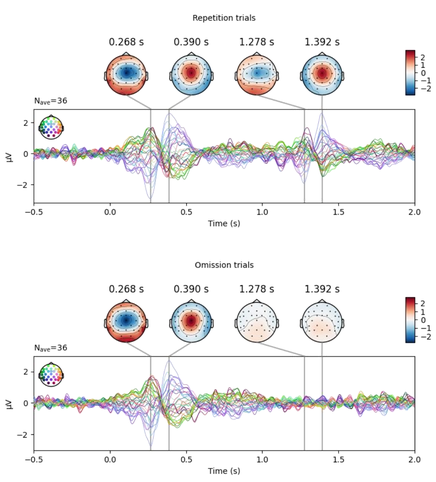
1 Behavioural control analyses





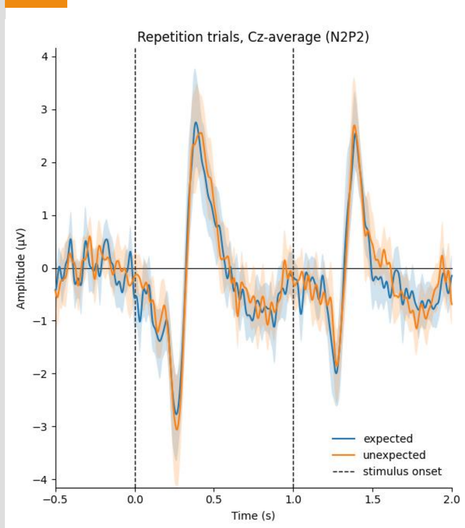
- Subjects could distinguish repetitions and omissions
- Stimuli were painful
- Subjects formed correct expectations

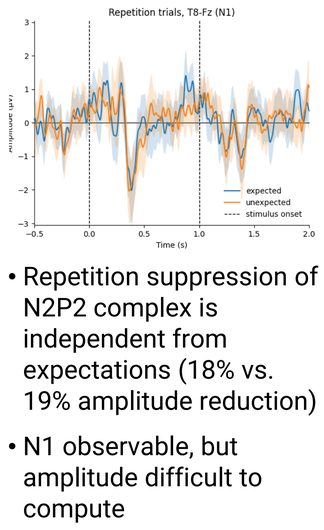
2 Time-locked response topography



- Clear N2P2 complex with central topography
- Amplitude smaller for repetition compared to first stimulus
- No responses for omissions in general

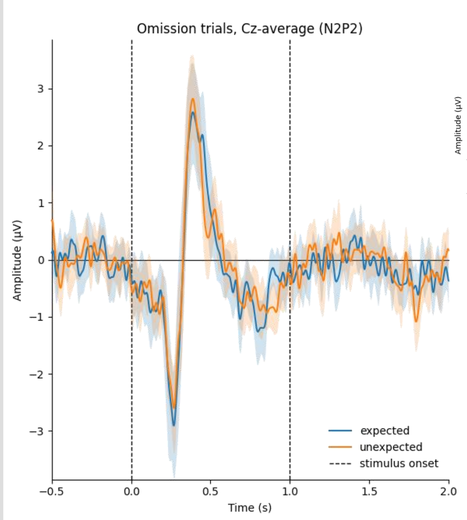
3 No expectancy effect on ERPs to repetitions

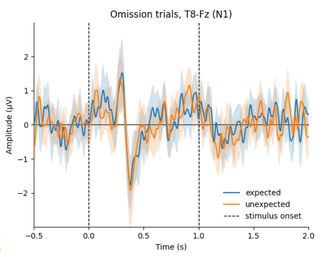




- Repetition suppression of N2P2 complex is independent from expectations (18% vs. 19% amplitude reduction)
- N1 observable, but amplitude difficult to compute

4 No expectancy effect on ERPs to omissions

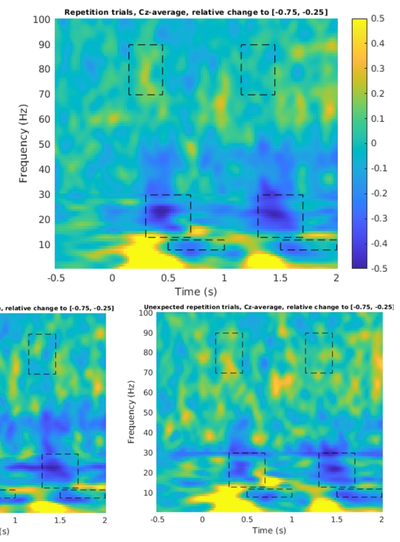




- No responses to omission of second stimulus, neither similar to N2P2, nor to N1

5 Repetitions: all hypothesised ERS/ERDs present

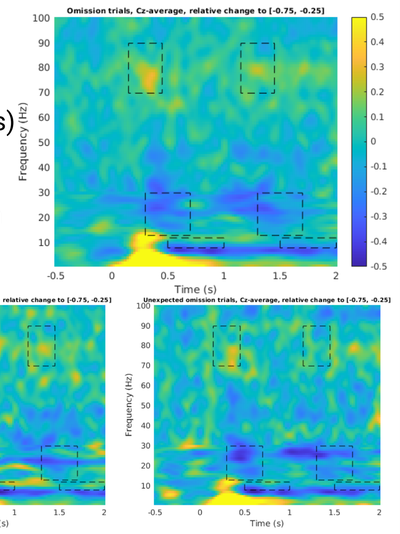
- ERS in theta to beta band, followed by ERD in higher frequencies for 1st and 2nd stimulus
- Gamma-band oscillation for 1st stimulus difficult to observe (limited SNR), less activation for 2nd stimulus
- More overall activity in unexpected vs. expected repetitions, no thorough comparisons (limited SNR)



6 Omissions: hypothesised ERS/ERDs to 1st stimulus

- ERS and ERD in alpha/beta band existent for 1st stimulus, probably slight ERD for omission (2nd stimulus)
- Gamma-band oscillation for 1st stimulus, maybe slightly for omission (2nd stimulus)

Due to currently limited SNR no thorough comparison between expectancy conditions possible.



Discussion

We developed a paradigm that potentially allows to disentangle different explanations for repetition suppression in nociception.

Participants were able to distinguish between repetition and omission trials and were able to form correct predictions regarding the stimulus-type-probability in the respective blocks. Stimuli were perceived as painful on average, however we did not reach our aimed for rating, since the temperature safety limit was reached for ~50% of participants.

We were able to observe robust laser-evoked potentials (N1 and N2P2) and found clear evidence for repetition suppression of the N2P2. There was however no expectational modulation thereof, currently speaking against a predictive processing account for repetition suppression in nociception.

In the time-frequency domain we were able to observe typical previously described features of responses following nociceptive laser stimuli (ERS followed by ERD in lower frequencies, characteristic gamma-band oscillations) (Ploner et al., 2017). We used a thorough cleaning approach for muscle artefacts (to be sure that the gamma band synchronization observed is of cortical origin), but this unfortunately led us to discard large portions of our trials and thus reduced the available SNR.

In ongoing work we are evaluating more sophisticated artefact correction methods, the use of which might then also allow us to check for prediction (error) related patterns in the time-frequency domain as well as for the N1 component. Further, we are analysing the concurrently acquired autonomic nervous system data for expectation effects on repetition suppression.

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