Subcortical involvement in phonological input processing: an electrophysiological registration study

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Introduction

The involvement of subcortical nuclei in auditory phonological input processing has only been studied by measuring neuromodulation effects on different aspects of auditory comprehension. Although these phonological effects of subcortical modulation have been well described, it is unclear if phonologically related local field potentials can be elicited in the main subcortical nuclei. The current study applied direct electrophysiological registration in thalamus, subthalamic nucleus (STN) and pedunculopontine nucleus (PPN) to determine if they are involved in phoneme discrimination and word recognition.

Method

Direct registration of event-related potentials (ERPs) is only possible in patients recruited for deep brain stimulation

- 20 patients with STN stimulation for Parkinson's disease (age 45-71; 9 male, 11 female)
- 2 patients with thalamic stimulation for essential tremor (age 56-73; 1 male, 1 female)
- 1 patient with PPN stimulation for Parkinson's disease (age 50; male)

Experiments performed with (ON) and without (OFF) dopaminergic medication

- Phoneme discrimination task : auditory oddball paradigm in pre-attentive (MMN) and attentive (P300) condition
- Word recognition task : pseudowords (deviant stimuli) and real words (standard stimuli)

Results

Fig 1. Grand average of difference waves for the pre-attentive phoneme discrimination paradigm in the subthalamic nucleus.

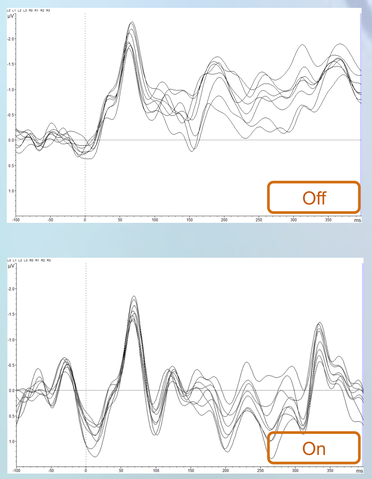


Fig 2. Grand average of deviant stimuli for the attentive phoneme discrimination paradigm in the subthalamic nucleus.

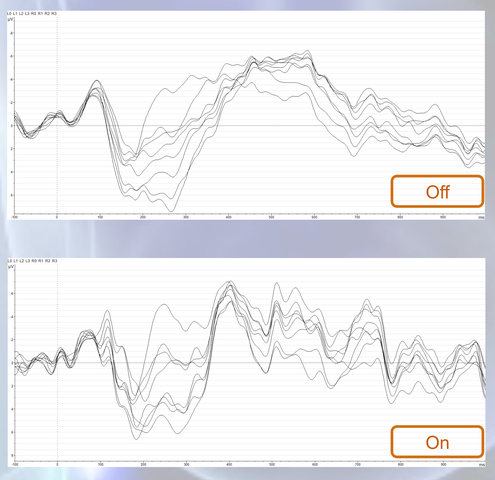
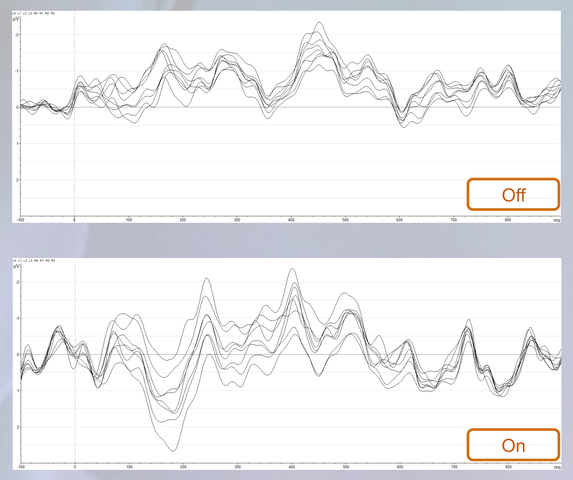


Fig 3. Grand average of standard real words for the word recognition paradigm in the subthalamic nucleus.



- STN:
  - Pre-attentive ERP at 64.26ms and 60.71ms post-stimulus (respectively left and right hemisphere)
  - Attentive ERP at 241.86ms and 241.15ms post-stimulus (respectively left and right hemisphere)
  - Word recognition ERP at 172.72ms and 173.72ms post-stimulus (respectively left and right hemisphere)
- PPN: Mid-latency auditory potentials. No phonologically related long-latency potentials.
- Thalamus: No phonologically related potentials.

Discussion

These data suggest an important role of the PPN and STN in the spectrotemporal preparation of phonological input processing and a primary role for the STN in phonological input processing.
In comparison with the normative cortical data (Aerts et al., 2013), these potentials could be detected in a time window prior to the cortical time frame. Within the lateral part of the thalamus no phonological related potential could be detected.

References

De Letter (2014). Electrophysiological registration of phonological perception in the subthalamic nucleus of patients with Parkinson's disease. *Brain Lang*.
Aerts (2013). Neurophysiological investigation of phonological input: aging effects and development of normative data. *Brain Lang.*

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