LETTER

Spectral power changes prior to psychogenic non-epileptic seizures: a pilot study

INTRODUCTION
Psychogenic non-epileptic seizures (PNES) are the most common manifestation of functional (psychogenic) neurological symptoms. Clinically, they consist of intermittent episodes that resemble epileptic seizures and can involve changes in behaviour, movement, sensation, autonomic function or consciousness. To date, there are no positive EEG features that have been identified that are diagnostic of PNES and therefore, the diagnosis is primarily based on clinical assessment and the absence of epileptic activity during the seizure.

Our goal was to identify a positive marker of PNES, by assessing EEG spectral power changes prior to non-epileptic attacks.

We hypothesised that decreases in β power (desynchronisation in the 13–30 Hz band) might occur prior to a non-epileptic seizure. β-Desynchronisation is known to occur prior to cued movement (event-related desynchronisation, ERD) or self-paced movement and was recently shown to occur prior to functional myoclonic jerks.1

METHODS
Participants
We recruited three patients previously diagnosed with PNES from the Movement Disorder outpatient clinics at the National Hospital for Neurology and Neurosurgery. Three EEG recordings of patients with convulsive epileptic attacks were used as control. The study was approved by the local Ethics Committee and informed consent was obtained.

Procedure
Patients were seated in a comfortable chair while a 32-channel EEG was recorded and a video was made. We asked each participant to sit in a relaxed position with their eyes open and to let attacks happen in their usual way if they occurred. Given the unpredictable nature of the attacks, patients were allowed to talk during the recording period.

Analyses
Data were analysed using Morlet wavelet transformations with Statistical Parametric Mapping (SPM, v12b). EEG files were epoched to frames from 12 s before to 6 s after the beginning of attacks. Time–frequency analysis was performed using the Multitaper method (SPM default settings). The logRatio method was used to rescale the data and the period of −12 s until −10 s (relative to the attack) was used as a baseline.

The average power relative to baseline in the β (13–30 Hz) range over electrodes Cz, C3 and C4 was calculated for the interval starting 12 s before and ending at the beginning of the attack. To detect changes in the second range, a moving average method, comprising 20 values, was used for the whole epoch.

RESULTS
Demographics
Patients with PNES were female and aged 43, 59 and 61. A typical PNES attack had a duration of minutes. Warning before occurrence of an attack was present in two patients (patient 1 sometimes, patient 2 usually) and absent in one. Comorbidity consisted of functional tremor and migraine in patient 1, functional weakness in patient 2 and a combination of migraine and functional weakness in patient 3.

Clinical description
Each patient had a single non-epileptic attack during the EEG recording, which were confirmed by the patients to be typical of their attacks. In patient 1, the event lasted 1 min and was characterised by a head drop with closure of her eyes and unresponsiveness with retained perception of sound and touch. Patient 2 had a similar presentation with closure of her eyes and a combination of unresponsiveness and retained perception, but without a head drop, lasting 2 min. Patient 3 had generalised rhythmic shaking of all four limbs with eyes closed and loss of perception and responsiveness, lasting 2 min. Epileptic seizures were all generalised convulsive

Spectral power analysis
All three patients with PNES showed a decrease in β power (desynchronisation) prior to their attack, while this was not present in any of the epilepsy patients. Time courses of these individual attacks of the three patients and their mean β activities are shown for PNES and epileptic patients in figure 1. The minimum β power in the peri-ictal interval was found to be around 6 s prior to the attack for patient one. For patients 2 and 3, this value was, respectively, 5 and 4 s before attacks. The maximum mean β desynchronisation was 5 s prior to the onset of movement.

DISCUSSION
This pilot study suggests that desynchronisation of β power might be a marker of an upcoming non-epileptic attacks. If confirmed in a larger study, it could potentially be a valuable positive marker for PNES. Although all patients confirmed their PNES were typical of their usual attacks, they may theoretically be different as they occurred in a laboratory setting. A next step would therefore be to analyse attacks during ambulatory EEG recordings. Importantly, we did not see desynchronisation prior to a convulsive epileptic attacks, which is consistent with
a majority of previously published studies of extracranial EEG in epilepsy patients. Oscillations in the β frequency range are the product of synchronisation across populations of neurons. Suppression of β power occurs prior to cued and self-paced movement and is modulated by attention.² It has been proposed that β activity in the basal ganglia-cortical system provides an internal index of the likelihood of the need for a novel voluntary action, with suppression of β indicating a higher likelihood.³ More specifically, changes in β power prior to movement may index a change in motor attention that promotes a new sensory state at the expense of the current sensory state.⁴ If this increase in precision is sufficient, then movement occurs in keeping with the new expected sensory state.

Dissociation, the mechanism suggested to underpin PNES, is often characterised as a loss of attentional focus and resulting disintegration of emotional and sensorimotor function. However, if β power suppression prior to the onset of PNES reflects an increase in attention towards future movement, this is rather at odds with current models of dissociation as the mechanism underlying PNES. Our suggestion of increased attention towards upcoming movements is in line with patient reports of a degree of control over and awareness of an imminent seizure.⁵ Therefore, this pilot study provides early evidence for β oscillations being a potentially useful diagnostic marker of PNES and also challenges current pathological accounts of this common disorder.

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