Assessing large spontaneous and sensory-evoked sleep slow waves and their relation to dreaming

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The overarching aims of this proposal are 1) to identify the neurophysiological processes underlying type I slow waves and 2) to manipulate them in order to determine whether and how they relate to dreams. The specific aims are outlined below:...

Ethical review	Approved WMO
Status	Recruiting
Health condition type	Other condition
Study type	Interventional

Summary

ID

NL-OMON56292

Source
ToetsingOnline

Brief title
Slow waves and dreaming

Condition

- Other condition

Synonym
NA

Health condition

normal brain physiology, no disease

Research involving
Human

Sponsors and support

Primary sponsor: Netherlands Institute for Neuroscience
Source(s) of monetary or material Support: ERC Starting Grant Dreamscape 101039782

Intervention

Keyword: consciousness, dream, sleep

Outcome measures

Primary outcome

1) First part of the study:

• EEG topographies and sources of modality-specific and supramodal responses

• Differences in topographies at the scalp and source level and in

trial-by-trial dynamics between evoked and spontaneous type I potentials

2) Second part of the study:

• Correlation between the degree of sensory experience in the dream (visual,

tactile, auditory) and the modality-specific component of the type I potential

preceding the awakening (if present, result of first part of the study)

• Correlation between the degree of surprise experienced in the dream and the

supramodal component of type I potentials

Secondary outcome

• Differences in topographies at the scalp and source level and in

trial-by-trial dynamics between type I potentials in sleep and wakefulness

• Presence, latency and order of muscle activations recorded by EMG sensors in

association with type I potentials

• Presence and latency of pulse wave amplitude and heart beat variability

changes associated with type I potentials

Study description

Background summary

This project addresses the challenging and longstanding question of how the brain generates dreams. Although dreams have interested humankind since the earliest ages, the precise mechanisms underlying dreaming and their function are still unknown. Understanding dreaming not only serves to satisfy scientific curiosity. It will also pave the way for a better understanding of sleep disorders that are related to abnormal forms of mental activity during sleep. Indeed, while most people hardly remember any mental experiences upon awakening, and besides the occasional nightmare, do not consider dreams as problematic, for up to 5% of the population, dreams can become a real burden Complaints related to mental activity during sleep include, amongst others, recurrent nightmares; parasomnias, representing abnormal, often dream-related behavior; epic dreaming disorder, a condition in which dreams are perceived as excessive and tiring, and paradoxical insomnia, characterized by the subjective impression of feeling awake during sleep and relentless ruminations (recurrent thoughts). In addition, a better understanding of dreaming may shed light on related phenomena including hallucinations and delusions encountered in psychiatric disorders.

As a highly subjective phenomenon that is confined to the realm of sleep1, dreaming has remained inaccessible to direct scientific investigation for a long time. It was initially assumed that dreams occurred almost exclusively during rapid eye movement (REM) sleep, a sleep stage that owes its name to the brisk eye movements that occur under closed eye lids, and in which brain activity, measured with electroencephalography (EEG), is fast and surprisingly wake-like. However, later studies established that dreams can also occur in Non-REM (NREM) sleep, a sleep stage with very different EEG patterns, consisting in prominent low-frequency oscillations called slow waves. In a recent study, we investigated the neural correlates of dreaming using high-density (hd-)EEG, combined with over 800 serial awakenings to collect dream reports6. We discovered a neural signature of dreaming shared by both REM and NREM sleep, characterized by a local activation of posterior brain regions (grouped under the name *posterior hot zone*). We were also able, for the first time, to image brain activations corresponding to specific dream contents in full-fledged sleep, including faces, movement, speech, and the spatial setting of dreams. Although this landmark study provided a potential answer to the longstanding question of why dreaming can occur in behavioral states with globally different EEG patterns (by showing that dreaming requires a local activation, irrespective of the EEG in the rest of the cortex), it remains

unknown which neurophysiological processes underlie this neural signature of dreaming, and how the contents of dreams are generated.

Intriguingly, in a series of subsequent studies, we found that dreaming is closely related to two types of brain waves, which will be referred to here as type I and type II potentials. More specifically, we found that a dream was particularly likely to be reported when in NREM sleep, a large and widespread slow wave (type I potential) appeared in the EEG recording shortly before the awakening, and when, at the same time, slow waves in the posterior hot zone of the dreams (type II potentials) were particularly small. The two types of slow waves display distinct variations across the night, occur on different EEG backgrounds, induce specific EEG changes, are differentially affected by development and experience. Recent studies have documented two similar types of slow waves also in rodent NREM sleep and even suggested that they serve distinct sleep-related functions (memory consolidation vs. forgetting). Although slow waves are a typically hallmark of NREM sleep, they may also occur in REM sleep, albeit with a smaller amplitude. Interestingly, we recently discovered that also in REM sleep there are two types of slow waves (called sawtooth waves and medio-occipital slow waves), with similar properties to those in NREM sleep. Finally, brain waves similar to type I potentials can be seen during wakefulness, in response to unexpected sensory stimuli. Taken together, these observations suggest that the neurophysiological processes underlying the two types of slow waves could be present in different behavioural states (REM and NREM sleep).

Study objective

The overarching aims of this proposal are 1) to identify the neurophysiological processes underlying type I slow waves and 2) to manipulate them in order to determine whether and how they relate to dreams.
The specific aims are outlined below:
Primary Objectives
1) First part of the study: provide a detailed cortical mapping and comparison of spontaneous and sensory-induced type I brain potentials
2) Second part of the study: to determine how spontaneous type I brain potentials relate to dream contents
Secondary Objective(s):
1) To compare type I potential *equivalents* across behavioural states (wake, NREM and REM sleep)
2) To determine whether type I brain potentials are associated with specific patterns of muscle activations and autonomic nervous system changes

Study design

This is an interventional study with a within-subject design:
In the first part of the study, stimulus-induced type I brain potentials

(resulting from the administration of sensory stimuli, i.e. the intervention) will be compared with naturally occurring type I brain potentials during sleep within the same subject and night of sleep.
In the second part of the study, the intervention will consist in awakening study participants at different times of the night and asking them about dreams and their characteristics. The characteristics of type I potentials preceding the awakenings will be compared between different *outcomes* (presence of dreaming, sensory modality of the dream, surprise in the dream, etc.).

Intervention

Sensory stimuli will be applied during wake and sleep - including visual, auditory, and tactile stimuli. These stimuli are well within the comfortable range, and can be applied during sleep without disturbing the participant.

Study burden and risks

The risks associated with this study protocol are minimal for the study participants and essentially consist in unlikely allergic reactions to the EEG net or electrode gel, fatigue and sleepiness the day after the study due to slight sleep fragmentation, and in susceptible individuals, occurrence of a migraine, seizure or hypomanic episode. Measures have been taken to prevent or minimize these risks, including thorough screening of participants, adequate information and appropriate instructions. There is not direct benefit for participants.

Contacts

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Trial sites

Listed location countries

Netherlands

Eligibility criteria

Age
Adults (18-64 years)

Inclusion criteria

• Age 18-55 years • Good sleep quality (Pittsburg Sleep Quality Index <5) • Regular sleep-wake patterns • Usual sleep duration of at least 7 hours per night.

Exclusion criteria

• Inability to follow procedures (eg due to insufficient knowledge of project language, cognitive or auditory impairments, etc.)
• Individuals with known structural brain injury
• Individuals with a history of epileptic seizures or suspected epilepsy
• History or presence of a condition that may affect brain or sensory function or development;
• History of a medical condition that may affect sleep and/or brain activity
• History or presence of psychological/psychiatric conditions that may affect the subject's sleep and/or ability to follow experimental procedures;
• Persons with substance abuse (alcohol or other substances) in the past 6 months
• Nursing women or female subjects who are pregnant or planning to become pregnant.
• Current or recent intake of medications with psychotropic effects (eg, antipsychotics, antidepressants, anxiolytics, psychostimulants, antihistamines, or beta-blockers - based on subject reporting and clinician judgment).
• Insufficient sleep quality or irregular wake-sleep rhythm
• Traveling to time zones with a time difference of more than 1 hour in the 2 weeks prior to the study days
• Patients with extreme chronotypes (30 points or lower, or 70 points or higher on the Morningness-Eveningness questionnaire)
• snoring

Study design

Design

Study type: Interventional

Masking:	Open (masking not used)
Control:	Uncontrolled
Primary purpose:	Other

Recruitment

NL

Recruitment status:	Recruiting
Start date (anticipated):	20-11-2023
Enrollment:	25
Type:	Actual

Ethics review

Approved WMO Date:	20-10-2023
Application type:	First submission
Review commission:	MEC-U: Medical Research Ethics Committees United (Nieuwegein)
Approved WMO Date:	06-05-2024
Application type:	Amendment
Review commission:	MEC-U: Medical Research Ethics Committees United (Nieuwegein)

Study registrations

Followed up by the following (possibly more current) registration

No registrations found.

Other (possibly less up-to-date) registrations in this register

No registrations found.

In other registers

Register	ID
CCMO	NL84313.100.23