

New Hypothesis and Theory about Functions of Sleep and Dreams

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Abstract

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Aim: The aims of the study were: 1. revealing the new indicator(s) in internal organization of sleep in psychotic states; 2. constitution of new neurophysiologic and statistical models of sleep perturbation in psychotic states and/or altered states of consciousness based on experimental data. 3. Introduction of new sleep marker as biological marker for distinction of sleep organization by different psychotic states. 4. Established new hypothesis and theories in functions of sleep and dreams.

Methods: The clinical neurophysiologic test (Polysomnography - PSG) were performed on 90 drug-free patients - 60 with depression (30 patients with reactive depression F32.0, F32.1, and 30 patients with depression with psychotic feature F32.3); and 30 patients with Acute schizophrenia and schizophrenia-like states F23.1, F23.2 (all according to the DSM-IV criteria). Polysomnography was used for two nights, sleep staging (according to the criteria of Rechtschaffen & Kales, 1968) and statistical analysis of 130 sleep parameters with logistic regression (discriminative analysis "step by step"). All patients were drug-free in 3 days (1st adaptation night and 2 nights sleep investigation). The bigger part of investigation was performed in "Zentrum fuer Chronomedizin" in Wuerzburg (Germany) and one part at Psychiatric Clinic in Belgrade (Serbia).

Results: 1. The results of our investigations demonstrate that the ratio between REM and NREM time in the first period of sleep (index of endogenous perturbation of sleep or IEP-P1=REM-1/NREM-1) is statistically the most significant chronobiological marker of internal sleep organization (through maturation and in different pathological states); 2. IEP-P1 is a highly reliable indicator of the development of endogenous perturbation of sleep in depression, mania, schizophrenic and other psychotic states, and in organic brain syndromes.

Conclusion: IEP-P1 could be a new biological marker to distinction of sleep organization in different psychotic states and other states of altered consciousness. The developed statistical models could be the basis for new hypothesis and theories about functions of sleep and dreams.

Introduction

The sleep process

Sleep is a regular, recurrent, easily reversible state of the organism that is characterized by relative quiescence and by a great increase in the threshold of response to external stimuli relative to the waking state [1].

The most important question in sleep research is: Why we sleep? What are the functions of sleep? Some researchers have even implied that sleep is a "vermiform appendix" that may have once served the function of keeping ancestors out of harm's way for a portion of the day but has no remaining function now.

Most researchers believe that sleep is an adaptive behavior (adaptation to day/night, light/darkness natural rhythm; or bioenergetics / thermoenergetic process that saves energy; or that sleep does serve some restorative function.

Based on the research, two most important functions of sleep are hypothesized:

1. The physiological function of sleep as an adaptive behavior is: saving the brain from critical cooling and overheating [2, 3]; and

2. The psychological function of sleep is: sustaining the continuity of mental functions/psychic life through the dream process [2, 3].

Sleep and dream

Many psychological and psychophysiological studies indicate that both electrophysiological types of sleep are identifiable differently in mental activity.

The mental activity in NREM sleep is generally less vivid, less visual, less well recalled, more conceptual, more plausible, and less bizarre, more like thinking than dreaming. It is also less emotional and more concerned with contemporary waking experience and under greater volitional control.

On the other hand, the mental activity in REM sleep - dreaming, has opposite characteristics. Dreams have their own language, different symbolism with individual and collective meaning, altered dimensions of time and space (similar to the altered state of consciousness).

Freud's (1933) observation that state of sleep makes the formation of dreams possible by a reduction of the power of the censorship ("the way to unconscious..."), may have a neurophysiologic analogy in the activation of REM through the activation of rhombencephalic and associated limbic circuits in relation to the reduction of controlling influences flowing from the corticofugal inhibitory systems [4].

Freud (1933) also viewed the dream process as a regressive mental functioning in the sleep state [4]. The regressive form of mental functioning in the dream process can be connected to the rhombencephalic pattern of sleep that is both ontogenetically and phylogenetically a more primitive form of sleep activity - Jouvet (1966) [5] referred to such REM activation as "archisleep".

Modern neurophysiologic research has opened up new vistas in the understanding of the mechanisms of the dreaming process. Two basic and conflicting hypotheses remain: 1. Freud's basically psychological hypothesis of diminished endopsychic censorship; and 2. psychophysiological hypothesis of spontaneous activation of neuronal circuits as the underlying cause of dreaming activity.

Hobson (2009) [6] said that REM sleep may constitute a protoconscious state, providing a virtual reality model of the world that is of functional use to the development and maintenance of waking consciousness.

Kruger and Obal (2009) [7] in their neuronal group theory of sleep function hypothesized that sleep serves to stabilize these competitive processes by providing a pattern of stimulation that serves to maintain a synaptic infrastructure upon which wakefulness-driven synaptic changes are superimposed. They assume that sleep is 'quantal' in nature in that sleep is a statistical property of a population of neuronal groups in different states.

In our hypothesis [8-10] the REM sleep (as one dimension of a very complex process that is dreaming)

has the underlying mechanisms in electromagnetic phenomena which enable neuronal and interpersonal communication.

The aims of the study were: 1. revealing the new indicator(s) in internal organization of sleep in psychotic states; 2. constitution of new neurophysiologic and statistical models of sleep perturbation in psychotic states and/or altered states of consciousness based on experimental data; 3. introduction of new sleep marker as biological marker for distinction of sleep organization by different psychotic states; 4. established new hypothesis and theories in functions of sleep and dreams.

Methods

The clinical neurophysiologic test (Polysomnography - PSG) were performed on 90 drug-free patients - 60 with depression (30 patients with reactive depression F32.0, F32.1, and 30 patients with depression with psychotic feature F32.3); and 30 patients with Acute schizophrenia and schizophrenia-like states F23.1, F23.2 (all according to the DSM-IV criteria). All patients were diagnosed by an experienced clinical psychiatrist and fulfilled ICD-10 criteria (World Health Organization, n.d.) [11] for either major depression (F32.2) or schizophrenia (F20). The mean duration of the illness in the group with schizophrenia was 12.60 years (SD = 6.53) and in the group with depression 12.93 years (SD = 6.13). Men/women ratio 1:1. All patients were in-patients. The exclusion criteria for all subjects were the following: presence of neurological or medical illness, current or recent alcohol abuse or drug addiction (except for nicotine), presence of any psychiatric disorder in the group of healthy control subjects and any comorbid psychiatric disorder in patients. All subjects provided written informed consent to participate in the study. All subjects underwent a 16-channel EEG recording for 24 hours using the Oxford Medilog 9000 ambulatory EEG system plus 2 EOG (electrooculogram) and 1 EMG (submental electromyography) channels. The analysis was restricted to an 8-hour-period from 10 p.m. until 6 a.m. For the subsequent statistical analysis the following sleep parameters were extracted: total sleep time, sleep latency, number of awakenings, and time of awakening after sleep onset, slow wave sleep, REM latency, REM 1, Non-REM 1, Index of endogenous periodicity (Table 1).

Polysomnography was used for two nights, sleep staging (according to the criteria of Rechtschaffen et Kales, 1968) [12] and statistical analysis of sleep parameters with logistic regression (discriminative analysis "step by step"). All patients were drug-free in 3 days (1st adaptation night and 2 nights sleep investigation). All ethical standards are satisfied. The bigger part of investigation was performed in "Zentrum fuer Chronomedizin" in

Wuerzburg (Germany) and one part at Psychiatric Clinic in Belgrade (Serbia).

Results

On the basis of our investigation of sleep process through statistical analysis of data (sleep variables) originated of polysomnogram (PSG) and 24 hours ambulatory EEG/polygraphy of circadian rhythms by different states of altered consciousness and by psychotic disorders (affective and paranoid psychosis, and schizophrenia [3, 8], we derivate different statistical models which characterize the different organization/disorganization of sleep, sleep-wake cycles and consciousness, by clinically and neurophysiologic very important pathological states.

Statistical models

According to the results of logistic regression (discriminative analysis step by step, forward wald) with variables derived from polysomnogram (PSG), we developed some other statistical models of sleep perturbation in different psychopathological states and states with altered consciousness.

Statistical model of sleep in reactive depression

The statistical Model of exogenous perturbation of sleep is the characteristic of exogenous/reactive depressive states. The most discriminative sleep variables are: 1) increased Number of Nocturnal Awakenings (NAW); 2) Shortened REM-sleep; 3) prolonged first sleep period (first NREM/REM cycles in night); and 4) decreased REM/NREM Ratio.

Index of Endogenous Perturbation

The main result of all these investigations and the statistical analysis demonstrate that the ratio between REM and NREM time in the first period of sleep or the Index of Endogenous Perturbation (IEP-P1) is statistically the most significant chronobiological marker of internal sleep organization through cerebral maturation and in different pathological states:

$$\text{IEP - P1} = \text{REM-1} / \text{NREM-1}$$

Index of Endogenous Perturbation [3, 8, 10]

The IEP-P1 is a highly reliable indicator of the development of ENDOGENIC PERTURBATION OF SLEEP in depression, mania, schizophrenic and other psychotic states & organic brain syndrome.

Statistical model of sleep in endogenous depression

We have also determined in discriminative analysis the indicators of development of endogenic or internal perturbation of sleep in endogenic depression the Models of endogenic perturbation of sleep (probability level 95%). These are: 1) decreased NAW; 2) reduction of "delta-sleep" (stages 3 and 4 NREM); 3) shortened first sleep period of night; 4) increase of total Wakefulness; 5) Shortened REM-1 latency (Kupffer); 6) increase (or decrease) of IEP-P1 [8].

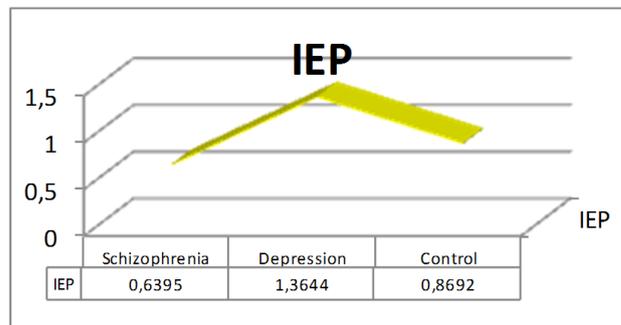


Figure 1: Averages of IEP values in groups of schizophrenic patients, depressive patients, and healthy control.

Statistical models of sleep organization in different psychotic states

Two basic but completely opposite models of sleep perturbation are the result of our neurophysiologic investigation of sleep in psychotic disturbances:

Model - "Delta Sleep Deficite Type" (with reduction of "delta-sleep"):

- in endogenous depression and delusional (paranoid) states: 1) shortened REM-latency; 2) Reduction of "Delta-Sleep"; 3) increased Index of Endogenous Perturbation (IEP); 4) prolonged REM-I phase (SOREMP).

Model - "REM Sleep Deficit Type" (with reduction of REM-1 phase):

- in Schizophrenia and Schizophrenia-like states: 1) prolonged REM-latency; 2) disturbed "delta-sleep"; 3) decreased Index of Endogenous Perturbation (IEP); 4) reduction of REM-1 PHASE (SOREMP).

From these two basic models after statistical analysis according to the clinical categories of psychotic states and altered states of consciousness, four new statistical submodels were derived.

Submodel - "Delta Sleep Deficite Subtype 1" - Delta Sleep Deficiency - reduction of "delta-sleep" - in endogenous psychotic depression, manic and paranoid psychotic states:

From the clinical point of view these patients have an experience or feeling of transpersonal communication: so called "Hyper-communication

states" [3, 10].

The Index of Endogenic perturbation of sleep (IEP-P1) is very high:

$$\text{IEP-P1} > 2.40$$

Submodel - "Delta Sleep Suficite Type" - "Delta sleep suficite" - increase of "delta-sleep", on the endpoint without REM-sleep - in coma and clinical death.

We named this states as "Pseudo-communication states" [3, 10]. The patients have stories about phantom-like "out of body" experiences. The IEP-P1 has a tendency to diminish to zero:

$$\text{IEP-P1} = 0$$

Submodel - "REM sleep Deficit Type" - "REM-sleep deficiency" - reduction of REM-1 phase - in Schizophrenia and Schizophrenia-like disorders:

This states we named as "Hypo- and Uncommunication states" (autism) [3, 10]. The IEP-P1 is very low:

$$\text{IEP-P1} < 0.30$$

Submodel - "REM sleep excess type" - "REM-sleep suficite" - increase of REM-1 phase and REM sleep in total, on the endpoint without DELTA-sleep - in Oniroid states and Delirium.

So called "Discommunication states" [10] - with perceptive distortions, hallucinations, disorientation. The IEP-P1 is very high:

$$\text{IEP-P1} > 4.0 \Rightarrow \infty$$

Our Hypothesis

Function of sleep and dreams

From our point of view we have assumed three important functions of sleep and dreams:

1. The physiological functions from sleep our point of view is: saving the brain from critical cooling and overheating [3, 8].

We have created this new, original hypothesis about passive and active protective help systems, which, through sleep process, protect the brain from critical cooling and/or overheating [8].

In fact, reducing the brain tissue temperature would lead to regression of brain's electrical activity during NREM sleep, while through active processes of REM sleep metabolic homeostasis and homoeothermic conditions would be regained. NREM periods are time when nature is trying to cut down some energy spending by passively preserving it - passive help system. This is managed by progressive inhibition of telencephalic activity and by marked reduction in muscle tone (disconnection of telencephalic region from rhombencephalic motor mechanisms). Since inactivation of great muscle groups is offering bad

saving plan due to their significant role in thermoproduction, active help system is handling this thermoenergetic disbalance and keeping the brain away from the critical cooling point - through REM sleep, active neuronal and metabolic processes in the brain stem are released. They include increased cerebral blood flow, increased glucose utilization and rising brain tissue temperature. Thanks to these active processes, the brain is protected from critical cooling and yet another life saving and function preserving mechanism is in effect.

- The roles of cerebrospinal fluid (CSF), the circulatory and respiration systems are very important in these thermoregulatory processes and in maintains of stabile working temperature of brain independently from body temperature: "air plus fluid cooling system of brain" [3].

- Continuation of respiration - the only way to eliminate residual air because of muscle hypotony/relaxation in REM [10].

2. The psychological function of sleep is the continuation of mental functions through the dream process.
3. The hypothetical role of sleep, dreams and altered states of consciousness could be in interpersonal communications [3].

New hypothesis and theory about potentially functions of NREM and REM sleep

On the basis of our clinical and neurophysiologic investigations we are trying to develop a new theory about sleep and communication capability of the brain.

1. Possible role of REM sleep in INTRANET (intrabrain) communication.

Used only conditionally the conventionally terms in computer technology, we assume that the brain in REM-sleep ("dreams") works on [3]: 1) selection and saving of information; validation of information; 3) "compression/ decompression" ("pack/unpack") of the memory data; 4) creating the new "short-cuts" (symbols); 5) "clean-up" of memory data/information; 6) "defragmentation"; 7) "upgrading" ("live update") the programs with new information/experiences/learning (with data from "intranet-communication" and training of neuronal networks), and maybe from external "internet-interbrain-communication", too.

2. Possible role of NREM sleep in INTERNET (interbrain) communication.

We assume that, because of electromagnetic nature of basic processes in sleep [3], the hypothetically communication process in sleep develops in next steps: 1) the reduction of vigilance in NREM-sleep is a *conditio sine qua non* for triggering of REM sleep and "connection" and "logging onto the

network"; 2) NREM-sleep is a basis/introduction for "communication-sleep" or REM-SLEEP [3]; 3) REM-sleep is a state/time of "surfing" on the network, "downloading" and "upgrading" (live update) of some "programs" and "data basis" ("wireless" from other brain, mother brain ?, "provider brain", or other external data basis...? natural, cosmic, artificial...?).

Conclusions

- The sleep process is very important in many ways, but we point out the protection of the brain from critical cooling and overheating. The sleep process secures the brain from overheating and critical cooling, and crash because of thermal excess.
- The next physiological role of sleep is in the continuation of respiration as only way to eliminate residual air because of muscle hypotony in REM sleep.
- The psychological (psychophysiological) function of sleep is the continuation of mental functions through the dream process
- And on the endpoint it is our theory about electromagnetically nature of sleep we assumed the hypothetical role of sleep, dreams and altered states of consciousness in interpersonal communications. The psychotic states and the other states of altered consciousness are real states with different basic psycho physiological have other (bigger) capability for perception and communication, or they are only states with subjective feeling of hypercommunication?
- The electromagnetic nature of sleep process and of interneuronal-intranet and extraneuronal-internet communications is the next biggest challenge for further research of sleep, consciousness and of basic brain functions.
- Further investigations are necessary to support or denied our new hypothesis and theory about electromagnetic nature of sleep and capability of brain to communicate in sleep and altered states of consciousness.

Sleep and dreams as communication states (K. G. Jung) [12]

v"As a further determinant of dreams I have acknowledged the telepathic phenomenon. Today we can not doubt in reality of that phenomenon. It is very easy to deny that this phenomenon exists, without checking the proof material. But that would be unscientific behaviour, which doesn't deserve our attention!" (KARL GUSTAV JUNG)

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