V. Dubrovnik Conference on Cognitive Science

DUCOG

Sleep, neural oscillations and cognition

Keynote speakers:
György Buzsáki, Peter Achermann, Philippe Peigneux, Victor Spoormaker

Invited speakers:
Róbert Bódizs, Susanne Diekelmann, Péter Halász, Gareth Gaskell, Marcello Massimini, Péter Simor, Aleksandra Vicentic, Ursula Voss

Dubrovnik, 16-19 May 2013.
Centre for Advanced Academic Studies (CAAS) Dubrovnik
University of Zagrab

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CENTRAL EUROPEAN COGNITIVE SCIENCE ASSOCIATION

PROGRAMME

Thursday, 16th May

17.00-19.00	Registration
19.00 -19.30	Welcome words, reception
20.00	Dinner in downtown

Friday, 17th May

8.00-9.00	Coffee and registration
9.00-11.00	**Symposium I. From sleep regulation to individual differences in sleep EEG: states, traits and correlates**
9.00-10.00	*Peter Achermann*: Slow waves and sleep regulation
10.00-10.30	*Róbert Bódizs*: Sleep electroencephalogram fingerprinting: theoretical and practical considerations
10.30-11.00	*Aleksandra Vicentic*: Oscillatory Brain Dynamics in Cognition and Mental Health: Translational Implications
11.00-11.30	Coffee break
11.30-12.30	**Poster session I.**
12.30-14.00	Lunch break
14.00-14.10	**Student talk** - *Dominik Heib*: Theta activity during recall indicates overnight memory consolidation
14.10-16.10	**Symposium II. Sleep, dreaming, emotions and consciousness**
14.10-15.10	*Victor Spoormaker*: Disturbed sleep in posttraumatic stress disorder: causal feature or epiphenomenon? Evidence from experimental studies on fear extinction
15.10-15.40	*Péter Simor*: Aroused sleep, alert dreams: electrophysiological alterations in nightmare disorder
15.40-16.10	*Ursula Voss*: Can we influence consciousness in dreams? Results from transcranial alternating current stimulation
16.10-16.30	Coffee break
16.30-17.30	**Poster session II.**
17.30-18.00	Social programme

Saturday, 18th May

8.00-9.00	Coffee
9.00-11.00	**Symposium III. Neurobiology of neural oscillations and sleep**
9.00-10.00	*György Buzsáki*: Neural syntax and brain oscillations
10.00-10.30	*Péter Halász*: Input dependent regulation of NREM sleep – reactive slow wave activity
10.30-11.00	*Marcello Massimini*: Bistability, slow waves and information processing in thalamocortical circuits
11.00-11.30	Coffee break
11.30-12.30	**Poster session III.**
12.30-14.00	Lunch break
14.00-16.00	**Symposium IV. Sleep and memory: rehearsal of the past or preparation for the future?**
14.00-15.00	*Philippe Peigneux*: Memory consolidation processes in sleep and sleep-related disorders
15.00-15.30	*Susanne Diekelmann*: Memory reactivation during sleep and the role of future relevance
15.30-16.00	*Gareth Gaskell*: Sleep and language learning: integrating memories
16.00-16.30	Coffee break
16.30-17.30	**Poster session IV.**
17.30-18.00	Farewell words
18.00-18.15	Assembly meeting
20.00-	Social programme

Sunday, 19th May

8.00-10.00	Checking out

POSTER SESSIONS SCHEDULE

Poster session 1: Friday, May 17, 11:30-12:30

The role of slow-wave sleep on encoding and consolidation of associative memories
Esther Alberca-Reina, JL Cantero, M Atienza

Executive functions and mindfulness
Mónika Albu, Máté Szondy

Electrophysiological evidence for semantic congruency processing and task-dependent motor preparation in light sleep
Hernan Anllo, Thomas Andrillon, Leonardo Barbosa, Sid Kouider

Does post-training sleep favors the consolidation of motor but not sequential components in visuomotor sequence learning ?
Guillermo Borragán, Charline Urbain, Alison Mary, Remy Schmitz, Philippe Peigneux

Speeding up the Classification of Biomedical Signals via Instance Selection
Krisztián Buza, Julia Koller

Is sleep playing a role in the consolidation of new phonological categories?
Gregory Collet, Rémy Schmitz, Charline Urbain, Jacqueline Leybaert, Cécile Colin, Philippe Peigneux

The effect of sleep-disorder on declarative and non-declarative memory consolidation in children
Eszter Csábi, Pálma Benedek, Karolina Janacsek, Katona Gábor, Dezső Németh

Mental rotation: effects of gender, training and sleep consolidation
Ursula Debarnot, Pascale Piolino, Jean-Claude Baron, Aymeric Guillot

Sleep in Disorders of Consciousness: A preliminary evaluation
Renata del Giudice, Malgorzata Wislowska, Julia Lechinger, Nicole Chwala-Schlegel, Steven Laureys, Manuel Schabus

Pronoun reference resolution in a pro-drop language
Petar Fabijanić, Marijan Palmović

Spatiotemporal dynamics of the slow oscillation in the cortex and thalamus of the anesthetized rat
Richárd Fiáth, Patrícia Beregszászi, György Karmos, Domonkos Horváth, Bálint Péter Kerekes, Arno A. Aarts, Patrick Ruther, Hercules P. Neves, László Acsády, István Ulbert

Age-related changes in resting state functional network characteristics
Bálint File, Brigitta Tóth, Roland Boha, Zsófia Kardos, Márk Molnár

Poster session 2: Friday, May 17, 16:30-17:30

Hot and cold executive functions in obstructive sleep apnea syndrome
Paula Fischer, Monika Albu, Bence Neszmélyi, Mária Takács, Attila Terray-Horváth, Zoltán Szakács

Impact of sleep on real-life declarative learning
Kerstin Hoedlmoser, Kathrin Bothe, Tina Moeckel, Philippe Peigneux, Manuel Schabus

Associations between sleep and vocabulary development in infants
Klára Horváth, Kim Plunkett

How can we improve skill learning? Role of sleep and the dorsolateral prefrontal cortex
Karolina Janacsek, Ádám Hörömpöli, Adrienn Adonics, Walter Paulus, Andrea Antal Dezso Nemeth

Detection of changes in neural oscillations during movement imagination
Ana Branka Jerbic

Neural activity accompanied by rapid eye movements during REM sleep in the human brainstem: an fMRI study
Shigeyuki Kan Takahiko Koike, Satoru Miyauchi

Altered fronto-midline theta dynamics accounts for aging effect on short term memory
Zsófia Kardos, Brigitta Tóth, Roland Boha, Bálint File, Márk Molnár

A non-invasive polysomnographic study on dogs (*Canis familiaris*) during owner-dog co-sleeping
Anna Kis, Sára Szakadát, Péter Simor, Márta Gácsi, József Topál, Ádám Miklósi, Róbert Bódizs

Suggestibility of dream contents
Judith Koppehele-Gossel, Katharina Bey, Anna Melnikova, Ursula Voss

Noise-induced modulation of the event-related potential is similar for various high-level stimulus categories
Petra Kovacs, Kornel Nemeth, Gyula Kovacs, Pal Vakli, Marta Zimmer

Cortico-cardiac coupling during sleep: coherent, phase-locked and infraslow fluctuations in band-limited EEG amplitude and heart-rate
János Körmendi, Péter Simor, Katalin Rónai, Júlia Luca Szőcs, Péter Andréka, István Mucsi, Róbert Bódizs

Short term effects of moderate alcohol drinking on cognitive function
Hiroyuki Kuraoka, Chie Hagiwara, Meikan Seki, Hanae Izu, Katsumi Matsumaru, Shinji Miyake

Lexical selection and cognitive control in children with SLI
Enikő Ladányi, Lilla Zakariás, Ágnes Lukács

Poster session 3: Friday, May 18, 11:30-12:30

Resting EEG predicts CRS-R score in Disorders of Consciousness
Julia Lechinger, Kathrin Bothe, Wolfgang Klimesch, Manuel Schabus

Sleepwalking Movement Behaviour: A Study on (Somnambular) Perception of Space
Mihaela Mitrovic, Luka Katic

The Relationship between Event Related Potential and Subjective Evaluation by Semantic Differential Method
Midori Motoi, Takayuki Nishimura, Yuka Egashira, Shigeki Watanuki

Upgrading the sleeping brain with targeted memory reactivation
Delphine Oudiette, Ken A. Paller

Visual word recognition in masked priming paradigm
Marijan Palmović, Nevena Padovan

Label-Induced Categorization is Indexed by Alpha Desynchronization in Adults and 9-Month-Old Infants
Eugenio Parise, Gergely Csibra

Cognitive robustness and videogames
Mieczyslaw Pokorski, Lukasz Borecki

Does superior intelligence protect from biological aging: the case of sleep EEG power spectra?
Adrián Pótári, Róbert Bódizs

Artifact rejection in sleep EEG recordings with EEGLAB
Péter Przemyslaw Ujma

Effects of attention and emotion on early visual cortex activity measured with simultaneous EEG-fMRI
Karsten Rauss, Virginie Sterpenich, Laurent Schuepbach, Patrik Vuilleumier, Sophie Schwartz

The evaluation of online computer games as tools for cognitive training
Antónia Reindl, István Czigler

Left-right asymmetry of the rodent hippocampus
Yoshiaki Shinohara, Aki Hosoya, Hajime Hirase

Poster session 4: Friday, May 18, 16:30-17:30

The dreaming sleep stage as a model for schizophrenia? Common neurobiological and phenomenological features of schizophrenia and REM sleep
Dagna Skrzypińska, Monika Słodka, Barbara Szmigielska

Sleep and network state dependent specialisation of distinct GABAergic neuron firing in the hippocampus
Peter Somogyi, Linda Katona, Damien Lapray, Tim Viney, Thomas Klausberger

Time-of-Day has an opposite effect on the generation of past and future events
Ágnes Szőllősi, Mihály Racsmány

Violent somnambulism: a parasomnia of young men with stereotyped, claustrophobic dreams
Anna Szűcs, Rezső Zoller, Gábor Barcs, Pál Szabó, Anita Kamondi, György Purebl

Reduced N1-suppression for self-initiated sounds in schizophrenia
Annamária Tóth

Role of negative emotion regulation in a cognitive theory of nightmares
Işıl Uluç

Vasopressin absence resulted sleep deficits and schizophrenia related EEG alterations in Brattleboro rats
János Varga, Nikolett Bakos, Kata Terstyánszky, Dóra Zelena

Narrative analysis in aphasia
Martina Vuković Ogrizek, Ivona Radić Tatar

Sleep-dependency and relations of implicit and explicit episodic memory consolidation in humans
Frederik Weber, Jingyi Wang, Jan Born, Marion Inostroza

Sleep-dependent memory consolidation in disturbed sleep
Małgorzata Wisłowska, Dominik P.J. Heib, Julia Lechinger, Kerstin Hoedlemoser, Manuel Schabus

Transcortical motor aphasia: A special case of executive dysfunctions?
Lilla Zakariás, Attila Keresztes, Gyula Demeter, Ágnes Lukács

Effect of stress and progressive muscle relaxation on short-term and long-term memory of neutral and emotional words
Mirta Zelenika

Tutorial I.

Slow waves and sleep regulation

Peter Achermann
University of Zurich, Institute of Pharmacology and Toxicology, Switzerland

It was recognized early on that sleep intensity is reflected in the sleep electroencephalogram (EEG) by the prevalence of low frequency, high amplitude waves called slow waves (Blake and Gerard, 1937). Subsequent studies confirmed that the responsiveness to stimuli decreases as EEG slow waves become more predominant (Williams et al., 1964). Therefore, under normal physiological conditions, slow waves in the non-rapid eye-movement (non-REM) sleep EEG can be regarded as an indicator of "sleep depth" or "sleep intensity".

The term 'slow waves' is often used in a rather loose way in the literature and typically comprises different rhythmic components like slow oscillations (< 1 Hz) and delta activity (1 – 4 Hz). At the cellular level slow oscillations consist of sequences of depolarized (up states; neuronal activity) and hyperpolarized (down states; neuronal silence) components (Steriade et al., 1993). At the level of multi-unit activity recorded in the cortex, slow oscillations are reflected in sequences of "on" (spiking) and "off" (no spike activity) periods (Nir et al., 2011; Vyazovskiy et al., 2009).

Characteristic properties of slow oscillations depend on the level of sleep pressure. Increased sleep pressure results in larger amplitude waves with steeper slopes and decreased number of multi-peak waves (Bersagliere and Achermann, 2010; Esser et al., 2007; Riedner et al., 2007; Vyazovskiy et al., 2007). Furthermore, sleep deprivation results in a redistribution of waves between 0.5 and 2 Hz: wave incidence below 0.9 Hz is reduced while waves above 1.2 Hz are increased, i.e. waves became faster (higher frequency) (Bersagliere and Achermann, 2010). Moreover, sleep deprivation increased EEG power only at frequencies above 1 Hz. Similarly, Vyazovskiy et al. (2007) reported a peak at 1.5 Hz in the power density spectrum of local field potentials in rats in early sleep (high sleep pressure) which shifted to 0.75 Hz in late sleep (low sleep pressure).

To further examine regional aspects of slow waves, we used source modeling and topographic maps to locate and display activation of brain structures in the 0.5 - 2 Hz frequency range during slow wave sleep under normal conditions and after sleep deprivation in the first non-REM sleep episode (where sleep pressure is highest). Power maps revealed a frontal predominance of all frequencies between 0.5 and 2 Hz. Furthermore, an occipital focus of activity was present below 1 Hz. Maps at 1 Hz and below were not affected by sleep deprivation, whereas an increase in power was present in the maps above 1 Hz. Based on the response to sleep deprivation, low- and mid-delta activity (0.5 - 1 Hz; 1.25 - 2 Hz) were dissociated. Electrical sources within the cortex revealed a predominantly frontal distribution of activity for both low- and mid-delta activity. Sleep deprivation resulted in an increase in source strength for mid-delta activity only, mainly in parietal and frontal regions.

A salient aspect of sleep is that it is homeostatically regulated (Borbély, 1982). Sleep pressure builds during the day and dissipates across the night (homeostatic Process S). A sleep deficit results in the prolongation and intensification of sleep during subsequent sleep. An important physiological marker of non-REM sleep pressure is EEG spectral power in the delta band (sleep EEG power between 0.75 and 4.5 Hz), also referred to as slow-wave activity (SWA). SWA shows a rebound following sleep deprivation proportional to the amount of sleep lost. Moreover, SWA declines across the sleep episode (Achermann and Borbély, 2011). Process S can be modeled as a saturating exponential function during wakefulness and an exponential decline during sleep. Considerable individual variation in the parameters of Process S have been observed (Rusterholz et al., 2010).

SWA shows a frontal predominance that increases most prominently after sleep deprivation (Finelli et al., 2001; Marzano et al., 2010; Riedner et al., 2007). Similarly, the dynamics of the homeostatic Process S (building up during waking; dissipating during sleep) also shows regional specificity. The

decrease and build-up of Process S are slowest in fronto-central areas and fastest in parieto-occipital (decrease) and frontal (buildup) areas (Rusterholz and Achermann, 2011). Furthermore, distinct individual patterns were observed.
We also examined whether the dynamics of sleep homeostasis (i.e., time constants of buildup and decline of Process S) change across early development in a longitudinal study (at 2, 3 and 5 years of age). Time constants of the buildup increased with increasing age while the time constants of the decline were similar across ages (LeBourgeois et al., 2012). Jenni et al. (2005) observed a faster increase of Process S in early pubertal children compared with mature adolescents, while the decrease of S was similar in both groups (cross sectional study). The increased maturational increase in the time constant of the build-up may reflect an increased tolerance to sleep deprivation.

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Keywords: slow oscillations, topography, sleep homeostasis
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Tutorial II.

Neural syntax and brain oscillations

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Tutorial III.

Memory consolidation processes in sleep and sleep-related disorders

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The relationships between sleep and cognitive processes are a growing area of interest for cognitive and behavioral neurosciences, providing new tools to better understand and dissociate the mechanisms subtending efficiency in cognitive functioning, and especially in the creation, storage and consolidation of novel information in long-term memory systems. Many studies have been conducted in healthy young adults, essentially focusing on the promoting role of post-training sleep in the consolidation of novel memory traces and/or on the deleterious effect of prior sleep deprivation on various cognitive processes. Besides, neuroimaging studies have evidenced the reinstatement of learning-related neurophysiological patterns during sleep, suggesting continued information processing. They also evidenced sleep-dependent modifications in neurophysiological activity patterns subtending retrieval of the learned information and/or optimized practice, even in conditions where behavior was seemingly similar, suggesting the development of qualitatively different cerebral strategies over post-training sleep. Additionally, accumulated evidence indicates that post-training sleep benefits to the consolidation of recently learned information in healthy adults and children, and experimental data suggest close interactions between the development of sleep-dependent plasticity markers, cortical maturation and cognition in children. However, although sleep-dependent consolidation effects in children are clearly established for declarative memories, they remain more debated in the procedural memory domain. In this respect, there is an persisting debate about the role of sleep, sleep stages and mechanisms for the consolidation of different forms of long-term memories. In this lecture, I will try discussing these issues, also presenting behavioral data investigating sleep-dependent memory consolidation in healthy children and in children with epilepsy with and without treatment, and neuroimaging data showing sleep-related changes in cerebral networks subtending implicit, procedural sequence learning in healthy adults. Finally, I will propose that studying sleep and memory consolidation processes in developmental disorders and acquired childhood pathologies can provide novel, enlightening clues to understand the pathophysiological mechanisms subtending the disruption of long-term cerebral plasticity processes eventually leading to cognitive and learning deficits in children.

Keywords: memory consolidation, sleep, neurophysiology, children
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Tutorial IV.

Disturbed Sleep in Posttraumatic Stress Disorder: Causal Feature or Epiphenomenon? Evidence from Experimental Studies on Fear Extinction

Victor Spoormaker, Anna Sturm, Anja Peters, Manuel S. Schröter, Simone Scharl, Vanessa Scholz, Katia C. Andrade, Sara A. Kiem, Roberto Goya-Maldonado, Philipp G. Sämann, Michael Czisch
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Background
Clinical studies have revealed that sleep disturbances are prevalent in posttraumatic stress disorder (PTSD), manifest in highly distressing subjective sleep complaints like recurrent nightmares and insomnia. A meta-analytic review of polysomnographic clinical studies found reduced slow-wave sleep, increased stage 1 sleep and increased rapid-eye-movement (REM) density in PTSD patients compared to controls (Kobayashi et al., 2007). This altered REM density might occur due to REM fragmentation (Spoormaker & Montgomery, 2008), which includes more but shorter REM periods that have been found to be predictive of PTSD symptom severity months later (Mellman et al., 2002), in line with the hypothesis that REM disturbances may be the hallmark of PTSD (Ross et al., 1989). The main research question is whether sleep disturbances play a causal role in the development and maintenance of PTSD, or whether they are an epiphenomenon that does not require specific diagnosis and treatment.

Two lines of clinical findings are indicative of a causal role for sleep disturbances in PTSD:

1. Insomnia is a frequent residual symptom after successful treatment of PTSD (Nappi et al., 2011), and
2. treatment of sleep disturbances only – through cognitive-behavioral therapy (Krakow et al., 2001) or the alpha1-antagonist Prazosin (Taylor et al., 2008) – alleviates general PTSD symptom severity.

However, although these clinical findings are *indicative* of a critical / causal role for sleep disturbances in the course of PTSD, they do not provide *conclusive* evidence. The contribution of third factors confounding the relationship between sleep disturbances and PTSD symptom severity (e.g. trait factors) has to be excluded. This can be done by modeling PTSD symptomatology in the laboratory setting, which is increasingly done by fear conditioning and extinction tasks in both animal and human models. Impaired fear extinction and recall of fear extinction has been observed in PTSD (Blechert et al., 2007; Milad et al., 2009; Wessa & Flor, 2007) and models the clinically observed continued fear expression related to neutral stimuli coincidentally paired with the traumatic event. In our experimental line of research, we employ simultaneous skin conductance response (SCR) and functional magnetic resonance imaging (fMRI) during extinction-based tasks and polysomnographic measures in the sleep laboratory.

Experimental work
In our initial study (Spoormaker et al., 2010) we demonstrated that we could model the temporal relationship between disrupted sleep and PTSD-like symptomatology, while elucidating its underlying neural circuitry. Healthy subjects that showed strong physiological responses to mild electrical shocks had poor sleep in a long afternoon-nap afterwards, with reduced REM sleep. Furthermore, these subjects showed impaired recall of fear extinction mediated by decreased activity in the ventromedial prefrontal cortex, a region critical in extinction recall.
In our second study (Spoormaker et al., 2012), we demonstrated that REM sleep has a causal role in impairing fear extinction recall in humans. One night with selective REM sleep deprivation (versus an equal amount of awakenings in NREM sleep stages) resulted in higher SCR to a previously extinguished stimulus but not to other stimuli. This effect was mediated by differential activity in

the middle temporal gyrus, in a region that we had previously found to be co-activated with the vmPFC during error signaling in a fear conditioning task (Spoormaker et al., 2011).
In our third study (Sturm et al., submitted manuscript), we demonstrated that disrupted REM sleep after an aversive event is not causally affected by the intensity of the aversive event. We modulated shock intensity (high versus low intensity shocks), and could show that this affected NREM sleep stages, in particular slow-wave sleep, but not REM sleep. Adding a fear extinction session before sleep improved sleep and increased slow-wave sleep amount. Disrupted REM sleep may therefore be a marker of a personality trait such as noradrenergic hypersensitivity, which causes both a strong physiological response to an aversive event and disrupted REM sleep afterwards.
In our most recent study (Peters et al., submitted manuscript), we evaluated the effects of sleep loss before the occurrence of an aversive event, to examine whether sleep deprivation causes more robust fear conditioning. Here we noted that one night of partial sleep deprivation, depriving subjects of a sleep period rich in REM sleep, did not affect differential fear conditioning (difference in physiological response to the conditioned and the safety stimulus), but did robustly affect physiological reactivity during fear conditioning to all stimuli. Sleep deprived subjects showed reduced habituation to stimuli, and this sustained physiological reactivity was correlated with increased activity in subcortical circuitry.

Conclusion / Outlook
Our experimental studies therefore separated causal effects and effects of potential trait factors, and our current working hypothesis is 1) that trait factors are critical in both the physiological response to an aversive event and disruptions in subsequent sleep, and 2) that sleep disturbances play a causal role in impairing the PTSD-like symptomatology of fear extinction recall. Interestingly, research in animal models combining contextual fear extinction with sleep protocols seem to point towards a similar role of REM sleep, particularly pontine wave activity (Datta & O'Malley, 2013), as a trait-factor relevant for the consolidation of fear extinction memory. These experimental studies are relevant for understanding core PTSD-symptomatology (Germain, 2013), and at this stage separate diagnosis and treatment of sleep disturbances early in the course of PTSD seems warranted – possibly to kick-start natural extinction-based processes.

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Keywords: PTSD, REM sleep, fear extinction, sleep deprivation
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Short Talk I.

Sleep electroencephalogram fingerprinting: theoretical and practical considerations

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The individual-specificity of state-dependent neuronal oscillations is one of the most robust findings in sleep research. Although the first reports on the individual-specific character of EEG alpha waves were published in the mid 1930s already, no systematic analyses focused on this issue in the following decades. Unfortunately, the consistent and striking individual variability in sleep EEG is most often considered as "noise" or error variance by studies aiming to reveal the regulation or the function of sleep. My first aim is to review the early scattered and recent semi-systematic reports on the reliability or repeatability of individual-specific sleep-wake dependent EEG measures with a special emphasis on NREM sleep delta and sigma oscillations. In the following I will draw the attention on the significant biobehavioural correlates of the individual features of these oscillations revealing the potential genetic and neuronal bases of some prominent inter-individual differences in sleep and cognition. Furthermore, I will focus on the so-called individual fingerprinting of sleep EEG resulting in a set of reliable parameters reflecting the spectral profiles of the antero-posterior pattern of 8–16 Hz activity, as well as in individual- and derivation-specific objective criteria of defining different types of sleep spindles. Spindles defined on the basis of sleep EEG fingerprinting correlate with cognitive abilities and structural brain features of healthy adults and form sets of prominent physiological markers of specific cognitive and emotional profiles in healthy or atypically developing subjects (eg. Williams syndrome). By presenting several findings coming from the above approach I argue that these techniques of unravelling individual differences could strengthen or constrain the theoretical formulations of sleep and behaviour relationships and have wide-range practical implications for cognitive/clinical neuropsychiatry and perhaps personality psychology.

Keywords: sleep EEG, individual differences, sleep spindles, slow waves, Williams syndrome
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Short Talk II.

Memory reactivation during sleep and the role of future relevance

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Sleep is known to benefit the consolidation of memories. In an active process of system consolidation sleep reorganizes and integrates new memory representations into the network of pre-existing long-term memories (Diekelmann & Born 2010). This process is assumed to rely on covert reactivations of new memories and is probably selective, favoring particularly those memories that are relevant for future behavior. Memory reactivations occur spontaneously after learning, mainly during slow-wave sleep (SWS), but can also be externally triggered by associated memory cues (Rasch et al. 2007). The application of learning-associated odor cues during SWS lead to an immediate stabilization of new memories making these memories resistant against subsequent interference (Diekelmann et al. 2011). Similar odor reactivations during the wake state resulted in a destabilization of memories making these memories susceptible to subsequent interference. Functional magnetic resonance imaging revealed that odor reactivation during SWS mainly activated hippocampal regions and the retrosplenial cortex, whereas during wakefulness reactivation was primarily associated with activations in prefrontal areas. Furthermore, reactivation during sleep can accelerate sleep-dependent consolidation processes. Reactivation during a short sleep period induced memory benefits that are normally seen only after longer sleep periods, an effect that depended on SWS rather than rapid eye movement (REM) sleep (Diekelmann et al. 2012). Recent research further provided evidence that consolidation processes during sleep target selectively those memories that are relevant for the future. Relevance of memories can be signaled by different factors, e.g. expectancy of a retrieval test, instructions to remember, and monetary reward, all of which have been shown to improve memory consolidation during sleep (Wilhelm et al 2011, Fischer et al. 2009). The prototype of future-relevant memory, i.e. prospective memory for intended actions, was found to benefit particularly from sleep (Diekelmann et al. 2013). This evidence collectively suggests that memories are stabilized during sleep via covert reactivations of the newly acquired memories and that there is some form of selection mechanism that determines which memories gain preferential access to sleep-dependent memory consolidation based on the future relevance of these memories for the individual.

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Keywords: memory reactivation, sleep, consolidation, future relevance, prospective memory
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Short Talk III.

Sleep and language learning: integrating memories

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Learning language involves much more than the ability to recall how new words sound or what they mean. Here I address how we acquire new words, and crucially how we integrate their representations into our existing networks of linguistic knowledge. I examine two examples of this integration process. In the first, participants are required to learn fictitious novel words that are highly similar to existing words (e.g., "cathedruke" related to "cathedral"). They can then be tested in terms of how easy it is to recall the novel word (a measure of the strength of the new memory) and to what extent this novel word representation takes part in the competition process involved in the recognition of the existing word (a measure of the integration of the new memory). The second measure is particularly valuable since it is a clear marker of systems consolidation (Davis & Gaskell, 2009). Research in our lab has shown that sleep is associated with the integration of memories (Dumay & Gaskell, 2007), with a particular involvement of slow-wave sleep and sleep spindle activity (Tamminen et al., 2010).
The second paradigm involves plasticity relating to the typical locations of speech sounds in spoken syllables (phonotactic constraints). These constraints can be learned in a relatively short space of time, but recent work has shown that when constraints involve combinations of speech sounds, their manifestation in speech errors occurs only after a 24-hour consolidation period (Warker, 2013). In an ongoing study we have examined the role of sleep in this process using a nap paradigm, finding that sleep facilitates phonotactic integration, with again a specific role for slow-wave sleep.
Both these paradigms highlight the fact that one crucial component of sleep in memory consolidation goes beyond mere strengthening of recently acquired memories. Sleep facilitates the integration of new memories in established neocortical circuits, such that the new memories can exhibit an appropriate impact on the processing of established knowledge. As a consequence, sleep prepares us for the future by refining our mental representation of the (linguistic) world.

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Keywords: word learning, memory consolidation, phonotactic integration
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Short Talk IV.

Input dependent regulation of NREM sleep: reactive slow wave activity

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In this speech I will try to show how sensory input during NREM sleep participate in sleep regulation and show how the effect of sensory inflow and homeostatic regulation of slow wave economy is interdigited.
The effect of sensory input prevail on the one hand through arousal and in the other hand through paradoxical sleep promotion (antiarousal mechanism). The response along sleep cyclicity to sensory input is state dependent: in periods of high homeostatic pressure, by reactive slow wave activity promotes the sleep process, while in low homeostatic presure periods promotes arousal.
In the light of this dynamic interrelationship between sensory input and slow wave producing mechanisms we tend to reinterpret the biological role of Cyclic Alternating Pattern System emphasizing its role in providing „slow wave injections" when sleep is disturbed, fuelling slow wave homeostasis in an instant way. Therefore we propose that frontal lobe is under double homeostatic protection by traditional long term and also by short term homeostatic slow wave regulation.
Lastly I would like to call attention to a general principle along the wake /sleep continuum which is valid on different levels from the circadian rhythm to slow wave oscillations and presents itself on different timescale from hours to hundred miliseconds time span. This is the alternations of being in close contact with surrounding environment and separation from the environment
The continuous alternating presence of trophotrop vs. ergotrop states on different levels and different time windows make possible for living organisms to fulfill the contradictory task of simultaneous separation from and remaining in contact with their environment (open system requirements).

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Keywords: Sleep homeostasis, arousal, open system
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Short Talk V.

Bistability, slow waves and information processing in thalamocortical circuits

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In a series of experiments we recorded the electroencephalogram (EEG) response to transcranial magnetic stimulation (TMS) in several different conditions including wakefulness, NREM sleep (Massimini et al., 2005; 2007), REM sleep (Massimini et al., 2010), anesthesia (ferrarelli et al., 2010), and in patients who emerged from coma (Rosanova et al., 2012). TMS/EEG measurements showed that, while during wakefulness and REM sleep the brain is able to sustain long-range, complex patterns of activation, during NREM sleep and anesthesia, when consciousness fades, this ability is lot: the thalamocortical system, despite being active and reactive, either breaks down in causally independent modules (producing a local slow wave), or it bursts into an explosive and non-specific response (producing a global EEG slow wave). In brain-injured patients who emerged from coma results where strikingly similar: a widespread and complex response in subjects who regained a minimal level of consciousness and sleep-like local, or global, slow waves in vegetative patients who where behaviorally awake but unconscious.
We hypothesize that, like spontaneous sleep slow waves, the slow waves triggered by TMS are due to bistability between upand down-states in thalamocortical circuits. In this condition, the inescapable occurrence of a silent, down state after an initial activation impairs the ability of thalamocortical circuits to sustain long-range, differentiated patterns of activation, a theoretical requisite for consciousness (Tononi and Edelman, 1998). According to animal experiments and computer simulations, thalamocortical bistability may result from increased K-currents, from alterations of the balance between excitation and inhibition and from partial cortical de-afferentation. We hypothesize that these factors may play an important role in determining loss, and recovery, of consciousness also in brain-injured subjects. If this is the case, some types of brain lesions may impair information transmission, above and beyond the associated anatomical disconnection, by inducing bistability in portions of the thalamocortical system that are otherwise healthy.

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Massimini et al., *Cog. Neurosci.* 2010
Rosanova et al., *Brain* 2012
Tononi and Edelman, *Science* 1998

Keywords: consciousness, sleep, anesthesia, coma, complexity, connectivity
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Short Talk VI.

Aroused sleep, alert dreams: electrophysiological alterations in nightmare disorder

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Idiopathic nightmare disorder affects 4-5 % of the adult population and is characterized by highly disturbing mental experiences that usually awaken the dreamer from late-night sleep (ICSD-2, 2005). One specific feature of nightmarish experiences is the intensification of dreaming, reflected by perceptually vivid, reality-like and emotionally laden mental experiences as well as increased dream recall (Nielsen and Zadra, 2011). Recent theoretical models suggest that nightmares reflect the failure of emotional-regulatory processes – due to inefficient prefrontal inhibitory functions as well as hypersensitive amigdalar reactivity - during emotional memory activation in REM sleep (Levin & Nielsen, 2007). Accordingly, subjects with frequent nightmares showed impaired prefrontal functions in different executive tasks (Simor, Pajkossy, Horváth, & Bódizs, 2012), but it is not clear to what extent are these differences influenced by underlying psychopathological symptoms and/or reduced sleep efficiency.

Even though nightmares are often co-morbid with a wide variety of mental complaints (Levin & Nielsen, 2007), research indicates that frequent nightmares are more appropriate to be considered as a specific sleep disorder that is independent in its origins from waking psychopathological symptoms (Coolidge, Segal, Coolidge, Spinath, & Gottschling, 2010; Spoormaker et al., 2006). Accordingly, nightmare subjects (NMs) were reported to exhibit impaired sleep efficiency, reduced slow wave sleep, longer REM sleep as well as increased sleep fragmentation especially during NREM sleep (Simor, Horváth, Gombos, Takács, & Bódizs, 2012). Altered NREM sleep architecture was independent of co-morbid psychopathological states, but increased REM sleep durations seemed to be the function of heightened negative affect. In addition, NMs showed alterations regarding the microstructure of sleep, exhibiting increased arousal responses composed of high-frequency oscillations (Simor, Bódizs, Horváth, & Ferri, 2013).

Sleep fragmentation and impaired sleep-regulation with increased sympathetic arousals suggest that NMs' sleep is characterized by the presence of transient wake-like oscillations during sleep. In our latest study, EEG spectral power analyses showed increased relative low alpha power (7.75-9 Hz) in NREM sleep and increased high alpha power (10-14.5 Hz) in REM sleep in NMs compared to controls. Enhanced low alpha power in NREM and increased high alpha power in REM were strongly related to each other in the NMs group while they were not associated in control subjects, suggesting that enhanced alpha power is a peculiar characteristic of the sleep pathophysiology of nightmare disorder, but is modulated in a sleep-state-dependent manner. We suggest that increased alpha activity during NREM and alpha oscillations incorporating higher frequencies in REM sleep in NMs reflect transient “hybrid” states between sleep states and wakefulness.

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Keywords: Nightmares, dreaming, sleep, alpha power
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Short Talk VII.

Can we influence consciousness in dreams? Results from transcranial alternating current stimulation

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In our prior work on lucid dreaming we have proposed a relationship between lower gamma band activity and higher order consciousness. Here, I will present data suggesting that gamma activity is actually causally related to higher order consciousness in dreams. In this pilot study, we used transcranial alternating current stimulation (tACS) to electrically stimulate the brain during REM sleep. The study was carried out double blind, and with several control conditions. Our analyses show that the external application of a weak electrical current changes the ongoing cortical activity as evidenced by EEG recordings. This effect was traceable only for the low gamma stimulation and not for control conditions. Regarding subjective correlates of induced EEG changes during REM sleep, we observed increased dissociative thought specific to lower gamma stimulation. Dissociative thought has been shown to be typical for lucid dreaming, especially in young children. We interpret this finding as strong support for the gamma band hypothesis stating that frequencies around 40 Hz are somehow involved in higher order or secondary consciousness.

Keywords: consciousness, dreams, REM, tACS, dissociation
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Short Talk VIII.

Oscillatory Brain Dynamics in Cognition and Mental Health: Translational Implications

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Synchronized neural oscillations are postulated to be an important mechanism that allows coordination of neural activity across large-scale networks. A large body of evidence suggests that synchronization on different oscillatory frequencies reflects dynamical coordination of neural networks that underlies cognitive and perceptual functions (Uhlhaas et al 2009a, Buzsaki and Watson 2012). For example, coherence in local field potentials in theta (5-12 Hz) and gamma frequency range (40-80 Hz) have been functionally linked to memory consolidation and episodic/relational learning (Benchenane et al 2010; Young and Shapiro 2011). The strength of theta-gamma coupling correlates with increases in performance accuracy (Tort et. al., 2009) and predicts improvements in working memory performance (Shirvalkar et al., 2011). Findings from human electro-encephalography (EEG) studies show the association between enhanced theta oscillations over prefrontal cortical sites and working memory for temporal order (Hsieh et al 2011). Similarly, intracranial recordings in humans demonstrate cross-frequency coupling with a wide spatial distribution during working memory (van der Meij et al 2012). Growing evidence from clinical studies supports the notion that disruptions in synchronous oscillations give rise to cognitive dysfunctions in mental disorders (Uhlhaas and Singer, 2006) which suggests that dysfunctions in large-scale network dynamics might have a causal role in mental disorders. In particular, a multiple line of evidence points out to deficits in gamma band oscillations during performance of a range of cognitive tasks in schizophrenia (Gandal et al 2012), suggesting that disturbances of neural oscillations and synchrony may be endophenotypes. Similarly, in EEG and magneto-encephalography (MEG) studies of children with autism spectrum disorder (ASD), there are reports of alterations in neural synchrony during cognitive tasks (e.g. a decrease in phase locking of beta- and gamma-frequencies, see Stroganova et al 2012), which supports the role of altered neural synchrony in the pathophysiology of ASD. Long-term behavioral treatment in autism was associated with normalization of patterns of brain activity and better social functioning (Dawson et al 2012), while repetitive trans-cranial magnetic stimulation lead to the normalization of gamma oscillations and to improvement in cognition (Farzan et al 2012) in schizophrenia patients. These findings further suggest that oscillations may be intermediate, modifiable phenotypes. Given the growing evidence that neural synchrony is important for normal cognition and that disturbances in this synchrony underlie cognitive dysfunction in mental disorders, understanding the neural mechanisms of synchronized oscillatory activity has translational implications for understanding the pathophysiology of mental illnesses. Moreover, because cognitive dysfunction is problematic across many brain disorders, adopting oscillatory synchrony as parameters to delineate aberrant neural dynamics will increase understanding of pathophysiology of different brain disorders independently of their diagnosis. Finally, testing whether existing or new treatments improve electrophysiological signatures of cognition and normalize aberrant neural synchrony will facilitate the design of more effective treatments to reduce the burden of cognitive dysfunctions in mentally ill.

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Keywords: brain oscillations, synchronization, large-scale brain dynamics, schizophrenia
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Theta activity during recall indicates overnight memory consolidation

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In this study we investigated whether brain responses during recall before sleep indicate the success of subsequent consolidation during sleep. 24 subjects participated in the present study. In the evening before sleep each participant learned 160 word-pair associates. Recall performance was tested twice: immediately after learning (R1) as well as after 8 hours of sleep. During recall, only the first word of each pair was presented (cue) and subjects had to report the respective corresponding word. Based on their overnight changes in memory performance subjects were divided into groups (I+=memory enhancer; I-=memory non-enhancer). During R1, I+ showed a stronger ERP-positivity around 400-500ms after appearance of the cue-word than I- [$p<0.01$]. Furthermore, time-frequency analysis revealed that this difference derive from a stronger theta activity in I+ compared to I- [$p<0.01$]. Interestingly, amplitude differences in this time range were strongly correlated with (i) the overnight change in memory performance [$r=.62$, $p<0.01$] and (ii) the intensity of fast sleep spindles in N2 [$r=.56$, $p<0.01$]. We conclude that recall before sleep can determine which memories will be consolidated during sleep. Such determination might be reflected by theta activity and occurs in a time range (400-500ms) that is related to the access to semantic memory systems.

Keywords: recall, theta, eeg, sleep, memory
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The role of slow-wave sleep on encoding and consolidation of associative memories

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Evidence suggests that slow-wave sleep plays a crucial role in facilitating memory consolidation and a specific role in synaptic homeostasis, which, in turn, might enhance memory encoding. We investigated these two memory functions of sleep by manipulating the amount of sleep either prior to or following encoding (full night of sleep vs. early-night partial sleep deprivation); the semantic context where the to-be-remembered memories were encoded (semantically congruent vs. semantically incongruent); and the kind of episodic material to be remembered (single items vs. associations). Two main results were derived from testing memory after an interference task on the second day following training. Firstly, sleep deprivation in the night before training was detrimental to associative memory, probably because it interfered with local homeostatic processes and, consequently, with subsequent encoding processes. Nevertheless, the semantic congruence of context overcame these negative effects. Secondly, sleep deprivation in the night after training slowed down recollection of all memories, likely due to interference with consolidation processes. These results suggest that the two hypotheses about the memory function of sleep are not mutually exclusive but complementary.

Keywords: slow-wave sleep, memory consolidation, synaptic homeostasis, sleep deprivation, associative memory
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Executive functions and mindfulness

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Mindfulness involves nonjudgmental attention to present-moment experience. This study investigates the link between self-reported mindfulness and executive control processes as well as emotional and social skills. The study addresses the relationship between a dispositional measure of mindfulness (FFMQ, Baer et al., 2006) and measures of attention, cognitive inhibition (Stroop interference task), working memory tasks, cognitive flexibility (Necker cube illusion). Beside these tests of cognitive executive functions, neuropsychological measures of emotions were used as well. Overall the results suggest that working memory, Stroop-interference and cognitive flexibility are positively related to levels of mindfulness. Correlations between self-reported mindfulness and all cognitive executive measurements were of moderate to high strength. Furthermore, Necker cube illusion measuring cognitive flexibility could be used as an objective tool for measuring mindfulness abilities. On the other hand, emotional and social skills measurements exhibited a negative correlation with self-reported mindfulness (especially with Nonjudging factor). This pattern of results suggests that mindfulness is intimately linked to improvement of executive functions and cognitive flexibility. Emotional functions tend to show an inverse pattern, explained by the fact that mindfulness-based interventions are focusing on reduction of emotionality. The relevance of these findings for mental balance and well-being are discussed.

Keywords: mindfulness, executive functions, cognitive flexibility, emotional functions
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Electrophysiological evidence for semantic congruency processing and task-dependent motor preparation in light sleep

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Limitations on information processing during sleep could be a result of the breakdown in brain effective connectivity and/or deactivation of the prefrontal cortex, traditionally linked to cognitive control. In our experiment, we hypothesized that the automatization of a semantic discrimination task during wakefulness would allow the persistence of task-relevant semantic processing and covert motor preparation during light sleep (late N1 and N2 stages). Twenty-three healthy participants laid comfortably and engaged on a classic auditory semantic discrimination task with sentence conveying congruent („John parks the car") or incongruent („John parks the lung") meanings. Each answer ('Congruent'/'Incongruent') was mapped with a given hand response (Right/Left). The participants were asked to answer to the stimuli task while falling asleep. Auditory stimulations were pursued during sleep and electroencephalographic data were recorded throughout the experiment. We contrasted the evoked electrophysiological responses between 'Right/Left' and 'Congruent/Incongruent' conditions in the time/frequency domain. For both wake and sleep epochs, we found (i) a lateralized event-related desynchronization (ERD) time-locked with the N400 component, consistent with semantic congruency processing and (ii) an ERD in the beta-band, mainly centered on the premotor cortex, consistent with motor preparation. These results bespeak the continuation of task-dependent information processing in light sleep.

Keywords: N1/N2 Sleep, semantic processing, motor activation, LRP, ERD
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Does post-training sleep favors the consolidation of motor but not sequential components in visuomotor sequence learning ?

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Whether sleep contributes to the consolidation of visuo-motor memories remains disputed. We investigated the impact of post-learning sleep on their consolidation using a tactile screen variant of the deterministic serial reaction time task. At learning, subjects practiced blocks 1-6 and 8 (64 trials/block) using a deterministic sequence A. Block 7 was made with inverted sequence B. In the night after learning, participants slept normally (SN) or stayed awake (SA) all night, then had two supplementary nights of sleep. On day 4, they were retested using block sequences 9-12 (AABA). Learning on day 1 was similar between SN and SA groups. Comparison between end of learning (A8) and retest (A9) disclosed a sleep-dependent performance improvement with faster RTs overnight in the SN but not SA group ($p < .05$). Interference effects (RTs A10 < B11) were similar between groups ($p > .48$). The (re)learning curve for a subsequent different deterministic sequence C (blocks 13-20) was also similar between groups, indicating that proactive interference effects from previously learned sequence A on sequence B were not modulated by sleep-related consolidation processes. It suggests that sleep mostly favors the consolidation of the motor but not the sequential component in visuomotor sequence learning.

Keywords: sleep, visuo-motor sequence learning, consolidation
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Speeding up the Classification of Biomedical Signals via Instance Selection

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Monitoring the electrical activity of the heart by electrocardiograph (ECG) or the electrical activity of the brain by electroencephalograph (EEG) may result in huge amounts of data if the observation is performed for several hours or days. While human expertise cannot be replaced by computers, in case of such huge amounts of data, the detailed analysis of the entire signal by human experts would require unrealistic effort. Therefore, in practice, relatively small parts of the entire signal are analysed by human experts in detail. The analytic process can be supported by automatic recognition tools, so called classifiers, in various ways. Classifiers may point out abnormal parts of long signals so that these parts are checked by human experts. Furthermore, automatic recognition systems may immediately alert human experts when the system detects serious abnormalities. In our previous work, we focused on the classification of ECG signals which is the common theoretical background of various recognition tasks associated with ECG. Here, we extend the scope of our previous study and point out that our technique can also be used to speed up the classification of further medical signals, such as EEG.

Keywords: ECG, EEG, classification, machine learning, instance selection
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Is sleep playing a role in the consolidation of new phonological categories?

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Since a long time, studies have shown that the perception of nonnative phonological contrasts is improved after a short period of auditory training and retained over a long period of time after the end of training. However, the role of sleep in the consolidation of this type learning remains debated. In the present study, we investigated the role of post-training sleep in the consolidation of new phonological categories. Adult French-speakers were trained to identify two synthetic speech variants of the syllable /də/ during two 1-h training sessions. The 12-h interval between the two sessions included either a sleep (8 pm to 8 am +or- 1h) or a wake (8 am to 8 pm +or- 1 h) period. Results showed that identification dramatically improved over the first training session in both groups, and then slightly decreased over the 12-h offline interval to remain above chance levels. The analysis of reaction times (RT) showed slowed down responses after sleep as compared to wakefulness, suggesting higher attention devoted to the novel phonological stimulus. Notwithstanding, our results essentially suggest that post-training sleep does not benefit more than wakefulness to the consolidation of new phonological categories.

Keywords: sleep, auditory training, identification, new phonological categories
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The effect of sleep-disorder on declarative and non-declarative memory consolidation in children

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While there is mounting evidence for the importance of sleep for different memory systems in adults, so far remarkably little is known about the effect of sleep disorders on declarative and non-declarative memory consolidation for children. In the present study we examined the effects of sleep disorders on different aspects of memory functions by testing children with sleep-disordered breathing (SDB) characterized by disrupted sleep patterns. We used a story recall to measure declarative memory and Alternating Serial Reaction Time (ASRT) task, which enables us to measure general skill learning and sequence-specific learning separately. Our data showed differences in the pattern of declarative memory formation between the SDB and control groups. The SDB group demonstrated decreased performance from evening to morning, while the control group did not. The pattern of the offline consolidation of sequence-specific and general skill learning was similar in both groups. Our findings suggest that sleep-disordered breathing affects declarative and non-declarative memory differently in children. Moreover, these findings imply that the disrupted sleep pattern in childhood influences the more attention-demanding and cortical structure-guided explicit processes, while the less attention-demanding implicit processes mediated by subcortical structures are preserved.

Keywords: sleep, sleep-disordered breathing, declarative memory, non-declarative memory, development
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Mental rotation: effects of gender, training and sleep consolidation

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A wide range of experimental studies have provided evidence that a night of sleep contributes to memory consolidation. Mental rotation (MR) skill is characterized by fundamental aspects of both cognitive and motor abilities which can be improved within practice sessions, but little is known about the effect of consolidation after MR practice. Given the well-established gender difference in MR, we investigated the effect of MR training and the following corresponding day- and sleep-related time consolidations. Forty participants (20 women) practiced a computerized version of the Vandenberg and Kuse MR task. Performance was evaluated before MR training, as well as prior to, and after a night of sleep or a similar daytime interval. Data showed that while men outperformed women during the pre-training test, brief MR practice was sufficient for women to achieve equivalent performance. Only participants subjected to a night of sleep were found to enhance MR performance during the retest, independently of gender. These results provide first evidence that a

night of sleep facilitates MR performance compared with spending a similar daytime interval, regardless of the gender of the participants. Since MR is known to involve motor processes, the present data might contribute to schedule relevant mental practice interventions for fruitful applications in rehabilitation and motor learning processes.

Keywords: Mental rotation, Sleep, Memory consolidation, Gender, Training
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Sleep in Disorders of Consciousness: A preliminary evaluation

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Patients with altered states of consciousness, such as Vegetative State/Unresponsive Wakefulness Syndrome (VS/UWS) and Minimally Conscious State (MCS) are considered to be not or only partially conscious. The diagnostic differentiation of these states is extremely difficult and leads to a high rate of misdiagnosis. Unfortunately the latter often has implications for the patients' management. Earlier findings revealed abnormalities of sleep in DOC and suggested that the presence of organized sleep patterns and some sleep features (i.e. K-complexes and sleep spindles) may be markers for good outcomes. Despite these findings, the understanding of sleep in DOC is incomplete and still not part of the regular assessment. We therefore performed PSG over at least 24 hours and characterized sleep in DOC patients. First results emphasize that the presence of some specific sleep features such as slow wave sleep (SWS), sleep spindles and presence of rapid eye movement (REM) might have diagnostic relevance and allow for a better distinction between MCS and VS/UWS states.

Keywords: Sleep, Polysomnography, Disorders of consciousness, Coma
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Pronoun reference resolution in a pro-drop language

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Accessibility is thought to be the main factor for the reference resolution of a pronoun. One of the factors that defines the accessibility is word order. The reference of a pronoun is more likely to be the subject or the first mentioned noun as in The father goes fishing with his son. He... where he is more likely to be the father. In this study we checked these claims in an eyetracking experiment with Croatian sentences varying in the presence of the relevant pronoun. Croatian is a pro-drop language, therefore in the examples above the pronouns would not necessarily be present. Indeed, preliminary data show that around 1/3 of the participants switch reference from father to son in a non-default non-pro-drop situation. Contextual information (in this experiment the availability of the relevant information on a picture) contributes to the gaze switch that indicates different resolution of the reference ambiguity. Therefore, in Croatian the reference resolution of a pronoun is strongly influenced not by grammatical information (word order, thematic role information etc.), but by pragmatic or contextual factors. Speakers tend to attribute a function to every part of an utterance: non-default explicit pronoun indicates the reference shift, although there is no

grammatical justification for it.

Keywords: reference resolution, eyetracking, pro-drop language, Croatian language
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Spatiotemporal dynamics of the slow oscillation in the cortex and thalamus of the anesthetized rat

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The slow oscillation(SO), the major brain rhythm during slow-wave sleep and anesthesia, is characterized by rhythmic alternation of active and inactive states. Several properties of the SO are still under debate, including the underlying generation mechanisms. There is plentiful evidence of a cortical origin, however the neocortex is strongly and reciprocally interconnected with the thalamus, therefore the possible role of this latter structure in the genesis of the SO cannot be ignored. In addition, the SO behaves as a travelling wave and groups faster brain rhythms. To investigate this complex spatiotemporal dynamics, simultaneous sampling of the electrical activity from numerous points of the brain is needed. We recorded the local field potential and unit activity from various cortical and thalamic areas of ketamine-xylazine anesthetized rats with a high contact density, four-shaft silicon probe with electronic depth control, whereon the experimenter can select the appropriate 32 recording channels electronically along the 8 mm long shafts of the microelectrode from the more than thousand contact sites. We found significant differences between the temporal dynamics of active states appearing in different thalamic nuclei and cortical structures. Furthermore, examined firing properties of single cells recorded from the thalamus showed nucleus-specific differences as well.

Keywords: sleep, slow oscillation, high density neural recording, electronic depth control
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Age-related changes in resting state functional network characteristics

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Cerebral aging is likely to affect the configuration and temporal dynamics of functional cortical circuitries, thereby leading to age-associated differences in neuronal correlates of cognitive functioning. Studying cortical rhythms in pathological aging as dementia and Alzheimer disease in resting brain provided apparent functional disconnection between anatomically distinct cortical regions particularly linked with the dynamic of alpha frequency band. In the present study the role of altered functional connectivity was investigated with respect to aging by analyzing the spatial distribution of EEG phase synchronization. EEG data of young (18-26 years, N=14) and (60-71

years, N=16) elderly subjects were recorded during eyes closed resting condition. The functional modular structure was determined by using graph partitioning algorithms. Each module was investigated based on the strength of intra- and inter-modular connectivity. The most consistent modules in both groups were localized bilaterally in the parieto-occipital region. Apparent decrease of connectivity strength of these modules was observed in the elderly. In summary our results show that the optimal modular pattern of adult age is gradually replaced by a more random topology (disconnection of sub-networks) in the elderly suggesting that loss of communication between different functional modules reflects age-related cognitive decline.

Keywords: sleep, visuo-motor sequence learning, consolidation
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Hot and cold executive functions in obstructive sleep apnea syndrome

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The present study aims to evaluate hot and cold executive functions of patients with obstructive sleep apnea syndrome (OSAS) in comparison with healthy subjects. Hot executive functions are responsible for emotional/motivated decisions and personality dependent factors while cold executive functions are purely cognitive executive functions, for example working memory, attention. The study focuses on three main cold executive functions: updating of working memory, shifting between mental tasks and inhibition. These were measured with different subtests of the Test of Attentional Performance (TAP). Hot executive functions were measured with the Big Five Inventory (BFI) and Spielberger STAI II, respectively. Results indicate that sleep apnea can affect the examined executive functions; moreover most of the patients with OSAS showed impaired performance on at least one of the subtests. It seems that patients with cognitive deficit also have a deficit with the hot executive functions. For example patients with OSAS reached a higher level on the trait anxiety test. Executive dysfunctions can be used as diagnostic cues in patients with OSAS together with sleep diagnostic results. One future perspective is to involve further groups with different sleeping disorders and to find out different diagnostical patterns in cold and hot executive functions.

Keywords: hot and cold executive functions, obstructive sleep apnea syndrome, Test of Attentional Performance, personality traits
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Impact of sleep on real-life declarative learning

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The aim of this project was to investigate the beneficial effects of sleep on real-life declarative learning. 12 male subjects (M=23.5, SD=3.06 years) spent 2 nights in the sleep laboratory. Subjects had to encode 50 Spanish-vocabulary. Each vocabulary was paired with the corresponding line drawing taken from the International-Picture-Naming-Project database. After 2 encoding sessions

subjects performed a (cued) recall task which was repeated in the morning thereafter. On average, subjects correctly retrieved 53.89% (SD=15.44%) in the evening and 53.99% (SD=15.04%) in the morning. Overall change between evening and morning recall failed to reach significance (t11=-0.160, p=0.876). According to their overnight performance increase subjects were divided into \'memory-enhancer\' (M=5.00, SD=2.53 letters) and \'memory-non-enhancer\' (M=-4.50, SD=2.07 letters). We could show that frontal slow (11-13Hz) sleep spindle activity is more pronounced in \'memory enhancer\' esp ecially during the first (t10=2.674; p=0.023) and the last quarter of the night (t10=2.352; p=0.040). Furthermore, a negative relationship (r11=-0.659; p=0.020) between the duration of REM and overnight memory change was found. Even if we are aware of the limitations of our study (no control-condition, low sample size), these findings indicate that slow sleep spindle activity after real-life declarative learning improves, whereas REM interferes with sleep-dependent declarative memory consolidation.

Keywords: declarative memory, real-life, sleep spindles, REM
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Associations between sleep and vocabulary development in infants

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Even though the influence of sleep-wake rhythms on cognitive functioning is well-studied in adults, little is known about this relationship in infancy when significant changes happen both regarding sleep patterns and cognitive development. Our research aims to investigate the impact of sleep on later vocabulary development. Data for 23 14-month-old were included in the current analysis from a pool of 150 families who took part in this study from the Oxfordshire area. Parents were given the Sleep and Naps Oxford Research Inventory (SNORI) - a sleep diary over seven consecutive days, and the Oxford Communicative Development Inventory (OCDI). Infants' vocabulary development was followed up two (17 infants) and six months (14 infants) after the completion of the SNORI. Among sleep variables, nap time and nap-sleep proportion correlated positively with the OCDI comprehension score in 14-month-olds. Vocabulary size at 16-months and 20-months were also associated with nap time and nap-sleep proportion, although in the latter case this association was weak. The number of awakenings was correlated significantly with the six-month increase in both comprehensive and productive vocabulary size. Interestingly, a greater number of awakenings was associated with larger vocabulary size. These findings suggest that napping may have an important role in language development at 14-months.

Keywords: language development, sleep, vocabulary size, infants
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How can we improve skill learning? Role of sleep and the dorsolateral prefrontal cortex

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Sequence learning is crucial in everyday life from childhood to old age; it underlies the acquisition of motor, cognitive, as well as social skills. Previous studies have shown the involvement of the fronto-striatal circuits in this type of learning. The specific functions of the components of these

circuits are, however, still debated. The aim of the present study was to investigate the role of the dorsolateral prefrontal cortex (DLPFC) in implicit sequence learning and consolidation. We used anodal transcranial direct current stimulation (tDCS) to modify the activity of the right DLPFC during the learning phase. Based on previous studies, anodal tDCS enhances neural plasticity on the stimulated area, supporting learning processes. Consequently, some studies have reported improved learning following a similar stimulation but these improvements lasted only for a short period of time. We went beyond these studies by including a second session after a 12-hour delay period, during which half of the participants slept (PM-AM group) and the other half stayed awake (AM-PM group). This way we could examine the effect of sleep on the stabilization and improvement of skills. Our results showed that sleep and the stimulation of the right DLPFC together improved the learning performance, while, if separated, they had no significant effects. These results suggest that the right DLPFC has a specific role in the consolidation of the acquired knowledge during sleep but not during waking time. Our findings can help to refine current models of learning and memory.

Keywords: sequence learning, consolidation, sleep, transcranial direct current stimulation, skill acquisition, prefrontal cortex
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Detection of changes in neural oscillations during movement imagination

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Movement execution is accompanied by specific changes in brain activity. Apart from movement-related evoked potentials that are phase-locked to a movement onset, movement planning and execution also results in changes in neural oscillations that are not phase-locked to a movement onset. An attenuation/enhancement of amplitude of specific frequency band of neural oscillations is called event-related desynchronization (ERD) / event-related synchronization (ERS). ERD occurring during movement execution and planning is specific for mu rhythm, while ERS of beta band (beta rebound) is an event emerging after movement execution. Imagined movements show much resemblance concerning brain activity to real movements. This fact is greatly used in brain-computer interface (BCI) implementations. In this study, single trial ERD/ERS detection during imagined movements was studied. Even though a good recognition of movement imagination can be achieved (true positive rate, TPR), occurrence of false positives (FP) represents an important problem. Changes of classification parameters (dwell time and threshold) were investigated in order to provide higher TPR and lower FPR. The study confirms the importance of custom designing of BCI for each user.

Keywords: brain-computer interface, movement imagination, event-related (de)synchronization
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Neural activity accompanied by rapid eye movements during REM sleep in the human brainstem: an fMRI study

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Sleep studies have produced many important findings. However, there is a gap in knowledge

between human and animal studies. Human studies have mainly explored cortical activity using EEG and/or fMRI, whereas animal studies have mainly investigated neural activity in subcortical structures, especially in the brainstem, using electrophysiological measurements. To narrow this knowledge gap, we investigated human brainstem activity during REM sleep using simultaneous EEG/fMRI recording. We acquired fMRI and polysomnogram data from six healthy adults (5 males, 1 female; age range: 22-34). Four subjects reached REM sleep, and all showed significant activation accompanied by REMs in the upper and lower part of the pons. Careful examination including neuromelanin-sensitive MRI revealed that upper activation corresponded to pedunculopontine and laterodorsal tegmental nuclei (PPT/LDT) or sub-LDT, and lower activation corresponded to the pontine reticular formation (PPRF). This study is the first to show localized brainstem activation accompanying REMs, and clearly demonstrates that fMRI can detect transient brainstem activity during sleep. In future studies, not only cortical and subcortical activity, but also their interaction in the human brain during sleep will be investigated using simultaneous EEG recording with high spatial resolution fMRI.

Keywords: REM sleep, rapid eye movements, brainstem, fMRI
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Altered fronto-midline theta dynamics accounts for aging effect on short term memory

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Short term memory allows active maintenance of transient events from the environment, hereby establishing the basis of decision making and learning to utilize information beyond its transient sensory availability. Medial temporal and frontal brain regions supporting encoding operations undergo substantial neurochemical, anatomical, and functional changes throughout life, thereby leading age related decline of memory functions. In the present study young (19-26 years, N=20) and elderly (61-71 years N=16) adults participated in a visual delayed match to sample task, in which they had to remember 3 or 5 colored squares, while 33 channel EEG recording was performed. The study aimed to investigate age-related alteration of persistent delay period fronto-midline theta (4-7 Hz) activity as a function of memory load and subsequent performance. In the young frontal-midline theta activity was shown to be sensitive to both increased memory demands and subsequent memory performance. Contrary to this, in the elderly reduced fronto-midline theta activity and decreased performance were observed. This frontal theta activity was shown to be correlated with later performance indicating the role of sustained attention in active maintenance. In conclusion aging may alter the cortical circuitries of theta dynamics, thereby leading to age-associated decline of memory function.

Keywords: aging, memory, fronto-midline theta
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A non-invasive polysomnographic study on dogs (*Canis familiaris*) during owner-dog co-sleeping

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Recently dogs (*Canis familiaris*) have been demonstrated to be a promising model species for studying human behaviour as they have adapted to the human niche and developed human-like socio-cognitive skills. Research on dog behaviour, however, has so far almost exclusively focused on awake functioning. Here we present a non-invasive polysomnographic technique applied to dogs: scalp EEG, EOG, ECG, EMG and respiratory movements were recorded while subjects (N=14) were sleeping together with their owners for 3 hours during day-time. In order to validate this method, we investigated whether pre-sleep experiences influence brain activity during sleep similarly to humans. Adaptation to the laboratory (1st recording) was followed by two experimental sessions (2nd and 3rd recordings), involving either active (6-8 hours of walking and/or training) vs. passive pre-sleep wakefulness, or learning (known actions such as Sit! prompted by new commands) vs. control (known actions prompted by known commands) tasks before the sleep recordings.The design allows the comparison of the macro- and microstructure of sleep in different conditions in order to reveal possible experience-dependent changes in dogs' sleep. Our results validate the family dog as a model species for studying the effect of pre-sleep activities on EEG pattern under natural (non-laboratory) conditions.

Keywords: dog (*Canis familiaris*), non-invasive polysomnography, EEG, memory
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Suggestibility of dream contents

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Previous research has shown that congenitally handicapped and amputees continue to dream of themselves as unharmed, even years after amputation. The current study investigated whether these findings are indicative of a non-relatedness of waking and dream self or other factors such as “wish-fulfilment” or lack of 3rd person perspective in the dream. Applying a repeated measures design, consisting of a control condition and two experimental phases, we tested whether the dream self would be affected by either pre-sleep enhanced conscious perception of a specific body part or by an attended to alteration of that body part. Subjects reported ten dreams for each of the three phases of the experiment. In phase 1, participants were only told to remember their dreams. In phase 2, they were instructed to attend to their right arm before sleep, and in phase 3, to look intensely at an experimentally applied large red dot on their right arm before sleep. We found no evidence that attributes or manipulations of the wake self were transported into the dream. We did not observe any experimentally induced increase in awareness of the body part attended to (arm) or changes in associated features like shape, colour, or laterality. Results are interpreted with regards to protoconsciousness theory, claiming that dreams provide a virtual world in which a “protoself” operates independent of waking conscious awareness.

Keywords: dreaming, dream content, protoconsciousness, body scheme
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Noise-induced modulation of the event-related potential is similar for various high-level stimulus categories

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In previous studies it has been found that adding noise to faces modulates the amplitude of the N170 and P2 components of the event-related potential (ERP) incrementally. However, to date it has not been investigated whether this manipulation affects the ERP for non-face stimuli to the same extent as well. To this end, we measured the event related potentials for faces and cars at three different noise levels. Subjects performed a two-alternative age discrimination test with seven stages of difficulty for both stimulus categories. Adding noise gradually to the stimuli increased the latency and decreased the amplitude of P1 for both categories, but the effect was more pronounced for faces. For the N170, there was a reduction in amplitude and a delay in latency with increasing levels of noise for both categories. We found an enlargement of the P2 ERP component amplitude that was present for both categories, but greater for faces than for cars. The inter-trial coherence (ITC) analysis revealed that the N1-P2 modulation is primarily attributable to the noise-dependent reduction of the ITC in the 4-15 Hz frequency range in the 130-200 ms post-stimulus window.

Keywords: noise processing, category effect, N170, P2
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Cortico-cardiac coupling during sleep: coherent, phase-locked and infraslow fluctuations in band-limited EEG amplitude and heart-rate

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Introduction: Previous studies reported significant associations between sleep EEG microarousals and episodes of tachycardia-bradycardia. Moreover, sleep EEG spectral power was shown to correlate with heart rate variability (HRV). In spite of these reports, no direct evidence for a common infraslow cortico-cardiac oscillation was given. Our aim is to unravel the commonalities in and interrelationships between neural and vegetative (cardiac) oscillations in humans.
Methods: Instantaneous amplitude for the standard frequency bands were extracted from EEGs of 71 whole polysomnographic records of 65 healthy human adults. ECG records were transformed to interpolated RR-series. Connectivity between EEG amplitudes and RR was analyzed by several methods. The same analyses were run with 24 heart-transplanted patients.
Results: Analyses revealed increased connectivity between NREM sleep delta/beta and infraslow RR-fluctuations in healthy subjects. REM sleep beta, but not delta amplitudes were shown to cohere and phase-couple with slow-frequency RR-fluctuations. Heart-transplanted patients showed reduced EEG-ECG connectivity, depending in part on the time interval between transplantation and sleep-laboratory testing.
Discussion: Brain electrical activity is strongly related to infraslow fluctuations in heart-rate during sleep. Thus, low frequency components of HRV have their corresponding EEG signatures. Results reveal that this brain-heart „hot-link" is provided by the innervations of the heart.

Keywords: sleep, EEG, heart rate variability, connectivity
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Short term effects of moderate alcohol drinking on cognitive function

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Nineteen male students who are not abstainers participated in this experiment measuring the short term effects of moderate drinking on cognitive function. They were instructed to drink one can (350ml) of beer in ten minutes. Cognitive function was measured four times by a short term memory test: before drinking, immediately after drinking, 15 minutes after drinking, and 45 minutes after drinking. As a cognitive task, twenty illustrations were presented on a PC screen one by one in one minute, and participants were instructed to memorize them and draw them on a test form after the presentation. Six out of ten ALDH2 positive participants showed higher cognitive performance immediately after drinking compared with before drinking, whereas the performance of five out of nine ALDH2 negative participants decreased immediately after drinking. No significant main effect or interaction was found in cognitive performance. The difference in the effects of alcohol on the cognitive task scores between ALDH2 positive group and the negative group was very small, although their graph patterns, including the recovery period until 45 minutes, indicate interesting patterns that were opposite to each other. Further investigation with more participants is necessary to conclude the effect of moderate alcohol drinking.

Keywords: alcohol, beer, short term memory
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Lexical selection and cognitive control in children with SLI

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Specific language impairment (SLI) is often associated with impairments in cognitive control, but the relationship between these deficits and linguistic problems is unknown. For investigating this question, we assessed lexical retrieval abilities with a picture naming task and cognitive control with a verbal and non-verbal Stroop task and a stop-signal task in children with SLI and age-matched controls, and studied correlations between the results. In the naming task, the level of conflict was manipulated by (1.) the context of the pictures (semantically homogeneous vs. mixed blocks) and (2.) the number of possible names of the picture (high vs. low naming agreement). RT-s were expected to be higher in case of homogeneous vs. mixed as well as low vs. high agreement pictures. We also hypothesized that the effect of conflict (differences between high and low conflict conditions) would correlate with cognitive control measures. Both hypotheses were supported by the results. Furthermore the performance of the SLI group was significantly lower than the

performance of the control children both in the picture naming and cognitive control tasks which shows that lexical problems are present beyond grammatical problems in SLI, and to some extent, they can be accounted for by impairments in cognitive control.

Keywords: specific language impairment, word retrieval, cognitive control
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Resting EEG predicts CRS-R score in Disorders of Consciousness

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Patients suffering from a Disorder of Consciousness still present a diagnostic challenge because their assessment is mainly based on behavioural scales although their motor responses are often strongly impaired. We, therefore, investigated resting EEG trying to find indicators of the patient's current state independent of rather complex abilities (e.g. language comprehension). Resting EEG was recorded on four occasions in seven Minimally Conscious State and ten Vegetative State patients. Behavioural assessments were conducted using the Coma-Recovery Scale - Revised. The signal was analyzed in the frequency domain and association between CRS-R Score and EEG amplitude were calculated using Pearson correlation and repeated measures ANOVAs. Analyses revealed robust negative correlations with relative band amplitude in frequencies below 8 Hz and positive correlations with frequencies above 12 Hz. Furthermore, absolute occipital alpha (8-12Hz) amplitude and the spectral peak were highly indicative of the patient's CRS-R Score. The strong relationship between various resting EEG parameters and CRS-R score provides significant clinical relevance. Not only is resting activity easily acquired at bedside, but furthermore, it does not depend on explicit cooperation of the patient. Especially in cases where behavioural assessment is difficult or ambiguous, spectral analysis of resting EEG can, therefore, complement clinical diagnosis.

Keywords: Disorders of Consciousness, resting state, spectral EEG, CRS-R score
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Sleepwalking Movement Behaviour: A Study on (Somnambular) Perception of Space

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Perception of space during a sleepwalking episode is one of the least observed aspects of somnambulism. Since sleepwalking occurs in a low/altered state of consciousness, a study of spatial cognition during a somnambular event can be used to identify parts of consciousness that are left awake and then, their correlation with mental processing of space. We studied 10 experiments and 20 scientific papers on parasomnia phenomena and sleepwalking to map out varying degrees of consciousness through analysis of movement patterns, level of spatial cognition skill and interaction with the environment. In addition, we used a questionnaire focused on somnambular behaviour and activities to complete the analysis. Collected data was sorted, evaluated and classified according to path length, path shape, duration and frequency of sleep disorder episodes, patterns of spatial physical activity and type of interaction with the environment. Overlap of spatial cognition data with different sleep related properties such as phases, waves and neural oscillations showed distinct connections between the two levels of research. The results indicated specific patterns of spatial perception and orientation according to neural activity and neurotransmitters. Results have also shown that while the majority of sleepwalkers stay within a known environment during a

somnambular episode, the ones who wander into a previously unknown space seem to have approximately the same level of spatial orientation and coordination. Therefore, the part of consciousness that remains awake during this non-REM phase of sleep may be linked to mental visualization, mapping and wayfinding, as well as spatial cognition in general.

Keywords: somnambulism, parasomnia, spatial perception, sleepwalking, spatial cognition
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The Relationship between Event Related Potential and Subjective Evaluation by Semantic Differential Method

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This study aimed to identify the relationship between Event Related Potential (ERP) components and the evaluations on sound impression using the Semantic Differential (SD) method. The participants were 26 young university male students with normal hearing capability. ERPs were recorded from 64 electrodes based on the 10–20 International system during the presentation of four types of short and sharp sound stimuli. Their subjective evaluations on these sounds were also collected and were analyzed using the SD method. Fourteen pairs of adjectives were extracted using factor analysis into three factors: Evaluation, Activity, and Potency. Then, the relationships between ERP components and 8 impression scores (3 factors and the other 5 pairs of adjectives that have high uniqueness) were analyzed using regression analysis. The results show that the score of the factor of evaluation negatively correlates with the evoked response occurred in 50-150 ms after the onset of the stimulus (N1 amplitude; $p<0.05$). Meanwhile, the score of Activity factor and the adjective of "shrill" have positive correlations with the evoked response occurred 600-800 ms after the onset of the stimulus (LPC mean amplitude; $p<0.05$). The results of this study suggest that ERPs amplitude is related to impressions by the SD method.

Keywords: Evaluation factor, SD method, ERP, N1
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Upgrading the sleeping brain with targeted memory reactivation

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A fundamental feature of human memory is the propensity for beneficial changes in information storage after initial encoding. Recent research findings favour the possibility that memory consolidation during sleep is instrumental for actively maintaining the storehouse of memories that we carry through our lives. The information that ultimately remains available for retrieval may tend to be that which is reactivated during sleep. A novel source of support for this idea comes from demonstrations that neurocognitive processing during sleep can benefit memory storage when memories are covertly cued via auditory or olfactory stimulation. Investigations of these subtle manipulations of memory processing during sleep can help elucidate the mechanisms of memory preservation in the human brain.

Keywords: sleep, memory consolidation, targeted memory reactivation, sleep replay
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Visual word recognition in masked priming paradigm

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Ability to read requires numerous prerequisites to be succesfully performed. Recognition of particular letter string as a mother tongue word is certainly one of it.
Neuroimaging studies attributte word recognition to the processes carried out by left ventral pathway. It has been shown that lexical decision elicites N400 effect in left inferofrontal region implying different processing of meaningful and meaningless letter string. However, various studies support importance of early left ventral pathway involvement in visual word recognition.
Our study used masked priming paradigm on lexical decision task in order to descibe early and late components of visual word recognition in adult participants. Three types of masked prime (identical words + two types of graphically degraded words) preceded words or pseudowords by 80 ms and were masked by a string of "#". In total 60 words and pseudowords was presented.
Masked priming paradigm reveals that masked prime presented prior to target letter string can modulate early components of visual processing such as N2 and N250. Such early modulations can facilitate or interfere with higher-level word processing. Consequently, it is suggested that if disrupted, early visual processing could underlie reading difficulties.

Keywords: word recognition, masked priming, lexical decision, ERPs
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Label-Induced Categorization is Indexed by Alpha Desynchronization in Adults and 9-Month-Old Infants

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Previous research has shown that spoken words facilitate the categorization of perceptually similar objects in infants. The present study addressed the question whether labels alone, without perceptual similarities, could make adults and 9-month-olds group objects together. We measured the desynchronization of alpha-band EEG oscillations in a category oddball paradigm. Experiment 1: Seventeen adults learnt one of two pseudo-words for each of six unfamiliar objects without shared perceptual features. Subsequently, four of the six objects, three sharing the label and one having the other label, were presented without labels on screen, with equal frequency. Participants responded to the oddball category with stronger attenuation of alpha oscillation over the left frontal region ($t(16) = 3.95$, $p = .001$). Experiment 2: Fourteen 9-month-old infants were engaged in a live familiarization with an experimenter presenting them the six unfamiliar objects one by one, while uttering the two novel labels. Right after the familiarization, we presented them with the four objects the same way as above. Stronger alpha attenuation in response to the oddball category ($t(13) = 2.29$, $p = .039$) suggested that 9-month-olds, just like adults, exploited the labels to form two object categories.

Keywords: Categorization, Labeling, Alpha Desynchronization, Oddball, Infants
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Cognitive robustness and videogames

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Neuronal networks are subject to the training process as any other function of the body. This knowledge is used in medical rehabilitation to reverse neural impairment. Less is known about the influence of neuronal training on cognitive robustness of young healthy persons. Habitual videogame playing is an archetype example of multitask neuronal training reinforced by motivation to accomplish the task. The present study seeks to determine conscious mental activity, such as memory, thinking, perceptiveness, and decision making, in regular video gamers. Mental functions were assessed in 30 habitual users (aged 20-25) of the multiplayer videogame Counter Strike-First Person Shooter, playing at least three times a week, and 30 non-players, using the computerized psychological tools: RehaCom, Vienna Test System, and Wechsler WAIS-R test. The gamers scored significantly better in all cognitive functions investigated; e.g. episodic memory (16.7±0.8SD vs. 11.3±1.0 digits remembered), conceptual thinking (15.5±1.2 vs. 10.0±1.0 points), and perception of details (16.4±0.8 vs. 10.6±1.0 points) compared with non-gamers. We conclude that conscious mental activity and the cognitive elements of perception are enhanced by regular video gaming. Thus, video games offer an unintentional cognitive training; the process is likely underlain by recruitment of alternative neuronal pathways, normally constituting a dormant reserve.

Keywords: cognitive activity, memory, perceptiveness, conceptual thinking, video games
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Does superior intelligence protect from biological aging: the case of sleep EEG power spectra?

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Age-related changes in sleep EEG are well documented. High intelligence was hypothesized to be protective against cognitive and biological aging. Here we aim to test this hypothesis by analyzing age-related sleep-EEG changes in subjects with average and superior intelligence. We performed polysomnographic recordings and sleep-EEG spectral analyses of 24 subjects with average and 19 subjects with superior intelligence (IQ between 90-110 vs. >130, age range: 17-55 years). Rank-correlations between sleep EEG band power and age were calculated separately for the groups. Subjects with average intelligence showed age-dependent declines in NREM EEG total, delta-theta and sigma, as well as REM EEG delta power. Increases in NREM beta as well as REM sigma and beta powers were also evidenced. In the superior intelligent group no significant relationship between age and any of the analyzed sleep EEG measures was found. Our findings on subjects with average intelligence are consistent with the well documented aging of sleep-EEG. However, no age effects in the sleep EEG of young to middle aged subjects with superior intelligence were found. Findings suggest that superior intelligence could be a protective factor against the aging of neural networks generating synchronized oscillations during sleep.

Keywords: sleep , aging , intelligence, eeg power,
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Artifact rejection in sleep EEG recordings with EEGLAB

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Rejecting artifacts is an essential first step in sleep EEG analysis. This task is not difficult, but extremely time consuming. Various automated algorithms are available for EEG artifact rejection, but the most effective spectrum-based algorithms frequently fail because of the various typical spectra seen in ddifferent sleep stages. This simple but effective EEGLAB preprocessing algorithm can significantly shorten artifact rejection. We used EEGLAB to compute the probability distribution of EEG, EOG and EMG channels and the kurtosis of EEG data. 4-second epochs with extreme values were rejected as artifacts. Different extreme values were given for each signal type and statistical parameter. In a selected sample of recordings this method was able to correctly classify 75.2% of data as artifact-free, correctly detect 12.4% as artifacts, while missing artifacts in 6.5% of data and incorrectly classifying 5.89% as artifacts. Typically EMG-unrelated high-frequency artifacts were missed and large delta waves were falsely detected. This algorithm does not substitute visual screening of data but it only takes approximately 5 minutes to run and it significantly reduces the time required to screen data as only false decisions must be corrected.

Keywords: sleep EEG, artifact rejection
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Effects of attention and emotion on early visual cortex activity measured with simultaneous EEG-fMRI

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The biased-competition theory of selective attention provides a powerful model of how top-down processes may influence perception. However, it remains unclear how this theory can account for the potent influence of emotional stimuli on sensory processing. We hypothesized that emotional stimuli resist competition for attentional resources, and that this resistance is linked to the interaction of low-level sensory cortices and specialized emotion-detectors. Healthy participants (n=14) were shown neutral or emotional faces at different levels of competition with surrounding distractors while EEG and fMRI were acquired simultaneously. Results show that increased competition reduces low-level visual cortex activity elicited by neutral stimuli. Conversely, increased competition enhances activity elicited by emotional stimuli in object-selective visual areas and in the amygdala. Additional analyses integrating both measurement modalities will reveal the timing of these effects.

Keywords: attention, emotion, biased competition
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The evaluation of online computer games as tools for cognitive training

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During the past decade, the need for efficient cognitive training tools has rapidly increased, while online gaming has become worldwide a popular leisure activity. Despite the concerns of its possible negative social and/or behavioral effects, a growing body of literature reports drastic enhancement

of attention performance directly caused by gaming. Effects on short-term memory and executive functions are, however, inconsistent, and conclusions are rather incomplete: although game genres show tremendous variability, many previous studies have only examined one specific genre. Therefore, the aim of our study was to investigate whether playing certain game genres truly enhances various aspects of cognitive performance. Two experimental groups without previous gaming experience went through a two-week training of playing either an action video game, or a role-playing game. Two matched control groups consisting of gamers and non-gamers lacked training. Measures of cognitive performance covered attention, short-term memory, and executive functions. Performance was assessed prior and after training among the training groups as well as the control groups. Results showed significantly better post-training performance within experimental groups and the gamer control group, and also in comparison to the non-gamer control group. Based on these positive findings, online games can be considered as enjoyable, and, in fact, efficient tools for cognitive training.

Keywords: online computer games, cognitive training, attention, short-term memory, executive functions
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Left-right asymmetry of the rodent hippocampus

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Left-right asymmetry of the brain is widely recognized among general population. Since the first discovery of the cortical left dominance for language ability, most of the studies on brain asymmetry have been conducted in the primates. However, limited numbers of the subjects and variability of the genetic background obscured the molecular/circuitry basis of the lateralized functions. Recently, emerging evidences show such laterality is also observed in the rodents, ideal animals for genetic studies. Here, I present anatomical/physiological asymmetry of the rodent hippocampal CA3-CA1 circuitry. 1) The size and receptor contents of the hippocampal CA3-CA1 synapses are determined by the laterality of presynaptic neurons. The CA1 synapses receiving from the right CA3 inputs tend to be larger and contain more glutamate receptors. This CA3-CA1 asymmetry is disrupted by the inhibition of the nodal flow in the early developmental stage. 2) Gamma rhythms, implicated in cognition, are greater in the right hippocampus of enriched environment-reared rats. Such environmental effects are accompanied by a lateralized synaptic reorganization and an interhemispheric gamma synchrony, suggesting a cooperative but distinct operation of bilateral hippocampi. Together, the hippocampal CA3-CA1 circuitry is designed to be asymmetrical by the genetic programming, and the postnatal experience sculpts the functional lateralization.

Keywords: hippocampal laterality, CA3-CA1 synapse
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The dreaming sleep stage as a model for schizophrenia? Common neurobiological and phenomenological features of schizophrenia and REM sleep

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Aim. The goal of the poster presentation is to present the common neurobiological and

phenomenological features of schizophrenia and rapid eye movement (REM) sleep.
Method. A literature review of studies that have examined associations between schizophrenia and REM sleep.
Results. Many researches revealed that schizophrenia and REM sleep are characterized by common neurobiological and phenomenological features. The common neurobiological markers of the REM sleep stage and schizophrenia are: intracerebral disconnections, deactivation of dorsolateral prefrontal cortex, disturbed responsiveness and sensory deafferentation processes. Another part of evidence is based on the results of electrophysiological data, as well as data collected through neuroimaging methods including the activity of dopamine, acetylcholine, noradrenaline, serotonin and glutamate. Moreover, the data from the descriptions of daily experiences and the narratives of dreams reported by control subjects and subjects suffering from schizophrenia revealed that the waking cognition of schizophrenic patients shares a common degree of formal cognitive bizarreness with the dream reports of both non-clinical and clinical populations. On the phenomenological level, dreams (lucid dreaming excepted) and schizophrenia are both characterized, among others, by: autism, loss of autonomy in relation to mental content, lack of insight and inappropriate affect.
Conclusions. A common electrophysiological, tomographic, neurochemical and phenomenological characteristics of these two states suggest that data about REM sleep could help to introduce a useful model of schizophrenia.

Keywords: schizophrenia, sleep, REM
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Sleep and network state dependent specialisation of distinct GABAergic neuron firing in the hippocampus

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The firing of interconnected cortical pyramidal cells and GABAergic interneurons is related to network states during behaviour and natural sleep. In the hippocampus, each pyramidal cell receives about 2000 synapses from about 20 types of distinct interneuron, which predicts that the release of GABA to pyramidal cells from different cell types is differentiated in time. We have explored whether distinct interneurons, defined by their synaptic connections and molecular expression, release GABA differentially during different sleep and oscillatory states in rats. Single interneurons were recorded in the CA1 area while the rat explored and/or slept in a small arena, and subsequently the cells were labelled for histological identification. Distinct types of interneuron increased, decreased or did not change their firing rates during sleep as compared to the awake state, and their firing behaviour correlated with the synaptic targets of their axons. We conclude that the release of GABA to different domains of pyramidal cells is reorganised for each sleep and oscillatory state, reflecting one mechanism of network state re-setting.

Keywords: theta, slow wave sleep, REM sleep, inhibition, interneuron
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Time-of-Day has an opposite effect on the generation of past and future events

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An important aspect of the circadian rhythm is the cortisol-circadian-cycle. Fries and her colleagues (2009) hypothesized that the high level of cortisol in the morning (Cortisol Awakening Response, CAR) had a negative effect on declarative memories and a positive effect on prospective memory representations. We tested this hypothesis in two experiments. In Experiment 1, participants recalled remote autobiographical events in the morning (7-11 a.m.) or evening (7-11 p.m.), and then rated the phenomenal characteristics of the memories on 7-point scales. According to our results, memories retrieved in the evening were given higher ratings on Time and Time integration. In Experiment 2, we replicated these results and pointed out that the Time-of-Day (ToD) effect was reversed, when people imagined possible future events: future episodes contained more contextual details (time and location) and were more important in the morning than in the evening. However previous studies confirmed that imagined events are less vivid than real memories, we suggest that there is an important factor, which influences the differences between the phenomenal characteristics of past and future event: the Time-of-Day.

Keywords: Time-of-Day effect, Cortisol Awakening Response, autobiographical memories, imagined future events
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Violent somnambulism: a parasomnia of young men with stereotyped, claustrophobic dreams

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We aimed to characterize a subgroup of arousal parasomnias associated with violent behavior in adults We performed a retrospective multi-centre observational cohort study on clinical data of adult patients seen for the clinical suspicion of arousal parasomnia associated with violence. We analyzed the clinical and polysomnographic features of thirteen patients seen for the clinical suspicion of arousal parasomnia associated to violence. Nine young patients (8 males 1 female) had a common pattern of abnormalities: coexisting clinical signs of REM sleep behavior disorder and arousal parasomnia; similar 'claustrophobic' dreams and dream enactment episodes; but no REM sleep without atonia proven by polysomnography. We call this syndrome 'violent somnambulism'. We conclude that violent somnambulism is a distinct NREM sleep-related overlap parasomnia needing further characterization. Sleep related violence may be consistent also with other neuro-psychiatric conditions. The etiologic clarification and treatment of such cases may prevent life-threatening sleep-related events.

Keywords: sleep walking; sleep-violence, parasomnia
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Reduced N1-suppression for self-initiated sounds in schizophrenia

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The acoustic hallucinations in schizophrenia are generally explained by the lack of awareness of inner-speech, relation to the internal forward model. Absence of a match between intentions and the

efference copy cause sense of external control. The working of the internal forward model is reflected in auditory ERP as N1 suppression. The N1 reflect dampening of auditory cortex responsively during talking and speech in non-clinical participants but not in patients with schizophrenia. A number of studies with non-clinical participants reported that the amplitude of the N1 attenuated when it was elicited by self-initiated sounds. Horváth et al. (2012) reproduced action-stimulus contiguity (temporal proximity) is sufficient to suppress sensory processing related to the detection of auditory events in non-clinical participants. I would like to examine patients with schizophrenia and control participants with this coincidental paradigm. If patients will not show reduction in N1 to their self initiated sounds, suggest that this mechanism of auditory cortex suppression is dysfunctional in schizophrenia.

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Keywords: Corollary distance, ERP, N1, Schizophrenia
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Role of negative emotion regulation in a cognitive theory of nightmares

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Nightmares are a special and problematic kind of dreams accompanied by negative emotions so intense that the dreamer is awakened by them. In contrast, bad dreams are accompanied by less intense negative emotions, and the dreamer is not awakened. [2] This paper draws on Levin and Nielsen's Neurocognitive theory of dreaming [3] for a detailed look at the factors identified by Spoormaker's Cognitive Theory of Recurrent Nightmares [5] and a critique of their explanatory potential in the distinction of successful and failed fear extinction and emotion regulation processes in nightmares and bad dreams. With reference to results obtained by Blagrove et al. [1] on the relationship of nightmare frequency and distress to well being, we question the distinction between nightmares and bad dreams and discuss entailed knock-down effects on the fear extinction function attributed to bad dreams.
This finally motivates the proposal to carry out an in-depth comparison of the studies by Levin and Nielsen [2,3,4] and the research by Blagrove et al. [1], so as to clarify whether the posited fear extinction function of bad dreams is compatible with the findings of the latter: This research aims at verifying support for the position that bad dreams in fact do not serve the function claimed and at developing an extension of Spoormaker's Cognitive Theory of Recurrent Nightmares [5] that also covers bad dreams.

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Keywords: Nightmares, fear extinction, well being
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Vasopressin absence resulted sleep deficits and schizophrenia related EEG alterations in Brattleboro rats

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Vasopressin deficient, Brattleboro (BB) rats show behavioral similarities to schizoprenics: negative (social withdrawal) and cognitive symptoms (sensomotory gating and working memory deficit) were found and improved by antipsychotic treatments. Here we aimed to find EEG disturbances typical to schizophrenics and/or memory deficit in 24h frontoparietal recordings. Resting stress hormone levels were also measured at different time points by radioimmunoassay to further investigate circadian rhythmicity. Object recognition tests proved that BB rats have impaired discrimination abilities. The quantitative EEG analysis showed circadian rhythm alterations: the BB rats spent more time awake during their inactive phase. The sleep decrease was due to lower REM duration. The qualitative analyses of wake and REM stages revealed deceleration in the theta frequency band. Stress hormone production confirmed the disturbed circadian pattern of BB rats with smaller variability. The observed REM deficits undoubtedly contribute to memory impairments, and often occure together with circadian rhythm alterations. Although these EEG alterations might be observable in other mental disorders, but all data together suggest that BB rats are good model of schizophrenia.

Keywords: vasopressin, memory, EEG, circadian rhythm
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Narrative analysis in aphasia

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Aphasia, as a result of a stroke, affects all aspects of language, including narrative skills as an important part of everyday speech. The narration of stories is a complex task that requires the integration of linguistic, cognitive, and social abilities. Linguistically, a person must lexically encode information about the characters and events of the story using the morphosyntactic devices to articulate the sequence of events and their temporal relations. Cognitively, they must infer the motivation for protagonist´s actions, as well as the logical relations between events and the theme of the story. Narrative skills are still very rarely studied in aphasic population. In this paper, examinees with aphasia were presented with the 24-page wordless picture book Frog, where are you? and asked to tell the story based on the pictures in the book. All narratives were recorded on

audio-tape and transcribed. We examined whether the patients with aphasia included basic components of the story according to Trabasso and Rodkin´s model of causality. Examinees are 15 aphasic patients who have primarily nominal difficulties, aged 30-75, involved in speech and language therapy in Polyclinic SUVAG and have suffered the stroke before more than 6 months. The results have shown that examinees did not have difficulties with introduction of the story. They had more difficulties with trials in the middle and understanding the goal of the story.

Keywords: aphasia, narrative skills, story
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Sleep-dependency and relations of implicit and explicit episodic memory consolidation in humans

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Research in rats using spontaneous preferences during exploration as a measure of memory has indicated that sleep is important for the consolidation of episodic-like memories. How those findings relate to humans is unclear. We used spontaneous preferences during visual exploration and verbal recall as, respectively, implicit and explicit measures of memory, to study effects of sleep on episodic memory consolidation in humans. During encoding before retention intervals that covered night-time sleep or daytime wakefulness, young adults were presented with two episodes one hour apart. Each episode entailed a spatial configuration of four different faces in a 3x3 grid of locations. After the retention interval implicit spatio-temporal recall performance was assessed by eye-tracking visual exploration of another configuration of four faces; of which two were from the first and second episode, respectively; of these one was presented at the same location as during encoding and the other was presented at a novel location. Afterwards explicit verbal recall was assessed. Measures of implicit episodic memory retention were positively correlated with explicit recall ($r=0.41$, $p<0.05$), and were better after night-time sleep than daytime wakefulness ($p<0.05$). Together with concordant observations in rats our results indicate that consolidation of genuinely episodic memory benefits from sleep.

Keywords: episodic memory consolidation, implicit memory, humans, eye-tracking, sleep
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Sleep-dependent memory consolidation in disturbed sleep

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Literature on sleep-dependent memory consolidation gives a somewhat inconsistent picture. Complementing research on healthy individuals it is also of interest whether people with chronic sleep problems like insomnia show overnight consolidation. However, up to now, most studies did not consider age as a significant factor influencing study outcomes. In the present study we now explicitly addressed whether mechanism underlying consolidation of declarative memories changes with increasing age.Twenty-four subjects with primary insomnia were divided into two age groups: younger (25.7 +/- 6.3) and older (43.9 +/- 3.8). Each patient performed a declarative memory task followed by (i) an evening retrieval session, (ii) 8-hours of nocturnal sleep with polysomnographic recordings and (iii) a morning retrieval session.Data revealed that overnight memory change was related, in the younger age group, to slow (N3) sleep spindle activity, whereas in the older group,

consolidation appears to occur in relation to slow oscillations. We conclude that age is an up-to-now to little respected moderating factor when it comes to sleep-dependent memory consolidation. In insomnia it appears that young (< 38 age) and older individuals are using different mechanisms to consolidate freshly encoded information.

Keywords: memory, insomnia, age, sleep spindles, slow oscillations
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Transcortical motor aphasia: A special case of executive dysfunctions?

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Recent studies imply that executive functions (EF) are closely related to our ability to comprehend and produce language, and that functional communication and language recovery in aphasia depend not only on language ability but on EF as well. Some patients with transcortical motor aphasia (TMA) show language deficits only in tasks in which conflicting representations must be resolved by EF. Because EF in aphasia have been studied mostly using neuropsychological tests, there is a need for systematic experimental investigations of these skills among aphasics. Five individuals with TMA, five individuals with conduction aphasia, and ten healthy controls performed four nonverbal tasks that are supposed to index different EF components: To measure updating of working memory representations, we designed a visual and an auditory n-back task. To assess inhibition of prepotent responses, we used a modified stop-signal and a nonverbal Stroop task. Although our results demonstrate executive deficits in both aphasia types, the pattern of deficits was clearly different. Based on these results, and on earlier data, we suggest that tests of EF should be inherent part of clinical aphasia assessment.

Keywords: language, executive functions, inhibition, aphasia, rehabilitation
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Effect of stress and progressive muscle relaxation on short-term and long-term memory of neutral and emotional words

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Stress has a complex effect on learning and memory in that it may improve or weaken them. This study aimed to establish the effect of stress and progressive muscle relaxation on short-term and long-term memory of neutral and emotional words. The participants (n=90) were divided by random selection into two experimental and one control group and their heart rate variability was measured. The participants in the first experimental situation were exposed to the Trier Social Stress Test (n=32). In the second experimental situation the participants listened to a recording for progressive muscle relaxation (n=32). Memory was tested directly after exposure to the experimental or control situation by the immediate recall method. The next day, their memory of the list of words was tested by free recall and recognition. The results showed that listening to the relaxation recording led to a significantly higher high-frequency variability which is an indication of effective relaxation. Positive and neutral words were remembered much better than negative ones, but there were no significant differences in the memory of neutral and emotional words between groups of participants. The data indicate the need for more strict experimental control to

examine the effect of stress and relaxation on memory.

Keywords: stress, progressive muscle relaxation, learning, memory, heart rate variability (HRV)
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