Results: In waking state, at least 10 cortical regions showed consistent responses during the 1-s period following noxious stimuli. Most of these responses arose from sensory cortices (operculo-insular) and mid-anterior cingulate regions, but very reproducible field potentials were also obtained from dorsolateral frontal (BA 45, 46, 9, 10), posterior parietal (BA 40, 5, 7) and medial temporal regions (hippocampus, amygdala). Sleep onset was asynchronous, the thalamus being deactivated minutes before all cortical areas, while awakening was synchronous in thalamus and cortex. Passage from waking to light sleep (N2) was characterized by moderate attenuation of sensory and mid-cingulate activity, contrasting with severe attenuation of responses from parieto-frontal networks. Sleep spindles did not block cortical noxious responses, and sometimes even enhanced them. REM-sleep was uniquely characterized by the disappearance of mid-anterior cingulate activity linked to attentional and motor reactions, with a preservation of sensory nociceptive responses. Thus, the dissolution of consciousness is associated with orderly changes in cortical responses to phasic pain stimuli. Networks essential to maintain declarative consciousness-memory are among the first to become unresponsive, while low-level sensory cortices remain active for much longer. Sleep spindles do not block sensory responses to pain and a striking dissociation between sensory and attention-orienting responses characterizes REM-sleep.

Conclusion: The differential dynamics of cortical activation to pain stimuli is consistent with altered intracortical connectivity and 'local sleep' theories. Whether a potentially dangerous stimulus such as noxious heat succeeds to disrupt sleep is probably determined by the interaction between activities in such different networks, and their cross-synchronization through thalamic nuclei.

Acknowledgements: Labex "Cortex", APICIL Foundation, INSERM (Interface grant), Rhône-Alpes Region.

http://dx.doi.org/10.1016/j.sleep.2015.02.094

Risk factors of frequent nightmares among the general Finnish adult population

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Introduction: Nightmares are intensive disturbing dreams that awaken the dreamer from sleep. Frequent nightmares can be a serious problem and are often related to mental disorders and increases risk for suicide. The current study investigates risk factors for frequent nightmares in a representative population sample of Finnish adults.

Materials and methods: The current study utilized data from surveys of 2007 and 2012 of the National FINRISK Study from Finland (N = 13 922). The surveys consist of random cross sectional population samples from adults aged 25–74 who filled in a comprehensive health questionnaire including items on sleep and mental well-being and participated in a physical examination.

Nightmares were assessed with self-estimated frequency during the last month. Their association with items measuring sociodemographic factors, other sleep problems, mental health, life satisfaction, alcohol consumption, medication and physical health were investigated. For statistical analyses Pearson chi square, one-way ANOVA, multinomial logistic regression and factor analysis were used.

Results: Insomnia and depression symptoms as well as the use of hypnotics and antidepressants are major risk factors for frequent nightmares ($p < 0.001$). Strong associations also exist between nightmares and life dissatisfaction, self-estimated poor physical health, heavy use of alcohol and several measures of self-estimated anxiety and stress symptoms ($p < 0.001$). Nightmares are also more common among women than men and among elderly than young ($p < 0.001$).

In addition to these strong associations, there are various factors that have statistically significant associations with nightmares with modest effect sizes. These include sleep duration and chronotype that have previously been identified as nightmare risk factors.

Conclusion: A wide variety of factors related to psychological and physical well-being are associated with nightmare frequency. As such, there does not appear to be a single leading cause for nightmares but frequent nightmares are related to decrease in well-being that may be caused by many different factors.

Acknowledgements: The following non-profit organizations have funded the study: Jenny and Antti Wihuri Foundation; Finnish National Doctoral Programme of Psychology; Sigrid Juselius Foundation; Turku Institute for Advanced Studies.

http://dx.doi.org/10.1016/j.sleep.2015.02.095

Association between sleep characteristics and mild cognitive impairment: The HypnoLaus/Psycholaus study

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Introduction: Recent research has identified relationships between sleep duration and quality and increased risk of cognitive decline and dementia. The aim of this study was to explore the association between subjective sleep complaints and objective sleep structure measured by polysomnography (PSG), and cognitive deficits in a large unselected general population sample.

Materials and methods: Data from the participants of a population-based cohort study (HypnoLaus/Psycholaus, Lausanne, Switzerland) was collected. Assessments included socio-demographic, personal and treatment history. Sleep-related complaints and habits were investigated using the Pittsburgh Sleep Quality Index (PSQI) and the Epworth Sleepiness Scale (ESS). All subjects underwent a complete PSG at home. Diagnostic information of the cognitive function was collected using the Clinical Dementia Rating Scale (CDR). Participants with a global CDR score >0.5 were considered as having mild cognitive impairment (MCI), and compared with subjects without cognitive deficits (CDR score = 0, control group).

Results: Two hundred sixty subjects (mean age: 60.9 ± 12 years, 52% women) with MCI were identified. Compared with 301 controls without cognitive deficits (mean age: 61.1 ± 11.5 years, 54% women), after adjusting for age, gender and level of education, MCI subjects reported poorer sleep quality (PSQI score: 5.5 ± 0.2 vs. 4.9 ± 0.2) and higher ESS scores (5.2 ± 0.2 vs.4.7 ± 0.2), although the differences were not statistically significant ($p = 0.07$ and $p = 0.09$, respectively). Concerning PSG sleep variables, subjects with MCI spent less time in REM sleep (73.9 ± 1.9 vs.79.5 ± 1.7 min, $p = 0.037$ and 19 ± 0.4 vs. 20.2 ± 0.3%, $p = 0.038$) and had higher apnea/hypopnea index (AHI) in NREM sleep (21.2 ± 1.1 vs. 17.9 ± 1/h, $p = 0.046$). No significant differences were found between groups concerning other sleep related parameters (as the total sleep time, the sleep latency, the time spent in slow wave sleep, the arousal index, the AHI, the desaturation index, the periodic leg movement index), nor for the intake of drugs potentially influencing sleep (neuroleptics, antidepressants, hypnotics).

Conclusion: Compared with subjects without cognitive deficits, subjects with MCI showed a trend toward more sleep-related complaints and higher sleepiness scores. They had lower REM sleep duration and higher AHI in NREM sleep, but we did not find major differences concerning other objective sleep variables measured by PSG.

http://dx.doi.org/10.1016/j.sleep.2015.02.096

Effect of conditioned stimulus exposure during slow-wave sleep on fear memory extinction in humans

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Introduction: Repeated exposure to a neutral conditioned stimulus (CS) in the absence of a noxious unconditioned stimulus (US) elicits fear memory extinction. The aim of the present study was to investigate the effects of mild tone exposure (CS) during slow-wave sleep (SWS) on fear memory extinction in humans.

Materials and methods: We recruited 66 healthy volunteers and conducted this experiment in a sleep laboratory on two consecutive nights. The main purpose of the first night was to exclude participants who had primary sleep disorders. We also asked them to complete the Pittsburg Sleep Questionnaire Index (PSQI) to investigate sleep habits and assess the subjective sleep quality. On the experimental night, all of the healthy volunteers underwent an auditory fear conditioning paradigm, during which tones served as the CS, and a mild shock served as the unconditioned stimulus (US). Three groups were exposed to the CS for 3 or 10 min or an irrelevant tone (control stimulus, CtrS) for 10 min during SWS. The fourth group served as controls and was not subjected to any interventions during sleep. All of the subjects completed a memory test 4 h after SWS-rich sleep to evaluate the effect on fear extinction. Additionally, we conducted similar experiments using an independent group of subjects (n = 30) during the daytime to test whether the memory extinction effect was specific to the sleep condition. Totally, we recruited 96 healthy volunteers (44 male; age, 24.0 ± 2.4 years [mean ± SD]) and 83 participants included in the final analysis.

Results: A total of 96 healthy subjects completed the study but 13 subjects were excluded from the final analysis. No significant differences exist in age, body mass index (BMI), systolic blood pressure (SYS), diastolic blood pressure (DIA), and PSQI score between the six groups. All of the participants' PSQI scores were <5, indicating that they had regular sleep habits and good sleep quality. We compared polysomnography (PSG) data between 2 days to roughly determine the sleep architecture with and without CS+ presentation, and the sleep profile appeared to be unchanged. We then compared mean EEG power for tone-on and tone-off blocks and no significant differences observed for the following frequency bands, such as delta, theta, alpha, etc., which confirmed that the subjects remained asleep during tone stimulus presentation. Concerning the behavior results, participants who were re-exposed to the CS either during SWS (SWS-3 min CS group and SWS-10 min CS group) or wakefulness (Wake-10 min CS group) showed attenuated fear responses, whereas fear memory remained intact in the 10 min CtrS group, which suggested that this manipulation only affected fear memory which was reactivated by re-exposure to the CS during sleep.

Conclusion: Repeated CS exposure during SWS resulted in memory extinction without altering sleep profiles that may be comparable to exposure therapy applied during wakefulness. Moreover, our findings introduce an alternative approach that may safely reduce fear in patients and have potential clinical value.

Acknowledgements: This research was supported by the Natural Science Foundation of China (no. 81271489, 31230033, 81171251 and 81328010) and the National Basic Research Program of China (no. 2015CB856400). We are grateful to Fei Lei and Li-Na Du for assistance of PSG recording and Dr. Larry D. Sanford for revising our manuscript.

http://dx.doi.org/10.1016/j.sleep.2015.02.097

Partial directed coherence and memory impairments in OSA participants in a population based study (EPISONO) from Sao Paulo, Brazil

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Introduction: OSA is a common sleep disorder with neurocognitive impairments. The pathophysiological mechanisms underlying the side effects of OSA in brain activity are not completely understood. We aim to verify the association between apnea–hypopnea-index (AHI), PDC (partial directed coherence) and short/long memory evaluations in a population based sample from Brazil.

Materials and methods: The EEG recordings from 938 valid full night polysomnography (PSG) were analyzed from a total base of 1101 participants of EPISONO study. Socio-demographic variables (sex, age, schooling), BMI, apnea–hypopnea-index (AHI) were measured. In order to assess some cognitive (memory) impairments, 16 questions were asked about retrospective (RM) (e.g. "Did you lost things like newspaper or glasses frequently") and prospective memory (PM) ("Did you decide to do something but forget it afterwards?") related to day-life activities. Partial directed coherence (PDC) was calculated using EEG recording for each one of four PSG electrodes (C3-C4, O1-O2). PDC is a measure of brain connectivity (based on Granger causality) that shows only direct flows between channels in both ways. Forward and backward PDC levels were measured between Central and Occipital hemispheres. Linear regressions and a path analysis were calculated with RM and PM scores as dependent variables. PDC levels in each sleep stage (S1, S2, S3-4, REM) and AHI were independent variables on the model. Age, BMI and sex were used as covariates for all models.

Results: We found some negative correlations between PDC levels of connectivity and AHI levels in central and occipital hemispheres in S3-4 and REM stages. Adjusting for participants' BMI, sex and age, lower PDC levels were associated with higher AHI levels in central electrodes on S3-4 stage (AHI over 30, C3-A1 to C4-A2 = 0.53; backward = 0.51 vs. AHI lower than 30, C3-A1 to C4-A2 = 0.76, backward = 0.59). Among occipital electrodes in REM stage we also have a negative association (AHI over 40, C3-A1 to C4-A2 = 0.51; backward = 0.38 vs. AHI lower than 40, C3-A1 to C4-A2 = 0.60, backward = 0.71). Finally, a path analysis model presents a moderation effect of AHI on the association between PDC values and RM and PM scores, supporting the consideration that lower scores of RM and PM are more associated with lower PDC coherence in participants with higher AHI levels.