Results: In support of our hypothesis, playing relaxing words during non-rapid eye movement sleep extended the time spent in slow-wave sleep during the period, when words were presented. Furthermore, power in the slow-wave activity band was increased several seconds after the cue for relaxing compared with control words. The increased sleep depth by means of relaxing words was accompanied by a reduced interhemispheric asymmetry of SWA and slow-wave density in the during-cueing period. The changes observed in objective sleep translated to the subjective level with an increase in subjective sleep quality and alertness ratings.
Conclusion: The present study showed that the semantic meaning of words presented during NREM sleep is capable of affecting sleep physiology, SWS maintenance and the subjective evaluation of sleep quality. Our results support the notion that the activation of mental concepts during sleep can influence sleep depth and provide a basis for interventions using targeted activations to promote sleep depth and sleep quality to foster well-being and health.
Support (if any):

036

THE EFFECT OF EXERCISE ON SLEEP ARCHITECTURE AND MEMORY CONSOLIDATION DURING A DAYTIME NAP

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Introduction: Slow wave sleep (SWS) is thought to especially benefit declarative memory (i.e., memory for facts and events). As such, recent studies have used various methods to experimentally increase the amount of slow wave sleep that participants obtain, with the goal of assessing how SWS affects declarative memory consolidation. Studies dating back decades have reported that exercising before sleep may increase time spent in SWS. Thus, the aim of the current project was to determine whether exercising after learning verbal information enhances slow wave sleep during a subsequent nap and/or enhances memory for verbal information.
Methods: Participants who exercised regularly were recruited to attend two 2.5hr laboratory sessions. During each session, they trained on a paired associates learning task and then completed either a 20min cardiovascular exercise routine or a 20min stretching routine. Following a 1hr nap opportunity, participants were tested on their memory. PSG was recorded during the nap, and scored following AASM criteria. Participants were excluded from analysis if they failed to sleep for at least 10 min. Following exclusions, n=30 participants were included in analysis.
Results: Contrary to our hypotheses, there was no significant difference between the exercise and stretching conditions for minutes spent in slow wave sleep (p=.16), % time spent in slow wave sleep (p=.22), or raw improvement in paired associated performance (p=.23). The amount of SWS obtained during the nap did not correlate with performance in either condition (SWS min vs. memory in exercise condition: r28=.10, p=.60; sleep condition: r28=-.06, p=.74). Exercise did not affect time spent in any other sleep stage, nor did it affect total sleep time.
Conclusion: Contrary to our hypotheses and the results of prior research, we were unable to detect a significant effect of exercise on slow wave sleep. Also contrary to our hypotheses, exercise did not affect memory retention across the nap interval. These null results could indicate that there is no effect of exercise on nap sleep and/or associated memory retention. However, it could also be that we lacked sufficient power to detect effects that were smaller than expected.
Support (if any):

037

SUBJECTIVE SLEEP AND OBJECTIVE COGNITION IN MIDDLE-AGED AND OLDER ADULTS: DOES SEX MATTER?

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Introduction: Worse sleep has been linked to cognitive dysfunction in aging populations. There are known sex differences in the prevalence and presentation of both sleep disturbance and cognitive impairment, but research investigating sex differences in the associations between sleep and objective cognition is limited and inconclusive. We examined sex as a moderator of associations between self-reported sleep and objective cognitive performance in middle-aged/older adults.
Methods: Sixty-four adults aged 50+ (Mage= 63.8, SD=7.7; 33 men/31 women) who were cognitively healthy (no mild cognitive impairment, dementia or neurological disorders) completed an online survey (via Qualtrics) measuring self-reported sleep (Pittsburgh Sleep Quality Index; PSQI). Participants completed online cognitive tasks (via Inquisit) measuring inhibition (Stroop task; interference reaction time scores), attentional orienting (Posner Endogenous Cueing Task; reaction time difference between invalidly cued and validly cued trials), and working memory (Sternberg task; proportion correct). Multiple regressions examined whether PSQI subscores (sleep quality, sleep duration, sleep efficiency) were independently associated with or interacted with sex in their associations with cognition, controlling for age and education.
Results: Sex interacted with sleep quality in the association with endogenous attentional orienting (p=.01, R-squared=.10). Specifically, worse sleep quality was associated with worse attentional orienting in women (B=22.73, SE=9.53, p=.02) but not men (p=.24). Sex interacted with PSQI-sleep duration (p=.03, R-squared=.08) and PSQI-sleep efficiency (p=.03, R-squared=.08) in the association with inhibition performance. Specifically, worse sleep duration (B=235.28, SE=77.51, p=.004) and sleep efficiency (B=211.73, SE=68.70, p=.003) were associated with worse interference scores in men but not women (ps>.05). No variables were associated with working memory.
Conclusion: In middle-aged and older adults, sex moderates associations between self-reported sleep and objective cognition, depending on the sleep parameter and cognitive ability assessed. Findings suggest that women are more vulnerable to the effects of poor sleep quality on spatial attention, whereas men are more vulnerable to the effects of shorter sleep duration and worse overall sleep fragmentation on ability to inhibit task-irrelevant stimuli. Future studies should investigate sex-specific associations between sleep and cognition over time in order to better understand the prospective trajectories of these processes during aging.
Support (if any):

038

SLEEP AND HIPPOCAMPAL FUNCTION DURING AN ASSOCIATIVE MEMORY TASK ARE INFLUENCED BY SURGICAL MENOPAUSE AT MIDLIFE

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Introduction: 17β-estradiol loss is related to Alzheimer's disease (AD) risk factors, including disordered sleep and associative memory decrements. Women have higher risk for AD than men, and those with midlife 17β-estradiol loss due to surgical menopause, including bilateral salpingo-oophorectomy (BSO) before age 48, have even higher risk. We wondered whether sleep and associative memory in women with BSO (mean age 44–46) would be comparable to those with spontaneous/natural menopause (SM; mean age 57), and whether 17β-estradiol-based hormone therapy (ET) might mitigate these effects.
Methods: We assessed sleep using the average of three nights of portable polysomnography (Temec) in women with BSO either taking ET (BSO+ET; n=16), or not (BSO; n=18), and in older spontaneously menopausal women (SM; n=14). Using EEG (Fp1-Fp2), we obtained sleep staging automatically (Neurobit Technologies). Participants also completed a face-name associative memory task during functional magnetic resonance imaging. Recognition accuracy and brain activation during encoding were measured.
Results: BSO exhibited reduced sleep efficiency compared to BSO+ET. For BSO, there was no relationship between percent of total sleep time in N3 and hippocampal activation during associative encoding, even though percent of total sleep time in N3 was negatively associated with hippocampal activation during associative encoding in BSO+ET. For all groups, including BSO, lower latency to consolidated N3 correlated with better associative memory accuracy. There were no group differences in associative memory accuracy. In contrast to BSO, SM showed significantly longer latency to consolidated N3 than BSO+ET.
Conclusion: Younger women with BSO have comparable sleep to older women in SM. In younger women with BSO, ET improves sleep efficiency. Further, while associative memory may be disrupted by increased latency to consolidated N3 in all women, BSO and BSO+ET showed similar associative memory accuracy and latency to consolidated N3. Only BSO+ET exhibited a significant correlation between hippocampal activity during associative encoding and time spent in N3, indicating that ET may support the negative relationship between N3 and hippocampal function. Overall, ET in younger women with BSO potentially ameliorates poor sleep and associative memory decrements.
Support (if any): Alzheimer's Association/Brain Canada Foundation: AARF-17-504715; Wilfred and Joyce Posluns Chair in Women's Brain Health and Aging

039

SLEEP PREFERENTIALLY SUPPORTS PROBLEM-SOLVING SKILLS VIA GREATER FUNCTIONAL CONNECTIVITY BETWEEN THE CAUDATE AND CEREBRAL CORTEX

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Introduction: Sleep consolidates memory, including newly acquired procedural skills. One putative systems-level mechanism for this function of sleep is via sleep-dependent strengthening of functional connectivity between the putamen and the cortico-hippocampal-striatal-cerebellar network, which supports procedural motor skills. For procedural motor skills that also require problem solving and rule-learning, sleep preferentially benefits the cognitively complex aspects over the motor skills required to execute the solution itself. The caudate is implicated in higher-order cognitive components of skill learning, which include error monitoring and automizing new information. In the current study, we investigated how sleep alters functional connectivity in higher-order learning networks that support problem solving and rule learning-related procedural skills.
Methods: Participants (n = 38) were trained on a procedural skills task; the Tower of Hanoi (ToH), that requires the acquisition of a novel cognitive strategy (e.g., recursive logic), while undergoing functional magnetic resonance imaging (fMRI). After either a full night of sleep (n=19) or a full day of wakefulness (n=19), participants were retested on the same task in the fMRI. Resting state activity was acquired before (R1) and after the training session (R2), and before the retest session (R3).
Results: Behavioral performance on the ToH improved following sleep compared to wake (reduced number of errors: t(38)=2.92, p=0.006, d=1.24). Regions associated with higher-order learning and cognitive complexity (i.e., the caudate) and regions typically implicated in sequence learning (i.e., the putamen, hippocampus, cerebellum) were selected as regions of interest (ROI). Increased functional connectivity across the retention interval (R3-R2) was observed in the sleep vs. wake condition between the caudate and the motor cortex (t(36)=3.32, p=0.042, FWE). By contrast, changes in functional connectivity were not observed between the putamen and other ROIs.
Conclusion: These results suggest that sleep supports improved consolidation of motor skills that involve the acquisition of a novel cognitive strategy. Sleep enhanced functional connectivity in brain areas associated with higher-order cognitive skills (i.e., the caudate), but not regions typically associated with motor skills (i.e., the putamen) that are required to execute the solution to the cognitive procedural skill.
Support (if any): Natural Science and Engineering Research Council of Canada

040

SLEEP DEPRIVATION DISRUPTS BINDING OF INFORMATION WITH ITS CONTEXT

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Introduction: Effective memory often requires recall of both specific information and the context in which the information was encountered. Total sleep deprivation (TSD) is known to impair memory for information items (e.g., words on a studied list), but the impact of TSD on binding, or associative linking, between items and context is not clear.
Methods: N=68 healthy adults (ages 22–40; 35 females) completed a 4-day (3-night) in-laboratory study. After a baseline night with 10h nighttime sleep opportunity, participants were randomly assigned to either 38h TSD (n=38) or a well-rested control (WRC) condition with 10h nighttime sleep opportunity (n=30). Both study arms concluded with a 10h nighttime recovery sleep opportunity. Participants completed a standardized recognition memory task at 14:50 on day 2 (baseline, session 1) and again 24h later (session 2). The memory task consisted of a study phase in which words with negative, positive, and neutral affective valence were spoken by a female or male speaker (50% each); followed immediately by a test phase, in which subjects made recognition judgments for the items (words) and their source (speaker).
Results: Mixed-effects ANOVA revealed significant interactions of session by condition for both word and speaker recognition ($p<0.001$). When sleep-deprived, TSD participants recognized fewer words and, for words that were correctly recognized, they were worse at recognizing the speaker, compared to baseline and to the WRC group. Negatively valenced words were associated with poorer word recognition ($p<0.001$), and in session 1 poorer source recognition ($p = 0.032$), but these valence effects did not interact with sleep deprivation.
Conclusion: TSD impaired memory for items, but more importantly, also impaired memory for the context in which items were presented,