Special Abstract
Supplement Two
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The effect of sleep loss on adolescent fluid intelligence performance: A dose-response study**

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Introduction: Sleep loss is prevalent among adolescents, with many adolescents worldwide failing to obtain an optimal amount of sleep each night. Insufficient sleep results in considerable impairment to numerous domains of adolescent functioning, including neurocognitive performance, learning capacity, and academic outcomes. While poor sleep has also been associated with diminished fluid intelligence and executive functioning, which are important abilities for successful academic performance, few studies have examined this in adolescents.

Methods: To address these limitations in the current literature, this study investigated the effect of sleep loss on adolescent fluid intelligence performance by employing an experimental, dose-response paradigm under controlled laboratory conditions. Thirty-four adolescents aged 15 to 18 years completed two objective tasks of fluid intelligence following two baseline nights (10 hours time in bed (TIB)) and again after either one night of total sleep deprivation (TSD) or five nights of chronic sleep restriction (5 hours or 7.5 hours TIB).

Results: Overall, decreased sleep opportunity resulted in significant impairments to fluid intelligence performance. The pattern of results reflected a dose-dependent relationship, whereby greater sleep loss was associated with greater fluid intelligence performance deficits.

Conclusions: Given the importance of learning and academic outcomes during this developmental phase, the findings have significant applied ramifications for individuals and health and educational bodies, as well as highlighting the role of sleep for optimal cognitive functioning and academic performance.

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The effects of sleep loss on risk-taking behaviour in adolescents: does personality moderate this effect?

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Introduction: Sleep loss is prevalent among adolescents and is argued to lead to increased risk-taking behaviour (RTB). However, research in this area is limited and predominantly cross-sectional. The current study aims to experimentally manipulate sleep duration to examine how sleep restriction (SR) affects RTB in adolescents, and whether this effect is moderated by the personality traits of extraversion and neuroticism.

Methods: Twenty-two healthy adolescents aged 15 to 17 took part in the study utilising a laboratory-based SR protocol. Participants had two nights of baseline sleep (10h), five nights of SR (5h/7.5h), and two nights of recovery sleep (10h). Risk-taking was measured using the Balloon Analogue Risk Task (BART) and the Iowa Gambling Task (IGT).

Results: Results indicated no increase in risk-taking on the BART following either SR condition. Risk-taking on the IGT significantly decreased following SR, however, the magnitude of this decrease was less for adolescents in the 5h than 7.5h condition. This indicates that participants took significantly more risks when restricted to 5h sleep than they did when restricted to 7.5h sleep per night. Extraversion and neuroticism did not significantly moderate the relationship between sleep duration and RTB for either measure.

Conclusions: The contradictory findings between the BART and IGT may be due to differences in the cognitive load associated with the task. While the BART involves simple decision-making, the IGT requires more complex cost-benefit analysis on which to base risk-taking decisions. This highlights the potential importance of cognitive load when examining the relationship between sleep loss and RTB.
A quantitative investigation of factors associated with undiagnosed and diagnosed sleep apnoea in a male population cohort

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Objectives: To examine various characteristics of diagnosed and undiagnosed obstructive sleep apnoea (OSA) and to identify factors that may contribute to high prevalence of under-diagnosis.

Methods: The Men Androgen Inflammation Lifestyle Environment and Stress (MAILES) study is a longitudinal, biomedical cohort study of randomly selected Australian men. Questionnaires and clinic assessments collected information on demographics, OSA symptoms, comorbidities and mastery. Sleep studies were conducted in 2011 through 8-channel in-home polysomnography (PSG). Epworth Sleepiness Scale (ESS) data were collected after PSG; ESS measured daytime sleepiness (ESS ≥ 11 indicates a sleep disorder).

Participants: In the third stage of the MAILES study a random sample (n = 857) undertook an in-home unattended PSG testing with a total of n = 837 valid results.

Results: The prevalence of undiagnosed OSA among the study population (n = 837) was high (n = 443, 52.9%). Results for excessive daytime sleepiness were as follows: men without OSA – 16%, men with undiagnosed OSA – 17%, men with diagnosed OSA – 42%.

1. Compared to men without OSA, undiagnosed OSA was not significantly associated with excessive daytime sleepiness (OR = 1.29, 95%CI [0.74-2.22]). However, it was significantly associated with loud snoring/choking, comorbidities, depression, obesity, limited health literacy.

2. Compared to men without OSA, diagnosed OSA was significantly associated with loud snoring/choking, low vitality, treated comorbidities, obesity, higher mastery scores.

3. Compared to undiagnosed OSA, diagnosed OSA was significantly associated with loud snoring/choking, low vitality, treated comorbidity, obesity, adequate health literacy.

Conclusion: OSA may present in atypical fashion, with no daytime sleepiness but tiredness/fatigue, excessive snoring/choking and various clinical features. Increased patient and clinician awareness regarding OSA symptomatology is of high importance. In our study, patients with undiagnosed OSA had depression, untreated comorbidities and low health literacy. Whereas men with diagnosed OSA were more likely to have clinical features of OSA, which may positively affect the decision to seek a diagnosis.

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Evidence for psychological interventions in children with sleep disordered breathing

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Children with reduced sleep quality due to sleep disordered breathing have a lower self-reported quality of life, increased problematic behaviours and reduced neurocognitive function. These children, when identified, tend to be treated via surgical procedures such as tonsillectomy, adenoidectomy or adenotonsillectomy, are prescribed continuous positive airway pressure while sleeping, or undergo orthodontic procedures. All of these treatments are medical but symptoms are predominantly psychological. Furthermore, the benefit of these medical interventions are questionable with mixed evidence for treatment efficacy. Additionally, it is unclear whether some level of sleep disordered breathing in childhood might be a normal part of growth and development. A different approach is needed.

Some work has been done looking at the potential for psychological intervention in sleep disordered breathing in childhood with so much of the importance placed on the psychological consequences of the condition. Models that include a role for psychological resilience and beliefs about sleep as mediators of the impact of sleep quality on important daytime functional outcomes have been validated. Resilience has been shown to be an important and under-recognised factor in determining the negative impacts of sleep problems in children. This relationship suggests that, for some children with disordered sleep, resilience training and sleep education could be effective strategies to enhance cognitive function, behaviour and quality of life while avoiding invasive and costly medical procedures.
Introduction: Shiftworkers have impaired performance when driving at night, however little is known about the impact of multiple nightshifts on driving performance and how driving at night is influenced by eating.

Methods: This study aims to explore the effects of these factors on simulated driving performance across 4-simulated nightshifts. Healthy non-shiftworking males aged 18-35 (n = 10) were allocated to an eating at night (n = 5) or no eating at night (n = 5) condition and, during the simulated nightshifts, performed 40-minute simulated drives and subjective sleepiness scales at 1730h, 2030h and 0300h. Participants in the eating at night condition ate a large meal during the nightshift.

Results: Mixed models analyses and a generalised linear equation revealed novel findings in regards to eating and performance, with significantly more driving impairments in the eating condition at 0300h. As hypothesised, participants, across both conditions, performed significantly worse and were significantly more sleepy at 0300h than at 1730h and 2030h. Contrary to hypotheses, there was no cumulative decrease across nightshifts and this may reflect practice effects and adaption to shiftwork.

Conclusions: From these results, shiftworkers should take care when driving during the night, and should limit big meals at night if they are planning to drive. Future research should explore multiple nightshifts in shiftworker populations and should explore post-prandial effects on on-road driving and cognitive tasks.

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The role of attention in sleep dependent emotional memory consolidation

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Introduction: Extant literature suggests alpha-band oscillatory activity is involved in modulations of perception and attention, and that attention modulates emotional memory processes at encoding. However, few studies have investigated the oscillatory correlates of attention at encoding of emotional memory, particularly in sleep paradigms where sleep is thought to play an active role in memory consolidation. The current study aimed to address this gap by investigating whether alpha oscillatory activity at encoding modulates sleep-dependent emotional memory consolidation.

Methods: 14 (5 male) adults, aged 18 - 41 years (mean age 27.3 ± 2.2 years), participated in a within-subjects experimental design consisting of sleep and wake conditions. Participants underwent a learning task using emotionally valenced (positive, neutral, negative) stimuli, followed by an immediate and delayed recall session where participants distinguished learned target stimuli from distractor stimuli. Polysomnography was used to quantify sleep, while electroencephalography was used to measure alpha oscillatory activity to index attentional state.

Results: A generalised linear mixed effects model was used to determine the effects of sleep, alpha and emotion on memory performance, while modelling variations in participants’ responses to the emotional stimuli. It was found that memory performance was greater after wake compared to sleep. Further, increased alpha synchronisation at encoding modulated memory performance after wake, but not sleep.

Conclusions: These findings provide support for existing oscillatory accounts of attention effects on memory during typical periods of wake, but do not support models of improved memory consolidation over sleep, or an influence of attention at encoding for sleep-related memory.

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Caffeine intake and sleep quality in South Australian children**

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Introduction: Australia has no current guidelines for caffeine intake. The 2007 National Child Nutrition and Physical Activity Survey (using 24-hr recall) revealed that, on average, children 9 - 13y consumed 19.2mg caffeine/day. The potential impact of caffeine consumption on sleep in children has not been systematically investigated. With a newly developed questionnaire, this study explored caffeine consumption and sleep in school-aged children.

Method: Children aged 8 - 12y (n = 325, average age = 10.1 ± 1.3y, 48% male) were recruited through South Australian schools and the community. Demographics, caffeine intake (a new Food Frequency Questionnaire for caffeine), and daytime sleepiness (Paediatric Daytime Sleepiness Scale) were obtained via child and parent report.

Results: Daily caffeine intake ranged between 0 – 73.7mg (9.9 ± 14.6mg). Intake was not different by gender (p = 0.45). The proportion of children consuming caffeine in each age range was: 89% for 8 year olds (7.9 ± 11.9mg), 82% for 9 year olds (6.8 ± 9.7mg), 86% for 10 year olds (8.5 ± 13.0mg), 90% for 11 year olds (9.4 ± 13.6mg) and 92% for 12 year olds (15.9 ± 19.6mg). One quarter (n = 71) of the sample consumed between 15.0mg (~100ml of iced coffee) and 73.7mg (~one latte) of caffeine/day. Daily caffeine consumption had a significant relationship with age (r = 0.20, p = 0.001) and daytime sleepiness (r = 0.13, p = 0.03). Significant relationships were also found with sleep routine (r = 0.17, p = 0.005), morning tiredness (r = 0.21, p = 0.001), night arousals (r = 0.17, p = 0.005) and restless sleep (r = 0.15, p = 0.01).

Conclusion: Results suggest that the majority of children aged 8 – 12y consume caffeine. Findings indicate that increasing caffeine intake in children may be associated with elevated daytime sleepiness, morning tiredness, restless sleep and night arousals, and disrupted sleep routine.

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What is the impact of social support on the relationship between child sleep disturbance and postnatal depression?

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Aims: To determine the extent to which the social support that caregivers receive affects the relationship between Postnatal Depression (PND) and child sleep problems.

Methods: The sample consisted of 108 participants who were caregivers of children between 6 - 18 months of age. Participants completed an online survey comprised of the Edinburgh Postnatal Depression Scale, The Social Provisions Scale and The Brief Infant Sleep Questionnaire. Pearson’s product-moment correlations and moderation analyses were utilised to explore relationships and moderation effects.

Results: Results showed that parents of children who were sleep disturbed had higher levels of PND and less social support. A significant negative relationship between social support and PND was found \( (r = -0.539, p = 0.000) \). Correlations between PND and nocturnal sleep \( (r = -0.231, p = 0.016) \) and nocturnal wakefulness \( (r = -0.228, p = 0.018) \) were significant. Social support was also significantly correlated with nocturnal sleep \( (r = 0.329, p = 0.001) \) and nocturnal wakefulness \( (r = 0.199, p = 0.039) \). No moderating effect of social support on the relationship between child sleep disturbance and PND was found for either sleep variables \( b = -0.014, 95\% \text{ CI} [-0.099, 0.071], t = -0.33, p = 0.745; b = 0.065, 95\% \text{ CI} [-0.267, 0.396], t = 0.39, p = 0.700 \).

Discussion: Parents with high social support have lower PND scores and their children present with less sleep problems. Although a significant moderating effect of social support on the child sleep and PND relationship was not found, the significant correlations between the three variables reveal that caution must be taken when concluding there is no moderating effect.
Pets in beds: towards an understanding of human-animal co-sleeping practices among dog owners

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Around half of all pet owners (namely of dogs and cats) share their bedroom or bed with their pets during the night. Although human-animal co-sleeping is not new, what we know about the practice of co-sleeping is limited to studies of interpersonal co-sleeping, especially human adults, or parent-child co-sleeping arrangements. This has led to an incomplete and anthropocentric understanding of co-sleeping. We attempt to rectify this by presenting the findings of three research studies. In study 1, we report the prevalence and implications of human-animal co-sleeping from a large online survey of sleep behaviour of Australians (n = 10128). In Study 2, we look at Australian dog owners (n = 1328) in order to explore which owners are most likely to co-sleep, how they co-sleep, and their decision-making processes. In Study 3, we look specifically at a sample of owners around the world that co-sleep with their dogs (n = 680), and determine what impact the practice of co-sleeping with dogs has on sleep quality and quantity. Overall, despite some negative repercussions of human-dog co-sleeping, owners appear to remain motivated to co-sleep, suggesting that there must be some benefits to continuing the practice. We propose that human-animal co-sleeping is a form of co-sleeping that deserves to be approached as an equally legitimate and significant form of co-sleeping. An understanding of human-animal co-sleeping has significant implications for human sleep, human-animal relations, and animal welfare, as well as clinical applications to human sleep and sleep hygiene. We argue that by approaching co-sleeping broadly as a social practice involving human relations with other human and non-human animals, we can fulfil a call for a greater understanding of the diverse manifestations and meanings of sleep.
The effect of sleep loss on working memory function in rested and sleep deprived patients with obstructive sleep apnoea

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Introduction: Obstructive sleep apnoea (OSA) is rising in prevalence and is linked with impaired performance on numerous cognitive domains including working memory (WM) function. WM is important for efficient goal directed information processing, learning and task performance. WM function is impaired by sleep loss compromised in healthy young subjects and may adversely affect safety during periods of increased sleep pressure (e.g. early morning). The effect of sleep loss on WM function in OSA patients is unclear. This study investigated WM function in OSA patients exposed to extended wakefulness and explored clinical subjective sleepiness and sleep study metrics as WM predictors.

Methods: 58 patients with OSA underwent a baseline laboratory polysomnography (PSG) followed by 28 hours of extended wakefulness (6:00am Saturday – 10:00am Sunday). WM was measured 2 hourly over the 28 hours using visual 2- and 3-back tasks with completion time (CT) and accuracy (Acc) as main outcomes. These were averaged over day (2:00pm, 4:00pm, 6:00pm) and night (12:00am, 2:00am, 5:00am). Correlations, regression and mixed models were performed to explore PSG variables (sleep indices, apnoea-hypopnoea index and oxygen indices) and subjective sleepiness (ESS) as correlates and predictors of WM.

Results: There was a significant day to night decline in both N2 and N3-back CT and Acc performance (all p < 0.01). The effect size of extended wakefulness on WM performance decline was very large ranging from 1.4 - 1.9 for Acc and 1.1 - 1.2 for CT. ESS and O2 desaturation time < 90% were significant predictors of day and night N2-back CT R2 = 0.25, p < 0.01, while Acc was predicted by ESS and Body Mass Index (BMI) R2 = 0.25, p < 0.05). There were no significant predictors of N3-back performance, the absolute day to night change in WM performance. Mixed models confirmed that sleepy patient (ESS ≥ 10) had significantly impaired WM function compared with non-sleepy (ESS < 10) patients during both day and night time test, but this difference was absent for the N3-back test.

Conclusions: Sleep loss has a significant and large negative effect on WM function in OSA. Subjective sleepiness, hypoxemia and BMI appear to be best clinical predictors of N2-back, but as the task complexity is increased, these factors were no longer predictive. The impact of WM impairment on real life productivity and safety warrants further research.