The effects of sleep restriction and sleep deprivation in producing false memories

Alex Chatburn,a,b,⇑ Mark J. Kohler,a,b Jessica D. Payne,c Sean P.A. Drummond,d,e

a Cognitive Neuroscience Laboratory, University of South Australia, Adelaide, Australia
b Centre for Sleep Research, University of South Australia, Adelaide, Australia
c Sleep, Stress and Memory Laboratory, Department of Psychology, University of Notre Dame, USA
d School of Psychological Sciences and Monash Institute of Cognitive and Clinical Neurosciences, Monash University, Australia
e Department of Psychiatry, University of California, San Diego, CA, USA

ABSTRACT

False memory has been claimed to be the result of an associative process of generalisation, as well as to be representative of memory errors. These can occur at any stage of memory encoding, consolidation, or retrieval, albeit through varied mechanisms. The aim of this paper is to experimentally determine: (i) if cognitive dysfunction brought about by sleep loss at the time of stimulus encoding can influence false memory production; and (ii) whether this relationship holds across sensory modalities. Subjects undertook both the Deese-Roedigger-McDermott (DRM) false memory task and a visual task designed to produce false memories. Performance was measured while subjects were well-rested (9h Time in Bed or TIB), and then again when subjects were either sleep restricted (4h TIB for 4 nights) or sleep deprived (30h total SD). Results indicate (1) that partial and total sleep loss produced equivalent effects in terms of false and veridical verbal memory, (2) that subjects performed worse after sleep loss (regardless of whether this was partial or total sleep loss) on cued recognition-based false and veridical verbal memory tasks, and that sleep loss interfered with subjects' ability to recall veridical, but not false memories under free recall conditions, and (3) that there were no effects of sleep loss on a visual false memory task. This is argued to represent the dysfunction and slow repair of an online verbal associative process in the brain following inadequate sleep.

1. Introduction

Sleep is vital for optimal functioning during wakefulness, and sleep loss has wide ranging effects on overall neurocognitive performance (Ratcliff & Van Dongen, 2009). Numerous studies have shown that sleep loss has a deleterious impact on basic elements of cognitive functioning, such as attentional processing (Van Dongen, Maislin, Mullington, & Dinges, 2003), response inhibition (Drummond, Paulus, & Tapert, 2006) and working memory (Drummond, Anderson, Straus, Vogel, & Perez, 2012; Turner, Drummond, Salamat, & Brown, 2007); as well as elements of higher cognitive functioning, such as rule based learning (Whitney, Hinson, Jackson, & Van Dongen, 2014), memory encoding (Drummond et al., 2000; Mander, Santhanam, Saletin, & Walker, 2011; Saletin & Walker, 2012; Yoo, Hu, Gujar, Jolesz, & Walker, 2007) and the ability to plan and implement intentions (Diekelmann, Wilhelm, Wagner, & Born, 2013a, 2013b). Sleep has also recently been suggested to play a role in associative memory formation (Lewis & Durrant, 2011; Payne, 2011; Stickgold & Walker, 2013); for instance, in the selective learning of relevant (as opposed to irrelevant) information (van Dongen, Thie len, Takahama, Barth, & Fernández, 2012; Wilhelm et al., 2011), rules governing sets of stimuli (Durrant, Taylor, Cairney, & Lewis, 2011) and the generalisation of specific learning for general application (Lau, Alger, & Fishbein, 2011). The impact of sleep loss on these latter functions is, however, relatively unknown.

It must also be acknowledged that the impacts of sleep on cognitive functioning are not always obvious (Killgore, 2010). For instance, studies have found differential effects of sleep loss on different components of both working memory (Drummond et al., 2012; Turner et al., 2007) and executive functioning (Tucker, Whitney, Belenky, Hinson, & Van Dongen, 2010). This is likely due to the fact that the cognitive systems of the brain are comprised of interacting subcomponents, and rarely does a cognitive
task rely on only a single brain region. Sleep loss may similarly influence memory in a non-uniform fashion. For instance, sleep loss reduces the amount of information remembered by individuals both by negatively impacting the capacity for encoding new memories (Mander et al., 2011; Payne & Kensinger, 2010; Tononi & Cirelli, 2014), as well as through the loss of sleep-based benefits in terms of memory consolidation (Diekelmann & Born, 2010a; Rasch & Born, 2013). This pattern is likely to hold for associative memory as well, given that associative linkages between individual memories have been found to occur both during wakeful encoding (Staresina & Davachi, 2008, 2009, 2010) and across a range of processes during sleep (Chatburn, Lushington, & Kohler, 2014; Ellenbogen, Hu, Payne, Titone, & Walker, 2007; Payne et al., 2009).

False memory; memory for events or items which were never actually experienced by the individual, serves as an example of the effects of sleep loss on complex associative memory processing. False memories can occur across all stages of memory processing, albeit from differing mechanisms and may, depending on the circumstances, represent both memory errors (Read, 1996; Reyna & Lloyd, 1997; Smith & Hunt, 1998) as well as the natural associative processes of human memory (Stickgold & Walker, 2013). That is, false memories can arise from: (1) spreading activation in neural networks and self-referential encoding; (2) competing imagery during encoding; (3) memory reactivation and generalisation during consolidation; or (4) monitoring errors during retrieval (Straube, 2012). Sleep and sleep loss have also been found to differentially impact false memory generation. Sleep (in comparison to wakefulness) has been found to reduce false memories when using recognition-based retrieval procedures (Fenn, Gallo, Margoliash, Roediger, & Nushbaum, 2009). However, sleep (relative to sleep deprivation) has also been found to simultaneously increase both correct recall and false memory using recognition procedures (Darsaud et al., 2011). Finally, sleep (relative to wakefulness) has been found to simultaneously increase both correct recall and false memory when free recall procedures are used, although this may preferentially affect those with lower memory performance (Diekelmann, Born, & Wagner, 2010; Payne et al., 2009). Other than consolidation effects, sleep deprivation at memory retrieval has been linked with increased endorsement of false memories (Diekelmann, Landolt, Lahl, Born, & Wagner, 2008; Diekelmann et al., 2010), as has sleep deprivation at encoding (Frenda, Patihis, Lofrus, Lewis, & Fenn, 2014). Overall, the behavioural evidence is broadly in support of the idea of false memories arising from multiple mechanisms during the different stages of memory processing, with both sleep and sleep loss playing a role in at least some of these.

Further work is required before it can be determined if false memories in regards to sleep are predominantly memory errors, a product of associative mechanisms, or both. Sleep deprivation and memory studies to date have typically used either total (TSD) or partial sleep deprivation (PSD), but not compared the effects of each. The impact of different doses of sleep and sleep loss in producing false memory specifically has also not been thoroughly studied, and all studies to date have used either wake or total sleep deprivation paradigms to study the phenomenon. Given that partial sleep loss is likely to be more common than total sleep deprivation in the general population and organisational settings (Durmer & Dinges, 2005), an understanding of the genesis of false memory under well-rested and also under conditions of total (TSD) and partial sleep deprivation (PSD) is important. In this study, new information must be learned and utilised immediately during sleep loss, brought about by either PSD (4h TIB for 4 nights) or PSD (30h total SD), without the benefit of a sleep-based consolidation period. It should be noted that the sleep literature has so far taken a singular approach to studying false memory; the vast majority of studies have used the DRM false memory task (Roediger & McDermott, 1995). While this is a valid and reliable method of eliciting false memories, false memories can occur in nonverbal domains as well (Frenda et al., 2014). In all, there are still several issues that need to be addressed in the false memory, sleep and memory, and sleep research literatures before a comprehensive understanding of false memory in the context of sleep is available.

Here, we address some of these issues by assessing the impact of both TSD and the purportedly equivalent period of PSD (i.e., sleep loss (SL) of either 30h time awake; and 4h TIB for four nights; Van Dongen et al., 2003), in comparison to a well-rested baseline (WR), on false memory generation in both the verbal and visual domains. This allows us to test: whether false memory generation is differentially impacted by PSD and TSD; whether different modalities of false memory are influenced in the same manner as one another; and whether different types of memory (free recall and recognition) are differentially effected by PSD and TSD. We hypothesised that: (i) PSD and TSD will not significantly differ in their effects on veridical and false memory; (ii) sleep loss (PSD and TSD) will increase the rates of false memory production; and that (iii) sleep loss will increase false memory in both verbal and visual modalities.

2. Methods

2.1. Participants

44 healthy, normally functioning individuals (25F, 19 M; Mage = 24.9 ± 5.29y) gave informed consent and participated in the study. Subjects were screened for sleep disorders, drug use, axis I psychiatric conditions and medical disorders through a combination of structured interview and laboratory testing. To be included in the study, subjects had to report maintaining regular sleep-wake schedules (7–9h TIB, with bed times of 2000-0000 and wake times of 0600-0800).

2.2. Procedure

Subjects maintained their normal sleep schedules for one week prior to participation. Adherence to at-home schedules was verified with wrist actigraphy, voicemail call-ins and sleep diaries. They then undertook both a well-rested condition (9h TIB for six nights; 4 at home followed by 2 in the laboratory) and either a total sleep deprivation (30h total) or sleep restriction (4h TIB for four nights) condition. Participation in the partial or total sleep loss conditions was randomised, and order of condition (rested or deprived) was counterbalanced across subjects. The well-rested sleep schedule was based on each subject’s habitual sleep schedule at home. If they did not report normally spending 9h in bed per night, sleep time was extended from their habitual schedule equally in the evening and morning to achieve a 9-h window. Similarly, the sleep restriction schedule was determined by shrinking time in bed equally in the evening and the morning. While in the laboratory, subjects were monitored with actigraphy throughout the day and night, and were monitored with polysomnography during sleep periods. Wakefulness during total sleep deprivation (TSD) and partial sleep deprivation (PSD) was guaranteed through staff interaction, and subjects were allowed to play games, watch television and browse the internet. Stimulant and alcohol consumption was prohibited 48h before entering the laboratory and during the lab stay. Test administration was scheduled at 5h post habitual wake time in the TSD condition and 7h post habitual wake time in the PSD and well-rested conditions. This variation was due to constraints imposed by other aspects of the study design. Given the relatively neutral circadian time represented by the mid-day
دریافت فوری
متن کامل مقاله
امکان دانلود نسخه تمام متن مقالات انگلیسی
امکان دانلود نسخه ترجمه شده مقالات
پذیرش سفارش ترجمه تخصصی
امکان جستجو در آرشیو جامعی از صدها موضوع و هزاران مقاله
امکان دانلود رایگان ۲ صفحه اول هر مقاله
امکان پرداخت اینترنتی با کلیه کارت های عضو شتاب
دانلود فوری مقاله پس از پرداخت آنلاین
پشتیبانی کامل خرید با بهره مندی از سیستم هوشمند رهگیری سفارشات