

Editorial

Can sleep patterns prior to negative emotional experiences predict intrusive memories?

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Research has attempted to determine the role of sleep in the processing of emotional experiences. The main research question has been whether sleep (compared to wake) decreases the affective response associated with the memory of aversive experiences. This has been studied by contrasting the effects of sleep versus wake in the immediate aftermath of such experiences, and further through examining whether any particular sleep variable, such as time spent in various sleep stages, affects this processing. Research on these topics has so far yielded highly mixed results [1–3].

There is, however, one aspect of emotional memory processing where research on sleep–wake contrasts has yielded more consistent findings. Namely, sleep seems to make the memories of negative events less likely to be spontaneously and involuntarily recalled (referred to here as *intrusive memories*). A common way to experimentally study this has been to utilize the so-called trauma film paradigm [4]. In this paradigm (as used in the studies described below) participants first view a film clip with highly aversive content. They are then provided with a diary in which they are asked to report all intrusive memories they have of the film during a certain time period following the viewing of it (typically a week). They are also asked to rate the degree of emotional distress associated with each intrusion. Four recent meta-analyses (utilizing slightly different inclusion criteria and analytic strategies) have shown a decrease in the number of intrusive memories after sleep [5–8]. See also [1, 9–11] for narrative reviews. Since the publication of these meta-analyses, there has been one additional study published on this topic, which showed an effect similar to the aggregate effect size of the meta-analyses [12]. Sleep does not seem to affect the self-reported distress associated with the intrusive memories [5–8]. Studies on which sleep stages are associated with intrusions have so far yielded mixed findings [1, 7], as in other research regarding sleep physiology and emotional memory processing [1, 3, 13]).

A study by Alkalame et al. [14], published in this issue, focused on the role of sleep prior to viewing the trauma film. They examined whether any sleep characteristics during the four nights before viewing the trauma film could predict subsequent

intrusions. They included 27 participants, divided into two different groups. The first group slept as usual throughout the experiment. The second group was subjected to a circadian misalignment manipulation. This entailed sleeping during their usual hours during the first two nights but then having their sleep period advanced by four hours (i.e. going to bed four hours earlier than their usual) during the third night, and then by an additional 4 hours during the fourth night. All participants then viewed the trauma film and kept an intrusion diary for the subsequent three days. Due to the low number of participants in each group, the groups were not directly contrasted. Instead, statistical analyses were correlational and analyzed the role of prior sleep features in predicting intrusions for the whole sample combined. Results revealed that the average percentage of total sleep time (TST) spent in rapid eye movement (REM) sleep, REM efficiency (minutes spent in REM sleep divided by the total duration of all REM episodes), and TST were associated with fewer intrusions. None of these variables were associated with intrusion-related distress.

The authors interpret these results as showing that sleep, and especially certain features of REM sleep, prior to a negative emotional experience serves a protective function by making the memories of the event less intrusive. The result regarding TST is in line with a study by Short et al. [15] showing that a higher degree of insomnia symptoms prior to viewing a trauma film increased subsequent post-traumatic stress disorder (PTSD)-like symptoms associated with the film. This is in line with work showing that sleep disturbances and insomnia prior to potentially traumatic events or otherwise negative life experiences are associated with an increased likelihood of being more adversely affected by them [16–18] (but see also van Liempt et al. [19] who found that nightmares, but not insomnia, prior to military deployment was predictive of having developed PTSD at post-deployment follow-up).

Results related to REM sleep have been more mixed in the previous literature. REM sleep has been found to both increase and decrease reactivity to emotional stimuli [1, 3]. Moreover, there is no consensus that REM sleep is a protective factor against having anxious responses to various stressors. A recent study for example showed that baseline REM sleep in college students was

positively correlated with increased test anxiety when exams were approaching [20].

There are several different theoretical accounts on which factors might mediate the association between sleep patterns and the development of intrusive memories. One such factor could be that intrusions stem from the memory not being properly consolidated [21]. Just as sleep after encoding seems to have positive effects on memory consolidation [22, 23], sleep deprivation also makes it more difficult to encode new memories [23]. Short sleep, or other forms of sleep disturbances prior to an aversive event, could thus result in impaired encoding of the experience, resulting in the memory of it becoming more intrusive.

Another potential explanation is that poor sleep impairs cognitive control abilities, which results in a general inability to keep unwanted thoughts and memories out of awareness [24]. Sleep disturbances seem to increase mind-wandering and the general occurrence of spontaneous thoughts [25]. For example, in people with PTSD, Dietch et al. [26] still found an increase in intrusion symptoms after nights of poor sleep years after the original traumatic experience. A recent study on day-to-day associations between sleep patterns and mind-wandering found that reduced time spent in REM and N2 sleep was associated with increased mind-wandering the next day [27]. This study interestingly, and perhaps somewhat contradictory to theoretical accounts, also found that increased TST was associated with more mind-wandering the next day (However, see also [28]).

A third contributing factor could be that certain sleep patterns lead to increased negative affect, which results in the aversive event being experienced as yet more negative, which could then in turn make the memory of it more intrusive. Recent meta-analytic work has, however, shown that sleep deprivation leads to a more negative mood, but not necessarily to negative stimuli being experienced as being more negative [3, 29].

As is often the case with sleep studies, it is difficult to say whether a certain sleep pattern is a causal factor or simply a marker of something causal, such as general negative affect or arousal. For example, a person with poor sleep might also have high levels of anxiety or arousal, which might make them react more negatively to emotional events, without sleep necessarily playing any causal role. Short et al. [15], for example, found that the association between insomnia symptoms prior to viewing the trauma film and subsequent intrusions was moderated by insomnia symptoms also being associated with greater distress reported immediately after viewing the film. Similarly, a certain sleep pattern during the night after viewing the film might be a marker of having been more negatively affected by the film rather than that sleep pattern after viewing it is causally involved in modulating the subsequent ability to adaptively cope with the experience. Poor sleep quality [30] and REM fragmentation [31] might also be markers of previous negative life events, which could make an individual more susceptible to having adverse reactions to novel aversive experiences.

In non-experimental work (i.e. in which sleep has not been manipulated in any way), a person with a certain sleep pattern prior to viewing a trauma film is also likely to show this pattern during the nights after viewing it. Future work with large enough sample sizes would, even if not experimental, be able to test whether the effects of sleep prior to the trauma analog are still present when controlling for the sleep that follows it, and vice-versa. In that way, it would be possible to determine whether sleep patterns prior to viewing the film are more important than sleep patterns after viewing it.

For a review of work on the effect of REM fragmentation on emotional processing, see [32], and see also [33] for a recent finding on the ability to experimentally reduce REM fragmentation. See also [8] for a meta-analysis of all experimental methods prior to, during, and after lab analog trauma exposure aimed at modulating intrusions.

In summary, Alkalame et al. [14] have provided an exciting contribution. Should these results be replicated in larger samples (especially considering that sleep and memory research has in general been severely underpowered [23]), and in experimental designs, it could provide us with a tool for assessing who would be at risk for developing PTSD. It would also provide another compelling argument for allowing individuals who are likely to experience trauma in their line of work to be provided sufficient time to properly rest in between work shifts.

Finally, we would like to end with two suggestions. First, virtually all studies reporting data on REM fragmentation have reported positive results. Therefore, there is a risk that null findings on this topic are underreported. We would thus suggest that researchers re-analyze relevant polysomnography data to examine whether associations between REM fragmentation and emotional processing can also be found in datasets for which this was not the main research question. Such an endeavor would be easy to carry out and would provide important knowledge. Second, a standardized definition of REM fragmentation should be agreed upon in order that different studies can be more easily compared.

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