Golden slumber?

The elusive role of sleep in emotional memory

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Publication date
2025

Chapter 6

General discussion

A common advice for people who struggle to fall asleep assumes it is mostly a matter of habits. Something that can be fixed with better bedtime routines, less caffeine, or a different mattress. But for many, the problem is not so much what we do before we go to sleep, but what we carry into it. The stress, the fear, the grief, the shame. Emotions that outlast the moments that caused them, shaping our thoughts and behaviours in limiting and unwanted ways. And it is actually sleep – a state where we seem to be *just gone* – that might change the emotional weight those moments may bring. In this dissertation, we explored the relationship between emotional memories and sleep, focusing on how those memories make us feel. Specifically, we investigated whether, and under what conditions, sleep can alter the emotional impact memories have on us, particularly those we might wish to forget. Conflicting findings from earlier research have led to competing hypotheses on the effect of sleep. With the aim to clarify these discrepancies, we used more naturalistic, emotionally engaging paradigms to better reflect real-world experiences. In this final chapter, we summarise the main results from the preceding chapters, reflect on what we have learned, what remains uncertain, and how future research might build on these insights to better understand the role of sleep in processing emotional memories and its relevance for preventive interventions.

Brief summary of the main findings

The goal of each chapter was to examine whether sleep alters the emotional intensity of distressing memories, thereby testing two competing hypotheses. The most prominent hypothesis in the field, known as the "sleep to forget and sleep to remember" hypothesis (Walker & van der Helm, 2009), suggests that sleep downregulates the affective tone of emotional memories. The alternative hypothesis, also referred to as the "emotional salience consolidation" account (Baran et al., 2012; Pace-Schott et al., 2011; Wagner et al., 2002; Werner et al., 2015), proposes that sleep preserves or even strengthens their emotional charge. Many earlier studies investigating the effect of sleep on emotional memory used negatively valenced images to create emotional memories and relied solely on self-report measures to assess changes in emotional tone. Moreover, they often lacked control stimuli (i.e., non-encoded stimuli), making it difficult to determine whether variations in emotional responses upon re-exposure to those images reflected memory-specific processing or more general shifts in emotional reactivity. Chapter 2 and 3 aimed to address these limitations by inducing more personally meaningful memories (i.e., own out-of-tune singing), incorporating both subjective and objective measures of emotional responses, and including control

stimuli to assess memory specificity. In Chapter 2, we found that, overall, physiological responses (i.e., facial blushing) to embarrassing stimuli were reduced after a single night of sleep, compared to a similar period of daytime wakefulness. However, this reduction was not specific to the previously experienced embarrassing episode but also occurred in response to the newly created embarrassing episode (i.e., the control stimulus). In contrast to previous findings (e.g., Baran et al., 2012; Chambers & Payne, 2014; Cox et al., 2018; Gilson et al., 2016; Gujar et al., 2011; Lara-Carrasco et al., 2009; Rosales-Lagarde et al., 2012; Sopp et al., 2017; van der Helm et al., 2011; Wagner et al., 2002; Wassing et al., 2019; Werner et al., 2021), the subjective ratings of emotional responses showed no effect of sleep. Hence, we found no clear evidence that sleep selectively alters the emotional tone of an embarrassing *memory*.

Given that one night of sleep may be insufficient for the processing of emotional memories to be completed, Chapter 3 extended this work by examining whether several nights of sleep would alter the emotional tone of an embarrassing memory one week later. To infer whether any observed changes were sleep-dependent, we manipulated the timing of sleep following the initial emotional experience, comparing the effects of sleeping soon upon exposure to an embarrassing stimulus with those of a longer period of wakefulness. This was based on previous research suggesting that particularly early sleep supports further emotional memory processing (e.g., Bolinger et al., 2019). Again, facial blushing decreased over time, but this reduction was not linked to memory reactivation or sleep timing. In contrast, subjective ratings of valence became generally more negative, but this change, too, was neither memory-specific nor dependent on the time interval to sleep. The remaining subjective ratings showed no significant changes. Together, these findings suggest that the observed increase or decrease in emotional responses were again likely driven by general emotion regulation processes, rather than by memory reactivation or the timing of sleep. However, since only sleep timing was manipulated, it remains unclear whether sleep-dependent processes contributed to these changes.

Challenging the assumption of the dominant hypotheses that sleep has a uniform effect on *all* emotional memories, Chapter 4 investigated whether the *future relevance* of emotional memories might influence how sleep changes their emotional tone. This was based on the idea that sleep might preserve the emotional tone of memories important for future behaviour, while weakening less relevant ones. Deviating from the paradigm used in Chapter 2 and 3, we employed a novel evaluative learning task to induce memories associated with neutral or negative emotions, which were subsequently framed as relevant

or irrelevant to participants' upcoming experience one week later. We found that arousal ratings decreased for future-irrelevant memory cues relative to future-relevant memory cues both after 12 hr and one week, but this effect occurred regardless of sleep. Of note, the short-term decrease in subjective arousal only became evident when excluding participants who could not correctly recognize which memory cues were future-relevant and which were irrelevant. Valence ratings remained unchanged and were neither affected by future relevance nor by sleep. Given the absence of differential skin conductance responses to negative versus neutral stimuli, no additional analyses were performed on this outcome measure. Taken together, our findings showed no evidence that future relevance determines whether sleep either downregulates or preserves the emotional tone of memories.

Finally, unlike the preceding chapters where emotional memory assessment relied on experimentally induced reactivation, either through re-exposure (Chapters 2 and 3) or associative cues (Chapter 4), Chapter 5 focused on a more naturalistic form of memory expression by examining sleep's effect on the development of *intrusive memories*. Unlike prior research that typically uses trauma-film paradigms to induce distressing episodes, we employed a more self-relevant experience – the Trier Social Stress Test (TSST; Kirschbaum et al., 1993) – to elicit intrusive memories. Results showed that participants who slept shortly after performing the TSST did not report lower intrusion-related disruptiveness (i.e., intrusion load) over the following week compared to those who experienced a longer interval of wakefulness. Exploratory analyses, however, revealed that changes in intrusion load were related to sleep quality after accounting for individual differences in stress reactivity. Specifically, higher subjective sleep quality on the night following the TSST was linked to lower intrusion load, whereas greater variability in subjective sleep quality across the experimental period was associated with higher intrusion load. In contrast to previous research (Kleim et al., 2016; Sopp et al., 2019a, 2021; Werner et al., 2021; Woud et al., 2018; Zeng, Lau, et al., 2021), analyses on intrusion frequency alone showed no effect of sleep. These findings suggest that while the timing of sleep may not influence changes in the emotional tone of spontaneously retrieved memories, sleep quality could play a significant role – particularly when considering both the frequency and distress of intrusive memories. Of note, only a limited number of intrusions were reported in the week following the TSST, indicating that this paradigm may not be ideal for investigating intrusive memories, and findings should be interpreted with caution.

Sleeping to forget *or* sleeping to remember?

We began this dissertation with a practical question: is it better to sleep or stay awake after a distressing experience? This question carries important implications for understanding how sleep influences the impact of emotional memories, and its potential role in preventing dysfunctional behaviours and thoughts that may ultimately lead to the onset of affective disorders. While theoretical models offer conflicting predictions, our findings point to a more nuanced reality. Despite our early optimism, the path proved more complicated than anticipated, yielding a series of humbling, and at times, frustratingly inconclusive studies. Thus, what initially appeared to be a straightforward yes-or-no question is one that we can only answer with *"maybe"*. This outcome may seem unsatisfying – and one might even wonder whether all the effort over the past years and the mortification (yes, this word came up) participants had to endure were worth it – but we still gained some valuable insights.

Crucially, across all studies, we found no evidence that sleeping shortly after a stressful event preserves or exacerbates its emotional impact more than staying awake does. This challenges the "emotional salience consolidation" account (Baran et al., 2012; Pace-Schott et al., 2011; Wagner et al., 2002; Werner et al., 2015) and suggests that sleep is unlikely to be harmful in the immediate aftermath of emotional experiences. In fact, our study described in Chapter 5 actually showed sleep-related decreases in the emotional impact of memories. As such, this study provides tentative support for the "sleep to forget and sleep to remember" hypothesis (Walker & van der Helm, 2009), indicating that a good night of sleep after a distressing experience is not only harmless, but potentially beneficial.

However, if sleep indeed weakens the emotional intensity of memories, our findings demonstrate that this effect may be limited, emerging only with certain outcome measures and under specific experimental conditions. Chapter 2 presented the most straightforward comparison between effects of nighttime sleep and daytime wakefulness on emotional memory processing, but the results may suggest that sleep enhanced emotion regulation rather than altering memories' affective tone (potential methodological explanations are discussed in the following section). This initial finding prompted a series of systematic adjustments across subsequent chapters. In Chapter 3, we refined our methodological approach by modifying the experimental paradigm to align with additional predictions of the "sleep to forget and sleep to remember" hypothesis, assuming one night of sleep might be insufficient for complete emotional memory processing. This time, we found no link between emotional responses and sleep. We should note though that this paradigm manipulated the time interval between the emotional experience and subsequent sleep,

whereas the hypotheses do not specify an optimal time window for sleep to occur following memory formation. Although the observed effects may not depend on sleep timing, they could still be influenced by sleep-related processes. Yet, we would have expected consistent changes in both subjective and objective emotional responses triggered by memory reactivation. These inconclusive findings led us to reconsider the adaptive function of sleep, questioning whether sleep would consistently strengthen or weaken emotional memories irrespective of the nature of the emotional experience. Consequently, the existing hypotheses may be too simplistic in their current form, and other factors may determine the direction in which sleep alters the emotional tone of memories – sometimes preserving or even enhancing it, and other times reducing it (Genzel et al., 2015; Hutchison & Rathore, 2015). To address this possibility, we moved on to expand the theoretical scope in Chapter 4, introducing future relevance as a potential moderating factor. We hypothesized that if the emotional tone of a memory holds value for guiding future behaviour (e.g., avoiding threats), it is adaptive for sleep to preserve it. Conversely, in the absence of such relevance, maintaining that emotional tone may be an inefficient use of resources. To test this, we employed evaluative learning as a different type of memory induction, along with an alternative form of reactivating the memory (i.e., cued recall rather than re-exposure). Although some emotional responses varied with the memory's relevance to upcoming experiences, these changes were again unrelated to sleep. Accordingly, Chapter 5 introduced a final conceptual refinement of operationalising emotional memory, shifting our focus to a more clinically relevant and ecologically valid outcome: the occurrence and impact of intrusive memories. In this paradigm, memory retrieval was assessed via spontaneous recall rather than experimental cues. Nonetheless, only exploratory analyses provided subtle indications of a sleep-related reduction in the emotional impact of memories.

What distinguishes Chapter 5 not only from the previous chapters, but, to our knowledge, also from all other studies in this field, is its approach to assess changes in memories' emotional impact through their disruptiveness (i.e., intrusion load). Rather than relying solely on emotional responses (i.e., intrusion distress), which may reflect variations in the emotional tone of memories, it also incorporates a potential indicator of successful memory integration: the frequency of uncontrolled memory retrieval (i.e., intrusion frequency). This method might align more closely with the "sleep to forget and sleep to remember" hypothesis, which posits both a reduction in affective tone and the preservation and, importantly, integration of memory content. Measuring the disruptiveness of intrusive memories through their frequency *and* distress may provide a more clinically meaningful

read-out than distress or frequency alone, as is common in prior studies (for review, see e.g., Ogden et al., 2024). Research on disorders such as post-traumatic stress disorder (PTSD) – where intrusive memories are a core symptom – indicates that their development is not merely predicted by the frequency of intrusions but rather by the experienced distress they trigger (Michael et al., 2005; Shalev, 1992). Intrusions that are not evaluated as highly negative nor evoke substantial distress are less likely to trigger cognitive suppression or avoidance responses, which are critical to the onset and maintenance of psychological disorders (Barlow, 2004). After all, from a clinical perspective, it is not merely the presence of emotional memories that poses a problem, but their uncontrolled re-emergence and their interference with daily life. Hence, it would be valuable for prior studies, where possible, to reanalyse their data to examine the effect of sleep on the combined frequency and distress of intrusive memories (i.e., intrusion load).

In sum, our stepwise modifications reflect an effort to thoroughly test and extend the original hypotheses. Although we found no *convincing* support for the "sleep to forget and sleep to remember" hypothesis, the results suggest that sleep's effect may depend heavily on how memory and emotion are assessed, and under which experimental or naturalistic conditions these processes occur. Therefore, the most cautious conclusion we can draw is that there appears to be no reason to advise against sleeping soon after experiencing a stressful event.

The (non)existent effect of sleep on the emotional tone of memories

The absence of clear effects of sleep may not simply reflect that the theories are too vague or the effects too subtle. We should also take a critical look at our own approaches. Hence, in this section, we first discuss why an effect of sleep may have emerged in some of our studies but not in others, followed by what might have kept us from finding memory-specific changes in emotional responses.

The first example involves the inconsistent effects of sleep observed across Chapters 2 and 3. Why we found sleep-related reductions in facial blushing in Chapter 2 but not in Chapter 3 might be explained by methodological adaptations to the paradigm, particularly the *timing* of exposure sessions. In Chapter 2, initial exposure to the embarrassing episode occurred between 08:00-10:00 for the wake group and 20:00-22:00 for the sleep group, with re-exposure taking place 12 hr later. As the initial exposure served as a baseline, we did not anticipate any group differences in emotional responses at that point. However, we found greater subjective emotional responses in the morning than in the evening, as evidenced by

higher embarrassment ratings in the wake group compared to the sleep group. This pattern may be linked to diurnal fluctuations in cortisol (i.e., the stress hormone): cortisol levels typically peak in the morning (e.g., Nagamine et al., 2017), which may have intensified feelings of embarrassment in participants in the wake group. In contrast to the subjective ratings, visual inspection of facial blushing at initial exposure revealed lower blushing responses in the morning than in the evening, possibly pointing to underlying time-of-day effects as well (though these were not statistically significant). Baseline facial blood flow (i.e., measured before exposure to a song fragment) appeared unaffected by circadian factors, and follow-up analyses suggested that time-of-day effects were *not more likely* than sleep itself to explain the overall reduction in blushing responses after a night of sleep. We therefore interpreted the main findings as evidence for a sleep-related reduction in facial blushing – albeit with a shadow of a doubt remaining. Hence, in Chapter 3, we excluded early morning sessions and ensured that both groups returned at the same time of day for their second exposure session. Although initial exposure still occurred at different times between groups (between 12:00-14:00 and 20:00-22:00), no diurnal differences were found in objective and subjective emotional responses. Curiously, neither did we observe a sleep-dependent reduction in facial blushing. However, since Chapter 3 did not directly compare sleep versus wake, but the duration of wakefulness between initial exposure and subsequent sleep, this limits a direct comparison. Still, these results suggest that circadian factors may have contributed, at least in part, to the findings in Chapter 2, raising the possibility that the sleep-dependent reduction in facial blushing reported there was confounded by time-of-day effects.

The changes in emotional responses reported in Chapter 4 could not be associated with sleep-related processes either. Although we found future relevance to moderate the emotional tone of memories as indicated by changes in arousal ratings, this was independent of sleep. The lack of a sleep effect might be explained by the relatively low emotional intensity of the negative memories induced. Negative memory cues elicited emotional responses that were only slightly below neutral, suggesting the negative affect may have been too mild leaving little opportunity for further reduction in negativity. This interpretation is supported by the absence of significant differences in skin conductance responses between negative and neutral memory cues. As a result, a sleep-related downregulation of emotional valence may not have been necessary or observable in this study.

Beyond the inconsistent effects of sleep on emotional responses across studies, an important aspect of the proposed hypotheses is that any such effects should be related to

changes in memory. If the reduction in facial blushing observed after a night of sleep – but not after an equivalent period of wakefulness – was indeed sleep-related in Chapter 2, it did not appear to be specifically linked to memory reactivation but rather reflected a more general reduction in emotional reactivity. However, the lack of memory-specific effects of sleep in Chapter 2 might have been due to the limited sleep opportunities provided to our participants. To address this, one key adjustment in Chapter 3 was to extend the interval between the first and second exposure sessions from 12 hr to one week. Still, no memory-specific changes in emotional responses were observed there either. It is possible that the longer delay between sessions gave participants more time to ruminate on their initial experience. Any potential downregulating effects of sleep may have been overshadowed, as the prolonged anticipation of reliving the embarrassing episode likely intensified emotional responses during the second session, reflected in more negative valence ratings.

Another reason for the missing memory-specific effect in both Chapter 2 and 3, might be related to the control stimulus used in those studies. Although we selected two very different songs, the similarity between the re-exposed embarrassing stimulus and the newly exposed embarrassing stimulus (i.e., control stimulus) may have been too high. This interpretation is supported by findings indicating that the playback order during the second session influenced participants' blushing responses across both studies. Specifically, whichever recording was played first elicited a stronger physiological response, independent of whether it matched the one heard previously or was new. After conducting the first karaoke study described in Chapter 2, we initially considered whether the observed pattern reflected physiological constraints on repeated blushing within a short time frame. To address this, we extended the interval between playback of the embarrassing recordings in Chapter 3. However, the recording that was played back first still elicited stronger facial blushing. Thus, the most plausible explanation for the lack of memory-specific effects is that the control stimulus may have unintentionally reactivated the memory trace of the already encoded embarrassing stimulus. As a result, our design may have tested whether sleep reduces emotional responses to the exact previously encountered stimulus (i.e., stimulus-specific features), or more generally to similar, contextually related stimuli. Some research on emotional memory trade-offs indicates that sleep may favour the consolidation of gist-based representations (i.e., the underlying meaning) over detailed, verbatim memories (e.g., Bookbinder & Brainerd, 2017; Hu et al., 2006). If sleep primarily enhances meaning-based processing, the observed reduction in emotional intensity might be linked to more context-specific than to stimulus-specific details. This interpretation may be supported by findings

from Chapter 3, where valence ratings became more negative for both the re-exposed and newly exposed recordings. Since sleep has been linked to enhanced emotion regulation (Gruber & Cassoff, 2014), the increase in negativity cannot be easily explained by improved emotion regulation, and instead suggests the involvement of memory-related processes. However, emotional responses to previously heard and new embarrassing stimuli did not differ after wakefulness either. Hence, our findings cannot confirm whether sleep specifically modulates the emotional tone of more gist-like memory content.

How certain can we actually be that memory reactivation was triggered in our studies? Although we tried to verify memory reactivation through recognition and free recall in Chapter 3, emotional responses triggered by memory reactivation may have been confounded by simply re-experiencing the embarrassing stimulus – a limitation that also applies to Chapter 2. Hence, we cannot be certain to what degree emotional responses were triggered by memory reactivation alone. In Chapter 4, memory reactivation was verified through recognition tests. However, because we did not assess how certain participants were of their answers, some correct responses may have been guesses rather than recall. Notably, short-term decreases in subjective arousal were only observed when excluding participants with incorrect recognition memory, suggesting that guessing likely had no significant impact on the results. Chapter 5 may provide the most direct examination of whether observed changes in the development of intrusive memories were linked to changes in emotional memory. However, in the absence of control stimuli, we cannot exclude the possibility that these effects reflect broader emotion regulation processes rather than memory-specific changes.

Given the methodological limitations, the absence of evidence cannot easily be considered as a falsification of the current hypotheses on the role of sleep in emotional memory. Future research needs to address these limitations by controlling for time-of-day effects with circadian control groups (Cunningham et al., 2022), improving verification of memory reactivation using perhaps not only behavioural but also neurophysiological measures, focusing on emotionally intense and clinically relevant paradigms, and incorporating more appropriate control conditions. At the same time, we must also consider the possibility that these hypotheses may not be viable, as the evidence from our studies – as well as from others – is not particularly convincing.

A brief perspective on current sleep research and future avenues

One thing we realised when investigating sleep's role in emotional memory processing is that many claims, often made with great confidence by well-established researchers, are not as firmly supported by empirical evidence as they might seem. Null findings are still sometimes dismissed as uninformative and therefore struggle to get published. As a result, the field may be facing a replication crisis of its own, where effects that once seemed robust are proving increasingly difficult to replicate. It appears, however, that we are also entering a more reflective phase, marked by a growing number of reviews and meta-analyses recognizing that some of sleep's supposed benefits may not hold up under more careful investigation. A prominent example is the widely held assumption that sleep selectively enhances the consolidation of emotional over neutral material: meta-analytic evidence revealed that the effect proved to be small and reliably observable only under very specific methodological conditions (Lipinska et al., 2019). The inconsistency of findings on whether and how sleep influences the affective tone of emotional memories further highlights the complexity of sleep's role in emotional memory processing (for review, see Davidson & Pace-Schott, 2021; Tempesta et al., 2018). Even research focusing on more clinically relevant outcomes, such as the development of intrusive memories, offer only limited support for the proposed benefits of sleep (Davidson & Marcusson-Clavertz, 2023; Larson et al., 2023; Ogden et al., 2024; Schäfer et al., 2023; Varma et al., 2024). Attempts to link these effects to specific sleep stages have likewise been inconclusive (which might be further complicated by the fact that different brain regions can be in different sleep stages simultaneously (e.g., as shown in rats by Emrick et al. (2016)). Thus, if the effects of healthy sleep are indeed small and only evident under certain conditions, how relevant is the study of sleep and emotional memory in healthy populations for understanding its role in vulnerable and clinical groups?

Given these inconsistencies in findings, there is a growing need for new theoretical frameworks that might better explain sleep's role in emotional memory processing. A recent model by Cabrera and colleagues (2024) not only details how sleep adaptively modifies emotional memory traces via neurophysiological mechanisms, but also how disrupted sleep may lead to maladaptive outcomes when those processes fail. While conceptually related to the "sleep to forget and sleep to remember" hypothesis, the model shifts emphasis from reducing emotional intensity to promoting emotional adaptation, highlighting complementary roles of non-REM (NREM) and REM sleep. Crucially, it suggests that emotional adaptation may be disrupted when REM sleep is impaired, as is often proposed in insomnia (Van Someren, 2021) – a condition highly predictive of, and comorbid with,

depression, anxiety, and post-traumatic stress disorder. Insomnia is characterized by hyperarousal (Bonnet & Arand, 2010; Riemann et al., 2010), potentially leading to elevated noradrenaline levels that persist into sleep. Since healthy REM sleep involves a marked drop in noradrenaline, sustained elevations could fragment REM sleep and interfere with the decoupling of distress from emotional memories. On this basis, the authors argue that pharmacologically suppressing severely fragmented REM sleep (such as through some antidepressants) might be less detrimental than its maladaptive impact on emotional processing. Notably, human studies are inconclusive as to key aspects of the model, some supporting the role of REM and the transition to REM sleep in emotional adaptation (e.g., van der Helm et al., 2011; Wassing, Lakbila-Kamal, et al., 2019), while more recent experiments show that emotional adaptation may be more strongly linked to NREM than REM sleep (Halonen et al., 2024; Hein et al., 2024). In addition, evidence for REM sleep fragmentation in insomnia remains inconclusive and may apply only to specific subtypes of insomnia (Riemann et al., 2012), possibly due to inconsistent definitions of arousals in polysomnographic signals.

No matter how we approach it, one thing is clear: more research is needed using carefully designed paradigms that directly test the specific questions at hand. While this was precisely our goal, it is important to note that based on our findings and the inconsistency in prior research, healthy sleep may not offer a strong advantage over staying awake, but perhaps it does provide a clear benefit compared to disrupted sleep. Given that intense emotional experiences can disrupt subsequent sleep, examining how such disruptions affect emotional memory may also yield findings of greater clinical relevance. Hence, we believe future research should include individuals with (sub)clinical levels of disrupted sleep to better understand whether they experience impairments in emotional memory processing. Although we initially attempted to explore this in Chapter 3, recruiting participants with poor sleep within our target age range proved too challenging. Another approach to investigating the underlying neurophysiological mechanisms involves pharmacologically manipulating specific sleep stages. As previously mentioned, certain antidepressants are known to suppress REM sleep. Additionally, other medications may be able to modulate noradrenaline levels, either increasing or decreasing its release, which could be used to either simulate fragmented REM sleep in a healthy population or consolidated REM sleep in insomnia patients (as is currently tested in dr. Van Someren's Lab). However, in protocols that disrupt sleep in healthy participants, it is essential to assess changes in memory after several nights

of sleep to ensure that both sleep deprivation and initial recovery sleep do not interfere with retrieval processes (Cunningham et al., 2022).

Lastly, it is important to acknowledge that most studies investigating the effect of sleep on emotional memory processing (including our own) are based on small sample sizes, resulting in potentially underpowered analyses. After going through the long days and early starts of multi-day protocols myself, I can surely see why this limitation is so common. However, it raises important questions about the reliability of the often-mixed findings in the field. One promising (yet slow) development in psychological research is the increasing collaboration between laboratories. Such collaborative efforts should be strongly encouraged, as they not only enhance statistical power through larger sample sizes but also improve the generalizability of findings across diverse populations and settings.

Conclusion

I am not going to lie – completing this dissertation has been nothing short of a rollercoaster, marked by a few highs and many lows, leaving behind some lasting (and at times borderline traumatic) memories, and, ironically, costing me quite a few nights of sleep. If the past few years have taught me something, it is that emotions, memory, and sleep are far more complex research topics than I ever anticipated, not to mention the combination of all three of them. Despite our best efforts, we must acknowledge that our studies, too, could not provide a definitive answer to whether sleep alters the impact emotional memories have on us. Emotional memory processing seems to be influenced by a multitude of interacting factors, and isolating the unique contribution of sleep remains a methodological and conceptual challenge. Still, I hope our work has contributed to clarifying the complexities involved, whether by highlighting key methodological pitfalls or encouraging more ecologically valid and clinically relevant approaches.

And to end on the question we began with – should we just go to sleep after experiencing a bike accident? It probably wouldn't hurt.