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REVIEW

Sleep and Autobiographical Memory

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Abstract

Purpose of Review Sleep is important for memory consolidation in laboratory-based stimuli, but less is known about how sleep impacts autobiographical memory. In our paper, we review the following: (i) the methods used to study autobiographical memory, (ii) the literature on sleep and autobiographical memory, and (iii) the role that dreaming may play in autobiographical memory consolidation.

Recent Findings Reduced sleep durations, sleep deprivation, and sleep apnea were associated with reduced autobiographical memory specificity. Sleep disruptions also affected the emotional quality of these memories, such that participants recalled more negative memories and memories that were either less emotional or more negative. Sleep, relative to wake, and percent of slow-wave sleep were associated with more detail for autobiographical memories from 12–24 h prior. Finally, improved sleep quality proximal to encoding predicted improved memory accuracy at delays of around one month.

Summary There is evidence that sleep is important in maintaining our ability to retrieve specific and positive autobiographical memories. In addition, there is preliminary evidence that slow-wave sleep and sleep quality are associated with greater detail and accuracy for recent autobiographical memories.

Keywords Autobiographical memory · Sleep · Memory consolidation · Dreaming · Sleep quality · Emotion

Introduction

A series of meta-analyses have established that sleep benefits many different kinds of memory, including memory for distinct events (i.e., *episodic* memory [1–3]), novel word learning [4], and motor memory [5]. However, much less is known about how sleep influences memory for the events of our lives – a type of memory termed *autobiographical memory*. Autobiographical memory can be defined as the type of memory that concerns a coherent recollection of personally experienced events that contribute to one's sense of self [6]. Understanding the role of sleep in autobiographical memories in general, and recent autobiographical memories in particular, is critical to determining the external validity of experiments involving laboratory-based stimuli, which tend to focus on recent timescales. In addition, both sleep disturbances and impairments in autobiographical memory are observed in memory disorders, such as Alzheimer's disease [7, 8].

Unlike most laboratory-based stimuli, autobiographical memories are typically multimodal (i.e., they vary in spatial, temporal, emotional, and narrative content), and have personal relevance [9]. Critically, autobiographical memories for specific events (termed *episodic* autobiographical memories) also involve a memory of the self experiencing the event, and this "autonoetic" component is thought to be a key element of episodic autobiographical memory [10, 11]. In contrast to laboratory-based stimuli, autobiographical memories are linked together into a personal history and life narrative [11], leading to inherent integration between memories. Autobiographical memory not only guides present and future behaviour but also serves social and emotional functions [12]. For these reasons, recalling certain autobiographical memories may bring up other strongly related memories, as well as various thoughts and emotions related to one's sense of their own identity and personal experiences. Autobiographical memories can be thought to consist of three components: lifetime periods (an abstract level of memory that relates to themes at specific life periods, e.g., when I was in university), general events (summaries of repeated events,

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e.g., basketball on Tuesdays), and event-specific knowledge (an event that occured at a specific time and place; [13]). The different components of autobiographical memory may be differentially consolidated by sleep. For instance, sleep may preserve details for event-specific knowledge and summarize repeated events into general events. Prior research has focused on event-specific knowledge (e.g., [14]), however, it could be interesting for future studies to investigate how sleep affects memory for general events and lifetime periods.

Several theories have proposed various consolidation trajectories for autobiographical memories. Although most autobiographical memories become schematized into more general representations with time, certain autobiographical memories retain their perceptual and temporal details [15]. Some theories of memory consolidation suggest that there are multiple simultaneous memory traces (e.g., event-specific detailed memory, event-general schematic memory, abstract knowledge) that can form at the time of encoding and coexist over time [16]. These multiple representations may change in strength and dominance, as well as in response to specific task demands. Other theories, such as traditional or systems consolidation, propose that memories are only initially dependent on the hippocampus and then become represented in the neocortex [17]. Both theories agree that at least certain memories undergo changes over time and that even memories that retain their specificity differ from recent specific memories in terms of their neural representations. For instance, the anterior hippocampus represented both recent (within 2 weeks) and remote (within 10 years) autobiographical memories, but the CA3 and DG subregions of the posterior hippocampus represented only remote autobiographical memories [18], suggesting that memories gradually cease to be represented by the posterior hippocampus. Specific remote autobiographical memories were also more easily detected in the ventromedial prefrontal cortex compared to recent memories [19].

Several theories have proposed specific models for how autobiographical memories may be processed during sleep. One model of memory consolidation proposes that autobiographical memories are fragmented and decontextualized by appearing in novel or bizarre contexts during dreaming, allowing the salient components of an autobiographical memory to be integrated into existing memory networks [20]. This view holds that autobiographical memory decontextualization could be adaptive, promoting the ability to retrieve autobiographical memories in a variety of situations. One potential mechanism for memory integration during dreaming could be the simultaneous reactivation of recent and remote memory fragments [21]. The related Network Exploration to Explore Possibilities (NEXTUP) theory also proposes that dreaming is a unique form of memory processing that involves fragments of both episodic and semantic memories [22, 14••]. However, the NEXTUP theory argues that fragments of unresolved questions throughout the day (e.g., what time a bus will leave the next day) are incorporated into the dream to explore possible situations, create relevant feelings, and understand how the dreamer responds to various dream situations. Therefore, a key component of this theory is that dreaming generates new knowledge from existing memories.

In this review, we begin with an overview of the relevant methods used to measure autobiographical memory. We then review the existing literature on sleep and autobiographical memories. We conclude with a discussion of the possible role of dreaming in autobiographical memory consolidation.

Autobiographical Memory Methods

Memory assessment in laboratory settings has primarily focused on measuring accuracy. However, autobiographical events unfold outside of the controlled laboratory setting and are therefore difficult to verify. One approach to measuring accuracy in these memories has been to ask about an event shortly after its occurrence and then ask the same questions at a later date to determine changes or forgetting (e.g., [14]). Alternative paradigms have also been developed to measure various features of autobiographical memories beyond accuracy. Four main measures of autobiographical memory are: (1) the Autobiographical Memory Test (AMT; [23]), (2) the Autobiographical Interview [24], (3) the Autobiographical Memory Interview [25], and (4) the Test Episodique de Mémoire du Passé autobiographique (TEMPau task; [26]). These tasks are described in Table 1.

The AMT was developed as a tool to measure autobiographical memory *specificity*, or the ability to recall a specific memory in response to a variety of emotional cues [23]. In the AMT, participants are presented with both positive and negative cue words and asked to recall a personal event associated with each cue. Events that have been personally experienced and occur at a specific time and place are recorded as *specific* (e.g., "Having dinner at Maria's house two weeks ago"). Some studies also classify memories as *overgeneral* if they last longer than a day, contain many events, or refer to a person or object (e.g., "My vacation in the Philippines"). The AMT has been a useful measure of autobiographical memory in many clinical groups. Lower autobiographical memory specificity has been found in people who have attempted suicide [23], people with depression [27], and people who have been exposed to trauma [28]. One theory suggests that when participants complete the AMT, they may passively avoid specific information about aversive events in their lives and therefore truncate the search for specific memories to avoid mood disturbance [29].

The next three measures all assess autobiographical memory with a focus on distinguishing between episodic

Table 1 Autobiographical memory measures

Task	Memory Cues	Dependent variable(s)	Scoring
AMT	Positive and negative emotion words (e.g., happy, successful, angry, lonely)	Number of specific or overgeneral memories	Memories are scored as specific if they have been personally experienced and occur at a specific time and place. Another approach is to score memories as overgeneral if they last longer than a day, contain many events, or refer to a person or object.
Autobiographical Interview	Life periods (e.g., early childhood, under age 11, middle age, 35–55)	Internal and external details	Memories are segmented into details and scored according to internal if they relate directly to the main event and external if they are semantic or not specific to the main event.
Autobiographical Memory Interview	Three life periods (i.e., childhood, early adult life, and recent events)	Total autobiographical score, background personal semantic score, total personal semantic score	Each event receives an episodic score that is combined into a total autobiographical score. Responses to questions about life history create a background personal semantic score (based on general background information) and a total personal semantic score (based on the three life periods).
TEMPau	Life periods (e.g., 0 -17 years old, 18 – 30 years old)	Overall autobiographical memory score, strictly episodic memory score, and in some cases a justified remember score	Each event receives an episodic score that is combined into an overall autobiographical memory score. Only events that are specific and detailed are combined into an episodic memory score. Finally, justified remember scores correspond to the total number of event features (what, where, and when) that were accompanied by both a remember response and specific details.

memory (i.e., memory for details that are specific to the cued event) and semantic memory (i.e., memory for details that are not specific to that unique event). In the Autobiographical Interview, participants are provided with several life periods (e.g., early childhood, under age 11; middle age, 35–55) and are asked to recall a personal event from each period that occurred at a specific time and place and lasted no more than half a day. Following recall, memories are segmented into two types of details: (1) *internal details* that reflect episodic reexperiencing of the main event (i.e., they directly relate to the main event and are specific to that time and place), and (2) *external details* that pertain to factual or extended events that do not require recollection of a specific time and place, or reflect details that are unrelated to the main event.

In the related Autobiographical Memory Interview, participants are provided with three life periods (childhood, early adult life, and recent events) and are asked to recall three personal events from each period that occurred at a specific time and place. Memory for specific events is rated on a 4-point episodic scale ranging from a score of 0 for no response or a response based on semantic memory to a score of 3 for an episodic memory that is specific in time and place. Participants are also asked to answer factual questions for each life period (e.g., names of friends) to represent personal semantic memory.

Finally, in the TEMPau task, participants are also provided with five different life periods (e.g., 0 -17 years old, 18 – 30 years old) and asked to recall a personal event from each one that occurred at a specific time and place that lasted no longer than a day. Following the recall of each event, three components of the memory (what, where, and when) are probed using a Remember/Know/Guess procedure, during which participants are asked whether they can recollect the experience (Remember), if they have no recollection (Know), or if they are unsure (Guess). Every time they make a Remember response, participants are asked to justify their response by providing specific sensory details. Each memory receives a score on a 5-point semantic to episodic scale ranging from a score of 0 for an absence of memory or general information about a theme to a score of 4 for a specific event with sensory details situated in time and space.

Two key distinctions across these autobiographical memory tasks are (i) the time points from which memories are cued, and (ii) whether the memory cue is emotional. The AMT seeks to elicit specific autobiographical memories from any point in time, whereas the Autobiographical Interview, the TEMPau task, and the Autobiographical Memory Interview seek to elicit events from specific age ranges or time points. In addition, due to its emotional cues, performance on the AMT reflects both autobiographical memory and emotional well-being.

Sleep and Autobiographical Memories

Researchers began to explore the connection between sleep and autobiographical memory specificity in part due to an intersection of research findings that individuals with depression often exhibit both reduced memory specificity (e.g., [27]) and sleep-related issues (e.g., [30]). Due to broader findings that sleep benefits other forms of memory (e.g., episodic memory [1••]), it was predicted that sleep would also benefit autobiographical memory specificity. Sleep deprivation [31], shorter sleep durations as measured through actigraphy [32], and reduced REM in sexual assault survivors [33••] have all been associated with a reduction in autobiographical memory specificity. In addition, individuals with sleep disruptions as a result of obstructive sleep apnea, a respiratory disorder that causes interruption in airflow through the upper airway during sleep [34], display a greater number of overgeneral memories on the Autobiographical Memory Test and poorer semantic memory in early adult life on the Autobiographical Memory Interview [35]. These effects highlight that reduced sleep durations and sleep disruptions may impede the ability to access specific autobiographical memories. Sleep disruptions also impaired recall of personal semantic memory, indicating that disruptions can influence both episodic and semantic autobiographical memory components. Importantly, the association between sleep duration and autobiographical memory specificity was independent of the effects of rumination and depressive symptoms [32], indicating that sleep had an impact on autobiographical memory over and above these emotional effects.

Sleep not only influences autobiographical memory specificity but also affects the emotional quality of autobiographical memories. Across several studies, both sleep deprivation [31] and insomnia severity [36] have been associated with an increased recall of negative memories. This intriguing trend suggests that sleep disturbances may lead to a negativity bias in the retrieval of autobiographical memories. Additionally, the effects of sleep deprivation extend to a reduction in the recall of positive memories [31], and participants with poor sleep quality report more frequently experiencing negative events compared to participants with good sleep quality [37]. In another study, individuals experiencing sleep disruptions, as assessed through polysomnography, tended to recall less emotional autobiographical memories in response to neutral stimuli [33••]. Another study found that participants with poor sleep quality used more negative emotion words when describing recent negative events [37]. Taken together, these findings demonstrate that sleep disturbances impact emotional autobiographical

memory processing, leading to both an increased recall of negative memories and either decreased emotionality or increased negativity in how an autobiographical memory is described.

Sleep and autobiographical memory has also been explored in individuals with highly superior autobiographical memory (HSAM). People with HSAM can recall events from their lives, including specific dates, with high detail and accuracy [38]. Interestingly, HSAM individuals did not differ from controls on cumulative sleep quantity, feelings of being well-rested, or daytime naps over a week [39], suggesting that self-reported sleep measures cannot account for the exceptional memory performance in these individuals. However, other sleep characteristics (e.g., sleep spindles) may differ between people with HSAM and controls. Future research could explore sleep patterns in this group using polysomnography to provide further insight into their unique memory abilities.

Several studies have also investigated the role of sleep in very recent memories (within the past week). Although we were only able to find four relevant studies, each employing a distinct method to assess autobiographical memory, there is emerging evidence suggesting that sleep plays a role in the consolidation of these recent memories. A 12-h sleep delay, relative to a wake delay, was associated with better memory retention for 12 specific probe questions (e.g., "Who was the last person you had a conversation with yesterday evening? What were they wearing?"; [40]). In contrast, an exploratory analysis from a different study found no differences in internal or external detail counts on the Autobiographical Interview between recent events that were recalled after having slept or not [41]. However, these two studies employed different tests and the open-ended nature of the Autobiographical Interview might lead to ceiling effects for adults that obscure differences between conditions. A study investigating self-reported sleep quality found that better sleep quality proximal to experiencing an event predicted better memory for that event after delays of 30–46 days [14]. Overall, these results suggest that sleep in general, and sleep quality in particular, may contribute to the preservation and stabilization of recent autobiographical memories.

Finally, there has been one study investigating the role of sleep physiology on recent autobiographical memories. In patients with Alzheimer's disease, the percent of time spent in slow-wave sleep predicted the number of Justified Remember responses on the TEMPau task (i.e., memory responses that were accompanied with specific sensory details), indicating that detailed memory recall is

Box 1 Sleep and memory for autobiographical events and video clips in CT: a critical role for the fornix.

A unique relationship between sleep and both autobiographical and naturalistic memories was seen in case CT described in [45••]. At the age of 16, CT underwent surgery for a midline tumor involving her septum pellucidum and extending down into her fornices bilaterally. Following tumor diagnosis and surgery, CT experienced significant memory deficits that followed an unexpected pattern. CT's family reported that she could retain information throughout the day, but when waking up in the morning or after a nap, she would have forgotten all the information she had learned before sleep and would expect to be in the hospital for her surgery. Her last stable episodic memory appeared to be of the moments before undergoing anesthesia. An overnight polysomnography revealed normal sleep patterns, with the exception of decreased SWS (15%), increased stage N1 (7.6%), and increased arousal index because of spontaneous arousals (21.3 arousals/hr).

We tested CT on the Autobiographical Interview and found that she was able to retrieve memories for events prior to her surgery, but was unable to retrieve memories for events that took place following her surgery if she had slept between the event and the retrieval attempt (i.e., any event that was outside of the current day of testing). However, she could recall a vivid memory from an event 6 – 8 h prior, so long as the event and the memory test were not separated by sleep (Fig. 1A). For example, CT was able to remember the experimenter and various details (e.g., drinking coffee together) when she stayed awake, but was not able to remember either the experimenter or any details about their time together after an equivalent delay that included sleep.

To have a more controlled demonstration of this phenomenon, we also tested CT on her memory for videos following delays that were either spent sleeping (Nap delay) or awake (Wake delay) (Fig. 1B). On two successive days, CT and age-matched controls watched an episode of the TV show *Poirot* and either took a nap or stayed awake before completing a memory test. Although CT performed numerically worse than controls in both conditions, sleep profoundly exacerbated her memory impairment, such that she could not recall any details following a nap.

In high-resolution MRI scans of CT's brain, we observed (i) perturbed white matter, particularly in the right fornix column, (ii) evidence of the impact from the trans-callosal surgical approach on the mid-anterior corpus callosum, and (iii) no differences in hippocampal volumes between CT and controls. These findings indicate that the fornix is important for processing episodic memories during sleep. We suggest that as a key output pathway of the hippocampus, the fornix may (i) ensure that specific memories are replayed during sleep, (ii) maintain the balance of sleep stages, or (iii) allow for the retrieval of naturalistic and autobiographical memories following sleep.

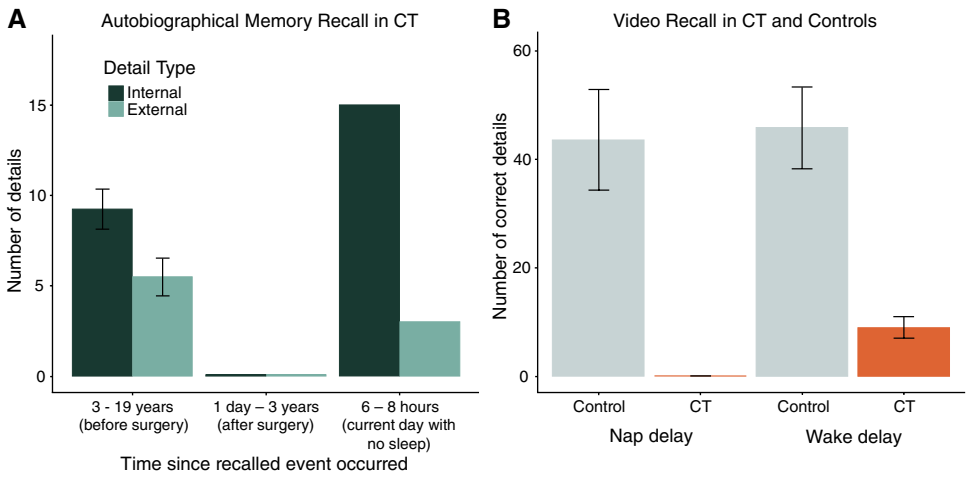

Fig. 1 Autobiographical Memory and Memory for Video Clips in CT, a Patient with Fornix Damage. (**A**) CT completed the Autobiographical Interview and recalled events from four life periods from before her surgery (i.e., 0 – 6 years old, 7 – 10 years old, 11 – 13 years old, and 14 – 16 years old), as well as the time period after her surgery (i.e., 17 – 19 years old). CT was 19 years old at the time of testing. Her memory appeared to be intact for all time periods before her surgery and are collapsed on the graph ("before surgery"). For the time period following her surgery, she could not remember any details of any event that took place prior to the current day ("after surgery"). However, she could recall an event from the day of testing that had taken place 6 – 8 hours prior and was not separated by sleep ("current day with no sleep"). (**B**) Over two subsequent days, CT and controls watched a TV episode and either took a nap or stayed awake before completing a memory test. CT completed the experiment twice (with two different episodes). CT was not able to recall any details from the TV episode following a nap, but she could recall details if she stayed awake. Statistically, we found evidence of an interaction, such that CT recalled fewer details than controls in the nap but not wake condition. Error bars indicate the standard error of the mean

associated with slow-wave sleep in those with Alzheimer's disease [42]. Future work could investigate whether similar findings apply to other groups, including healthy younger and older adults. Studies that describe sleep and autobiographical memory are given in Table 2.

Dreaming

Given the established role of sleep in memory consolidation, it has been proposed that our nightly dreams reflect some element of memory consolidation [21]. Several studies have found associations between dreaming about a laboratory task and subsequent memory performance on the same task, including a picture-word association task [46], a spatial learning task [47, 48], a procedural learning task [49], and a multisensory episodic memory task [50]. Dreaming may be the phenomenological experience of memory reactivation and replay during sleep [21, see 51 for a review].

If dreaming is associated with memory consolidation, it may play a role in the consolidation of autobiographical memories in particular. Notably, dream reports frequently contain references to events from the day before [52, 53, 54], suggesting that these recent memories may be reactivated during dreaming. Compelling evidence that the incorporation of recent memories into dreaming is functionally significant comes from a study that found that the number of recent waking experiences in REM dreams was associated with frontal theta activity during REM [55]. Recent memory fragments in REM dreams may therefore reflect theta-mediated memory consolidation. Critically, there was no association between frontal theta activity during REM and more remote memories. In addition, recent evidence shows that a greater number of memories are incorporated into REM and N1 dreams compared to other NREM dreams [54], suggesting that dreaming in these sleep stages may be involved in integrating recent and remote memories. There is debate over whether the presence of memory fragments in our dreams reflects memory consolidation, or serves other purposes, such as the generation of anticipated feelings [56]. Subsequent research should aim to examine whether incorporating elements of experienced events into dreams affects subsequent autobiographical memory performance, perhaps by identifying features of autobiographical memories that are thought to change during their consolidation.

Future Directions

Future research could assess whether sleep physiology in a large sample can predict autobiographical memory specificity and emotional quality. More research is needed to assess the role of sleep and wake delays, sleep physiology, and sleep quality on recent autobiographical memories. Studying recent events presents a unique challenge due to the likelihood that participants will remember recent, self-relevant events very well. We encourage the development of new tasks that focus on

Table 2 Sleep and autobiographical memories

Authors (reference)	Sample	Relevant Measures	Timescale of AM	Participant Groups	Results
Barry et al. [32]	$n=54$, 47 f	AM: AMT Sleep: Daily diary and actigraphy for one week	Any	Students	Shorter sleep duration (actigraphy) was associated with reduced memory specificity.
Zare Khormizi et al. [31]	$n=100$, 50 f	AM: AMT	Any	Sleep-deprived nurses ($n=50$, 25f) and well-rested nurses ($n=50$, 25f)	Sleep-deprived participants retrieved (i) fewer memories overall (i.e., any memory related to the cue), (ii) fewer specific memories (i.e., a memory that occurred at a specific time and place), (iii) more negative memories, and (iv) fewer positive memories.
MacDonald & Kormi-Nouri [36]	$n=313$, 197 f	AM: Autobiographical Memory and Emotion Elicitation Sleep: Insomnia severity index [43]	Within the last 10 years	Students	Insomnia severity predicted the number of negative events that participants recalled.
Lukowski et al. [37]	$n=141$, 124 f	AM: Write a negative and positive event within last 2 weeks and their most significant negative and positive event across two sessions Sleep: PSQI	Within the last 2 weeks for one set and at any time point for other set	PSQI groups: 5 or lower ($n=66$), Above 5 ($n=75$)	Participants with poor sleep quality (PSQI <5) (i) thought about their negative memories more frequently, (ii) reported negative events that occurred more frequently, (iii) used more negative emotion words when describing recent negative events, and (iv) were less confident that their positive memories were their own and not influenced by pictures or conversations.
Thomas et al. [33••]	$n=40$, 40 f	AM: AMT Sleep: 1 night of polysomnography	Any	Sexual assault survivors ($n=20$) and women with no history of trauma exposure ($n=20$)	Disrupted sleep (e.g., lower sleep efficiency) in both groups predicted a lower emotionality score for autobiographical memories in response to neutral cues. Disrupted sleep in sexual assault survivors was also associated with a lower emotionality score in response to negative cues. Less REM in sexual assault survivors was associated with reduced memory specificity in response to positive cues.

Table 2 (continued)

Authors (reference)	Sample	Relevant Measures	Timescale of AM	Participant Groups	Results
Delhikar et al. [35]	$n=88$	AM: Autobiographical Memory Interview and AMT	Autobiographical Memory Interview: childhood (up to high school), early adult life, and recent life AMT: any time point	Patients with obstructive sleep apnea ($n=44$) and age-matched controls ($n=44$)	Patients performed worse on personal semantic recall of early adult life on the Autobiographical Memory Interview and displayed a greater number of overgeneral memories on the AMT.
Patihis [39]	$n=58$, 15 f	AM: HSAM was identified based on the Public Events Quiz and the 10 Dates Quiz [38] Sleep: Sleep diaries	Public Events Quiz: events within the individual's lifetime 10 Dates Quiz: Dates from age 15 to the day of testing	People with HSAM ($n=20$, 5f) and controls ($n=38$, 10 f)	HSAM individuals did not differ from controls on cumulative amount of sleep, feelings of being well-rested, number of naps, or length of naps.
Murre et al. [14]	$n=609$, 434 f, 175 m	AM: Internet-based diary technique. Sleep: PSQI [44]	Phase 1: Within the past 6 days Phase 2: Same memory at a delay	PSQI groups: 5 or lower ($n=376$), Above 5 ($n=233$) Memory groups: short delay (2–15 days; $n=283$) and long delay (30 – 46 days; $n=326$)	Poor sleep quality (<5 on PSQI) was associated with reduced memory accuracy at a long but not short delay.
Aly & Moscovitch [40]	$n=20$	AM: 12 questions about events that happened the previous evening or that morning Sleep: self-reported sleep duration	12 h prior	Younger adults (19–29 years; $n=10$) and older adults (69–80 years; $n=10$)	Participants had better memory for personal events following a sleep delay compared to a wake delay.
Rauchs et al. [42]	$n=28$, 17 w	AM: TEMPau Sleep: polysomnography (only Alzheimer's group)	Within the past 24 h	Alzheimer's group ($n=14$, 8 w) and control group ($n=14$, 9 w)	The percentage of time spent in slow-wave sleep predicted the number of Justified Remember responses for memories from the previous day for the Alzheimer's group.
Grysman [41]	$n=95$, 54 f	AM: Autobiographical interview for one event from today and one from the last 24 h	Within the last 24 h	52 students (31 f) reported sleeping in between experiencing the event and reporting it, and 43 students (23 f) did not	Events before or after sleep did not differ in internal or external details.

AM Autobiographical Memory, *AMT* Autobiographical Memory Test, *f* female, *HSAM* Highly Superior Autobiographical Memory, *m* male, *PSQI* Pittsburgh Sleep Quality Index, *REM* Rapid Eye Movement Sleep, *TEMPau* Test Episodique de Mémoire du Passé autobiographique, *w* women. Note that not all studies used consistent terms when reporting sex and gender, and some studies did not report sex and gender. We use the terminology employed by the authors of each study where possible

other memory features that may be influenced by sleep (e.g., emotional quality or vividness) that are less likely to be at ceiling following short delays. Investigating the relationship between sleep and autobiographical memory will improve our understanding of which autobiographical memories are chosen for long-term consolidation and how they evolve over time.

Finally, two research areas are promising in relation to sleep and autobiographical memory: investigations into the role of the fornix and studies that explore the role of dreaming. We described CT, a young woman with damage to the right fornix who experienced severe memory deficits in both memory for videos and autobiographical memory following sleep (Fig. 1, [45]). This case demonstrates that the fornix may be playing a key role in episodic memory consolidation. Future research can investigate whether fornix microstructure predicts individual differences in memory consolidation during sleep. Although there have not been any studies to our knowledge that have directly tested dreaming and autobiographical memory consolidation, this research area is interesting due to the presence of recent autobiographical events in our dreams [52, 53, 57] and findings that dreaming about laboratory-based tasks is associated with improved memory [46, 47]. There are many challenges to this research area, including the ability to "match" content in dreams to everyday life events. However, at least one study has shown that participants can make connections between their dreams and waking lives [57].

Conclusion

In conclusion, sleep is important for autobiographical memory specificity, emotion, detail, and accuracy. Sleep disruptions result in impairments in autobiographical memory specificity [31, 32, 35] and alter the emotional quality of autobiographical memories [31, 33, 36, 37]. Preliminary evidence also suggests that sleep is involved in the consolidation of recent autobiographical events, such that sleep, relative to wake, sleep quality, and slow-wave sleep are associated with better memory performance [14, 40, 42].

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Declarations

Conflict of Interest The authors declare no conflicts of interest.

Human and Animal Right and Informed Consent No animal or human subjects participated in this study.

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- •• Of major importance

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