

The Relationship between Sleep Quality and the Emotional Valence of Autobiographical
Memories

A Project Submitted for Departmental Honors
In the Department of Psychological Science

by

Alexis Chambers

Faculty Mentor: Michael J. Tagler, Ph.D.

Ball State University
Muncie, Indiana

May, 2010

Expected Date of Graduation: May, 2010

Abstract

A popular and current research focus is the relationship between sleep and memory. In numerous studies, adequate sleep has been related to improved memory for facts and pictures, specifically emotionally salient ones. However, because such studies have primarily investigated sleep's effects on the encoding of general episodic memory, the effects of sleep on the retrieval of autobiographical memory have been largely ignored. The present study's objective was to determine whether sleep quality and daytime sleepiness relates to the retrieval of emotional autobiographical memory. Specifically, it was hypothesized that decreased sleep quality and more daytime fatigue relates to increased recall of negative memories. Participants completed measures of sleep quality, sleepiness, mood, depression, and reported a memory of a meaningful personal experience before subsequently rating this memory on scales of vividness, emotional valence, rehearsal, and age. Results indicate that while overall sleep quality does not relate to the emotional valence of autobiographical memories, poorer sleep efficiency does correspond to an increase in negative memory recall. Further, multiple regression analysis revealed daytime sleepiness to be a significant predictor of more negative memories recalled. These results add to the previous literature by highlighting the importance of sleep on the retrieval of emotional personal memories. Future research is needed to replicate and extend these findings.

Acknowledgements

I would like to thank my advisor Dr. Michael Tagler whose encouragement and guidance made this project possible. I would also like to thank Stephen Hopkins and Christopher Thomas for their generous time contribution to the data collection process. Finally, I would like to thank Dr. David Perkins and the 2009-2010 Psychological Science Departmental Honors students for their helpful comments and suggestions.

Sleep and Emotional Memory

The purpose of sleep has eluded and puzzled scientists for decades. It was initially thought that the brain essentially “shut down” during sleep. However, advancements in technology which allowed for the recording of brain wave activity during sleep forced researchers to realize that this previous assumption was incorrect. Such advancements provided researchers in the 1950’s with the ability to make much headway in the study of sleep. This was the decade in which rapid eye movement (REM) sleep was first observed in the makeshift University of Chicago sleep laboratory of Nathaniel Kleitman. It was also the decade in which William Dement, a student of Kleitman, was able to differentiate between the first four non-REM stages of sleep and the fifth REM stage of sleep, where dreams would most often occur. This along with the discovery that the brain would favor REM after several days of sleep deprivation led to the belief that Sigmund Freud’s theory of dreams may be correct. Perhaps the purpose of sleep, or at the very least REM sleep, was to assuage the immoral pressure of the id and prevent psychotic episodes. Although popular for about a decade, this notion quickly lost support (Dement & Vaughan, 1999).

More recently, a large body of cognitive and neuroscience psychology evidence has related mechanisms of sleep with memory consolidation and retrieval processes. Specifically, memory consolidation has been shown to benefit from ample sleep after encoding (Atienza & Cantero, 2008; Drosopoulos, Wagner, & Born, 2005; Drosopoulos, Shulze, Fischer, & Born, 2007; Hu, Stylos-Allen, & Walker, 2006; Payne, Stickgold, Swenberg, & Kensinger, 2008; Wagner, Gais, & Born, 2001; Wagner, Kashyap, Diekelmann, & Born 2007; Walker, 2009) as well as prior to encoding (Yoo, Hu, Gujar, Jolesz, & Walker, 2007). Put simply, such studies point toward the notion of sleep as a memory aid.

Furthermore, an increasing number of studies have found that emotional factors influence the strength of memories at retrieval (Hu et al., 2006; Payne et al., 2008; Wagner et al., 2001; 2007; Walker, 2009). Specifically, research has shown memories to be strengthened by emotional stimuli as opposed to neutral stimuli. For example, to investigate whether emotional content impacted the encoding of central and background elements of pictures when participants either slept or stayed awake, Payne et al. (2008) had participants study photos in which either neutral or negative foreground objects (intact car or wrecked car) were superimposed on neutral backgrounds (a street scene). This method followed the rationale of the weapon-focus effect, in which those who are attacked better remember the weapon used in the attack than the appearance of the attacker (Stanny & Johnson, 2000). While they did find that memory for background material was indeed hindered by associated negative objects, sleep did not have any significant effects on memory for backgrounds, whether presented with negative or neutral objects. More importantly, they found that participants who had a full night of sleep between encoding and retrieval remembered the negative foreground objects better than those who did not sleep. This effect was not found for neutral foreground objects.

Alternatively, Hu et al. (2006) investigated how levels of arousal of emotional stimuli affected memory consolidation after either sleeping or staying awake. They had participants study pictures that were emotionally similar, yet rated as either high or neutral on a scale of arousal. In this case, differences between positive and negative valence were not important, but the strengths of such emotions were. They found that memory accuracy for highly arousing emotional pictures was greater when participants had a full night of sleep after encoding in contrast to staying awake. This was not found for neutral emotional pictures. Thus, emotional

content, especially highly arousing emotional content, has been found to enhance memory for pictures in conjunction with a full night of sleep.

However, napping has also been found to aid emotional memory for pictures. Nishida, Pearsall, Buckner, and Walker (2008) found that participants better remembered negative pictures as opposed to neutral pictures when they were allowed a 90-minute nap between encoding and retrieval. The confidence in this result was strengthened by the presence of not only two learning groups, a nap and no-nap group, but also two learning periods consisting of different material, one four hours prior to the memory test and one 15-minutes prior. Only the material learned four hours prior to the test in the nap group went through the sleep phase. The authors found that only memory for the emotional pictures in this learning period was strengthened. Also, REM sleep achieved during the nap was related to better emotional memory, especially if REM was achieved quickly. Thus, even sleep for a short duration can enhance emotional memory, particularly when REM sleep is involved.

This effect of emotional memory enhancement has also been shown for memory of descriptions. Wagner, Gais, and Born (2001) gave their participants either negative or neutral passages to read and tested the recall of the descriptions three hours later. Negative passages gave graphic details about physical disabilities or antisocial behavior, while neutral passages described mundane concepts. They found that participants who slept during a three-hour consolidation period better remembered the negative descriptions than participants who stayed awake. Additionally, they found that REM sleep had the strongest positive impact on emotional memory consolidation.

However, other studies have reported contradictory results regarding the relationships among emotion, sleep, and memory. For example, Wagner et al. (2007) used pictures of facial

expressions either depicting happy, angry, or neutral expressions as stimuli. They found that while sleep did enhance memory, it did not preferentially enhance memory for emotional facial expressions. While this seems to be in disagreement with other studies supporting superior memory recall for emotional stimuli, the authors suggest that the facial expressions used in their study may not have been strong enough to reveal the effect. For instance, they speculate that pictures of faces laughing instead of simply smiling may have been a more powerful emotional memory cue.

Similarly, Atienza and Cantero (2008) did not find a significant effect of emotional material on memory after sleep. Their participants memorized various pictures of positive, negative, or neutral material, such as faces, animals, and scenery, and then were either allowed to sleep or were sleep deprived. After sleep deprivation, emotional pictures were actually remembered slightly better than neutral ones. However, this result was not statistically significant. Therefore, Atienza and Cantero (2008) propose the idea that emotion and sleep act independently to affect memory recall, with either emotion or sleep able to influence the strength of memories.

Unfortunately, there appears to be little research that can distinguish between the effects of negative (e.g., sadness, disgust) and positive (e.g., happiness, excitement) emotional material. For example, studies that found effects of emotional memory on sleep consolidation were specifically concerned with negative versus neutral material (Payne et al., 2008), or did not distinguish between positive or negative content (Hu et al., 2006). Among the published studies that chose to discriminate between positive and negative emotions, there were no significant results (Atienza & Cantero, 2008; Wagner et al., 2007). However, a currently unpublished study by Walker (see Walker, 2009) found that declarative memory for negative stimuli was not

significantly different between normal sleep and sleep deprived conditions while memory for positive and neutral stimuli were significantly hindered after sleep deprivation. Therefore, Walker suggests that negative memories may be more resilient during times of sleep loss, allowing one to remember negative material better after than positive or neutral material.

More Elaborate Declarative Memories: Autobiographical Memory

As reviewed above, most of the currently available research on sleep and memory has focused on declarative memory function, specifically episodic memory (i.e., memory for particular stimuli). Indeed, many of the aforementioned studies have required participants to memorize passages or picture content and later recall such information. Further, much of the literature has focused on the effects of sleep at encoding of learned material. In contrast, the effects of sleep on the retrieval of autobiographical memories have not been examined. The purpose of the current study is to determine if the amount or quality of sleep prior to retrieval of an autobiographical memory will be related to the emotional valence of retrieved memories.

Autobiographical memories are largely episodic, but also contain semantic features and are more complex than the memories typically studied in laboratory experiments.

Autobiographical memories tend to be personally meaningful as they concern memory of the self's personal real-life experiences. Recent research on autobiographical memory has examined the differences between voluntary and involuntary memories. Voluntary autobiographical memory occurs when one is specifically asked to recall a personal memory, while involuntary autobiographical memory occurs when one spontaneously remembers a personal memory without a request to do so (Berntsen, 1998).

Testing voluntary autobiographical memories is simple enough in a lab setting; however, testing involuntary memories can be problematic in such an environment. Studies have been able

to solve this problem by requiring participants to record spontaneous autobiographical memories in diaries over a specific amount of time (Berntsen, 1998; Schlagman & Kvavilashvili, 2008). Additionally, Schlagman and Kvavilashvili (2008) also used a method whereby participants were distracted by taking part in a monotonous computerized game during which random words or phrases were presented on the screen. Participants were asked to ignore these words but to record any time a random autobiographical memory came to them. Researchers were then able to decipher whether the cue words prompted such memories and also were provided with a reaction time for such memory occurrences. When comparing such memories with those found in the diary method, Schlagman and Kvavilashvili (2008) discovered that both methods produced similar memories and thus concluded that involuntary memories could be studied successfully in a laboratory setting.

From methods such as these, the two different types of autobiographical memory have been compared and some important differences have emerged. For example, involuntary memories have been found to occur more quickly (Schlagman & Kvavilashvili, 2008) and are more specific than voluntary ones (Berntsen, 1998; Schlagman & Kvavilashvili, 2008). However, there is some debate as to the emotional valence of the two types of memories. For example, Berntsen (1998) found that there were more positive than either negative or neutral memories for both voluntary and involuntary memories, but also found that involuntary memories tended to be more positive than voluntary memories. Conversely, Schlagman and Kvavilashvili (2008) found that valence of memories for both involuntary and voluntary conditions depended on the valence of the word stimuli prompts. Furthermore, they found that while voluntary memories were no more likely to be prompted from negative, positive, or neutral words, involuntary memories were more likely to be prompted by negative words. Notably,

research has not yet investigated the degree to which sleep relates to the emotional valence of autobiographical memory retrieval.

The Role of Depression

Autobiographical memories are often different for those who are depressed as compared to those who are not. Most importantly, depressed individuals have been found to retrieve more negative autobiographical memories than those who are not depressed (Kuyken & Howell, 2000; Lemogne et al., 2005; Serrano, Latorre, & Gatz, 2007). In addition, a large number of studies have shown that sleep problems are often comorbid with depression (Dieter, 2007; Jansson & Linton, 2007). Because depression already has an established relationship with both autobiographical memory recall and sleep, it is important to consider its potential influence on the results of the current study.

The relationship between depression and autobiographical memory has been studied by comparing depressed individuals with non-depressed controls. One such study investigated depression's effects in older participants. Serrano, Latorre, and Gatz (2007) administered the Autobiographical Memory Test (AMT), a timed measure of autobiographical memory specificity in response to a positive, negative, or neutral word prompt. Most notably, they found that among depressed individuals, fewer positive memories and more negative memories were retrieved than among controls. They also found that depressed individuals were more likely to be unable to retrieve a positive memory to a positive word prompt, but this was not so for negative word prompts.

This trend has been found in younger individuals as well. Kuyken and Howell (2000) also used the AMT to assess differences in depressed and non-depressed individuals. Similar to findings of Serrano et al. (2007), they found that depressed adolescents rated memories slightly

less pleasantly than controls. Also, they found that those who were depressed repeatedly thought more about negative memories than positive ones. Such a tendency could explain why depressed individuals more easily recall negative as opposed to positive autobiographical memories.

Other methods for finding this effect of depression have been used as well. For example, Lemogne et al. (2005) used an interview procedure to inquire about both a positive and negative experience from each of five life stages. They compared results from depressed individuals to those without depression on three components. They asked participants whether the memory was remembered in detail or known and whether it was remembered in first-person or as an outsider looking in. They also had raters listen to the memories at a later time and code whether they were specific or general. The authors found that non-depressed individuals remembered positive experiences better, more specifically, and had memory of the event in first-person more than those who were depressed. Conversely, while these non-depressed individuals also remembered negative memories better than those who were depressed, such memories were not remembered more specifically or in first-person more than those who were depressed. Further, depressed individuals scored higher for negative memories as opposed to positive memories for each of the three components, revealing that these memories were remembered better, more specifically, and in first-person more so than positive memories.

Taken together, the aforementioned studies indicate a possible interference of depression on the valence of autobiographical memory retrieval. Any effect of sleep may potentially be confounded or overshadowed by the presence of this disorder. Further, as mentioned, sleep and depression already have a verified relationship. For example, it has been found that depression is predicted by insomnia (Dieter, 2007) and can even maintain insomnia in some sufferers (Jansson & Linton, 2007). On the other hand, sleep deprivation for depressed individuals, especially

deprivation of REM sleep, has been shown to reduce depressive symptoms (Sejnowski, 2010). Because of these coexisting relationships, the causal order of depression, sleep problems, and memory effects is unclear. Thus, for the current study, it is necessary to include a measure of depression to rule out such a possible confound.

Effects of Mood on Autobiographical Memory Valence

It has been documented through several studies that mood state can also affect the types of autobiographical memories recalled. However, there is some debate as to whether mood affects memory in a congruent or incongruent way. For example, some studies suggest that those in bad moods will recall more negative memories (mood congruent) while others suggest they will recall more positive memories (mood incongruent). The reason for mood congruent memory is intuitive; being in a bad mood primes one to conjure bad memories (Eich & Macaulay, 2000). However, the idea behind mood incongruent memory is the maintenance of mood state (Parrott & Sabini, 1990). In other words, those in bad moods remember more positive memories to lighten their mood.

One example of this mood incongruent memory concept comes from a study by Parrott and Sabini (1990). In their quasi-experiment, they induced mood states by returning a midterm exam on which students either did as well/ better than they thought or worse than they thought. They confirmed the accuracy of this method by having students rate the extent they felt each of a series of single (happy) or bipolar (ashamed-proud) emotions on a 7-point scale at the end of the study. Students first recorded the grade they expected to get on the exam, and after receiving the tests, recorded the grade they actually obtained. Without knowledge of the true objective of the experiment, the students then were asked to record three memories from a specified time in their past. These memories were coded for both negative and positive valence.

While only the first of the three memories produced significant results, Parrott and Sabini (1990) found that students who were in a poor mood due to their performance on the exam recalled more positive memories while those in a good mood recalled more negative memories. The authors suggested that this mood incongruent recall effect was perhaps due to an automatic mood maintenance process as the participants were largely oblivious to any such effects. However, this technique did present some problems as there may have been pre-existing differences between subjects, especially in their responses to grades and resulting memories.

In a second experiment meant to better control for individual differences, Parrott and Sabini (1990) used weather conditions to induce mood states. Participants were approached on either a sunny or cloudy day and asked to write one memory from a specified time period in their past. They were given a 10-point scale to rate their mood afterward. Similar to their first study, the authors found that those in positive moods due to sunny weather recalled significantly more negative memories. However, they did not find a significant incongruent effect for those in poorer moods on cloudy days. Thus, investigations of mood incongruent recall outside of the laboratory yields mixed results for negative mood states.

Interestingly, evidence suggests that mood incongruent recall occurs when participants' moods are natural, or induced unbeknownst to them, while mood congruent recall is often observed in laboratory settings in which participants are aware of a mood state requirement. This was the case in the subsequent studies of Parrott and Sabini (1990). Of their five studies, the authors only found one case of mood congruent recall. This occurred in study three in which participants not only listened to mood inducing music but were also told to try to achieve a particular mood. In this experiment, they found that participants in good moods retrieved positive memories while those in bad moods retrieved negative memories. However, in the

authors' other studies using this same music method, but in which participants were not told to alter their mood, mood incongruent recall was once again found. Thus, it appears that certain laboratory methods lend themselves to mood congruent memory while more natural methods enhance mood incongruent memory.

Conversely, Eich and Macaulay (2000) found verification for mood congruent memory in both an induced and simulated mood condition. They used the Continuous Music Technique (CMT) in a previous study to induce participants to experience happiness or sadness by listening to music, and simply asked participants in the current study to act as if they were either happy or sad. In both studies, participants in happy moods recalled happier autobiographical memories, evidence of mood congruent recall. However, in only the simulated mood experiment was there a significant mood congruent recall effect for sad mood. What is noteworthy in these experiments is that during the CMT, participants consider either happy or sad thoughts while listening to similar music. This appears to be what Parrott and Sabini (1990) considered to be an unnatural mood state because participants were aware of a certain mood requirement. Though, Eich and Macaulay (2000) report that participants felt such moods were realistic. Thus, mood congruent recall may depend on the interpretation of what a natural mood state entails.

As mood state, whether induced in a natural or laboratory setting, has been shown to have significant effects on the emotional valence of autobiographical memories recalled, it is important to consider mood states for the purposes of the current study. It is unclear whether mood will have a more important effect on memory valence as compared to sleep or whether sleep may moderate any such relationship. Thus, a measure of current mood states was included to investigate such an association.

Overview of the Proposed Study

The purpose of the current study is to examine the relationship between sleep quality and autobiographical memory recall. Previous literature in the area of sleep and memory largely excludes these types of memories and as a result the relationship between sleep and autobiographical memory is unclear. Recent studies also have tended to focus on the encoding of information, with little research existing on sleep and retrieval of memories. Further, while emotional memories as opposed to neutral memories have been found to be aided most by sleep, there have been no clear conclusions on the distinction between positive and negative valence in association with sleep. Thus, the objective of the current study is to investigate such relationships through the voluntary recall of an existing autobiographical memory.

While there is some ambiguity between current findings on the emotional component of memories, the current study hypothesizes that sleep deprivation will correlate with the retrieval of more negative autobiographical memories, as is suggested by Walker's unpublished results (see 2009). As his results imply, negative material may be more impervious to sleep deprivation and fatigue than either positive or neutral material. In order to investigate this hypothesis, the current study was administered in survey format in which participants responded to questions about their recent habits and feelings before being asked to describe an autobiographical memory. As has been mentioned previously, there are several factors aside from sleep that may impact the valence of autobiographical memories recalled. Depression has been related to recall of more negative autobiographical memories while mood states have been found to either affect such memories in congruent or incongruent ways. Thus, measures of both depression and mood were added to measures of sleep habits and fatigue to account for any of these likely effects as well as to investigate any relationships among them.

Method

Participants

Ball State University students ($N = 136$) ranging in age from 18 to 38 years old enrolled in Psychology 100 during the 2010 spring semester signed up for the study via the online research participation site. Approximately 68 percent of the participants were female while 32 percent were male. A majority of the participants were Caucasian (90.4%) while the remainder of the sample indicated African American (7.4%), Hispanic (0.7%), or other decent (1.5%). Participants received one half hour of research participation credit for their contribution to the study.

Materials

Positive and Negative Affect Schedule (PANAS). The PANAS (Watson, Clark, & Tellegen, 1988) is a 20 item self-report measure of mood. Participants are asked to indicate to what extent they are currently feeling each of 10 positive (i.e. interested, excited, enthusiastic) and 10 negative (i.e. upset, guilty, ashamed) emotions from 1 (very slightly or not at all) to 5 (extremely). The PANAS has high internal consistency reliabilities for both the positive affect scale (Cronbach's α from 0.86 to 0.90) and the negative affect scale (Cronbach's α from 0.84 to 0.87), as well as a low correlation between the two scales (ranging from -0.12 to -0.23; Watson, Clark, & Tellegen, 1988).

Beck Depression Inventory (BDI-II). The BDI-II (Beck, Steer, Ball, & Ranieri, 1996) measures the experience of depressive symptoms over the past two weeks. Participants are asked to indicate to what extent they feel each of 21 depressive symptoms (i.e. sadness) ranging from 0 (I do not feel sad) to 3 (I am so sad or unhappy that I can't stand it). The measure yields one overall score, which is a combination of scores for all of the individual items. The BDI-II has high internal consistency (Cronbach's $\alpha = 0.91$; Beck, Steer, Ball, & Ranieri, 1996).

Epworth Sleepiness Scale (ESS). The ESS (Johns, 1991) is a measure of daytime sleepiness. Participants are asked to rate how likely they are to fall asleep in eight situations from 0 (not at all) to 3 (high chance). Situations include sitting and reading, as a passenger in a car for an hour without a break, and sitting quietly after a lunch without alcohol. The ESS yields a score ranging from 0 to 24 with scores of 16 or higher indicating a higher level of sleepiness that is often found in individuals with sleep disorders such as narcolepsy. According to Johns (1991), scores on the ESS were found to have acceptable correlations with Multiple Sleep Latency Tests during the day ($r = -0.51, p < 0.01$) and polysomnography sleep latency tests at night ($r = -0.38, p < 0.01$).

Pittsburgh Sleep Quality Index (PSQI). The PSQI (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989) is a 19-item measure of usual sleep habits over the past month. Participants are asked to answer four free response questions about sleep duration as well as 15 multiple-choice items about sleep quality. The measure yields seven individual scores ranging from 0 (no difficulty) to 3 (severe difficulty) as well as a total score ranging from 0 to 21. The individual scores include scores for subjective sleep quality (rated by the participant), sleep latency (the amount of time needed to fall asleep), sleep duration (amount of sleep), habitual sleep efficiency (relationship between bedtime, wake time, and hours of sleep), sleep disturbances (extent to which participants are kept awake at night), use of sleep medications, and daytime dysfunction (dysfunction due to sleepiness or loss of enthusiasm). A total score greater than five is indicative of considerable sleep difficulties. The PSQI possesses high internal consistency (Cronbach's $\alpha = 0.83$), acceptable correlations between individual and total scales ($r = 0.35$ to $0.76, p < 0.01$), and satisfactory test-retest reliability for the total score ($r = 0.85, p < 0.01$) and for the individual scores ($r = 0.65$ to $0.84, p < 0.01$; Buysse, Reynolds, Monk, Berman, & Kupfer, 1989).

Autobiographical Memory Measure. Participants were asked to record an autobiographical memory within 10 minutes given the following instructions: “In the next 10 minutes, please describe the **first** memory that comes to mind of a significant personal experience from any time in your past.” After completing the memory, participants were then asked to provide further information about the memory including the valence of the memory (1 very negative, 2 somewhat negative, 3 neutral, 4 somewhat positive, 5 very positive), how old (in years) they were in the memory, how often the memory had been previously thought of (1 never, 2 once or twice, 3 a few times, 4 several times, 5 many times), and how vivid the memory was to them (1 very vague to 7 very vivid; adapted from Schlagman & Kvavilashvili, 2008).

Procedure

Participants completed the measures on laptop computers in groups of ten or less in a small classroom setting. Before beginning the study, they were informed that they would be completing a survey requesting information about their sleep habits, memory, and related psychological attributes. They were also instructed on the procedure for using the laptops as well as the 30-minute time limit, after which they would be forced to stop. After reading the study description and agreeing to the inclusion/exclusion criteria, participants first completed a demographic questionnaire followed by the PANAS, BDI-II, ESS, and PSQI in randomized order, and then the Autobiographical Memory measure. Once everyone had finished, participants were debriefed and offered a copy of the information.

Results

An alpha level of 0.05 was used in the statistical analyses to investigate the hypothesis. It was predicted that participants experiencing lower sleep quality and more fatigue would recall more negative memories. Additional aspects of the reported autobiographical memories were

analyzed to explore further possible relationships between sleep and memory. These aspects included memory vividness, rehearsal, and age. The age of the memory was computed by subtracting the self report of the participants' age in the memory from their age at the time of the experiment which yielded the age of the memory in years.

Gender and Memory

An independent samples t-test was performed to investigate the differences between men and women on the aspects of the autobiographical memories they recall. Results were not significant for any of the four aspects measured. Specifically, men ($M = 5.95$, $SD = 1.07$) and women ($M = 5.79$, $SD = 1.29$) did not differ on the level of vividness of the memories they reported, $t(131) = 0.73$, $p > 0.05$, $d = 0.14$. Men ($M = 3.65$, $SD = 1.07$) and women ($M = 3.69$, $SD = 1.13$) also did not differ on the amount of previous rehearsal of the memories they reported, $t(132) = -0.20$, $p > 0.05$, $d = -0.04$. Men ($M = 3.40$, $SD = 1.59$) and women ($M = 3.58$, $SD = 1.59$) tended to report memories with similar emotional valences, $t(129) = -0.60$, $p > 0.05$, $d = -0.11$. Finally, men ($M = 3.15$, $SD = 4.12$) and women ($M = 3.67$, $SD = 4.57$) reported memories that were of similar ages, $t(129) = -0.63$, $p > 0.05$, $d = -0.12$. These results indicate that there are no differences in the autobiographical memories men and women report.

Relationships Among Autobiographical Memory Aspects

Pearson's r correlations were performed to investigate relationships between the vividness, rehearsal, emotional valence, and age of the reported memories. Only one significant correlation emerged: Older memories tended to be rated as less vivid, $r = -0.35$, $p < 0.01$.

Positive and Negative Affect

Scores on the scale of positive affect, consisting of the 10 positive emotions on the PANAS indicated moderate levels of positive affect among the participants ($M = 25.65$, $SD =$

7.18). An independent samples t-test was performed to investigate differences between men and women. Women ($M = 24.70$, $SD = 6.84$) reported significantly less positive affect than men ($M = 27.70$, $SD = 7.53$), $t(133) = 2.30$, $p = 0.02$, $d = 0.42$. Pearson's r correlations were used to investigate the relationship between positive affect and memory (see Table 1). The positive affect scale did not correlate significantly with memory vividness ($r = -0.05$, $p > 0.05$), memory rehearsal ($r = -0.10$, $p > 0.05$), emotional valence of the memory ($r = 0.07$, $p > 0.05$), or age of the memory ($r = 0.02$, $p > 0.05$).

Scores on the scale of negative affect ($M = 15.33$, $SD = 4.77$), consisting of the 10 negative emotions on the PANAS were significantly lower than the positive affect scale, $t(134) = 15.08$, $p < 0.01$. An independent samples t-test performed on the scores of men and women indicated that men ($M = 16.44$, $SD = 5.93$) and women ($M = 14.80$, $SD = 4.05$) tended to report similar experiences of negative emotions, $t(133) = 1.88$, $p > 0.05$, $d = 0.32$. Pearson's r correlations were used to investigate the relationship between negative affect and memory. Similar to the scale of positive affect, the negative affect scale also did not correlate significantly with memory vividness ($r = -0.10$, $p > 0.05$), memory rehearsal ($r = 0.03$, $p > 0.05$), emotional valence of the memory ($r = -0.14$, $p > 0.05$), or the age of the memory ($r = -0.01$, $p > 0.05$). These results suggest that there is little relationship between the current mood of participants and the aspects of the autobiographical memories they recall.

Depression

Scores on the Beck Depression Inventory-II indicated generally low levels of depression among participants ($M = 10.22$, $SD = 7.03$). An independent samples t-test was performed on the scores of men and women. The results were not significant, indicating that men ($M = 9.79$, $SD = 7.66$) and women ($M = 10.42$, $SD = 6.75$) scored similarly on presence of depressive symptoms, t

(133) = -0.49, $p > 0.05$, $d = -0.09$. Pearson's r correlations were used to investigate the relationships between the BDI-II and the measures of sleep and memory. The BDI-II did not correlate significantly with the PSQI measures of sleep quality. This included the subscales of sleep duration ($r = 0.52$, $p < 0.01$), sleep disturbances ($r = 0.32$, $p < 0.01$), sleep latency ($r = 0.26$, $p < 0.01$), daytime dysfunction ($r = 0.40$, $p < 0.01$), and sleep quality ($r = 0.44$, $p < 0.01$). The BDI-II also correlated with the total PSQI score ($r = 0.48$, $p < 0.01$) indicating that higher levels of depression correspond to lower levels of sleep quality. Conversely, the BDI-II did not correlate significantly with memory vividness ($r = -0.003$, $p > 0.05$), memory rehearsal ($r = 0.15$, $p > 0.05$), emotional valence of the memory ($r = -0.03$, $p > 0.05$), or the age of the memory ($r = -0.02$, $p > 0.05$). Such results imply that while levels of depression do correlate with sleep difficulties, they do not correspond to the tested aspects of autobiographical memories that participants recalled.

Daytime Sleepiness

Scores on the Epworth Sleepiness Scale were low ($M = 8.48$, $SD = 3.17$), indicating levels of daytime sleepiness well below the sleep disorder range. An independent samples t -test was performed on the scores of men and women. The results were not significant, indicating that men ($M = 8.53$, $SD = 2.94$) and women ($M = 8.46$, $SD = 3.28$) did not report different levels of daytime sleepiness, $t(133) = 0.13$, $p > 0.05$, $d = 0.02$. Pearson's r correlations were used to investigate the relationship between fatigue and memory. The ESS did not correlate significantly with memory vividness ($r = -0.03$, $p > 0.05$), memory rehearsal ($r = 0.15$, $p > 0.05$), emotional valence of the memory ($r = -0.13$, $p > 0.05$), or the age of the memory ($r = 0.06$, $p > 0.05$). These results contradict the hypothesis that higher daytime fatigue will correspond to more negative autobiographical memories recalled.

Sleep Quality

Total scores on the Pittsburgh Sleep Quality Index generally indicated poor levels of sleep quality among the participants ($M = 6.13$, $SD = 3.03$). An independent samples t-test was performed to investigate the differences between the scores of men and women. While results were not significant for the total PSQI score, results for the subscale of sleep latency were significant indicating that women ($M = 1.32$, $SD = 1.03$) need longer to fall asleep than men ($M = 0.88$, $SD = 0.88$), $t(133) = -2.38$, $p = 0.02$, $d = -0.46$. Pearson's r correlations were used to explore the relationship between sleep quality and memory. Results revealed that the total PSQI score did not correlate significantly with memory vividness ($r = -0.11$, $p > 0.05$), memory rehearsal ($r = -0.01$, $p > 0.05$), or emotional valence of the memory ($r = 0.03$, $p > 0.05$). However, this score did correlate with the age of the memory ($r = 0.20$, $p = 0.03$) so that those with poorer overall sleep quality tended to recall older memories. Further, the PSQI subscale of sleep efficiency did correlate significantly with memory vividness ($r = -0.21$, $p = 0.02$) and the emotional valence of the memory ($r = -0.20$, $p = 0.03$) while the subscale of sleep latency correlated significantly with the age of the memory ($r = 0.21$, $p = 0.02$). Thus, congruent with the present hypothesis, less sleep efficiency corresponded to more negative memories. In addition, less sleep efficiency also corresponded to more vague memories while longer sleep latency corresponded to older memories.

Multiple Regression Analysis for Emotional Valence of Memory

A standard multiple regression was performed with the emotional valence of the autobiographical memory as the criterion and the positive affect scores, negative affect scores, total ESS scores, total BDI scores, total PSQI scores, as well as PSQI subscales of sleep duration,

sleep latency, daytime dysfunction, sleep efficiency, sleep quality, sleep medication, and sleep disturbance entered simultaneously as predictors.

A significant model emerged, $F(11, 110) = 1.97, p = 0.04, R^2 = 0.165$. Significant predictors included the total ESS score ($\beta = -0.19$), $t(110) = -2.07, p = 0.04$ as well as the PSQI subscale of sleep efficiency score ($\beta = -0.29$), $t(110) = -2.97, p < 0.01$, indicating that higher levels of daytime sleepiness and lower sleep efficiency are predictive of more negative memory recall. The remaining measures of mood, depression, and sleep quality (see Table 2) did not contribute to a significant prediction of this model. The total PSQI score was excluded from the model as it did not satisfy inclusion criteria of 0.05. The R^2 of this model was 0.165, indicating that 16.5% of the variance in the emotional valence of the memories was accounted for by the predictors.

Multiple Regression Analysis for Memory Vividness

Because memory vividness was found to correlate with memory age and subsequently vague memories were found to be related to poorer sleep efficiency, a standard multiple regression was performed to investigate whether memory vividness may be a function of memory age. The vividness of the autobiographical memory was set as the criterion and memory age, positive affect scores, negative affect scores, total ESS scores, total BDI scores, total PSQI scores, as well as PSQI subscales of sleep duration, sleep latency, daytime dysfunction, sleep efficiency, sleep quality, sleep medication, and sleep disturbance were the predictors.

A significant model emerged, $F(12, 108) = 2.46, p = 0.01, R^2 = 0.214$. However, the only significant predictor was memory age ($\beta = -0.32$), $t(108) = -3.56, p < 0.01$, indicating that older memories tended to be more vague. The remaining measures of mood, depression, and sleep did not contribute significantly to the model. The total PSQI score was excluded from the model as it

did not meet inclusion criteria of 0.05. The R^2 of the model was 0.214, indicating that 21.4% of the variance in memory vividness was accounted for by the predictors.

Discussion

This is the first study [known](#) to investigate the relationship between sleep and autobiographical memory retrieval. The results of the current study show that poorer sleep efficiency is related to the recall of more negative autobiographical memories. This is consistent with the findings of Walker (2009), which suggest that perhaps negative memories are less susceptible to effects of sleep deprivation, allowing them to be more readily retrieved than memories for either positive or neutral material. However, this was the only measure of sleep quality which correlated with memory valence. Similarly, the measure of daytime sleepiness also did not correlate with memory valence. However, this measure was a significant predictor of memory valence in the multiple regression analysis indicating that there is a relationship between daytime sleepiness and autobiographical memory valence, specifically between higher levels of daytime sleepiness and more negative memories. Thus, it appears that there is good reason to consider one's prior sleep when analyzing the retrieval of emotional autobiographical memories.

Further, memory vividness was similarly related to sleep efficiency so that poorer sleep efficiency corresponded to more vague memories. It is possible that, like negative memories, vague memories are more resistant to disrupted sleep and are thus more readily recalled than vivid memories. However, another possibility is that vividness of memories recalled is more a function of memory age rather than sleep. Consistent with this notion, memory vividness did correlate with memory age and memory age was a large predictor of memory vividness in the multiple regression analysis. Indeed, it makes intuitive sense that older memories are more likely

to be vague rather than vivid and thus this relationship is relatively unclear. Therefore, more research may be necessary to better define the relationship between sleep and memory vividness.

Finally, memory age was related to overall sleep quality and sleep latency so that poorer sleep quality and longer sleep latency corresponded to reports of older memories. Applying Walker's (2009) suggestion for memory valence, older memories may be more resistant to reduced sleep quality and longer sleep latency than more recent memories allowing them to be more readily retrieved. Alternatively, another possibility is that older memories have had more opportunities to be rehearsed and are thus more salient to the individual. However, as memory age did not correlate with rehearsal, this does not appear to be the case in the present study.

Also worth noting is that, contrary to findings of previous studies on autobiographical memory, depression and mood appeared to play a negligible role in the types of memories participants recalled. Not only did the BDI-II and the PANAS fail to correlate with the emotional valence of reported memories, which was the main reason for their inclusion, but they also failed to correlate with any of the additional characteristics of the autobiographical memories recorded. This contradicts findings for either mood congruent (Eich & Macaulay, 2000) or mood incongruent (Parrott & Sabini, 1990) memory, as the emotional valence of memories recalled neither matched nor opposed current mood states. Similarly, those reporting more depressed symptoms did not recall significantly more negative memories, as has been a relationship found in the past (Kuyken & Howell, 2000). However, the BDI-II did correlate with measures of sleep quality (PSQI), confirming a relationship between these two constructs. Although, as higher depressive symptoms corresponded with poorer sleep quality, the relationship that emerged challenges the idea of sleep deprivation acting as an aid for depressive symptoms (Sejnowski, 2010) and supports the idea that depression is comorbid with sleep difficulties (Dieter, 2007;

Jansson & Linton, 2007). These results suggest that sleep may be a more important contributing factor to emotional memory recall than either mood or depression and that further research on the relationship between sleep and depression is needed.

Limitations

There are limitations to the current study. Firstly, the data presented are correlational and thus cannot be definitively used to determine cause-and-effect relationships. As such, it cannot be said that poorer sleep efficiency causes one to remember more negative memories. It is possible that the causal direction is reversed, such that the tendency to recall more negative memories may lead to worry, anxiety, and rumination that interferes with sleeping. However, it is again important to note that depression was not found to be related to memory recall. Future studies should be designed to more carefully examine the causal order of these variables. In addition, future studies should employ alternative sleep measures to replicate and extend these findings (e.g., sleep diaries, wrist actigraphy).

Further, the current sample size was relatively small, which could affect the significance of the results obtained. This is especially significant for the substantial amount of predictors entered into the multiple regression analysis. Future studies which employ larger sample sizes are expected to adjust this shortcoming and provide more accurate figures.

Finally, due to the lack of previous research on the topic of sleep and autobiographical memory, there were no standardized measures of autobiographical memory to employ in the current study. The measure used was adapted from another study (Schlagman & Kvavilashvili, 2008) in which the measure was used for similar purposes. However, for the purposes of the current study, ratings of vividness, rehearsal, emotional valence, and age were the product of

participants' subjective perception. Future research is expected to provide more stringent methods for measuring such aspects of autobiographical memories.

Appendix

Table 1. Memory Characteristic Correlations

	Memory Characteristic			
	Vividness	Rehearsal	Emotional Valence	Age
Total Sleep Quality	-0.11	-0.01	0.03	0.20*
Sleep Duration	-0.07	-0.002	0.09	0.11
Sleep Latency	-0.16	-0.004	-0.02	0.21*
Daytime Dysfunction	-0.06	0.10	0.06	0.10
Sleep Efficiency	-0.21*	-0.06	-0.20*	0.14
Sleep Quality	-0.01	-0.01	0.12	-0.002
Sleep Medication	-0.03	-0.04	0.03	-0.01
Sleep Disturbance	-0.13	-0.03	0.04	0.07
Daytime Sleepiness	-0.03	0.15	-0.13	0.06
Depression	-0.003	0.15	-0.03	-0.02
Positive Affect	-0.05	-0.10	0.07	0.02
Negative Affect	-0.10	0.03	-0.14	-0.01

* Indicates significance at 0.05 level

Table 2. Predictors of Emotional Memory Valence

Predictor	β	t	p
Total ESS score	-0.19	-2.07	0.04
Total BDI score	-0.10	-0.81	0.42
Sleep Duration (PSQI)	0.21	1.74	0.08
Sleep Latency (PSQI)	-0.09	-0.84	0.40
Daytime Dysfunction (PSQI)	-0.02	-0.21	0.83
Sleep Efficiency (PSQI)	-0.29	-2.97	0.00
Sleep Quality (PSQI)	0.08	0.69	0.49
Sleep Medication (PSQI)	-0.02	-0.17	0.86
Sleep Disturbances (PSQI)	0.17	1.53	0.13
Positive Affect	0.09	0.93	0.35
Negative Affect	-0.17	-1.72	0.09

The total PSQI score was excluded from the model

References

- Atienza, M., & Cantero, J. L. (2008). Modulatory effects of emotion and sleep on recollection and familiarity. *Journal of Sleep Research, 17*, 285-294.
- Beck, A. T., Steer, R. A., Ball, R., & Ranieri, W. F. (1996). Comparisons of Beck Depression Inventories -IA and -II in psychiatric outpatients. *Journal of Personality Assessment, 67*, 588-597.
- Berntsen, D. (1998). Voluntary and involuntary access to autobiographical memory. *Memory, 6*, 113-141.
- Buysse, D. J., Reynolds, C. F., Monk, T. H., Berman, S. R., & Kupfer, D. J. (1989). The Pittsburgh Sleep Quality Index: A new instrument for psychiatric practice and research. *Psychiatry Research, 28*, 193-213.
- Dement, W. C., & Vaughan, C. (1999). *The Promise of Sleep*. New York: Dell Publishing.
- Dieter, R. (2007). Insomnia and comorbid psychiatric disorders. *Sleep Medicine, 8*, S15-S20.
- Drosopoulos, S., Wagner, U., & Born, J. (2005). Sleep enhances explicit recollection in recognition memory. *Learning and Memory, 12*, 44-51.
- Drosopoulos, S., Schulze, C., Fischer, S., & Born, J. (2007). Sleep's function in the spontaneous recovery and consolidation of memories. *Journal of Experimental Psychology, 136*, 169-183.
- Eich, E., & Macaulay, D. (2000). Are real moods required to reveal mood-congruent and mood-dependent memory? *Psychological Science, 11*, 244-248.
- Hu, P., Stylos-Allan, M., & Walker, M. P. (2006). Sleep facilitates consolidation of emotional declarative memory. *Psychological Science, 17*, 891-898.
- Jansson, M., & Linton, S. J. (2007). Psychological mechanisms in the maintenance of insomnia:

- Arousal, distress, and sleep-related beliefs. *Behaviour Research and Therapy*, *45*, 511-521.
- Johns, M. W. (1991). A new method for measuring daytime sleepiness: The Epworth Sleepiness Scale. *Sleep*, *14*, 540-545.
- Kuyken, W., & Howell, R. (2000). Facets of autobiographical memory in adolescents with major depressive disorder and never depressed controls. *Cognition and Emotion*, *20*, 466-487.
- Lemogne, C., Piolino, P., Friszer, S., Claret, A., Girault, N., Jouvent, R., Allilaire, J., & Fossati, P. (2005). Episodic autobiographical memory in depression: Specificity, autoneotic consciousness, and self perspective. *Consciousness and Cognition*, *15*, 258-268.
- Nishida, M., Pearsall, J., Buckner, R. L., & Walker, M. P. (2008) REM sleep, prefrontal theta, and the consolidation of human emotional memory. *Cerebral Cortex*, *19*, 1158-1166.
- Parrott, G. W., & Sabini, J. (1990). Mood and memory under natural conditions: Evidence for mood incongruent recall. *Journal of Personality and Social Psychology*, *59*, 321-336.
- Payne, J. D., Stickgold, R., Swanberg, K., & Kensinger, E. A. (2008). Sleep preferentially enhances memory for emotional components of scenes. *Psychological Science*, *19*, 781-788.
- Schlagman, S., & Kvavilashvili, L. (2008). Involuntary autobiographical memories in and outside the laboratory: How different are they from voluntary autobiographical memories? *Memory & Cognition*, *36*, 920-932.
- Sejnowski, T. (2010, April 7). In sleepless nights, a hope for treating depression. *The New York Times*. Retrieved from <http://opinionator.blogs.nytimes.com/2010/04/07/in-sleepless-nights-a-hopefor-treating-depression/?emc=eta1>
- Serrano, J. P., Latorre, J. M., & Gatz, M. (2007). Autobiographical memory in older adults with

- and without depressive symptoms. *International Journal of Clinical and Health Psychology*, 7, 41-57.
- Stanny, C. J., & Johnson, T. C. (2000). Effects of stress induced by a simulated shooting on recall by police and citizen witnesses. *American Journal of Psychology*, 113, 359-386.
- Wagner, U., Gais, S., & Born, J. (2001). Emotional memory formation is enhanced across sleep intervals with high amounts of rapid eye movement sleep. *Learning and Memory*, 8, 112-119.
- Wagner, U., Kashyap, N., Diekelmann, S., & Born, J. (2007). The impact of post-learning sleep vs. wakefulness on recognition memory for faces with different facial expressions. *Neurobiology of Learning and Memory*, 87, 679-687.
- Walker, M. P. (2009). The role of sleep in cognition and emotion. *The Year in Cognitive Neuroscience 2009*, 168-197.
- Watson, D., Clark, L., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology*, 54, 1063-1070.
- Yoo, S., Hu, P.T., Gujar, N., Jolesz, F. A., & Walker, M.P. (2007). A deficit in the ability to form new human memories without sleep. *Nature Neuroscience*, 10, 385-392.