The Effect of Sleep on False Memories

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Abstract

A false memory is recalling incorrect information or recalling an event that did not happen. Everyone is susceptible to false memories. There is no known cure or defense and relatively little is known about how they occur. Though there is relatively little known, much research shows sleep, consolidation specifically, is crucial to solidifying memories (Payne, Chambers, and Kensinger, 2012). Consolidation is a process where new, labile memories are integrated into the vast network of pre-existing long-term memories. A key component of this process is the active re-processing of these memories because this is the version of the memory that will be recalled (Diekelmann and Born, 2010). Memory is malleable, so it is important to understand how it is affected. This study seeks to find a connection between the number of hours of sleep a subject gets and how many times they experience a false memory. Using the Deese-Roediger-McDermott paradigm (DRM), subjects were asked to memorize three lists of 15 words all related to a single theme word. Then, subjects were asked to recall words from each list. A false memory was counted each time a subject mistakenly reported the theme word. We hypothesized that subjects sleeping a "normal" eight hours per night would experience fewer false memories compared to subjects who slept greater than eight or less than five hours per night. We sought to answer the question: is someone more or less susceptible to false memories based on the number of hours they sleep? However, results suggest there is not a significant relation between amount of sleep and false memory.

Keywords: false memory, consolidation, Deese-Roediger-McDermott paradigm

The Effect of Sleep on False Memories

A false memory is when someone reports something that did not actually happen or remembers it very different from how it actually happened (Roediger & McDermott, 1995). This error in memory happens involuntarily and often without the person realizing it because false memories can so closely resemble a person's actual experiences (Brainerd, Holliday, & Reyna, 2011). False memories are relevant to some high-stakes situations in which lives can depend on the truthfulness of what a someone is saying. Court cases, for example, often rely on eyewitnesses' testimonies to recount exactly what happened during an incident in question. When crucial details are missing in a case, eyewitnesses are usually the people who can place a suspect at a scene or assist in reconstructing a timeline of events (Quigley-McBride, Smalarz, & Wells, 2018). Incorrectly recalling the events in question can result in innocent people being convicted. So, it is important to understand what factors make someone more susceptible to false memories.

In a 1978 study, researchers showed that misleading postevent information can impair a person's memory of an original event (Loftus, Miller, & Burns, 1978). This means that the way eyewitnesses are questioned matters. A study conducted by researchers in 2001 showed it is possible to forcibly press witnesses into confabulating, or fabricating memories, in instances where they do not recall certain details by asking them leading questions (Zaragoza, Payment, Ackil, Drivdahl, & Beck, 2001). In a case like this, the eyewitness might, knowingly or unknowingly, speak about an event using details they did not recall on their own to appease law enforcement when they are using suggestive questioning and making them feel like they need to speak about an event in a certain way. For example, imagine there is an eyewitness to a car accident being questioned by police. An officer asks the eyewitness, "How fast were the cars

going when they *hit* each other?" and the eyewitness estimates based on their recollection. But, what if the officer asked, "How fast were the cars going when they *smashed into* each other?" (Figure 1). As the eyewitness thinks back to the accident, how bad they recall the accident having been could be altered by the format of the questions they are asked. Further, repeated postevent questioning can cause eyewitnesses to be more confident about details they were unsure of at the start. This "artificial" confidence can become their confident testimony, resulting in the witness naming someone innocent as the perpetrator of a crime (Shaw III & McClure, 1996). So, it is important to understand false memories to know when this is more likely to occur (Garrison, 2017).

Figure 1. Image of an imaginary car crash. This image depicts how leading questions can change eyewitnesses' memory. Taken from an experiment conducted by researchers Loftus and Palmer in 1974. They demonstrated that subjects would falsely remember there being glass at the crime scene if they were asked how fast the cars were going when they smashed into each other. But, found subjects would not when "hit" was substituted for "smashed into" (Loftus & Palmer, 1974).

Next, another component of memory is sleep. Sleep is a state that optimizes the consolidation of newly acquired information in memory (Diekelmann & Born, 2010). And, consolidation is a process that changes new, labile memories into more stable representations that are integrated into a vast network of pre-existing long-term memories (Diekelmann & Born,

2010). The consolidation mechanism strengthens associations during sleep which can be observed as stabilization of memory and as enhancement of memory. In other words, the memories are resistant to interference from other, similar memories and there is an observable increase in performance on memory-related tasks. The greatest benefits of sleep on memory are seen after an 8-hour night of sleep, 1-2-hour naps, and 6-minute naps (Diekelmann & Born, 2010).

A simple test of memory involves giving subjects a list of words to memorize and measuring how accurately they recall the words. The Deese-Roediger-McDermott paradigm (DRM) is a test of false memory which has subjects memorize a list or lists of words which are all related to a critical lure, or theme, word (i.e. if the lure word is sweet, the list might include: candy, sugar, tooth, and cake). The idea behind the DRM was originally conceived of from the observation that subjects were more likely to incorrectly report a nonrepresented word having been on a list when that word was semantically related to the other words. Researcher James Deese used this idea to construct the early stages of the DRM by constructing lists based on word association norms (Lampinen, Neuschatz, & Payne, 1997). In 1995, researchers Roediger and McDermott conducted experiments using Deese's model of word lists and showed that this false memory effect was not due to the serial position of the words or random guessing. Rather, they found that Deese's hypothesis was correct and that critical lure words were recalled often with more than half of the subjects reporting that they were sure the critical lure had been on the list (Roediger & McDermott, 1995). Many more studies were conducted by Roediger, McDermott and others that continued to replicate these findings, leading the DRM to become the most widely accepted and used measure of false memory.

Previous research has found a significant relation between the occurrence of false memories and the amount of sleep a subject got. One such study conducted in 2010 used the Deese-Roediger-McDermott paradigm to test which conditions produce false memories (Payne et al., 2009). To do so, researchers compared subjects assigned to a "sleep" group and a "wake" group. Subjects in the "sleep" group studied the DRM lists at 9 PM then returned at 9 AM to be tested, while subjects in the "wake" group studied the DRM lists at 9 AM and returned at 9 PM to be tested. Overall, they found that subjects in the "sleep" group remembered the lists significantly better than the "wake" group showing that the absence of sleep affects accuracy of recall (Payne et al., 2009).

Another study conducted in 2009, showed that false memory errors could be decreased after sleeping (Fenn, Gallo, Margoliash, Roediger III, & Nusbaum, 2009). They, similarly, split subjects into sleep and wake groups, which either studied the DRM lists at 10 AM or 10 PM. In the first experiment of the study, subjects were presented with the lists auditorily. In the second experiment, the subjects were presented with the lists visually. Both experiments produced similar results, however, in the second experiment, the researchers also showed that false memory errors increased in the sleep deprivation, or wake condition, as well as showing false memory errors decreased in the sleep condition (Fenn et al., 2009).

In the current study, we hypothesized that subjects who slept eight hours the previous night would experience fewer false memories compared to subjects who slept greater than eight or less than five hours the previous night. We sought to answer the question: is someone more or less susceptible to false memories based on the number of hours they sleep?

Methods

In the current study, we hoped to find a correlation between the number of hours of sleep subjects got and the number of false memories they experienced. To test false memory we used the DRM, a measure of false memories which requires subjects to memorize lists of words then tests them at recall. In this study, specifically, subjects memorized three lists of 15 words each (Figure 2). Each list was made up of words connected by a theme, or critical lure word. Every time subjects reported remembering this critical lure word, we counted it as a false memory. Other mistakes, such as reporting a word not shown on the list, were recorded as errors, but not as false memory errors, rather these were considered errors in accuracy. For example, subjects commonly reported words like alarm, night, and pillow, which are all related to the "sleep" themed list but are neither on the list nor the critical word.

Subjects were recruited from SONA, the University of Oregon's human subjects pool. The people in this pool are students enrolled in introductory psychology, and sometimes linguistics, courses. They are required to participate in a certain number of hours of empirical research for course credit. Subjects complete pre-screening questionnaires to be included in the pool.

Immediately following free recall of the lists, subjects were asked 4 questions about their previous night's sleep. The first question asked, "How many hours of sleep did you get last night?" The response options were 0-5 hours, 5-6 hours, 6-7 hours, 7-8 hours, or 8+ hours. The second question asked, "How much does this compare to how much you typically sleep?" The response options were "much less than normal," "slightly less than normal," "about normal," "slightly more than normal," and "much more than normal." The third question asked, "How awake/alert do you feel right now?" The response options were on a 9-point scale (1 = extremely

alert, 9 = extremely sleepy/fighting sleep). And, the fourth question asked, "How awake/alert do you typically feel at this time of day?" The response options were the same as the previous question.

List 1	List 2	List 3
Table	Thread	Bed
Sit	Eye	Awake
Seat	Sewing	Tired
Couch	Sharp	Dream
Desk	Point	Wake
Recliner	Prick	Snooze
Sofa	Thimble	Blanket
Wood	Haystack	Doze
Cushion	Thorn	Slumber
Swivel	Hurt	Snore
Stool	Injection	Nap
Sitting	Syringe	Peace
Rocking	Cloth	Yawn
Bench	Knitting	Drowsy
Chair	**Needle**	**Sleep**

Figure 2. Deese-Roediger-McDermott paradigm (DRM). These are the three lists of 15 words each that subjects memorized and recalled. The bolded words at the bottom are the theme words, also known as the critical lure words. Subjects did not see words during the experiment.

Results

Eighty-five subjects participated in this study. The average number of critical errors recorded was *M*= 1.671 (*SD*= 1.04). The average number of correct words reported (no errors, critical or otherwise) was *M*= 24.682 (*SD*= 6.182). And, the most selected "hours of sleep" option were the second and third options, *M*= 2.859 (*SD*= 1.125), meaning the average number of hours slept was about six or seven hours.

A correlational analysis showed there was not a significant relationship between the number of hours a subject slept, and the number of critical errors subjects made during recall, $r(85) = .062$, $p = .576$ (Figure 3). Further analysis showed a Bayes Factor of .16, suggesting very little evidence for a correlation. Also, no significant relationship was found between the subjects' accuracy and the number of critical errors they made, $r(85) = .104$, $p = .344$ (Figure 4). Figure 4 shows the correlation between the number of hours of sleep subjects got and their accuracy. In this study, accuracy means how correctly subjects recalled words that were on the list. Subjects were given scores of 1 for reporting a correct word and a score of 0 for reporting an incorrect word, whether it be one of the three critical lure words, a word not on any of the lists, or a misspelled word. Scores for accuracy and critical lure words were aggregated separately.

Lastly, in replication of previous research, there was a significant correlation between the number of hours a subject slept and their accuracy during recall, $r(85) = .223$, $p = .040$ (Figure 5).

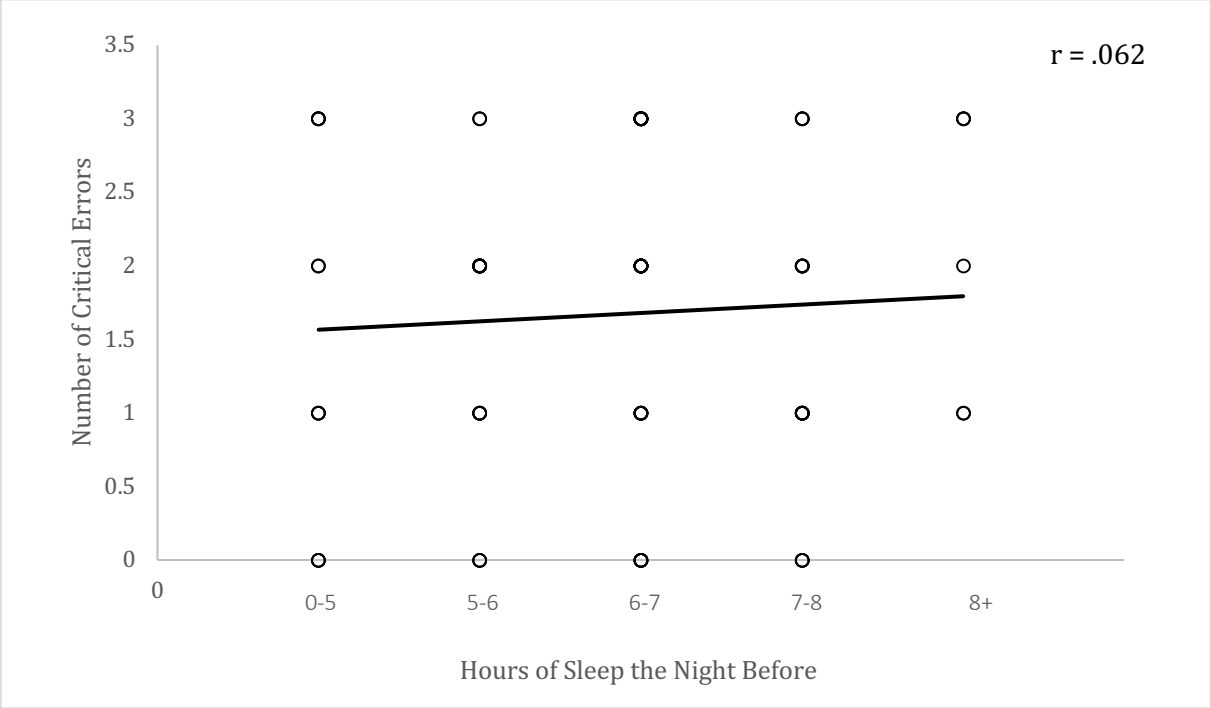

Figure 3. Scatterplot. Shows the correlation between the number of hours of sleep subjects got the previous night and the number of critical errors subjects made.

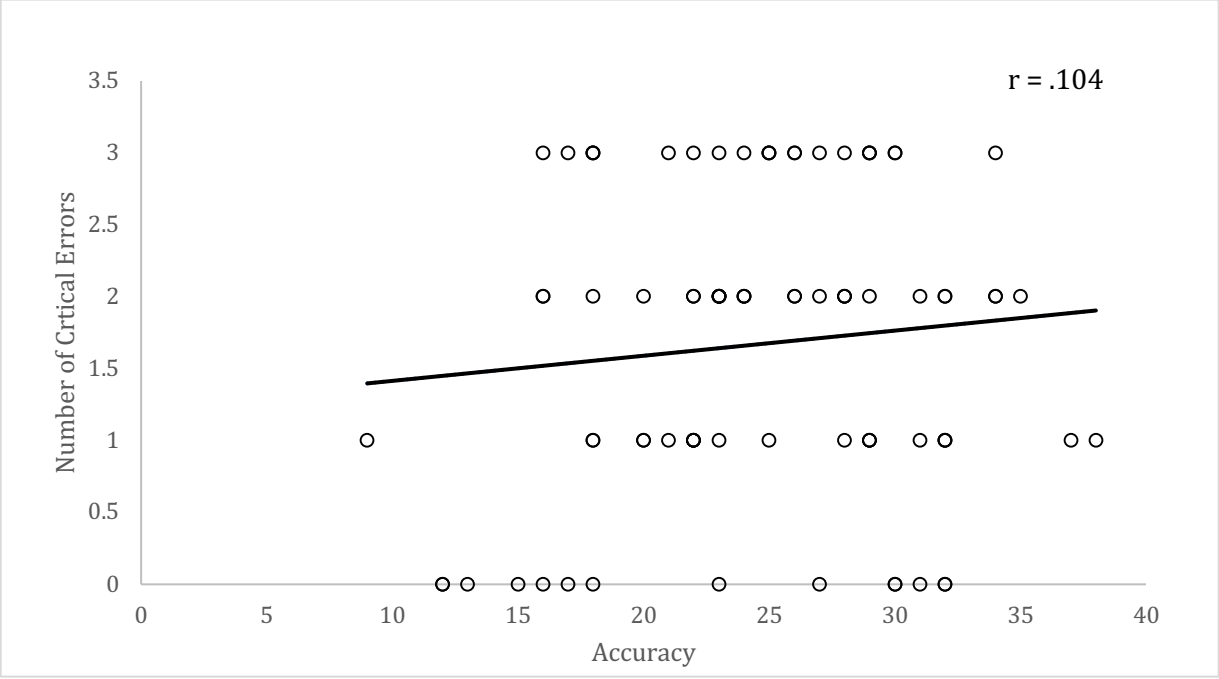

Figure 4. Scatterplot. Shows subjects' accuracy of recall and the number of critical errors they made.

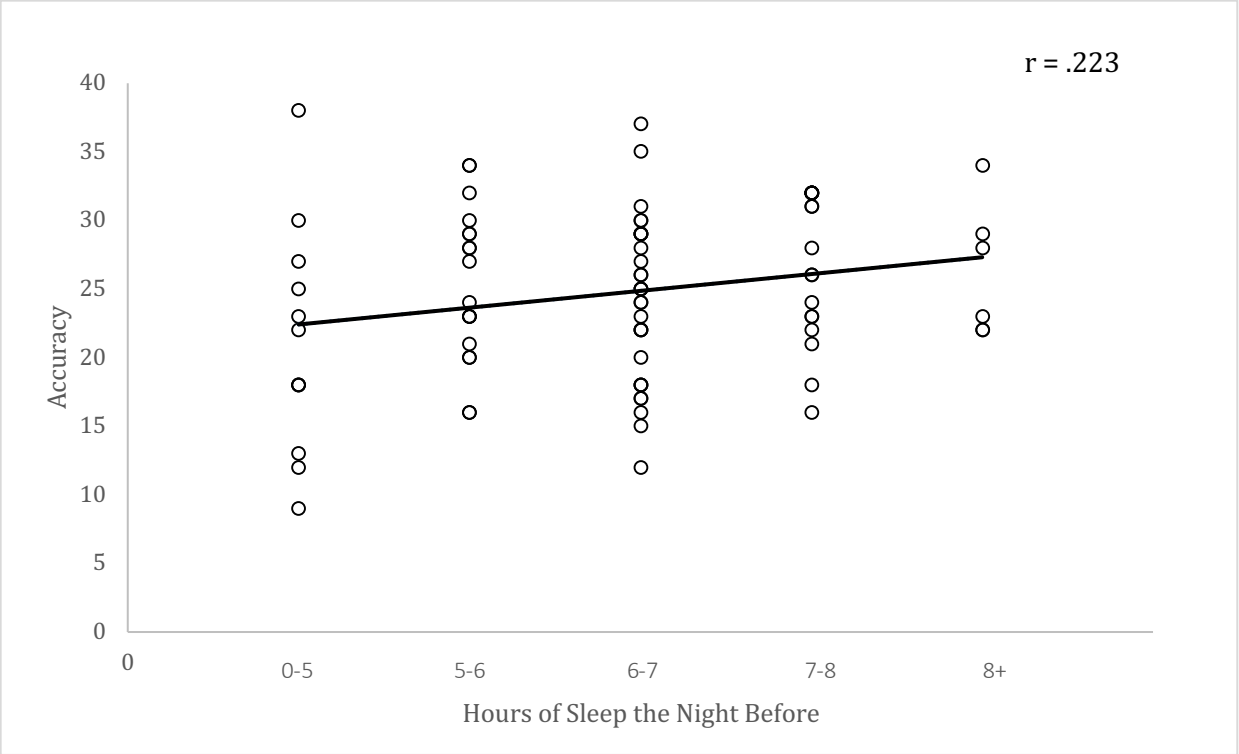

Figure 5. Scatterplot. Shows the correlation between the number of hours of sleep subjects got the previous night and their accuracy of recall.

Discussion

Although this study hoped to find a correlation between the number of hours of sleep subjects got and the number of false memories recorded during recall, no significant relation was found. These results suggest there is no association between sleep and false memories and that someone is not more or less susceptible to false memories based on how many hours of sleep they get. However, previous studies that found significant correlations between the same variables also manipulated their subjects' sleep.

In the current study, we measured sleep using a self-report questionnaire, which could be a reason why we were unsuccessful in replicating the previous studies' findings. For future research on this topic, it could improve findings if we measure sleep more precisely. Some ideas for doing this include in-lab, overnight sleep observations or having subjects keep a sleep diary (Figure 6). Sleep diaries are more detailed accounts of a subjects' sleeping habits and they provide data for a longer period of time, usually a week.

Further, just 85 subjects participated in the current study. This number was at the lower end of how many subjects we had hoped to include. To measure individual differences, we hoped for closer to 120 subjects.

Also, the DRM can be made up of many different words and critical lures, with some being better than others. This means DRM lists can vary in their associate strength (Fenn et al., 2009). The associate strength of the critical lure to the words on the DRM lists could have affected the subjects' ability to "recognize" the lure word. For example, if the critical lure word was not related to the other words enough, subjects would almost never or never report it. Alternatively, if the DRM lists used were too associated with their respective critical lures, the subjects might report them too often. Since List 3 had so many other "lures" brought in by

subjects (i.e. alarm, night, pillow), this might be something to consider for future experiments using the same lists.

Today's Date	4/5/18							
1. What time did you get into bed?	10:15 PM							
2. What time did you try to go to sleep?	11:30 PM							
3. How long did it take you to fall asleep?	55 min.							
4. How many times did you wake up, not counting your final awakening?	6 times							
5. In total, how long did these awakenings last?	2 hours 5 min.							
6a. What time was your final awakening?	6:35 AM							
6b. After your final awakening, how long did you spend in bed trying to sleep?	45 min.							
6c. Did you wake up earlier than you planned?	□ Yes □ No	□ Yes □ No	□ Yes □ No	□ Yes □ No	□ Yes □ No	□ Yes □ No	□ Yes □ No	□ Yes □ No
6d. If yes, how much earlier?	1 hour							
7. What time did you get out of bed for the day?	7:20 AM							
8. In total, how long did you sleep?	4 hours							

Figure 6. Consensus Sleep Diary. This is an excerpt from the Consensus Sleep Diary, which asks subjects questions about their sleeping habits. The questions get more detailed as they go on, and there are 21 questions total on the full version. Subjects are meant to complete the questions upon awakening. All answers included in the table are examples.

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