The Relationship Between Affect in Dreams and Emotional Memory Consolidation

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Abstract

Research in the field of cognitive neuroscience has focused on the role of sleep in various neurocognitive processes such as memory consolidation, however, an area that has not been fully researched is the role of dreaming in these memory processes. This study aimed to determine the relationship between affect experienced in dreams and emotional memory consolidation. Considering that REM dreams are laden with emotion and that emotion enhances memory, one possibility is that dreaming affect could also play a role in emotional memory consolidation. The hypothesis was that the greater the intensity of affect in a dream, the greater the memory retention will be for emotional information, but not neutral information. 126 healthy participants, aged 18 – 50, were recruited. On the night of the study, the participant viewed a series of pictures from the SA-APS in an online environment. Afterwards, they verbally recalled as many pictures as possible. The following morning, they were asked to recall any dreams and rate the emotional intensity of their dreams. Participants then again verbally recalled all the pictures that they could remember from the previous night. Contrary to the prediction, affect intensity, regardless of valence, did not predict memory consolidation of valenced information. The findings rather showed a general effect of dream affect intensity on overall memory retention. Furthermore, a specific emotion, fear, seemed to drive this general consolidation effect. The secondary analysis revealed that an increase in negative affect in dreams predicted better memory retention of negative information. Increased negative affect may create a need for increased mental processing and, in turn, support better memory consolidation. These findings have implications for psychiatric disorders, such as major depression, which is characterised by negative affect and increased memory sensitivity for negative stimuli.

Keywords: affect, dreams, emotional memory consolidation, REM sleep

List of Abbreviations

DSA	Department of Student Affairs
DSM-V	Diagnostic and Statistical Manual of Mental Disorders-V
DSM-IV	Diagnostic and Statistical Manual of Mental Disorders-IV
IAPS	International Affective Picture System
NREM	Non-Rapid Eye Movement
PTSD	Post Traumatic Stress Disorder
REM	Rapid Eye Movement
SA-APS	South African Affective Picture System
SRPP	Student Research Participant Programme
UCT	University of Cape Town

Table of Contents

List of Tables

List of Figures

Introduction

Research in the field of cognitive neuroscience has greatly focused on the role of sleep in various neurocognitive processes such as memory consolidation. However, an area that has not been fully researched is the role of dreaming in these memory processes. Dreaming is a universal human experience, yet the purpose of dreaming is still poorly understood.

Literature Review

Sleep research in the field of psychology and neuroscience has focused on the role of sleep in several emotional and cognitive processes (Walker, 2010), including those centred on the role of sleep-dependent learning, brain plasticity, and more recently emotion regulation and emotional processing. Despite the vast amount of sleep research, there are still contradictory research findings on the functions of sleep (Walker, 2010).

One area of sleep research that has received significant attention is the relationship between sleep and memory consolidation, particularly of neutral, declarative memory. Memory consolidation refers to the time-dependent process where recent information is integrated from short-term memory into long-term memory (Rauchs & Peigneux, 2012). Research has shown that one of the functions of sleep is to consolidate memory traces into long-term memory storage (Wamsley & Stickgold, 2011). During sleep, the cerebral blood flow to the frontal areas of the brain decreases, whereas activity in areas related to memory (e.g., medial prefrontal cortex, anterior cingulate, and the hippocampal complex) increases compared to wakefulness (Braun et al., 1997). Brain imaging studies also show the reactivation of brain regions responsible for encoding new memories during sleep. Reactivation of hippocampal memory traces is seen in hippocampal sharp wave ripples. These ripples then coordinate with thalamocortical spindles, which are thought to be a neurophysiological marker for memory redistribution (Schäfer et al., 2020). Therefore, memory consolidation ensures that recent experiences are transformed and restructured to be integrated into existing memory networks (e.g., Payne et al., 2009). This integration allows memories to be more useful in future, for example, to gain insight or draw inferences to aid decisions and future behaviours (Payne et al., 2009).

Sleep-dependent emotional memory consolidation, another aspect of declarative memory consolidation, has also received some attention. Emotional memory refers to the memories of information that is valenced and/or arousing (Kensinger & Murray, 2012). Some

studies suggest that emotional memory is enhanced during sleep (e.g., Hu, Stylos-Allan, & Walker, 2006; Payne, Stickgold, Swanberg, & Kensinger, 2008; Wagner, Gais, & Born, 2001). According to these studies, emotional memories are more readily consolidated compared to neutral memories (e.g., Hu et al., 2006; Nishida, Pearsall, Buckner, & Walker, 2009; Payne et al., 2008; Wagner et al., 2001; Wagner, Hallschmid, Rasch, & Born, 2006). According to Heuer and Reisberg (1990), emotional stimuli are remembered better than neutral stimuli in real-life events and laboratory studies. A possible explanation for this trend is that emotional memories are considered important in guiding future behaviours (Lipinska, Stuart, Thomas, Baldwin, & Bolinger, 2019; van der Helm & Walker, 2011). Therefore, if these emotional memories are preferentially consolidated, they are easily accessible when needed in future to guide behaviours or decisions. Neutral memories have a tendency to fade over time as they are less significant for future use (Lipinska et al., 2019). Studies have also shown that a period of sleep will enhance this preference for emotional stimuli over neutral stimuli even further (Kleinsmith & Kaplan, 1963; LaBar & Phelps, 1998; Levonian, 1972). Hu et al. (2006) conducted a study with 14 participants. The participants were exposed to an emotional memory task, the International Affective Picture System (IAPS), a collection of pictures with standardised emotional ratings. Participants completed the emotional memory task that involved an initial study period, which was followed by a recognition trial (12 hours later). The task was administered in two phases: once with 12 hours of sleep and once with 12 hours of wakefulness. This study concluded that emotional memory consolidation is selectively facilitated during sleep and that emotional stimuli were better remembered only after a period of sleep and more so than following a waking period (Hu et al., 2006).

There is, however, contradicting research and some studies have not demonstrated that effect (e.g., Atienza & Cantero, 2008; Bolinger, Born, & Zinke, 2018; Jones, Mackay, Mantua, Schultz, & Spencer, 2018; Morgenthaler et al., 2014; Tempesta, Socci, Dello Ioio, De Gennaro, & Ferrara, 2017). Atienza and Cantero (2008) conducted a study with 28 participants and found that although emotional images are better remembered than neutral ones, arousal played a much stronger role than valence. Bolinger et al. (2018), conducted a study with 16 participants and did not find preferential enhancement of negative stimuli over neutral. Therefore, in a review assessing the current literature, Lipinska et al. (2019), found that the existing literature does not conclude whether sleep preferentially consolidated emotional memories over neutral memories. The meta-analysis did, however, find that certain methodological aspects did allow for this preferential memory consolidation effect to be observed. This effect was especially seen when studies used free recall of memories rather

than recognition measures and also when the memory measures (free recall or recognition) were baseline controlled (i.e., delayed recall was controlled for initial learning) (Lipinska et al., 2019). Furthermore, this preferential consolidation effect was also found in studies that compared negative versus neutral information, as well as in studies that compared both positive and negative information combined versus neutral information.

Considering the contradictory evidence regarding emotional memory consolidation, it is likely that an additional factor, explaining these contradictions, has not been explored. Within the literature, the evidence points to some possible explanatory mechanisms. This consolidation effect (emotional over neutral memories) seems to occur when REM sleep is considered. According to Wagner et al. (2001), a preference for the consolidation of emotional texts over neutral texts was only seen after a period of REM sleep. This study recruited 23 participants and four years later the study was replicated with the same 23 participants and had the same findings (Wagner et al., 2006). In Nishida et al's. (2009) study, 31 participants were exposed to the IAPS. The study concluded that there is a significant enhancement of emotional memory following a period of REM sleep. In a recent meta-analysis of 34 sleep studies, Schäfer et al. (2020), concluded that when comparing REM sleep to NREM sleep, REM sleep has a greater influence on emotional memory consolidation than NREM. REM sleep is a unique sleep stage because, during this stage, individuals are likely to experience dreaming, particularly dreams that are longer and contain emotional content, in comparison to dreams elicited from NREM sleep. Dreams during NREM sleep are more likely to contain thought-like experiences than intense emotions (Smith et al., 2004).

While there is abundant and contradictory research on sleep and emotional memory consolidation, research on the relationship between dreaming and emotional memory consolidation during sleep is greatly lacking. Furthermore, the association between dreaming and sleep-dependent emotional memory consolidation may help to explain the contradictions in the literature. Some studies have loosely speculated about the link between sleep-dependent memory processing and emotions, imagery and thoughts experienced in dreams (e.g., Ji & Wilson, 2007; Payne & Nadel, 2004). Ji and Wilson (2007), theorised that the reactivation of memories seen in the sensory cortex during sleep might be related to the imagery experienced during dreaming. However, few studies have considered the subjective experience of dreaming and its relationship to emotional memory consolidation (Wamsley & Stickgold, 2011). One such study has found that the incorporation of a recent learning experience (i.e., a maze learning task) into a dream, resulted in better memory performance following a nap (Wamsley, Tucker, Payne, Benavides, & Stickgold, 2010). This same study

was replicated, and similar results were found following a full-night sleep (Wamsley & Stickgold, 2019). These two studies have established the association between dream content and memory consolidation. However, dreams are not only comprised of content. Dreams are laden with emotion. Since REM dreams are often highly emotionally charged and contain fragments of recent waking-life experiences (Fosse, Fosse, Hobson, & Stickgold, 2003), one speculative possibility is that the reactivation of these waking experiences paired together with emotional valence experienced in the dream helps to strengthen the consolidation process. It is well established that emotion enhances memory encoding and retrieval during waking life, therefore, if emotions are activated during dreaming there is reason to believe that this enhancement of memory consolidation will also be seen in dreaming. Apart from this reasoning, there is another related strand of reasoning as to why emotion in dreaming may enhance emotional memory consolidation. Many researchers posit that dreams are there to solve emotional problems to guide future behaviour (Cartwright, 1974; Lipinska et al., 2019; van der Helm & Walker, 2011). Therefore, considering that both emotional memory consolidation and dreaming likely exist to solve emotional problems and guide future behaviours, emotion during dreaming may modulate emotional memory consolidation to achieve this goal. Furthermore, there is a theory that suggests that the purpose of emotion is to achieve a state of homeostasis and that emotions arise because there is an unresolved cognitive task (Solms, 2019). Emotions, therefore, likely exist to signify that something needs to be resolved so that we can learn from previous experiences (i.e., our memory). Therefore, knowing that dreams are laden with emotions and contain elements of waking life, dreaming may modulate memory consolidation to help achieve this state of homeostasis.

It is important to consider how dream reports are collected as this may alter the quality of the reports. One aspect that does significantly influence dream content is a laboratory setting. A study done by Dement, Kahn, and Roffwarg, (1965), found that of 813 REM dream reports collected, 22% of participants incorporated some aspect of the laboratory setting in their dreams. Sleeping in an unfamiliar place would very likely overshadow any other stimuli introduced before sleep. Taking this into consideration, conducting home-collected dream report studies might be advantageous.

Despite there being a robust explanation for why dreams may be linked to memory consolidation, research that attempts to address this hypothesis is lacking (Wamsley & Stickgold, 2011). Considering the evidence that suggests the role of REM sleep in emotional memory consolidation and the knowledge that highly emotional dreams occur during REM sleep, the likelihood that dreams modulate emotional memories is reasonable.

Rationale, Aims and Hypotheses

This study aimed to determine the relationship between the affect experienced in dreams and emotional memory consolidation. A relationship between increased dream emotionality and increased emotional memory retention could lead to the conclusion that dreams assist in consolidating emotional memories.

It is well established (with some contradiction) that sleep, especially REM sleep, plays a role in emotional memory consolidation. Furthermore, the relationship between dream content and memory consolidation has also been considered. However, few studies have considered the role of emotion during dreaming in sleep-dependent emotional memory consolidation. Considering the fact that REM dreams are laden with emotion and that emotion enhances memory, one possibility is that dreaming could also play a role in emotional memory consolidation. This study follows this road of inquiry: the affect in dreams will modulate emotional memory consolidation, where affect refers to the subjective experience of emotions.

This hypothesis was tested:

- H1: The greater the intensity of affect in a dream (regardless of the valence), the greater the memory retention will be for emotional information, but not neutral information.

However, there is one important caveat that considers the possible differential roles of positive and negative emotions generated during dreaming. Based on previous data collected in UCT's psychology department, positive and negative affect in dreams may differentially modulate emotional memory consolidation. (Bonheim & Klipp, 2020). This was a small, underpowered pilot study that explored the role of dreaming in emotional memory consolidation. Preliminary findings suggest that where negative affect in dreams may be associated with poorer recall accuracy for valenced information, positive affect in dreams may be associated with better recall accuracy for the same kind of information (Bonheim & Klipp, 2020). This data was very preliminary, and it is presently unknown why this effect may occur. The directionality of the effect should, therefore, be considered with caution; however, their study does highlight the importance of investigating positive and negative dream affect contributions separately. The current study, therefore, also explored the valence-specific association between dream affect intensity and emotional memory retention as an alternative pattern in the data, tested by the hypothesis.

Methods

Design and Setting

This study followed a quasi-experimental design to investigate the relationship between affect in dreams and emotional memory retention. The independent variable is the dream emotionality reports and the dependent variable is emotional memory consolidation, as measured by memory retention. This study is a virtual-contact study and made use of at-home data collection. Participants completed all tasks at home or online, but I had virtual meetings with each participant.

Participants

Recruitment

Firstly, a power analysis was conducted to determine the number of participants required for the study to address the aims and hypotheses to a satisfactory manner. Few studies of emotional memory consolidation reported effect sizes, however, Hu et al. (2006) reported Cohen's d = 0.36 and Payne et al. (2008) reported partial eta squared = 0.2. Therefore, the range of the effect size (reported as Cohen's f) will be f = 0.18 – 0.5, where the average effect size will be f = 0.34. Conditions that will be controlled for include caffeine intake, smoking, age, gender, and sleep quality (i.e., total sleep time, sleep latency quality, number of awakenings, length of awakenings, and alertness upon waking). To achieve a statistical power of 0.8, an average effect size of 0.34, and ensure that the predictors are significant, at least 113 participants must be involved in the study.

Convenience sampling was used during the recruitment process which involved sending an email via the University of Cape Town's internal network and emailing system (DSA) and the Psychology Department's Student Participation Programme (SRPP). The email was sent out once via each channel over the course of one year. Overall, 444 potential participants completed the screening questionnaire. Of the 444 potential participants, 153 qualified for the study. A sample of 126 out of the 153 agreed to participate in the study. Therefore, the final sample included to participate in the study was comprised of 126 healthy participants, from a university population, aged 18-34 years old.

Exclusion Criteria

Participants were excluded from the study based on the following exclusion criteria:

1. Participants must be aged 18-50 years old. This age range is chosen to control for the effects of age on sleep and memory (Cherdieu, Reynaud, Uhlrich, Versace, & Mazza, 2014).

2. Participants should not suffer from a sleep disorder (e.g., insomnia) or psychiatric disorder (e.g., PTSD or major depression), as well as take medication for such.
3. Participants must not be sleep deprived (i.e., they must regularly sleep between 7-9 hours a night) or have significant sleep difficulties/disorders.
4. Participants should not suffer from any medical or neurological condition (e.g., head injury) that affects sleeping, dreaming or emotional and cognitive functioning.
5. Participants must not have a history of past, or current substance or alcohol abuse. Sleep and memory in those who make excessive use of alcohol or other substances will be affected (Park et al., 2015).
6. Participants must have access to a laptop/computer, phone and a stable internet connection.

Twenty-three participants were excluded for the following reasons: 20 were excluded due to not having a dream on the night of the study. A dream was defined as a long and bizarre story, an image that vanishes rapidly, or waking up thinking of the previous night's pictures they saw. Another three participants were excluded for caffeine intake after 10 am. The final sample size was 103 participants (female: n =73).

Materials and Measures

Screening Measures

A link to an online survey (Google Form) was sent to potential participants via email, whereby they were screened to ensure that they fall within the inclusion criteria for this study. The following screening measures were used:

The Pittsburgh Sleep Quality Index (PSQI, Smyth, 2000). The PSQI is a 9-item self-report questionnaire used to assess the quality of sleep in the past month. This questionnaire measures seven components of sleep, including sleep duration, sleep latency, sleeping medication, sleep disturbances, subjective sleep quality, habitual sleep efficiency, and daytime dysfunction. The scores for the seven components are summed and produce a global score. A global score of more than 5 is considered poor sleep quality, therefore, only participants with a global score of less than or equal to 5 were included in the study. The PSQI has an internal consistency and reliability coefficient (Cronbach's alpha) of 0.83 (Smyth, 2000).

The Patient Health Questionnaire for Depression-9 (PHQ-9, Kroenke, Spitzer, & Williams, 2001). The PHQ-9 is a self-report questionnaire, consisting of nine items that screen for and measure the severity of depression. The PHQ-9 considers the diagnostic

criteria of the DSM-IV for depression as well as other major symptoms often seen in depression. A score between 5-9 indicates minimal depressive symptoms, 10-14 shows mild depression, 15-19 is moderately severe depression and more than or equal to 20 indicates severe depression. Therefore, all participants with a score greater than 9 were excluded from the study. A score of more than or equal to 10 has a specificity and sensitivity of 88% accuracy for major depression (Kroenke et al., 2001). The PHQ-9 is a valid measurement for the South African population (Haas et al., 2020) as well as for other low-income countries such as Zimbabwe (Chibanda et al., 2016)

The 5-Item Primary Care Post-Traumatic Stress Disorder Screen (PC-PTSD-5, Prins et al., 2016). The PC-PTSD-5 is a questionnaire that consists of five yes or no questions to screen for PTSD according to the DSM-V criteria. Participants who answered 'yes' to three or more of the questions were excluded from the study. A cut-off score of three provides maximum sensitivity (Prins et al., 2016). The PC-PTSD-5 demonstrates high diagnostic accuracy and is also high in content and face validity relative to the DSM-V criteria. The PC-PTSD-5 has been used in South African studies (Haas et al., 2020)

Alcohol Use Disorders Identification Test Consumption (AUDIT-C, WHO, 2001). The AUDIT-C is a three-item instrument that screens for alcohol abuse or dependence and heavy drinking. The AUDIT-C is a shortened version of the AUDIT. The AUDIT-C is considered valid, practical and brief (Bush, Kivlahan, McDonell, Fihn, & Bradley, 1998). The scores on the AUDIT-C range from 0-12, where higher scores indicate a higher risk for behaviours such as heavy drinking or dependent drinking. A cut-off score of 3 for women and 4 for men is standard practice, however, according to DeMartini and Carey (2012), the cut-off scores should be more forgiving when considering university students because alcohol consumption is generally higher in students. Therefore, the cut-off scores that were used are 5 for women and 7 for men. Both the AUDIT and the AUDIT-C show similar abilities for detecting heavy drinking, alcohol abuse or dependency (Bush et al., 1998). The AUDIT-C has successfully been used in South African studies (Morojele et al., 2017).

The Drug Abuse Screening Test (DAST-10, Skinner, 1982). The DAST-10 is a 10-item yes or no questionnaire measuring the severity of drug dependence. Answering 'yes' to 3-5 questions indicate moderate drug abuse problems, 6-8 questions indicate substantial problems and 9-10 indicate severe drug abuse problems (Skinner, 1982). Therefore, participants who answered 'yes' to three or more questions were not included in the study. The DAST-10 demonstrates a good internal consistency range of 0.86 – 0.94 and can

discriminate between current versus non-current drug users (Yudko, Lozhkina, & Fouts, 2007).

Demographic Information and Medical History Questionnaire. An online questionnaire about demographic information (e.g., name, surname, gender, age, contact details etc.), medical history (e.g., medical conditions, medication, head injury etc.), and some sleep details were sent to the potential participants to complete.

Experimental Measures

The following experimental measures were used:

Sleep Diary (National Sleep Foundation, 2021). Participants were expected to complete the National Sleep Foundation's sleep diary for at least three days before their scheduled date, including on the night of the study. The sleep diary was used to assess the participants' sleep, ensuring that they are not sleep deprived and that they had a good quality sleep on the night of the study. This sleep diary provides information such as the time a participant went to bed, the number of times they woke up during the night, and if they had any difficulty falling asleep.

The South African Affective Picture System (SA-APS, Nestadt & Kantor, 2015). The SA-APS is an adapted version of the International Affective Picture System (IAPS) to be more appropriate for the South African population. The IAPS is a database consisting of pictures that fall into three categories, 'positive', 'negative', and 'neutral'. Examples of positive pictures include food, human and animal babies, or erotic pictures. Negative pictures include, for example, injured or deceased people, gun violence, or natural disasters and examples of neutral pictures are ordinary objects such as a CD or a bus, or human faces with a neutral expression. The SA-APS consists of 340 pictures (Nestadt & Kantor, 2015). For this study, a series of 72 pictures were chosen for the emotional memory task (i.e., 24 pictures from each valence category) (Ackermann, Hartmann, Papassotiropoulos, De Quervain, & Rasch, 2015). An additional four neutral pictures were used (two at the start of the slideshow and two at the end of the slideshow) to account for any primacy and recency effects. If participants recalled any of these four pictures, it was not considered part of their memory retention score (Ackermann et al., 2015).

Designing the Emotional Memory Task. The SA-APS pictures were inserted into an Excel spreadsheet and sorted according to their valence. Pictures with valence ratings between 1 and 3,99 were placed into a new sheet, named Negative, those ranging between 4 and 5,99 were placed into a sheet named Neutral and those ranging between 6 and 9 were

placed into a sheet named Positive. Each of the three new sheets was then arranged according to the arousal rating of the pictures (ordered from low to high arousal ratings). The top half of the Negative sheet was pasted into a new sheet, named Negative_Calm and the bottom half was named Negative_Aroused. The same was done for the Positive sheet. The Neutral sheet was not arranged according to arousal (Backs, Da Silva, & Han, 2005). The correct number of pictures was then chosen from each of the five spreadsheets by using the RandBetween Excel function to randomly generate row numbers. This procedure was followed to ensure a representative sample of the pictures regarding their valence and arousal properties.

The pictures corresponding to the randomly generated row numbers were then pasted into a PowerPoint presentation. The picture order was randomised but ensured that no more than four pictures from the same valence were shown consecutively (Ackermann et al., 2015). One black slide and one black slide with a white fixation cross were shown for 500ms each before a new picture. The picture was then presented for 2,5 seconds (Ackermann et al., 2015). After the participants watched the entire slideshow, they were instructed to verbally recall as many pictures as possible by describing each picture in as much detail as possible. Participants were prompted with phrases such as “Is there anything else you can remember?”. The task did not have a time limit and participants were also not told how many pictures there were.

Oral Dream Report Recording. Upon waking, participants were asked over the phone to give a spontaneous report of their dreams. Participants were probed with a question such as “What was going through your mind just before you up?”. This is a standard procedure for collecting dream reports (Cartwright, Luten, Young, Mercer, & Bears, 1998). Spontaneous home dream-recall reports have been used in other studies (Blagrove et al., 2011). After recalling their dreams, participants were asked to subjectively rate the affect they experienced in their dreams on a scale from zero to 10. The scale consisted of seven affects based on Panksepp’s theory of basic emotions (Panksepp, 1992). These include anticipation/seeking, anger/rage, anxiety/fear, sexual desire/lust, nurturance/care, grief, and joy/play (Van Der Westhuizen & Solms, 2015).

Procedure and Data Collection

Screening and Introductory Meeting

Interested participants received an email explaining the study and a link to an online screening questionnaire (via Google Forms). Potential participants signed a consent form agreeing to complete the screening questionnaire. The questionnaire consisted of the

following sections: Demographic details, medical details, PSQI, PHQ-9, PC-PTSD-5, AUDIT-C and DAST-10 which ensured that participants met the inclusion criteria. Eligible participants were then invited via email to partake in the study. Before participating, all participants were required to sign a consent form after reading the information provided about the procedure and purpose of the study. A 10-minute online introductory meeting was also held with each participant where the study was explained to them and a date and time for the night and following morning of the study was set. During this meeting, participants were instructed to abstain from alcohol and to have only one caffeinated drink (coffee, tea, etc.) in the morning before 10 am on the day of the study, if they were accustomed to drinking caffeine. Participants who were occasional smokers were also asked to not smoke on the day of the study. The participants were also given a trigger warning during this meeting that ensured that they were aware of the unpleasant pictures that they would see on the night of the study. Participants were required to complete a sleep diary for at least three days prior to their scheduled date, including on the night of the study.

Night-time Procedure

On the night of the study, the participant and I logged onto a Microsoft Teams (MS) Teams meeting at the scheduled time. Consent was obtained beforehand to record all the online sessions. The night-time procedure took approximately half an hour; therefore, these meetings were set to start half an hour before the participants' usual bedtimes. Before starting the emotional memory task, I confirmed that the participant's alarm was set for the correct time the following morning. This time was chosen by the participant as their usual wake-up time, as long as it was 7-9 hours from their usual bedtime. I also confirmed that the participant was using a laptop instead of a smartphone, as the pictures would likely be too small to see on a smartphone screen. Another trigger warning was given just before starting the slideshow. They were also encouraged to ask me to stop the presentation should they become too overwhelmed. Microphones and cameras were switched off to minimise any distractions for the participants.

The emotional memory task involved watching the slideshow that automatically played through all 74 pictures. Once the slideshow ended, I instructed the participant to "Tell me about as many pictures as you can remember, in as much detail as possible. The order in which you recall them does not matter". Participants were given as much time as they needed and were prompted if necessary. After the participant indicated that they cannot remember anything further, they were reminded to not do anything such as read or spend time on their

phone after the meeting ended. They were instructed to go to sleep as soon as possible, and the meeting was then ended.

Morning Procedure

The following morning, I phoned the participant at the prearranged time, just after their alarm would have gone off. These phone calls were also recorded. Upon answering the phone, the participant was asked "What was going through your mind just before you woke up?". If participants were confused by the question, they were asked more directly "What did you dream about?". If a participant could not recall a dream immediately, they were given a couple of minutes to think. After recalling their dreams, participants then verbally rated the affects experienced in their dreams on a scale from 0-10. I asked them to rate each of the following emotions: Anticipation, anger, anxiety, sexual desire, nurturance, grief, and joy.

After the dream reports, the participant completed the emotional memory task again. However, this time, they did not watch the slideshow. They were only instructed to recall as many pictures as they could from the previous night. They should include any new pictures that they might have remembered and any pictures that they already mentioned the previous night. After completing the emotional memory task, participants were thanked for participating and were reminded to submit their sleep diaries. I also conducted a debriefing phone call with each participant after they completed the study.

Data Analysis

IBM SPSS Statistics Package (version 28.0) and Microsoft Excel were used to analyse the data. The alpha level was set to $p<.05$. Descriptive statistics were generated to provide information about the sample characteristics, as well as the sample's dream affect and memory retention.

Descriptive Statistics

Dream Affect. The seven possible affects in dreams (seeking, rage, fear, lust, care, grief, and play) were measured on a scale from zero to 10. For each participant, a total for all seven affects was calculated (i.e., Total Emotions). For the secondary analysis, the seven affects were divided into two groups: positive and negative affect (i.e., Positive Emotions and Negative Emotions respectively). The positive affect group contained an average, for each participant, for the affects of seeking, lust, care, and play. The negative affect group contained an average, for each participant, for the affects of rage, fear, and grief.

Furthermore, comparison tests for nonparametric data, such as Wilcoxon signed-rank tests and Friedman tests, for multiple comparisons, were run to describe the differences in average dream affects.

Memory Retention. A memory retention score for positive, negative, and neutral information was calculated for each participant based on the pictures they recalled. An overall memory retention score was also calculated (Total Retention). Each picture that a participant correctly recalled was coded as either positive, negative, or neutral. Both an independent rater and I determined whether a picture was correctly described or not. Any differences were discussed until a conclusion was reached. Each category of valence was totalled and memory retention scores for each participant were calculated by dividing their morning memory recall by the night memory recall and then expressed as a percentage for each valence category. The retention scores do not consider which specific pictures had been initially recalled at the pre-sleep task, vs. those that had not been recalled but rather the number of pictures that were recalled from each valence category. Calculating memory retention scores for each participant outlines how the participants remembered information.

Furthermore, comparison tests such as repeated measures ANOVAs were run to describe the differences in average memory retention for each valence category.

After this, correlation analyses and general linear models were run.

Hypothesis Testing: Predicting Memory Retention Using Dream Affect

Correlation Analysis. Correlation analyses were conducted to determine whether any relationships between memory retention and overall dream affect exist. Pearson's R correlations were reported for all data that is normally distributed (a significance value of the Shapiro-Wilk Test greater than .05 indicates normality). However, for all nonparametric data, Spearman's Rho correlations were reported.

General Linear Models. General linear models were then run to predict memory retention using dream affect (Total Emotions) and to account for the control variables: age, gender, caffeine intake, smoking, and sleep quality. The control variable, sleep quality, consists of five separate components garnered from participant sleep diaries. These include total sleep time (in hours), sleep latency quality which refers to the ease with which a participant fell asleep, number of awakenings throughout the night, the total length of these awakenings (in minutes), and alertness which refers to how awake the participant felt upon waking. Separate correlation analyses were run on the memory retention scores and each of the five sleep quality variables. Only the sleep quality variables that had a significant

correlation with the memory retention scores were included in the general linear model. This method was chosen to avoid running many models and increasing type I error probability, as well as to avoid including too many terms within a model.

Secondary Analyses: Investigating the Independent Contributions of Positive and Negative Dream Affects on Memory Retention

Correlation Analysis. This time the data was used to run correlation analyses to determine whether any relationships between memory retention and positive or negative dream affect, as well as any individual affects exist. Again, Pearson's R correlations were reported for all normally distributed data and Spearman's Rho for all nonparametric data.

General Linear Models. There is a possibility that the positive and negative affects in dreams may differentially modulate emotional memory consolidation. Therefore, general linear models, with the same control variables, were performed to explore this possibility. The memory retention scores for positive, negative, neutral, and total retention for each participant were again used for these models. This time, the variables, Positive Emotions and Negative Emotions were used.

Lastly, if the general linear models for positive and negative affect significantly predicted memory retention, additional general linear models, with the same control variables, were run to explore the prediction of the seven individual affects on those memory retention scores.

Ethical Considerations

All study procedures were approved by the University of Cape Town Department of Psychology's Research Ethics Committee (UCT REC; PSY2021-018).

Informed Consent

All participants were asked to sign a consent form, whereby they agreed to participate in the study. The consent form detailed the purpose of the study and explained the procedure. The potential benefits and risks of participating in the study were also explained. It was made clear to the participants that their participation is voluntary and that they may withdraw from the study at any time without an explanation if they wish to do so. The researcher's and supervisor's email addresses were provided to all participants whereby they were allowed to ask any questions they might have had regarding the study or their involvement therein. All participants were 18 years or older, therefore, no parental consent was needed.

Confidentiality

Participants' names, surnames and contact details were collected to stay in touch throughout the study. However, it was made clear to all participants that their personal details will be kept confidential as detailed in the data storage section and their details will not be made known to anyone outside the research team. No participant's name or surname was included in the research but rather each participant was allocated a participant ID number. Therefore, participants were not personally identifiable. Their dream reports were also not linked to their names in the research and were, therefore, anonymous. All dream reports and emotional memory task results were kept in password-protected files and, on a password-protected laptop where only the researchers involved had access to the files.

Risks and Benefits

All participants were made aware, in both the informed consent form and verbally during the virtual data-collection meeting, that the pictures that they are going to see in the emotional memory task might elicit strong, possibly unpleasant, emotions. They were again reminded that they may withdraw from the study if they feel too unsettled by the images. There was also the possibility of having a bad dream/nightmare due to the pictures.

There were no direct benefits to participating in this study. All participants who were psychology students at UCT earned a total of 3 SRPP points for completing the screening questionnaire and participating in the study. Furthermore, other participants stood a chance to win one in four gift vouchers (R200 Pick n Pay voucher, R300 Woolworths voucher, R400 Takealot voucher, or R500 Takealot voucher).

Debriefing

The contact details of the Student Wellness Services at UCT were provided to each participant if they required a further debriefing after the emotional memory task. I checked in with participants after the emotional memory task for a debriefing and referred them to the UCT counselling services if necessary. All participants who agreed to participate completed the study procedure. No one reported feeling overly distressed or in need of further support. Participants were also screened to be free of psychopathology to mitigate the risk of emotional distress.

Results

Descriptive Statistics

Sample Characteristics

The initial sample included 126 participants; however, 20 participants did not report any dreams and were, therefore, excluded. Further, another three participants had to be excluded due to caffeine intake after 10 am. Additionally, six memory retention datapoints were excluded due to being extreme outliers (measured as greater than three interquartile ranges from the median). This method of outlier exclusion was chosen because of the nonparametric distribution of the data (Wang et al., 2021). Table 1 shows the frequencies of participant self-reported gender, caffeine intake, age, and smoking frequency within the sample. Caffeine intake indicates use on the day of the study. A participant was classified as a smoker if they reported any use of cigarettes or vaping that involved nicotine.

Table 1

Frequency of Scores for Sample Characteristics

Variable	Frequencies (%)
Participant gender	
Female	73 (70.87%)
Male	30 (29.13%)
Caffeine intake	
None	80 (77.67%)
Morning coffee	23 (22.33%)
Age	
18-25 years	93 (90.29%)
26-35 years	10 (9.71%)
Smoking	
Smoker	8 (7.77%)
Non-smoker	95 (92.23%)

Note. Percentages are reported in parentheses.

The sample consisted of 103 participants, with the majority being female (70.87%). Participant ages ranged from 18 to 34 years (M = 22.07, SD = 3.18) with most participants being between the ages of 18 and 25 years old (90.29%). Further, 92.23% of participants

were non-smokers and the majority of participants decided to have no caffeine on the day of the study (77.67%).

Table 2

Frequency of Scores for Sample Sleep Quality

Variable	Frequencies (%)
Total sleep time (Hours)	
<7	8 (7.77%)
7-9	95 (92.23%)
>9	0 (00.00%)
Sleep latency quality	
With difficulty	18 (17.48%)
After some time	34 (33.01%)
Easily	51 (49.51%)
Number of awakenings	
0	59 (57.28%)
1	24 (23.30%)
2	15 (14.56%)
3	5 (4.85%)
Length of awakenings (Min)	
0	59 (57.28%)
1-5	22 (21.36%)
6-10	8 (7.77%)
11-20	8 (7.77%)
>20	6 (5.83%)
Alertness	
Still tired	24 (23.30%)
Somewhat awake	53 (51.46%)
Wide awake	26 (25.24%)

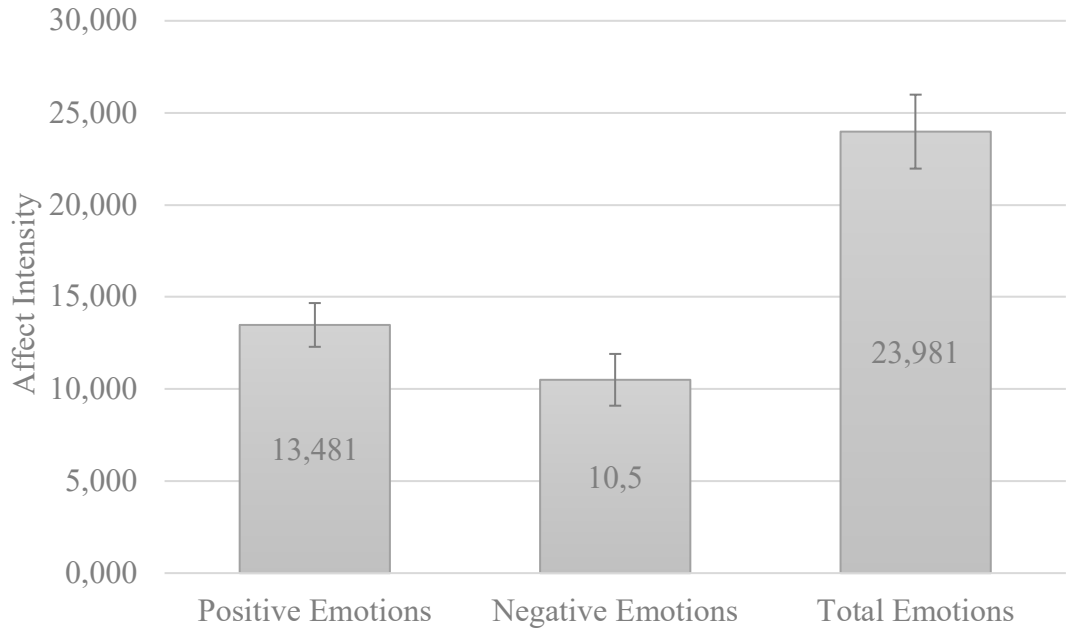
Note. Percentages are reported in parentheses.

Describing Participants' Sleep Quality

Table 2 shows the sleep quality data that was collected from the sleep diaries. The data presented reflects participants' sleep on the night of the study. Participants were instructed to sleep between 7-9 hours on the night of the study. The night-time and morning meetings were scheduled in such a way as to accommodate participants' usual bedtimes as long as they slept for 7-9 hours. The majority of participants managed to do so (92.23%), however, 7.77% of participants either struggled to fall asleep or woke up before their scheduled alarm and ended up sleeping for less than 7 hours. The shortest duration of sleep on the night of the study was 5 hours. Sleep latency quality refers to the subjective experience of the ease with which a participant fell asleep. The majority of participants felt as though they fell asleep easily (49.51%), whereas 17.48% experienced difficulty falling asleep after the emotional memory task. The sleep diary also measured night-time awakenings and the length of these awakenings. Most participants did not have any night-time awakenings (57.28%) and of those who did have awakenings, the majority only lasted between 1-5 minutes (21.36%). Lastly, the sleep diary also measured a participant's alertness (how awake they felt) upon waking the following morning. The majority of the participants rated that they felt 'somewhat awake' (51.46%), whereas 25.24% felt wide awake and 23.30% still felt tired.

Figure 1

Average Total, Positive and Negative Affects Reported in Dreams



Describing Participants' Dream Affect

Figure 1 shows the intensity of the affects that participants reported in their dreams, with the error bars indicating 95% confidence intervals. The highest possible affect score is 70 since each of the seven affects could be rated on a scale from zero to 10. Further, participants reported a higher intensity of positive emotions compared to negative emotions in their dreams. A Wilcoxon signed-rank test showed that this difference in average intensity of reported emotions is significant, with a small effect size (Z = -3.360, p = <.001, r = - .23).

Figure 2

Average Affects Reported in Dreams

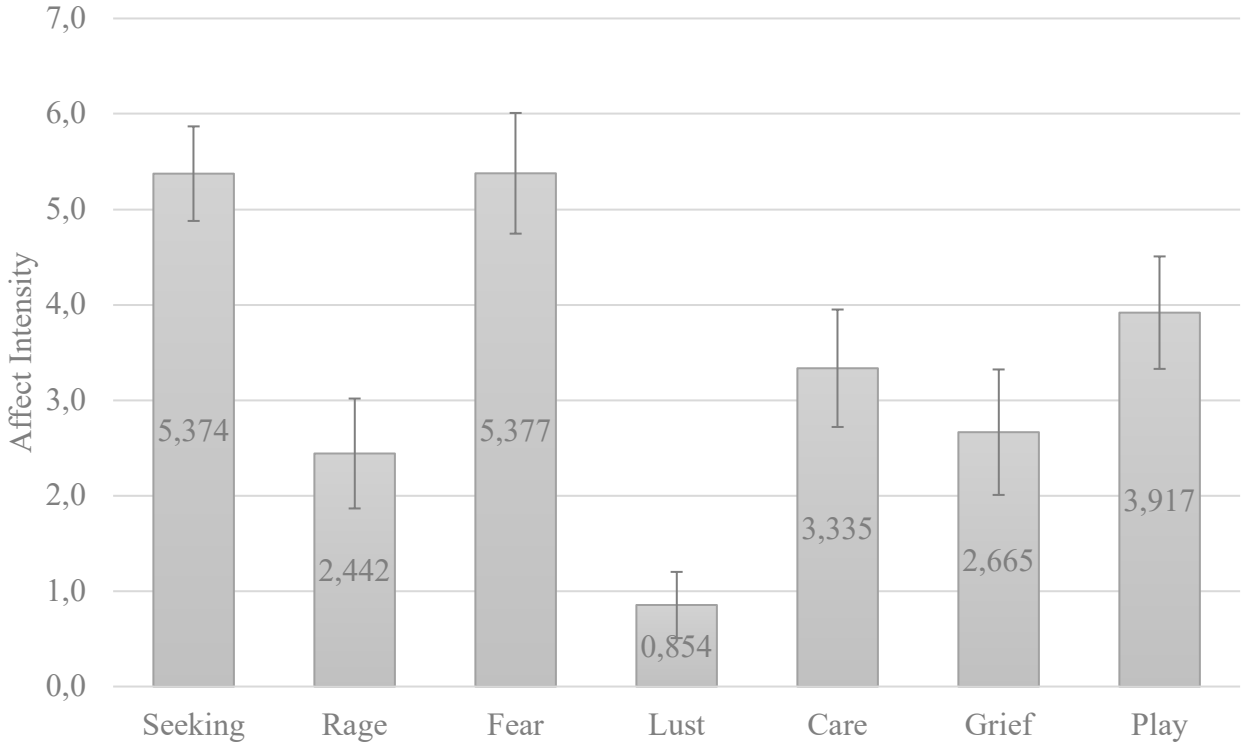
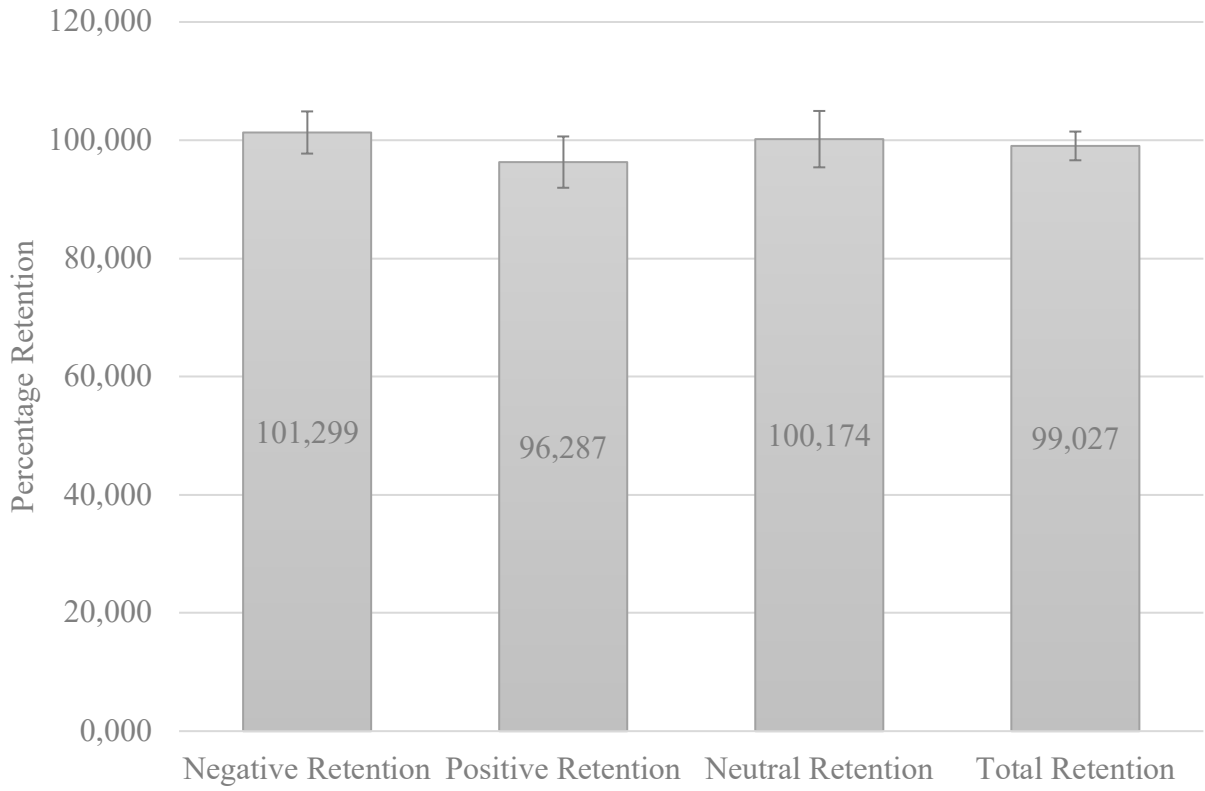


Figure 2 shows the intensity of the individual affects that participants reported in their dreams, with the error bars indicating 95% confidence intervals. The highest possible affect score is 10 since each of the seven affects could be rated on a scale from zero to 10. Fear was the highest reported affect, followed by anticipation/seeking. The affect with the lowest average intensity reported in dreams is sexual desire. A Friedman test showed that there is a significant difference between the individual affects reported $\chi^2(6) = 175.74$, p = <.001. Post hoc Wilcoxon tests revealed that participants endorsed a significantly greater feeling of seeking than rage, lust, care, grief, or play. They also endorsed a significantly greater feeling

of rage than lust. However, they endorsed a significantly lesser feeling of rage than fear or play. Participants endorsed a significantly greater feeling of fear than lust, care, or grief. Lastly, they also endorsed a significantly lesser feeling of lust than care, grief, or play.

Figure 3

Average Memory Retention Scores for Each Valence Category



Describing Participants' Emotional Memory Retention

Figure 3 shows the average total memory retention score, as well as an average memory retention score for each of the valence categories (negative, positive, and neutral), with the error bars indicating 95% confidence intervals. The average total retention was 99.03%, meaning that participants, on average, remembered approximately 99% of the pictures the following morning that they did the night before. When considering each valence, the average memory retention was the highest for negative retention. Participants retained 101.3% of negative pictures during the morning emotional memory task, compared to the night-time memory task. Participants, therefore, on average, remembered a very similar number of negative pictures before and after sleep. Retention for positive pictures where 96.29%, meaning that participants, on average, remembered slightly fewer positive pictures during the morning memory task compared to the night. Lastly, the average neutral retention

score was 100.17%, meaning that participants, on average, remembered a very similar number of neutral pictures during both the night-time and morning memory tasks.

A repeated measures ANOVA determined that the differences in average memory retention for each category (positive, negative, and neutral pictures), were not significant ($F(2, 194) = 2.122$, $p = .123$, $\eta p^2 = .021$). Therefore, the difference in average memory retention for all three categories was similar (i.e., positive retention was not significantly different to neural or negative retention). Appendix N shows participants' raw pre-and post-sleep memory performance.

Hypothesis Testing: Predicting Memory Retention Using Dream Affect

Correlations Between Overall Dream Affect Intensity and Emotional Memory Retention

Table 3

Correlation Analysis Between Overall Dream Affect and Emotional Memory Retention

	1	2	3	4
1. Total Emotions				
2. Negative Retention	.112			
3. Positive Retention	.079	.128		
4. Neutral Retention	.135	.029	.047	
5. Total Retention	.152	.695**	.619**	.452**

Note: Spearman's rho correlations are reported above. * p<.05, **p<.01

The data for the variables were not all normally distributed; therefore, Spearman's rho correlations are reported. The one-tailed correlations showed that Total Emotions has a weak positive correlation with Negative Retention and is not statistically significant ($p = .133$). Total Emotions also has a weak positive correlation with Positive Retention and is not significant ($p = .217$). Further, Total Emotions also has a weak positive correlation with Neutral Retention but is not statistically significant ($p = .089$). Lastly, Total Emotions has a weak positive correlation with Total Retention and is not significant ($p = .063$). The correlation analysis, therefore, shows that the overall affect in dreams had no significant correlation with overall or emotional memory retention.

Predicting Emotional Memory Retention Using Overall Dream Affect Intensity

Neither Total Emotion nor the other control variables had any significant influence on either Positive or Neutral Retention. Therefore, these are not discussed below but are

presented in Appendix K. The significant models for both Negative Retention and Total Retention are discussed below.

Table 4

Predicting Negative Retention Using Overall Dream Affect Intensity

Variable	*Type III SS*	*df*	*MS*	F	*p*	ηp ^{2}
Corrected Model	4664.719[a]	4	1166.180	3.996	.005	.143
Intercept	10223.024	1	10223.024	35.029	<.001	.267
Age	998.889	1	998.889	3.423	.067	.034
Alertness	2844.028	2	1422.014	4.872	.010**	.092
Total Emotions	820.445	1	820.445	2.811	.097	.028
Error	28017.382	96	291.848			
Total	1069091.735	101				
Corrected Total	32682.101	100				

Note: * p<.05, **p<.01. Model with the dependent variable, Negative Retention: Intercept + Age + Alertness + Total Emotion.

[a.] R Squared = .143 (Adjusted R Squared = .107)

This model indicates that there is no significant relationship between Negative Retention and Total Emotion when accounting for all of the control variables. Alertness had a significant effect on Negative Retention. Where Negative Retention was better when participants indicated that they felt “wide awake” upon waking (*M* = 109.82, *SD* = 20.83) compared to those who reported feeling “somewhat awake” (*M* = 97.07, *SD* = 14.65) or “still tired” (*M* = 101.05, *SD* = 19.0) upon waking, with a medium effect size. The overall model explained .107 variance, with a medium effect size.

Table 5

Predicting Total Retention Using Overall Dream Affect Intensity

Variable	*Type III SS*	*df*	*MS*	*F*	*p*	ηp^2
Corrected Model	2116.042[a]	3	705.347	5.171	.002	.137
Intercept	9367.267	1	9367.267	68.678	<.001	.412
Age	668.144	1	668.144	4.899	.029*	.048
Caffeine Intake	1110.082	1	1110.082	8.139	.005**	.077
Total Emotions	544.468	1	544.468	3.992	.048*	.039
Error	13366.647	98	136.394			
Total	1015738.852	102				
Corrected Total	15482.690	101				

Note: * p<.05, **p<.01. Model with the dependent variable, Total Retention: Intercept + Age + Caffeine Intake + Total Emotion.

[a.] R Squared = .137 (Adjusted R Squared = .110)

This model indicates that there is a significant relationship between Total Retention and Total Emotion when accounting for all of the control variables. Therefore, as Total Emotion in a dream increased, so did Total Retention, with a small effect size. Both Age and Caffeine Intake had a significant effect on Total Retention. Where the mean Total Retention was better for participants between the ages of 25 and 34 (M =103.4, SD = 16.22) and worse for younger participants, aged 18-24 (M = 99.8, SD = 12.8), with a small effect size. Total Retention was worse when participants had caffeine on the morning of the study (M = 93.57, SD = 10.71) compared to no caffeine on the day of the study (M = 100.62, SD = 12.44), with a medium effect size. The overall model explained .110 variance, with a medium effect size.

Secondary Analyses: Investigating the Independent Contributions of Positive and Negative Dream Affects on Memory Retention

Correlations Between Positive and Negative Dream Affect Intensity and Emotional Memory Retention

Table 6

Correlation Analysis Between Positive and Negative Affect and Emotional Memory Retention

	1	2	3	4	5
1. Positive Emotions					
2. Negative Emotions	.188*				
3. Negative Retention	.061	.096			
4. Positive Retention	.103	.065	.128		
5. Neutral Retention	.174*	.016	.029	.047	
6. Total Retention	.126	.103	.695**	.619**	.452**

Note: Spearman's rho correlations are reported above. * p<.05, **p<.01

The data for most of the above variables had a nonparametric distribution; therefore, Spearman's rho correlations are reported. The one-tailed correlations showed that Positive Emotions have a weak positive correlation with Negative Retention and is not statistically significant (p = .272). Positive Emotions also have a weak positive correlation with Positive Retention and is not significant (p = .153). Further, Positive Emotions have a weak positive correlation with Neutral Retention but is statistically significant (p = .040). Lastly, Positive Emotions have a weak positive correlation with Total Retention and is not significant (p = .104). The correlation analysis, therefore, suggests that the Negative Emotions experienced in dreams had no significant correlation with overall or emotional memory retention. However, it does suggest that an increase in Positive Emotions experienced in dreams leads to increased memory retention for neutral information.

Correlations Between Individual Dream Affect Intensity and Emotional Memory Retention

A more in-depth correlation analysis was also done to determine whether any of the seven separate affects in dreams had a relationship with memory retention. Spearman's rho correlations revealed no significant correlations between individual affects and Positive Retention or Neutral Retention. However, Total Retention and Negative Retention, both had significant correlations with some of the individual affects. These are reported in the tables below.

Table 7

Correlation Analysis for Negative Memory Retention and Individual Dream Affects

	1	2	3	4	5	6	7
1. Negative Retention							
2. Seeking	-.002						
3. Rage	-.030	.175*					
4. Fear	.180*	.403**	.216*				
5. Lust	.070	.071	.367**	.041			
6. Care	.123	.116	.158	.094	.278**		
7. Grief	.145	.205*	.456**	.447**	.173*	.492**	
8. Play	-.082	.102	-.176*	-.251**	.109	.060	-.262**

Note: Spearman's rho correlations are reported above. * p<.05, **p<.01

Spearman's rho correlations revealed that Negative Retention had a weak positive correlation with Fear and is statistically significant (p = .036). None of the other individual affects had a significant influence on Negative Retention. This correlation analysis shows that an increase in the affect, Fear, leads to an increase in memory retention for negative information.

Table 8

Correlation Analysis for Total Memory Retention and Individual Dream Affects

	1	2	3	4	5	6	7
1. Total Retention							
2. Seeking	-.018						
3. Rage	-.056	.175*					
4. Fear	.182*	.403**	.216*				
5. Lust	.064	.071	.367**	.041			
6. Care	.146	.116	.158	.094	.278**		
7. Grief	.165*	.205*	.456**	.447**	.173*	.492**	
8. Play	.019	.102	-.176*	-.251**	.109	.060	-.262**

Note: Spearman's rho correlations are reported above. * p<.05, **p<.01

Spearman's rho correlations revealed that Total Retention had a weak positive correlation with Fear and is statistically significant (p = .033). Total Retention also has a weak positive correlation with Grief and is statistically significant (p = .049). None of the other individual affects had a significant influence on Total Retention. The correlation analysis, therefore, shows that an increase in the affects of Fear or Grief in dreams leads to an increase in overall memory retention.

Predicting Emotional Memory Retention Using Positive and Negative Dream Affect Intensity

This study also set out to explore the valence-specific association between dream emotionality and emotional memory retention as an alternative pattern in the data, since positive and negative affects in dreams may differentially modulate emotional memory consolidation. Therefore, separate models were run to determine whether Positive or Negative Emotions in dreams had any significant effects on memory retention.

As with overall dream affect, positive and negative affect did not differentially modulate Positive or Neutral Retention. Therefore, these are also not discussed below but are presented in Appendix L. The significant models for both Negative Retention and Total Retention are discussed below.

Table 9

Predicting Negative Retention Using Positive and Negative Dream Affect Intensity

Variable	*Type III SS*	*df*	*MS*	*F*	*p*	ηp^2
Corrected Model	4097.056[a]	3	1365.685	4.634	.005	.125
Intercept	296743.847	1	296743.847	1006.965	<.001	.912
Alertness	3114.181	2	1557.091	5.284	.007**	.098
Negative Emotions	1294.618	1	1294.618	4.393	.039*	.043
Error	28585.045	97	294.691			
Total	1069091.735	101				
Corrected Total	32682.101	100				

Note: * p<.05, **p<.01. Model with the dependent variable, Negative Retention: Intercept + Alertness + Negative Emotion.

[a.] R Squared = .125 (Adjusted R Squared = .098)

This model indicates that there is a significant relationship between Negative Retention and Negative Emotion when accounting for all of the control variables. Therefore, as Negative Emotion in a dream increased, so did Negative Retention, with a small effect size. Alertness also had a significant effect on Negative Retention. Negative Retention was better when participants indicated that they felt "wide awake" upon waking (M = 109.82, SD = 20.83) compared to those who reported feeling "somewhat awake" (M = 97.07, SD = 14.65) or "still tired" (M = 101.05, SD = 19.0) upon waking, with a medium effect size. The overall model explained .098 variance, with a medium effect size.

Table 10

Predicting Total Retention Using Positive and Negative Dream Affect Intensity

Variable	*Type III SS*	*df*	*MS*	*F*	*p*	ηp^2
Corrected Model	2060.950[a]	3	686.983	5.016	.003	.133
Intercept	10806.022	1	10806.022	78.901	<.001	.446
Age	623.851	1	623.851	4.555	.035*	.044
Caffeine Intake	1067.102	1	1067.102	7.792	.006**	.074
Negative Emotions	489.375	1	489.375	3.573	.062	.035
Error	13421.740	98	136.957			
Total	1015738.852	102				
Corrected Total	15482.690	101				

Note: * p<.05, **p<.01. Model with the dependent variable, Total Retention: Intercept + Age + Caffeine Intake + Negative Emotion**.**

[a.] R Squared = .133 (Adjusted R Squared = .107)

This model indicates that there is a trend-level significant relationship between Total Retention and Negative Emotions when accounting for all the control variables. Therefore, as Negative Emotions in a dream increased, so did Total Retention, with a small effect size. Considering that Total Emotion also had a significant relationship with Total Retention, this finding suggests that Negative Emotion is the driving force for the consolidation effect seen. Further, both Age and Caffeine Intake had a significant effect on Total Retention. Where the mean Total Retention was better for participants between the ages of 25 and 34 (M =103.4, SD = 16.22) and worse for younger participants, aged 18-24 (M = 99.8, SD = 12.8), with a small effect size. Total Retention was worse when participants had caffeine on the morning of the study (M = 93.57, SD = 10.71) compared to no caffeine on the day of the study (M =

100.62, *SD* = 12.44), with a medium effect size. The overall model explained .107 variance, with a medium effect size.

Predicting Emotional Memory Retention Using Individual Dream Affect Intensity

Lastly, models were also run for individual affects for each of the memory retention variables if the previous models indicated significant effects of either positive or negative emotions on memory retention. No individual affects significantly predicted negative retention. Therefore, this is not discussed below, but is presented in Appendix M. There was, however, a trend level significance between Total Retention and Negative Emotions in the previous general linear model for Total Retention. Further, the correlation analysis also revealed that there are significant correlations between Total Retention and the individual affects, Fear and Grief. Therefore, the following model was run:

Table 11

Predicting Total Retention Using Individual Dream Affect Intensity

Variable	*Type III SS*	*df*	*MS*	*F*	*p*	ηp^2
Corrected Model	2316.465[a]	3	772.155	5.747	.001	.150
Intercept	9929.901	1	9929.901	73.911	<.001	.430
Age	682.514	1	682.514	5.080	.026*	.049
Caffeine Intake	1129.516	1	1129.516	8.407	.005**	.079
Fear	744.891	1	744.891	5.544	.021*	.054
Error	13166.225	98	134.349			
Total	1015738.852	102				
Corrected Total	15482.690	101				

Note: * p<.05, **p<.01. Model with the dependent variable, Total Retention: Intercept + Age + Caffeine Intake + Fear.

[a.] R Squared = .150 (Adjusted R Squared = .124)

This model indicates that there is a significant relationship between Total Retention and Fear when accounting for all the control variables. Whereby an increase in Fear experienced in a dream, led to better Total Retention, with a small effect size. This indicates that the negative emotion that is the driver of total memory retention, is fear. Further, both Age and Caffeine Intake had a significant effect on Total Retention, which was previously discussed. The overall model explained .124 variance, with a medium effect size.

Summary of Hypothesis Testing: Predicting Memory Retention Using Dream Affect

Overall dream affect intensity (Total Emotions) did not predict positive, negative or neutral memory retention. However, overall dream affect intensity did significantly predict overall memory retention (Total Retention). Therefore, as overall dream affect intensity increased, so did overall memory retention.

Summary of Secondary Analyses: Investigating the Independent Contributions of Positive and Negative Dream Affects on Memory Retention

Negative emotions in dreams significantly predicted negative retention, where an increase in negative emotions in dreams led to an increase in negative retention. Further, Negative emotions also predicted overall memory retention (Total Retention), although on trend-level significance. Lastly, the individual affect, Fear, significantly predicted overall memory retention (Total Retention). Therefore, as fear in a dream increased, so did overall memory retention.

Discussion

This study aimed to determine the relationship between the affect experienced in dreams and emotional memory consolidation, where affect refers to the subjective experience of emotions and where emotional memory consolidation was measured by memory retention for valenced information (i.e., positive and negative information). The hypothesis was the following: The greater the intensity of affect in a dream (regardless of the valence), the greater the memory retention would be for emotional information, but not neutral information. If such a relationship can be shown, then it could lead to the conclusion that dreams assist in consolidating emotional memories. Some research has shown that sleep, especially REM sleep, plays a role in emotional memory consolidation (Nishida et al., 2009; Schäfer et al., 2020; Wagner et al., 2001, 2006). However, this study is one of few that has considered dreaming, specifically the affect in dreams, to be a modulating factor in emotional memory consolidation. Research has shown that REM dreams are laden with emotions (Fosse et al., 2003), that dreaming includes elements of waking experience, and that emotion enhances memory in waking-life (Heuer & Reisberg, 1990); therefore, a possibility is that dreaming plays a role in emotional memory consolidation.

This study also considered the possible differential roles that positive and negative emotions can have on emotional memory consolidation based on preliminary findings in a study done by Bonheim and Klipp (2020). Their study showed that positive and negative dream affects modulated consolidation in different directions. While the study was too small

to consider the specific modulation effects as representative of real effects, it did highlight the importance of investigating independent positive and negative dream affect contributions.

Summary of Results

The primary hypothesis of the study stated that an increase in dream affect intensity would lead to an increase in memory retention for valenced information, but not neutral information. This hypothesis was, however, disconfirmed. Contrary to the prediction, affect intensity, regardless of valence, did not predict memory consolidation of valenced information, specifically. However, a separate model that focused on a broader view of the data showed that the overall affect in dreams significantly predicts overall memory retention (i.e., memory retention for all three categories of information – positive, negative, and neutral together). Furthermore, while neither positive nor negative affective categories predicted overall memory retention, fear as a specific emotion, seemed to drive this effect.

Furthermore, the study also set out to determine whether positive and negative affect in dreams could differentially predict memory retention for valenced information (i.e., positive and negative information). The results showed that negative affect in dreams significantly predicted memory retention for negative information. An increase in negative affect in dreams led to increased retention of negative information, but not positive or neutral information. Furthermore, this effect was not specific to any particular negative affect (fear, rage or grief). Positive affect in dreams had no significant effect on memory retention.

Lastly, there was a trend-level significant relationship between negative affect in dreams and overall memory retention, where an increase in negative affect predicted increased overall memory retention. The association between negative affect and negative memory retention is, therefore, likely contributing to this broader modulation of memory consolidation.

The General Effect of Dream Affect Intensity on Memory Consolidation

Studies have found that during REM sleep, emotional memories are preferentially consolidated over neutral memories (e.g., Nishida et al., 2009) and that REM sleep plays a role in the processing of emotional events (Lara-Carrasco, Nielsen, Solomonova, Levrier, & Popova, 2009). For this reason, it was possible that the affect in dreams would specifically modulate emotional memories, over neutral memories. Although the hypothesis that stated that increased affect in dreams would lead to increased memory retention for both positive and negative information, but not neutral information, was disconfirmed, this study has, however, shown that affect in dreams does have a broader effect on memory retention.

Emotion and sleep independently influence declarative memory (Nishida et al., 2009). It is well-established that emotion enhances memory consolidation (Tyng, Amin, Saad, & Malik, 2017). Therefore, if emotions are activated during dreaming, it can lead to the conclusion that this enhancement of memory consolidation will also be seen in dreams. The amygdala and the mesolimbic dopaminergic pathway play a role in emotion regulation and memory. These same structures and pathways also form the neurobiological basis for dreaming (Perogamvros, Dang-Vu, Desseilles, & Schwartz, 2013; Solms, 2000), which provides all the more reasons why dreams likely influence memory. Our finding that the overall affect in dreams leads to an increase in memory retention, supports this. The reactivation of waking experiences paired together with emotionality experienced in dreams likely helps to strengthen the consolidation process. Speculatively, memory traces (for positive, negative, and neutral information) that were being activated during dreaming, may have been activated in the context of affect. That is why this increase in overall memory retention is a general, rather than a specific effect.

While dream affect regardless of valence is responsible for this general effect, the specific emotion which seemed to have an important influence was fear. Fear was also one of the most elicited emotions in the dream ratings. Research has shown that the experience of fear signals the release of the stress hormone, cortisol (Hannibal & Bishop, 2014). It is also known that both cortisol secretion and REM sleep increase during the second half of the night (Vgontzas et al., 1997). Cortisol continues to rise during this time of the night to peak with the cortisol awakening response (Hirotsu, Tufik, & Andersen, 2015). Moreover, studies have shown that cortisol promotes sleep-dependent memory consolidation (Bennion, Steinmetz, Kensinger, & Payne, 2015). The study by Bennion et al. (2015), showed that this effect is more prominent when comparing negative to neutral memory consolidation. Although the current study's finding points to overall memory retention, instead of negative over neutral, the experience of fear and potential subsequent release of cortisol may have had similar effects. Therefore, the experience of fear in dreams during this part of the night, when cortisol secretion is at its highest, may have aided in the modulation of overall memory consolidation.

The Specific Effects of Dream Affect Intensity on Memory Consolidation

Negative Dream Affect and Negative Memory Retention

While this study found a general memory consolidation effect, it also found an effect that is specific to memory retention for negative information. The findings show that negative

affect in dreams significantly predicted memory retention for negative information. Previous research shows that sleep benefits the consolidation of emotionally negative memories (Nishida et al., 2009). Some studies have considered the underlying mechanisms of this trend. For example, Schäfer et al. (2020), found that the memory consolidation effect seen after sleep is linked to specific sleep stages for specific information (emotional versus neutral information). The findings of the current study suggest that dreaming, specifically experiencing negative affect in dreams, could be the underlying mechanism that contributes to the consolidation of negative memories.

Emotional memory consolidation is a necessary process that integrates new affective experiences into existing memory networks (e.g., Payne et al., 2009). This processing ensures that previous experiences and memories can be used in future to aid in decision-making and guiding behaviour. Many researchers have suggested that dreaming also exists to aid in the processing of emotions to guide future behaviour (Cartwright, 1974; Lipinska et al., 2019; van der Helm & Walker, 2011). Both emotional memory consolidation and dreaming, therefore, may exist for the same purpose. Negative affect in dreams might, therefore, be a way of modulating emotional memory consolidation to cope with and process novel negative experiences.

Several theories exist to explain the nature of affect and its adaptive functions. One such theory is that affect helps to achieve homeostasis or balance. Emotions are experienced when there is a cognitive task that is unresolved (Solms, 2019). There is an imbalance or uncertainty that arises from novel experiences which creates the existence of emotions.

An important evolutionary function of the brain is to predict future states in an ever-changing world. These predictions need to be continuously updated or changed as we experience novel situations (Den Ouden, Kok, & de Lange, 2012). This is the basis of ‘learning from experience’. However, prediction errors can occur when there is a mismatch between previous expectations of what would occur in a particular situation and reality. Prediction errors suggest that one’s model of the world needs to be updated (Den Ouden et al., 2012). Emotional responses occur as the brain’s way of preparing for action by using predictions from previously learnt experiences. This is an important adaptive function because these predictions will drive the appropriate physiological responses in uncertain situations. (Den Ouden et al., 2012). Uncertainty and affect appear to be fundamentally linked to one another. Emotional experiences are determined by assessing the balance between what is known and what is unknown, as well as the learned predicted consequences

(Carleton, 2016). Therefore, emotions will arise when then there is a mismatch between what is expected versus reality (i.e., a prediction error).

Affect is shaped by the perceived certainty of a situation (Anderson, Carleton, Diefenbach, & Han, 2019). However, when a prediction error occurs in a novel situation, uncertainty arises. Uncertainty is typically experienced as aversive and is often associated with negative affect, specifically anxiety, as it reveals an inability to perceive the world accurately and act appropriately (Anderson et al., 2019). This uncertainty calls for the processing of one's emotions (which are usually negative affect) to decrease the amount of uncertainty to achieve a state of homeostasis. This processing then leads to 'learning from experience' through reconsolidation (Solms, 2019). Reconsolidation refers to predictive-work-in-progress. It is the process whereby a retrieved labile memory restabilises (Alberini, 2011; Nader, Schafe, & Le Doux, 2000). Researchers suggest that uncertainty influences emotional states by encouraging mental simulation of potential future outcomes (Anderson et al., 2019).

The findings of this study showed that increased negative affect in dreams leads to an increase in memory consolidation for negative information. Dreaming may be the mental simulation that occurs as a way of coping with increased uncertainty in novel situations. As previously mentioned, negative affect and uncertainty are fundamentally linked. Therefore, the experience of negative affect in dreams suggests an increased feeling of uncertainty and, in turn, a need for processing to update one's model of the world. The evidence that this processing occurred during dreaming, is seen in the finding that with increased negative affect, there is increased emotional memory consolidation for negative information. The experience of negative affect in dreams (as a result of uncertainty in novel situations), therefore, aided the process of learning from experience and updating one's model of the world. The uncertainty is reduced and when similar situations arise one can use the updated model to make correct predictions and guide behaviour.

The General Versus Specific Modulation of Memory Consolidation

Contrary to other research, this study has not found that emotional memories are preferentially consolidated over neutral memories since there were no significant differences in memory retention before and after sleep for the different valenced categories. This result was somewhat unexpected since studies have generally found that this consolidation effect is seen especially during free recall tasks, such as the one that was used during this study (Lipinska et al., 2019). However, despite not seeing this preferential consolidation effect of

emotional over neutral memories, the overall affect in dreams still modulated the consolidation process, nonetheless. Two patterns seem to exist. Firstly, in a more general sense, affect, and more specifically fear, modulated overall memory retention. Secondly, in a more specific sense, negative affect modulated memory for negative information. The reasons for these different patterns in the data are not clear.

The meta-analysis done by Lipinska et al. (2019) found that the memory consolidation for emotional information (specifically, positive and negative information combined), was greater than for neutral information; however, this was only found in a small set of studies. This current study, shows a pattern of association between dream affect and overall memory retention, in the context of no valence-specific memory retention differences. Therefore, perhaps the affect in dreams is promoting an equal distribution of memories that do not favour a particular valence category. All information is retained better to balance and not be biased to a specific type of information, which is often seen in pathology such as major depression. Such individuals, for example, are biased towards negative information (Foland-Ross & Gotlib, 2012).

There is a second, more specific, pattern in the data, where the negative affect in dreams modulates memory retention for negative information. This alternative pattern in the data, suggests that there is a different mechanism at hand. This mechanism may foreground (i.e., preferentially consolidate) that which is salient to a person, over what is neutral to that person. Theoretically, the purpose of preferential memory consolidation is to improve memory for information that is salient either because of reward, emotion, or the knowledge of a future memory test, for example (Bennion, Payne, & Kensinger, 2016). These consolidated, salient memories can then be used to guide future behaviour or learn from experience. A study by Bennion et al. (2016), investigated how sleep-dependent memory consolidation prioritises information when multiple saliences exist. Their study concluded that after a period of sleep, goal-directed salience cues (i.e., knowledge of a future memory test, and reward, to a lesser extent) were prioritised over emotionally salient cues. These findings indicate that sleep may preferentially consolidate information based on how relevant it is for future use. Therefore, this alternative pattern in the data may lend support to other research, such as Bennion et al., (2016), where negative affect in dreams modulated negative information because it was potentially more salient than other categories of information.

In addition, the positive affect in dreams had no significant influence on memory retention. A possible explanation for this is that there is abundant evidence for an asymmetry in how people use positive and negative information. People tend to show a negativity bias

where negative information gets attended to, learnt from, and used much more readily than positive information (Vaish, Grossmann, & Woodward, 2008). Overall, positive affect and positive information were likely not salient enough to elicit the same effects seen with negative affect and negative information.

Implication of Findings

These findings can have implications for mood disorders such as depression, which are characterised by negative affect and increased memory sensitivity to negative stimuli (Hamilton & Gotlib, 2008). The findings of this study show that an increased experience of negative affect leads to an increase in memory consolidation for negative information. If mood disorders, such as depression already have a predisposition to the experience of negative affect, then experiencing emotionally negative dreams can perpetuate depressive states because it leads to an increased focus on negative information. This finding is supported by research that has found that therapeutic REM sleep deprivation can decrease symptoms of depression (Riemann, Krone, Wulff, & Nissen, 2020). Further, most antidepressants affect sleep by suppressing REM sleep, which is, in part, the mechanism of action of antidepressants (Riemann et al., 2020; Steiger & Pawlowski, 2019). A study by Sikka, Engelbrektsson, Zhang, and Gross (2022), found negative affect in dreams to be associated with next-day affect levels, where increased negative affect in dreams where associated with increased negative affect the following day. If patients with major depression, who have an increased sensitivity for negative affect, experience negative affect in their dreams they are more likely to have better memory for negative information as shown by the current study and experience more negative affect the following day (Sikka et al., 2022), which can all perpetuate symptoms of their depression. This offers a mechanistic explanation for why REM sleep deprivation can be effective in treating depression. Less REM sleep will likely result in fewer dreams with high negative emotionality and, therefore, less preferential consolidation of negative information.

Other Influencing Factors

The results revealed three additional factors, other than affect, that also significantly influenced memory retention that is worth discussing. These factors include age, caffeine intake, and alertness (how awake a participant felt upon waking).

Age

Age had a significant effect on overall memory retention, where older participants (aged 25-34) had better retention than younger participants (aged 18-24). This is a

counterintuitive finding since it would be expected that memory performance becomes worse with age. Although this age gap is not significantly large, and there is not much research that could explain this trend, one study did find that there is a slight increase in REM sleep percentage for women from the age of 19 to mid-thirties (Floyd, Janisse, Jenuwine, & Ager, 2007). The current study did have a sample consisting of more females (70.87%). This might suggest that younger participants got slightly less REM sleep and potentially had fewer emotional dreams and, therefore, benefitted less from the modulation of overall memory consolidation after dreaming, compared to older participants. This is, however, highly speculative, as there is not much literature on the difference in sleep and memory between people in their early twenties versus their early thirties.

Caffeine Intake

Caffeine intake had a significant effect on overall memory retention, where participants who opted to have a morning coffee retained less information overall compared to those who chose to not have any caffeine on the day of the study. Interestingly, some studies suggest that caffeine intake enhances memory performance (Borota et al., 2018; Sherman, Buckley, Baena, & Ryan, 2016) which is contradictory to the current study's findings. Further, the relationship between caffeine and REM sleep is not fully understood, where some studies have found that caffeine caused a reduction in the duration of REM sleep (e.g., Robillard, Bouchard, Cartier, Nicolau, & Carrier, 2015), whereas others have not found this (e.g., Drake, Roehrs, Shambroom, & Roth, 2013). Therefore, the possibility exists that participants who had caffeine had poorer overall memory retention because they might have had less REM sleep, which led to less affect-intense dreams and, in turn, benefitted less from the modulation of memory consolidation. However, this is also unlikely since those who opted to have caffeine, would have had it before 10 am and, theoretically, the caffeine should not influence REM sleep that long after consumption. The possibility of participants reporting their caffeine use inaccurately should also be considered. Nevertheless, the results revealed that caffeine intake had a medium effect size, meaning that these results have convincing effects.

Alertness

Alertness had a significant effect on the retention of negative information, where those who indicated that they felt wide awake upon waking, had better memory retention for negative information. Alertness is a component of sleep quality; therefore, feeling wide awake upon waking suggests good quality of sleep the night before. Better sleep quality (in

the form of alertness), likely led to better REM sleep and more affect-intense dreams, and participants, in turn, benefitted from increased consolidation of negative information. The results also revealed that alertness had a medium effect size, indicating some convincing effects. However, despite the prominence of these effects, dream affect effects still existed.

Understanding the Sample's Dream Affect and Memory Retention Characteristics

The data revealed that there were no significant differences between emotional memory retention (positive or negative retention) and neutral retention after sleeping. This was an unexpected result because as mentioned previously, studies have shown that emotional memories are preferentially consolidated over neutral memories. However, contradicting research still exists, and this study was still able to show that dream affect can modulate memory consolidation.

Furthermore, this study found that positive affect in dreams was more prominent than negative affect. Dream content studies have, however, shown that dreams are often negatively biased, where there is more negative content than positive content in dreams (Valli, Strandholm, Sillanmaki, & Revonsuo, 2008). A theory known as the Threat Simulation Theory also argues that this negativity bias in dreams is real as it allows for the repeated simulation of threatening events in dreams, which acts as a biological defence mechanism (Valli et al., 2008). Although the current study did not explore dream content but rather dream affect, it remains an unexpected finding that positive affect was more prominent. There is, however, a study that found that their participants had a positivity bias where they subjectively perceived more positive emotions in their dreams compared to a blind rater. This study found that this positivity bias in dreams was associated with more positive emotions in the morning which supports the theories on emotion regulation functions of dreaming (Barbeau, Turpin, Lafrenière, Campbell, & De Koninck, 2022).

Lastly, the current study also showed that the affects of seeking and fear were the most prominent in the participants' dreams, whereas lust was the least prominent. Other studies have also found fear to be one of the most, and lust to be one of the least reported affects in dreams (Conte et al., 2020). Furthermore, the other most prominent affect in dreams was seeking. Panksepp's SEEKING system, or 'reward system', refers to the neural networks that are responsible for drive, motivation and goal-seeking. These networks are active during REM sleep (Perogamvros et al., 2013). Researchers such as Solms (2000), have, therefore, proposed that the SEEKING system is responsible for the generation of

dreams. This explains why the affect, seeking, was so prominent in participants' dream affect ratings.

Limitations and Future Directions

This study has a few limitations.

First, to achieve appropriate statistical power, the original aim of the sample size was set at 113 participants. Although the study was conducted with 126 participants, several participants had to be excluded. The final sample size was 103 participants. The results of the study may have been more pronounced with a larger sample size. Future studies should aim to have a larger sample size to achieve potentially more pronounced results.

Second, this study only made use of subjective self-report ratings of affect in dreams. The affect of the *content* of dreams was not analysed. Studies have shown that self-ratings can often differ from external ratings of dream emotionality (Sikka, Feilhauer, Valli, & Revonsuo, 2017). Therefore, a limitation of the current study is that it only considers one type of dream affect reporting. Future studies should consider using more than one measure of dream emotionality, for example, self-report ratings as well as content analysis.

Third, this study made use of at-home data collection to minimise risk during the COVID-19 pandemic. However, in doing so, several aspects of the data collection procedure could not be carefully controlled. These include, whether participants slept at the agreed-upon times, whether their dreams were from REM or NREM sleep, whether they followed the instructions to not take in any other information after the emotional memory task, and any potential internet connectivity issues that may have influenced the memory task. Considering these limitations, future studies can opt for a sleep laboratory setting. However, research shows that a laboratory can influence the content of dreams (Dement et al., 1965), but not necessarily the emotionality. Therefore, if content analysis of dreams is an objective of the study, then at-home data collection would likely be better, whereas if only self-report emotionality measures are the objective, then a laboratory can serve to have more control over the above-mentioned factors and REM dreams, specifically, can be recorded.

Fourth, the sleep diary that was used did not have the correct entries to calculate a composite sleep quality score for each participant. Five separate sleep quality components were, therefore, used. A different sleep diary with a composite sleep quality score may have provided a better impression of participants' sleep quality. However, the individual components did provide the opportunity to have a more in-depth look at different aspects of sleep.

Fifth, the score for anxiety/fear was contrasted with a score for grief. This may have conflated the anxiety/fear score, especially relative to grief because fear and panic are, in fact, two distinct emotions but were treated as one entity. This potentially caused a disproportionately high average 'fear' score. As a more refined approach, future research may rather consider three separate negative affects namely, fear, panic, and grief. Alternatively, contrasting fear with the combined affects of panic/grief because panic and grief tend to co-occur.

Summary and Conclusion

This study set out to determine whether there is a relationship between the affect experienced in dreams and emotional memory consolidation. Contrary to the prediction, overall affect intensity, did not predict memory consolidation of valenced information. However, the overall affect in dreams significantly predicted overall memory retention. Furthermore, fear as a specific emotion seemed to drive this effect. This study, therefore, contributed to the understanding that affect in dreams has a general effect on memory consolidation. Furthermore, the study also contributed to the understanding of a more specific effect, where negative affect specifically predicted better memory retention for negative information. Negative affect in dreams can serve as a signal of uncertainty and mental work that needs to be done to update one's model of the world for past experiences to guide future behaviours. It also suggests that dreaming could be a potential mechanism for the process of 'learning from experience'. The findings of this study also have implications for the understanding of the mechanisms and potential treatment of mood disorders such as major depression. Those who suffer from depression may disproportionally consolidate negative memories, because of their increased sensitivity to negative affect, which in turn perpetuates the mood disorder.

Dreaming is a universal experience, and its function is still not fully understood. This study contributed to this understanding, but sleep research, with a specific focus on dreaming, is still needed. Research should focus on understanding the role of affect in dreams and its potential effects on mood disorders.

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Appendix A: Participant Recruitment Email (SRPP)

Dear Student,

I am currently completing a Master's in Neuropsychology and would like to ask you to participate in my study that aims to better understand the role that our dreams play in our emotional memories.

What will be expected of you?

- If you decide to participate in this study, you will be required to be available for an introductory meeting, as well as one night and the following morning.
- Everything will be conducted online via Zoom/MS Teams.
- On the night of the study, you will be asked to complete an emotional memory task which entails looking at a series of pictures (online via Zoom/MS Teams) and then recalling the pictures straight afterwards.
    - Some of the pictures will be unpleasant to look at. Pictures might be triggering or disturbing, for example, some violence or nudity will be present.
- You will then be expected to set an alarm for a prearranged time the following morning and then go to sleep. I will contact you via a phone call just after your alarm goes off. You will be asked to recall any dreams you might have had and rate the emotional intensity of your dream(s).
- You will then complete the emotional memory task again (online via Zoom/MS Teams).

What makes you eligible to participate?

- Anyone between the ages of 18 and 50.
- You are not diagnosed with PTSD, major depression, or other psychiatric or sleep disorders.
- You do not abuse alcohol or drugs.
- You do not take sleeping medication.
- You do not sleep very irregular/short hours.
- You are comfortable with conversing and completing tasks in English.

- You can see well when working on a screen.

Participate and you will earn 3 SRPP points!

1 Point = Screening questionnaire

1 Point = Night-time online meeting

1 Point = Morning online meeting

(Completion of the entire study will be required to award all 3 SRPP points).

Voluntary Participation:

Participating in this study is completely voluntary. You are welcome to withdraw from the study at any time, without explaining.

Confidentiality:

All personal information will be kept confidential, and all dream reports will be kept anonymous. The online meetings will be recorded; however, no participant will be personally identifiable, and all data will be stored on a password-protected laptop. Only the researcher and supervisor involved will have access to this data.

If you would like to participate and you think that you meet the criteria, please click on the link below to complete the screening questionnaire to determine whether you are an eligible candidate. The questionnaire should take you about 10 minutes to complete.

Click here to complete the screening questionnaire:

https://forms.gle/JCKBmTRozk15krty6

If you meet the criteria to be a participant, I will contact you via email.

Thank you for considering participating in my study!

If you have any questions regarding the study, please feel free to contact any of the following:

Liëtte du Plessis (Researcher): DPLLIE002@myuct.ac.za

Dr Gosia Lipinska (Supervisor): gosia.lipinska@uct.ac.za

If you have any questions about your rights as a research participant, you may contact Rosalind Adams at the Psychology Department (021 650 3417) or email (rosalind.adams@uct.ac.za).

Kind regards,
Liëtte du Plessis

Appendix B: Participant Recruitment Email (DSA)

Dear Student,

I am currently completing a Master's in Neuropsychology and would like to ask you to participate in my study that aims to better understand the role that our dreams play in our emotional memories.

What will be expected of you?

- If you decide to participate in this study, you will be required to be available for an introductory meeting, as well as one night and the following morning.
- Everything will be conducted online via Zoom/MS Teams.
- On the night of the study, you will be asked to complete an emotional memory task which entails looking at a series of pictures (online via Zoom/MS Teams) and then recalling the pictures straight afterwards.
    - Some of the pictures will be unpleasant to look at. Pictures might be triggering or disturbing, for example, some violence or nudity will be present.
- You will then be expected to set an alarm for a prearranged time the following morning and then go to sleep. I will contact you via a phone call just after your alarm goes off. You will be asked to recall any dreams you might have had and rate the emotional intensity of your dream(s).
- You will then complete the emotional memory task again (online via Zoom/MS Teams).

What makes you eligible to participate?

- Anyone between the ages of 18 and 50.
- You are not diagnosed with PTSD, major depression, or other psychiatric or sleep disorders.
- You do not abuse alcohol or drugs.
- You do not take sleeping medication.
- You do not sleep very irregular/short hours.
- You are comfortable with conversing and completing tasks in English.

- You can see well when working on a screen.

Participate and you could win your share of over R1000 in Woolworths, Takealot and PnP vouchers!

Voluntary Participation:
Participating in this study is completely voluntary. You are welcome to withdraw from the study at any time, without explaining.

Confidentiality:
All personal information will be kept confidential, and all dream reports will be kept anonymous. The online meetings will be recorded; however, no participant will be personally identifiable, and all data will be stored on a password-protected laptop. Only the researcher and supervisor involved will have access to this data.

If you would like to participate and you think that you meet the criteria, please click on the link below to complete the screening questionnaire to determine whether you are an eligible candidate. The questionnaire should take you about 10 minutes to complete.

Click here to complete the screening questionnaire:
https://forms.gle/JCKBmTRozk15krty6

If you meet the criteria to be a participant, I will contact you via email.

Thank you for considering participating in my study!

If you have any questions regarding the study, please feel free to contact any of the following:
Liëtte du Plessis (Researcher): DPLLIE002@myuct.ac.za
Dr Gosia Lipinska (Supervisor): gosia.lipinska@uct.ac.za

If you have any questions about your rights as a research participant, you may contact Rosalind Adams at the Psychology Department (021 650 3417) or email (rosalind.adams@uct.ac.za).

Kind regards,

Liëtte du Plessis

Appendix C: Consent Form for Screening Questionnaire

Title: The Relationship Between Affect in Dreams and Emotional Memory Consolidation.

Dear Participant,

Thank you for taking the time to complete the screening questionnaire. I am conducting a study and the first step is to find out who is interested in the study and who meets the criteria.

If you meet the criteria for the study, you will be invited to:

1. An introductory meeting, as well as one night and the following morning.
2. On the night of the study, you will be asked to complete an emotional memory task which entails looking at a series of pictures (online via Zoom/MS Teams). Some of the pictures will be unpleasant to look at.
3. There will be a brief phone call the following morning to recall your dreams.
4. You will then complete the emotional memory task again (online via Zoom/MS Teams).

This study aims to investigate what role dreams, specifically the emotions we experience while dreaming, play in the consolidation of recent emotional memories. Few studies have looked at the relationship between dreams and emotional memory consolidation, therefore, this study will help us to understand this possible relationship better.

The purpose of this questionnaire is to determine whether you meet the criteria to participate in the rest of the study.

During this questionnaire you will be asked questions regarding your medical history, your sleeping habits, your mental health (i.e., questions about depression and anxiety), and questions about your alcohol and drug use. All information will be kept confidential and will not be shared with anyone outside the research team.

Participating in this screening questionnaire is completely voluntary and you are welcome to

withdraw from the questionnaire at any time if you wish to do so. If you are a UCT undergraduate student, you will receive 1 SRPP point for completing the questionnaire.
By clicking “I agree”, you agree to voluntarily participate in this screening questionnaire, and that you have read and understood this consent form.

Appendix D: Screening Questionnaire

Demographic Information:

1. Full name and surname
2. UCT student number (If applicable)
3. Course code (If applicable)
4. Contact details (email address and phone number)
5. Highest level of education
6. Sex: Male Female Nonbinary Other
7. Do you independently earn the majority of your income?
    a. Income bracket
    b. Number of people in your household
8. Annual household income of parents or guardians.
    a. Number of people in your parents' or guardians' household
9. Date of birth
10. What is your country of origin?
11. What is your home language?
12. Do you have access to a phone, laptop and stable internet connection?

Medical information:

1. Are you currently on any medication? If yes, please list ALL medications.
2. Have you ever had a head injury? If yes, did you lose consciousness?
3. Please list all past and current medical conditions.
4. Have you ever been diagnosed with a psychiatric condition? If yes, please list the condition(s).
5. Have you ever been diagnosed with a sleep disorder? If yes, which disorder?
6. Are you smoker? If yes, please specify (type of smoking, i.e., cigarettes, vaping etc.; how often; and is nicotine involved?)
7. If there are any other details about your medical history, that you have not mentioned yet, please add them here:

Sleep Details:

1. If you wake up in the night, do you find it easy to fall asleep again?

2. How many hours of sleep do you get regularly?
3. If a dream is defined as a long and bizarre story, an image that vanishes rapidly, or a feeling of having dreamed, on average, how many mornings per week over the last couple of months did you wake up with a dream in mind?

Sleep quality screening (PSQI):

PITTSBURGH SLEEP QUALITY INDEX (PSQI)

INSTRUCTIONS: The following questions relate to your usual sleep habits during the past month only. Your answers should indicate the most accurate reply for the majority of days and nights in the past month. Please answer all questions.

1. During the past month, when have you usually gone to bed at night?

   USUAL BED TIME _____

2. During the past month, how long (in minutes) has it usually take you to fall asleep each night?

   NUMBER OF MINUTES _____

3. During the past month, when have you usually gotten up in the morning?

   USUAL GETTING UP TIME _____

4. During the past month, how many hours of actual sleep did you get at night? (This may be different than the number of hours you spend in bed.)

   HOURS OF SLEEP PER NIGHT _____

INSTRUCTIONS: For each of the remaining questions, check the one best response. Please answer all questions.

5. During the past month, how often have you had trouble sleeping because you...

	Not during the past month	Less than once a week	Once or twice a week	Three or more times a week
(a) ...cannot get to sleep within 30 minutes	☐	☐	☐	☐
(b) ...wake up in the middle of the night or early morning	☐	☐	☐	☐
(c) ...have to get up to use the bathroom	☐	☐	☐	☐
(d ...cannot breathe comfortably	☐	☐	☐	☐
(e) ...cough or snore loudly	☐	☐	☐	☐
(f) ...feel too cold	☐	☐	☐	☐
(g) ...feel too hot	☐	☐	☐	☐
(h) ...had bad dreams	☐	☐	☐	☐
(i) ...have pain	☐	☐	☐	☐
(j) Other reason(s), please describe _____ _____				
How often during the past month have you had trouble sleeping because of this?	☐	☐	☐	☐

	Very good	Fairly good	Fairly bad	very bad
6. During the past month, how would you rate your sleep quality overall?	☐	☐	☐	☐

	Not during the past month	Less than once a week	Once or twice a week	Three or more times a week
7. During the past month, how often have you taken medicine (prescribed or "over the counter") to help you sleep?	☐	☐	☐	☐
8. During the past month, how often have you had trouble staying awake while driving, eating meals, or engaging in social activity?	☐	☐	☐	☐

	No problem at all	Only a very slight problem	Somewhat of a problem	A very big problem
9. During the past month, how much of a problem has it been for you to keep up enough enthusiasm to get things done?	☐	☐	☐	☐

	No bed partner or roommate	Partner/ roommate in other room	Partner in same room, but not same bed	Partner in same bed
10. During the past month, how much of a problem has it been for you to keep up enough enthusiasm to get things done?	☐	☐	☐	☐

If you have a roommate or bed partner, ask him/her how often in the past month you have had...

	Not during the past month	Less than once a week	Once or twice a week	Three or more times a week
(a) ...loud snoring	☐	☐	☐	☐
(b) ...long pauses between breaths while asleep	☐	☐	☐	☐
(c) ...legs twitching or jerking while you sleep	☐	☐	☐	☐
(d) ...episodes of disorientation or confusion during sleep	☐	☐	☐	☐
(e) Other restlessness while you sleep; please describe	☐	☐	☐	☐

_____

_____

Depression Screening (PHQ-9):

Patient Health Questionnaire (PHQ-9)

Patient name: _____ Date: _____

1. Over the last 2 weeks, how often have you been bothered by any of the following problems?

	Not at all (0)	Several days (1)	More than half the days (2)	Nearly every day (3)
a. Little interest or pleasure in doing things.	❒	❒	❒	❒
b. Feeling down, depressed, or hopeless.	❒	❒	❒	❒
c. Trouble falling/staying asleep, sleeping too much.	❒	❒	❒	❒
d. Feeling tired or having little energy.	❒	❒	❒	❒
e. Poor appetite or overeating.	❒	❒	❒	❒
f. Feeling bad about yourself, or that you are a failure, or have let yourself or your family down.	❒	❒	❒	❒
g. Trouble concentrating on things, such as reading the newspaper or watching TV.	❒	❒	❒	❒
h. Moving or speaking so slowly that other people could have noticed. Or the opposite; being so fidgety or restless that you have been moving around more than usual.	❒	❒	❒	❒
i. Thoughts that you would be better off dead or of hurting yourself in some way.	❒	❒	❒	❒

2. If you checked off any problem on this questionnaire so far, how difficult have these problems made it for you to do your work, take care of things at home, or get along with other people?

❒ Not difficult at all ❒ Somewhat difficult ❒ Very difficult ❒ Extremely difficult

TOTAL SCORE _____

PTSD Screening (PC-PTSD-5):

ID # _____

PC-PTSD-5

Sometimes things happen to people that are unusually or especially frightening, horrible, or traumatic. For example:

- a serious accident or fire
- a physical or sexual assault or abuse
- an earthquake or flood
- a war
- seeing someone be killed or seriously injured
- having a loved one die through homicide or suicide.

Have you ever experienced this kind of event?

YES NO

If no, screen total = 0. Please stop here.

If yes, please answer the questions below.

In the past month, have you…

1. had nightmares about the event(s) or thought about the event(s) when you did not want to?

   YES NO

2. tried hard not to think about the event(s) or went out of your way to avoid situations that reminded you of the event(s)?

   YES NO

3. been constantly on guard, watchful, or easily startled?

   YES NO

4. felt numb or detached from people, activities, or your surroundings?

   YES NO

5. felt guilty or unable to stop blaming yourself or others for the event(s) or any problems the event(s) may have caused?

   YES NO

Alcohol Use Screening (AUDIT-C)

Alcohol Use Disorders Identification Test-Concise (AUDIT-C)

General Instructions

The Alcohol Use Disorders Identification Test-Concise (AUDIT-C) is a brief alcohol screening instrument. Please give a response for each question.

Segment: _ _

Visit Number: _ _

1. **How often do you have a drink containing alcohol?**
   - ☐ Never
   - ☐ Monthly or less
   - ☐ 2-4 times a month
   - ☐ 2-3 times a week
   - ☐ 4 or more times a week
2. **How many standard drinks containing alcohol do you have on a typical day?**
   - ☐ 1 or 2
   - ☐ 3 to 4
   - ☐ 5 to 6
   - ☐ 7 to 9
   - ☐ 10 or more
3. **How often do you have six or more drinks on one occasion?**
   - ☐ Daily or almost daily
   - ☐ Weekly
   - ☐ Monthly
   - ☐ Less than monthly
   - ☐ Never

Drug Use Screening (DAST-10)

Drug Abuse Screening Test, DAST-10

The following questions concern information about your possible involvement with drugs *not including alcoholic beverages* during the past 12 months.

"Drug abuse" refers to (1) the use of prescribed or over-the-counter drugs in excess of the directions, and (2) any nonmedical use of drugs.

The various classes of drugs may include cannabis (marijuana, hashish), solvents (e.g., paint thinner), tranquilizers (e.g., Valium), barbiturates, cocaine, stimulants (e.g., speed), hallucinogens (e.g., LSD) or narcotics (e.g., heroin). Remember that the questions *do not* include alcoholic beverages.

Please answer every question. If you have difficulty with a statement, then choose the response that is mostly right.

In the past 12 months...		**Circle**	
1.	Have you used drugs other than those required for medical reasons?	Yes	No
2.	Do you abuse more than one drug at a time?	Yes	No
3.	Are you unable to stop abusing drugs when you want to?	Yes	No
4.	Have you ever had blackouts or flashbacks as a result of drug use?	Yes	No
5.	Do you ever feel bad or guilty about your drug use?	Yes	No
6.	Does your spouse (or parents) ever complain about your involvement with drugs?	Yes	No
7.	Have you neglected your family because of your use of drugs?	Yes	No
8.	Have you engaged in illegal activities in order to obtain drugs?	Yes	No
9.	Have you ever experienced withdrawal symptoms (felt sick) when you stopped taking drugs?	Yes	No
10.	Have you had medical problems as a result of your drug use (e.g. memory loss, hepatitis, convulsions, bleeding)?	Yes	No
Scoring: Score 1 point for each question answered "Yes," except for question 3 for which a "No" receives 1 point.		**Score:**	

Appendix E: Consent Form (SRPP)

Title: The Relationship Between Affect in Dreams and Emotional Memory Consolidation.

Dear Participant,

I am currently a neuropsychology Master's student at the Department of Psychology at the University of Cape Town (UCT) and would like to ask you to participate in my study that aims to better understand the role that our dreams play in our emotional memories.

Purpose:

This study aims to investigate what role dreams, specifically the emotions we experience while dreaming, play in the consolidation of recent emotional memories. Few studies have looked at the relationship between dreams and emotional memory consolidation, therefore, this study will help us to understand this possible relationship better.

Procedure:

If you decide to participate in this study, you will be required to be available for an introductory meeting, as well as one night and the following morning. On the night of the study, you will be asked to complete an emotional memory task which entails looking at a series of pictures (online via Zoom/MS Teams) and then recalling the pictures straight afterwards. Some of the pictures will be unpleasant to look at. Pictures might be triggering or disturbing, for example, some violence or nudity will be present. You will then be expected to set an alarm for a prearranged time the following morning and then go to sleep. I will contact you via a phone call just after your alarm goes off. You will be asked to recall any dreams you might have had and rate the emotional intensity of your dream(s). You will then complete the emotional memory task again (online via Zoom/MS Teams).

Possible Risks:

Some of the pictures might elicit strong emotions or will be unpleasant to look at. You might experience some uncomfortability. Pictures might be triggering or disturbing, for example, some violence or nudity will be present. You are welcome to withdraw from the study at any time, without providing an explanation, if any feelings of distress or discomfort are

overwhelming. You are welcome to contact UCT's Student Wellness Services (021 650 1017) for a debriefing. I will also have a short debriefing meeting with you after your participation in the study.

Possible Benefits/Compensation:

There are no direct benefits for participating in this study. Your participation will, however, be contributing to current research on understanding the role that dreams play in emotional memory consolidation. All those who fully complete their participation in the study will also receive 3 SRPP points.

Voluntary Participation:

Participating in this study is completely voluntary. As mentioned previously, you are welcome to withdraw from the study at any time, without explaining.

Confidentiality:

All personal information will be kept confidential, and all dream reports will be kept anonymous. No participant will be personally identifiable, and all data will be stored on a password-protected laptop. Only the researcher and supervisor involved will have access to this data.

Contact Details:

If you have any questions regarding the study, please feel free to contact any of the following:

Liëtte du Plessis (Researcher): DPLLIE002@myuct.ac.za

Dr Gosia Lipinska (Supervisor): gosia.lipinska@uct.ac.za

If you have any questions about your rights as a research participant, you may contact Rosalind Adams at the Psychology Department (021 650 3417) or email (rosalind.adams@uct.ac.za).

By ticking "I agree", you agree to voluntarily participate in this research study, and that you have read and understood this consent form.

☐ I agree

_____	_____
Name and Surname	Signature

Appendix F: Consent Form (DSA)

Title: The Relationship Between Affect in Dreams and Emotional Memory Consolidation.

Dear Participant,

I am currently a neuropsychology Master's student at the Department of Psychology at the University of Cape Town (UCT) and would like to ask you to participate in my study that aims to better understand the role that our dreams play in our emotional memories.

Purpose:

This study aims to investigate what role dreams, specifically the emotions we experience while dreaming, play in the consolidation of recent emotional memories. Few studies have looked at the relationship between dreams and emotional memory consolidation, therefore, this study will help us to understand this possible relationship better.

Procedure:

If you decide to participate in this study, you will be required to be available for an introductory meeting, as well as one night and the following morning. On the night of the study, you will be asked to complete an emotional memory task which entails looking at a series of pictures (online via Zoom/MS Teams) and then recalling the pictures straight afterwards. Some of the pictures will be unpleasant to look at. Pictures might be triggering or disturbing, for example, some violence or nudity will be present. You will then be expected to set an alarm for a prearranged time the following morning and then go to sleep. I will contact you via a phone call just after your alarm goes off. You will be asked to recall any dreams you might have had and rate the emotional intensity of your dream(s). You will then complete the emotional memory task again (online via Zoom/MS Teams).

Possible Risks:

Some of the pictures might elicit strong emotions or will be unpleasant to look at. You might experience some uncomfortability. Pictures might be triggering or disturbing, for example, some violence or nudity will be present. You are welcome to withdraw from the study at any time, without providing an explanation, if any feelings of distress or discomfort are

overwhelming. You are welcome to contact UCT's Student Wellness Services (021 650 1017) for a debriefing. I will also have a short debriefing meeting with you after your participation in the study.

Possible Benefits/Compensation:

There are no direct benefits for participating in this study. Your participation will, however, be contributing to current research on understanding the role that dreams play in emotional memory consolidation. All those who fully complete their participation in the study will also stand a chance to win one of four vouchers (R200 Pick n Pay voucher, R300 Woolworths voucher, R400 Takealot voucher, or R500 Takealot voucher).

Voluntary Participation:

Participating in this study is completely voluntary. As mentioned previously, you are welcome to withdraw from the study at any time, without explaining.

Confidentiality:

All personal information will be kept confidential, and all dream reports will be kept anonymous. No participant will be personally identifiable, and all data will be stored on a password-protected laptop. Only the researcher and supervisor involved will have access to this data.

Contact Details:

If you have any questions regarding the study, please feel free to contact any of the following:

Liëtte du Plessis (Researcher): DPLLIE002@myuct.ac.za

Dr Gosia Lipinska (Supervisor): gosia.lipinska@uct.ac.za

If you have any questions about your rights as a research participant, you may contact Rosalind Adams at the Psychology Department (021 650 3417) or email (rosalind.adams@uct.ac.za).

By ticking "I agree", you agree to voluntarily participate in this research study, and that you have read and understood this consent form.

☐ I agree

_____ _____

Name and Surname Signature

Appendix G: Consent Form for Audio Recording

In light of the COVID-19 pandemic, this study will be conducted virtually. The dream recall will happen telephonically and/or during a virtual Zoom meeting. Therefore, this serves as a consent form to audio record our phone calls and virtual meetings during the study. This means that your dream reports that you will be giving will be recorded for research purposes. The recordings may be transcribed and used in the research; however, your personal information and identity will not be included in the research at all. I will maintain confidentiality at all times.

All recordings will be deleted after the research is completed and you can request access to the recordings if you wish to listen to them.

To request a recording, please feel free to contact:
Liëtte du Plessis (Researcher): DPLLIE002@myuct.ac.za

By ticking "I agree" you agree to have your dream reports audio-recorded and transcribed. You are also agreeing that you have read and understood this consent form.

☐ I agree

_____ _____

Name and Surname Signature

Appendix H: Sleep Diary

Important notes:

- Start completing the sleep diary immediately after you receive the invitation to participate.
- Please highlight which day you completed the night of the study.

Week 1

Start date: _____

COMPLETE WHEN YOU WAKE UP						
Date: ____	**Date: ____**	**Date: ____**	**Date: ____**	**Date: ____**	**Date: ____**	**Date: ____**
I went to bed at: (Enter the time and highlight am or pm)						
am/pm	am/pm	am/pm	am/pm	am/pm	am/pm	am/pm
When I went to bed, I fell asleep: (Enter one option) 1 = With difficulty; 2 = After some time; 3 = Easily						
I woke up during my sleep: (Enter number of times and number of minutes)						
# Times: # Minutes:	# Times: # Minutes:	# Times: # Minutes:	# Times: # Minutes:	# Times: # Minutes:	# Times: # Minutes:	# Times: # Minutes:
I got out of bed at: (Enter the time and highlight am or pm)						
am/pm	am/pm	am/pm	am/pm	am/pm	am/pm	am/pm
I slept a total of: (Enter approximate hours/minutes						
My sleep was disturbed by: (List any factors that made it hard to sleep incl. noise, lights, pets, allergies, temperature, pain, stress, medication, etc.)						
When I woke up, I felt (Enter one option) 1 = Still tired; 2 = Somewhat awake; 3 = Wide awake						

COMPLETE AT BEDTIME						
Date: ____	**Date: ____**	**Date: ____**	**Date: ____**	**Date: ____**	**Date: ____**	**Date: ____**
I exercised at least 30 minutes at: Enter all that apply (Morning; Afternoon; Evening; Did not exercise today)						
Medications I used today:						
I took a nap today (Enter Yes or No. If yes, enter how long you napped)						
How likely was I to doze off while doing daily activities today? (1 = Not at all likely; 2 = Not very likely; 3 = Somewhat likely; 4 = Very likely)						
My mood today was: Bad; Okay; Good						
Approximately 2-3 hours before going to bed I drank/ate: (Enter all that apply: Alcohol, Heavy meal; Caffeine)						
I drank/ate something with caffeine at: Morning; Afternoon; Evening; Did not have caffeine today.						
In the hour before going to sleep, my bedtime routine included: (e.g., read book, used electronics, took bath, did relaxation exercises, etc.)						

Appendix I: Rejection Email

Dear student,

Thank you for completing the screening questionnaire. Unfortunately, you do not meet the criteria to participate in this study. Generally, students who suffer from sleep or psychiatric disorders (such as depression or anxiety) or who do not regularly sleep 7-9 hours a night were excluded from the study. Furthermore, those whose alcohol or drug use were high also had to be excluded. You will still receive 1 SRPP point for completing the questionnaire.

I truly appreciate you taking the time to complete the questionnaire and for your interest in my study.

If you have any further questions as to why you were not included in the study, feel free to send me an email: DPLLIE002@myuct.ac.za

Kind regards,
Liëtte du Plessis

Appendix J: Ethics Approval

UNIVERSITY OF CAPE TOWN

Department of Psychology

University of Cape Town Rondebosch 7701 South Africa
Telephone (021) 650 3417
Fax No. (021) 650 4104

08 April 2022

Liette Du Plessis
Department of Psychology
University of Cape Town
Rondebosch 7701

Dear Liette

I am pleased to inform you that ethical clearance has been given by an Ethics Review Committee of the Faculty of Humanities for the amendments to your study, *The relationship between affect in dreams and emotional memory consolidation.* The reference number remains PSY2021-018.

I wish you all the best for your study.

Yours sincerely

Lauren Wild (PhD)
Associate Professor
Chair: Ethics Review Committee

Appendix K: Predicting Positive and Neutral Retention Using Overall Dream Affect Intensity

Table 1

Predicting Positive Retention Using Overall Dream Affect Intensity

Variable	*Type III SS*	*df*	*MS*	*F*	*p*	ηp^2
Corrected Model	2531.566[a]	5	506.313	1.049	.394	.052
Intercept	8741.123	1	8741.123	18.116	<.001	.160
Age	581.372	1	581.372	1.205	.275	.013
Gender	36.263	1	36.263	.075	.785	.001
Caffeine Intake	1132.434	1	1132.434	2.347	.129	.024
Smoking	286.937	1	286.937	.595	.443	.006
Total Emotions	556.269	1	556.269	1.153	.286	.012
Error	45839.271	95	482.519			
Total	984762.923	101				
Corrected Total	48370.837	100				

Note: * p<.05, **p<.01. Model with the dependent variable, Positive Retention: Intercept + Age + Gender + Caffeine Intake + Smoking + Total Emotion.

[a.] R Squared = .052 (Adjusted R Squared = .002)

This model indicates that there is no significant relationship between Positive Retention and Total Emotion when accounting for all the control variables. Further, none of the control variables had a significant effect on Positive Retention. The overall model explained .002 variance, with a small effect size.

Table 2

Predicting Neutral Retention Using Overall Dream Affect Intensity

Variable	*Type III SS*	*df*	*MS*	*F*	*p*	ηp^2
Corrected Model	2802.119[a]	5	560.424	.948	.454	.047
Intercept	13871.154	1	13871.154	23.458	<.001	.196
Age	78.434	1	78.434	.133	.717	.001

Gender	371.540	1	371.540	.628	.430	.007
Caffeine Intake	666.955	1	666.955	1.128	.291	.012
Smoking	987.057	1	987.057	1.669	.199	.017
Total Emotions	623.303	1	623.303	1.054	.307	.011
Error	56766.006	96	591.313			
Total	1083128.502	102				
Corrected Total	59568.125	101				

Note: * p<.05, **p<.01. Model with the dependent variable, Neutral Retention: Intercept + Age + Gender + Caffeine Intake + Smoking + Total Emotion.

[a.] R Squared = .047 (Adjusted R Squared = -.003)

This model indicates that there is no significant relationship between Neutral Retention and Total Emotion when accounting for all the control variables. Further, none of the control variables had a significant effect on Neutral Retention. The overall model explained -.003 variance, with a small effect size.

Appendix L: Predicting Positive and Neutral Retention Using Positive and Negative Dream Affect Intensity

Table 3

Predicting Positive Retention Using Positive and Negative Dream Affect Intensity

Variable	*Type III SS*	*df*	*MS*	*F*	*p*	ηp^2
Corrected Model	2739.491[a]	6	456.582	.941	.470	.057
Intercept	8944.411	1	8944.411	18.425	<.001	.164
Age	535.167	1	535.167	1.102	.296	.012
Gender	25.150	1	25.150	.052	.820	.001
Caffeine Intake	1024.069	1	1024.069	2.110	.150	.022
Smoking	315.999	1	315.999	.651	.422	.007
Negative Emotions	704.836	1	704.836	1.452	.231	.015
Positive Emotions	3.072	1	3.072	.006	.937	.000
Error	45631.346	94	485.440			
Total	984762.923	101				
Corrected Total	48370.837	100				

Note: * p<.05, **p<.01. Model with the dependent variable, Positive Retention: Intercept + Age + Gender + Caffeine Intake + Smoking + Negative Emotion + Positive Emotion.

[a.] R Squared = .057 (Adjusted R Squared = -.004)

This model indicates that there is no significant relationship between Positive Retention and Positive or Negative Emotions when accounting for all the control variables. Further, none of the control variables had a significant effect on Positive Retention. The overall model explained -.004 variance, with a small effect size.

Table 4

Predicting Neutral Retention Using Positive and Negative Dream Affect Intensity

Variable	*Type III SS*	*df*	*MS*	*F*	*p*	ηp^2
Corrected Model	3342.187[a]	6	557.031	.941	.469	.056
Intercept	12678.036	1	12678.036	21.421	<.001	.184
Age	58.771	1	58.771	.099	.753	.001
Gender	299.640	1	299.640	.506	.478	.005

Caffeine Intake	748.774	1	748.774	1.265	.264	.013
Smoking	1063.172	1	1063.172	1.796	.183	.019
Negative Emotions	.056	1	.056	.000	.992	.000
Positive Emotions	1112.801	1	1112.801	1.880	.174	.019
Error	56225.938	95	591.852			
Total	1083128.502	102				
Corrected Total	59568.125	101				

Note: * p<.05, **p<.01. Model with the dependent variable, Neutral Retention: Intercept + Age + Gender + Caffeine Intake + Smoking + Negative Emotion + Positive Emotion.

[a.] R Squared = .056 (Adjusted R Squared = -.004)

This model indicates that there is no significant relationship between Neutral Retention and Positive or Negative Emotions when accounting for all the control variables. Further, none of the control variables had a significant effect on Neutral Retention. The overall model explained -.004 variance, with a small effect size. A model without Negative Emotions was also run, due to the significant correlation between Positive Emotions and Neutral Retention that was found, however, this did not change the significance of the relationship between Positive Emotions and Neutral Retention.

Appendix M: Predicting Negative Retention Using Individual Dream Affect Intensity

Table 5

Predicting Negative Retention Using Individual Dream Affect Intensity

Variable	*Type III SS*	*df*	*MS*	*F*	*p*	ηp^2
Corrected Model	5965.745[a]	6	994.291	3.498	.004	.183
Intercept	10299.236	1	10299.236	36.237	<.001	.278
Age	1189.404	1	1189.404	4.185	.044*	.043
Alertness	3298.244	2	1649.122	5.802	.004**	.110
Fear	568.225	1	568.225	1.999	.161	.021
Rage	233.543	1	233.543	.822	.367	.009
Grief	721.463	1	721.463	2.538	.114	.026
Error	26716.356	94	284.217			
Total	1069091.735	101				
Corrected Total	32682.101	100				

Note: * p<.05, **p<.01. Model with the dependent variable, Negative Retention: Intercept + Age + Alertness + Fear + Rage + Grief.

[a.] R Squared = .183 (Adjusted R Squared = .130)

This model indicates that there is no significant relationship between Negative Retention and individual emotions when accounting for all the control variables. Further, both Age and Alertness had a significant effect on Negative Retention. The relationships between Negative Retention and Age and Alertness were previously explained. The overall model explained .130 variance, with a medium effect size.

Appendix N: Participants' Raw Pre- and Post-Sleep Memory Performance

Participant	Night Negative	Morning Negative	Negative Retention	Night Positive	Morning Positive	Positive Retention	Night Neutral	Morning Neutral	Neutral Retention	Total Retention
1	10	7	70,00	9	8	88,89	5	5	100,00	83,33
2	10	11	110,00	10	11	110,00	4	5	125,00	112,50
3	10	12	120,00	6	5	83,33	8	10	125,00	112,50
4	12	12	100,00	10	9	90,00	7	7	100,00	96,55
5	12	13	108,33	7	7	100,00	7	7	100,00	103,85
6	15	13	86,67	8	6	75,00	6	6	100,00	86,21
7	18	21	116,67	5	7	140,00	9	10	111,11	118,75
8	18	18	100,00	14	13	92,86	10	10	100,00	97,62
9	13	12	92,31	4	5	125,00	7	8	114,29	104,17
10	13	15	115,38	7	5	71,43	8	7	87,50	96,43
11	18	14	77,78	13	11	84,62	10	9	90,00	82,93
12	10	12	120,00	5	4	80,00	5	3	60,00	95,00
13	16	15	93,75	7	8	114,29	9	9	100,00	100,00
14	13	16	123,08	10	13	130,00	4	9		140,74
15	13	15	115,38	11	11	100,00	4	7	175,00	117,86
16	14	11	78,57	7	9	128,57	7	6	85,71	92,86
17	15	15	100,00	9	9	100,00	6	6	100,00	100,00
18	13	14	107,69	7	6	85,71	7	8	114,29	103,70
19	17	15	88,24	14	12	85,71	10	10	100,00	90,24
20	17	16	94,12	15	16	106,67	11	8	72,73	93,02
21	14	17	121,43	14	12	85,71	6	8	133,33	108,82
22	10	13	130,00	9	8	88,89	5	5	100,00	108,33
23	11	10	90,91	5	6	120,00	4	3	75,00	95,00
24	13	12	92,31	13	9	69,23	6	8	133,33	90,63

25	10	11	110,00	7	8	114,29	6	6	100,00	108,70
26	15	16	106,67	10	9	90,00	10	9	90,00	97,14
27	15	14	93,33	9	11	122,22	8	8	100,00	103,13
28	10	9	90,00	7	10	142,86	7	7	100,00	108,33
29	14	12	85,71	5	3	60,00	7	5	71,43	76,92
30	16	15	93,75	6	5	83,33	6	5	83,33	89,29
31	15	15	100,00	9	10	111,11	10	7	70,00	94,12
32	11	11	100,00	4	4	100,00	3	4	133,33	105,56
33	9	12	133,33	8	7	87,50	7	9	128,57	116,67
34	20	15	75,00	16	13	81,25	12	14	116,67	87,50
35	18	15	83,33	14	10	71,43	11	11	100,00	83,72
36	13	19	146,15	11	11	100,00	11	10	90,91	114,29
37	15	13	86,67	10	9	90,00	6	6	100,00	90,32
38	14	12	85,71	11	10	90,91	6	6	100,00	90,32
39	13	16	123,08	12	10	83,33	13	9	69,23	92,11
40	8	9	112,50	5	3	60,00	7	5	71,43	85,00
41	20	17	85,00	8	10	125,00	9	9	100,00	97,30
42	6	9	150,00	7	7	100,00	6	4	66,67	105,26
43	14	16	114,29	12	12	100,00	10	6	60,00	94,44
44	17	18	105,88	13	14	107,69	11	15	136,36	114,63
45	14	16	114,29	11	12	109,09	11	9	81,82	102,78
46	13	14	107,69	10	6	60,00	4	4	100,00	88,89
47	18	17	94,44	5	8	160,00	7	10	142,86	116,67
48	10	10	100,00	6	7	116,67	7	8	114,29	108,70
49	18	17	94,44	10	10	100,00	11	12	109,09	100,00
50	16	17	106,25	15	16	106,67	13	15	115,38	109,09
51	17	11	64,71	7	7	100,00	8	8	100,00	81,25
52	9	9	100,00	7	7	100,00	5	4	80,00	95,24
53	11	11	100,00	9	10	111,11	9	8	88,89	100,00

54	9	11	122,22	9	10	111,11	7	8	114,29	116,00
55	15	15	100,00	6	6	100,00	6	8	133,33	107,41
56	13	15	115,38	7	6	85,71	6	6	100,00	103,85
57	14	15	107,14	7	5	71,43	4	5	125,00	100,00
58	15	16	106,67	14	15	107,14	7	6	85,71	102,78
59	5	7	140,00	7	7	100,00	5	3	60,00	100,00
60	8	13	162,50	3	4	133,33	6	5	83,33	129,41
61	17	18	105,88	14	14	100,00	11	11	100,00	102,38
62	14	11	78,57	10	9	90,00	10	10	100,00	88,24
63	19	18	94,74	4	8		8	9	112,50	112,90
64	9	11	122,22	7	6	85,71	5	4	80,00	100,00
65	12	10	83,33	9	7	77,78	1	1	100,00	81,82
66	19	19	100,00	11	12	109,09	6	7	116,67	105,56
67	12	12	100,00	9	7	77,78	6	4	66,67	85,19
68	10	12	120,00	3	6		10	8	80,00	113,04
69	15	16	106,67	10	11	110,00	2	3	150,00	111,11
70	12	1		6	6	100,00	6	2	33,33	
71	11	15	136,36	14	13	92,86	10	12	120,00	114,29
72	16	15	93,75	12	10	83,33	5	6	120,00	93,94
73	4	7		7	7	100,00	9	6	66,67	100,00
74	11	9	81,82	7	6	85,71	5	5	100,00	86,96
75	12	12	100,00	9	10	111,11	6	4	66,67	96,30
76	13	11	84,62	6	4	66,67	4	3	75,00	78,26
77	16	17	106,25	10	11	110,00	8	9	112,50	108,82
78	4	4	100,00	4	4	100,00	5	5	100,00	100,00
79	12	9	75,00	9	8	88,89	6	6	100,00	85,19
80	16	15	93,75	10	10	100,00	12	11	91,67	94,74
81	11	11	100,00	7	7	100,00	5	8	160,00	113,04
82	11	10	90,91	7	5	71,43	6	5	83,33	83,33

83	15	15	100,00	9	5	55,56	6	6	100,00	86,67
84	18	13	72,22	12	10	83,33	8	8	100,00	81,58
85	14	14	100,00	8	9	112,50	7	7	100,00	103,45
86	11	8	72,73	11	7	63,64	5	4	80,00	70,37
87	21	17	80,95	11	9	81,82	10	12	120,00	90,48
88	10	8	80,00	8	9	112,50	7	7	100,00	96,00
89	14	14	100,00	2	2	100,00	8	8	100,00	100,00
90	11	12	109,09	7	5	71,43	6	8	133,33	104,17
91	8	9	112,50	4	7	175,00	5	5	100,00	123,53
92	15	10	66,67	8	11	137,50	7	6	85,71	90,00
93	14	13	92,86	4	3	75,00	7	7	100,00	92,00
94	12	13	108,33	8	8	100,00	5	9	180,00	120,00
95	10	10	100,00	7	6	85,71	7	7	100,00	95,83
96	15	14	93,33	8	7	87,50	7	3	42,86	80,00
97	12	12	100,00	4	4	100,00	3	3	100,00	100,00
98	13	16	123,08	6	7	116,67	5	5	100,00	116,67
99	11	11	100,00	9	6	66,67	2	2	100,00	86,36
100	12	14	116,67	9	5	55,56	6	6	100,00	92,59
101	13	9	69,23	13	12	92,31	7	7	100,00	84,85
102	14	14	100,00	5	5	100,00	7	7	100,00	100,00
103	11	10	90,91	7	3	42,86	6	7	116,67	83,33