The Role of Dreaming in Affect Regulation

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COMPULSORY DECLARATION

This work has not been previously submitted in whole, or in part, for the award of any degree. It is my own work. Each significant contribution to, and quotation in, this dissertation from the work, or works, of other people has been attributed, and has been cited and referenced.

Signature: Signed by candidate Date: 12 August 2021

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Abstract

Research investigating the change in affect across sleep focuses on the association between sleep physiology and affect regulation and often do not consider the contribution of dreaming mentation to affet regulatory processes. The aim of this study was to investigate whether dreaming regulates affect by examining the change in affect within dreams and between dreams elicited during different timepoints in the night. The hypotheses were that if dreams are responsible for affect regulation, there will be a change in self-reported emotion within a dream, leading to less emotionality towards the end of a dream, as well as across the night - leading to less emotionality towards the end of the night. Furthermore, I hypothesized that these within-dream and between-dream changes will be associated with pre-sleep to post-sleep change in affect.

Healthy students (*N* = 24; age range 19 – 34 years) spent three non-consecutive nights at a sleep laboratory for PSG monitoring, collection of dream-reports and self-reported dream affect rating. Participants completed an adaptation night followed by two experimental nights. During the first experimental night participants were awoken in Rapid Eye Movement (REM) sleep during the early night (dream-point: Early REM) and on the second experimental night they were awoken in REM sleep towards the end of the night (dream-point: Late REM) to record their dreams using voice recordings and collect self-reported dream emotions using Visual Analogue Mood Scales (VAMS). Participants completed mood scales for emotions experienced in both the first part (1st dream-half) and last part (2nd dream-half) of their dream. Recorded dreams were transcribed and assessed for affective word content using the Linguistic Inquiry and Word Count program (LIWC). Furthermore, participants rated their mood before and after sleep using the Positive and Negative Affect Schedule (PANAS).

A mixed design ANOVA, with dream-half (1st versus 2nd dream-half), dream-point (1st versus 2nd half of the night) and valence (positive versus negative) as factors, was conducted on self-report dream affect ratings. The data showed a significant interaction between dream-half and dream-point, indicating a decline in emotionality from the first half to the second half of early REM dreams, followed by an increase in emotionality from the first to the second half of late REM dream, although still below that of early REM levels. A similar analysis of affective words reported in the dreams showed significant decrease in objectively scored emotional content of dreams from early to late REM. However, there was no association between change in dream affect and change in mood, possibly because participants had little variation in their mood.

These results suggest that there are fluctuations in dream affect during the night, which settle at a point between high initial dream affect and low late dream affect, which speculatively represents an emotional homeostatic settling point that allows for next-day readiness. This change towards a speculated homeostatic point and the overall attenuation of dream affect across the night, support the notion that dreaming plays a role in affect regulation.

Keywords: affect, dreaming, REM, regulation

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Introduction

We spend on average a third of our lives sleeping. During this time, the mental activity that individuals self-report is that of dreaming. In the scientific literature there is significant debate regarding the different functions of dreaming. Some researchers have proposed that dreaming performs the function of affect regulation (Cartwright et al., 1998; Gazzillo et al., 2019; Hartmann, 1998b; Indursky & Rotenberg, 1998; Kramer & Roth, 1972, 1978; Levin & Nielsen, 2009; Malinowski & Horton, 2015; Perogamvros et al., 2013; Perogamvros & Schwartz, 2012). Although there is some evidence to support this proposal, (Cartwright et al., 2003; Cartwright, Luten, et al., 1998; Cartwright, Young, et al., 1998; Indursky & Rotenberg, 1998; Punamaki, 1998; Schredl, 2010), evidence to the contrary also exists (Lara-Carrasco et al., 2009; Merritt et al., 1994; Wagner et al., 2002).

A related body of research has focused on the affect regulatory function of sleep, rather than dreaming (Mauss et al., 2013; Perogamvros & Schwartz, 2013; Van der Helm et al., 2011; Van der Helm & Walker, 2009, 2012; Vandekerckhove & Wang, 2018). The findings from these studies suggest that REM sleep in particular, which is the stage of sleep from which dream reports are obtained most reliability (Dement & Kleitman, 1957a, 1957b; Kales et al., 1967; Nielsen, 2000, 2004, 2011; Schredl, 2007; Stickgold et al., 1994), is responsible for affect regulation. These studies have not, however, considered the role of dreaming, which may be the underlying mechanism responsible for affect regulation.

In summary then, this study will explore whether dreaming, rather than sleep/REM sleep more generally, is the active ingredient contributing to affect regulation.

Literature Review

Why do we dream?

Societies have recorded and questioned the nature of dreams for centuries. The earliest documented dream in history is that of Dumuzi of Uruk, a Mesopotamian king (Hoffman, 2004). Other Mesopotamian writings contain accounts of dreams, especially of royal figures, and it is evident that this society paid importance to dreams (Hoffman, 2004). Dreams also played a significant role in the cultural and religious experiences of ancient cultures in Africa, and elsewhere (Tylor, 1871; Yonker, 1982).

In contemporary times, psychology and neuroscience has focused on understanding the function of dreams from a neurobiological point of view. Dream research is characterised by several dominant theoretical models, and it is reasonable to conclude that dreaming might fulfil more than just one function, and as will be seen in the discussion below, although some theories are quite disparate, some of these functions share common ground and are intricately linked.

An early, and influential, theory by Hobson (1977), however, proposed that dreaming is just epiphenomenal. He proposed that dreaming is the sleeping brain's attempt to make sense of random neuronal activity arising from the brainstem during REM sleep – called the Activation-Synthesis hypothesis (Hobson & McCarley, 1977). According to this model, dreaming (the synthesis) has no inherent meaning and is just a by-product of brainstem activity (the activation) during REM sleep. The model was later extended into the AIM model (internal activation (A)), information flow (I), and mode of information processing (M)). This model explained how much (A), and which (I) information is being processed by the brain, as well as how it is being processed (M). It allowed for the incorporation of both the neurobiological and psychological or cognitive changes associated with different conscious states, whether it be the waking state or the different stages of REM and NREM sleep (Hobson et al., 2000).

Another theory that considers dreaming to be epiphenomenal to brain process is the Continual-Activation Theory of Dreaming (Zhang, 2005). This theory proposes that we dream to keep our brains working when we are asleep to avoid the level of activation of the brain dropping below a given threshold when sensory input is diminished. During sleep, for example, the continual-activation mechanism in the brain will be triggered to generate a flow of information from the memory stores in order to keep the brain at a level activated above that of the threshold (Zhang, 2005).

More recently, Hobson proposed a functional, rather than epiphenomenal role for dreaming. He proposed a theory of REM sleep dreaming as a protoconscious state, where dreaming provides a virtual reality model of the world which is important for the developing and maintaining of waking consciousness (Hobson, 2009; Hobson et al., 2014) – a state to update and test-run 'the software', so to speak.

Other theories consider dreaming to serve an adaptive function that allows for information processing in a virtual environment. Revonsuo, for example, proposed in his Threat Simulation Hypothesis of Dreaming that dreams allow us to rehearse how to respond to possible threats or dangerous situations (Revonsuo, 2000). Related to this are theories suggesting that we dream to solve problems, either by the solution presenting itself in a dream (Barrett, 1993; White & Taytroe, 2003), or shortly after awakening due to insight gained through dreams (Montangero, 1993). In a more abstract way, it is proposed that one way in which dreaming aids in problem solving is through the production of schemas for new behaviour. These schemas are created by the integration of information from current experiences with past memories (Greenberg & Pearlman, 1975, 1993). A similar understanding of dreaming, as proposed by Fosshage, states that dreams function by organising information in order for us to adapt and meet our needs. (Fosshage, 1983, 1997, 2007). A body of research also focusses on the role of dreaming in information processing through memory consolidation. This research proposes that dreams help us to remember – i.e., dreaming plays a role in memory consolidation of important information (Stickgold et al., 2001; Wamsley, 2014; Wamsley et al., 2010; Wamsley & Stickgold, 2011, 2019). Furthermore, it also helps us to forget – the reverse learning theory of dreaming (Crick & Mitchison, 1983). This theory purports that dreaming assists in strengthening connections between appropriate memories, while weakening random associations, or put differently, remembering relevant and important information, while forgetting non-relevant and unimportant information.

Another strand of research focusses on dreaming as a regulator of emotional drives. Amongst these are Freud’s well-known theory of dreaming as a function of wish-fulfilment (Freud, 1900). This theory states that drives that cannot be satisfied in waking life, are being acted on while an individual sleeps – imagining that one is acting on these wishes. The fulfilment of the wish then defuses the pressure to act on it while awake (Solms, 2000b). This theory has gained some evidential support in light of recent progress in the neuroscientific field, most notably that REM dreams are driven by dopamine – the neurotransmitter crucial to motivational drives (similar to Freud’s libidinal drives or wishes) (Solms, 2001). It is also supported by the Reward Activation Model (RAM) for sleep and dreaming. This theory emphasises the role of the mesolimbic dopaminergic system, which is implicated in reward pathways and emotional functions, as the generator of dreams as well as contributing to the motivational content of dreams (Perogamvros & Schwartz, 2012).

Further, relating to motivational drives, and in line with information processing or the problem-solving function of dreaming in service of emotional adaptation, is the Control-Mastery Theory (CMT), which states that dreams portray our unconscious attempts at finding solutions to emotionally relevant problems and hence aid in our adaptation to reality (Gazzillo et al., 2019). Solms also proposes that dreams are our attempts at solving problems (Solms, 2022). He argues (and this is an oversimplified attempt to summarise a very complex principle) that propelled by the SEEKING drive, dreaming, like mind-wandering, enable us to find the simplest, most effective solution to problems we encounter while awake, in a continuous updating and testing, and therefore improved efficiency, of the generative model (Solms, 2021).

Further research has also focused on the affect regulatory role of dreaming (Cartwright et al., 1991, 2003, 2006; Cartwright, Luten, et al., 1998; Cartwright, Young, et al., 1998; Indursky & Rotenberg, 1998; Kramer & Roth, 1972; Punamaki, 1998), which proposes that dreams aid in rebalancing affect[1] after adverse experiences, or to put it differently, to work through emotional problems. A significant model proposing the role of dreaming in affect regulation is the *selective mood regulatory theory of sleep and dreaming* by Kramer (1993) and later elaborated on by Cartwright (Cartwright, 2005), and will be discussed in more detail further on. Solms (2021) also contribution to the role of dreaming in affect regulation by arguing that affect regulation is actually a by-product of finding solutions to our problems. He argues that we use dreams to try out different solutions to our problems. When we have a problem (i.e., our needs are not met), we move away from a state of homeostasis (Panksepp, 1998; Solms, 2021), which results in negative emotions or ‘unpleasure’. When we find effective solutions to those problems or situations (i.e., to meet our needs) we return towards homeostasis, and we experience positive emotions or ‘pleasure’. It is in this area of affect regulation that the focus of this study will be.

[1] In dream research, researchers tend to use the terms affect and emotion interchangeably, although it is widely accepted in the fields of (affective) neuroscience and neuropsychology that affect refers to the mental experience of emotions, which are, in turn, physical body states in response to external stimuli (Damasio, 1999; Panksepp, 1998; Van Nuys, 2013).

The selective mood regulatory theory of dreaming

Models that describe the function of dreaming as affect regulation propose that "dreaming modulates disturbances in emotion (affect), regulating those that are troublesome…. (and) that negative mood is down-regulated overnight" (Cartwright, 2010, p.73). Kramer formulated the *selective mood regulatory theory of sleep and dreaming* in which he proposes that a dream first states, works on and then resolves an affective problem, leading to a positive affective outcome – which he described as an improvement of mood across the night (Kramer, 1993). Kramer suggested a surge in emotion during REM sleep[2], and that dreaming attempts to contain this surge. Cartwright, who adopted Kramer's theory, suggested that this 'surge' could be when a disturbing waking experience is reactivated during REM sleep, where it is matched by similar feeling of earlier memories (Cartwright, 2010), echoing Greenberg & Pearlman (1975,1993) who suggested that dreaming aids in problem solving through the production of schemas for new behaviour, by integrating information from current experiences with past memories. The surge during this stage of sleep in confirmed by neuroimaging studies that showed an increase in the activity of the limbic system during REM sleep, when a significant elevation in activity occurs in the medio-basal prefrontal lobes, the thalamic nuclei, the pontine tegmentum and associated regions including the anterior cingulate cortex, the amygdala and the hippocampus (Maquet, 2000; Nofzinger, 2005; Van der Helm & Walker, 2009).

According to this model of dreaming, if the dream is successful, the emotion does not enter awareness and neither is it remembered, thus protecting sleep and, as Cartwright describes it, diffuses the emotional charge of the event, preparing the dreamer to wake up more positively (Cartwright, 2010). Or, viewed from the perspective of to the Control-

[2] Kramer used dream reports from REM sleep periods and considered "REM sleep as a marker for dreaming", hence the reference to REM sleep.

Mastery Theory, the unconscious attempts at finding solutions to emotionally relevant problems have been successful and hence aided in our adaptation to reality (Gazzillo et al., 2019), leaving us more positive. If the problem is unresolved, affect remains negatively toned and the dreamer becomes aware of the dream. Unsuccessful attempts at solving emotional problems manifest as bad dreams or nightmares (Kramer, 1993); and the dreamer can easily report the dream which is negatively charged.

Cartwright (2005) hypothesised that affective problems are not solved when dreams are overloaded with negative affect, or when they fail to successfully link to past memories, which according to this model is necessary for the reduction of disturbed mood. For example, individuals diagnosed with depression have a paucity of dream reports, suggesting that these individuals do not effectively activate past memories during dreaming and subsequently fail to integrate affect into their pre-existing long-term memory networks during sleep (Agargun & Cartwright, 2003) and they concurrently often feel worse in the mornings, suggesting that dreaming has not achieved affect regulation (Armitage et al., 1995; Cartwright, 1979; Cartwright et al., 1991; Cartwright, Young, et al., 1998; Gillin et al., 1979; Reynolds, 1987; Stieglitz et al., 1988).

Kramer further elaborates on his theory by defining the affective outcome of the dreaming process. He states the following:

> [P]sychological activities during sleep appear to be "corrective," operating to move the mood level toward a central and lower point. The dream seems particularly involved with one aspect of affect, i.e., unhappiness, and may be seen as a selective affective mood regulator, as an 'emotional thermostat'". (Kramer, 2014, p.136)

The concept of the 'emotional thermostat' is echoed by Panksepp where he suggests that "from a neuroscientific point of view, all these strategies reflect reactions to the essential need to maintain affective balance" (Panksepp & Biven, 2012, p.329) or affective homeostasis as he also refers to it (Panksepp, 1998, 2010). Put differently, dreams, by working through emotional issues or problems, re-establish emotional homeostasis and therefore regulate affect, creating a greater feeling of well-being. Therefore, moving away from this set point results in negative affect (or unhappiness as Kramer put it), and moving back towards the set point of homeostasis results in less or no unhappiness as an indication of the set-point being reached. In other words, the aim of affect regulation in this example, is not happiness, but rather no unhappiness, while the movement towards no unhappiness might be experienced as a pleasant feeling.

In summary, this model proposes that a successful dreaming process will result in affect regulation, characterised by post-sleep mood that is more positive – or more accurately, less negative – as it moves towards a set-point, in comparison to pre-sleep mood. However, an unsuccessful dreaming process will result in post-sleep mood that is more negative as it moves further away from the set-point, in comparison with pre-sleep mood. The model, however, holds two caveats – dreaming-dependent affect regulation will fail when the dream is overloaded with emotion, i.e., when the emotional charge is too high (or fails to contain a surge of emotion) or when it fails to integrate affective content with past memories. Although this model of dreaming is appealing, empirical evidence supporting it is currently sparse. A handful of studies support the outlined model.

Empirical studies demonstrating the role of dreaming in affect regulation

Several studies have investigated the effect of dreaming on affect regulation. Some of the most seminal studies in this regard were conducted by Cartwright and colleagues. Cartwright and her team studied the effect of REM dreaming on affect regulation in both depressed (Cartwright et al., 1991, 2003, 2006; Cartwright, Young, et al., 1998), and healthy participants (Cartwright, Luten, et al., 1998).

Cartwright demonstrated, in agreement with the *selective mood regulatory theory of sleep and dreaming*, overnight reduction in negative mood. One such study with healthy participants investigated the reduction of overnight negative mood in the context of 'normal' levels of pre-sleep depressive mood, i.e., unhappiness, as measured by the Profile of Mood States (POMS). Cartwright and colleagues recruited 60 student participants who did not have any current or history of depression. Participants slept two nights in a sleep laboratory and completed POMS before sleep and in the morning on awakening. For statistical analysis, the group was further divided into two groups: one with no pre-sleep negative mood and one with some pre-sleep negative mood. The study found that (a) there was a significant reduction of negative mood in those with some degree of pre-sleep depressed mood/unhappiness after a night of sleep; and (b) that there was progressive change in affect, demonstrated by an increasingly positive affect over successive REM periods throughout the night. This finding suggests that dreaming moderates mood overnight in normal subjects (Cartwright, Luten, et al., 1998).

Reduction of negative mood was also demonstrated in participants with mild to moderate depression (Cartwright et al., 2003; Cartwright, Young, et al., 1998). These studies demonstrated that in those with mild to moderate depression, the presence of negative dreams early in the night, and not towards the end, was followed by an improvement in mood a year later. This follows the pattern observed in normal down-regulating of negative affect due to successful (REM) dreaming in non-depressed participants as described above. In those who were not in remission a year later, the presence of negative dreams towards the end of the night was suggestive of a failure to self-regulate mood (Cartwright, Young, et al., 1998). In other words, the findings indicate that in participants where the affect in dreams changed from negative early in the night to positive towards the end of the night, the dreaming process was successful in solving the affective problems and resulted in a positive affective outcome (or the reinstatement of emotional homeostasis) – i.e., remission from depressed mood. Conversely in those participants in which the dream affect became more negative towards the end of the night, the dreams failed to solve the affective problem and affect regulation did not occur – i.e., remission was not obtained.

Cartwright furthermore demonstrated, in agreement with the *selective mood regulatory theory of sleep and dreaming*, that dreaming integrates affective information. Two respective studies, with 20 and 39 depressed participants following divorce, demonstrated that the 'current concerns', i.e., the divorce from the ex-spouse – featured in the REM dreams of participants (Cartwright et al., 2006; Cartwright, Young, et al., 1998), a finding that was echoed by earlier work by Hartman (1998) and Kramer (1991). Based on his analysis of dream series of adults after exposure to traumatic events, Hartmann too found that dreams featured the dominant emotional concern. He found that this also extends to more 'mundane' emotional concerns of 'stressful situations' like surgery and pregnancy. Analysing the content of the dreams, he found that the dreams were not necessarily about the event – "the sensory input from the actual trauma" – but rather about the overriding emotion. The dreams contextualise (find a picture context for) the emotional concern by making extensive, wider-ranging connections in the (neural) networks of the mind than during wakefulness. He called this the 'Contextualising Image' – a powerful central image in the dream (Hartmann et al., 2001; Hartmann & Kunzendorf, 2006). These connections are not random but are guided by the dreamer's emotional concerns (Hartmann, 1998a). Therefore, for the dream to successfully regulate affect, it needs to successfully integrate affective content (current concerns) with past memories – a process Kramer calls stating and working through an affective problem (Kramer, 1991, 2014; Kramer et al., 1974; Kramer & Roth, 1972).

The incorporation of personally significant (i.e., salient emotional) waking-life experiences (Malinowski & Horton, 2014; Schredl, 2006) and concerns (Eichenlaub et al., 2017; Nielsen & Stenstrom, 2005; Stickgold et al., 2001) into dreams have been observed in numerous dream studies. The more intense and emotional an experience is, the more likely it is to be incorporated into dreams (Cartwright et al., 2006; Schredl, 2006). Furthermore, these salient emotional experiences are incorporated more than once into dream material – often on the night immediately following the event (the day-residue effect) and then again about 6-8 nights later (the dream-lag effect) (Nielsen et al., 2004; Nielsen & Powell, 1992; van Rijn et al., 2015).

The Cartwright studies further demonstrated the important correlations between REM-dream patterns and content and later remission from depression. Those who dreamed about their former partner (i.e., current concerns), but failed to experience emotion during these dreams, and those who failed to embed their former partners into a network of associated memories, were less likely to be in remission one year later. This could be understood as the dream mechanism failing in its effort to regulate negative mood. Those in remission, however, reported notably more dreams in which the ex-spouse featured as a character, suggesting that dreaming which includes a representation of an emotionally salient character may signify an ongoing adaptive process (Cartwright et al., 1991, 2006).

Similar findings were obtained by Punamäki (1998) who studied the dreams of a number of Palestinian children residing in a violent area in Gaza as well as a control group living in a peaceful area in Galilee. She studied the ‘mental health function’ of dreaming, using spontaneous morning dream recall reports, and found that children exposed to traumatic events who had bizarre, vivid, and joyful dreams with happy endings (referred to as compensatory dreams), as opposed to dreams that contained attacking and frightening relationships, repetition of adverse experiences, persecution, unhappy endings, and lack of narrative content, did not exhibit psychological symptoms. This suggests that dreaming may regulate negative affects, since those children were also exposed to difficult circumstances.

In line with one of the caveats of the *selective mood regulatory theory of sleep and dreaming* that dreaming fails when there is an overload of emotion, Punamäki (1998) found a positive correlation between the incorporation of repetitious, unpleasant, and aggressive characteristics in dreams – i.e., an overload of emotion – and the occurrence of psychological symptoms in these children, indicating a failure of affect regulation. The failure of these dreams to regulate affect might be due to the fact that the waking level of negative affect is too high to be accommodated within a night (Cartwright, 2005; Cartwright et al., 2006; Cartwright, Young, et al., 1998) or the fact that these children were exposed to trauma on a regular basis.

Although most of the studies discussed above focussed on REM dreams (some used spontaneous recall the next morning), not all dreaming occurs during REM. However, as discussed previously, and a factor determining why this current study focuses on dreams during REM sleep, the REM environment is supportive of dreaming for the purposes of regulating affect and will be further elaborated on in the section below.

Neurophysiological and – anatomical support for the role of dreaming during REM sleep in affect regulation

Although REM sleep and REM dreaming are controlled by different brain mechanisms (Solms, 2000a), the REM environment may be conducive to the production of dreams that supports affect regulation. Research show that REM dreams are more emotional in content than those from other periods of sleep (R. Fosse et al., 2001; Hobson et al., 2000; Hobson & Stickgold, 1994; Oudiette et al., 2012; Suzuki et al., 2004; Wamsley et al., 2007). Neuroimaging studies showed an increase in the activity of the limbic system during REM sleep, when a significant elevation in activity occurs in the medio-basal prefrontal lobes, the thalamic nuclei, the pontine tegmentum, and associated regions including the anterior cingulate cortex, the amygdala, and the hippocampus (Maquet, 2000; Nofzinger, 2005; Van der Helm & Walker, 2009). Therefore, the same emotion and memory systems that are active with emotionally charged experiences during waking hours are active during REM sleep too, which may explain the heightened emotional tone of REM dreams. Furthermore, a study by Sterpenich and colleagues (2020) investigated the brain regions activated when participants experienced fear in their dreams (REM dreams and stage N2 NREM dreams). They showed that participants who experienced high levels of fear in their dreams had a subsequently reduced fMRI response to fear-eliciting pictures during waking in brain region associated with emotion processing, such as the insula, amygdala, and midcingulate cortex. These participants also experienced reduced emotional arousal during these tasks while awake. These findings suggest that dreams decrease an individual's waking reactivity to emotional stimuli, supporting the hypothesis that dreams act to down-regulate emotion. However, not all research findings have supported this hypothesis – some studies find contradictory results.

Empirical studies contradicting the role of dreaming in affect regulation

There are those who do not support the role of dreaming in affect regulation. Hobson (2009, p. 805) made the assumption that dreaming "is an indispensable — if sometimes misleading — subjective informant about what the brain does during REM sleep [and that] we may be bound to admit that dreaming itself could be an epiphenomenon without any direct effect on normal or abnormal cognition". His final stance on the function of dreaming is, in essence, that the dreaming brain creates a virtual reality in order to processes information and seeks to model and predict its waking environment as best as possible in order to guide behaviour, not to regulate affect (Hobson et al., 2014). This notion that dreaming is responsible for cognitive information processing has been supported by various studies (Cartwright, 1986; Fiss, 1986; Fiss et al., 1977; M. J. Fosse et al., 2003; Fosshage, 1997, 2007; Grieser et al., 1972).

Some sleep studies have examined changes in affective reactivity to negative stimuli, rather than changes in mood. Although these studies have not focussed on dreaming per se, they did specifically investigate the involvement of REM sleep – and therefore, by association, any dreaming that may have occurred during that state. Four studies conducted by separate laboratories examined this aspect of affect regulation and its relation to the stage of sleep during which dreams are most frequently reported (i.e., REM sleep) (Lara-Carrasco et al., 2009; Rosales-Lagarde et al., 2012; Van der Helm et al., 2011; Wagner et al., 2002). Wagner investigated the processing of emotional material during sleep by comparing the effects of early, SWS-rich sleep and late, REM-rich sleep on valence and arousal ratings of aversive pictures from the International Affective Picture System (IAPS) in healthy participants (Wagner et al., 2002). He found an increased negative reaction to negative stimuli after periods rich in REM sleep.

Similarly, Lara-Carrasco and her team investigated the effect of REM sleep deprivation on adaptation to negative pictures and found that negative ratings of IAPS pictures are increased following sleep that is rich in REM, compared to that of sleep which is REM deprived (Lara-Carrasco et al., 2009). Furthermore, she also collected dream reports. They were collected during the second part of the night (a phase rich in REM sleep and dreaming) and the researchers found that subjects who had the lowest intensities of negative emotions in dreams also showed the highest morning decreases in negativity ratings (Lara-Carrasco et al., 2009).

The studies by Van der Helm et al. (2011) and Rosales-Lagarde et al. (2012), however, showed opposite findings to those of Wagner and Lara-Carrasco. In the study by Van der Helm and colleagues, participants rated the subjective emotional intensity of images from the IAPS at two different sessions. Participants rated the same images at both test sessions, allowing the measurement of change in emotional reactivity to previously experienced affective stimuli following a period of either wakefulness or sleep. The results demonstrated less emotional reactivity to negative stimuli after a period with sufficient REM sleep (Van der Helm et al., 2011). Rosales-Lagarde et al. (2012) studied the effects of selective REM sleep deprivation on emotional responses and their brain correlates to threatening visual stimuli (pictures from the IAPS), using functional magnetic resonance imaging (fMRI). The authors found that a lack of REM sleep was associated with enhanced emotional reactivity to negative stimuli, at behavioural and neural levels (Rosales-Lagarde et al., 2012).

On the face of it, the findings of Wagner and Lara-Carrasco et al. contradict the findings by Van der Helm et al. and Rosales-Lagarde et al. because the studies demonstrated opposite effects in affective reactivity change over a period of sleep that is understood to be dominated by dreaming. However, none of these four studies measured dreaming, apart from Lara-Carrasco et al. (2009). If the process of dreaming, rather than REM sleep per se, is responsible for emotion regulation, the contradiction may be explained on the basis of whether the dreaming process was successful or not. That is, participants in these studies may have, through the dreaming process either (a) successfully integrated the negative stimuli into previous networks of associations and therefore experience decreased affective reactivity after a sleep-filled delay; or (b) have been overloaded with negative affect and/or failed to integrate the stimuli and therefore experienced increased affective reactivity over the same delay. Since three of the four studies did not measure dreaming, the reason for the contradictory results remains unanswered. The one study that did measure dreaming demonstrated a correlation between low intensities of negative emotions in late night dreams and a large decrease in morning negativity ratings. This finding echoes the Cartwright studies (Cartwright et al., 2003; Cartwright, Luten, et al., 1998) where low negative late night dream emotions were correlated with high morning mood, suggesting that dreaming down-regulates affect.

Rationale, Aims and Hypotheses

As outlined above, there is some evidence to support the fact that dreaming regulates negative affect, although this evidence is not undisputed. Most of the studies supporting the role of dreaming in affect regulation were completed more than 15 years ago and were largely produced by Cartwright and colleagues. Recent studies considering affect regulation during sleep have yielded inconsistent results, most likely because they have focused on REM sleep rather than dreaming. These studies have neglected the possibility that *dreaming* may be the underlying mechanism behind REM-related affect regulation and therefore failed to incorporate that into their investigations. The aim of this study was to avoid the REM sleep/dreaming conflation and to add to the body of evidence concerning the notion that dreaming regulates affect, i.e., it re-establishes emotional homeostasis by working through the emotion(s) elicited during the dream.

One novel way of examining affect regulation in dreaming is to see whether there is a difference in self-reported affect over the course of a dream. Although, as discussed above, research has mainly focussed on the regulation of negative affect – as measured by a decrease in negative affect across the night – this study focused on the regulation of both negative and positive affect, by investigating the change in both across the night. The reason for this is based on the principle of affective homeostasis set out by Panksepp (1998) and Solms (2020, 2021), which posits that deviation from homeostasis results in negative affect and return to homeostasis results in positive affect. Regulation of affect, therefore, involves changes in both positive and negative affect. If the dream performs affective work, then the beginning of the dream should be more emotional than the end of the dream. Furthermore, if dreams do regulate affect, then there should also be a progressive change in self-reported affect in dreams across the course of the night, resulting in a decrease in intensity or emotionality. Based on these propositions, the hypotheses of this study are:

H_1: The affective tone of a dream will be less emotional towards the end of the dream compared to the beginning of the dream;

H_2: Dreams during the early night will be more emotional compared to dreams later in the night, and;

H_3: The mood of the dreamer will improve over the duration of the night.

Methods

Research Design and Setting

Since the aim was to measure the emotional content of dreams at different points within a dream, as well as at different points during the night, a cross-sectional design was used for this study. For both hypotheses H_1 (the affective tone of a dream will be less emotional towards the end of the dream compared to the beginning of the dream) and H_2 (dreams during early night will be more emotional compared to dreams later in the night), the dependant variable was dream affect and the independent variable the time of measurement. For H_1, the time of measuring affect was the beginning versus the end of the dream (beginning: first half of the dream, end: second half of the dream). For H_2, it was early versus late dreams (early: early part of the night; late: late part of the night). For hypothesis H_3, the dependent variable was the general mood of the participants, and the independent variable, again, was the time of measuring – in this case before going to sleep and then again after awakening in the morning.

Participants

Recruitment

After approval for the study was granted by the Research Ethics Committee of the Department of Psychology (reference number PSY2018-004), recruitment of participants was done from the pool of University of Cape Town (UCT) students between the ages of 18 and 35 through the Department of Student Affairs' (DSA) research invitation programme. Details of the study as well as an invitation to participate and a link to an online questionnaire were emailed to all UCT student who opted to participate in ongoing research conducted at UCT.

The number of participants needed to detect effect sizes reported in studies of dreaming and affect was determined by performing a power analysis. Although reports of effect sizes in dream research are limited, one study examining the effects of dreams on waking life demonstrated effect sizes of *d* = 0.6 – 0.7 (Schredl, 2000). The power analysis showed that to attain a power level of 0.8 with an effect size of *dz* = 0.46 (average of *d* = 0.6 – 0.7 is equivalent to *dz* = 0.46) using dependent t-tests, a sample size of 30 participants would be needed, divided equally between males and females. A total of 577 students completed the online screening questionnaire. Since only 30 participants were needed, the first 30 (first 15 females and first 15 males) who qualified – and were available to participate - were chosen from the list created by Google forms based on chronological completion of the questionnaire by candidates. Of all the completed questionnaires, only 63 were eventually screened before the quota of 30 qualifying and available participants were met. Of the 63 screened, 46 qualified, but 16 were not interested or available to participate in the study any further. 12 candidates did not qualify due to poor sleep quality or the use of sleeping tablets, four did not qualify because they were on antidepressants and one participant was excluded because of smoking.

Unfortunately, due to the outbreak of the COVID-19 pandemic in 2020, UCT suspended all research activities involving personal contact on the 15th of March 2020 and not all 30 recruited participants could participate. The final sample size was N = 24, (females n = 14 and males n = 12). The mean age of the participants were 24.16 (SD = 8.96) years, ranging between 20 and 34 years.

Exclusion Criteria

1. Participants diagnosed with major depression, PTSD, alcohol and substance abuse – which are the four most prevalent psychiatric disorders in South Africa (Herman et al., 2009) – were excluded. Previous studies have shown that individuals diagnosed with psychiatric disorders like these typically have disrupted sleep (difficulty with falling and staying asleep (Nofzinger, 2005)) and disrupted dreams, characterised by a reduction in quality and quantity of dreams, a high percentage of failure to recall, poor

elaboration of dream plots and bland or negative dream affect (Armitage et al., 1995; Benca et al., 1992; Cartwright et al., 1991).

2. Potential participants that experienced poor quality of sleep and sleep disturbances were excluded from the study, as well as those with no or low dream recall frequency. Low dream recall frequency is described as once per month or less (Schredl, 2002).

3. Additionally, those reported drinking excessive amounts of caffeine (defined as 3 or more caffeinated substances a day) were excluded from the study.

4. Shift workers – i.e., students who work in restaurants/bars after midnight and students that have very irregular bedtimes – i.e., going to bed more than twice a week 3 hours later than their normal bedtime – were also excluded, since an irregular bedtime schedule has a negative impact on sleep quality (Joshi et al., 2015; Kabrita et al., 2014; Kang & Chen, 2009; Li et al., 2016; Soehner et al., 2011).

5. Participants taking sedative medication to aid with sleep and those taking chronic medication acting on the central nervous system (CNS) were excluded (Mahowald et al., 1998; Obermeyer & Benca, 1996).

6. Participants with a history of psychoactive drugs use, or smoking (including socially) and those with a history of alcohol abuse, were excluded from the study, as it has been shown that both nicotine and narcotics alter natural sleeping patterns (Domino & Yamamoto, 1965; Johnson & Breslau, 2001; Pagel, 2005; Stepanski & Wyatt, 2003).

7. Participants that had closed head injury or those with neurological or any other chronic medical condition affecting sleep (e.g., asthma or epilepsy) were excluded (Bazil & Malow, 2005).

Materials and Apparatus

Diagnostic and screening instruments:

The Patient Health Questionnaire for Depression (PHQ-9) (Kroenke et al., 2001). The PHQ-9 is a nine-question, multifunctional instrument for the screening of, diagnosing of, and measuring the severity of depression. It incorporates the diagnostic criteria for depression of the DSM-IV with other major depressive symptoms into a brief self-report tool. Numerous studies have demonstrated the diagnostic validity of the PHQ-9 (Kroenke et al., 2001; Nabbe et al., 2017) and a PHQ score ≥ 10 had sensitivity and specificity of 88% for major depression, respectively (Kroenke et al., 2001). Scores between five and nine indicate minimal symptoms, 10-14 indicate mild depression or dysthymia, 15-19 indicate moderately severe depression, and 20 and above indicate severe depression. Participants with a score of 15 and above were excluded from the study. The reason for considering participants with mild depressive symptoms (scores between 10-14), was to elicit and demonstrate the affect regulatory function of dreaming clearly. The validity of the PHQ-9 in South Africa has been demonstrated (Bhana et al., 2015; Cholera et al., 2014) as has its accuracy for detecting symptoms of depression in lower and middle income countries (Akena et al., 2012).

The 5-item Primary Care Post-Traumatic Stress Disorder Screen (PC-PTSD-5) (Prins et al., 2016). The PC-PTSD-5 is an updated version of the PC-PTSD in accordance with the new DSM-V criteria for PTSD. It is a concise questionnaire with five yes/no questions focussing on a traumatic event in the past that affects individuals' daily functioning in the last month. As with the original PC-PTSD, it shows good criterion validity, and the PC-PTSD-5 has a diagnostic accuracy of 95%. Participants with a score above three were excluded, since the authors of this screening tool found that the ideal cut-off score for sensitivity was three. They argue that optimised sensitivity will minimize false negative screen results, which is preferable for this particular screening tool. With a cut-off of three, they identified 94.8% of participants who were diagnosed with PTSD using the MINI (Prins et al., 2004, 2016). “The revised screening tool represents an advance beyond the PC-PTSD by reflecting the field’s most up-to-date knowledge of the PTSD construct, while still maintaining the strengths of the original screener” (Prins et al., 2016, p. 1210).

Alcohol Use Disorders Identification Test Consumption (AUDIT-C) (Babor et al., 2001; Bradley et al., 2003; Bush et al., 1998)**.** The AUDIT-C is an abbreviated version of the AUDIT – a ten-question test developed by a collaboration sponsored by the World Health Organization. The AUDIT-C has three questions and is a reliable, valid, and brief measure for detecting heavy drinking, active alcohol abuse, and dependence (Bradley et al., 2007; Bush et al., 1998; Frank et al., 2008). Each AUDIT-C question is scored zero to four points, resulting in a total score ranging from zero to 12 points. The higher the score, the greater the risky drinking behaviour. With little difference in the diagnostic ability of the AUDIT-C and AUDIT (both showing excellent scores for sensitivity and specificity,) the AUDIT-C is a stronger predictor of heavy drinking or alcohol dependence than the complete AUDIT and is therefore a more efficient tool to use (Bush et al., 1998). A cut-off score of four for men and three for women is considered standard. However, DeMartini and Carey (2012) optimised the AUDIT-C for use with college students and found that since the consumption of alcohol amongst students is higher, a more lenient cut-off score of seven for men and five for women should be applied. This still yields strong results in terms of sensitivity (0.82 for women; 0.80 for men) and specificity (0.82 for women; 0.74 for men) (DeMartini & Carey, 2012). Since this study used participants that were within the rage of college students, I used these adapted cut-off scores.

The Drug Abuse Screening Test – 10 Item Version (DAST-10) (Skinner, 1982). The DAST-10 is a 10-item yes/no questionnaire used to establish the severity of drug dependence. Answering ‘yes’ to three to five of the questions indicate a moderate degree of problems related to drug abuse, six to eight indicate a substantial problem and nine to 10 a severe problem (Skinner, 1982). In a comprehensive review of the psychometric properties of the DAST-10, Yudko et al. (Yudko et al., 2007) found an internal consistency reliability of 0.94 and sensitivity and specificity values that are comparable to values of the *Drug Abuse Screening Test - 28 Item Version* (DAST-28). Furthermore, it can discriminate between current and previous drug-users. The DAST-10 has been successfully used in South African settings (Peltzer et al., 2009). Participants that respond with 'yes' to more than three items were excluded.

The Pittsburgh Sleep Quality Index (PSQI) (Smyth, 2012). This is a nine-item self-report questionnaire used to assess the quality of sleep. It differentiates "poor" from "good" sleep by measuring seven domains concerning the sleeping habits of participants in the past month. It has an internal consistency and a reliability coefficient (Cronbach's alpha) of 0.83 for its seven components (Smyth, 2012). The seven components include scores for the use of sleeping medication, sleep latency, sleep duration, subjective sleep quality, habitual sleep efficiency, sleep disturbances, and daytime dysfunction. The component scores are added to produce a global score ranging between zero and 21. Participants with a global PQSI score of > five are classified as poor sleepers and therefore only participants scoring ≤ five were considered in this study.

Experimental Measures

Sleep diary. A sleep diary was used to assess participants' sleep for the seven nights prior to their first night in the sleep laboratory. The sleep diary is adapted from the American Association of Sleep Medicine (AASM) version which is often used in research. Participants completed the sleep diary in the morning after awakening and it included information about time going to bed, how long it took to fall asleep, time of awakening, and how many times they woke during the night. They were also asked, in addition to the sleep diary, to record any recollection of dream content.

Sleep adapted electroencephalography. Sleep was recorded with polysomnography (PSG) – an electroencephalograph (EEG) adapted for sleep research. It maps out sleep architecture and consists of electroencephalograph (EEG) electrodes that measure brain activity, electrooculograph (EOG) electrodes that monitor eye movements, electromyograph (EMG) electrodes that measure muscle tone, and electrocardiograph (ECG) electrodes that measure heartbeat. These measures are essential in identifying REM sleep, as brain activity measures alone are not reliable enough (Keenan, 2007). Sleep stages, as determined by the standard measurements of EEG, EOG, and EMG, were classified according to the latest specification provided by the American Academy of Sleep Medicine (Berry et al., 2012).

A Nihon Kohden NeuroFax EEG9000 with sleep options was used for the PSG recordings. It complies with all the digital system regulations. These include the filters on each channel, the rules for display and display manipulation (i.e., the ability to view the sleep data in variable time frames from five seconds to two minutes) as well as the digital analysis specifications (scoring data electronically or manually). A montage recommended by the latest technical specifications manual of the AASM (Berry et al., 2012) was used, but recording of the respiration parameters, leg movement or body positions were excluded, since using EEG, EOG and EMG measurements are adequate for determining REM sleep.

Measuring affect: The Positive and Negative Affect Schedule (PANAS) (Watson et al., 1988) is a standardised, 20-item psychological questionnaire measuring the internal, subjective perception of a participant's mood across a variety of positive (e.g., happy, energetic, and excited) and negative (e.g., distressed, scared, and guilty) emotional items, resulting in an accumulated score of positive and negative mood – referred to as Positive and Negative affect (Watson et al., 1988). The scale has different time settings, for example, This

Moment, Past Few Days or Past Few Weeks. Internal consistency remains reliable across the different time instructions (PA α = .86 to α = .90; NA α =.84 to α =.87). For this study, participants had to complete the questionnaire before going to bed and after waking in the morning, indicating how they felt at that specific moment. The PANAS was used to measure whether there was a change in mood across the night.

Dream report measures: Oral dream report recording. Participants were asked to give a spontaneous report of what they were dreaming upon awakening, and to include the 'feelings' they experienced during the dream. These reports were recorded using a recording app on a cell phone. If they indicated that they had not been dreaming, they were prompted with a phrase like: *Please tell me everything you can remember that went through your mind before I woke you.* This is a standard procedure often used in dream studies (Cartwright, Luten, et al., 1998; Foulkes, 1962).

Visual Analogue Mood Scales (VAMS): Visual analogue scales were used to rate the different emotions that participants experienced at the start of and towards the end of each of their dreams. The simplicity of these scales promotes a high degree of cooperation and their reliability and validity has been demonstrated (Ahearn, 1997). The 12 affects proposed in the *The Differential Emotions Scale* (DES-IV) (Izard et al., 1993) were used. Those included anger, contempt, disgust, sadness, shyness, shame, guilt, fear, and self-directed hostility as negative affects, and surprise, enjoyment (or happiness) and excitement representing positive affects.

Procedure

Every student who responded to the emailed DSA research invitation, had to complete the initial online screening questionnaire. This was to confirm their eligibility according to the exclusion criteria, that they understood the purpose of the study, and that they were willing to spend three non-consecutive nights in the sleep laboratory. Participants were required to read and sign (tick a box) an informed consent form to confirm their understanding of the process and their willingness to participate. The PHQ-9, PC-PTSD-5, AUDIT-C, DAST-10 and PSQI were administered as part of this online questionnaire to screen for the exclusion criteria. The screening questionnaire included information of mental health facilities for participants who completed the questionnaire and felt that they might be in need of mental health assistance. Care was also taken during screening to identify possible candidates who might need mental health assistance. Of the participants screened, none obtained scores in any of the questionnaires (for example depressive scores) that pointed to participants needing mental health assistance. The first 15 male and 15 female students who qualified (i.e., were not excluded by the exclusion criteria), were chosen from the list created by Google forms, and were invited to participate in the study.

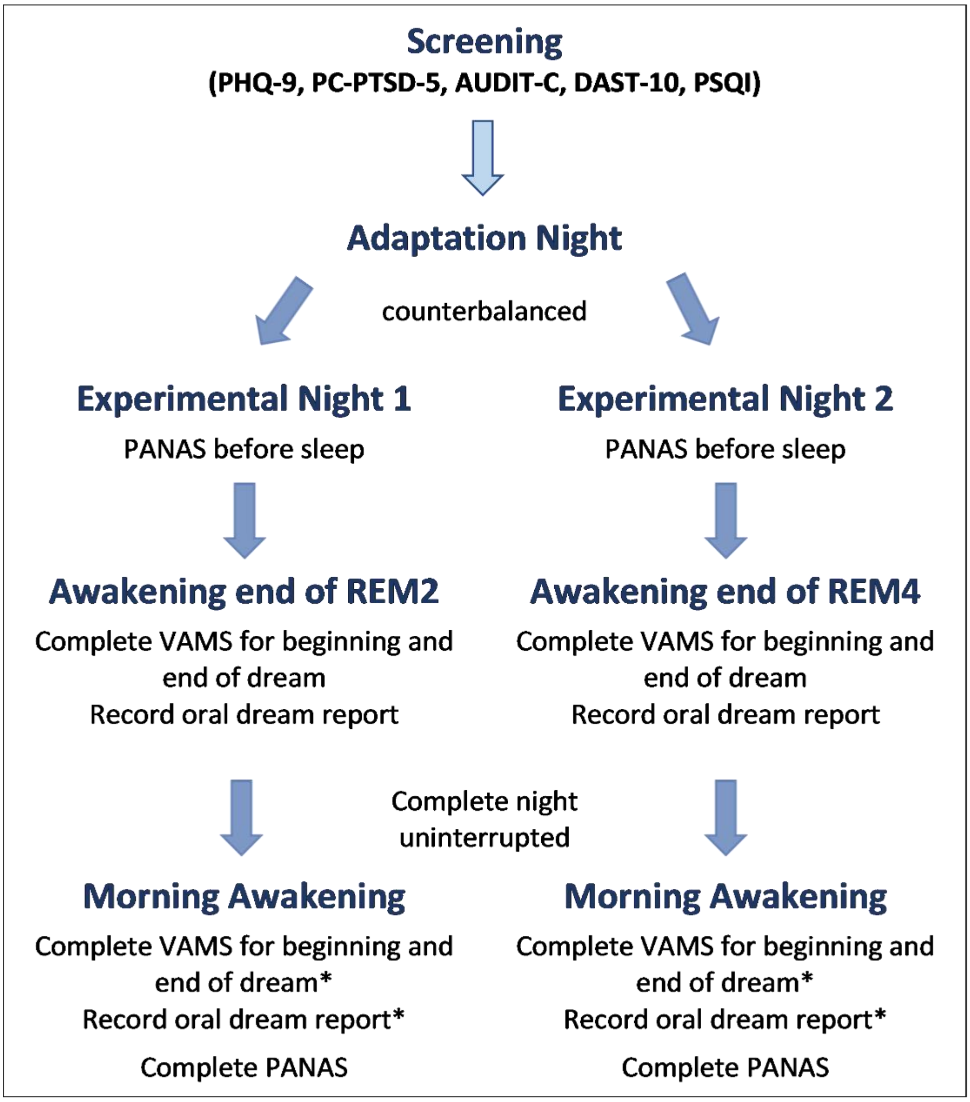
Those selected to participate in the study, were informed and an appointment for the first night in the sleep laboratory was arranged. Participants were remunerated for each night spent in the sleep laboratory (R150/night) and one participant, through a lucky draw, also received a R1000 Takealot gift voucher. Participants were asked to keep to their normal (but preferably regular) sleep-wake rhythm. Participants were also asked to keep a seven-day sleep diary at home prior to their first night in the sleep laboratory and to continue with it throughout the duration of the study. The purpose for this was to ensure that their laboratory measured sleep does not deviate substantially from home recorded sleep. Additionally, participants were asked to recall one dream at home to familiarize them with the dream reporting procedure and to encourage dream recall, which is improved by writing down dream content (Cohen, 1969; Revonsuo & Salmivalli, 1995).

For the purposes of this study, I focused on *dreaming occurring during REM sleep*. The reason for this is three-fold: REM dreaming is clearly distinguishable on polysomnography (Danker-Hopfe et al., 2009), REM dreaming yields more dream recall than dreaming elicited during other stages of sleep (Dement & Kleitman, 1957a, 1957b; Kales et al., 1967; Nielsen, 2000, 2004, 2011; Schredl, 2007; Stickgold et al., 1994) and REM dreams contain a higher degree of emotional content than dreams reported during other phases of sleep. (R. Fosse et al., 2001; Hobson et al., 2000; Hobson & Stickgold, 1994; Oudiette et al., 2012; Suzuki et al., 2004; Wamsley et al., 2007).

Polysomnography was used to identify the appropriate REM periods where awakening should occur (Berry et al., 2012). The adaptation night was used to determine the typical pattern of the participant's REM phases. On the experimental nights, PSG was subsequently used to identify the specific REM phase in question in order to wake the participant at the correct time – i.e., at the end of that particular REM period.

Figure 1

Flow Diagram of Experimental Procedure



* Eventually not incorporated into data analysis due to too few morning recollections

Sleep study

Adaption night. The first of three nights at the UCT Sleep Sciences Laboratory was an adaption night. Participants were asked to stick to their normal sleeping times and to arrive at the sleep laboratory 90 minutes before their normal sleeping time. The 90 minutes were used to familiarise them with the procedure, to sign a consent form, which also reaffirmed that all personal data are treated with confidentiality, and get them settled into their rooms, after which they were connected to the PSG via 18 electrodes (eight EEG electrodes for brain activity, two reference electrodes, one ground electrode, two EOG electrodes for eye movements, three EMG electrodes to the chin for muscle tone, and two ECG electrodes to measure heartbeat) according to guidelines set out by the AASM (Berry et al., 2012; Rosenberg et al., 2009; Westchester, 2009). Participants then went to bed and an alarm was set to wake them up at their normal time, since there are no external cues in the sleep laboratory, and it is easy to sleep undisturbed, far past one's normal sleeping hours. Participants were asked to complete their sleep diary upon awakening the next morning.

An adaptation night is necessary for participants to become accustomed to the laboratory setting to ensure that their sleep architecture in the laboratory would resemble that of their natural sleep architecture as closely as possible. Previous studies have demonstrated the first-night effect, where PSG recordings show more awakenings and less REM sleep than normally (Le Bon & Arpi, 2003).

A recovery period of a few days between sessions was allowed, to ensure that no REM sleep deprivation occurred which could affect the results of the study (Sikka et al., 2014).

Experimental nights. During the first experimental night participants were woken up towards the end of a REM period during the first half of the night to elicit dream-reports and dream affect and on the second experimental night the same participant were woken towards the end of a REM period during the last part of the night to elicit dream-reports and dream affect. Ordering effects were controlled by counter-balancing the first and second experimental nights in such a way that participants either attended the first or second night as the first condition they experienced.

First experimental night. The time interval between the adaptation and first experimental night were, on average, 4.6 (five) days. I allowed for some nights between the two to compensate for the possibility of poor sleep during the adaptation night.

The second night at the sleep laboratory participants were once again required to arrive 90 minutes prior to normal bedtime. They completed a PANAS and were then connected to the PSG. Participants were told that they would be awakened during the first half of the night, asked to record any dream content they had experiencing directly prior to waking and to fill out a basic questionnaire regarding the affect (‘feelings’ or ‘emotions’) they experienced at the beginning and towards the end of their dream. They were again reminded to set their alarm for normal waking time.

Participants were monitored and woken up towards the end of the second REM period (approximately 10 minutes after the start of the REM period). This time-period was chosen, similar to other studies (Cartwright, 1991; Cartwright et al., 2003; Cartwright, Luten, et al., 1998; Cartwright, Young, et al., 1998; Nielsen, 2004; Yu, 2015), to allow participants to experience REM and therefore increase the likelihood of a dream report. They were woken up by the researcher knocking on the door, calling their name, and switching on a dim light. Each participant was asked to report what was going through their mind (i.e., what they were dreaming) just before they were woken up. After their recollection, they were prompted with the additional question: “Was there anything else?” to ensure that nothing was left out. I recorded their dream reports using a smartphone. They then completed a VAMS for the first half and the second half of the dream(s) they had. Afterwards, they returned to sleep with no further interruptions and woke up at normal time, using an alarm. Their cell phones had to be switched off, since those could influence the PSG recording and create artifacts (American Association of Sleep Technologist, 2012). After awakening the next morning, they were again required to record an oral recollection of the last dream they had before awakening (if any), complete the VAMS for the emotions/affects experienced at the beginning and towards the end of that dream, their *sleep diary* and the PANAS before they left.

Second experimental night. The interval between the two experimental nights varied between three and 19 days. I originally aimed for an interval of between three to seven days, which would have allowed for a recovery period between the two nights to ensure that there was no REM sleep deprivation that could influence the results. However, due to various factors, including load shedding on the national electricity grid, this interval was longer for some participants. I was concerned that a too long interval between the two experimental nights might elicit a first-night effect during the experimental condition, however, a study by Lorenzo and Barbanoj (2002) demonstrated that the first-night effect was only observed during the first night of the very first experimental period, for lapses less than a month. The same procedure as experimental night one was followed, except that the participants were woken, approximately, 20 minutes into the fourth or last (therefore late) REM period of the night, to increase the likelihood of the participant reporting a dream (Cartwright, 1991; Cartwright et al., 2003; Cartwright, Luten, et al., 1998; Cartwright, Young, et al., 1998; Nielsen, 2004; Yu, 2015). The rest of the procedure remained the same as for the first experimental night.

Data Management and Statistical Analyses

Dream reports were transcribed before data analysis began. I assessed the dream reports for affective content using the Linguistic Inquiry and Word Count program (LIWC). LIWC is a text analysis software program that is used to analyse transcribed verbal text stored in Microsoft Word or other similar word processing software files (Tausczik & Pennebaker, 2010). LIWC 2015 is the latest version of the program, and includes approximately 80 separate dictionary files, each of which contains an assembly of words that belongs to a particular category (Pennebaker et al., 2015). The transcribed dream reports were run through this software to determine the number of emotional words used by participants. I used the dictionary files titled *positive emotion* and *negative emotion* for this procedure, i.e., the programme detected all the words that indicated positive and negative emotion and counted those for each dream. For the Visual Analogue Mood Scales (VAMS) completed by the participants after every awakening, each of the 12 affects was converted to a number out of 10 to be used for data analysis.

Inferential statistical analyses were done using SPSS version 27. Alpha was set at .05 for all decisions regarding statistical significance. To determine whether the data meet parametric assumptions of normality, I first examined the data for deviations from normality and variance distribution. In those instances where I found such deviations, I first attempted to transform the data to meet the required assumptions. Failing that step, I conducted non-parametric equivalent statistics.

Experimental checks – Sleep efficiency measures

To ensure that participants' home sleep was similar to their sleep in the laboratory, I compared their self-reported sleep efficiency (calculated from the PSQI questionnaire) to their sleep efficiency over the two experimental nights (calculated from the sleep scoring) in the sleep laboratory. I performed the Related-Samples Wilcoxon Signed Rank Test for non-parametric data because the data violated the assumption of normality.

For H_1 and H_2: Investigating dreaming affect in the first versus second half of the dream and over the course of the night

H_1 states that the affective tone of a dream will be less emotional towards the end of the dream compared to the beginning of the dream and H_2 states that dreams during early night will overall be more emotional compared to those later in the night.

To evaluate the validity of both these hypotheses, I performed a repeated measures ANOVA analysis, with different aspects of the analysis evaluating H_1 and H_2 respectively. The analysis was originally intended to consist of a 2 (dream-half: first half versus second half of the dream) x 3 (time-point: early-REM, late-REM, morning) x 2 (valence: Positive and Negative emotions) repeated measures ANOVA comparing the strength of aggregates of positive and negative emotions respectively, reported by participants using the VAMS, but since only nine participants had morning dream recall, I changed the time-point to two factors: early and late REM. Regarding the aggregates of positive and negative emotions, anger, contempt, disgust, sadness, shyness, shame, guilt, fear, and self-directed hostility were grouped as an aggregate of negative affect and surprise, enjoyment (or happiness) and excitement as an aggregate of positive affect. Together in consultation with the research team, I decided that surprise was too ambiguous and could have been interpreted by participants as either negative or positive and therefore surprise was not included in either of the positive or negative emotion aggregates for analysis.

For H_1, I was interested in the main effect of dream-half – the analysis was used to examine whether there is a difference in each of the affects when comparing the first and the second half of the dream. Unfortunately, an analysis of normality for the VAMS data obtained from both experimental nights revealed that three of these variables were not normally distributed and a transformation of data was subsequently performed. Square-root transformations successfully converted the data to fit a normal distribution (see Appendix A, Table A.1).

For H_2, I was interested in the main effect of time-point – the analysis was used to examine whether there is a difference in each of the affects garnered from dream reports during early-REM and late-REM dreams.

Furthermore, a similar ANOVA was conducted on the number of affective words recorded in the positive and negative emotion categories using the LIWC for early and late REM dreams. Analysis of normality, using the Shapiro-Wilk test, showed that these variables met this assumption (See Appendix A, Table A.2) and, therefore, standard analytic methods were applied.

The interaction of dream-half and time-point. This analysis explored whether there was a change in affect and affective dream content in each half of the dream with respect to when the dream was recorded. That is, this analysis investigated whether there was a progression in affect (hypothesised to be less emotional in the second half of the dream) with each successive dream report.

For H_3: The mood of the dreamer will improve over the duration of the night

The assumption of normality for two of the variables from the PANAS was not met (See Appendix A, Table A.3), and transformation of this data failed to convert data to fit a normal distribution, and therefore non-parametric tests were performed on this data. I, therefore, conducted a non-parametric Related-Samples Wilcoxon Signed Rank Test on both positive and negative emotions for PANAS pre-sleep vs. PANAS post-sleep scores. The PANAS scores were averaged for the two nights spent in the sleep laboratory.

Additional exploratory analyses

The association between change in mood and change in dreaming affect was examined by performing Spearman's Rho correlations. We wanted to examine to what extend both positive and negative affect was diminished through the process of dreaming and to what extend these changes were related to an aspect of affect outside of the dreaming process – i.e., whether changes in dream affect are related to changes in mood. I calculated change in mood as (a) post-sleep minus pre-sleep positive affect and (b) post-sleep minus pre-sleep negative affect. Spearman's Rho correlation was performed on the data, since the assumption of normality again, was not met.

Results

Descriptive Characteristics of the Sample

The final number of participants was 24 (females *n* = 10 and males *n* = 12). The mean age of participants was 24.16 (*SD* = 4.78) years, ranging between 19 and 34 years. The clinical characteristics of participants are drawn from the following screening measures: PSQI, PHQ-9, PC-PTSD-5, DAST-10 and AUDIT-C. Participants obtained an average PSQI score of 4.17 (*SD* = 1.24, ranging between 1 and 5), which classified all of them as good sleepers. Furthermore, all participants reported recalling their dreams at least once per week or more. None of the participants qualified as depressive, scoring between 0 – 6 on the PHQ (*M* = 2.58, *SD* = 2.06). All participants scored less than the cut-off score of 3 on the PC-PTSD-5 (*M* = 0.13, *SD* = 0.34, ranging between 0 – 1) and obtained an average score of 0.5 (*SD* = 0.72, ranging between 0 – 2) for the DAST-10, indicating no problems related to a substance use disorder. The average AUDIT-C score for male participants ranged between 0 – 7 (*M* = 2.69, *SD* = 2.29,) and females participants scored between 0 – 4 (*M* = 2.1, *SD* = 1.60).

In summary, therefore, all participants recruited to the study experienced relatively good sleep, did not experience depressive and posttraumatic symptoms suggestive of psychological difficulties, and did not report alcohol or drug use disorders.

Sleep-Architecture Profile of Participants

A sleep diary was used to assess participants' sleep for the seven nights prior to their first night in the sleep laboratory to ensure that their sleep were still within normal parameters before participating in the experimental sleep nights. Table 1 shows a summary of sleep parameters obtained from the sleep diaries.

Table 1

Table Of Sleep-Architecture Parameters of Study Participants 7 Days Prior to Adaptation Night

Parameters	Study Group (20-34y)
TST *(min)	433.31 (36.03)
Sleep efficiency (%)	92.64 (3.41)
Nr of self-reported awakenings	1.18 (1.16)
Sleep Latency (min)	15.03 (7.58)

Note. Study Group's values are presented as means and standard deviations.
** TST – total sleep time*

Sleep for both the experimental nights was scored and validated to check whether participants' sleep met with normal criteria. One participant had to be excluded for abnormal sleep architecture due to delayed sleep onset on one of the experimental nights. Furthermore, four participants, who had no dream recall on either of the two experimental nights, had to be excluded from analysis and their sleep was not scored. Therefore, only data from the remaining 19 participants were eventually included in the analysis.

The relevant sleep architecture parameters that were investigated, included total sleep time (TST), sleep efficiency, arousal index (AI), percentages of the different sleep stages (N1, N2, N3/SWS and REM sleep), wakefulness after sleep onset and sleep latency. Average values for these sleep-architecture parameters in healthy people are well established (Carskadon & Dement, 2010; Chokroverty, 2017; Ohayon et al., 2004; Roth, 2004; Vaudano et al., 2019). In young adults, for example, TST is between 439 – 446 min, sleep efficiency is 95%, the average arousal index is between 10.6 – 10.8, N1 sleep contributes approximately 5 – 10% of normal total sleep time, N2 50 – 60%, N3 15 – 20%, REM 20 – 25%, wakefulness after sleep onset is less than 5% of the TST and sleep latency is between 10 – 20 min (Berry & Wagner, 2015; Bonnet & Arand, 2007; Moraes et al., 2014; Philipson et al., 1980). A comparison of the sleep architecture and sleep stage distribution of this study's sample and that of normative values is made in Table 2.

Table 2

Table of Normal Sleep-Architecture Parameters for Young Adults and Experimental Group

Parameters	Group	
	Young adult population (18 – 40y)	Study Group (20-34y)
TST *(min)	439 – 446	410.55 (28.34)
Sleep efficiency (%)	95	92.30 (3.73)
Arousal index	10.6 – 10.8	10.34 (4.01)
N1 (%)	5 – 10	14.24 (5.40)
N2 (%)	50 – 60	47.18 (6.68)
N3 (%)	15 – 20	18.79 (6.42)
REM (%)	20 – 25	19.73 (5.37)
Wakefulness after sleep onset (%)	< 5	5.39 (3.50)
Sleep Latency (min)	10 – 20	4.89 (3.12)

Note. Study Group's values are presented as means and standard deviations. N1 (%), N2 (%), N3 (%), REM (%) indicate the percentage of time spent in that sleep stage in comparison to total sleep time.

* *TST – total sleep time*

As seen in Table 2 above, some of the sleep-architecture parameters of the sample (TST, sleep efficiency and N1%) differ from the normal average values. This is to be expected in a study where participants are woken up during the night and therefore have to return to sleep, and correspond with findings in other studies where sleep was disrupted (Roehrs et al., 1994). Notably the difference between this sample's TST, sleep efficiency and N1%, and that of the normative values is not great (TST: 28.45 minutes; sleep efficiency: 2.7%; N1%: 4.24%). Sleep latency was, however, much shorter than expected and in fact, would normally point to sleep deprived participants (Brunner et al., 1990; Elmenhorst et al., 2008; Levine et al., 1988; Roth & Roehrs, 2017). The above observation can, however, be explained by the time-consuming (and soothing) process of applying the electrodes to the scalps of the participants. The process induced somnolence.

Sleep efficiency for experimental nights (*M* = 92.30%, *SD* = 3.73) was further compared to that reported by participants in the screening questionnaire (PSQI: *M* = 88.04, *SD* = 8.15). I performed the Related-Samples Wilcoxon Signed Rank Test for non-parametric data because the data violated the assumption of normality ($W(19) = 0.85$, $p = 0.006$). This revealed no significant differences between sleep efficiency prior to and during the experimental nights ($Z = 1.851$, $p = 0.064$). These results, where self-reported sleep efficiency is lower than objectively measured sleep efficiency, are in line with findings from other studies (Jackowska et al., 2016; Means et al., 2003).

The dream recall percentage for the 24 participants, of which a total of 48 awakenings yielded 43 dream reports, was 89.6%. Although REM dream frequencies obtained from different studies vary, the results of this study fall withing the variation of results obtained from previous studies (Nielsen, 2004).

Experimental Data

Inferential statistical analyses of VAMS, LIWC data

Table 3

Table of Analysis from the General Linear Model/Repeated Measures ANOVA of Within-Subject Factors for the VAMS and LIWC Results

Effect	Value	*F*	*df*	*p*	Partial Eta squared
VAMS					
Dream-point (Early/Late REM)	0.07	1.43[b]	(1,18)	.247	0.074
Dream-half (First/Second half)	0.004	0.07[b]	(1,18)	.791	0.004
Valence: (POS/NEG emotion)	0.46	15.17[b]	(1,18)	.001	0.457
Dream-point*Dream-half	0.28	7.16[b]	(1,18)	.015	0.284
Dream-point*Valence	0.10	2.00[b]	(1,18)	.075	0.100
Dream-half*Valence	0.01	0.24[b]	(1,18)	.634	0.013
Dream-point*Dream-half*Valence	0.11	2.24[b]	(1,18)	.152	0.110
LIWC					
Dream-point (Early/Late REM)	0.25	6.01[b]	(1,18)	.025	0.250
Valence: (POS/NEG emotion)	0.18	4.02[b]	(1,18)	.060	0.183
Dream-point*Valence	0.09	1.68[b]	(1,18)	.211	0.085

b. exact statistic

Above results obtained using Pillai's Trace as the test of significance

VAMS – Visual Analogue Mood Scale, LIWC - Linguistic Inquiry and Word Count program

The tables below contain the descriptive statistics (Table 4) and the estimated marginal means (Table 5 and 6) for the analysis of the VAMS and LIWC data and will be referred to in the discussion of the hypothesis in the next section.

Table 4

Table of Descriptive Statistics of the Dependent Variables from the VAMS and LIWC Analysis (N = 19)

Dependent Variable	NEG Emotions	POS Emotions
*VAMS**		
Early REM - *First* Half	1.14 (0.40)	2.11 (0.79)
Early REM - *Last* Half	1.21 (0.69)	1.80 (0.97)
Late REM - *First* Half	1.16 (0.34)	1.51 (0.95)
Late REM - *Last* Half	1.22 (0.43)	1.75 (0.94)
LIWC		
	NEG emotional dream words	POS emotional dream words
Early REM	1.55 (1.19)	2.67 (2.10)
Late REM	1.22 (.87)	1.52 (1.26)

Note. Study Group's values are presented as means and standard deviations.

Note. * Square-root transformation values

NEG – negative; POS – positive

Table 5

Table of Estimated Marginal Means for Within-Subjects Effects for the VAMS Analysis

Within-Subjects Effects			Mean	Std. Error	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Dream-point:						
Early REM			1.57	0.12	1.33	1.81
Late REM			1.41	0.11	1.19	1.64
Dream-half:						
First Half			1.48	0.09	1.29	1.67
Second Half			1.50	0.10	1.30	1.70
Valence:						
NEG emotions			1.18	0.08	1.02	1.34
POS emotions			1.79	0.15	1.48	2.11
Dream-point*Dream-half						
Early REM	First Half		1.63	0.11	1.40	1.85
	Second Half		1.51	0.13	1.23	1.78
Late REM	First Half		1.34	0.12	1.09	1.58
	Second Half		1.49	0.11	1.25	1.72
Dream-point*Valence						
Early REM	NEG emotions		1.18	0.11	.94	1.41
	POS emotions		1.96	0.19	1.56	2.35
Late REM	NEG emotions		1.19	0.07	1.05	1.33
	POS emotions		1.63	0.19	1.24	2.03
Dream-Half*Valence						
First Half	NEG emotions		1.15	0.07	1.01	1.29
	POS emotions		1.81	0.17	1.46	2.16
Second Half	NEG emotions		1.22	0.10	1.01	1.42
	POS emotions		1.78	0.17	1.42	2.13
Dream-Point*Dream-Half*Valence						
Early REM	First Half	NEG emotion	1.143	0.09	0.95	1.34
		POS emotions	2.108	0.18	1.73	2.49
	Second Half	NEG emotions	1.213	0.16	0.88	1.54
		POS emotions	1.801	0.22	1.33	2.27
Late REM	First Half	NEG emotion	1.157	0.08	1.00	1.32
		POS emotions	1.513	0.22	1.06	1.97
	Second Half	NEG emotions	1.219	0.10	1.01	1.43
		POS emotions	1.751	0.22	1.30	2.20

POS- positive; NEG – negative

Table 6

Table of Estimated Marginal Means for Within-Subjects Effects for the LIWC Analysis

Within-Subjects Effects		Mean	Std. Error	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Dream-point:					
Early REM		2.11	.27	1.54	2.67
Late REM		1.37	.17	1.01	1.73
Valence:					
POS Emotional dream words		2.09	.30	1.46	2.72
NEG Emotional dream words		1.38	.17	1.02	1.74
Dream-point*Valence					
Early REM	POS emotional words	2.67	.48	1.66	3.68
	NEG emotional words	1.55	.27	.96	2.12
Late REM	POS emotional words	1.52	.29	.91	2.13
	NEG emotional words	1.22	.20	.80	1.64

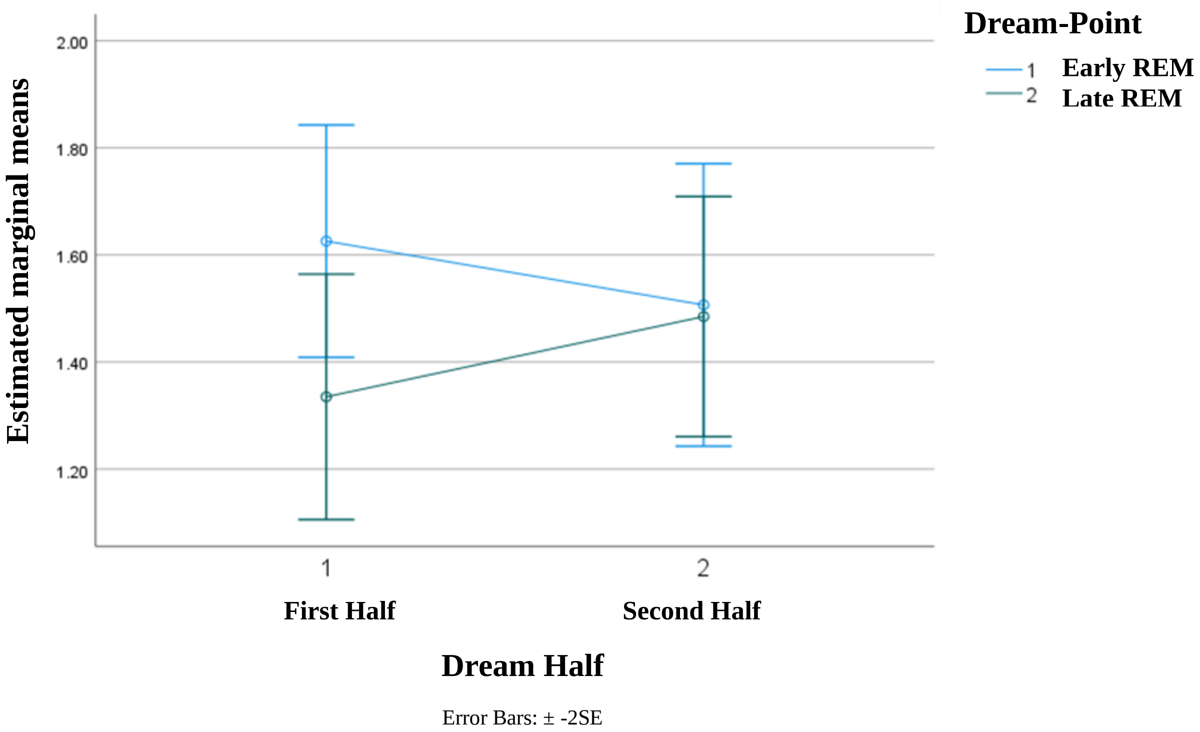
Testing H_1: The affective tone of a dreams will be less emotional towards the end of the dream compared to the beginning of the dream. For H_1, the main effect of dream-half was investigated. In other words, whether there is a difference in emotionality between the first and the second half of dreams (both early and late REM; see Table 3). Analysis of the data showed that there is no significant main effect of dream-half on emotional content (overall) in dreams and, furthermore, no significant interaction between dream-half and emotion, i.e., no significant difference in change of either negative or positive emotions between the first and second half of dreams (see Table 5 for mean values). In summary, the data do not support a reduction in both positive and negative affect, towards the end of the dream compared to the beginning of the dream.

Testing H_2: Dreams during early night will be more emotional compared to dreams later in the night. For H_2, the main effect of dream-point was investigated, in other words, whether there is a difference in emotions between early and late REM dreams. Data from both VAMS and LIWC was used in analysis to investigate this hypothesis. Analysis of the VAMS data revealed that there was no significant main effect of dream-point (i.e., early versus late REM dreams) on all emotional dream content (see Table 5 for mean values). There was also no significant interaction between dream-point and valence – therefore no significant difference in the change in either negative or positive emotions from early to late REM dreams. However, analysis of the *LIWC* results (which is an objective analysis of emotional dream-words), did show a main effect of dream-point on emotional content of dreams, indicating that emotion decreases from early to late REM with less emotion towards the end of the night.

Furthermore, investigation into the interaction between dream-point and dream-half revealed some interesting results. Self-reported dream affect decreased from the first half of early REM dreams to the last half of early REM dreams and, starting from a lower level, compared to the end of early REM dreams, affect increased from the first half of late REM dreams to the last half of late REM dreams, but remain lower than in early REM dreams (see Figure. 2).

Figure 2

Estimated Marginal Means for Dream-half/Dream-point interaction



These results indicate that emotion fluctuates during the night, with an initial decrease in emotion within a dream during the first half of the night, but a subsequent increase in emotion in the later part of the night. This increase tended towards almost exactly the same point as that of the initial decrease in the first half of the night.

Testing H3: The mood of the dreamer will improve over the duration of the night. For H3, change in mood was assessed using data obtained from PANAS. Non-parametric Related-Samples Wilcoxon Signed Rank Test was performed on both positive and negative responses before and after sleep. There was no significant difference in positive emotions before (*M* = 26.37, *SD* = 7.39) and after (*M* = 25.29, *SD* = 6.99) sleep (*Z* = -0.946, *p* = .344), and no significant difference in negative emotions before (*M* = 14.32, *SD* = 4.44) and after (*M* = 13.50, *SD* = 3.48) sleep (*Z* = -0.674, *p* = .501) and hence, my hypothesis was not supported.

Further findings

Analysis of VAMS further demonstrated that there was a main effect of valence, indicating that positive emotions were more strongly endorsed than negative emotions, in relation to the dream content recalled. Analysis of LIWC data showed trend-level support for this finding, with a large effect size.

Additional exploratory analyses. As presented in Table 7, Spearman's Rho correlation analysis showed no correlation between change in mood and change in self-reported dreaming affect.

Table 7

Correlation Matrix: Associations (Spearman's Rho) Between Change in Affect (Positive and Negative) Within and Between Dreams with Change in Mood (Positive and Negative) Across the Night (N=19)

	Change in Early REM NEG Dream Affect °		Change in Early REM POS Dream Affect °°		Change in Late REM NEG Dream Affect °°°		Change in Late REM POS Dream Affect °°°°		Change in NEG Dream Affect across the night $		Change in POS Dream Affect across the night $$	
	rho	*p*	rho	*p*	rho	*p*	rho	*p*	rho	*p*	rho	*p*
Difference in POS PANAS across night *	.069	.778	-.213	.382	.155	.527	-.129	.598	.008	.974	-.098	.691
Difference in NEG PANAS across night **	-.180	.462	.057	.816	-.159	.515	.090	.715	-.173	.478	-.070	.776

* post-sleep minus pre-sleep positive affect

** post-sleep minus pre-sleep negative affect

° Second half minus first half negative affect during Early REM dreams

°° Second half minus first half positive affect during Early REM dreams

°°° Second half minus first half negative affect during Late REM dreams

°°°° Second half minus first half positive affect during Late REM dreams

$ Late REM Minus Early REM negative affect

$$ Late REM Minus Early REM positive affect

POS – positive; NEG – negative

Discussion

The aim of this study was to investigate whether affect in dreaming changes in a predictable way that is suggestive of affect regulation. Contradictory evidence exists regarding the effects of sleep on affect regulation. One possible reason explaining the contradictory results is that researchers have not considered dreaming, rather than sleep, as the active component in sleep-dependent affect regulation.

To examine whether dream affect changes across the night, as a representation of affect regulation, I investigated the difference in self-reported affect over 1) the course of a dream and 2) the course of the night. I hypothesised that if the dream performs affective work, then the beginning of the dream should be more emotional than the end of the dream. Furthermore, if dreams do regulate affect, then there should be a progressive change in self-reported affect in dreams across the course of the night, resulting in a decrease in intensity or emotionality. This would also be correlated with a decrease between pre-sleep and post-sleep mood. To achieve these aims this study focussed on dreaming during REM sleep specifically, because it is the stage of sleep from which dream reports are obtained most reliability (Dement & Kleitman, 1957a, 1957b; Kales et al., 1967; Nielsen, 2000, 2004, 2011; Schredl, 2007; Stickgold et al., 1994).

Summary of results

Analysis of self-reported affect associated with each dream did not reveal any significant difference between the first and second half of dreams, or between early and late REM dreams. There was, however, a significant interaction between dream-half and dream-point, indicating a decline in emotionality from the first half to the second half of early REM dreams, followed by an increase in emotionality from the first to the second half of late REM dream, although still below that of early REM levels. Analysis of the number of emotional words within each dream, on the other hand, showed a significant decrease in the number of emotion words from early to late REM dreams. Furthermore, the findings showed no significant difference between pre- and post-sleep mood and no correlation between the change from pre- to post-sleep mood and the change from pre- to post-sleep dream affect.

H_1: The affective tone of a dream will be less emotional towards the end of the dream compared to the beginning of the dream

Hypothesis one stated that if dreams perform emotional work, i.e., affect regulation, then there should be a noticeable reduction in emotionality of the dream towards the end of the dream. The data from this study showed no significant change in self-reported affect between the first and the second half of dreams, and therefore hypothesis one was not confirmed. It is noteworthy, however, that there were no significant differences between the change in positive or negative affect from the first to the second half of the dream, suggesting that neither valence is regulated more than the other (see Table 4 and 5).

To the best of my knowledge, no other studies investigated affect change within REM dreams, i.e., between the first and second half of a specific dream. Most studies investigating self-reported affect during REM dreams only measured affect at a single point during a REM phase. How long into the REM period and during which REM phase awakening occurred, depended on the research protocol of that specific study (Nielsen, 2004). Two studies which did look at the change of affect in dreams across the same REM period were those of Kramer and colleagues (Czaya et al., 1973; Kramer et al., 1974). These investigated, apart from other variables, self-reported affect within a specific REM sleep period, which is likely to represent the evolution of a single dream (Fiss et al., 1974; Fiss, 1986; Kramer et al., 1974). The four participants were woken up at sequential times (0.5min, 2min, 5min, 10min, 20min and 30min) within the second and fourth REM period and asked to rate their dreams on various qualities including emotionality, anxiety and pleasantness. Regarding these qualities, the authors reported that there was an increase in these variables for both REM 2 and REM 4 with progression of time, until they plateaued after 10 min. For REM 4, which is longer than REM 2, this plateau continued until 20 minutes, after which there was a decrease in affect for a while, followed by an increase which led to another peak at 30 minutes into this REM period. These findings are, in part, discrepant to those of the current study when comparing the change in dream affect at equivalent awakening times during REM periods. For example, the dream affect of participants in this study decreased for early REM (REM 2 of this study), whereas that of the participants in Kramer's study increased for the corresponding time between 0 – 10 minutes. However, affect of participants in this study increased during late REM (REM 4 of this study) corresponding to the time between 0 – 20 minutes, which is in line with the affect experienced by the participants in Kramer's study (Czaya et al., 1973; Kramer et al., 1974), where there was the initial increase up to 10 minutes and then the plateauing of emotionality till 20 minutes – indicating the measured affect at 20min was higher than that at the beginning. It is important to note that it is difficult to map the times of the Kramer study exactly onto this study, since the awakenings of this current study was not done at exact times, as in the Kramer studies. Furthermore, the partial discrepancies between these studies could be due to the fact that the Kramer studies used serial awakenings, and frequent awakenings are likely to interfere with the dreaming process, causing it to 'restart' each time.

H_2: Dreams during early night will be more emotional compared to dreams later in the night

Hypothesis two also predicted that if a dream performs emotional work, which results in affect regulation, dreams towards the end of the night should be less emotional than dreams from the first half of the night. The results from this study showed no significant difference between overall dream-related self-reported affect in the first part of the night compared to later in the night. In other words, later dreams were not, as expected, less emotional than earlier dreams.

However, contrary to self-reported affect, there was a significant decrease in the number of positive and negative affective dream words, from early to late REM, lending partial support to the hypothesis. These findings, although measured differently from the Cartwright studies, are congruent with their findings (Cartwright et al., 1991, 2003, 2006; Cartwright, Luten, et al., 1998; Cartwright, Young, et al., 1998).

Furthermore, there was no significant difference between positive or negative affect experienced during dreaming between the first and the second half of the night, indicating that the earlier dreams do not contain more, or less, positive or negative affect compared to later in the night and that neither valence type undergoes change more than the other. These findings correspond with those from a study done by Yu (2015) on 20 healthy volunteers, where positive and negative affect were measured before and after sleep, as well as across the night by means of awakenings in each of the REM periods (Yu, 2015). He found no discernible pattern regarding the change in proportion of either positive of negative affect in successive REM periods across the night, indicating that neither valence type showed more change than the other from early REM periods to later periods. In support of these findings, Cartwright and colleagues found that healthy volunteers with low scores on the Depression Scale in the Profile of Mood Scales questionnaire, displayed an even distribution of positive and negative affect across the night (Cartwright, Luten, et al., 1998). In other words, also no significant change in either positive or negative affect from the first half of the night to the second half of the night.

Although there was no significant difference between self-reported affect in the first part of the night compared to those later in the night per se, there was, however, a significant difference when taking into account when the affect was generated within a dream (first or second half). Overall self-reported dream-affect decreased towards the second half of the dream compared to the first half, specifically, early in the night (second REM phase). Dream-affect obtained from dreams later in the night (fourth REM phase) showed the opposite pattern. The first half of dreams contained less self-reported positive and negative affect than the last half of those dreams (see Figure. 2). Thus, these results suggest that there is an initial decrease in dream affect during the night, followed by an increase towards early morning. Moreover, this rise in self-reported affect in the second half of dreams towards the end of the night, does not reach a level higher than which it ended during the last half of the early dreams; in fact, it appears that the trend in both the last half of the early dreams and the last half of the later dreams is towards a common value or setpoint. Speculatively, this point might represent a regulated affected homeostatic set-point (Panksepp & Biven, 2012; Solms, 2021).

The study by Yu (2015) demonstrated that both positive and negative affect follow a similar fluctuation pattern across the time-points that were measured during the experimental night. These time-points included pre-sleep, six consecutive REM periods and post-sleep self-reported dream affect. It showed an initial drop from pre-sleep through the early REM phases with some elevation during REM 3, reaching the nadir for both positive and negative affect at REM 5, after which followed an increase in affect strength through REM 6, ending with post-sleep affective values for both positive and negative affect less than the pre-sleep values (Yu, 2015). He interpreted these results to mean that while there is substantial fluctuation in dream affect throughout the night (and not the linear trajectory proposed by the *selective mood regulatory theory of dreaming*), the dreaming process still regulates affect back to a homeostatic set-point, similar to the findings of this study.

In contrast to these findings, other studies using healthy and depressed participants showed different results. Cartwright studied the change in dream affect across the night, and the resulting effect on next morning mood, in divorced subjects with untreated depression, and demonstrated a decrease in self-reported negative affect and corresponding increase in positive affect from the first to the second half of the night, as well as improved morning mood (Cartwright, 1991; Cartwright, Young, et al., 1998). Similar results regarding a decrease in self-reported negative affect from the first to the second half of the night were demonstrated in another group of healthy volunteers with mild pre-sleep elevated depressed mood (Cartwright, Luten, et al., 1998) and in an experimental setting in a study by Berger et al. (1988) where both healthy and depressed participants were shown a stressful movie to produce an increased negative emotional state. In this study the first and last REM dreams as well as pre- and post-sleep mood were measured after watching the stressful movie. Participants from the healthy group showed improved mood from the first to their last REM dreams, as well as improved morning mood. Results from the depressed participants, however, differed from those found in the beforementioned Cartwright studies in that they had less scoreable dreams and poorer mood from the first to the last REM dream reports. This lack in downregulating of negative affect in depressed participants, however, was observed in some participants of the Cartwright studies and Cartwright and colleagues postulated that one of the reasons might be that the negative pre-sleep mood is too high for the dream mechanism to perform the role of affect regulation (Cartwright, 1991, 2003, 2006; Cartwright, Young, et al., 1998).

My findings are in contrast to earlier formulations of the *selective mood regulatory theory* of dreaming that were heavily focussed on the change in negative dream affect across the night (Cartwright et al., 1991, 2003, 2006; Cartwright, Luten, et al., 1998; Cartwright, Young, et al., 1998; Indursky & Rotenberg, 1998; Kramer & Roth, 1972). My findings, together with Yu (2015) support the hypothesis that the regulatory function of dreaming applies to situations of elevated negative and as well as positive pre-sleep affect. Solms (2021) provides a credible explanation for the results found in this study, and for that of Yu (2015). According to Solms (2021), affect regulation is actually a by-product of finding solutions to our problems. We have basic intrinsic emotional drives that enable us to meet our needs in the world (Panksepp, 1998). When these needs are not met, we move away from a state of homeostasis (Panksepp, 1998; Solms, 2021), resulting in negative emotions or ‘unpleasure’. When we find effective solutions to those problems or situations (i.e., to meet our needs) we return towards homeostasis, and we experience positive emotions or 'pleasure'. Since there is an unlimited number of possible options to meet those needs (i.e., solve our problems), we use 'predictions' to guide our actions. If those predictions work, we are in homeostasis and no emotions arise. If, however, they do not work, we move away from homeostasis and we experience negative emotions. These predictions are updated in various ways through new learning, and dreaming is one such way – it supplies us with a safe environment to test out new solutions and update our predictions (Solms, 2022). Deviations from homeostasis during waking triggers negative affect which is reactivated during dreaming and sets in motion the process of 'trying out' of various solutions in order to update our predictions. When a satisfactory solution is found during dreaming, we return to homeostasis, and we experience positive affect in our dreams. This explanation could account for the finding in both this current study, and that of Yu (2015), that this process of affect regulation is not linear, but cyclical – various conflicting needs may be activated throughout the night, resulting in fluctuation of negative (unpleasant) and positive (pleasant) affect throughout the night and not only a decrease in negative affect replaced by an increase in positive affect towards the end of the night. Both studies found that even though there is a fluctuation in affect in non-depressed participants across the night, affect (both negative and positive) decreases from early to late night – which could be the indication that successful solutions to meet our needs have been found and therefore lead to the updating of more efficient predictions.

H_3: The mood of the dreamer will improve over the duration of the night

With this hypothesis, I tested the idea that if dreams are successful in regulating affect during a period of night-time sleep, the dreamer will wake up with improved mood. However, the findings did not support this hypothesis.

These results differ from that of similar other studies for a number of reasons. The sample in this study were non-depressed participants with very low depression scores obtained during screening (between 0 – 6). Furthermore, pre-sleep positive affect was low, ranging between 15 and 37, with the average score equal to 25.63 compared to the mean momentary value of 29.7 (*SD* = 7.9) and the average negative pre-sleep score was also low, ranging between 10 and 25.5, with the average score equal to 14.32 (the mean momentary value = 14.8, *SD* = 5.4) (Watson et al., 1988). The argument could therefore be made that there was little elevated pre-sleep affect (negative or positive) to down-regulate.

However, two studies on healthy volunteers (Cartwright, Luten, et al., 1998; Yu, 2015), where pre-sleep mood was within normal ranges, did show a down-regulation of affect across the night. The discrepancy between the results of this study and these other findings could be attributed to different methods used to determine pre- and post-sleep mood. The Cartwright study used the reduction in only the depression scores (one of the subgroups) of the Profile of Mood States Questionnaire to determine an improvement in mood (Cartwright, Luten, et al., 1998). Yu, on the other hand, used a more complex tool which included both positive and negative components to measure mood. He used a questionnaire based on the basic emotions as described by Panksepp (Davis et al., 2003; Davis & Panksepp, 2011; Yu, 2015) to which further affects were added. Altogether, five positive and six negative affects were represented in the questionnaire, which represents a richer picture of affect (Yu, 2015) and is closer to the questionnaire used in this study to assess pre-and post-sleep mood. In his study (where the first two nights were adaptation and baseline nights and the third night was an experimental night), despite an average reduction in post-sleep mood across the three nights in the sleep laboratory, the difference in pre- and post-sleep mood on the experimental night, did not reach significance. This might allude to the fact that the dreaming process exerts its effects potentially over a period of time, rather than one night (Cartwright, 2010; Van der Helm & Walker, 2009).

Another explanation of my results could be that, other than Yu, who used the same measuring tool for measuring affect before, during and after sleep (Yu, 2007, 2015), and therefore had a better comparison, my study used two different tools – one measuring pre-and post-sleep mood and the other measuring affect reported during dreaming, which may represent two related but different constructs.

Other findings

Although previous studies regarding the dominant affective valence in dreams have found various results, the results of this study indicated that amongst healthy, non-depressed, and non-traumatised participants, self-reported affect was significantly more positive than negative. This finding is similar to that of studies done by other researchers (Kahn et al., 2002; Sikka et al., 2017; Yu, 2007, 2015). Furthermore, some studies that have reported predominantly negative affect in dreams have used external raters to determine dream-affect (Schredl & Doll, 1998), while this study used participant self-ratings. Self-reported versus external ratings of dreams tend to differ with regard to emotionality and valence, where self-reported dreams are more emotional and more positive than externally rated dreams (Sikka et al., 2014, 2017).

Furthermore, some earlier studies that found dream content having a preponderance of threatening elements and negative emotions, especially fear and anxiety (Hall & Van de Castle, 1966; Merritt et al., 1994; Nielsen et al., 1991; Revonsuo, 2000; Valli et al., 2006, 2008; Valli & Revonsuo, 2009) were done with traumatised children and it is expected that these dreams would contain more negative emotions. Another factor which may influence the dominance of negative or positive affect in dreams is related to where the participant slept. Several studies have found that dream reports collected at home, for example, contain more negative emotions, probably due to recency and selection bias of negative remembered dreams (Domhoff & Schneider, 1999; St-Onge et al., 2005; Weisz & Foulkes, 1970). In contrast to this, a number of laboratory-based studies showed a more or less similar weighting of positive and negative affect in dreams (R. Fosse et al., 2001; St-Onge et al., 2005).

Limitations and Recommendations for Future Research

An initial sample size of 30 was envisaged, but due to the outbreak of the COVID-19 pandemic in 2020, all research activities at UCT involving personal contact were suspended on the 15th of March 2020; so, only 24 participants eventually participated, of which the data of only 19 could be used due to irregular sleep during participation. The small sample size was a significant drawback regarding the findings in this study.

Some methodological issues might have also impacted the findings. Firstly, this study focussed on one awakening in the first half of the night and another awakening on a different occasion in the second part of the night, predominantly to minimize the impact of REM sleep deprivation – and resultant REM rebound – on the measures. Although Cartwright and colleagues also focussed on the first versus the second half of the night, their process was a serial awakening during all successive REM periods and then grouping the first two REM periods as the first half of the night (with an average of the measures from REM one and two as the corresponding value) and the third and subsequent REM periods (with those averages as the corresponding value) for that last half of the night (Agargun & Cartwright, 2003; Cartwright, 1991; Cartwright, Luten, et al., 1998; Cartwright, Young, et al., 1998). This would have obvious impact on measures relating to first and second half of the night. Regarding which REM awakenings to select for measuring affect, Yu (2015), also awakened participants during all of the REM periods, but did not group them into first and last half of the night. He examined the self-reported affect for each REM period and looked at how those changed across the night. This method of serial awakenings has its limitations as well – for example because the method elicits REM deprivation and rebound. Both methodologies therefore present with challenges and we therefore need both kind of studies to see whether the results converge across the different methodologies.

Regarding when to awake participants, this study followed the protocol used by both Cartwright and colleagues and Yu, which was five minutes into the first, 10 minutes into the second, 15 minutes into the third and 20 minutes into the fourth and all subsequent REM periods (Cartwright, 1991; Cartwright et al., 2003, 2006; Cartwright, Luten, et al., 1998; Cartwright, Young, et al., 1998; Nielsen, 2004; Yu, 2015). This study therefore woke participants after 10 minutes into the second REM period and 20 minutes into the fourth. The aim was to give REM dreams enough time to do affective work. Awakenings even closer towards the end of the REM period would have given more accurate insight into the change of self-reported affect within the dream. However, this is difficult to do because it is unknown how long a specific REM period will last, and it is unknown whether dream reports at the point of transition from REM to another stage of sleep would be reliable.

Another consideration regarding methodology was the questionnaires used to measure self-reported affect during dreams, as well as those measuring mood before and after sleep. The Cartwright studies used a simplified measure for self-reported dream affect, requiring participants to classify only whether their dreams were positive, neutral or negative. Yu (2015) felt that splitting dreams into only “positive” or “negative” oversimplifies the complexity of the emotionality in dreams. He used a questionnaire that included 11 affective feelings which were classified into positive and negative categories and rated on a 10-point scale – very similar to this study, which used 12 affects proposed in the The Differential Emotions Scale (DES-IV) which contained positive and negative affect. The questionnaire used by Yu, (2015) was largely based on the primary emotional systems as identified by Panksepp and his colleagues (Davis et al., 2003; Davis & Panksepp, 2011; Panksepp, 1998). Furthermore, regarding measuring of mood pre- and post-sleep, the Yu study used the same questionnaire before, during and after sleep, which resulted in a more reliable comparison in the change of affect across sleep (Yu, 2015). This study used the PANAS for measuring pre- and post-sleep mood and could have benefitted from using the same measure to rate pre- and post-sleep emotion that was used to rate dream affect, as was done in the study by Yu (2015).

Conclusion

The results from this study, despite the many limitations, suggest that dream affect follows a non-linear pattern across the night, decreasing towards a settling point during the early night, before rising again to meet this point in the early morning hours. This common point could be interpreted as an homeostatic settling point – an indication of recalibrated emotional circuits – which would “allow us to navigate next-day social and psychological challenges” (Walker, 2017, p.15). This, together with the overall attenuation of dream affect across the night, might be a possible indication of an affect regulatory function for dreaming and supports the need for further investigation.

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Appendix A

Table A.1

Table of the Results from the Shapiro-Wilk Test of Normality for VAMS Variables Before and After Square-Root Transformations

	Before transformations			After transformations		
Variables	Statistic	*df*	Sig.	Statistic	*df*	Sig.
NEG Emotions: *Early* REM - *First* Half	.899	19	.046	.957	19	.523
POS Emotions: *Early* REM - *First* Half	.953	19	.443	.901	19	.052
NEG Emotions: *Early* REM - *Last* Half	.894	19	.038	.954	19	.457
POS Emotions: *Early* REM - *Last* Half	.913	19	.083	.941	19	.278
NEG Emotions: *Late* REM - *First* Half	.928	19	.159	.978	19	.910
POS Emotions: *Late* REM - *First* Half	.902	19	.052	.935	19	.218
NEG Emotions: *Late* REM - *Last* Half	.869	19	.014	.957	19	.508
POS Emotions: *Late* REM - *Last* Half	.910	19	.073	.938	19	.240

Table A.2

Table of the Results from the Shapiro-Wilk Test of Normality Performed on LIWC Dream Words

Variable	Statistic	*df*	Sig.
POS Emotional dream words: *Early* REM	0.929	19	.166
NEG Emotional dream words: *Early* REM	0.919	19	.110
POS Emotional dream words: *Late* REM	0.921	19	.116
NEG Emotional dream words: *Late* REM	0.947	19	.344

Table A.3

Table of the Results from the Shapiro-Wilk Test of Normality Performed on PANAS Values

Variable	Statistic	*df*	Sig.
Average POS Emotions before sleep	.931	19	.178
Average NEG Emotions before sleep	.784	19	.001
Average POS Emotions after sleep	.977	19	.901
Average NEG Emotions after sleep	.836	19	.004