



CLINICAL REVIEW

Sleep and emotion regulation: An organizing, integrative review



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SUMMARY

A growing body of research suggests that disrupted sleep is a robust risk and maintenance factor for a range of psychiatric conditions. One explanatory mechanism linking sleep and psychological health is emotion regulation. However, numerous components embedded within this construct create both conceptual and empirical challenges to the study of emotion regulation. These challenges are reflected in most sleep–emotion research by way of poor delineation of constructs and insufficient distinction among emotional processes. Most notably, a majority of research has focused on emotions generated as a consequence of inadequate sleep rather than underlying regulatory processes that may alter these experiences. The current review utilizes the process model of emotion regulation as an organizing framework for examining the impact of sleep upon various aspects of emotional experiences. Evidence is provided for maladaptive changes in emotion at multiple stages of the emotion generation and regulation process. We conclude with a call for experimental research designed to clearly explicate which points in the emotion regulation process appear most vulnerable to sleep loss as well as longitudinal studies to follow these processes in relation to the development of psychopathological conditions.

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An overview of sleep and emotion

Sleep plays a critical role in mental health and psychosocial adjustment across the life-span. Of particular concern is that inadequate or disrupted sleep is both a common symptom of and risk factor for a range of psychiatric disorders including, most commonly, anxiety and mood disorders [1,2]. In fact, inadequate sleep degrades several aspects of neurocognitive functioning, but its effects on psychological health are most robust [3]. Generally, sleep loss has been shown to increase the experience of negative emotions, reduce the occurrence of positive emotions, and alter the ways in which individuals understand, express, and modify these emotions [4,5]. Since inability to experience and control emotions in context-appropriate ways is a prominent feature of various forms of psychopathology [6], recent studies have increasingly aimed to identify emotion-related processes as explanatory mechanisms linking sleep and psychological risk. Experimental investigations

continue to proliferate, revealing complex, interactive relationships across domains. Several review papers also have emerged that are focused on sleep and affective disorders [7], bidirectional associations between sleep and emotions [4,8], and the impact of sleep on emotion-related brain functions [9,10].

Some noteworthy challenges nonetheless exist in attempting to synthesize a rapidly expanding body of emotion-based sleep research. First, although the terms are often used interchangeably, emotion, affect, and mood represent distinct albeit overlapping constructs [11]. More precisely, an emotion is a multi-faceted response to internal or external stimuli that allows the individual to meet the demands of their environment through changes in their subjective experience, behavior, and physiology [12]. Affect, by comparison, is a superordinate term that encompasses various emotions but does not differentiate between discrete states. Instead, affect is typically classified as either positive or negative in valence and high or low in arousal level. Emotions can be further differentiated from mood which is more diffuse, long-lasting, and less likely to occur in response to a particular situation or stimuli. Although sleep deprivation has been shown to impact emotions, affect, and mood alike, more precise ‘unpacking’ of these terms is an essential first step in clarifying the role of sleep in emotion regulation.

A second, even more challenging issue centers on the seemingly ubiquitous use of the term ‘emotion regulation’ within this body of

Abbreviations: ACC, anterior cingulate cortex; CBT, cognitive behavioral treatment; ERP, event related potential; fMRI, functional magnetic resonance imaging; IAPS, International Affective Picture System; NREM, non-rapid eye movement sleep; PFC, prefrontal cortex; REM, rapid eye movement.

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research. In fact, most studies do not explicitly examine regulatory processes related to emotion but rather focus on discrete emotions and/or overall emotional reactivity. Further, numerous facets of this construct exist and many activities that alter an emotional experience might be considered regulatory, whether intentional or not, and regulation can occur both before and after an emotion is experienced [13]. For example, emotion regulation can include the creation or modification of opportunities to experience an emotion, attending to specific features of a stimulus/situation over others, altering thoughts about a situation or feeling, and/or attempting to modify the actual emotion itself [14]. Emotion regulation is also influenced by an array of individual skills, such as the ability to correctly identify an emotional state as something that should be regulated, select an appropriate strategy, and effectively implement that strategy [15]. Using this conceptual framework it is clear that examinations of emotion regulation are useful only to the extent that distinction among specific components embedded within this construct are made. Commonly however, this complex process has been inadequately and imprecisely measured as part of sleep–emotion research, precluding meaningful comparison across studies and the development of a comprehensive theoretical model.

The current review aims to integrate and conceptualize available findings from studies focused on the impact of sleep on emotion-based outcomes among normal sleepers (i.e., non-clinical populations) using an organizing model of emotion regulation. We believe this is a critical step toward identifying constraining research gaps, designing more robust tests of putative mechanisms, and translating research findings into clinical action. Our review is purposely guided by the process model [14], the most widely cited framework available for understanding emotion regulation [16]. In the sections that follow we begin with a brief overview of sleep architecture and physiology as well as central neurobiological mechanisms involved in both emotion and sleep–wake regulation. We then provide a detailed description of the process model and its individual components. In subsequent sections, available research on sleep and emotion is reviewed and organized by specific components of the process model. This primarily includes adult-based outcomes as these studies occupy the major bulk of the literature. When available, relevant adolescent or child-based studies are included. We also consider other relevant emotion-based skills that likely contribute to individual differences in emotion regulation and additional factors to be considered when designing experimental studies. We conclude with a summary of findings and suggestions for future research.

Neurobiological underpinnings of sleep and emotion

At a neurobiological level, emotion regulation involves the interaction of subcortical brain structures of the limbic system (e.g., amygdala) that generate emotional responses to stimuli with control centers (e.g., prefrontal cortex) that regulate emotional responses and behavior [17]. Given that the brain structures and neurochemicals involved in the regulation of emotion also govern sleep [9], and nearly all affective disorders co-occur with sleep abnormalities [1,2], an intimate relationship between these two domains of functioning is intuitive.

To begin to understand the complexities of these relationships however, it is first necessary to consider some basic sleep processes. Sleep is comprised of two main types – rapid eye movement (REM) and non-rapid-eye movement (NREM) sleep (which is further divided into three stages: NREM 1–3, each reflecting different depths of sleep). REM sleep is uniquely marked by activation of emotion-related brain regions (e.g., amygdala, hippocampus) and inhibition of aminergic neurotransmitters including

norepinephrine and serotonin [18]. REM sleep occupies a central role in theories of emotional memory. According to the “sleep to forget, sleep to remember” model [5], REM sleep periods both strengthen the declarative component of emotional experiences via activation of the same emotion-related brain structures and attenuate their affective tone via inhibition of aminergic neurotransmitters, resulting in successful reactivation and neural integration of emotional events. However, a more tentative but competing model proposes a relationship whereby REM sleep rouses emotional reactivity, reinforcing the salience of emotional events [19,20]. As evidence to support both models exists, more research is needed to determine how REM sleep, precisely, may alter the specific processes involved in emotions and their regulation.

An organizing framework of emotion and emotion regulation

Arguably, one of the most fundamental distinctions when considering emotion regulation as a construct is the distinction between emotion generation and emotion regulation. Emotion generation occurs when an individual encounters an emotion-eliciting stimulus, attends to and appraises that stimulus, and then generates an emotional response (see Fig. 1). This has been referred to as the modal model of emotion regulation [21], as these features are present across many theories of emotion [15,22]. Responses are typically multi-faceted in that they involve simultaneous changes in subjective experience, behavior, and physiology [23]. Principally, emotional responses are adaptive in that they allow the individual to adjust to environmental demands. For example, many negative emotions promote responses that minimize potential harm (e.g., feeling fear prompts physiological responses that help avoid danger, such as increasing blood flow to the extremities to assist a quick escape). Likewise, positive emotions can prompt action tendencies that build social, physical, and psychological resources (e.g., joy promotes playful behavior which helps build social relationships and physical capacities) [24]. Yet emotional responses can also be maladaptive in terms of their intensity (the response is too large or small given the situation), duration (the emotion lasts too long or not long enough), frequency (experiencing an emotion too often or too seldom), and/or type (the emotion experienced is inappropriate for the current context) [6].

Emotion regulation can be distinguished from emotion generation in that it involves heterogeneous actions that influence what emotions we have, when we have them, and how we have them [14]. The process model [11,14] is rooted in the premise that emotion regulation strategies occur along a timeline of an unfolding emotional response, and highlights five different processes that may occur to alter the course of an emotion (see Fig. 2). These five processes are distinguished by the time points in the emotion-generative process where these emotion regulation strategies

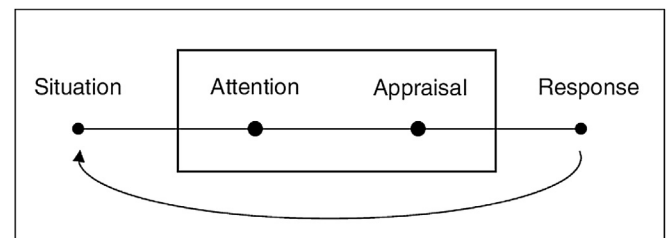


Fig. 1. The modal model of emotion.

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