The emotional component of insomnia disorder: a focus on emotion regulation and affect dynamics in relation to sleep quality and insomnia

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ABSTRACT

Theoretical models of insomnia disorder recognize an emotional component in the maintenance of the disorder. Nonetheless, the field of emotions is vast and different processes are involved in psychological wellbeing. The present narrative review focuses on emotion regulation and affect dynamics, synthetizing some of the most recent and relevant evidence on emotions in relation to the quality of sleep and to insomnia disorder. The literature underlines the close association between impaired sleep quality and difficulties in regulating emotions. Impaired sleep quality is also associated with reduced positive affect and increased negative affect, but little evidence supports a bi-directional association between affective states and sleep. Affect variability in relation to sleep has been less investigated. Initial evidence suggests that high variability in positive affect has a negative impact on sleep. Neurobiological and behavioural evidence indicates that insomnia disorder is associated with emotion dysregulation, negative affect and a distinct daily profile of affective states. More research is needed on the affective experience of patients with insomnia disorder, adopting multiple sampling of affect across the day and the week. Understanding how the unfolding of emotions over time interact with sleep alterations may help improve the tailoring and monitoring of treatments addressing disturbed emotional processes in insomnia disorder.

KEYWORDS

insomnia; sleep quality; affect dynamics; emotion regulation; narrative review

INTRODUCTION

While most theoretical models of insomnia disorder recognize maladaptive emotional processes (e.g., Espie, 2002; Harvey, 2002; Baglioni et al., 2010a; Riemann et al., 2010), the empirical literature has only recently begun to focus on emotional factors. Poor sleep or insomnia symptoms are closely linked to affective states (e.g., Vandekerckhove & Wang, 2017). Nonetheless, the literature is primarily based on alterations in sleep continuity or quality in the general population. While poor sleep quality is increasingly common, most people do not meet the diagnostic criteria of intensity, frequency and duration of symptoms and daytime consequences that define chronic insomnia disorder. Patients with insomnia disorder often experience a plethora of negative emotions related to sleep, such as worry about the daytime consequences of poor sleep and fear of never getting enough sleep. Negative affective states contribute to perpetuating insomnia disorder and increases the risk of developing psychopathological conditions (Herteinstein et al., 2019). Nonetheless, identifying the emotional component of insomnia is a challenge that mirrors the multidimensionality of emotions.

The present narrative review aims at clarifying the emotional component of insomnia disorder by specifically considering two main constructs: emotion regulation and affect variability. The first describes the goal-directed efforts to modulate the timing, expression, experience, and content of emotions (Gross, 2014). The second construct refers to individual differences in the fluctuations of affective states over time (Kuppens, Oravecz, & Tuerlinckx, 2010). Emotion regulation and affect variability both account for the dynamical nature of emotions, which are processes that constantly fluctuate over short- and long-term time scales (Larsen, 2000). While emotion regulation is recently receiving growing attention in insomnia research, affect variability has been rather neglected in relation to sleep. Individual differences in affect variability are expressions of differences in the general emotional response to salient events and in how emotions are regulated (e.g., Larsen 2000). Extreme and abrupt fluctuations in affect may represent early signs of emotion dysregulation and predict changes in psychological well-being (Kuppens et al., 2012). From a clinical perspective, monitoring affect variability over time may provide important information on the patient's reactions

to daily experiences and may help predict mood shift in the course of psychopathology (e.g., Wichers et al., 2010; van de Leemput et al., 2014). Overall, a better understanding of affect variability may help improve the specificity of diagnosis, predictions of prognosis, and the selection of treatment of psychopathological conditions in general, and insomnia disorder in specific. Our work aims to address affect dynamics and emotion regulation as part of the emotional component of insomnia disorder. We will focus on two main points: firstly, how to assess and interpret individual differences in emotion regulation and in affective variability, and secondly, how these differences are associated with sleep quality and insomnia disorder.

The present narrative review is structured as follows:

a) an overview of the main concepts and models related to emotion regulation and affect dynamics;

b) a synthesis of recent literature on the association of affect dynamics and emotion regulation with sleep quality;

c) a focus on insomnia disorder, outlining the most relevant evidence on affect dynamics and emotion regulation.

The review is concluded with a summary mapping relevant findings and open questions concerning the tight relationship between emotions and insomnia disorder, highlining the contribution that understanding the dynamics of affect can give to the comprehension of the emotional component of insomnia disorder. Clinical implications are explored. We will conclude with suggestions for future research to deepen our understanding of the complex relationship between emotions and insomnia.

AN INTRODUCTION ON EMOTION REGULATION AND AFFECT VARIABILITY

Defining Affect and Emotions

Table 1 presents a glossary of terms used in this review.

Affect is a superordinate term that encompasses various constructs, including emotions. Affective states are described along a continuum from pleasant to unpleasant (valence) and from low to high activation (arousal) (e.g., Russell, 2003; Kron et al., 2014).Thus, specific emotions occupy different positions in the circumplex of affect (Russel, 2003). *Emotions* are complex multidimensional processes that involve relatively brief behavioural, cognitive, and physiological changes (Mauss et al., 2005). They are intertwined with motivations (Lang & Bradley, 2010), and are embedded in the social context (Parkinson, 1996). Emotions are generated when a relevant situation is encountered, attended to and appraised in reference to current goals.

Table 1. Glossary of terms used in the review.

Term	***Definition***
Affective states	Umbrella term referring to any experience of emotions, moods, or feelings from pleasant to unpleasant and from low to high arousal
Emotions	Multicomponent affective states characterized by a range of behavioural, cognitive, and physiological changes
Affect variability	Fluctuations of affective states across time, measured as deviations from an individual average level
Emotion regulation	Modulations of the timing, expression, experience, and content of emotions

Affect variability

Individual differences in affect variability are expressed as the amplitude of deviations from one's average level, calculated on repeated observations with various statistical indices. The most used

index is intraindividual standard deviation (iSD): a larger iSD indicates higher fluctuation in affect. Unlike emotion reactivity, affect variability describes the swings in affect compared to the average emotional experience independent of specific reactions to life events. Affect variability is also a distinct construct from emotional instability, which refers to the magnitude of changes in affective states from one moment to the next (Houben et al., 2015). While average positive and negative affect have been linked to psychological health, their variability is also important for wellbeing. In a meta-analysis, Houben et al. (2015) found that lower levels of psychological well-being and a wide range of conditions, including depressive disorder, were characterized by higher fluctuations in affective states, especially in negative affect (Houben et al., 2015). In 2010, Kuppens et al. proposed a model to study individual differences in affect variability and their connection with psychological well-being, the so-called *DynAffect Model*. The model posits that the affective experience of each individual behaves as a system with an average value (*home base*), from which it fluctuates in response to external and internal stimuli (*affect variability*). When the system is pulled away from its home base, the individual is motivated to regain an "affective comfort zone". The home base represents an attractor to the system, pulling the affective experience back toward it (*attractor strength*). The extent to which efforts to regain an "affective comfort zone" are successful partly depends on emotion regulation ability (Kuppens et al., 2010). The three process – home base, affect variability, attractor strength – account for the temporal dynamics in affective experiences. Adopting the DynAffect Model, individual difference in the dynamics of affect can be assessed as differences in the average levels of positive and negative affect, in the magnitude of the fluctuations in affect, and in the ability to regulate affective experiences (Kuppens et al., 2010).

Emotion regulation

Emotion regulation is a fundamental construct for understanding affective experiences and how different persons respond to life events. The attempts to influence one's own emotions can take the

form of up- or down-regulation of both positive and negative states, depending on the context and active goals.

The *Process Model of Emotion Regulation*, developed by Gross (1998), conceptualizes emotion regulation as a process which takes place throughout the unfolding of emotional responses. Emotions are generated through a process of encountering a situation, attending to and appraising the stimuli, and then responding to it. The model identifies five stages of the emotion generation process in which regulation may occur: situation selection, situation modification, attentional deployment, cognitive change, and response modulation (Gross, 1998). Emotion regulation strategies may thus be centered on the antecedent, such as the re-evaluation of an emotional stimulus (*cognitive reappraisal*), or response-focused, such as the suppression of emotional expression (*suppression*) (Gross, 1998; Gross & John, 2003).

An alternative perspective on emotion regulation is that of the clinically oriented approach proposed by Gratz and Roemer (2004), which focuses on how individuals adaptively respond to emotional suffering. The authors' view on emotion regulation is based on a key concept of the "third wave" models of cognitive behavioral therapy: avoidance of emotional experience has a prominent role in the onset and maintenance of psychopathological disturbances. Emotion regulation is conceptualized as a multidimensional construct with various components, including awareness, understanding and acceptance of emotional states; the ability to control impulses, and to engage in goal-oriented behaviours in the presence of negative affect; flexible use of strategies to regulate the intensity or duration of emotional responses; access to strategies perceived to be effective (Gratz and Roemer, 2004).

At the neurobiological level, the process of emotion regulation involves a complex interplay between subcortical regions, primarily limbic areas, and cortical regions, with a large involvement of frontoparietal areas (Goldin et al., 2008; Etkin, Büchel, & Gross, 2015). A prevalent distinction in neuroscience is between explicit and implicit emotion regulation, primarily based on the degree of

insight and awareness. Conceptualizing emotion regulation as a decision-making process, Etkin and colleagues (2015) updated the classical distinction with the model-free and model-based regulation. In the model-free regulation, aligned with implicit regulation, the regulative action is evoked automatically by the stimulus, such as in the inhibition of fear, with activation of the ventral ACC (vACC) and the ventromedial PFC (vmPFC). In decision-making, activation of the vACC and vmPFC is associated with the choice with grater positive value (the "more good for me" choice). Model-based (explicit) regulation requires a model to be implemented to guide behaviours, and thus a conscious efforts and monitoring, with involvement of the frontoparietal executive network, insula, supplemental motor area (SMA) and pre-SMA. When regulation actions are model-based, the outcome experiences will lead to an update of the model and will determine the future choices. Both regulations modulate the activity of regions implicated in emotional reactivity (amygdala, insula, dorsal ACC and periaqueductal grey). The type of regulation that is implemented depends on a cost-benefit analyses, and thus by available cognitive resources, the context and the previsions made by the individual.

Difficulties in regulating emotions are transdiagnostic and relevant to various psychopathological conditions (Aldao et al., 2016), for instance, those characterized by high variability in affective states (e.g., borderline personality disorder), or sustained negative affect (e.g., major depressive disorder). However, a recent neuroimaging meta-analysis failed to identify any convergent regional brain abnormality related to the reappraisal task (Khodadadifar et al. 2020). This might be due to the complex nature of cognitive emotion regulation, heterogeneity of clinical populations, and experimental and statistical variability of individual studies.

In sum, the field of affective states is vast and different constructs are involved. The dynamic of affect and emotion regulation both contribute to psychological wellbeing and can be seen as interrelated (see Figure 1). Both awareness of affective experience and actual emotion regulation may influence

the variability of affect (e.g., Thompson et al., 2009). Firstly, emotions need to be identified to be the target of a decision-making process: is it an emotion that meets current goals? should it be regulated? And how? Throughout the generation of an emotional response, regulative efforts shape the time and course of the emotion, and thus higher fluctuations in affective states over time may indicate a difficulty in regulating emotional responses. Considering both constructs can help to better define how the affective experience unfolds over time in daily life.

Please insert "Figure 1. Dynamics of affect and emotion regulation" here

SLEEP QUALITY AND AFFECTIVE EXPERIENCES IN HEALTHY POPULATIONS

Affect dynamics and sleep quality

Over the past decade, several efforts have been made to organize the literature on emotions and sleep (e.g., Kahn, Sheppes, & Sadeh, 2013; Palmer & Alfano, 2017; Brink et al., 2022), indicating that sleep disruption is associated with altered affective experiences characterized by a reduced experience of positive affect and increased negative affect (Kahn et al., 2013; Vanek et al., 2020). A recent review (Brink et al., 2022) confirmed that cross-sectionally positive and negative affect are associated with sleep disturbance and sleep quality. Nonetheless, the authors underlined that the effects of sleep disturbances in daily life are likely non-linear, highly variable from individual to individual and dependent on prior sleep (Brink et al., 2022). Investigations into the bi-directional association between sleep and emotions have been limited. Despite a large body of evidence, no conclusions can be drawn on the effect of daytime affective experience on subsequent sleep (Konjarski et al., 2018; Brink et al., 2022).

Evidence on affect and sleep is primarily based on average positive and negative affect, with relatively less attention given to affect dynamics over time. Recent research utilized experience sampling to investigate day-to-day variations in sleep and emotions. A day-to-day covariation of sleep and affect

has been observed (e.g., Simor et al., 2015; Mousavi et al., 2022). In the review of daily investigations, Konjarski and colleagues (2018) found that poor sleep quality at night predicts subsequent negative affect, while good sleep quality predicts rating of positive affect. The opposite relationship, that is daytime affect predicting sleep, has been rarely confirmed and mostly for positive affect predicting better sleep quality (Konjarski et al., 2018). Between-person differences in affect variability have been rather neglected. Initial evidence points to a negative effect of positive affect variability on sleep (Ong et al., 2013; Leger et al., 2019; Ying et al., 2022). Higher variations in sleep quality and duration are associated with higher variations in positive affect across the week (Ying et al., 2022). Furthermore, while higher levels of positive affect are associated with better objective sleep efficiency, higher event-related fluctuations in positive affect are associated with reduced sleep efficiency, in particular among individuals with high trait positive affect (Ong et al., 2013). In a recent study, Leger et al. (2019) found that variability in positive affect across three daily time points was associated with shorter sleep duration, while average negative affect influences sleep quality more than its variability (Leger et al., 2019). Overall, between-person differences in positive affect variability are associated with sleep duration and quality on a relatively long-time scale (in days) and on short-time scale (across the day).

Bi-directional association between affect and sleep

The bi-directional hypothesis posits that sleep and emotional disturbances are mutually reinforcing (Harvey, 2008). An overlap between sleep-wake regulation and affective brain regions has been observed (e.g., Yoo et al., 2007). Nonetheless, while pre-sleep arousal interferes with sleep-wake regulation, the effect of daily affective experience in naturalist context is not confirmed (e.g., Simor et al., 2015). Individual differences in emotional reactivity, affective regulation and sleep reactivity may moderate the effect of daily affect on sleep (Kalmbach et al., 2018; Brink et al., 2022).

Inconsistency could also be explained by several factors. Firstly, different emotions (e.g., sadness and fear) may have differential impacts on sleep (Kalmbach et al., 2014). For instance, Tavernier et al.

(2015) observed that in adolescents, the influence of daily emotions on objective sleep indices was dependent more on the level of arousal of affective experiences than on their valence. Secondly, differences may arise from the time of negative emotions assessment. Affective states assessed in the afternoon may not capture the effect of later pre-sleep negative emotions on sleep, such as sleep-related worries (Simor et al., 2015). Studies on children demonstrated that affective states in the morning might be more vulnerable to sleep quality, while sleep may be more vulnerable to affective states in the evening (Könen et al., 2016). Thirdly, most studies are performed on non-clinical samples with relatively healthy sleep profile and low levels of sleep reactivity. Comparing patients with insomnia disorder, patients with bipolar disorder and healthy controls, Talbot and colleagues (2012) found a bidirectional association between daytime affect and sleep quality only in the clinical samples. The "dosage" of sleep and emotional difficulties may thus be an important moderator in the bi-directional relationship between sleep and emotions.

Emotion regulation and sleep quality

A relationship between sleep disruption and poor emotion regulation has been well-documented (e.g., Cerolini, Ballesio, & Lombardo, 2015; Palmer & Alfano, 2017). Adopting the *Process Model of Emotion Regulation* (Gross, 1998), as a framework for synthesizing the literature, Palmer and Alfano (2017) demonstrated that sleep plays a crucial role in each step of emotion regulation. Disrupted sleep is associated with daily dysfunctions (e.g., sleepiness and decreased motivation), which in turn may reduce the likelihood of engaging in positive emotion-eliciting activities (*situation selection*). The prioritization of sleep over other activities also reduces the occasions for positive emotional situations. The appropriate modification of emotion-eliciting situations (*situation modification*) may also be compromised by poor sleep, as it interferes with decision-making, impulse control, and social interactions. Nonetheless, these effects are primarily investigated as a reduction in social activities and difficulties in social interactions (e.g., Forest et al., 2022), while investigations on sleep in relation to explicit avoidance or modification of a situation are lacking (Palmer & Alfano, 2017). Alterations

in sleep quality or quantity also reduce the ability to effectively deploy attentional resources toward desirable or away from undesirable aspects of an emotion-eliciting situation (*attention deployment*). Lastly, adequate sleep plays a role in the ability to employ cognitive change and in the modulation of emotional responses (Palmer & Alfano, 2017). Furthermore, inadequate sleep is associated with increased use of maladaptive strategies such as expressive suppression (e.g., Latif et al., 2019). Expressive suppression is a response-focused strategies (*response modulation*) considered mostly maladaptive (Sloan et al., 2017), as it decreases the subjective and behavioural component of a negative emotion, but it increases amygdala and insular activation (Goldin et al., 2008). Poor sleep quality also impairs the ability to use cognitive reappraisal (e.g., Mauss et al., 2012), which is the re-evaluation of emotional events as "less bad" or "more good" for each individual (Etkin, Büchel, & Gross, 2015). At a neurobiological level, successful reappraisal involves the activation of different brain regions, including the frontoparietal executive network, and the decreased activation of emotional-reactivity regions, such as insula and amygdala (Goldin et al., 2008; Etkin et al., 2015).

Summary on sleep quality and affective experiences

Figure 2 graphically summarizes the associations between sleep quality and emotions. Poor sleep quality is associated with emotion dysregulation, which in turn can heighten the experience of negative emotions and dumped positive emotions. The bi-directional link between sleep and affect in naturalistic contest is still not confirmed. Evidence indicates that average affect and affect variability have different impacts on sleep quality. Changes in affect from average values are associated with changes in sleep. Initial evidence on daily and weekly variations suggests a negative effect of positive affect variability on sleep, but there is a need for replication.

Please insert "Figure 2. Sleep quality and emotions" here

THE EMOTIONAL COMPONENT OF INSOMNIA DISORDER

The affective experience of patients with insomnia disorder

Emotion-disturbed processes are associated with the course of insomnia disorder. Heightened emotional arousal is a stable feature in insomnia disorder, and as it can persist across 24 hours a day (Harvey, 2002; Morin et al., 2003; Baglioni et al., 2010a; Palagini et al., 2017). In patients with insomnia, daily stressor can have a heightened impact on sleep initiation and maintenance compared to healthy sleepers, due to enhanced sleep reactivity, negative appraisals of stressful events and use of maladaptive coping strategies (Kalmbach, Anderson, & Drake, 2018; Morin et al., 2003). On the other hand, insomnia symptoms alter emotional experiences, leading to mood alteration and posing a risk for the development of psychopathology (Baglioni et al., 2011; Herteinstein et al., 2019).

The feedback loop between sleep disturbance and increased cognitive and emotional reactivity is a hallmark of chronic insomnia disorder (Harvey, 2002; Riemann et al., 2010). Nonetheless, most evidence on sleep and emotions is derived from non-clinical samples, which may exhibit insomnia symptoms but lack the full range of cognitive, behavioral, and emotional alterations of chronic psychophysiological insomnia. Recent research has highlighted abnormalities in the brain circuits involved in sleep-wake regulation and emotional processes, further emphasizing the importance of distinguishing between different types of insomnia (for an overview, see Van Someren, 2021).

Recent interest has risen in emotion dysregulation as a mediating factor in the bi-directional association between insomnia and depression. Patients with insomnia disorder present higher levels of emotion dysregulation compared to healthy controls (Galbiati et al., 2020; Palagini et al., 2017; Palagini et al., 2019). The effectiveness of cognitive reappraisal depends on the top-down prefrontal regulation of limbic regions, which has been shown to be altered in insomnia disorder (Baglioni et al., 2014; Tahmasian et al., 2018; Ben Simon et al., 2020). Compromised inhibitory processes (Ben Simon et al., 2020) and altered amygdala reactivity and adaptation (Schiel et al., 2020) lead to hyperarousal. Impaired prefrontal processes associated with habitual short sleep duration, which is commonly reported by patients with insomnia disorder, may also be compensated with decreased amygdala reactivity to negative emotional stimuli (Schiel et al., 2022). Furthermore, REM sleep

fragmentation, a common feature in insomnia, interferes with overnight amygdala adaptation to distress, causing prolonged emotional distress (Riemann et al., 2012; Wassing et al., 2016; Wassing et al., 2019a; Wassing et al., 2019b).

Patients with insomnia are more prone to rumination and experimental avoidance (Carney, Edinger, Mejer, Lindman, & Istre, 2006; Palagini et al., 2015; Zakie et al., 2020). Rumination is an emotion regulation strategy positively linked with the severity of depression, anxiety and insomnia symptoms (Olatunji, Naragon-Gainey, & Wolitzky-Taylor, 2013; Lancee, Eisma, Van Zanten, & Topper, 2017). Rumination is a perpetuating factor according to the Cognitive Model of Insomnia (Harvey, 2002): daytime rumination triggers emotional distress and maintains high levels of psychophysiological activation at bedtime. There is evidence that higher rumination is not a direct consequence of poor sleep in general, as it seems to characterize insomnia, rather than other sleep disorders (Palagini et al., 2015). Experimental avoidance is the attempt to avoid the experience of negative emotions and thoughts, and it is associated with effort to suppress or control undesired thoughts and emotional states (Gratz and Roemer, 2004). Such effort depletes cognitive resources, increased the experience of negative emotions, and elevates the levels of psychophysiological arousal, leadings to more sleep disruption (Ashton et al., 2019). Studies comparing patients with insomnia to good sleepers found that patients with insomnia tend to utilize suppression and worry more frequently as thought control strategies (Harvey, 2001; Ree, Harvey, Blake, Tang, & Shawe-Taylor, 2005). The attempt to downplay cognitive activity at bedtime through thoughts controls has the paradoxical effect of increasing levels of cognitive arousal, which are incompatible with sleep (e.g., Ansfield, Wegner, & Bowser, 1996; Schmidt, Harvey, & Van der Linden, 2011).

Overall, different genetic, neurobiological, psychophysiological, and cognitive-behavioral mechanisms related to emotions, as well as personality traits, contributes to the aetiology and pathophysiology of insomnia and are posited to underly the bi-directional association between insomnia and mood conditions, particularly depression (Riemann et al., 2019). Difficulties in regulating daytime affective experiences, thought strategies such as rumination and avoidance,

contribute to heightened activation at bedtime. Attempts to tone down pre-sleep psychophysiological arousal are often unsuccessful. Strategies such as thought control and suppression fail to reduce the activation of emotion reactivity brain regions (e.g., the amygdala and insula). Failure to de-arouse results in impaired sleep. REM sleep fragmentation contribute to dysregulation by impairing amygdala overnight adaptation. Alterations in the prefrontal top-down regulation of limbic circuits impair the ability to employ effective emotion regulation strategies such as cognitive reappraisal. Consequently, patients with insomnia disorder are prone to experience dysregulation of negative emotions.

The contribution of affect dynamics in insomnia disorder

The affective experience of patients with insomnia disorder is more often characterized by dulled positive affect (e.g., Baglioni et al., 2010a). At a trait level, it has been proposed a distinction between subtypes of insomnia characterized by higher negative and lower positive affect (e.g., Blanken et al., 2019). Patients with insomnia disorder display higher reactivity to emotional stimuli, particularly to insomnia-related positive and negative stimuli (e.g., Baglioni et al., 2010b; Baglioni et al., 2014). Both emotion dysregulation and emotional reactivity may lead to higher variations in emotional experiences. Nonetheless, affect variability as a distinct construct from emotional reactivity has been overlooked in insomnia disorder. Hence, characteristic patterns of affect variability are still poorly understood. Evidence on day-to-day covariations in sleep and affect suggests that patients with insomnia have distinct affective dynamics in relationship with sleep (Talbot et al., 2012; Buysse et al., 2007; Telindert et al., 2018). Comparing patients with bipolar disorder, insomnia disorder, and healthy controls showed that only in insomnia disorder, positive moods in the evening were associated with worst sleep efficiency at night. On the other hand, both disorders showed a similar association between negative moods in the evening and sleep efficiency at night (Tablot et al., 2012). Sleep efficiency may be more vulnerable to emotional arousal in patients with insomnia disorder. Initial

evidence suggest that the pattern of variations in affect across the day distinguishes patients with insomnia disorder from good sleepers (Levitt et al., 2004; Buysse et al., 2007). In an ecological momentary assessment (EMA) study, Buysse et al. (2007) found that the time course of affect during the day was different in patients with insomnia disorder and healthy controls, namely negative emotions increased in patients and decreased in controls from morning to evening. They did not find a significant difference in daily variations in affective states. A small pilot study, on the other hand, found that insomnia disorder is characterized by higher variations in affective states across multiple sampling in a day (Levitt et al., 2004). A recent study performed by Telindert et al. (2018) compared patients with insomnia disorder and healthy controls on daily measurement of wanting and liking, two key dimensions of the reward system, and on positive and negative affect sampled multiple times a day. The authors found that the overall affect rating was not able to distinguish insomnia disorder from healthy controls, but the diurnal profile of affect did. Patients with insomnia disorder showed a morning peak in negative affect, while good sleepers showed a peak in the evening. Patients with insomnia disorder also showed lower ratings of wanting and liking and more daily fluctuations than good sleepers.

Overall, the affective experience of insomnia disorder appears more characterized by negative affective states. There is also evidence that the time course of positive and negative affect during the day differ in insomnia disorder compared to controls. Furthermore, for some affective states a difference in variability has been detected. Nonetheless, still little is known about the role of affect dynamics in insomnia.

Summary of affective experiences in insomnia disorder

In summary, there is mounting evidence suggesting that the emotional experience of patients with insomnia disorder may be characterized by high emotional reactivity, more intense and recurrent negative affect and by difficulties in downregulating negative emotions. Affective states may have a significant impact on sleep patterns in patients with insomnia disorder, which may be attributed to

sleep-related negative cognitions, poor overnight distress adaptation, or trait-level individual differences. The initial findings on affect variability raise new questions that need to be addressed to better characterize the emotional component of insomnia disorder (see Figure 3).

Please insert "Figure 3. The emotional component of insomnia disorder" here

CONCLUSIONS

Our narrative review aimed at addressing the emotional component of insomnia disorder by focusing on emotion regulation and affect variability. We selected some of the most relevant studies on emotion regulation and affect, and we highlighted the contribution of affect dynamics in the understanding of the emotional component of insomnia.

Several hypotheses on how insomnia and emotion regulation are linked have been proposed. What is still to be understood is how the dynamic aspects of affect enter into this interplay. Here we argued that affect variability should be further investigated as a mechanism trough which sleep impairment could lead to persistent emotional problems. Displaying high fluctuations in emotions may indicate difficulties in affective regulation or high emotional reactivity (Liu et al., 2016), both processes that have been shown to be linked with poor sleep quality (e.g., Van Someren, 2021). We showed a growing interest in the literature concerning the variability of affective states over time and sleep. Nonetheless, there are still several questions to be addressed. A compelling question is how affective states of patients with insomnia disorder changes over time, and how these changes relate to the maintenance of the disorder. The state of the research so far indicates a need to closely look at emotions in insomnia disorder and to approach the altered emotional process in clinical practice. Given the role of affect variability in mental health, we encourage future research to investigate the dynamic of affect in insomnia disorder by adopting experience sampling.

Clinical implications

Cognitive-Behavioural Therapy (CBT-I) is the first-line treatment for insomnia disorder (Baglioni et al., 2020). Recently, the need to integrate the emotional component into treatment programs has been increasingly recognized (e.g., Ong & Smith, 2017; Herteinstein et al., 2014; Cerolini & Lombardo, 2022). The evidence summarized in the present work further supports the need to address emotional factors in the context of sleep disturbance. Moreover, training in emotion regulation may result not only in a better balance between positive and negative emotions, but also in more sustainable fluctuations in affective experience. Variability in affective states is also addressed by treatment approaches routed in mindfulness principles, either with specific treatments aimed at reducing variability in negative affect (e.g., Dialectical Behavioural Therapy; Linehan, Bohus, & Lynch, 2007) or with mindfulness-based programs which cultivates emotional stability (e.g., Mindfulness-Based Cognitive Therapy; Segal, Williams, & Teasdale, 2002).

Affect variability is also relevant for the monitoring of treatments. If the evidence on the association between affect variability across the day and sleep is confirmed, this dimension may be closely monitored through multiple assessments across the day to identify emotion-disturbed processes in everyday life. The availability of easily accessible medium for multiple assessment offers the possibility to monitor affect variability, in particular in those patients displaying high trait positive and negative affect. Furthermore, affective states may be closely looked at in patients displaying high night-to-night variations in sleep indices. Multiple assessments may then serve as an indication of the patient's daily functioning in their natural context, and an early sign of difficulties to be addressed with emotion regulation training embedded in CBT-I programs.

Suggestions for future research

Our narrative review highlights a critical gap in the literature on affective states over time in patients with insomnia disorder. Firstly, future works could clarify the extent to which night-to-night variability in sleep is associated with variability in affective states. The literature here synthetized suggest deviations in average sleep indices are associated with affect variability, specifically in

positive affect compared to negative affect. More replications of these results are needed to disentangle the differential contribution of average positive and negative affect and their variability.

Secondly, future works could further explore the distinct pattern of affect variability in patients with insomnia disorder by conducting experience sampling at variable times in the day. Rating of overall affective states during the day may be highly sensitive to salient events, the time of assessment and contextual factors. In patients with insomnia disorder, a rating of negative affectivity before bedtime may reflect sleep-related emotional responses, while those in the morning may be expressions of sleep dissatisfaction. These considerations should be considered when conducting ecological momentary assessment in patients with insomnia disorder.

Thirdly, accumulating evidence supports the need to clarify the distinct effect of the properties of valence and arousal of affective states on sleep. Future work could sample positive and negative affect on short- or long-time scales and analyse the impact of specific emotions with high or low arousal separately.

Lastly, the mechanisms underlining the link between variability in affective states and sleep are not clear. In the present work, we based our assumption on the literature on affective variability as partly a consequence of emotion dysregulation (e.g., Houben et al., 2015). Nonetheless, as the DynAffect model (Kuppens et al., 2010) and other relevant literature have pointed out (e.g., Liu et al., 2017), variability in affective states may also reflect intrinsic fluctuations that are partly independent from external events. That is, trait-level individual differences may exist in affect variability. Future work should consider this possibility by monitoring reactions to life events together with affect variability.

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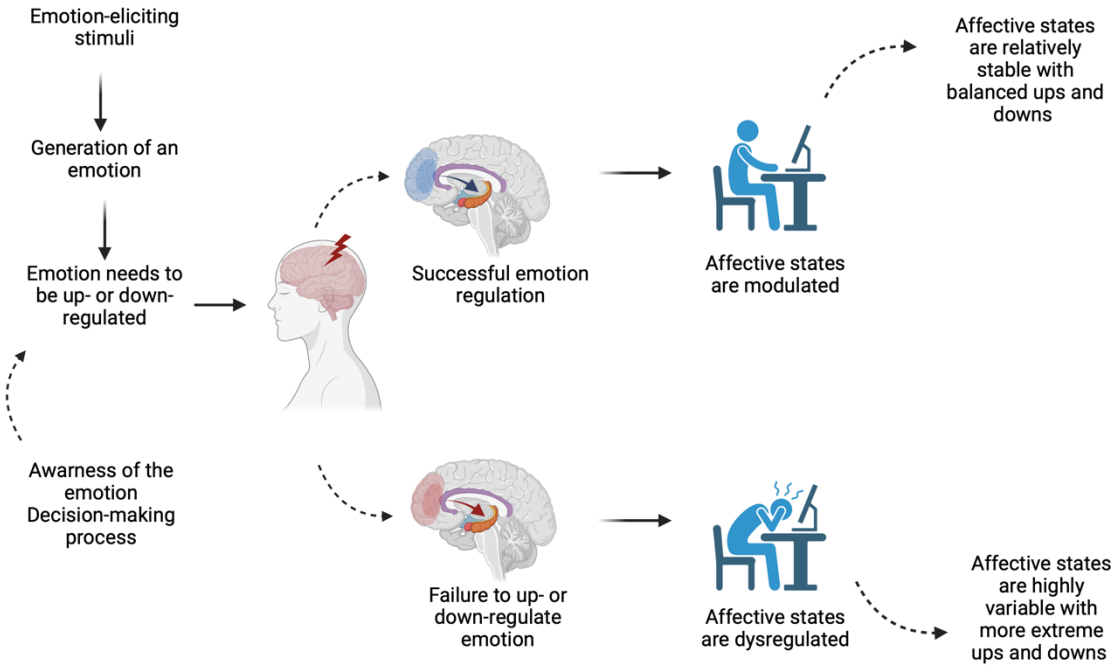

Figure 1. Dynamics of affect and emotion regulation. Emotion regulation is a continuing process, the outcome of which shapes the affective experience determining both average affect across time points and affect variability in a given time frame. Created with BioRender.com

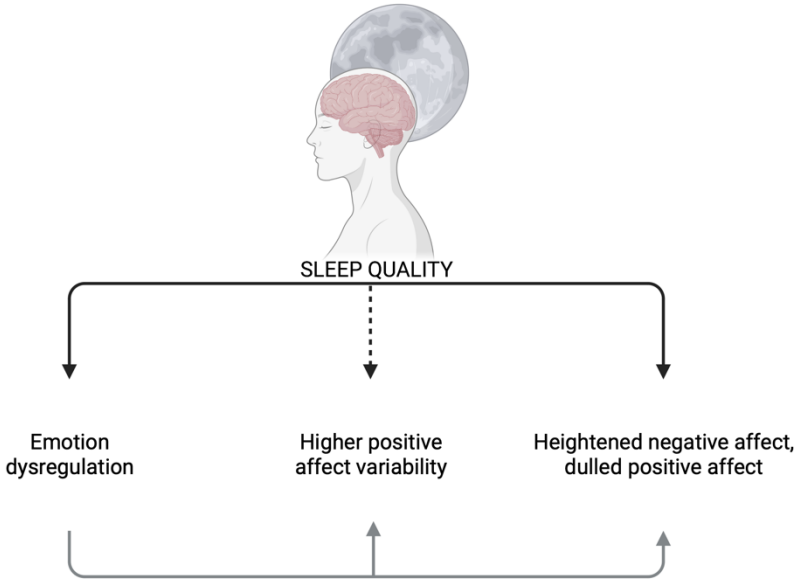

Figure 2. Sleep quality and emotions. Synthetic summary of main findings on emotion regulation and dynamics of affect in association with sleep quality. Firm lines indicate more robust evidence, while dotted lines indicates fewer evidence on the association. Created with BioRender.com

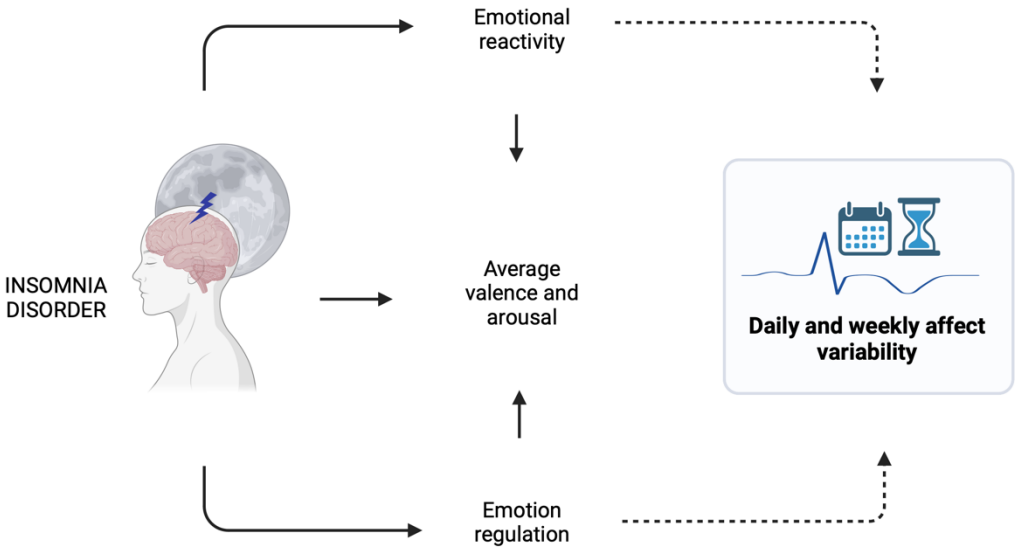

Figure 3. The emotional component of insomnia disorder. Main findings on emotion regulation and dynamics of affect in insomnia disorder are indicated with firm lines. While the contribution of emotional reactivity and emotion regulation has been documented, the role of emotional variability is still to be investigated (dotted lines indicate putative connections). Created with BioRender.com