



Insomnia and Emotion Regulation: Recent Findings and Suggestions for Treatment

Silvia Cerolini*, Andrea Ballesio and Caterina Lombardo

Department of Psychology, Sapienza University of Rome, Italy

*Corresponding author: Silvia Cerolini, Department of Psychology, Sapienza University of Rome, Italy, E-mail: silvia.cerolini@uniroma1.it

Abstract

Recent findings suggest that insomnia and emotion regulation are closely connected. Insomnia is widely associated with medical and psychiatric conditions as well as with impaired quality of life and emotional functioning. Additionally empirical evidence suggests that emotional dysregulation plays a crucial role in the onset and maintenance of psychopathological disorders. Although these seem to interact, very few studies investigated the relationship between disturbed sleep and problems in emotion regulation. Cognitive Behavioral Therapy for Insomnia (CBT-I) has been demonstrated to be effective in comorbid insomnia. However, emotion regulation skills are not included in this intervention. After reviewing the recent findings of the literature, we aim to discuss future directions for the inclusion of emotion regulation training in the treatment of insomnia disorder.

Keywords

Insomnia, Emotion regulation, Sleep, Emotions, Treatment

Introduction

A growing body of literature suggests that poor sleep or insomnia and emotion regulation are closely linked and there is a complex interplay between them [1]. Insomnia is a sleep disorder characterized by persistent difficulties in initiating, maintaining sleep or waking up too early in the morning or sleep that is chronically non-restorative or poor in quality. These difficulties are associated with negative daytime outcomes as fatigue, depression, changes in several cognitive functions such as alertness, attention, concentration, memory and executive functions [2,3]. Patients with insomnia sleep 25 min less than healthy good sleepers [4] and chronic insomnia (i.e. insomnia symptoms for at least 3 times per week over a period of at least 3 months) has negative outcomes on health [5,6], and quality of life [7]. Insomnia is also often associated with other mental disorders [8] and may be considered a risk factor for depression [9]. For these reasons DSM 5 [10] overcomes the distinction between primary and secondary insomnia identifying an “insomnia disorder” that may or may not be in comorbidity with other disorders.

Insomnia has also been associated with increased emotion regulation difficulties [11]. This effect could have important consequences for individuals healthy functioning as insomnia may affect mental health both directly and through the mediation of the emotional dysregulation. According to Gross [12], the terms ‘emotion regulation’ and ‘emotion dysregulation’ refer to processes by which

we change or maintain the intensity or the valence of an emotional experience in order to appropriately respond to environmental demands. The regulation of emotions may be conscious/overt or non-conscious/covert. Several authors have tried to identify different kind of regulatory strategies that we use in daily life to modify the magnitude and/or type of emotional experience or emotion-eliciting events [13].

The ability to adaptively regulate emotions is crucial for healthy functioning. Both negative and positive emotions may be regulated. Over the years many authors have focused mostly on strategies used to influence and modify negative emotions. In fact, negative emotions and dysregulation of negative affect have been shown to be related to psychopathology [13,14]. Moreover, different theoretical models have highlighted different specific strategies that are adaptive or maladaptive, and the latter has been correlated with different type of disorders. Maladaptive strategies which are generally considered to be associated with negative outcome are: avoidance, rumination and suppression (namely the suppression of the emotional display or of the emotional experience), whereas adaptive strategies are problem solving, acceptance and reappraisal [13].

It should be noted, that answering the question whether a strategy is adaptive or maladaptive is context-dependent [15] and new perspective theory [16] stated that flexibly adapting one’s behavior across different stressor situations is equally if not more important than the ability to use any single positive strategy. Nonetheless, most of the extant scientific literature addressed the relationship between the use of maladaptive strategies evidencing that their use is associated to psychopathological disorders such as depression [17-20], anxiety, eating disorders [13,14] and other mental disorders [21]. Moreover, recent results suggest that difficulties in emotion regulation may be markers of cognitive impairment in other psychological diseases [22].

Though it seems there is an obvious association between insomnia or poor sleep and difficulties in emotion regulation, it is still an area of research in considerable expansion, full of contradictory results and paucity of consistent empirical evidence. Although recent experimental research [23] studied altered emotion perception in individuals with insomnia disorder, studies investigating the ability to regulate emotion in patients with chronic insomnia are almost lacking. In this review a selection of recent empirical research will be presented, aiming to answer several questions and to highlight gaps and suggestions for future research and for treatment.

Citation: Cerolini S, Ballesio A, Lombardo C (2015) Insomnia and Emotion Regulation: Recent Findings and Suggestions for Treatment. J Sleep Disord Manag 1:001

Received: August 06, 2015; **Accepted:** August 26, 2015; **Published:** August 28, 2015

Copyright: © 2015 Cerolini S. This is an open-access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Does Emotional Experience Affect Sleep?

In a controlled study and using polysomnography [24] it was found a reduction of sleep efficiency, total sleep time, percentage of REM sleep as well as an increase of sleep onset latency, wake after sleep onset and slow wave sleep, after inducing the emotion of failure in a cognitive task in healthy adults. Schmindt et al. [25] found that pre-sleep self-reported emotion of regret was positively associated with the insomnia severity in elderly. More recently, a controlled study conducted by the same research group [25,26] found that the experimental induction of regret in healthy students increased sleep onset latency. In general, empirical research supports the idea that negative emotions experienced before bedtime impact sleep quality. The effect of positive emotions on sleep is under debate. According to Espie's theory [27] pre-sleep emotional activation of both negative and positive valence is supposed to disrupt sleep through an enhancement of emotional arousal. However, empirical evidence supporting this theory is still scarce whilst the opposite relationship has been sometimes reported. In a cross-sectional study, Steptoe et al. [28] found that positive emotions predicted a better sleep quality controlling for health and socioeconomic status and psychopathology. Wood et al. [29] found an association between the emotion of gratitude experienced before going to bed and a better sleep quality controlling for personality characteristics. In two weeks prospective study Kalmbach et al. [30] found that self-report positive emotions experienced during the day predicted a shorter sleep onset latency and a longer total sleep time at night.

Does the Quality of Sleep Affect Emotional Experience and the Ability to Recognize Emotions?

Several correlational and experimental studies have shown that whole-night sleep deprivation or sleep restriction across multiple nights (chronic sleep restriction) adversely influence adults' emotional functioning [31-33]. The experimental induction of sleep-deprivation increases negative affect and reduces positive affect [31,33,34]. A study by Tempesta et al. [35] investigated the effect of sleep deprivation on the emotional rating of standardized visual stimuli (pleasant, neutral and unpleasant stimuli) selected from the International Affective Pictures Stimuli (IAPS) [36]. Forty healthy participants, assigned to a deprivation group and a non-deprivation group, rated valence and arousal of the pictures. Their sleep was monitored using actigraphs. Both groups judged similarly pleasant and unpleasant the pictures, showing no significant effect of the sleep deprivation condition. Nevertheless, they judged neutral stimuli in a more negative way compared to the non-deprived group. Authors explain this finding according to the adaptive principle "better safe than sorry" [37], suggesting that sleep deprivation may exacerbate this tendency. They also found that the sleep deprived group showed higher negative mood than well-rested participants. Other studies investigated the effect of sleep deprivation on facial responsiveness to emotional stimuli. Facial emotional reaction has an important role in successful social interaction in every-day-life. Minkel et al. [38] found a reduction of facial emotional expressiveness in sleep deprived individuals while watching emotional film clips. Schwarz et al. [39] studied the effect of shortened night sleep on facial reactions to emotional stimuli using EMG task and rating their valence and arousal. Results showed slower facial muscular reactions to each type of emotional stimuli after sleep restriction but no difference in valence and arousal. Another interesting study by Talbot et al. [34] investigated the impact of sleep deprivation on the affective state in a sample of adolescents and adults. They measured their habitual sleep through sleep diaries and actigraphs for 5 consecutive nights, then they presented a sleep deprivation condition (2 consecutive nights) and a rested condition (order was counterbalanced). After each condition, they collected data using an Affective Functioning Battery, which included the Positive and Negative Affect Schedule and the version for children (PANAS and PANAS-C), a worry generation and most threatening worry task and a catastrophizing task. They found that, according to their hypothesis, individuals reported less positive affects during the sleep deprived condition respect to the

rested condition. In contrast, no significant difference was found in the negative affect between neither condition nor age group. These findings on adolescent sample are in line with the results of Dagsys et al. [40] who found that adolescents after sleep deprivation reported less positive emotions and lower positivity ratios (the balance between positive and negative emotions using PANAS-C). Another study of Baum et al. [41] has to be mentioned to extend the literature on adolescent sleep deprivation. Their experimental design included fifty adolescents (ages 14-17) and used self-report, parents' report and objective data. A 3-weeks sleep manipulation protocol was used, assessing emotions after a week of baseline, 5 consecutive nights of sleep restriction (6.5 h per night allowed) and 5 consecutive nights of normal sleep condition (10 h per night allowed) randomly assigned and counterbalanced across participants. They monitored their sleep through an actigraph and self-report instruments. They found an increasing in negative effects. Participants rated themselves as significantly more tense/anxious, angry/hostile, confused, fatigued, and as less vigorous during the sleep restriction condition. Both parents and adolescents reports revealed greater oppositionality/irritability and poorer emotion regulation during sleep restriction condition compared to normal sleep condition. They found no cross-condition differences in depression or hyperactivity/impulsivity. A young adult's population was studied by Haack & Mullington [42]. The authors investigated the effect of sustained sleep restriction of the 50% of the normal sleep time for 12 days on emotional and physical well-being. They found a reduction of optimism-sociability (15%) and an amplification of bodily discomfort (3%) with ad increasing of stomach pain, back pain and generalized body pain.

Taken together, results of the studies reviewed above allow us to conclude that poor sleep quality and sleep deprivation is associated to more negative emotional experience but just few studies investigated the daytime emotional experience in patients with insomnia. For instance, a study by Buysse et al. [43] using ecological momentary assessment, indicated that individuals with insomnia, when compared with good sleepers, reported higher negative mood and lower positive mood. Another study [44] using the same design for two weeks-period revealed that different indices of subjective sleep (e.g. total sleep time, sleep efficiency and time of awakenings) in individuals with insomnia were associated with measures of perceived daytime functioning including mood the following morning, compared to the good sleep group that showed no association.

Is the Relationship between Quality of Sleep and Quality of the Emotional Experience Bidirectional?

As aforementioned, sleep and emotion may be related through a bidirectional link [45]. According to the bidirectional hypothesis, daytime negative emotions are supposed to disrupt sleep and in turn, poor sleep may increase emotional experience the following day. However this bidirectional link has been only indirectly confirmed and to our knowledge only very few studies addressed it directly. To explore the bidirectional hypothesis of sleep and emotion, a recent study [46] used a 7 days prospective study with self-reported measures of sleep and emotions (PANAS). In the study, students were asked to complete a sleep diary and to evaluate their emotional experience every day in the afternoon. Results showed that people reporting poor sleep quality also referred to have more negative and less positive emotions during the day as compared to good sleepers. Similarly, participants who reported to have more positive and less negative emotions also reported better sleep quality. However, the results of the study did not support the bidirectional hypothesis: sleep diary completed in the morning predicted the emotional experience reported in the afternoon, whilst daytime emotions did not predict the sleep quality of the following night. Other studies using PANAS [47-49] support the hypothesis that poor sleep quality is linked to increased negative emotions and decreased positive emotions. Another recent study by Takano et al. [50] suggests the presence of a self-reinforcing cycle involving repetitive thoughts, mood and impaired sleep quality. They used a one-week sampling period with a mobile-phone-based experience sampling method (ESM) to collect

thoughts content and mood of participants eight times per day. Sleep parameters were measured with actigraphs. Results showed that repetitive thought was associated with longer sleep onset latency, impaired sleep efficiency and a reduction of total sleep time. They also found that impaired sleep efficiency was associated with decreased positive affect the subsequent morning and reduced positive mood was associated with increased repetitive thoughts during the day as in a vicious cycle.

Insomnia, Poor Sleep and Emotion Regulation

In a pioneering study, Harvey [51] compared individuals with insomnia and good sleepers in the use of thought control strategies using the Thought Control Questionnaire for Insomnia (TCQ-I). The results showed that participants with insomnia used the strategies of suppression, reappraisal and worry significantly more than good sleepers. Ree et al. [52] elaborated a refined version of the questionnaire, named the Thought Control Questionnaire Insomnia Revised (TCQI-R) evaluating a bigger number of cognitive emotion regulation strategies. Comparing persons with insomnia and good sleepers, the authors found that the firsts used all the strategies of thought control more frequently than controls, except for cognitive distraction, which was the only strategy associated with better sleep quality. In particular, aggressive suppression and worry showed to be associated with worse sleep quality. More recently, Nota & Coles [53] confirmed that rumination is cross-sectionally associated with short sleep duration. However, very few studies have investigated the relationship between insomnia symptoms and emotion regulation abilities. Racine and colleagues [54] found that short and long sleep duration (less or more than the population average sleep time, 6–8 hours) were associated with reduced ability of emotion regulation on a population of 523 black women. Women sleeping 6–8 hours seemed to be more able to regulate their daily lives emotions. The presence of Insomnia symptoms might mediate the association between emotion regulations and sleep duration. Another 3-years longitudinal study of Tavernier & Willoughby [55] on 942 university students, showed a significant bidirectional association between sleep problems and emotion regulation. That is, students who had more sleep problems also reported less positive social ties and in turn the latter predicted more sleep problems. Authors also found that problems in regulating emotions mediated the relationship between sleep disturbances and social ties. Recently, a study of Mauss et al. [56] found positive association between poor sleep and impaired emotion regulation ability. Particularly they investigated the effect of retrospective measures of sleep quality on a specific adaptive emotion regulation strategy: cognitive reappraisal (CRA), considered as the ability to cognitively reframe a particular emotional negative event in order to decrease its impact [57]. One hundred fifty-six participants completed self-report questionnaires and laboratory tasks. In an individual laboratory session, they first measured self-report sleep quality of the previous 24 h and of the whole week and CRA using a film clips task, following the procedures reported by Troy and colleagues [58]. Results showed positive association between subjective ratings of sleep quality and CRA. Specifically poor sleep quality of the past week was linked with decreased cognitive reappraisal ability, while poor sleep of the past 24h was marginally associated. The relationship between sleep quality and CRA was also statistically controlled for a large number of potential confounding variables (e.g. age, gender, mood and anxiety disorder symptoms, caffeine consumption), suggesting that it was not influenced by a third variable. In line with the hypothesis that poor sleep is associated with emotion regulation abilities another study of Velardin et al. [59] explored how sleep difficulties and sleep stability are related to cognitive control disengaging attention from negative emotional stimuli. Particularly they related this relationship with depressive symptoms over a 3-weeks period. First they found that a poor sleep quality during the 3 weeks period was associated with increased depressive symptoms when controlled for symptoms at baseline. Second, poor sleep quality predicted greater difficulties in disengaging attention and the latter consequentially predicted greater depressive symptoms. An experimental study of Vanderkerckhove et al. [60] tested whether different emotion regulation strategies

might influence sleep physiology. Participants were instructed to use either a cognitive-analytical or an experiential emotion regulation strategy before polysomnographic assessment. Results showed that experiential approach was related with increased total sleep time and sleep efficiency index and decreased nocturnal awakenings although an increase of sleep onset latency was observed compared to cognitive-analytical approach. Instead, a recent cross-sectional study of Sandru & Voinescu [61] found that difficulties in regulating emotions predicted self-reported poor sleep quality. Results show that emotion regulation difficulties were also associated with the presence of dysfunctional beliefs about sleep.

Evidence from neuroimaging studies seems to support the existence of the relationship between sleep quality and emotion regulation. The principal brain region involved in emotion regulation seems the prefrontal cortex (PFC), that plays an important role also in the cognitive control of emotions [62] and several studies suggest that the latter could be disrupted by disturbed sleep [63,64]. PFC has been shown to be sensible to sleep loss. Moreover, an experimental study by Yoo et al. [65] shows how participants who had been sleep deprived exhibited reduced functional connectivity between brain regions responsible for cognitive control (medial prefrontal areas) and emotional responses (amygdala) while viewing negative emotional pictures, compared to the control group. These findings are in line with results of studies that used chronic deprivation [66] and partial acute deprivation [67] supporting the association of these two main domains and supporting the role of emotion-regulatory control by prefrontal brain areas [62].

Implications for Treatment

Whilst cognitive and behavioral consequences of poor sleep and insomnia have been studied in depth over the last decades, emotional experience have been widely ignored and the empirical findings in this field still need to be replicated and confirmed. The consequence of this is that CBT-I, the main non-pharmacological therapy for insomnia, is mostly based on behavioral and cognitive techniques. However, results summarized above suggest that CBT-I programs could benefit from the inclusion of specific techniques targeting emotions and emotion regulation skills. To this issue, several studies have already been conducted for assessing efficacy of programs that specifically address emotions in insomnia. Ong and colleagues published a group of studies evidencing that mindfulness protocols alone [68] or combined with the standard CBT-I program [69,70] are effective in reducing insomnia symptoms. The protocol used taught participants to respond to disturbed sleep with mindfulness skills rather than react automatically by increasing effort to rest. A systematic review by Winbush and colleagues [71] identified 7 studies before 2007 assessing efficacy of mindfulness and the same research group also published a paper in 2011 [72] confirming efficacy of this approach.

In recent years, several authors proposed brief psychoeducational interventions focused specifically on improving emotional recognition and regulation. They applied these programs to Binge Eating Disorder (BED), for which, like for insomnia, a relationship has been established between severity of the symptoms and negative affect or emotion dysregulation. Efficacy of these programs in reducing BED episodes have been demonstrated [73-75]. Although these findings seem promising, no studies have applied these protocols to insomnia yet.

Conclusions and Suggestions for Future Directions

Results of the studies summarized in the present review confirm that emotion regulation may mediate the effect of insomnia symptoms on different psychosocial outcomes. The hypothesis that could be advanced is that sleep loss (either acute or chronic) may impair the ability to use functional or flexible emotion regulation strategies thus increasing negative mood which, in turn, may alter sleep in a vicious cycle that produces in the long run negative health outcomes. To our knowledge, no direct evidence supports this complex relationship

yet, with the exception of Tavernier & Willoughby's study [55]. Although the distinction between daytime and nighttime processes seems forced, most of the studies reviewed above support most of the bivariate relationships within this complex hypothesis namely that: negative emotions impair sleep; sleep deprivation increases negative emotions and reduces positive emotions; sleep deprivation impairs the use of adaptive emotion regulation strategies and impaired emotion regulation abilities is associated with poor sleep; if people are trained to use adaptive emotion regulation strategies (like, for instance, acceptance of mindfulness) insomnia symptoms can be reduced.

Speculating about the neurophysiological mechanisms that link bidirectionally insomnia and emotion dysregulation, sleep instability seems a good candidate. Current research indicates increased instability of both NREM [76] and REM Sleep [77] as crucial neurophysiological mechanisms in insomnia. The second is particularly relevant for the line of reasoning followed in the present review. According to the REM instability hypothesis, this brain state requires a fine balance between arousing and de-arousing brain mechanisms. For this reason it may be frequently interrupted by a cognitive activity related to pre-sleep arousing concerns. The chronic fragmentation of REM sleep might lead to dysfunctions in the emotional neural networks, including limbic and paralimbic areas that are specifically activated during REM sleep. This hypothesis would also partially explain the emotion regulation problems of persons with insomnia. As evidenced by Gujar et al. [78], REM sleep plays an important role in the maintenance of effective processes of emotion categorization during the day. More specifically, using a face recognition task the authors found that sleep loss amplified reactivity to negative emotions while a daily nap reversed this effect and enhanced the impact of positive stimuli. Based on these results the authors concluded that REM sleep may be necessary for the optimal homeostasis of emotional brain regulation.

It should be outlined, however, that most of the literature reviewed in the present paper shows the effects of sleep deprivation on emotional experience. However, sleep deprivation is not an "experimental model" of insomnia as the chronic sleep deprivation that characterizes insomnia disorder may be associated to adjustment processes that do not take place in the acute manipulation of sleep. Few studies evaluated the association between habitual poor sleep or habitual good sleep and emotional experience or emotion regulation suggesting that poor sleep is related to increased negative or reduced positive emotions. Again, poor sleep is not exactly the same as insomnia. Finally, the emotion regulation training proposed for BED has never been applied to insomnia. For these reasons, future research should address these issues considering patients with chronic insomnia.

References

- Gruber R, Cassoff J (2014) The interplay between sleep and emotion regulation: Conceptual framework empirical evidence and future directions. *Curr Psychiatry Rep* 16: 500.
- Scott JP, McNaughton LR, Polman RC (2006) Effects of sleep deprivation and exercise on cognitive, motor performance and mood. *Physiol Behav* 87: 396-408.
- Van Dongen HPA, Maislin G, Mullington JM, Dinges DF (2003) The cumulative cost of additional wakefulness: Dose-response effects on neurobehavioral functions and sleep physiology from chronic sleep restriction and total sleep deprivation. *Sleep* 26: 117-126.
- Riemann D, Nissen C, Palagini L, Otte A, Perlis ML, et al. (2015) The neurobiology, investigation, and treatment of chronic insomnia. *Lancet Neurol* 14: 547-558.
- Sarsour K, Morin CM, Foley K, Kalsekar A, Walsh JK (2010) Association of insomnia severity and comorbid medical and psychiatric disorders in a health plan-based sample: Insomnia severity and comorbidities. *Sleep Med* 11: 69-74.
- Riemann D (2007) Insomnia and comorbid psychiatric disorders. *Sleep Med* 8 Suppl 4: S15-20.
- Kyle SD, Espie CA, Morgan K (2010) "...Not just a minor thing, it is something major, which stops you from functioning daily": quality of life and daytime functioning in insomnia. *Behav Sleep Med* 8: 123-140.
- Staner L (2010) Comorbidity of insomnia and depression. *Sleep Med Rev* 14: 35-46.
- Baglioni C, Battagliese G, Feige B, Spiegelhalder K, Nissen C, et al. (2011) Insomnia as a predictor of depression: a meta-analytic evaluation of longitudinal epidemiological studies. *J Affect Disord* 135: 10-19.
- Diagnostic and Statistical Manual of Mental Disorders, DSM-5 (2013) American Psychiatric Association. American Psychiatric Publishing, Washington, DC.
- Baglioni C, Spiegelhalder K, Lombardo C, Riemann D (2010) Sleep and emotions: a focus on insomnia. *Sleep Med Rev* 14: 227-238.
- Gross JJ (2015) Emotion regulation: current status and future prospects. *Psychological Inquiry* 26: 1-26.
- Aldao A, Nolen-Hoeksema S, Schweizer S (2010) Emotion-regulation strategies across psychopathology: A meta-analytic review. *Clin Psychol Rev* 30: 217-237.
- Aldao A, Nolen-Hoeksema S (2012) When are adaptive strategies most predictive of psychopathology? *J Abnorm Psychol* 121: 276-281.
- Butler EA, Lee TL, Gross JJ (2007) Emotion regulation and culture: are the social consequences of emotion suppression culture-specific? *Emotion* 7: 30-48.
- Bonanno GA, Burton CL (2013) Regulatory Flexibility: An Individual Differences Perspective on Coping and Emotion Regulation. *Perspect Psychol Sci* 8: 591-612.
- Berking M, Wirtz CM, Svaldi J, Hofmann SG (2014) Emotion regulation predicts symptoms of depression over five years. *Behav Res Ther* 57: 13-20.
- Brockmeyer T, Bents H, Holtforth MG, Pfeiffer N, Herzog W, et al. (2012) Specific emotion regulation impairments in major depression and anorexia nervosa. *Psychiatry Res* 200: 550-553.
- Ehring T, Tuschen-Caffier B, Schnulle J, Fischer S, Gross JJ (2010) Emotion regulation and vulnerability to depression: spontaneous versus instructed use of emotion suppression and reappraisal. *Emotion* 10: 563-572.
- Jormann J, Gotlib IH (2010) Emotion regulation in depression: relation to cognitive inhibition. *Cogn Emot* 24: 281-298.
- Berking M, Wupperman P (2012) Emotion regulation and mental health: recent findings, current challenges, and future directions. *Curr Opin Psychiatry* 25: 128-134.
- Gul A, Ahmad H (2014) Cognitive deficits and emotion regulation strategies in patients with psychogenic nonepileptic seizures: a task-switching study. *Epilepsy Behav* 32: 108-113.
- Kyle SD, Beattie L, Spiegelhalder K, Rogers Z, Espie CA (2014) Altered emotion perception in insomnia disorder. *Sleep* 37: 775-783.
- Vandekerckhove M, Weiss R, Schotte C, Exadaktylos V, Haex B, et al. (2011) The role of presleep negative emotion in sleep physiology. *Psychophysiology* 48: 1738-1744.
- Schmidt RE, Renaud O, van der Linden M (2011) Nocturnal regrets and insomnia in elderly people. *Int J Aging Hum Dev* 73: 371-393.
- Schmidt RE, Van der Linden M (2013) Feeling too regretful to fall asleep: Experimental activation of regret delays sleep onset. *Cognitive Therapy and Research* 37: 872-880.
- Espie C, Broomfield NM, Macmahon KMA, Macphee LM, Taylor LM (2006) The attention-intention-effort pathway in the development of psychophysiological insomnia: A theoretical review. *Sleep Med Rev* 10: 215-245.
- Steptoe A, O'Donnell K, Marmot M, Wardle J (2008) Positive affect, psychological well-being, and good sleep. *J Psychosom Res* 64: 409-415.
- Wood AM, Joseph S, Lloyd J, Atkins S (2009) Gratitude influences sleep through the mechanism of pre-sleep cognitions. *J Psychosom Res* 66: 43-48.
- Kalmbach DA, Pillai V, Roth T, Drake CL (2014) The interplay between daily affect and sleep: a 2-week study of young women. *J Sleep Res* 23: 636-645.
- Franzen PL, Buysse DJ, Dahl RE, Thompson W, Siegle GJ (2009) Sleep deprivation alters pupillary reactivity to emotional stimuli in healthy young adults. *Biol Psychol* 80: 300-305.
- Killgore WDS, Kahn-Greene ET, Lipizzi EL, Newman RA, Kamimori GH, et al. (2008) Sleep deprivation reduces perceived emotional intelligence and constructive thinking skills. *Sleep Med* 9: 517-526.
- Babson KA, Trainor CD, Feldner MT, Blumenthal H (2010) A test of the effects of acute sleep deprivation on general and specific self-reported anxiety and depressive symptoms: an experimental extension. *J Behav Ther Exp Psychiatry* 41: 297-303.
- Talbot LS, McGlinchey EL, Kaplan KA, Dahl RE, Harvey AG (2010) Sleep deprivation in adolescents and adults: changes in affect. *Emotion* 10: 831-841.

35. Tempesta D, Couyoumdjian A, Curcio G, Moroni F, Marzano C, et al. (2010) Lack of sleep affects the evaluation of emotional stimuli. *Brain Res Bull* 82: 104-108.
36. Lang PJ, Bradley MM, Cuthbert BN (1999) International Affective Picture System Instruction Manual and Affective Ratings (Tech. Rep. No. A-4). The Center for Research in Psychophysiology, University of Florida, Gainesville (FL).
37. Gilbert P (1998) The evolved basis and adaptive functions of cognitive distortions. *Br J Med Psychol* 71 : 447-463.
38. Minkel J, Htaik O, Banks S, Dinges D (2011) Emotional expressiveness in sleep-deprived healthy adults. *Behav Sleep Med* 9: 5-14.
39. Schwarz JF, Popp R, Haas J, Zulle J, Geisler P, et al. (2013) Shortened night sleep impairs facial responsiveness to emotional stimuli. *Biol Psychol* 93: 41-44.
40. Dags N, McGlinchey EL, Talbot LS, Kaplan KA, Dahl RE, et al. (2012) Double trouble? The effect of sleep deprivation and chronotype on adolescent affect. *J Child Psychol Psychiatry* 53: 660-667.
41. Baum KT, Desai A, Field J, Miller LE, Rausch J, et al. (2014) Sleep restriction worsens mood and emotion regulation in adolescents. *J Child Psychol Psychiatry* 55: 180-190.
42. Haack M, Mullington JM (2005) Sustained sleep restriction reduces emotional and physical well-being. *Pain* 119: 56-64.
43. Buysse DJ, Thompson W, Scott J, Franzen PL, Germain A, et al. (2007) Daytime symptoms in primary insomnia: a prospective analysis using ecological momentary assessment. *Sleep Med* 8: 198-208.
44. Smith RA, Lack LC, Lovato N, Wright H (2015) The relationship between a night's sleep and subsequent daytime functioning in older poor and good sleepers. *J Sleep Res* 24: 40-46.
45. Kahn M, Sheppes G, Sadeh A (2013) Sleep and emotions: bidirectional links and underlying mechanisms. *Int J Psychophysiol* 89: 218-228.
46. Simor P, Krietsch KN, Koteles F, McCrae C (2015) Day-to-day variation in subjective sleep quality and emotional states among healthy university students- A 1 week prospective study. *Int J Behav Med*.
47. McCrae CS, McNamara JP, Rowe MA, Dzierzewski JM, Dirk J, et al. (2008) Sleep and affect in older adults: using multilevel modeling to examine daily associations. *J Sleep Res* 17: 42-53.
48. Scott BA, Judge TA (2006) Insomnia, emotions, and job satisfaction: A multilevel study. *Journal of Management* 32: 622-645.
49. Norlander T, Johansson A, Bood SA (2005) The affective personality: Ist relation to quality of sleep, well-being and stress. *Social Behavior and Personality* 33: 709-722.
50. Takano K, Sakamoto S, Tanno Y (2014) Repetitive thought impairs sleep quality: an experience sampling study. *Behav Ther* 45: 67-82.
51. Harvey AG (2001) I can't sleep, my mind is racing! An investigation of strategies of thought control in insomnia. *Behavioural and Cognitive Psychotherapy* 29: 3-11.
52. Ree MJ, Harvey AG, Blake R, Tang NKY, Shawe-Taylor M (2005) Attempts to control unwanted thoughts in the night: development of the thought control questionnaire-insomnia revised (TCQI-R). *Behav Res Ther* 43: 985-998.
53. Nota JA, Coles ME (2014) Duration and timing of sleep are associated with repetitive negative thinking. *Cognitive Therapy and Research* 39: 253-262.
54. Racine C, Kalra K, Ceide M, Williams NJ, Zizi F, et al. (2013) Sleep Duration, Insomnia Symptoms, and Emotion Regulation among Black Women. *J Sleep Disord Ther* 2.
55. Tavernier R, Willoughby T (2015) A longitudinal examination of the bidirectional association between sleep problems and social ties at university: the mediating role of emotion regulation. *J Youth Adolesc* 44: 317-330.
56. Mauss IB, Troy AS, LeBourgeois MK (2013) Poorer sleep quality is associated with lower emotion-regulation ability in a laboratory paradigm. *Cogn Emot* 27: 567-576.
57. Ochsner KN, Gross JJ (2005) The cognitive control of emotion. *Trends Cogn Sci* 9: 242-249.
58. Troy AS, Wilhelm FH, Shallcross AJ, Mauss IB (2010) Seeing the silver lining: Cognitive reappraisal ability moderates the relationship between stress and depression. *Emotion* 10: 783-795.
59. Vanderlind WM, Beevers CG, Sherman SM, Trujillo LT, McGeary JE, et al. (2014) Sleep and sadness: Exploring the relationship among sleep, cognitive control, and depressive symptoms in young adults. *Sleep Med* 15: 144-149.
60. Vandekerckhove M, Kestemont J, Schotte C, Verbraecken J, Weiss R, et al. (2012) Experiential versus analytical emotion regulation and sleep: Breaking the link between negative events and sleep disturbance. *Emotion* 12: 1415-1421.
61. Sandru C, Voinescu BI (2014) The relationship between emotion regulation, dysfunctional beliefs about sleep and sleep quality- an exploratory study. *Journal of Evidence-Based Psychotherapies* 14: 249-257.
62. Ochsner KN, Rayb RD, Cooperb JC, Robertson ER, Choprab S, et al. (2004) For better or for worse: neural systems supporting the cognitive down- and up-regulation of negative emotion. *NeuroImage*, 23: 483-499.
63. Goel N, Rao H, Durmer JS, Dinges DF (2009) Neurocognitive consequences of sleep deprivation. *Semin Neurol* 29: 320-339.
64. Tucker AM, Whitney P, Belenky G, Hinson JM, Van Dongen HP (2010) Effects of sleep deprivation on dissociated components of executive functioning. *Sleep* 33: 47-57.
65. Yoo SS, Gujar N, Hu P, Jolesz FA, Walker MP (2007) The human emotional brain without sleep--a prefrontal amygdala disconnect. *Curr Biol* 17: R877-878.
66. Baglioni C, Spiegelhalter K, Regen W, Feige B, Nissen C, et al. (2014) Insomnia disorder is associated with increased amygdala reactivity to insomnia-related stimuli. *Sleep* 37: 1907-1917.
67. Motomura Y, Kitamura S, Oba K, Terasawa Y, Enomoto M, et al. (2013). Sleep debt elicits negative emotional reaction through diminished amygdala-anterior cingulate functional connectivity. *PLoS One* 8.
68. Ong J, Sholtes D (2010) A mindfulness-based approach to the treatment of insomnia. *J Clin Psychol* 66: 1175-1184.
69. Ong JC, Shapiro SL, Manber R (2008) Combining mindfulness meditation with cognitive-behavior therapy for insomnia: a treatment-development study. *Behav Ther* 39: 171-182.
70. Ong JC, Shapiro SL, Manber R (2009) Mindfulness meditation and cognitive behavioral therapy for insomnia: a naturalistic 12-month follow-up. *Explore (NY)* 5: 30-36.
71. Winbush NY, Gross CR, Kreitzer MJ (2007) The effects of mindfulness-based stress reduction on sleep disturbance: a systematic review. *Explore (NY)* 3: 585-591.
72. Gross CR, Kreitzer MJ, Reilly-Spong M, Wall M, Winbush NY, et al. (2011) Mindfulness-based stress reduction versus pharmacotherapy for chronic primary insomnia: a randomized controlled clinical trial. *Explore (NY)* 7: 76-87.
73. Clyne C, Latner JD, Gleaves DH, Blampied NM (2010) Treatment of emotional dysregulation in full syndrome and subthreshold binge eating disorder. *Eat Disord* 18: 408-424.
74. Courtney Clyne, Janet D Latner, David H Gleaves, Neville M Blampied (2010) Treatment of Emotional Dysregulation in Full Syndrome and Subthreshold Binge Eating Disorder. *Eat Disord* 18: 408-424.
75. Svaldi J, Tuschen-Caffier B, Trentowska M, Caffier D, Naumann E (2014) Differential caloric intake in overweight females with and without binge eating: Effects of a laboratory-based emotion-regulation training. *Behav Res Ther* 56: 39-46.
76. Parrino L, Ferri R, Bruni O, Terzano MG (2012) Cyclic alternating pattern (CAP): the marker of sleep instability. *Sleep Med Rev* 16: 27-45.
77. Riemann D, Spiegelhalter K, Nissen C, Hirscher V, Baglioni C, et al. (2012) REM sleep instability--a new pathway for insomnia? *Pharmacopsychiatry* 45: 167-176.
78. Gujar N, McDonald SA, Nishida M, Walker MP (2011) A role for REM sleep in recalibrating the sensitivity of the human brain to specific emotions. *Cereb Cortex* 21: 115-123.