

Research Article

Emotional Experience, Presence and Severity of Insomnia and Depressive Symptoms: An Ecological Study of their Effects on Sleep Quality

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ABSTRACT

Behavioral and neuroimaging studies suggest that sleep disturbances and emotions are closely related. However, there is still no consensus regarding the role of emotions in the etiology of insomnia disorder and how daily sleep and emotions are linked. The aim of this study was to explore the relationship between emotional experience and subjective sleep quality, taking into account the presence and severity of insomnia and depressive symptoms and using an ecological momentary assessment. The sample consisted of adults reporting chronic (n=51) and subthreshold (n=134) insomnia or good sleep quality (n=66). Participants completed sleep diaries and reported their emotions both before going to sleep and after awakenings for 7 days. For each participant a night of good and a night of bad sleep quality were selected based

on sleep efficiency index (SEI). Results showed that the groups differed significantly in sleep efficiency, depressive and insomnia symptoms (insomnia group reported lower SEI and higher scores of depression and insomnia severity). Secondly, pre-sleep emotions, both negative and positive, influenced the quality of sleep of the good night only in the group of participants that reported subthreshold insomnia symptoms. In other words, in transient insomnia the lower are both negative and positive emotions before going to bed the better is sleep quality. In chronic insomnia, a good sleep quality is predicted only by less severe depressive symptoms that also predict the intensity of negative affect before falling asleep in all groups.

MesH headings/keywords: Sleep; Insomnia; Emotion

Introduction

Insomnia is the most common sleep disorder affecting up to 10% of the general population [1] and associated with decreased quality of life [2] and higher risk of developing psychopathology [3]. According to the Diagnostic and Statistical Manual of Mental Disorders 5th Edition [4] insomnia disorder is defined by difficulties in falling asleep and/or maintaining sleep and/or early morning awakenings and/or presence of non-restorative sleep that occur alongside daytime cognitive, social and emotional dysfunction. Psychophysiological theories of insomnia recognize enhanced emotional reactivity as predisposing, triggering and/or maintaining factors [5-7]. With respect to emotional valence, studies agreed about the role of negative affect in sleep impairment and the role of sleep restriction on mood and positive emotions [8-12]. However, the role of positive emotions remains debated in literature [13]. Espie's theory [7] suggests that both positive and negative emotions are supposed to disrupt sleep enhancing levels of emotional arousal while some studies suggest that positive emotions are associated with good sleep quality [14-15]. A study of Ong et al. [16] found an overall positive relation between trait positive emotions and sleep while positive emotions reactivity was associated with poorer sleep quality.

Furthermore, daytime negative affect or subclinical depression seem to be higher in individuals with insomnia

compared to healthy good sleepers [17]. Longitudinal research and meta-analysis evidence that sleep problems usually precede [1,18,19] and even predict depression [3]. A recent longitudinal study in general population evidenced that insomnia with short sleep duration at baseline predicts depression at 7.5 years follow up independently of coping strategies whilst insomnia with normal sleep duration predicts depression only with the mediation of poor coping resources [20].

Empirical research evidenced how enhanced emotional experience, emotional instability and difficulties in emotion regulation are common features of insomnia [3,21-23] and are related to the sleep of healthy individuals [8,24,25]. Indirect evidence supporting the presence of altered emotional processes in insomnia derives from neuroimaging literature which evidenced an abnormal activity in cerebral areas associated with emotional reactivity such as the amygdalae [26] and a reduction in functional connectivity between amygdalae and prefrontal areas related to emotion regulation [27].

Most of the studies which investigated the role of emotional activation in insomnia used laboratory procedures [3,23] or survey methods [17]. Ecological studies using momentary assessment of emotions are very limited [8,28,29]. Some of them [8,29] support the bidirectional link between sleep and emotion suggesting that daily affect may affect sleep quality and sleep quality may affect emotions during the following day in a

vicious cycle. The present study aims to explore the relationship between emotional experience, insomnia and depression using a prospective design and an ecological momentary assessment with sleep and emotion diaries.

Method

Participants

The initial sample consisted of 314 participants (172 females- 54,8% and 142 males- 45,2%), mean age 36.17 ± 12.39 . Data were collected between 2011 and 2012 using a non-probabilistic snowball sampling.

Measures

The sleep disorders questionnaire (SDQ)[30]: It is a brief self-report questionnaire that evaluates the presence of insomnia according to both DSM-IV-TR diagnostic criteria and the quantitative criteria indicated by a consensus report [30,31]. This instrument allows to define three groups of sleep quality: Good sleep which includes people who report no sleep complaints; Persistent chronic insomnia, which characterizes people who report clinically significant symptoms of insomnia on the basis of diagnostic criteria and Subthreshold insomnia, which consists of people who report frequency, persistence, or consequences of insomnia symptoms lower than those indicated by diagnostic criteria. Violani et al. [30] evidenced a good validity of this classification showing that the SDQ has a sensitivity of 95% and a specificity of 87%.

Beck depression inventory-II (BDI): It is a 21 item self-report rating inventory assessing presence and severity of depressive symptoms [32]. It is one of the most widespread instrument used to measure depression. We used the Italian validation of Ghisi et al. [33].

The insomnia severity index (ISI) [34]: Italian version, by Battagliese and Lombardo [35], was used to have a parametric measure of insomnia severity. Summing the result of seven items, ranging from 0 (insomnia absent) to 28 (very severe insomnia), a total score of the insomnia severity during the preceding two weeks can be obtained. A score ≤ 7 is considered the cut-off for the absence of clinically significant insomnia.

Momentary assessment

Positive and negative affect schedule (PANAS): It is a 20-item self-report measure and it is one of the most widespread instrument to assess independently positive affect (PA) and negative affect (NA) [36]. In the present study we used the Italian version validated by Terracciano et al. [37]. Participants were asked to rate a list of 10 positive and 10 negative adjectives on a 5-point Likert scale (such as “distressed”, “guilty”, “inspired”, “strong”). The “moment instruction” (“Rate how do you felt at the present moment”) was used, anchored at 30 minutes before going to sleep and 30 minutes after awakening.

Sleep diary: The sleep diary is a self-report measure in which participant's estimates a number of sleep variables as time before falling asleep or number and duration of nocturnal awakenings, etc. It allows calculating the total sleep time (TST), the total time in bed (TBT) and the sleep efficiency index

(SEI). The sleep diary is considered the gold standard among subjective measure of sleep [37,38].

Procedure

Participants were students of the Faculty of Psychology at Sapienza University of Rome and their acquaintances. If they agreed to be involved in the study, they signed a consent form and underwent a screening procedure. Finally, they received the instruction to complete the sleep and emotion diaries.

Upon recruitment participants completed self-report questionnaires assessing the presence and severity of symptoms of insomnia (SDQ, ISI) and depression (BDI). After that, they were asked to keep sleep diaries for 7 consecutive nights and to complete the PANAS within 30 minutes before going to bed and within 30 minutes after awakening. Participants were left free to start the sleep and emotion momentary assessment whenever convenient for them but it was mandatory to keep notes of sleep and emotions diaries for 7 consecutive nights. The procedure was in agreement with Helsinki Declaration [39], participants were asked to sign an informed consent upon acceptance to participate. They received a file including questionnaires and diaries that had a code on each page in order to match all the data provided by each participant while keeping them anonymous.

Data preparation

For each participant the Sleep Efficiency Index (SEI) was computed for each night. Based on SEI values, two nights were selected among the 7 recorded: A good (Good Night) and a bad (Bad Night) night. Since irregular sleep patterns may occur during weekends [40], only the weekdays records were considered. Moreover, since a restore bias may occur after a night of bad sleep [41] the Good Night was never the first measured (as we do not know the sleep quality of the preceding night) as well as the one following the Bad Night (i.e. the night with the worst SEI). A mean SEI (SEI-M) was also computed averaging the SEIs of all the 5 weeknights (thus excluding the weekends).

The BDI total score was computed excluding the item dealing with sleep disorders symptoms. Two positive and 2 negative affect (PA and NA) scores were computed summing up PANAS items related to the evening preceding and the morning following the selected nights. The sample was divided in 3 subsamples based on SDQ data, four groups differing for self reported sleep quality were defined: participants who report good sleep (Good Sleep), participants who report subthreshold insomnia symptoms (Subthreshold), participants who report persistent insomnia (Insomnia) and other sleep problems (Others).

Data analyses

MAs a Manipulation check

Differences in sleep quality: Differences among groups on ISI scores were assessed through one way ANOVA. A one way ANOVA was also used for evidencing differences across groups in SEI-M. In order to verify that the sleep efficiency index indices differed between across good and bad nights and across among groups we performed a mixed design factorial ANOVA. Differences among groups on ISI scores were assessed through

one way ANOVA. Significant effects were further analyzed through Tukey or LSD Post hoc tests.

Hypotheses testing

Differences in mood and emotions: A one way ANOVA was computed for evidencing differences across groups and in the BDI total score. A mixed design factorial ANOVA with Night (Good night, Bad Night) and Moment (Pre-, Post-Sleep) as within subjects factors and Group (Good Sleep, Sub threshold, Insomnia) as between subjects factor was used for evidencing differences on positive and negative emotions. Significant effects were further analyzed through Turkey or LSD Post hoc tests.

Sleep and emotions: In order to explore the correlations between positive and negative emotions and the quality of sleep, bivariate correlations were computed between PA or NA, measured both before (pre-sleep) and after (post-sleep) sleep and the SEI indices of both the selected nights. Based on the scientific literature [8-12] we decided to accept a one-tail significance level of $\alpha \leq .05$ for NA (pre- and post-sleep) and SEI correlations as it was expected that pre-sleep NA disrupt sleep and that post-sleep negative affect increases following a bad night of sleep. Similarly, since a one-direction hypothesis was advanced for the relationship between post-sleep PA and SEI (higher PA after a good night of sleep), a one-tail $\alpha \leq .05$ was used as significance level. On the contrary, as a bidirectional hypothesis could be advanced for the correlations between pre-sleep PA and SEI [7,13-16], a two-tails $\alpha \leq .05$ was chosen.

Sleep and emotions controlling for negative mood: Lastly, to control for the effect of depression, Correlation analyses between emotions and SEIs were repeated controlling for BDI scores through partial correlation analyses using the same α levels as for the bivariate correlations.

Results

Descriptives of the sample

Eighteen participants reporting other sleep problems (e.g. restless legs syndrome, excessive sleepiness, frequent nightmares) and 29 who did not complete the measures were excluded from the following analyses. The final sample consisted of 251 participants (114 males and 137 females, mean age 35.8 ± 12.18). The sub-samples consisted respectively of 66 (Good Sleep: GS), 134 (Subthreshold: ST) and 51 (Persistent Insomnia: PI) participants. Sleep groups did not differ for age ($\chi^2=82.3$ $p=.84$) and gender ($\chi^2=2.16$ $p=.34$).

Manipulation check

Differences in sleep quality: Groups differed significantly on the average of the weekdays SEI-M ($F_{(2,248)}=18.23$; $p<0.001$), on ISI scores ($F_{(2,248)}=91.43$ $p<0.001$). Tukey post hoc tests revealed that all groups differed significantly ($p<0.01$). Means and standard deviations are reported in Table 1.

The SEI differed significantly between nights ($F_{(1,248)}=194.07$; $p<0.001$), and groups ($F_{(2,248)}=16.6$; $p<0.001$). The interaction groups*nights was also significant ($F_{(2,248)}=11.80$; $p<0.001$). All groups slept significantly worse in the Bad Night than in the Good Night (all $ps<0.001$) and all groups differed during

the Bad Night (Good Sleep: $M=94.89$, $SD=6.21$; Subthreshold: $M=91.12$, $SD=7.74$; Insomnia: $M=86.36$, $SD=10.89$, all $ps<0.05$) while during the Good Night only the Insomnia group (PCI: $M=96.47$, $SD=4.9$) showed a SEI lower than both the Good Sleep ($M=98.53$, $SD=0.99$, $p=0.000$) and Subthreshold ($M=97.83$, $SD=2.36$; $p=0.011$) (Figure 1).

Hypotheses testing

Depressive mood: Groups differed significantly on BDI scores ($F_{(2,248)}=38.16$; $p<0.001$). All groups were significantly different according to Tukey post hoc tests ($p<0.01$).

Negative emotions: Results of the mixed design factorial ANOVA Night* Moment* Groups for negative affect showed a significant interaction Night * Moment ($F_{(1,242)}=10.06$, $p=0.002$) and a significant main effect of Groups ($F_{(2,242)}=5.30$; $p=0.006$). These effects were no longer present when the BDI score was used as covariate.

Positive emotions: The mixed design factorial ANOVA Night * Moment * Groups showed a significant main effect of the factor Moment ($F_{(1,242)}=10.70$, $p=0.001$), a significant interaction Night * Moment ($F_{(1,242)}=10.99$; $p=0.001$) and a significant main effect of the Group ($F_{(2,242)}=3.82$; $p=0.023$). The effects of the factors Moment and Groups subsisted also controlling for BDI score, while the interaction was no longer significant. As regards the main effect of the factor Moment, PA at awakening was higher ($M=24.55$; $se=0.48$) than before falling asleep ($M=23.20$; $se=0.44$). As regards the main effect of the factor Group LSD post hoc tests revealed that subthreshold group ($M=22.59$; $se=0.51$) reported lower PA ($p<0.05$) than both the other two groups (respectively Good Sleep: $M=24.64$; $se=0.76$; Persistent Insomnia: $M=24.40$; $se=0.93$), that did not differ from each other.

Correlation between sleep quality and emotions: Since the analyses described above evidenced differences across groups, nights and moments, correlation coefficients between pre-sleep and post-sleep PA/NA and SEI were computed separately for groups and nights. Coefficients are reported in Table 2.

Significant negative correlations were found between Good night's SEI and pre-sleep NA ($r=-0.165$, $p=0.028$) and post-sleep PA ($r=-0.229$, $p=0.004$) in the Subthreshold group. In the same group the correlation between pre-sleep PA and SEI ($r=-0.168$, $p=0.052$) was marginally significant. Also in the Insomnia group the pre-sleep NA correlated negatively with good night's SEI ($r=-0.25$, $p=0.038$).

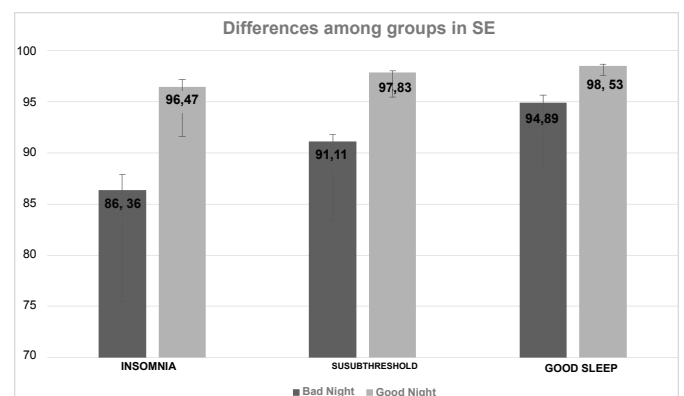


Figure 1: Sleep Efficiency Index (SEI) across groups and nights.

Table 1: Descriptive Statistics of people reporting good sleep, sub threshold symptoms and full blown symptoms of insomnia.

	N	Males	Females	Age	Weekdays SEI	BDI	ISI
Good sleep	66	35	31	35.23 ± 11.06	97.30 ± 2.12	2.91 ± 3.99	1.92 ± 2.34
Subthreshold	134	58	76	36.26 ± 13.04	95.39 ± 3.81	6.24 ± 6.59	4.52 ± 3.81
Insomnia	51	21	30	35.33 ± 11.37	92.34 ± 7.25	13.94 ± 10.02	11.27 ± 5.12
Total sample	251	114	137	35.8 ± 12.18	95.27 ± 4.72	6.93 ± 7.86	5.21 ± 5

Table 2: Bivariate Bravais-Pearson Correlations between Pre-sleep/Post-Sleep Positive (PA) and Negative (NA) Affect and Sleep Efficiency Index (SEI).

	Good sleep		Subthreshold		Insomnia	
	Good Night SEI	Bad Night SEI	Good Night SEI	Bad Night SEI	Good Night SEI	Bad Night SEI
Pre-sleep	r=-.153	r=-.116	r=-.168	r=-.012	r=.223	r=-.036
PA**	p=.220	p=.353	p=.052	p=.894	p=.116	p=.806
Pre-sleep	r=-.034	r=-.087	r=-.165	r=-.136	r=-.250	r=-.221
NA*	p=.394	p=.243	p=.028	p=.060	p=.038	p=.062
Post-sleep	r=-.143	r=-.013	r=-.229	r=-.053	r=.054	r=.000
PA*	p=.127	p=.460	p=.004	p=.272	p=.356	p=.50
Post-sleep	r=.113	r=-.013	r=-.083	r=-.108	r=-.146	r=.046
NA*	p=.185	p=.459	p=.169	p=.107	p=.155	p=.377

*One-tail α ** Two-tail α

Significant correlations are highlighted in red.

Sleep and emotions controlling for negative mood: Results of the partial correlation, controlling for BDI, revealed that the correlations between pre-sleep NA and post sleep PA and SEI in the Subthreshold group are still significant ($r=-0.156$, $p=0.036$; $r=-0.233$ $p=0.004$), while in the Insomnia group the correlation between pre-sleep NA and SEI was no longer significant ($r=-0.129$, $p=0.188$). Moreover, controlling for BDI, the marginally significant correlation between pre-sleep PA and SEI in the Subthreshold group, become stronger and significant ($r=-0.181$, $p=0.037$). No significant results were found for the Bad Night in no group either partialling out or not the effect of BDI.

Discussion

The present study aimed to explore the relationship between emotional experience and sleep quality taking into account the presence and severity of insomnia and depressive symptoms and using a prospective design. Taken together, results suggest that the intensity of pre-sleep emotions, both negative and positive, may influence the quality of sleep only in the group of participants that report subthreshold insomnia symptoms, namely in people who complain of acute or transient insomnia. These results are consistent with Espie's theory stating that both positive and negative emotions are supposed to disrupt sleep enhancing levels of emotional arousal [7]. It is also consistent with results of those studies that evidence a disruptive effect

of emotions (both negative and positive) on sleep [8-12]. The most relevant finding of the present study is that emotions may influence the subsequent sleep quality but only in the good night. In other words, if you complain of transient insomnia symptoms, the lower you experience emotions (both negative and positive) before going to bed, the better you sleep. On the contrary, no relationship was found between emotions experienced before the worst recorded night and pre-sleep emotions. Maybe the worst night of sleep is predicted by other variables that were not observed in the present study. Among these variables, we can hypothesize that physiological arousal, daily stress, rumination etc. may play an important role. Future studies will examine these other variables together with pre-sleep emotions.

People who complain of persistent insomnia symptoms, not only report symptoms that are subjectively perceived as more severe than those classified as subthreshold but they also show, as compared to both those classified as subthreshold and those classified as good sleepers, poorer sleep quality and higher depression. In this group, a sleep of good quality is predicted only by less severe depressive symptoms. Depressive symptoms also predict the intensity of negative affect before falling asleep in all groups. Inconsistently with previous results [14,15], a reverse relationship is found between SEI in the good night of sleep and positive emotions at awakening. Again, this is true only for those people who report transient or subthreshold insomnia symptoms.

Before concluding, several limitations of the present study should be acknowledged. First of all, since we divided the whole sample in 3 subsamples on the bases of their reported symptoms, the subsamples (especially the good sleep group and the insomnia group) were quite small, notwithstanding the good total sample size of more than 250 participants. The limited sample sizes may have reduced the power of the statistical tests preventing us to find significant results. However, if we observe the size of the correlation coefficients instead of their statistical significance, it is possible to notice that the correlations in the Insomnia group are similar (and sometimes even bigger) to the Subthreshold group. Thus it is possible that the non-significance of the expected correlations in the Insomnia groups depends on two reasons: first a big portion of the variance is accounted for by severity of the depressive symptoms as discussed above; second the role of emotions is not significant due to the small sample size of the Insomnia group. Future studies with bigger sample sizes are needed to extend this conclusion.

A second limitation deals with the type of data we used. The major strength of the present study is the ecologically derived prospective data. However, all the data are self-reported. Future studies should evaluate whether these relationships stands also using objective assessment of sleep quality (e.g. through portable devices like actigraphic recordings).

Lastly we have to recognize that although people took note of 7 consecutive nights, since the recordings started in different days of the week we could only select two week-days, the best and the worst, losing other useful information coming from the nights recorded but not analyzed. Actually, for increasing compliance we decided to give participants the liberty to start the recordings whenever they preferred to. All the students accepted to participate and to recruit a mean of 4 other participant. Future studies will evaluate these relationships using the same recording schedule for all participants (e.g. starting the recordings from Monday and stopping at Sunday).

Conclusions

The results of this study show that sleep and emotions are strictly connected and this may have a significant impact on mental health. Insomnia symptoms result related to mood, particularly depressive symptoms, confirming the growing body of literature stating that depression and insomnia are often in comorbidity [42]. The main characteristic of this study, namely the use of ecological momentary assessment, allow to evaluate the effect of both chronic (negative mood) and transient changes (pre-sleep and post-sleep) in emotions in both transient and chronic insomnia. Results evidenced that a chronic negative mood is the better predictor of worse sleep quality in persistent insomnia while in transient insomnia; poor sleep is predicted by changes in negative and positive pre-sleep emotions. Taken together, these results may suggest that the promotion of healthy lifestyles may benefit from taking into account sleep hygiene and strategies for improving emotional experience. Also treatment protocols for insomnia, for example Cognitive Behavioral Therapy for Insomnia (CBT-I), may benefit from addressing emotions and emotion regulation, as they play an important role on sleep quality.

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