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Psychophysiological reactivity to sleep-related emotional stimuli in primary insomnia

Chiara Baglioni [a,*], Caterina Lombardo [a], Emiliano Bux [a], Stig Hansen [b], Christine Salveta [c], Stephany Biello [d], Cristiano Violani [a], Colin A. Espie [c]

[a] Department of Psychology, "Sapienza" University of Rome, Via dei Marsi 78, 00185 Rome, Italy
[b] Department of Clinical Physics, South Glasgow University Hospitals Division, Southern General Hospital, 1345 Govan Road, Glasgow G51 4TF, Scotland, UK
[c] Section of Psychological Medicine and Sleep Research Laboratory, University of Glasgow, Sackler Institute of Psychobiological Research, Southern General Hospital, 1345 Govan Road, Glasgow G51 4TF, Scotland, UK
[d] Department of Psychology, University of Glasgow, 58 Hillhead Street, Glasgow G12 8QB, Scotland, UK

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ABSTRACT

The present study examined psychophysiological reactivity to emotional stimuli related and non-related to sleep in people with primary insomnia (PPI) and in good sleepers (GS). Twenty-one PPI and 18 GS were presented with five blocks of neutral, negative, positive, sleep-related negative and sleep-related positive pictures. During the presentation of the pictures, facial electromyography (EMG) of the corrugator and the zygomatic muscles, heart rate (HR) and cardiac vagal tone (CVT) were recorded. Subjective ratings of the stimuli were also collected. We found that only PPI exhibited greater inhibition of the corrugator activity in response to sleep-related positive stimuli compared to the other blocks of stimuli. Furthermore, PPI rated the sleep-related negative stimuli as more unpleasant and arousing and showed higher CVT in response to all stimuli as compared to GS. Results were interpreted as indicating that PPI exhibit craving for sleep-related positive stimuli, and also hyper-arousability in response to sleep-related negative stimuli, as compared to GS. Our results suggest that psychological treatment of insomnia could benefit by the inclusion of strategies dealing with emotional processes linked with sleep processes.

Introduction

Insomnia as a disorder is defined as difficulties in initiating/maintaining sleep and/or non-restorative sleep accompanied by decreased daytime functioning persisting for at least four weeks (American Academy of Sleep Medicine, AASM, 2005). Aetiological theories (Espie, 2002; Espie, Broomfield, MacMahon, MacPhee, & Taylor, 2006; Harvey, 2002; Lundh & Broman, 2000; Morin, 1993; Perlis, Giles, Mendelson, Bootzin, & Wyatt, 1997; Riemann et al., 2010) consider heightened levels of autonomic, cortical, cognitive, and emotional arousal as relevant maintaining factors of insomnia. Although widely recognized as important (e.g. Espie, 2002; Lundh & Broman, 2000; Morin, 1993; Riemann et al., 2010), investigations of the aetiological role of emotional arousal in insomnia have been classically based on indirect evidence. These have involved studies showing that neurotic temperamental traits are associated with insomnia (e.g. Espie, 1991; LeBlanc et al., 2007), studies investigating the content of intrusive thoughts experienced by people with insomnia during the pre-sleep period (e.g. Van Egeren, Hayness, Franzen, & Hamilton, 1983; Wicklow & Espie, 2000), and studies demonstrating significant comorbidity with clinical anxiety or depression (e.g. Chang, Ford, Mead, Cooper-Patrick, & Klag, 1997; Ford & Kamerow, 1989; Riemann, 2007).

Considering the dimensional approach to the study of emotions (e.g. Bradley, 2000; Lang, 2002, chap. 14), the emotional experience is described as referring to two main dimensions: the valence (positive vs negative) and the arousal (from low to high). Based on this, the majority of research considering insomnia has largely focussed on the dimension of arousal, but not on the dimension of valence. A small number of studies have investigated the relationship between positive (e.g. excited, enthusiastic) and negative (e.g. hostile, upset) affective states and poor sleep quality using self-report questionnaires (e.g. McCrae et al., 2008; Norlander, Johansson, & Bood, 2005; Scott & Judge, 2006). These studies

* Correspondence to: Chiara Baglioni, Department of Psychiatry & Psychotherapy, University of Freiburg Medical Center, Hauptstraße 5, 79104 Freiburg, Germany. Tel.: +49 761 270 6589; fax: +49 761 270 6619.

E-mail addresses: chiara.baglioni@uniklinik-freiburg.de (C. Baglioni), caterina.lombardo@uniroma1.it (C. Lombardo), emiliano.bux@alice.it (E. Bux), s.hansen@clinmed.gla.ac.uk (S. Hansen), c.salveta@clinmed.gla.ac.uk (C. Salveta), s.biello@psy.gla.ac.uk (S. Biello), Cristiano.Violani@uniroma1.it (C. Violani), c.espie@clinmed.gla.ac.uk (C.A. Espie).

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showed that people with insomnia report heightened negative and diminished positive emotional states as compared to good sleepers. Three studies have examined the relationship between emotions and sleep measuring psychophysiological responses to visual stimuli validated both for the dimensions of arousal and valence. In two studies, Franzen, Buysse, Dahl, Thompson, and Siegle (2009) and Franzen, Siegle, and Buysse (2008) measured pupillary responses to high arousing positive and negative emotional pictures and low arousing neutral pictures in sleep-deprived participants as compared to control groups. Main results showed that responses to negative pictures were larger in sleep-deprived participants as compared to controls. In a functional magnetic resonance imaging (fMRI) design study of sleep deprivation, Yoo, Gujarm, Hu, Jolesz, and Walker (2007) presented pictures ranging from emotionally neutral (neutral valence, low arousal) to increasingly aversive quality (negative valence, high arousal). The sleep deprivation group displayed enhanced activity in the amygdala and reduced functional connectivity between the amygdala and the medial prefrontal cortex (MPFC). These results were interpreted as an increased neurobiological response to emotional stimuli and a reduced inhibitory influence of the MPFC on emotional reactivity after sleep deprivation. Taken together, these studies show that sleep deprivation alters emotional responses to negative stimuli, thus, sleep seems to be important for maintaining adaptive emotional processes. However, as these studies focussed on sleep deprivation, no data about emotional reactivity in insomnia are available up to date. In fact, insomnia is a condition which differs from sleep deprivation because it implies chronic sleep difficulties (more than four weeks), primarily subjective complaints, impairments in sleep quality and not necessarily in sleep quantity, and adaptation processes. Moreover, the studies aforementioned did not specifically considered the valence dimension. In fact, Yoo et al. (2007) did not use positive stimuli, and Franzen et al. (2009, 2008) used pupillary responses which are indices of more general emotional information processing. Bradley (2000) has indicated that facial electromyography (EMG) measures specifically the emotional valence. The activity of the corrugator muscle (knits the eye brow into a frown) is both potentiated by unpleasant pictures and inhibited by pleasant pictures when compared to neutral stimuli. In contrast, the activity of the zygomatic muscle (pulls the corners of the mouth back and up into a smile) increases in response to pleasant pictures, while unpleasant stimuli elicit no inhibition (e.g. Larsen, Norris, & Cacioppo, 2003). The aim of the present study was to evaluate facial EMG responses to positive and negative emotional stimuli related and not related to sleep in people with primary insomnia and good sleepers. We assumed that the presentation of symptom-relevant emotional stimuli would enhance responses in the group with insomnia due to a greater attention directed to this material and due to personal relevance.

The following predictions were considered. As compared to neutral stimuli and as compared to good sleepers, people with primary insomnia should exhibit enhanced corrugator activity in response to sleep-related negative stimuli. Additionally, they may show diminished corrugator activity and heightened zygomatic activity in response to sleep-related positive stimuli. With respect to stimuli not related to sleep, people with primary insomnia should present enhanced responses in the corrugator activity to negative stimuli. Additionally, two alternative predictions were considered with respect to positive stimuli. Diminished responses to positive stimuli in the zygomatic muscle have been reported for individuals with dysphoria compared to healthy controls (Sloan, Bradley, Dimoulas, & Lang, 2002). As insomnia is a condition highly linked with depression and with a waking complaint of negative mood changes, we may see a reduced response in the zygomatic muscle to positive stimuli in individuals with primary insomnia. Alternatively, this reduced response may be unique to depression as primary insomnia is an independent diagnostic entity from mood disorders (e.g. Perlis et al., 2006; Riemann & Voderholzer, 2003).

In addition to these hypotheses, we also expected that people with primary insomnia would respond with higher autonomic arousal to all stimuli. Thus, numerous studies have demonstrated increased levels of arousal in people with primary insomnia when compared to good sleepers (for a review see Riemann et al., 2010). Additionally, Lundh and Broman (2000) suggested that people with insomnia are characterized by an increase in the levels of arousal in response to sudden, new or emotional stimuli (*hyper-arousability*). In the current experiment, we also recorded heart rate (HR) and cardiac vagal tone (CVT) during the presentation of the visual stimuli. As an increase of the heart rate is linked to heightened arousal stimulation (Witvliet & Vrana, 1995) and higher CVT has been associated with greater reactivity to stimuli (Movius & Allen, 2005), we predicted alterations in these measures.

Finally, subjective ratings of the valence and the arousal of the pictorial stimuli were also collected. We predicted that people with primary insomnia would demonstrate an altered valence and arousal ratings of sleep-related stimuli as compared to good sleepers.

Method

Participants

Participants were 39 (31 F, 8 M) university students, including 21 individuals with primary insomnia and 18 good sleepers (Table 1). Their age ranged between 18 and 30 years (mean age ± standard deviation – sd = 22.4 y ± 2.96). Participants with primary insomnia (PPI) met the Diagnostic and Statistic Manual of Mental Disorders, Fourth Edition (DSM-IV, American Psychiatry Association, APA, 2002) criteria as measured through screening questionnaires and a clinical assessment interview. These criteria include: duration of the symptoms of at least one month, and complaints of decreased functioning at work and/or in social and personal life. Additionally, PPI met quantitative criteria of insomnia as reported by Lichstein, Durrence, Taylor, Bush, and Riedel (2003) which indicate a frequency of the symptoms of three or more nights per week. Controls participants (good sleepers – GS) met the Research Diagnostic Criteria for normal sleepers indicated by Edinger et al. (2004).

This study arises from a collaboration between the University of Glasgow Sleep Research Laboratory (UGSRL) and the Department of Psychology of the "Sapienza" University of Rome. Nineteen participants were recruited and recorded in Glasgow, 11 PPI (all F, 20.54 y ± 1.69) and 8 GS (5 F; 3 M, 23.25 y ± 3.06). Twenty participants were recruited and recorded in Rome, 10 PPI (8 F; 2 M, 23.7 y ± 2.49) and 10 GS (7 F; 3 M, 22.4 y ± 3.68).

Table 1
Study participants.

	PPI	GS	X^2/F	p
Women/men	19/2	12/6	$X^2_{(1,N=39)} = 3.37$	0.07
Age (in years)	22.8 ± 3.31	22.0 ± 2.64	$F_{(1,37)} = 0.58$	0.45
ISI	12.09 ± 3.32	1.33 ± 1.53	$F_{(1,37)} = 159.86$	<0.001
STAI-T	44.09 ± 8.53	36.11 ± 6.99	$F_{(1,37)} = 10.01$	0.03
MEQ	43.14 ± 8.71	47.72 ± 7.72	$F_{(1,37)} = 2.97$	0.09
KSS	5.00 ± 2.15	4.39 ± 1.65	$F_{(1,36)} = 0.95$	0.34

Note. Data are presented as mean ± sd. One-way ANOVAs and chi-squares were computed. Abbreviations: ISI: Insomnia Severity Index; STAI-T: State-Trait Anxiety-Trait version; MEQ: Morningness–Eveningness Questionnaire; KSS: Karolinska Sleepiness Scale; PPI: People with Primary Insomnia; GS: Good Sleepers.