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The mediating role of sleep-related metacognitive processes in trait and pre-sleep state hyperarousal in insomnia disorder

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ABSTRACT

Objective: Trait predisposition to hyperarousal and pre-sleep state hyperarousal are considered key factors in insomnia, but research also supports the role of cognitive and metacognitive processes. Therefore, the aim of this study was to evaluate the relationship between unhelpful sleep-related beliefs, sleep-related metacognition and trait/pre-sleep state arousal in insomnia disorder.
Method: Sixty-eight subjects with insomnia disorder (DSM-5) and 36 good sleepers were evaluated with a set of questionnaires that included Dysfunctional Beliefs about Sleep scale (DBAS), Metacognitions Questionnaire – Insomnia (MCQI), Arousal Predisposition Scale (APS), and Pre-sleep Arousal Scale (PSAS). The statistical analyses included univariate, multivariate regression and mediation analyses.
Results: Subjects with insomnia reported higher scores on the DBAS, MCQI, APS, and PSAS (p's < 0.001) compared to good sleepers. In the insomnia group, trait hyper-arousal was best determined by insomnia-related metacognition ($p = 0.02$). Pre-sleep cognitive arousal was determined by insomnia-related metacognition ($p = 0.001$) and trait hyperarousal ($p < 0.0001$) after controlling for years of insomnia. Insomnia-metacognitive activity mediated the association between trait-hyperarousal and cognitive arousal ($p = 0.01$, $p = 0.002$) and the bidirectional association between pre-sleep cognitive and somatic arousal ($p = 0.002$, $p = 0.04$).
Conclusion: This study suggests that a broad range of cognitive and metacognitive processes may be involved in the development of sleep-related arousal among people with insomnia. Insomnia metacognitive activity may influence trait factors and pre-sleep state factors depending on insomnia duration. Both insomnia evaluation and treatment may also be focused on insomnia metacognitive processes especially in subject with a long history of insomnia.

1. Introduction

Chronic insomnia is the most commonly reported sleep disturbance and it constitutes a highly prevalent health problem afflicting approximately 1/3 of the adult population; about six to 13% of the general population meets the diagnostic criteria for insomnia as a disorder [1,2]. Insomnia disorder is characterized by night-time symptoms (difficulties initiating and/or maintaining sleep and/or early awakening) but also by daytime symptoms, distress and/or impairment in daytime functioning, such as difficulty with concentration, memory, fatigue, and/or mood: it is now considered a 24-hour sleep–wake disorder [1,2]. It may precipitate, exacerbate, or prolong a broad range of comorbid conditions that include mental and physical illness [3–10]. Moreover, insomnia is related to cognitive impairment [11–13], it is associated with work disability and reduced work performance [14] and it has a negative impact on the direct and indirect costs of the healthcare system and society [15,16]. Studying the mechanisms involved in the development and maintenance of insomnia should be a priority in order to better identify strategies that improve prevention and treat insomnia and its comorbid conditions.

Research into the cause of chronic insomnia has identified physiological, cognitive, and emotional hyperarousal as the key factor present across a 24-hour day [17,18]. Such hyperarousal includes trait predisposition toward hyperarousal, which refers to a pattern of excessive responsiveness to stimuli during wakefulness [19–22], and pre-sleep state hyperarousal, which refers specifically to the cognitive and somatic hyperarousal in the pre-sleep period i.e. while attempting to fall asleep [19–23]. It has been hypothesized that the additive effect of trait factors including trait hyperarousal, combined with state factors, including pre-sleep hyperarousal, contributes to the development and maintenance of insomnia [19–27]. Traditionally, pre-sleep hyperarousal has been hypothesized to be related to unhelpful sleep-related cognitive

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processes, including unhelpful beliefs [26,27] which play a role by interfering with arousal regulation, in turn, contributing to the development and maintenance of insomnia [23–31]. Current models of insomnia refer particularly to the cognitive-beavioural framework where cognitive factors play a key role in the perpetuation of insomnia (for an overview see [32]); Cognitive-Behavioral Therapy for Insomnia – CBT-I is currently considered the first line treatment for adults with chronic insomnia [33,34].

Recently, cognitive models have begun to include the role of metacognitions. Whereas cognition typically refers to the content of thoughts, metacognition is a multifaceted concept that involves a higher order of mental activities that serve as a source for interpreting and controlling cognitive events (i.e., thoughts) themselves, and to appraise, monitor, regulate or control cognition [35–39]. From this definition of metacognition, it follows that disturbances in thinking also should be under the influence of metacognition. An integrated metacognitive model emphasizes beliefs about the importance, meaning, and power of thoughts and beliefs about the need to control thoughts [35–39]. The Metacognitions Questionnaire has been developed to evaluate metacognitive processes and beliefs, measuring positive and negative beliefs about worry, cognitive confidence, beliefs about the need to control thoughts and cognitive self-consciousness [40]. In the context of mood and anxiety disorders, it has been hypothesized that both cognitive and metacognitive factors may contribute to the development and maintenance of the disorders [35–42]. Metacognitive models as well as metacognitive treatments have been developed for anxiety and depressive disorders; this therapeutic approach is currently considered as a part of the so-called "third wave" of cognitive behavioral therapies [35–42].

Ong et al. [35] proposed a two-level model of sleep-related arousal that includes metacognitive processes in addition to cognitive processes. "Primary arousal" consists of the cognitive activity directly related to the inability to sleep. This includes the thoughts that interfere with sleep and the beliefs about daytime consequences of poor or insufficient sleep. "Secondary arousal" consists of how one relates to thoughts about sleep at a metacognitive level. At this level, metacognitive arousal tends to amplify the negative emotional valence and/or create a bias in the attention to and perception of sleep-related thoughts at the primary level in insomnia disorder. Support for this model comes from emerging evidence indicating that insomnia-related metacognitive processes may be crucial in the aetiology and/or maintenance of insomnia. Specifically, they may also have a role in modulating trait and pre-sleep state hyperarousal in insomnia [43–47]. However, it is not clear if both sleep-related cognitive and metacognitive processes are related to arousal in insomnia when considering these two processes at the same time; this point has never been studied in a sample of insomnia subjects.

Thus, the primary objective of this study was to evaluate the relationship between unhelpful sleep-related beliefs, insomnia-related metacognitive processes and trait predisposition to hyperarousal in subjects with insomnia disorder. The secondary objective was to evaluate the relationship between unhelpful sleep-related beliefs, insomnia-related metacognitive processes and pre-sleep state arousal in subjects with insomnia. To address these aims, we also evaluated insomnia severity, while controlling for anxiety and depressive symptoms in a sample of subjects with insomnia disorder and in a sample of good sleepers.

2. Methods

2.1. Selection of subjects and distribution of psychometric questionnaire

Between July 2014 and July 2015, consecutive outpatients visiting the Sleep Center of the Psychiatry Unit II, University of Pisa, Italy, who met the diagnostic criteria for insomnia disorders (ID) according to the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) [2], were recruited for the purposes of this study, together with a group of healthy subjects.

The subjects of both groups underwent a face-to-face evaluation conducted by a psychiatrist (LP). Their sleep disorders were assessed by clinical evaluation and the use of sleep questionnaires. The evaluation also considered insomnia severity, unhelpful sleep-related cognitive and metacognitive processes about insomnia, trait and state pre-sleep arousal, anxiety and depressive symptoms. The inclusion criteria for subjects with insomnia disorder were as follows: i) difficulty in initiating and/or maintaining sleep and/or early morning awakening, ii) for at least 3 months, iii) sleep disturbance causes clinically significant distress or impairment in important areas of functioning, and iv) no sleep-disruptive medical/psychiatric conditions, substance abuse, and/or other sleep disorders. Only individuals who reported sleep difficulties for at least three nights per week and were un-medicated at the moment of the visit were enrolled in the study.

The exclusion criteria for subjects with insomnia disorder were cognitive impairment, a past or current diagnosis of psychiatric disorders, or other sleep disorders (i.e. obstructive sleep apnea syndrome, restless legs syndrome, etc.) according to the guidelines of the International Classification of Sleep Disorders (third edition) [1].

Good sleepers were recruited from the hospital and from among the university personnel. Participants underwent a face-to-face assessment and completed the same set of questionnaires used for subjects with insomnia. The inclusion criteria of the healthy participants were 1) <30 min of sleep onset latency or 2) wake time after sleep onset in usual nocturnal sleep [48]. The exclusion criteria were the following: i) subjects with a past or current diagnosis of cognitive impairment, sleep or psychiatric disorders; ii) habitual use of hypnotics or alcohol at bedtime; iii) subjects engaged in shift-work; iv) subjects with a total sleep time < than 7 h, and v) failure to complete the questionnaires. The study conformed to the Declaration of Helsinki. All participants provided written informed consent prior to being enrolled in the study.

2.2. Sleep scales

Insomnia severity was evaluated with the Insomnia Severity Index (ISI) [25]. The Index is a 7-item self-report questionnaire with a recall period of the last two weeks. It is a reliable and valid instrument used to detect cases of insomnia and to estimate insomnia severity. The sum yields a global score ranging from 0 to 28. For the purposes of this study, according to the ISI authors' recommendations, an ISI score of 8 or higher indicated insomnia (absence of insomnia sum score 0–7) [25].The ISI has been validated in Italian samples [49].

The Dysfunctional Beliefs and Attitudes About Sleep Scale (DBAS) was used to evaluate unhelpful cognitions about sleep [30]. The DBAS consists of 16 statements exploring various sleep/insomnia-related cognitions (e.g., beliefs, attitudes, expectations, appraisals, and attributions). The nature of these beliefs is clustered around 5 conceptually-derived themes: (a) misconceptions about the causes of insomnia (e.g. "I believe insomnia is essentially the result of a chemical imbalance"); (b) misattribution or amplification of its consequences (e.g. "I am concerned that chronic insomnia may have serious consequences on my physical health"); (c) unrealistic sleep expectations (e.g. "I must get 8 h of sleep to feel refreshed and function well the next day"); (d) diminished perception of control and predictability of sleep (e.g. "When I sleep poorly on one night, I know it will disturb my sleep schedule for the whole week"); and (e) faulty beliefs about sleep-promoting practices (e.g. "When I have trouble sleeping, I should stay in bed and try harder"). The participant indicates his or her level of agreement with each statement on a visual analogue scale, scoring between 1 ('strongly disagree') and 10 ('strongly agree'). Items are summed up to yield a total score (maximum possible score of 160). High scores on the DBAS are indicative of pronounced unhelpful beliefs about sleep [30]. For the Italian version see Devoto and Violani [50].

Sleep related metacognitive processes were evaluated using the Metacognitions Questionnaire – Insomnia (MCQ-I) [43]. The MCQ-I is a self-administered questionnaire with 60 items that have to be