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## Opportunities for optimizing the treatment of Insomnia Disorder

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## SUMMARY

Insomnia Disorder is a highly prevalent disorder, that is defined by persistent nocturnal sleep complaints – trouble falling or maintaining sleep – and impaired daytime functioning. People suffering from insomnia often experience impairments in many aspects of their daytime functioning, among which: memory problems, difficulty concentrating, increased error and accident proneness and headaches. This can result in higher medical costs and more work absenteeism. Insomnia Disorder places a tremendous burden on health and society. Therefore, adequate treatment is important. The recommended treatment for insomnia is cognitive behavioral therapy for insomnia (CBTI). A wide body of evidence shows its effectiveness. However, the remission rate is only 56%, leaving room for improvement. Another group of treatments for Insomnia Disorder, known as chronobiological treatment (CT), is far less studied but seems promising in alleviating insomnia complaints, either as a stand-alone treatment, or combined with CBTI.

Perhaps finding or combining new treatment protocols is not the only opportunity to improve the treatment of Insomnia Disorder. Personality traits have been shown to be related to Insomnia Disorder. It still remains inconclusive, however, which personality traits are most directly associated to which insomnia complaints. Investigating these associations may open a door to more personalized treatment of Insomnia Disorder.

The thesis before you aims to identify opportunities to improve the treatment of Insomnia Disorder and optimize its effectiveness. In order to do so, our focus is threefold. First, we investigate different forms of treatment for insomnia. We conducted a randomized controlled trial (RCT) that evaluates the relative effectiveness of CBTI and three forms of CT (bright light, physical activity and warm baths) or their combination. Second, we focus on individual differences between people who suffer from insomnia, such as personality traits and subtypes of insomnia, and how these differences relate to insomnia symptoms and treatment effects. By increasing the understanding on how individual differences may influence how Insomnia Disorder presents and is affected by treatment, we pave the path towards more personalized treatment. Third, we discuss the importance to focus not only on nocturnal, but also on daytime symptoms of insomnia. Nocturnal complaints of insomnia are the inability to fall asleep, maintain sleep or waking up unrested. Daytime complaints are defined in the ICSD and DSM and range from headache and stomachache, to fatigue and tiredness, to the inability to concentrate and memory loss. Insomnia Disorder is defined by both types of symptoms. However, the effect of treatment on daytime symptoms is less studied than the effect on nocturnal symptoms. Shifting or broadening the focus to daytime complaints may provide more insight in the effectiveness of the treatments.

To achieve the aim of identifying opportunities to optimize the treatment of Insomnia Disorder, in **chapter 2** we elaborately describe a study protocol for an RCT that was the first to evaluate, in a single design, the relative effectiveness of internet-supported cognitive behavioral therapy for insomnia (ICBTI), three types of chronobiological treatment (bright light, physical activity and warm baths) and the combination of ICBTI with CT. The primary outcome is the difference in sleep efficiency pre to post treatment. Sleep efficiency is calculated as the percentage of time spent asleep of the time spent in bed for sleep. Chapter 2 discusses the rationale and treatment application, the procedure for recruiting and selecting participants and the trial execution and the statistical methods used to analyze the data.

Subsequently, in **chapter 3** we report the results of this RCT. The main results were that ICBTI improved diary-derived sleep efficiency, whereas none of the active CTs on their own elicited improvement compared to the placebo control condition. Adding CT to ICBTI did however have benefits that appeared only at follow-up. For participants that only received ICBTI, a part of the initial sleep efficiency improvement was lost during the month following completion of treatment. Those that received ICBTI in combination with any active CT better maintained their initial gain in sleep efficiency and moreover fell asleep more easily, slept longer and had less nocturnal wakefulness. Immediate effects of ICBTI on sleep efficiency are at least partly driven by the reduced time in bed demanded by the sleep restriction intervention that is integral part of ICBTI. However, at follow-up, the participants that had combined ICBTI with CT experienced more sleep and less nocturnal wake compared to those who only received ICBTI, while time in bed did not differ. Supported by additional benefits to complaints about early morning awakening and daytime functioning, the findings indicate that the addition of either bright light, physical activity or warm baths solidifies the sleep improvement induced by ICBTI. CT interventions are low in cost and risk, making them a valuable addition to consolidate ICBTI effects on sleep in Insomnia Disorder.

**Chapter 4** is a methodological chapter that evaluates if the profile similarity framework can be used as a means improve the within-subject comparability of different assessment formats. The personality similarity framework is a theoretical framework that compares the profiles of personality factors, rather than individual components. In order to evaluate the profile similarity framework, we use two versions of the same personality questionnaire, namely the mini-IPIP and the IPIP-NEO-120 that measure the Big Five personality traits. Additionally, this study evaluates the psychometric properties of the Dutch translations of the mini-IPIP and the IPIP-NEO-120. We found that the psychometric properties of the Dutch translations of the IPIP-120-NEO and the mini-IPIP resembled the original English questionnaires well. The factor structures, scale-reliabilities and discriminant validity were similar to the original versions. The profile similarity framework showed that the correlations between the personality profile scores were more robust and less format-dependent than the correlations

between personality factors. These findings show the way to more consistent personality factors and profiles obtained across different assessment formats and languages.

The study described in **chapter 5** investigates how the different complaints of insomnia relate to personality traits. In this chapter, we show direct and indirect associations between the Big Five personality traits and insomnia, as measured by the Insomnia Severity Index (ISI), by using network analysis in a large sample. As expected, and often reported, neuroticism was directly related to insomnia complaints, most strongly with the nocturnal complaint of having difficulty initiating sleep and the daytime complaint of interference with daily functioning. These relationships were positive, meaning highly neurotic people experience more difficulty initiating sleep and more interference with daily functioning. Interestingly, the personality trait conscientiousness showed a positive association with the nocturnal insomnia complaint of difficulty maintaining sleep and a negative association with daytime complaint of interference with daily functioning. This suggests that while highly conscientious people are more likely to experience difficulty maintaining sleep, they are less likely to report that sleep problems interfere with their daily functioning. These inverse associations of conscientiousness and insomnia complaints cancel out with the use of the overall insomnia severity measure. Since neuroticism was found to have only positive associations with insomnia symptoms, it is also related to the overall insomnia severity measure and therefore more easily associated to insomnia. The difference in findings between these two personality traits underscore the value of symptom-level analyses. The network approach allowed to discriminate direct associations from indirect relations and thereby identify possible targets for improving CBTI with the highest probability of effectively changing the network of associated complaints.

In **chapter 6** all results are discussed and put into perspective. Additionally, we explain why not all intended analyses as described in the study protocol in chapter 2 were presented in chapter 3. The additional results are described in a paper that was outside the scope of this thesis. This study found five well distinguished subtypes of Insomnia Disorder. These subtypes are not only distinguished by sleep complaints, but also by other traits, such as personality, life history, medical history et cetera. Preliminary results show that different subtypes respond differently to ICBTI.

In conclusion, we identified three opportunities to optimize the treatment of Insomnia Disorder. First of all, the results of our RCT show that combining ICBTI with any form of CT sustains the initial benefits of the former treatment on sleep efficiency over a longer period, than when applying stand-alone ICBTI. Since this was a first study to show this, it leaves ample opportunity to further refine this combination of treatments to find the optimal combination.

Second, we found that personality traits have different associations with different symptoms of insomnia disorder. Additionally, our research group identified five distinct subtypes of insomnia and showed that these subtypes respond differently to ICBTI. The improved treatment effect of combined

treatment may therefore be moderated by individual differences such as personality profiles or insomnia subtypes. And treatment effect could be further improved by personalizing treatment based on personality traits and/or insomnia subtype.

And third, we identified the different relationships between personality traits and nocturnal and daytime symptoms of insomnia. Currently, most research focusses on the effect of treatments of insomnia on nocturnal symptoms. The rationale behind this is that nocturnal symptoms precede daytime symptoms of insomnia. However, some of the daytime symptoms, such as worry, can also be predisposing factors of insomnia. Relieving the daytime symptoms could perhaps release some of the burden of insomnia, which could lead to less rumination and better sleep. On top of this reversed effect, focusing on both relieving nocturnal and daytime symptoms of Insomnia Disorder will increase the effectiveness of treatment and lead to better results.