

Sleep and pain are definitely coupled—but how tight is this coupling?

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There is considerable evidence that substantial sleep interruption, be it experimentally induced by sleep deprivation or clinically caused by insomnia, definitely leads to changes in pain processing and to increased prevalence of clinical pain.¹⁻⁴ Simpson et al.⁵ in the present volume of *PAIN* give a very impressive example of this relation by showing that experimentally induced “chronic insufficient sleep” may increase vulnerability to chronic pain because of altered pain processing in the form of habituation and sensitization. In a within-subject design, the authors let their participants live for 50 days in a hospital environment, with 25 days of restricted sleep and no full sleep recovery and with 25 days of undisturbed night sleep as control condition. The study represented a major challenge for both the participants and the investigators. However, this challenge seems worth the effort because stable changes in pain processing could be documented as consequences of massive and prolonged sleep interruption. The necessary timing of sleep

interruption for changes in the pain system was variable and left open the question of what type of interruptions of night sleep is necessary or sufficient.

Thus, it is still not clear how substantial or how prolonged interruptions of the sleep system have to be to affect the pain system and if nonpathological changes in the sleep system are sufficient to drive alterations in the pain system. For example, one might assume that there are only relatively small covariations between sleep and pain, which would then require major disturbances of sleep to affect pain. Such an association might even be functionally adaptive because it would prevent smallest sleep disturbances from already dysregulating the pain system. Under this perspective, everyday variations of nocturnal sleep may have no impact on pain; in other words, it may well be that the 2 functions remain disconnected as long as sleep varies within normal and nonpathological limits (see “threshold-dependent covariation between sleep and pain” in **Fig. 1**). Thus, the question of which

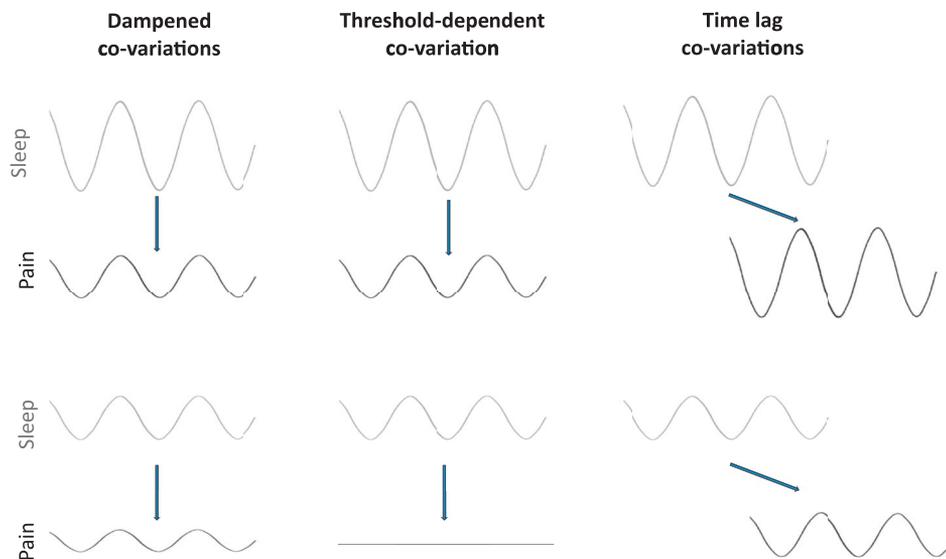


Figure 1. Examples of potential covariations between the time signal sleep and pain. The arrows indicate the direction of the covariations.

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dosage and timing of sleep interruptions are necessary to affect the pain system has to be answered. At the moment, we mainly know about the coupling between sleep and pain at its extremes of little or substantial covariations.

Although this approach of studying sleep and pain covariations using substantial interruptions of sleep was a necessary first step, such a research study will not necessarily advance our understanding of the coupling between pain and sleep in the future. Thus, in future studies, it is important to study the relationship in a more fine-grained manner. This would be based on varied types of quantitative relationships between the 2 variables. Examples of various potential relationships are given in **Figure 1**. As displayed on the left side of **Figure 1**, it is possible that there is a dampening of covariations, for example, that strong variations in sleep only lead to comparably little variations in pain (the size of which may again be modulated by other related processes). Another possibility may be that there is a time lag in covariations, for example, that the effects of sleep variations on pain occur with varying time lags (see the right side of **Fig. 1**), which may also be modified by other variables. For sure, studying these various, potential relationships will be very time and effort consuming because the investigation of several baseline and testing nights is mandatory to assess these relationships. However, there is not much of an alternative when we are both interested in a better understanding of the physiology of

coupled sleep and pain and in the borders, which separate nonpathological from pathological covariations between sleep and pain.

Conflict of interest statement

The author has no conflict of interest to declare.

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