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# Pillow Talk: The Epigenetic and Physiological Effects of Sleep Deprivation

Jennifer D. Cotter SMCC, Professor Elizabeth Ehrenfeld SMCC

## Abstract

Circadian rhythms, or the 24-hour biological cycles of living cells, function as the body's internal clock. Although circadian rhythms and sleep are very different processes, they are closely related to one another as these cycles play an important role in sleeping and waking patterns. Recent studies have shown that lack of sleep or sleep of poor quality can disrupt circadian rhythms and may actually cause cognitive disorders and memory loss, facilitate false memory production, and even alter gene expression in humans. This literature review is focused on identifying the epigenetic and physiological effects of disruptions and desynchronization in circadian rhythms due to sleep deprivation with the intention of understanding the importance of sleep in human wellness.

## Clock Gene Function

There are numerous clock components that have been associated with everything from the normal regulation of sleep, reproduction, psychiatric diseases and mood, cardiac and metabolic function, immune system, and even the cell cycle and proliferation, to the ageing process. The functions of those genes associated with the sleep cycle and their relationships with one another are outlined in Table 1 and Figure 1.

Health dimension	Genes
<b>Sleep Timing (Diurnal Preference)</b>	Clock, Per1, Per2, Per3, CK1δ, CK1ε
<b>Sleep Homeostasis</b>	Clock, Npas2, Per1, Per2, Dbp, Per3

Table 1. Clock genes and their role in the sleep cycle. (Mongrain, et al, 2009)

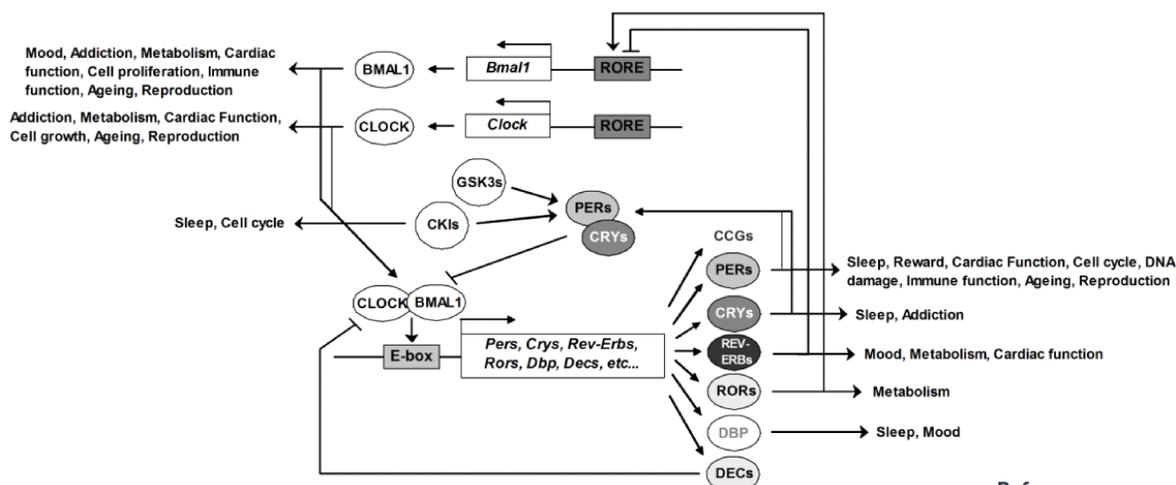


Figure 1. Schematic view of the circadian clock mechanisms and their association with physiology. The CLOCK/BMAL1 heterodimer activates the expression of a number of clock genes. Among these, Pers and Crys give rise to protein products that inhibit their own expression, while Rev-Erbs and Rors genes products repress or activate the transcription of Clock and Bmal1 respectively. (Mongrain, et al, 2009)

## Why Is Sleep So Important?

The sleep cycle, especially NREM sleep, plays a vital role in the maintenance of a variety of aspects of health, namely:

- Healthy Brain Function
- Emotional Health and Well-Being
- Growth and Repair of Body Tissues
- Hormonal Balance
- Healthy Immune System Function
- Maintaining Daytime Alertness and Focus
- Memory Consolidation

Functional magnetic resonance imaging of a human brain in each of the three main states of consciousness occurring throughout a circadian cycle is displayed in Figure 2. Note differences between a brain in awake state (A) and in NREM sleep (B) specifically.

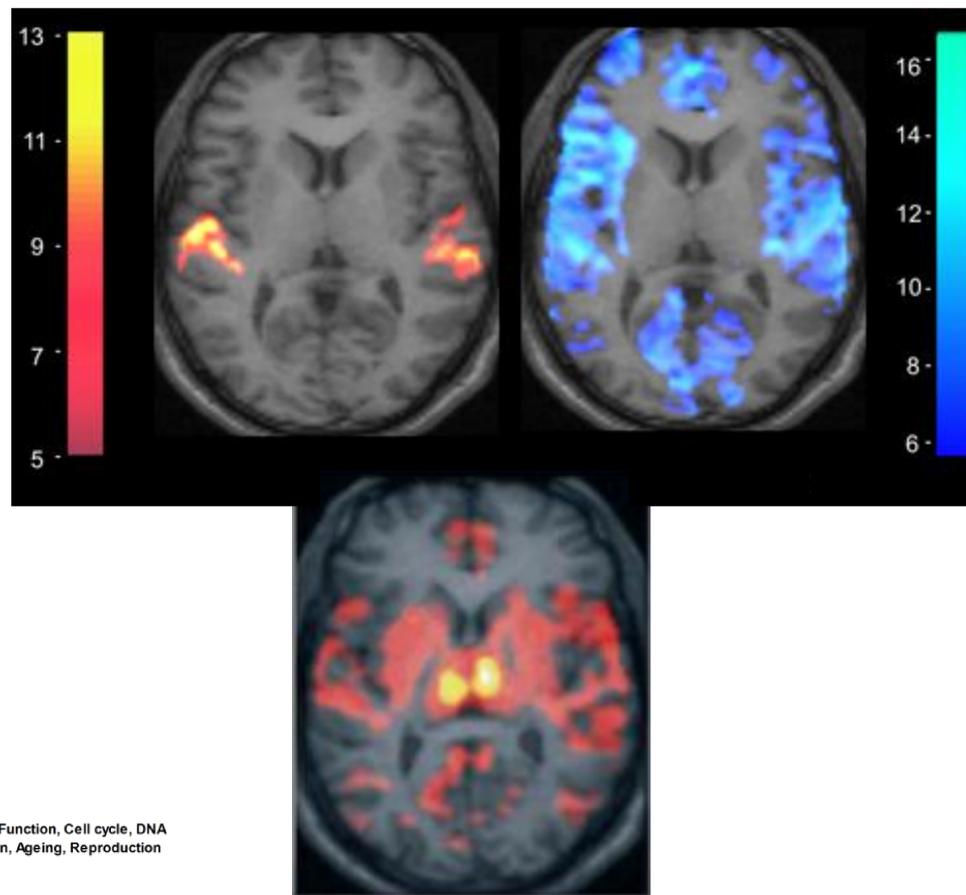


Figure 2. fMRI of a human brain. Awake (A), in NREM sleep (B), in REM sleep (C). (MPI of Psychiatry)

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## Why Should I Care?

Sleep deprivation can have many negative effects on the body and mind, some of the most notable of which are:

- Decreased Neurological Function (as shown in Figure 3.)
- Changes to Mental State
- Memory Consolidation Impairment
- Hormonal Changes
- Metabolic Alterations
- Immune System Impairment
- Stunted Growth
- Changes to Clock gene expression
- Possible Gene Mutation

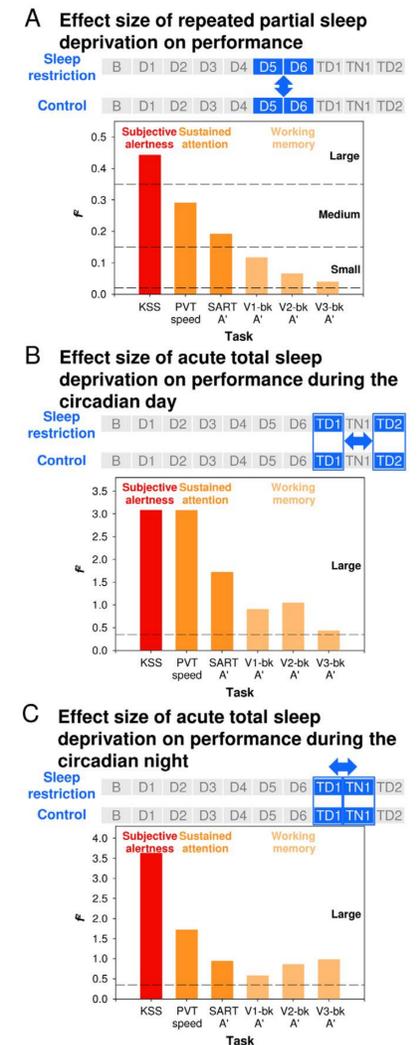


Figure 3. Comparison of effect sizes for Subjective Alertness, Sustained Attention, and Working Memory. (A) Effect size of repeated partial sleep deprivation. It was assessed by comparing performance during D5 and D6 between conditions. (B) Effect size of acute total sleep deprivation on performance during the circadian day. It was assessed by comparing performance on TD1 to performance on TD2 across conditions. (C) Effect size of acute total sleep deprivation on performance during the circadian night. It was assessed by comparing performance on TD1 to performance on TN1 across conditions. Horizontal lines indicate cut-offs for small, medium, and large effect sizes. (Lo, et al, 2012)