

# Exploring the function of sleep

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Is sleep essential? Ask that question to a sleep-deprived new parent or a student who has just pulled an "all-nighter," and the answer will be a grouchy, "Of course!"

But to a sleep scientist, the question of what constitutes sleep is so complex that scientists are still trying to define the essential function of something we do every night. A study published this week in *PLoS Biology* by Chiara Cirelli and Giulio Tononi addresses this pressing question.

The search for the core function of sleep can seem as elusive as the search for the mythological phoenix, says Cirelli, an associate professor of psychiatry at the University of Wisconsin School of Medicine and Public Health in Madison.

Some scientists argue that sleep is merely a way to impose a quiet, immobile state (rest), and isn't important by itself in mammals and birds. This is the so-called "null hypothesis," and Cirelli and Tononi reject it.

"We don't understand the purpose of sleep, but it must be important because all animals do it," Cirelli says.

There's no clear evidence of an animal species that doesn't sleep, she says. Even the dolphin—which is sometimes held up as an animal that doesn't sleep because it moves continuously—will show "unihemispheric sleep" with one eye closed and one half its brain showing the slow waves characteristic of deep sleep.

"The very fact that dolphins have developed the remarkable specialization . . ., rather than merely getting rid of sleep altogether, should count as evidence that sleep must serve some essential function and cannot be eliminated," Cirelli says.

She also argues that sleep is strictly regulated by the brain, because sleep deprivation is followed by a rebound, in which the sleep-deprived animal either sleeps longer, or spends more time in the deeper sleep characterized by large slow brain waves.

Prolonged sleep deprivation has been shown to kill rats, flies and cockroaches. Humans who have a genetic insomnia can also die. In less extreme cases, sleep deprivation affects cognitive function in animals ranging from flies to rodents. Rats kept awake will engage in "micro-sleep" episodes, and sleep-deprived humans tend to fall asleep even in the most dangerous circumstances.

Because it is universal, tightly regulated, and cannot be lost without serious harm, Cirelli argues that sleep must have an important core function. But what?

"Sleep may be the price you pay so your brain can be plastic the next day," Cirelli and Tononi say.

Their hypothesis is that sleep allows the brain to regroup after a hard day of learning by giving the synapses, which increase in strength during the day, a chance to damp down to baseline levels. This is important because the brain uses up to 80 percent of its energy to sustain synaptic activity.

Sleep may also be important for consolidating new memories, and to allow the brain to "forget" the random, unimportant impressions of the day, so there is room for more learning the next day. This could be why the brain waves are so active during certain periods of sleep.

"While there may still be no consensus on why animals need to sleep, it would seem that searching for a core function of sleep, particularly at the cellular level, is still a worthwhile exercise," she concludes.

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