# Study of sleeping fur seals provides insight into the function of REM sleep

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A fur seal sleeping in water, where one half of its brain sleeps at a time and it does not experience REM sleep. During unihemispheric sleep in the water the fur seals adopt a rather odd characteristic posture. The flipper attached to the waking part of the brain stays moving in the water to maintain its position, while the other flipper is taken out of the water and 'rests.' The eye attached to the

waking part of the brain is aimed into the water, where sharks and other predators come from. The other eye, is closed because if is attached to the sleeping part of the brain, and it faces the sky. Seals are not threatened by birds. Credit: Svetlana Artem'eva

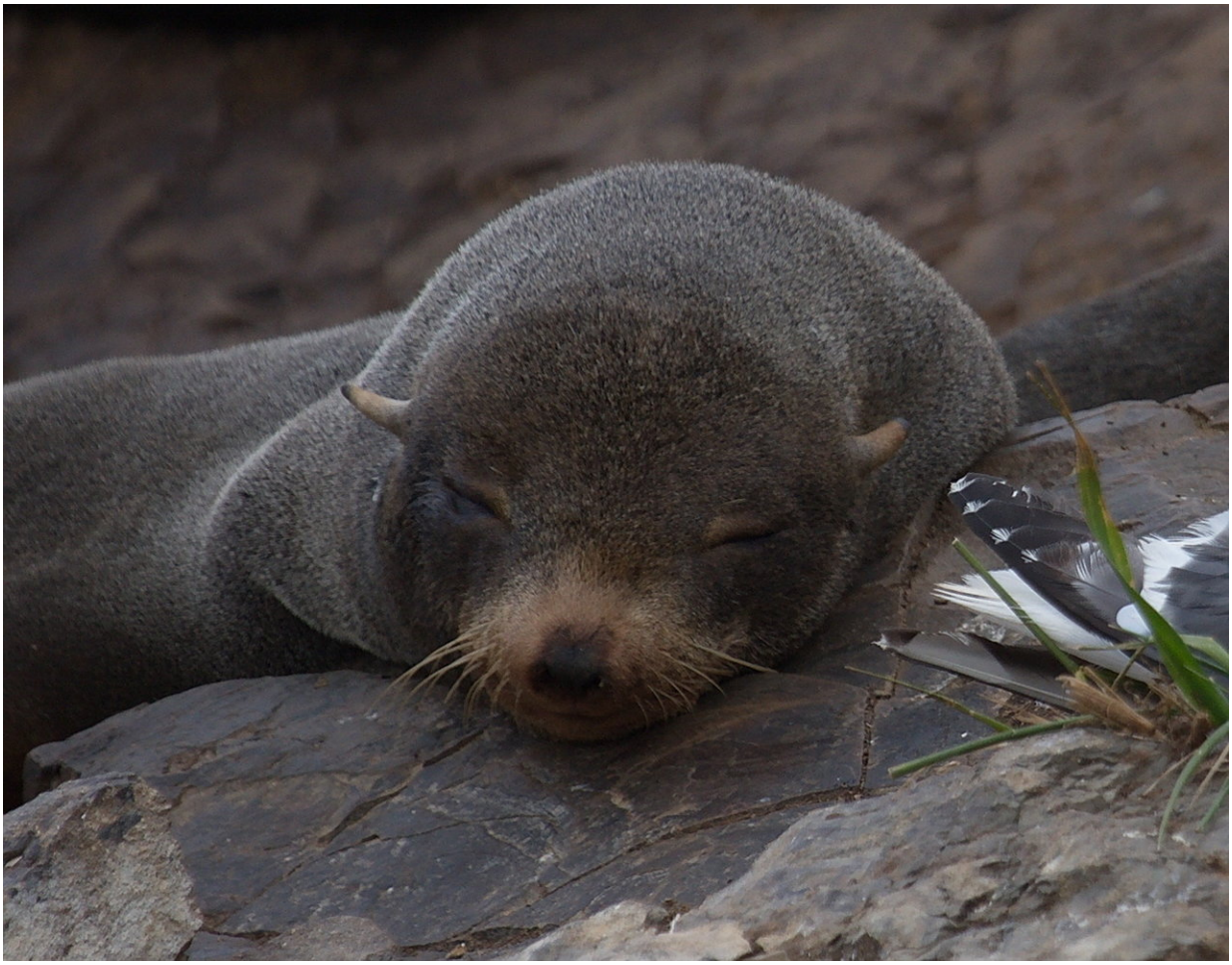
All land mammals and birds have two types of sleep: rapid eye movement (REM) and non-REM (also called slow-wave sleep). Earlier evidence had suggested that REM sleep—associated with dreaming—is essential for physical and mental well-being and learning, and that a lack of it could even be deadly. But the underlying function of REM sleep has been a mystery since its discovery in 1953. Now researchers reporting in *Current Biology* on June 7 have a new insight into the function of REM sleep, based on studies of a seemingly unlikely animal: the fur seal.

The team, including Oleg Lyamin and Jerome Siegel, University of California, Los Angeles, find that fur seals sleep on land in the same way other mammals do. But fur seals spend most of their lives in the water. When sleeping in water, fur seals show non-REM sleep in only one brain hemisphere at a time, just as dolphins do. The new study finds that, like dolphins, fur seals go without REM sleep when in the water.

"We show that when the fur seal stays in seawater, where it spends most of its life, it goes without REM sleep for days or weeks," Siegel says. "After this nearly complete elimination of REM sleep, it displays minimal or no REM sleep 'rebound' upon returning to baseline conditions. It just resumes its 'on-land' bilateral non-REM and REM sleep pattern."

The findings are consistent with the hypothesis that REM sleep, which has been shown to warm the brain, functions to reverse the reduced metabolism and brain cooling that occurs in bilateral non-REM sleep.

Siegel says that this warming of the brain can be seen as preparation for waking, noting that humans and other animals are much more alert when they awaken from REM sleep.



A fur seal sleeping on land, where it experiences bilateral sleep like land mammals do, including alternating periods of non-REM and REM sleep. Credit: Svetlana Artem'eva

The absence of REM sleep in dolphins and related whales, and in fur seals during aquatic sleep, can be explained by the fact that half their

brain is always awake, which keeps the brain and especially the brainstem warm and makes REM sleep unnecessary, Siegel explains.

Dolphins have intricate social and hunting behavior, and the dolphin brain is larger than the human brain. Fur seals are also very social animals capable of complex motor and sensory learning. The majority of their lives are spent in the water, keeping track of where prey and potential predators are and navigating over long distances. It appears that REM sleep is not necessary for these behaviors.

Siegel notes that earlier studies of REM sleep deprivation are difficult to interpret because sleep deprivation itself is stressful and these prior studies did not selectively eliminate REM sleep. But the suppression of REM sleep in fur seals in water is the normal pattern, not a consequence of deprivation. The researchers now suspect that REM sleep does for brain temperature what shivering does for body temperature, bringing the brain back to a normal waking temperature so animals wake up alert and responsive.

The researchers will continue to explore the connection between REM sleep and brain temperature. They also hope to apply this data to understanding narcolepsy, which is characterized by a disruption of the REM sleep mechanism.

**More information:** *Current Biology*, Lyamin et al.: "Fur Seals Suppress REM Sleep for Very Long Periods without Subsequent Rebound" DOI: 10.1016/j.cub.2018.05.022

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