

Study in mice shows how chronic caffeine consumption alters sleep pattern and blood flow

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A new study finds that chronic caffeine consumption has surprising effects on sleep patterns and brain blood flow in mice, increasing brain blood flow during sleep.

The study, led by Dr. Andrew Charles of UCLA, was conducted using a minimally invasive microchip and video recording system, which allowed the [mice](#) to remain freely moving while it recorded various physiological and behavioral parameters over extended periods, ranging from weeks to months. This enabled the researchers to examine the effects of chronic caffeine consumption on the timing of sleep, (including REM sleep), as well as on brain [blood](#) flow in the wake and sleep states.

The study found that mice consistently have a "siesta" during the latter part of their awake phase. Daily caffeine abolished this siesta and consolidated wakefulness during the awake phase. It also shifted the onset of sleep (particularly REM sleep) by up to 2 hours relative to the light dark cycle. Interestingly, the mice that consumed caffeine when awake slept more solidly, and their overall amount of non-REM and REM sleep was not changed because they "slept in" later.

The researchers found that brain blood flow was generally correlated with activity, causing it to be higher during the awake state and lower during sleep. The exception to this pattern was periods of REM sleep, during which there were large increases in brain blood flow in the absence of any movement. Chronic caffeine consumption had remarkable effects on brain blood flow during both the wake and sleep states, causing a reduction in brain blood flow during the awake phase, and a significant increase in brain blood flow during the sleep phase.

These results have a number of significant implications:

- These mice (and perhaps some humans) may be genetically encoded to have a "siesta" during their wake phase;
- Mice compensated for the delayed sleep onset by sleeping more solidly and "sleeping in." Since most individuals are not practically able to "sleep in" to compensate for delayed sleep

onset, this may explain the perception that caffeine reduces sleep quality;

- REM sleep is associated with a dramatic increase in [brain blood flow](#) that is augmented by caffeine. Brain blood flow during non-REM sleep was also increased during caffeine administration. The authors say these effects raise the possibility that caffeine's neuroprotective effects, particularly against [neurodegenerative diseases](#) like Parkinson's, could be linked to its enhanced blood flow during [sleep](#), aiding in the clearance of metabolic waste.

The research is published in the journal *PNAS Nexus*.

More information: Kimiya Aframian et al, Effects of chronic caffeine on patterns of brain blood flow and behavior throughout the sleep-wake cycle in freely behaving mice, *PNAS Nexus* (2023). [DOI: 10.1093/pnasnexus/pgad303](https://doi.org/10.1093/pnasnexus/pgad303)

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