January 25, 2019

Why Do We Sleep?

There are plenty of theories, but nobody really knows for sure

BY TEODORA STOICA

Neuroscience

This article was published in Scientific American's former blog network and reflects the views of the author, not necessarily those of Scientific American

---

Try to explain to an alien why we sleep. Give it your best shot.

"Well, we get tired. And our brain needs to rest."

"I see. So, you find another way to defend yourself during rest?"

"Well ... no. Our body is paralyzed, and we lose consciousness."

There is an awkward pause. The alien tilts its head, feigning understanding.

"But! We sometimes dream!"in

"Dream?"

Blindly, unaware of how ridiculous you sound, you continue with unprecedented speed and cadence: "Yes! Dreams are fantastical stories projected from the mind *into* the mind, sometimes mixed with things that have *already* happened!"

You catch your breath, and smile idiotically.

"And ... this helps with survival?"

"Well ... no. Sometimes the content confuses us in waking life," you suddenly realize.

The alien blinks silently a few times, furrowing his non-eyebrows:

"Let me see if I understand. Your species spends one third of their lives paralyzed watching fantasy movies?"

It is reasonable to assume the human race is doomed at this uncomfortable juncture in the conversation, and aliens will plan their stealthy attack during this incapacitated, seemingly futile stage of our existence.

But sleep isn't futile. In fact, theories on sleep assert its role in reenergizing the body's cells, clearing waste from the brain, and supporting learning and memory. It can even regulate mood, appetite and libido. Yet what precisely happens in our head when it hits the pillow? E.T., you got some learnin' to do.

Reflections on why we sleep have existed since the beginning of recorded history. Some 2,000 years ago, Leucippus, the first "atomist," described sleep as something that happened to the body when "the excretion of fine-textured atoms exceeds the accretion of psychic warmth." Fanciful.

Another famed ancient, Lucretius, thought sleep is caused by the spirit being attacked and weakened into a state of senescence by mysterious air particles. Absurd. Lastly, Aristotle distinguished sleep and waking as diametrically opposed phenomena characterized by the absence or presence of perception. On the money. He stated: "Sleep is induced by the exhalations of ingested foods which thicken and heat the blood, rising to the brain where they are cooled before coalescing in the heart."

Well at least he had the brain part right. Indeed, electroencephalographic (EEG) data measuring brain waves have categorized sleep into two states: non-REM (or NREM, further divided into stages S1, S2, S3 and S4) and REM, which repeat every 90 minutes several times during the night.

When overcome by drowsiness but still awake, brain waves become slower, increase in height (amplitude) and become more synchronous (alpha waves). The first official stage of sleep serves as transition between awake and sleep, and is characterized by theta waves, which are even slower in number (frequency) and greater in amplitude than alpha waves. Many sleep-deprived individuals experience microsleeps (frighteningly, while driving!), which are second-long temporary sleep episodes where theta waves replace alpha wave activity. Most people are not even aware they were asleep.

During stage 2 sleep, theta wave activity continues, interspersed with oscillations between the thalamus, a region of the brain regulating sleep, and the rest of the cortex. Stages 1 and 2 are relatively "light" stages of sleep, where waking up is easy and the sleeper might not recognize they were asleep at all.

Onto stage 3 and 4, characterized by delta waves, the slowest and highest amplitude brain waves, the most unlike waking brain waves. Since delta sleep is the deepest sleep, it is the most difficult stage in which to wake sleepers, and when they are awakened, they are usually sleepy and disoriented. Interestingly, delta sleep is when sleep walking and sleep talking is most likely to occur.

During NREM sleep, sensory information continues to be transferred and encoded in a similar way to the brain when awake—especially at the level of sensory cortices. As sleep progresses, reactivity and awareness decrease. Perceptual activity becomes progressively autonomous. The mind becomes focused inwards and becomes less constrained by input from the external environment.

This pattern is visualized in analyses examining resting-state networks, networks of brain regions activated synchronously. The data show that two networks remain active similarly to when awake: the default mode network and sensory motor network. The default mode network is activated during self-generated thought (daydreaming), while the sensory network is activated during stimulus perception. Connectivity to the central executive network, a network active during higher-order processing such as inhibition, is reduced (Figure 1), letting thoughts roam fancy free and creating illogical scenarios where dragons mothered by a platinum beauty queen roam the planet—for example.

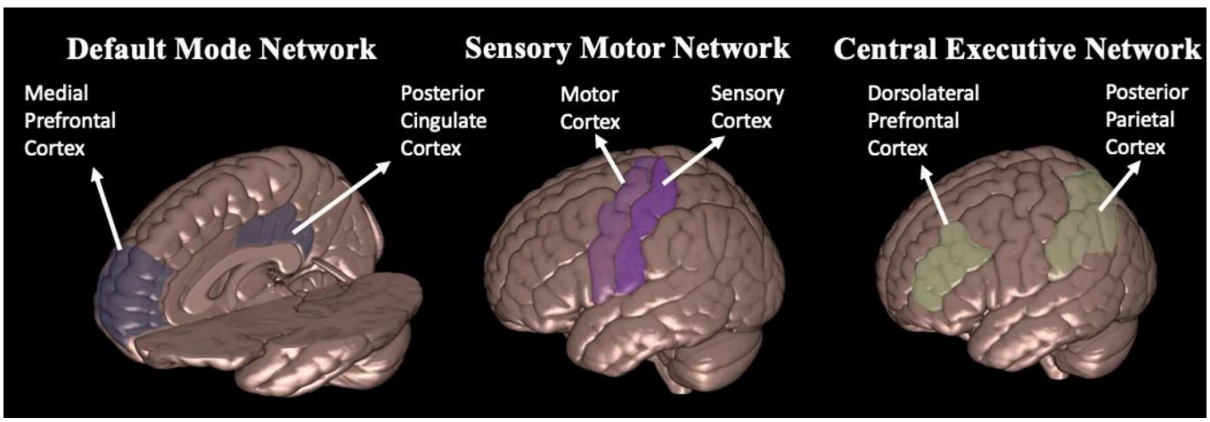


Figure 1. The resting state networks (RSNs) involved in sleep. Credit: Teodora Stoica

Finally, the one Freud was all excited about: REM. This stage gets its name from the darting eye movements that accompany it (Rapid Eye Movement). Interestingly, it is also characterized by a sudden and dramatic loss of muscle tone—effectively paralysis. Importantly, it is neurologically identical to waking (dyssynchronous brain waves) and further characterized by variable changes in blood pressure, heart rate and overall breathing rate. And of course, dreams.

Plato was the first to muse psychologically about dreams, stating: “In all of us, even the most highly respectable, there is a lawless wild beast nature, which peers out in sleep.” This presages Freud’s wish-fulfillment theory of dreaming yet doesn’t neurologically explain that thing Martin Luther King, Jr., had in 1963.

Firstly, dreams are *not* hallucinations. While they share some characteristics in common with clinical disorders such as schizophrenia, hallucinations are defined by whole-brain activation. They are veridical movies projected onto reality that the individual remembers well. Dreams in contrast, are characterized by primary and secondary sensory cortices activation, coupled with disrupted recruitment of the frontal cortex, gate keeper of important higher-order functions like inhibition. If the dream is imbibed in high in emotional content, the limbic system is also implicated.

Critically, lack of frontal function opens the floodgates to reduced self-awareness and bizarre dream contents, while restricting any incoming information and creating a tight self-contained dream loop. This is perhaps most poetically described by Heraclitus, who commented on the subjective nature of dreams in his memorable phrase, “for those who are awake there is a single, common universe, whereas in sleep each person turns away into his own private universe.”

A note on lucid dreaming—being aware that you’re in a dream. A few studies have found evidence for increased activation of the prefrontal cortex during lucid dreaming, compared to normal REM sleep. The area’s typical *de*activation is responsible for the socially inappropriate behaviors and inability to reason logically that is sometimes experienced during dreams, if they are remembered upon waking.

In case you don't remember your dreams, you can always Google them. Seriously. The Google artificial neural network is like a computer brain, inspired by the central nervous system of animals. When given free rein to create images out of white noise, it outputs beautiful, intricate, Escher-esque images, what Google engineers are terming "AI Dreams."The neural network's dreams are being used to understand how a computer can make sense out of nonsense—or learn.

We've arrived at E.T.'s original inquiry: "But *why* do we sleep?" The easiest answer is, we don't yet know, but theories abound. One theory has to do with sleep playing an important role in memory consolidation, that is, a memory's ability to stick. Research suggests REM sleep strengthens weakened neural circuits holding past memories to prepare them for future cognitive processing, in addition to filtering out unnecessary memories. A study by Poe, et. al (2014) articulates this: "The evidence points to an overall function of embossing of synaptic circuits to add definition to and integrate memories, distinguishing them from the noise introduced to synaptic weights throughout wakefulness."

Termed the "synaptic homeostasis hypothesis," it suggests that during sleep there is widespread weakening of connections (synapses) throughout the brain. This is thought to counterbalance the overall strengthening of connections that occurs during learning when we are awake. By pruning away excess connections, sleep effectively "cleans the slate" so we can learn again the next day. Interfering with this scaling down process can, in some cases, lead to more intense (and perhaps unwanted) memories.

Another theory, since E.T. doesn't seem impressed, is that sleep is restorative: it flushes out toxins. During sleep, the space between brain cells increases, allowing toxic proteins to be flushed out. It's possible that by removing these toxins from the brain, sleep may stave off neurodegenerative diseases like Alzheimer's. Indeed, in an October 2013 issue of the journal *Science*, researchers published the results of a study indicating that the brain utilizes sleep to flush out toxins. This waste removal system, they suggest, is one of the major reasons why we sleep.

While we don't have a precise overarching definition of sleep's function, it impacts different physiological and psychological purposes including cleaning up brain toxins and consolidating information into memory, so it is possible that each of these theories can be used to explain why we sleep; we just haven't worked it out. Give us a break, E.T., we're asleep most of the time.

TEODORA STOICA is a Ph.D. candidate in the Translational Neuroscience Department at the University of Louisville. She writes about science on her personal blog CuriousCortex and is a member of the Communications Committee at the Organization for Human Brain Mapping. You can follow her on Twitter @CuriousCortex.

More by Teodora Stoica

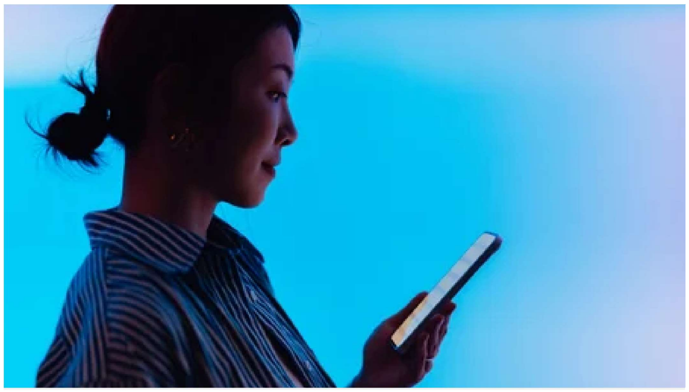
In return, you get essential news, **captivating podcasts**, brilliant infographics, **can't-miss newsletters**, must-watch videos, **challenging games**, and the science world's best writing and reporting. You can even **gift someone a subscription**.

There has never been a more important time for us to stand up and show why science matters. I hope you'll support us in that mission.

Thank you,
David M. Ewalt, Editor in Chief, *Scientific American*

Subscribe

Popular Stories

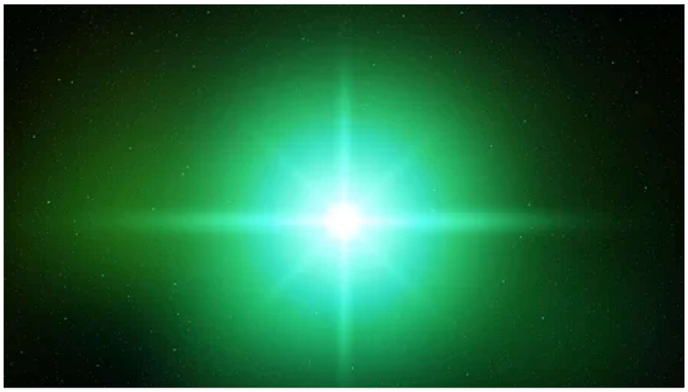


MIND & BRAIN | JANUARY 16, 2026

RFK, Jr., shifts focus to questioning whether cell phones are safe. Here's what the science says

The possible health effects of radiofrequency waves emitted by cell phones has been a subject of debate for decades

JACKIE FLYNN MOGENSEN



THE UNIVERSE | JANUARY 16, 2026

For Stars, It's Not Easy Being Green

Stars emit lots of green light, but our eyes don't let us see them that way

PHIL PLAIT

SPACE EXPLORATION | JANUARY 17, 2026

NASA's *Artemis II* mission to the moon is inching toward launch

NASA rolled out the fully stacked *Artemis II* rocket and Orion capsule on Saturday, embarking on a four-mile journey to the launch pad

CLAIRE CAMERON

ANIMALS | JANUARY 16, 2026

It's so cold in Florida that iguanas might rain from the skies

Florida's iguanas are an introduced species, and they aren't used to the chilly temperatures the state is currently experiencing

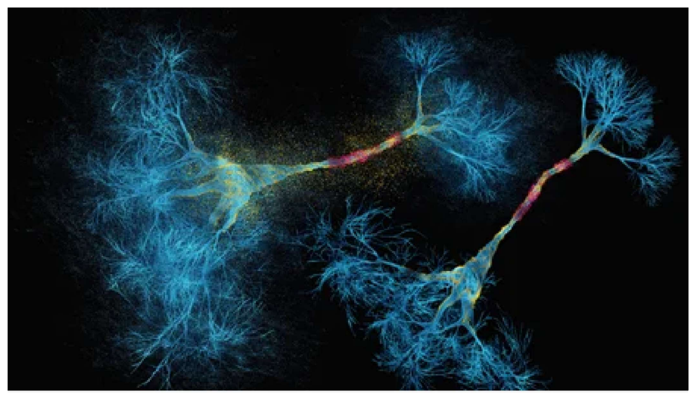
MEGHAN BARTELS

ARTIFICIAL INTELLIGENCE | JANUARY 17, 2026

The next AI revolution could start with world models

Why today's AI systems struggle with consistency, and how emerging world models aim to give machines a steady grasp of space and time

DENI ELLIS BÉCHARD



STRING THEORY | JANUARY 14, 2026

Does String Theory Explain the Wiring of the Brain?

Mathematical tools from string theory are giving scientists a new way to study the networking of neurons

LEE BILLINGS