

# How learning happens in the brains of sleeping babies

By [Carolyn Wilke](#)

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Dozing in a bassinet, a newborn wears a stretchy cap fitted with more than 100 soft electrodes. A low beep sounds, and she squints. Nearby, scientists watch jagged lines moving across a computer screen, recording electrical activity in the infant's brain. The scientists want to know what's going on in there — and that tiny squinting action suggests that the baby has been learning while she sleeps.

A newborn's job is to learn about and adapt to everything in their environment, says William Fifer, a developmental neuroscientist at Columbia University. Yet newborns spend some 70 percent of their time asleep. So Fifer and developmental psychologist Amanda Tarullo, now at Boston University, decided to see whether they could detect learning happening while babies slumber.

Infants just 1 or 2 days old, the researchers found, can learn that a tone predicts a gentle puff of air. Eventually, the infants blink after hearing the tone alone, much as Russian physiologist Ivan Pavlov's famous dogs drooled in response to certain sounds that initially had been followed by food.

In adults, the importance of sleep for learning has been well established. But much less is known about how sleep and learning interact in newborns, or how that relationship changes as infants grow into preschoolers.

Naps are especially puzzling. Studies suggests they're crucial to early learning, but most kids naturally stop napping between the ages of 3 and 5. No one knows why, but researchers' emerging understanding of napping and learning may eventually help parents, preschools and policymakers make decisions that improve kids' health and learning.

## Sleeping on it

Sleep patterns change dramatically as kids develop. Newborns sleep some 16 to 18 hours a day. At first, they sleep randomly throughout the day, but by about six months their inner clocks sync up with the day-night cycle. By about 12 months, infants snooze mostly at night, with a couple of daytime naps. By around two years, most kids are down to one nap a day.

Research suggests that napping is important in infant learning. “Sleep is crucial for earliest word learning,” says Manuela Friedrich, a neuroscientist at Humboldt University of Berlin.

In a 2015 study, Friedrich’s team presented 90 infants ages 9 to 16 months with images of unknown objects — things that looked like dumbbells or Tinkertoys, for instance. While viewing each image, the children heard the object’s name — a made-up word, such as “bofel” or “zuser.” An hour or two later, the researchers showed the infants the images again, either paired with the object’s “name” or a different made-up word.

The researchers examined electroencephalogram (EEG) recordings for evidence that the infants made the connection. Previous research had identified certain features of an EEG trace — like a voltage blip — that appear when people hear something unexpected. In Friedrich’s study, the EEG recordings suggested that kids who’d taken a nap before the tests remembered the word-object pairs they had seen previously. Non-nappers did not.

Not only that, but the infants who dozed appeared to group the objects they had learned into categories: When they saw new objects similar to ones they had seen before, their EEG activity suggested they were expecting a previously learned word.

In the same study, Friedrich and her colleagues also found that babies’ ability to lump objects into categories correlated with an EEG feature during naps called sleep spindles: fast bursts of electrical activity. Higher-amplitude sleep spindles — ones with larger swings of voltage — occurred only in kids who learned to generalize the words.

These sleep spindles often co-occur with slow-wave sleep, a particular frequency of slowly oscillating EEG activity. In adults, slow waves occur during deep sleep and have been linked to memory consolidation, the process by which short-term memories are turned into more enduring memories. But children experience more slow waves during naps than adults do.

Naps may help youngsters consolidate memories at a time when they’re learning vast amounts of crucial information. “The science seems to suggest that there’s a unique role of napping” in early cognitive development, says Simona Ghetti, a developmental psychologist at the University of California at Davis and co-author of a 2020 article in the *Annual Review of Developmental Psychology* on memory in the developing brain.

Naps also seem to help babies make sense of sentence structure.

When cognitive psychologist Rebecca Gómez of the University of Arizona in Tucson and colleagues exposed 48 15-month-olds to a made-up language, with strings of words such as “vot wadim jic” and “vot kicey jic,” kids who napped seemed better able to grasp patterns, such as catching on that the first word of a sentence always determined the third word. The researchers view this as a step toward understanding grammar.

In older children, naps may help with more than just language. In a 2020 study, Rebecca Spencer, a cognitive neuroscientist at the University of Massachusetts Amherst, and her graduate student Sanna Lokhandwala mimicked a common preschool activity: story time. They created several books that told a short story — about a day at the zoo, for example. In Spencer’s sleep lab, a researcher read these books to 3- to 6-year-olds, pointing out the pictures along the way.

Immediately after reading a story, the researchers asked the kids to place in order a set of pictures from the books. Then some children napped for up to

two hours while others stayed awake. The researchers found that nappers more accurately recalled the order of events in a second memory test. These kids also performed better on the same test the next day.

## Why stop napping?

When kids who take naps regularly miss their naps, they tend to fare poorly on memory tests, researchers have found. “Naps are awesome — they’re doing all of this important stuff for kids at a really critical time,” Spencer says.

But kids eventually give up their regular naps. “Why stop napping when it’s so important?” she adds.

Because kids transition out of naps over a fairly wide age range, from ages 3 to 6, she suspects that the answer may have to do with brain development: Perhaps at a certain point the brain changes in some way that makes napping less crucial for learning.

Some evidence for this comes from Spencer’s collaboration with [Tracy Riggins](#), a developmental cognitive neuroscientist at the University of Maryland at College Park. Using magnetic resonance imaging (MRI) to scan children’s brains, they are focusing on the hippocampus, a part of the brain important for creating new memories.

Spencer and Riggins hypothesize that the development of the hippocampus drives the transition away from regular napping. Research with lab animals and adult humans suggests that the hippocampus acts as short-term storage for new information learned during wakefulness; during sleep, those memories get transferred to the cerebral cortex for longer storage.

Spencer likens the hippocampus to a bucket. Early in development, when the bucket for holding memories is small, it has to be emptied more frequently, during sleep. Young children do this by napping. When little kids who are habitual nappers are deprived of a nap, they forget a lot of information, Spencer says. But as the hippocampus develops, so does its capacity.

“If I’m more mature, and I have a bigger hippocampus, I can hold more without having to empty my bucket,” she says. Spencer and Riggins think this may explain why the need for naps diminishes as kids age.

## Decisions for parents, preschools

Researchers hope findings like these can eventually help improve education and sleep for young children, and help policymakers and parents make better decisions about napping.

In the United States, politicians and school superintendents have often argued that preschools should focus on instruction, not sleeping. And in some parts of the country, educational standards have shifted to reflect that idea. For instance, in Massachusetts where Spencer works, teachers tell her the amount of preschool time set aside for napping has decreased in the last 10 to 15 years. Standards also have loosened around making classrooms conducive to sleep, for instance by enabling teachers to darken rooms during naptime. In some schools, parents can choose to send younger kids to swim lessons or Zumba fitness classes instead of napping, Spencer says. She’s worried about the effect that has on learning.

For very young kids who are habitual nappers, missing naps harms their cognitive performance — they’ll lose information they’ve learned in the morning without an afternoon nap, Spencer says. She wishes parents were more aware of the benefits of napping.

“If somebody is making a policy decision, or you’re letting parents choose between the nap room and the non-nap classroom, I think it should be an informed choice,” she says.

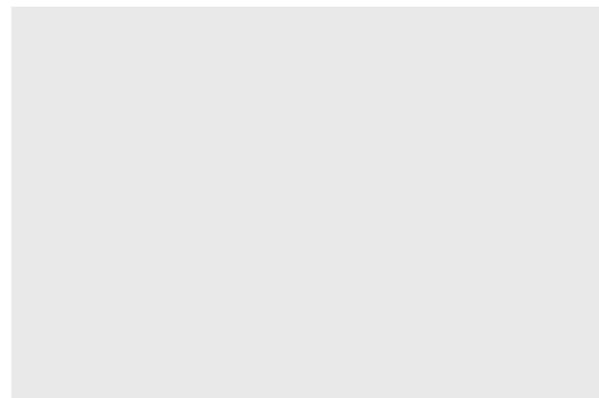
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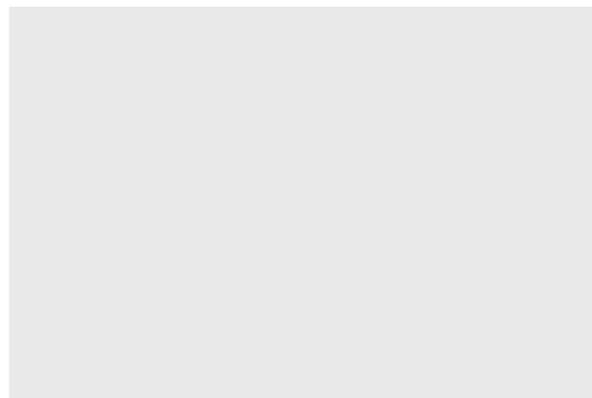
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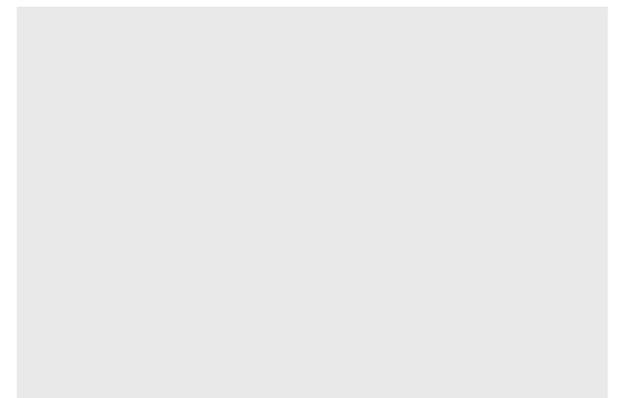
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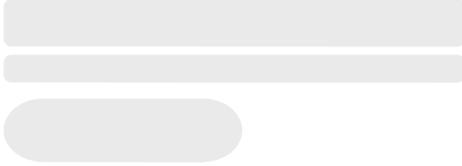
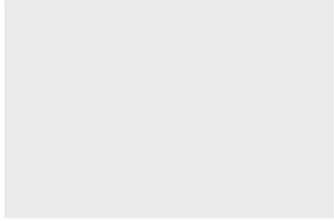


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