As in humans, sleep solidifies a bird's memories

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Sleeping is known to help humans stabilize information and tasks learned during the preceding day. Now, researchers have found that sleep has similar effects upon learning in starlings, a discovery that will open up future research into how the brain learns and preserves information.

The research, published Wednesday by *The* Journal of Neuroscience, fills an important gap between human behavioral findings and animal experiments of how the brain changes after learning and sleep.

"We really wanted to behaviorally show that these types of sleep-dependent memory benefits are occurring in animals," said Timothy Brawn, graduate student at the University of Chicago and lead author on the study. "What was remarkable was that the pattern here looks very similar to what we see in humans. There wasn't anything that was terribly different."

In order to survive, animals must be able to learn from experience, and understanding the biology of this process remains an open scientific question. Previous research has demonstrated that sleep plays in important role in vocal learning in birds, and is also important for stabilizing memories in humans.

In 2008, Brawn and co-authors Kimberly Fenn, Howard Nusbaum, and Daniel Margoliash found that a night's sleep stabilized the skills of people learning to play a first-person shooter video game. That study

built upon prior research from Fenn, Nusbaum and Margoliash in 2003 that found sleep helped college students retain perceptual learning of computer-generated speech.

But sleep-dependent consolidation had not been conclusively proven behaviorally in adult animals. So Brawn set out to replicate the findings of his human study in the starling, a bird known for its vocal production and listening skills.

Starlings were trained to discriminate between two five-second snippets of birdsong in a learning task called a go-nogo procedure. If they heard one song, the "go" stimulus, they would receive a food pellet after correctly poking their beak into a hole in their cage. If the other song, the "no-go" stimulus, was played, it signaled that the bird should not poke its beak in the hole, or else the lights in the cage were briefly shut off.

Groups of starlings were trained in the task at different times of day, then re-tested later to see how well they retained their learning. In all groups, performance on the task improved after the birds slept, relative to their performance before sleep. That result replicated the sleep-dependent enhancement pattern observed in human studies.

Another human learning pattern, called waking performance deterioration, was not conclusively replicated in the starlings. When humans are taught a task in the morning, their performance on some tasks worsen over the course of the day, only to rebound after a period of sleep.

Starlings also showed a slight decrease in their performance of the no-nogo task over the course of a day without sleep, but those changes were not statistically significant. Brawn theorized that the deterioration may be more pronounced in humans because, unlike caged starlings, the

human task must compete with the rest of the day's experiences.

"In human studies, we can't control what they're doing throughout the day," Brawn said. "In starling experiments, they don't have any other interactions… I think there's a much reduced interference effect here." Future experiments with starlings and humans can directly study the effects of interference on learning and how sleep may overcome those effects.

Regardless, the discovery of similar sleep-dependent consolidation of learning in starlings and humans opens up new possibilities for research into the mechanisms of learning and memory.

"The result suggests this is a very broad, general phenomenon that might be shared across a great many vertebrates," said Margoliash, professor of organismal biology, psychology and neuroscience. "It was quite important to show that and it now opens the possibility for mechanistic and behavioral experiments in animals that are difficult to do in humans."

Such exploration will continue a long collaboration between Margoliash and Nusbaum's groups that offers the unique ability to simultaneously study the interaction between learning, memory and sleep in multiple species, with results from bird experiments informing human studies and vice versa.

"There are very few paradigms of research that have unfolded at the same time in parallel between using humans and animal subjects," said Nusbaum, professor and chair of psychology. "These scientific advances suggest that we may be able to use birds to study the role of sleep in vocal learning and language development in humans."

What's clear now from an abundance of data is that sleep is an important

stabilizer of learning across species, suggesting a long evolutionary history of this particular function. Brawn said he was convinced enough of the phenomenon to apply it to his own study habits.

"If I have an afternoon test, I want to make sure I've done a lot of studying the day before rather than just doing it the morning of the test," Brawn said.

More information: The article, "Sleep-Dependent Consolidation of Auditory Discrimination in Adult Starlings," will be appear in the January 13th issue of *The Journal of Neuroscience*.

Provided by University of Chicago

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