

Researchers developing new interactive sleep app

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Credit: Brown University

There are plenty of cellphone apps on the market designed to help people monitor their sleep patterns. The apps generally record data on when people go to bed and when they wake, and many use the device's

microphone and accelerometer to take note of noises in the night and to monitor how much people toss and turn.

A group of Brown University computer scientists and clinical psychologists have come up with an approach that takes [sleep](#) monitoring one step further. The approach, dubbed [SleepCoacher](#), uses sleep analytics to generate personalized recommendations informed by the scientific literature on sleep. SleepCoacher then guides users through a self-experimentation framework to help people find the recommendations that best work for them.

"The idea is to not only present people with information about their sleep, but to give them some control over it by giving recommendations along with a step-by-step plan for improving their sleep," said Nediya Daskalova, a doctoral student in computer science at Brown who is leading the development of SleepCoacher.

Daskalova presented [a paper on the SleepCoacher approach](#) recently at the User Interface Software and Technology Symposium in Japan. The presentation included the results of two small pilot studies of SleepCoacher users, which found that 80 percent of people who followed the recommendations at least 60 percent of the time reported improvement in their sleep. The team is now working on a self-contained SleepCoacher app that they hope to make available to users early next year.

Daskalova and her team developed SleepCoacher under the direction of Jeff Huang, an assistant professor of computer science at Brown and leader of Brown's Human-Computer Interaction Group.

"Our work is the first of its kind to guide people to figure out whether the data is causal, instead of just correlation," Huang said. "That's particularly exciting for me. We have an approach that could work in the

long term to continuously improve sleep over months or even years. And because we are aiming for a lifetime of improvement, this could be personalized for whether you are a night owl or morning person, a light or heavy sleeper, or even someone who needs more than the usual eight hours of sleep."

For the pilot studies, the team used a slightly modified version of a commercially available cellphone app called Sleep as Android. In addition to the app's standard monitoring capabilities, the modified version allows people to enter a rating of how refreshed they feel in the morning, as well as noting other factors that might affect sleep, like whether they had caffeine or alcohol during the day, or whether they exercised.

Using that data, the SleepCoacher algorithm looks to see what factors, either detected by the app or reported by the participants, were correlated with three key sleep outcomes: how long it took people to fall asleep, how many times they woke up during the night and how refreshed they reported feeling in the morning.

When a strong correlation is detected, the algorithm generates a recommendation based on a collection of 117 recommendation templates developed in consultation with a group of clinical psychologists and psychiatrists from Brown's Alpert Medical School. The recommendations were sent via text message to participants in the two studies, the first of which included 24 participants and the second 19.

"For example," Daskalova said, "a recommendation might say: 'We noticed that you go to bed at 10 p.m. on average. When you go to bed at 10:30 or later, you report feeling worse in the morning. We recommend you try to go to bed closer to 10.'"

SleepCoacher then guides users through mini experiments to see if that recommendation is useful. Users are instructed to follow the recommendation for several nights and then ignore it for several nights. By measuring differences in sleep outcome when the user follows the recommendation and when they don't, SleepCoacher determines whether or not that recommendation is right for that user.

"Just because something is highly correlated with an outcome doesn't mean that if you change it it's going to improve your sleep," Daskalova said. "The self-experiments help us build smarter recommendations that, over time, learn what might be actually important for individual users."

Daskalova said she was surprised to see just how much variation there was among people who participated in the studies.

"Some people who took a nap late in the day, for example, reported feeling better the next day, while others reported feeling worse," she said. "Ambient noise at night was a problem for some people and not others. There's really a lot of variation, which makes this problem so interesting to solve."

The SleepCoacher self-experiment process is designed to account for that variation and help people develop a tailored plan for better sleep. An important component of the approach, Daskalova says, was engaging the team of clinical professionals from the Alpert Medical School who work in the area of sleep. That team included Nicole Nugent, Julie Boergers and John McGeary.

"In addition to our clinical experience, we are active researchers," Nugent said. "So we could make sure that the recommendations came from the individual's data and what we know from science."

Nugent stressed that approaches like SleepCoacher are not a replacement

for clinical intervention for people who have serious psychiatric disorders that often interfere with sleep, like post-traumatic stress disorder or serious anxiety disorders.

"This approach is really aimed at people whose sleep is a little off and who would like some help," she said. "I think that a surprising number of Americans and people around the world have poor sleep hygiene and don't actually know it. What's so great about SleepCoacher is that it allows people to be mindful and aware of their [sleep patterns](#), and it gives them personalized direct feedback that is consistent with what we know in the literature about what [healthy sleep](#) looks like."

The code behind SleepCoacher is open-source and available on the project's website. The team is in the process of making self-contained SleepCoacher apps for iOS and Android, which they hope to make available on January 1. They also intent to perform more expansive studies of the apps to test their efficacy.

Provided by Brown University

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