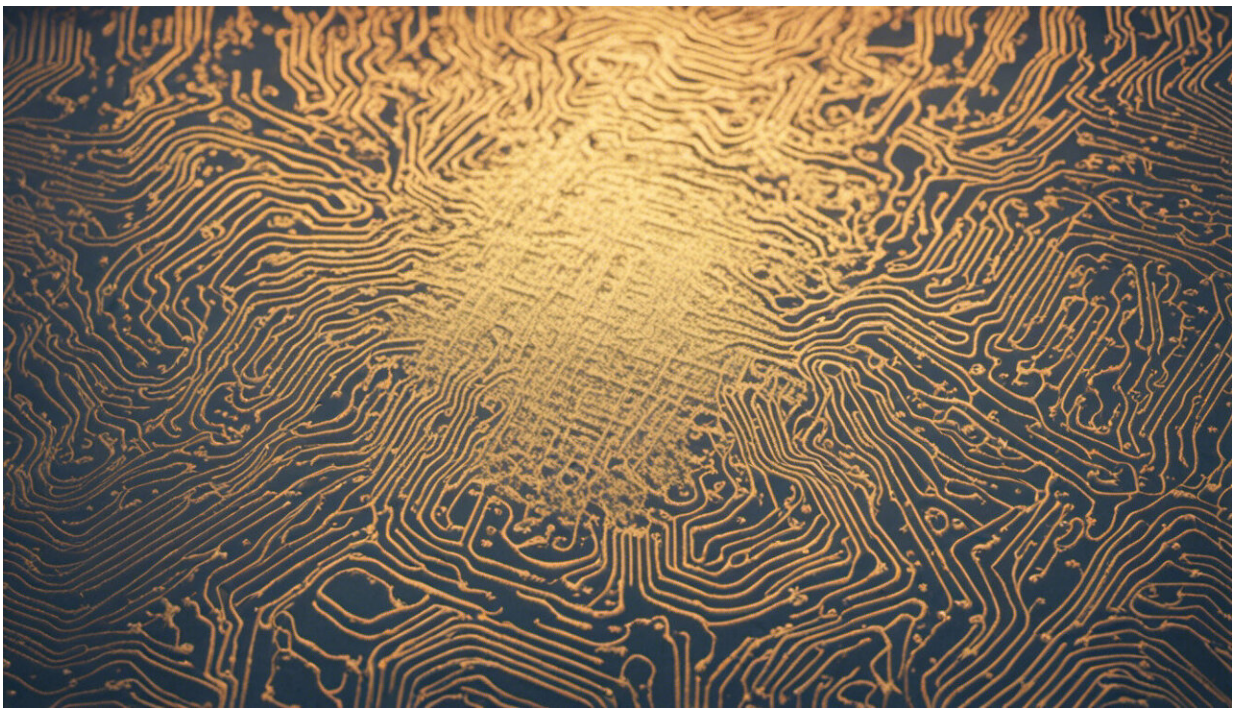
Software that analyzes sleep patterns without human input could help improve sleep research

August 2 2013



Credit: AI-generated image (disclaimer)

Sleep research typically involves recording electroencephalography (EEG) and electromyography (EMG) signals of brain activity over long periods of time, then painstakingly analyzing these records in a process called sleep staging to determine how much time the subject spent in

each stage of sleep. Genshiro Sunagawa from the Laboratory for Systems Biology at the RIKEN Center for Developmental Biology and colleagues have now developed a fully automated analysis process that promises to improve the speed and reliability of sleep staging analysis.

Sleep consists of several different stages, and each has a characteristic pattern of brain activity. Sleep staging is commonly performed by visual inspection of EEG and EMG recordings to identify these characteristic patterns—a process that is both slow and susceptible to variations among even well-trained observers. Both of these problems could be solved by the introduction of an automated process, but as Sunagawa explains, this is not as straightforward as it seems.

"Even though there are some rules that define sleep stages, the definitions are not clear enough to allow sleep staging to be performed by computers. In addition, if there is a lot of noise in the recordings, then we have to extract the real data—using a computer to do this is not easy," he says.

Sleep staging programs exist, but either require human input to define sleep stages with some subjectivity, or use 'hard' rules that are not always appropriate and can fail. Sunagawa and his colleagues combined a set of recently developed algorithms to develop an unsupervised, automated sleep staging program called FASTER that eliminates these problems.

To ensure that FASTER was accurate, the researchers used brain recordings from healthy mice to optimize the hard rules used by the program. They then tested it with mice with drug-induced disrupted sleep patterns, and with mice that displayed sleep defects due to genetic modification. In both cases, FASTER proved to be accurate more than 90% of the time.

"FASTER stages sleep using animal EEG and EMG, and requires no

human judgment," says Sunagawa. "While it takes a few hours to analyze mouse data from one day manually, FASTER can do the same analysis in ten minutes."

For Sunagawa, the benefits of the system's speed and accuracy are clear. "By dramatically improving the sleep staging process in both quality and throughput, FASTER will help with processes such as screening for drugs and searching for sleep mutants. It will open the door to quantitative and comprehensive animal sleep research."

More information: Sunagawa, G. A., Sei, H., Shimba, S., Urade, Y. & Ueda, H. R. FASTER: an unsupervised fully automated sleep staging method for mice. *Genes to Cells* 18, 502–518 (2013). dx.doi.org/10.1111/gtc.12053

Provided by RIKEN