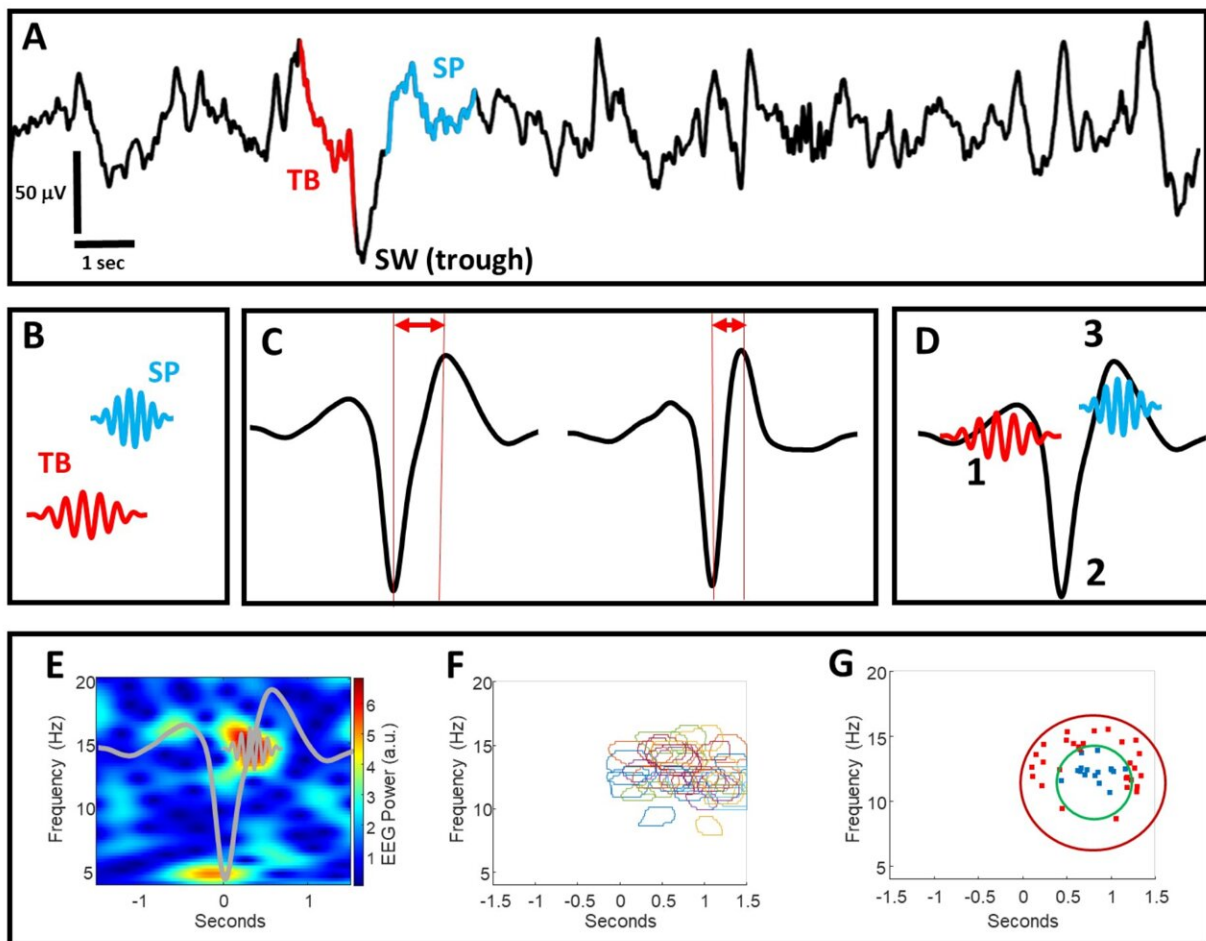# A fitness tracker for brain health: How a headband can identify early signs of Alzheimer's disease in your sleep

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A) An illustrative example of raw sleep EEG data containing an identified theta burst (TB) event and a spindle (SP) event, each temporally coupled to the trough of a slow wave (SW) event. Note that not all SW events can be matched to

coupled TB or SP events. B) A conceptual illustration of TB and SP oscillatory events that are individually identified from raw EEG (illustration not to scale). C) Slow wave (SW) oscillations are identified from raw EEG and characterized as having low or high transition frequencies by measuring the distance from their troughs to peaks. D) Temporal sequences of "1" TBs, "2" SWs, and "3" SPs create "coupling" as the events co-occur in fixed time windows from one another (illustration not to scale). E) An example of a normalized time-frequency EEG spectrogram containing an individual SP event coupled to the trough of an individual SW (SW and SP shapes are superimposed as a conceptual illustration, not to scale). F) An example of event detection wherein the time-frequency location of individual SP events from multiple spectrograms are outlined and superimposed. G) An example of precision event topographical localization. The precision of SP event centroids in panel "F" is calculated by measuring the number of SP event centroids within the inner ring, divided by the total number within the outer and inner ring areas. Abbreviations: SP = spindle, SW = slow wave, TB = theta bursts. Credit: *Alzheimer's & Dementia* (2023). DOI: 10.1002/alz.13420

Researchers from the University of Colorado Anschutz Medical Campus and Washington University in St. Louis have identified a way to assess brain activity in sleep that occurs in the earliest stages of Alzheimer's disease, typically many years prior to developing symptoms of dementia.

The digital biomarker uses electroencephalography (EEG) that can be recorded from simple headband devices to detect brain wave patterns related to memory reactivation in sleep, which are part of a system that processes memories in deep sleep.

Study results published today in *Alzheimer's & Dementia* identify a relationship between EEG readings and levels of specific molecular changes indicative of pre-symptomatic Alzheimer's disease. Additional findings further demonstrate that early stages of mild cognitive impairment due to Alzheimer's disease can be detected in the EEG

signals.

"This digital biomarker essentially enables any simple EEG headband device to be used as a fitness tracker for brain health," says Brice McConnell, MD, Ph.D., assistant professor of neurology at the University of Colorado School of Medicine and study senior author. "Demonstrating how we can assess digital biomarkers for early indications of disease using accessible and scalable headband devices in a home setting is a huge advancement in catching and mitigating Alzheimer's disease at the earliest stages."

In the largest study of its kind to date, researchers analyzed data from 205 aging adults, identifying measurable problems with memory reactivation in association with levels of proteins such as amyloid and tau that build up in Alzheimer's Disease.

"What we found is these abnormal levels of proteins are related to sleep memory reactivations, which we could identify in people's brainwave patterns before they experienced any symptoms," says McConnell. "Identifying these early biomarkers for Alzheimer's disease in asymptomatic adults can help patients develop preventative or mitigation strategies before the disease advances."

Researchers say this is an exciting step towards using wearables as digital biomarkers for disease detection. "We are just scratching the surface with this work, paving the way for affordable and easy-to-use devices to monitor brain health," says McConnell. "This is proof of principle that brain waves during sleep can be turned into a digital biomarker, and our next steps involve perfecting the process."

Provided by CU Anschutz Medical Campus

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