

inWave: Revitalizing Aging Brains by Enhancing Deep Sleep

Christina Hummel, Janis Iourovitski, Summer Duffy, Joshua Blair, Spencer Shumway

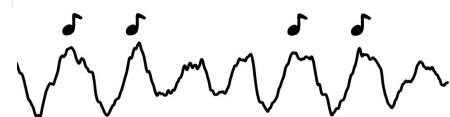
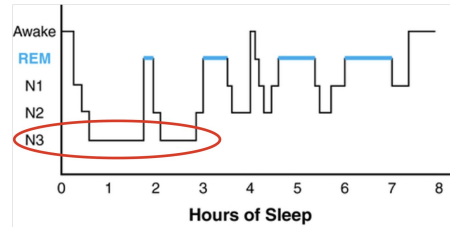
Abstract

Between the ages of twenty and fifty, individuals' slow-wave sleep (SWS) is diminished by 80%. This dramatic decrease is remarkable, as SWS facilitates memory consolidation as well as the clearing of neural waste associated with Alzheimer's Disease. Improving SWS in older adults holds promise as a therapy for these and other age-associated health problems.

To date, the best-studied and most successful method of SWS enhancement is Acoustic Stimulation (AS). AS has been validated as an effective slow wave driver by sleep laboratories around the world, and has been linked to many exciting clinical effects including improvements in memory, executive function, alertness, and other cognitive effects. This technique involves measuring brain activity via electroencephalography (EEG) and feeding those data into an AI algorithm to precisely time the delivery of specialized sounds to the user which stimulates the brain, enhancing slow wave activity.

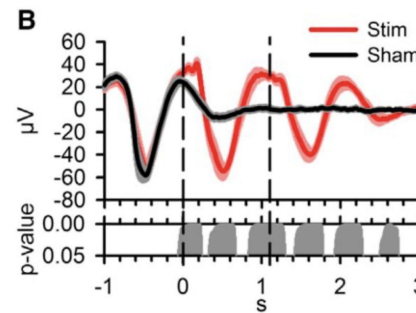
inWave is developing a wearable technology that makes AS accessible to older adults in the comfort of their own homes. By adapting this technology to the unique needs of older adults and packaging the complex sensors, circuitry, and algorithms required for AS into a comfortable and easy-to-use headband, we are translating this laboratory technique into an accessible therapy.

Slow Wave Sleep



Ngo et al., "Auditory Closed-Loop Stimulation of the Sleep Slow Oscillation Enhances Memory," 545-553.

Acoustic Stimulation



Papalambros et al., "Acoustic enhancement of sleep slow oscillations and concomitant memory improvement in older adults," 109.

Need Validation

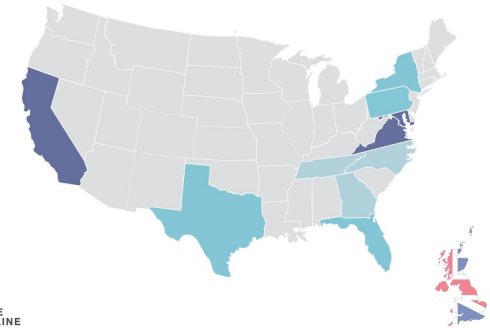
Customer Discovery
85 Total Interviews

Demographics

50+ 42% 58%
AGE MALE FEMALE
54% 12% 58%
WHITE BLACK OTHER

Insights

54% 60%
TRACKED SLEEP HAD SUBJECTIVE COGNITIVE DECLINE



Cognitive Decline

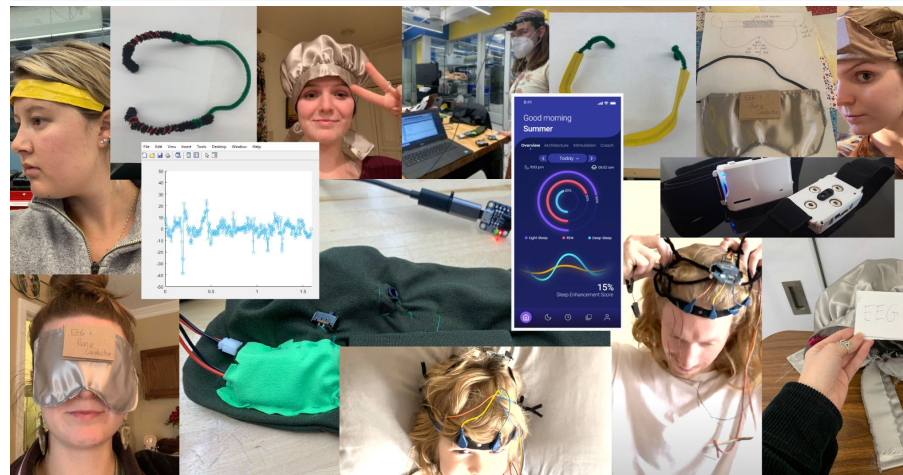
Next 30 Years

2X
Geriatric Population

13 M
Dementia Diagnoses

\$488B
Caregiving Costs

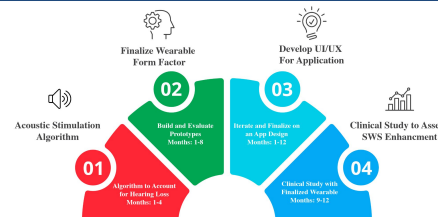
Prototypes



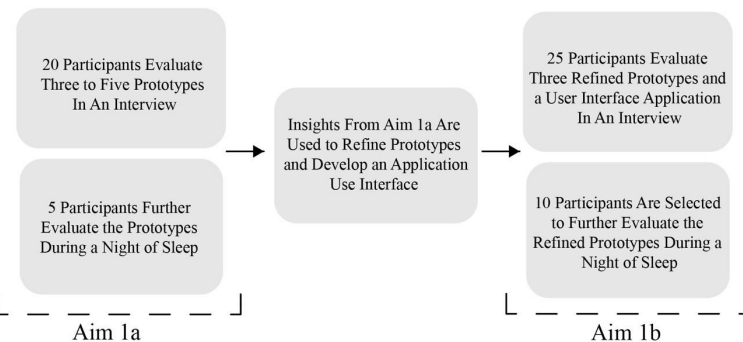
Next Steps



The inWave team is working to finalize our EEG hardware for the upcoming study and then we'll shift our focus to further developing our new older-adult-focused acoustic stimulation algorithm.



Planned Clinical Study



Aim 1 is broken down into two sub aims, which are geared to assess the feasibility of prototypes in two phases. Aim 1a will be used to test the feasibility and acceptability of 3-5 prototype concepts designed by the study team. The insights gathered from Aim 1a will then be used to refine the prototypes and develop a user interface that mimics a potential mobile application that a user would use to interact with a wearable device. In Aim 1b, we will repeat the procedures of Aim 1a using prototypes that have been refined based on results of that Aim to finalize a wearable prototype concept. The study design can be seen in Figure 1.

Older Adults Experiencing Cognitive Decline
Need a Method to Enhance Their Slow Wave Sleep in Order to Improve Their Declarative Memory



Our technology can be divided into two systems - a sleep EEG wearable that delivers acoustic stimulation and the artificial intelligence that makes this possible.

Our Collaborators



Acknowledgments

Dr. Peter Abadir
Dr. Mark Wu
Dr. Adam Spira
Dr. Youseph Yazdi
Dr. Paul Rosenberg
Dr. Nicholas Reed
Dr. William G. Coon
Dr. Bryan Hansen

A special thanks to the Johns Hopkins Center for Bioengineering Innovation and Design for the support of this work