



Temporal Alpha Responses to White Noise in Cognitively Normal and Impaired Older Adults

Malaika Kumar, Katherine Cassiano, Vishnu Shandilya Mungamuru Chenchu, Kwaku Addo-Osafo, Joshua Stepter, Karen Elrayes, Aisha Mohammed, Sydney Kilgore, Katy Figueroa, Keith Vossel

Affiliations: Department of Neurology, David Geffen School of Medicine at UCLA

Background

- Alpha waves (8-12Hz) are commonly associated with sensory gating and inhibition^{1,2,3}
- Auditory stimuli result in alpha modulations⁴
- Posterior temporal cortex (PTC) is important in auditory processing
- Planum temporale as the auditory center, specifically for spectrally complex, non-semantic sound⁵
- White noise contains all frequencies at an equal intensity
- Healthy, young adults demonstrated reduced alpha-band activity when listening to white noise in comparison to silence or quieter/more pleasant conditions⁶
- Cognitively impaired populations, specifically those with Alzheimer's Disease (AD) Lewy Body Dementia (LBD) and Mild Cognitive Impairment (MCI) show decreased alpha reactivity in comparison to older adults^{7,8,9}
- Limited research on white noise in relation to alpha rhythms in aging and impaired populations

Aims

Investigate the effect of white noise on alpha power in cognitively normal (CN) and cognitively impaired (CI), older adults

Methodology

- Human electroencephalography (EEG) data extracted from twenty one older adults (N=21) enrolled in the Music Stimulation to Improve Cognition (MUSIC) Study within the David Geffen School of Medicine
 - 10 CN participants (incl. 1 with questionable CI)
 - 11 CI participants (8 MCI/AD, 3 LBD)
- Participants recruited through Institutional Review Board (IRB) approved methods including participant databases, flyers, outreach events and clinical referrals
- Eligibility screenings were conducted, consents were acquired, and relevant medical, family and neuropsychological histories were collected
- Identification into one of the cohorts by Dr. Vossel: Cognitively Normal, MCI/AD or LBD
- Clinical Dementia Rating (CDR) and Mini-mental State Exam (MMSE) neuropsychological testing administered
- Pure tone hearing recognition test at 40dB for eligibility
- Participants were connected to EEG with 200-to-2000Hz sampling rate and 10-20 lead placement
- Participants listened to a 10-minute segment using headphones while keeping eyes fixed on an "+" sign directly in front of them
- Segments of interest for this study are 5-minute baseline (silence) and 1-minute white noise

EEG Data Extraction and Analysis

- Alpha band power spectral density (PSD) from 8-12Hz were extracted
 - Persyst software correlates video recording with EEG data
 - Matlab¹⁰ performed pre-processing (60Hz notch filter, artifact reduction, and low pass filters) and Welch's method for PSD calculations
 - Alpha power was averaged for T5 and T6 electrodes to represent the PTC
- T5/T6 compared between baseline and white noise segments
- Statistical analysis in JASP¹¹, graphs in PRISM¹², heat map plots using Python¹³

Results

- Age Demographic:** No significant difference in ages between cohorts
- Cognitively Normal Participants:** Strong downward trend in alpha power in response to white noise (*Mean Difference in Alpha PSD = -1.8, SD = 2.7, all units $\mu V^2/Hz$*), $p=0.0597$, with medium effect size of *Cohen's d = 0.51* [Figure 1]
- Cognitively Impaired Adults:** Smaller trend in alpha power in response to white noise (*Mean Difference in Alpha PSD = -0.53, SD = 1.1, all units $\mu V^2/Hz$*) with very small effect size of *Cohen's d = 0.12* [Figure 2]
- Control lead (Fz):** No significant change in response to white noise

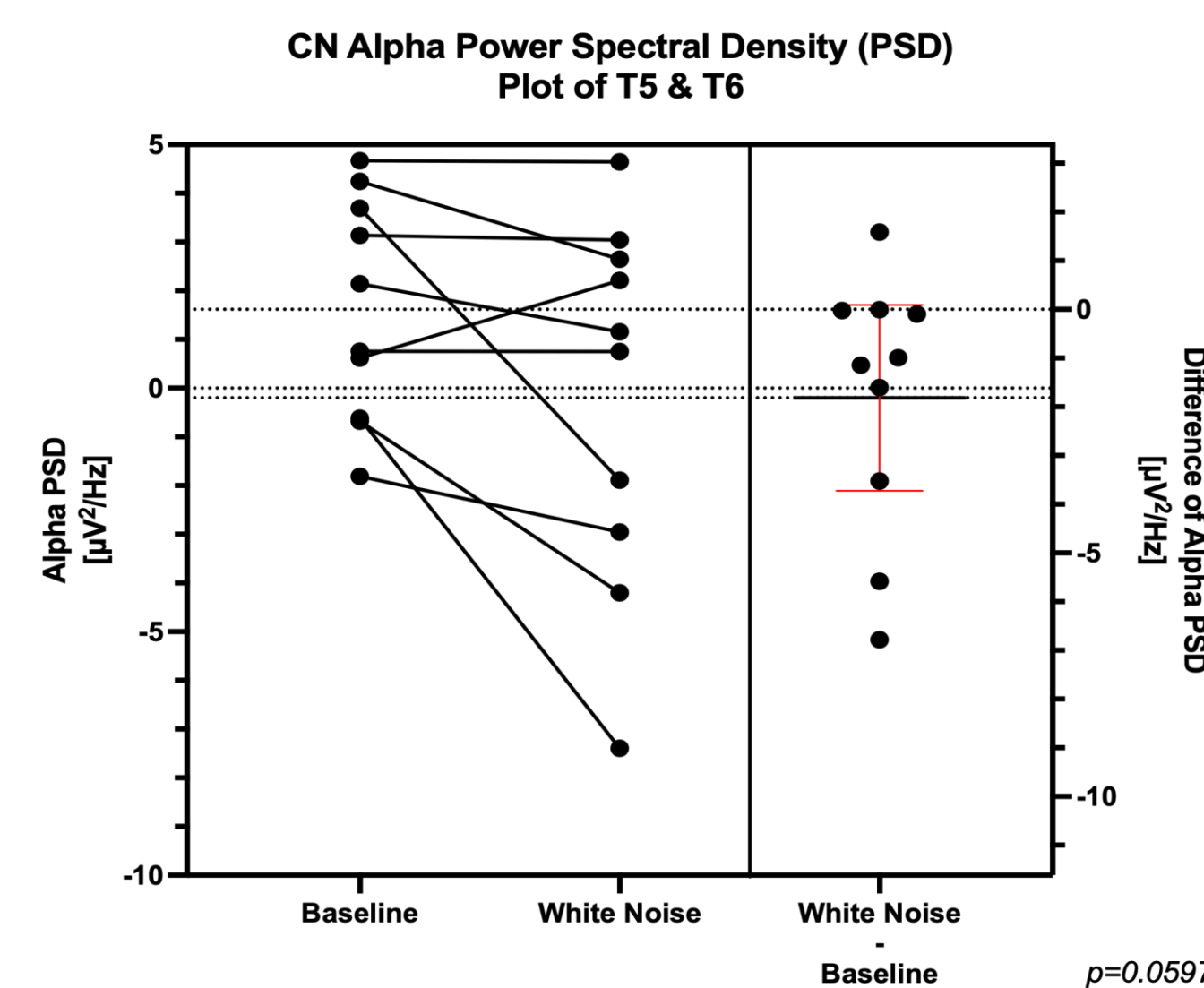


Figure 1: CN Alpha Power Spectral Density ($\mu V^2/Hz$) plot of T5/T6 combined channel analysis

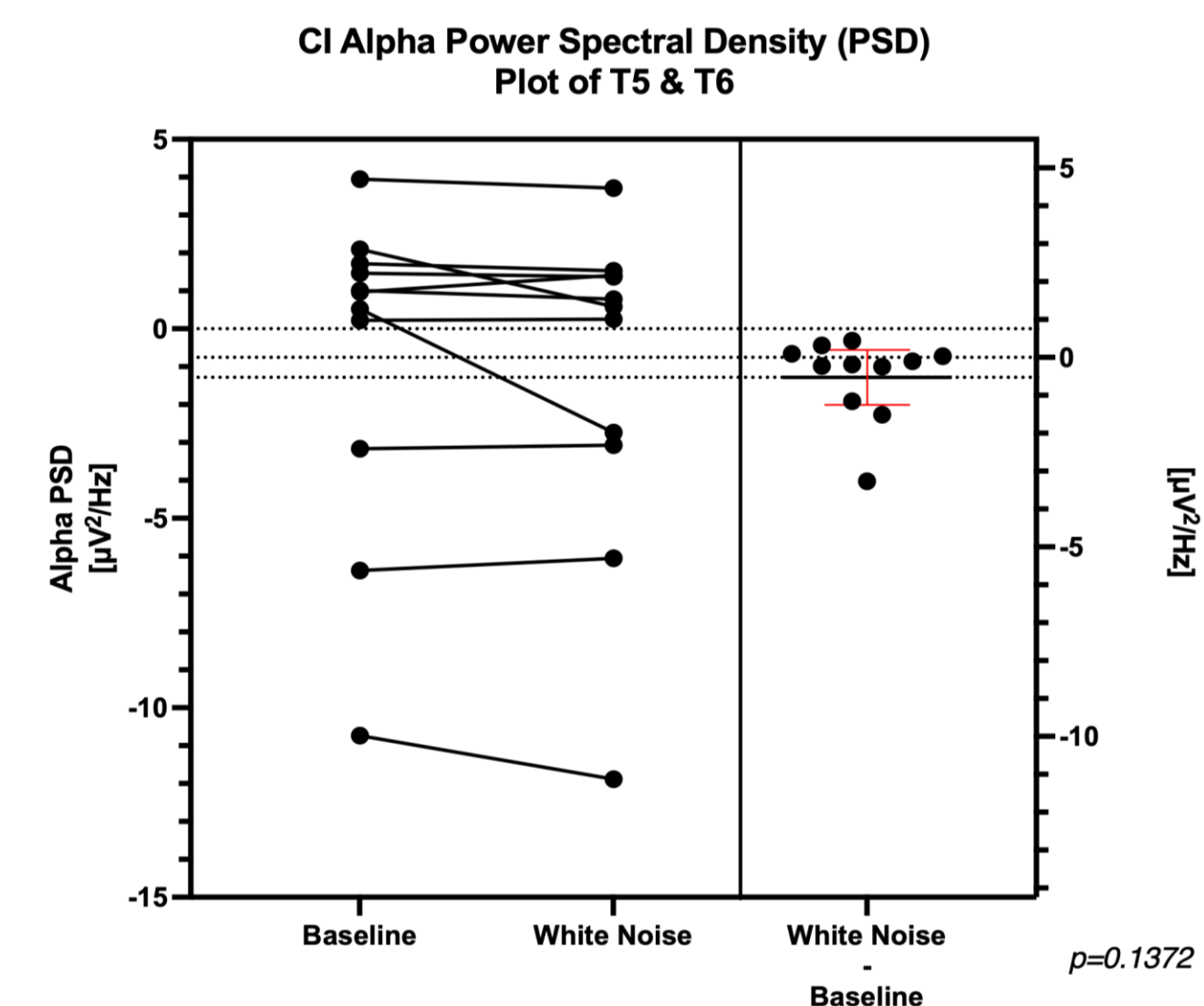


Figure 2: CI Alpha Power Spectral Density ($\mu V^2/Hz$) plot of T5/T6 combined channel analysis

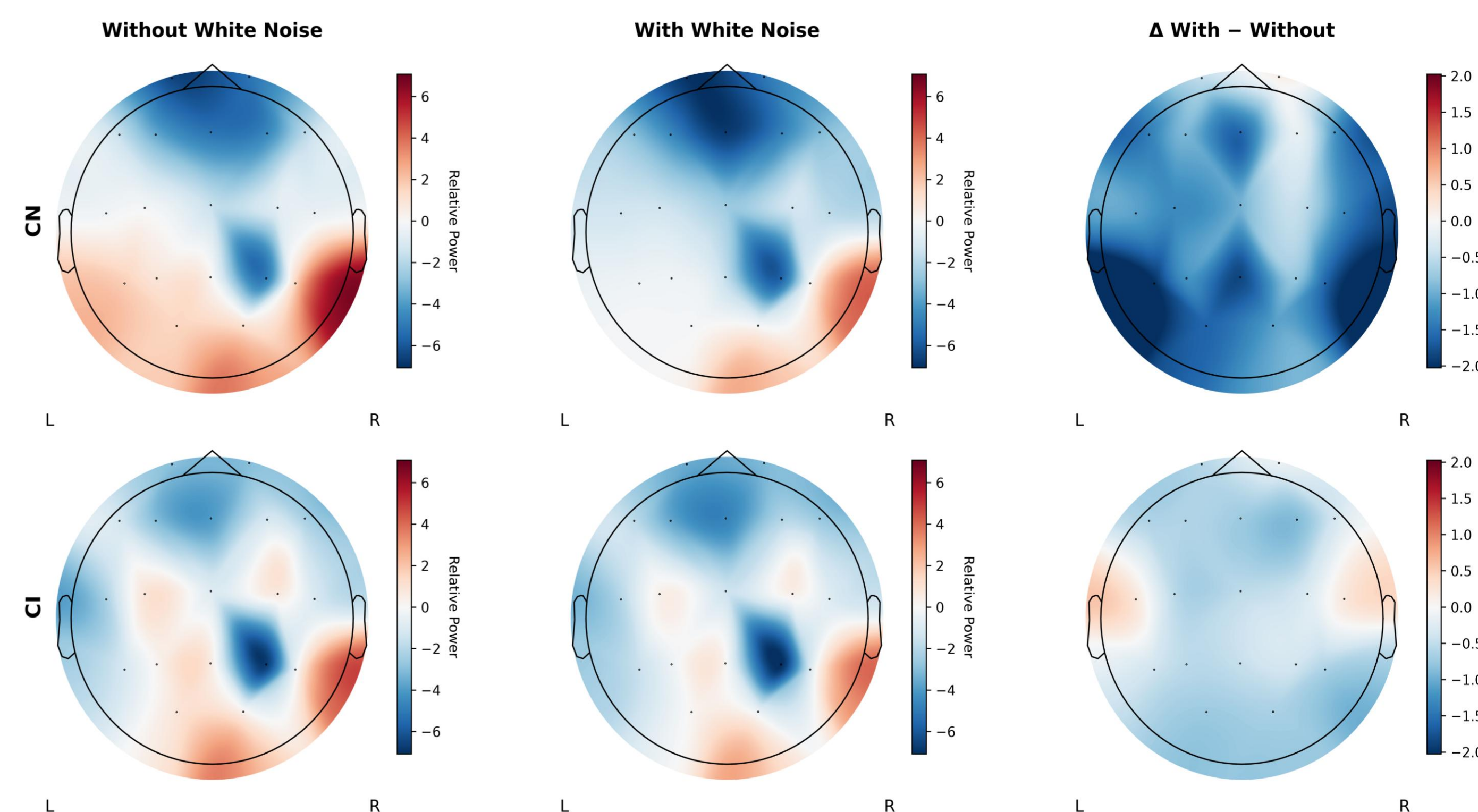


Figure 3: Heat map plot of Alpha PSD ($\mu V^2/Hz$) for CN participants (top) and CI participants (bottom) without white noise, with white noise, and the change between conditions, from left to right.

Discussion

- Continuous white noise elicits potential decreased posterior temporal alpha power in aging adults
- Healthy, older adults demonstrated a much stronger effect size in alpha power modulation to white noise ($d=0.51$) in comparison to impaired, older adults ($d=0.12$) which could demonstrate diminishing alpha reactivity and network responsiveness to external auditory inputs in CI individuals
- Region specificity of alpha modulation in response to auditory stimuli
- Potential for posterior temporal alpha during white noise stimulation to serve as a non-invasive method for assessing temporal lobe network responsiveness in aging populations
- Neurofibrillary tangles (NFT) formed due to tau protein aggregates have previously been found to reduce alpha synchrony¹⁴, and therefore, network coordination. While tau was not measured in this study, the apparent attenuated response in CI is consistent with tau-related network deterioration straining oscillatory responses to sensory input
- Important to consider that
 - Sample size is small with N=21
 - CI cohort is heterogenous in its diseases, limiting disease specific conclusions

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