

EEG Markers of Impaired Neural Dynamics in MCI and AD

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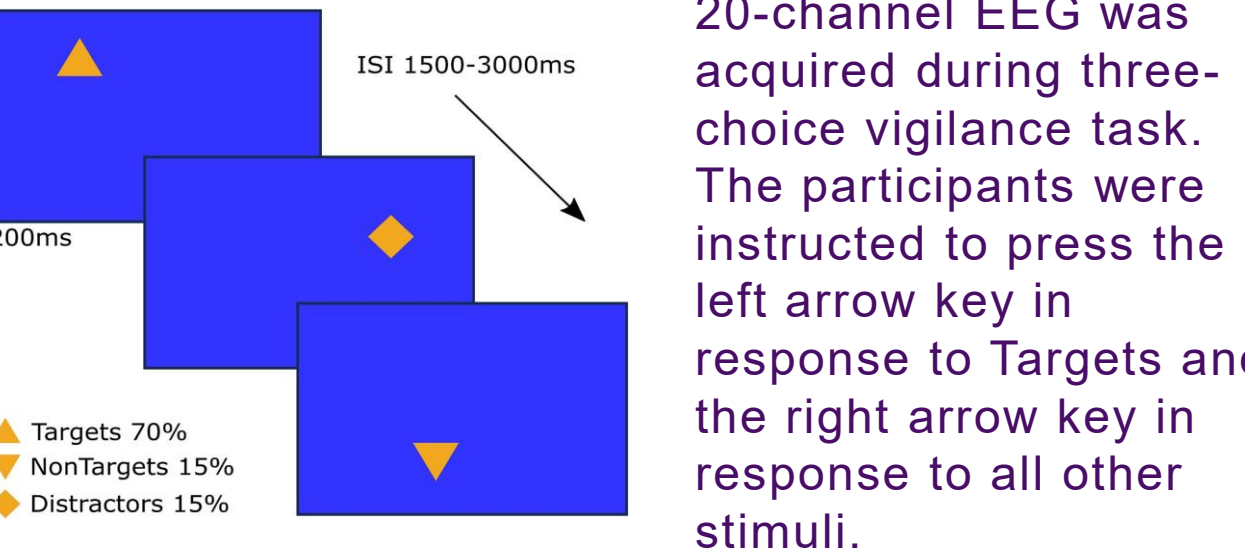
Key takeaway: Disrupted task-evoked beta modulation and delta–theta temporal consistency in MCI/AD are associated with slower and less stable sustained-attention performance.

INTRODUCTION

Resting-state EEG abnormalities have been reported in MCI and Alzheimer’s disease, but less is known about task-evoked neural dynamics during sustained attention. Here, we **investigated event-related spectral perturbations (ERSP) and inter-trial coherence (ITC)** during a three-choice vigilance task to characterize task-evoked neural coordination in MCI and AD.

METHODS

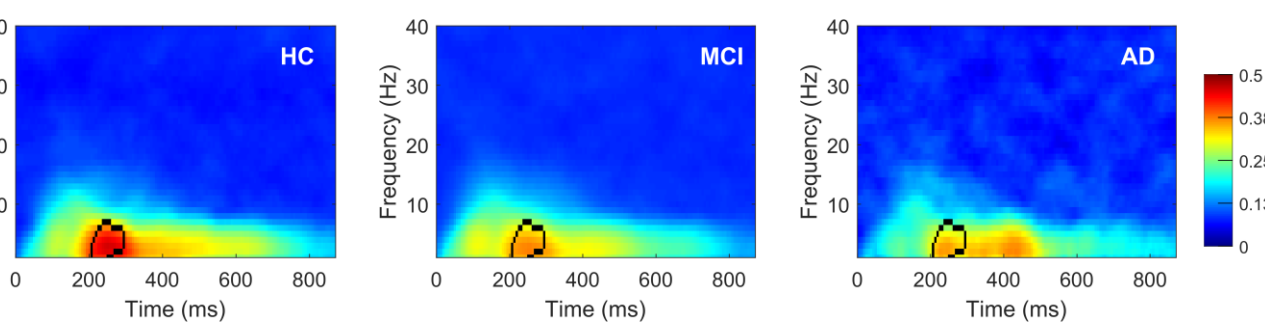
Participants included patients with a clinical diagnosis of mild cognitive impairment (MCI; n = 209, ages 51–90) or Alzheimer’s disease (AD; n = 15, ages 57–90) who received standard clinical care at Hawaii Pacific Neuroscience Center (HPN). Healthy controls (HC; n = 86, ages 50–90) were selected from the Advanced Brain Monitoring (ABM) reference database.



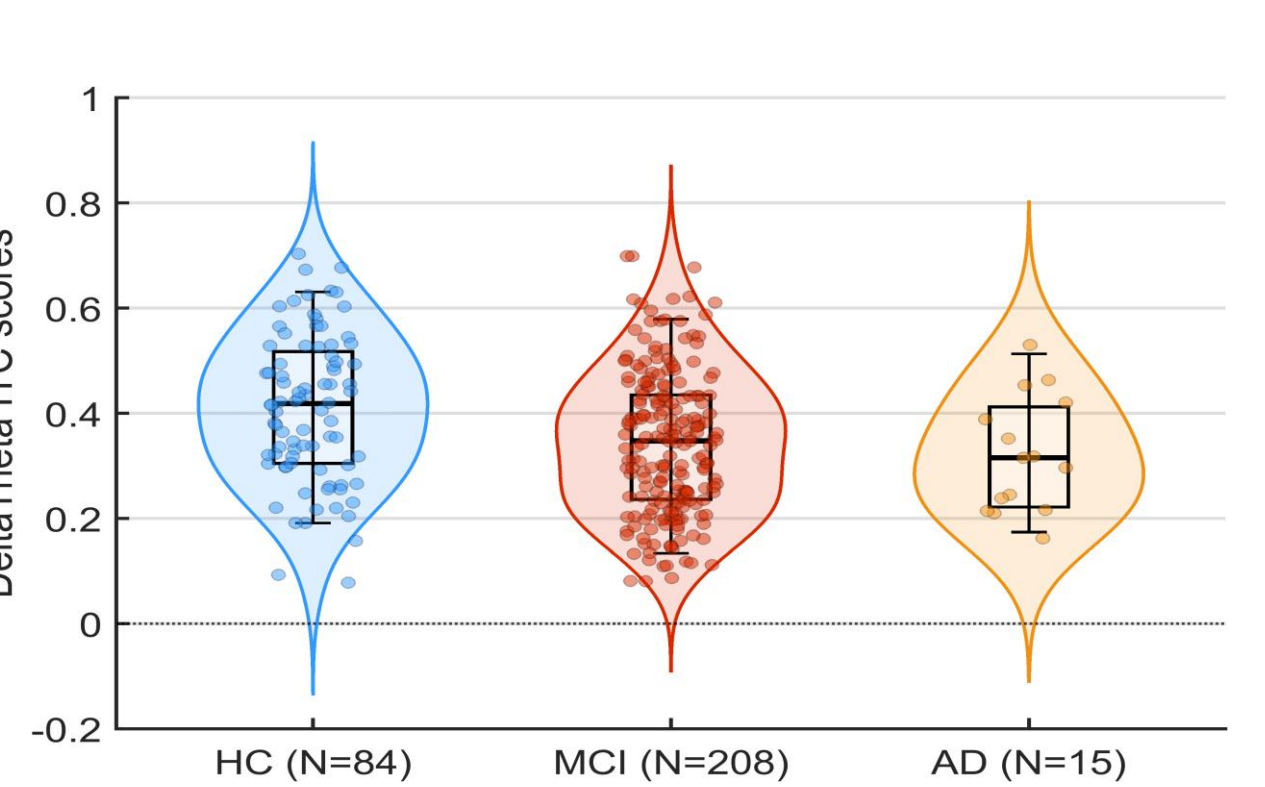
ERSP and ITC were computed from stimulus-locked time–frequency maps. MCI–HC group differences were tested using cluster-based permutation analysis across channel × frequency × time. Significant clusters were extracted as subject-level scores across HC, MCI, and AD and related to behavioral performance using age- and sex-adjusted partial correlations.

ITC abnormalities

ITC results. Cluster-based permutation testing identified four significant clusters. The primary cluster of interest showed reduced delta–theta ITC (1–7 Hz) in patients during mid-latency stimulus processing (~200–300 ms), consistent with reduced temporal consistency of stimulus-locked neural responses. This effect was most prominent over posterior scalp regions and was observed in both MCI and AD relative to HC, suggesting disrupted early neural timing during sustained-attention processing.



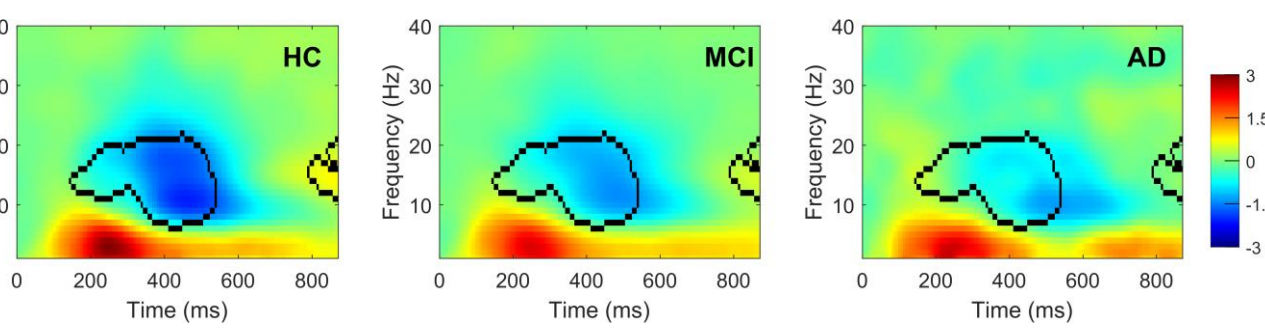
Reduced delta–theta ITC suggests less consistent stimulus-locked neural timing in MCI/AD.



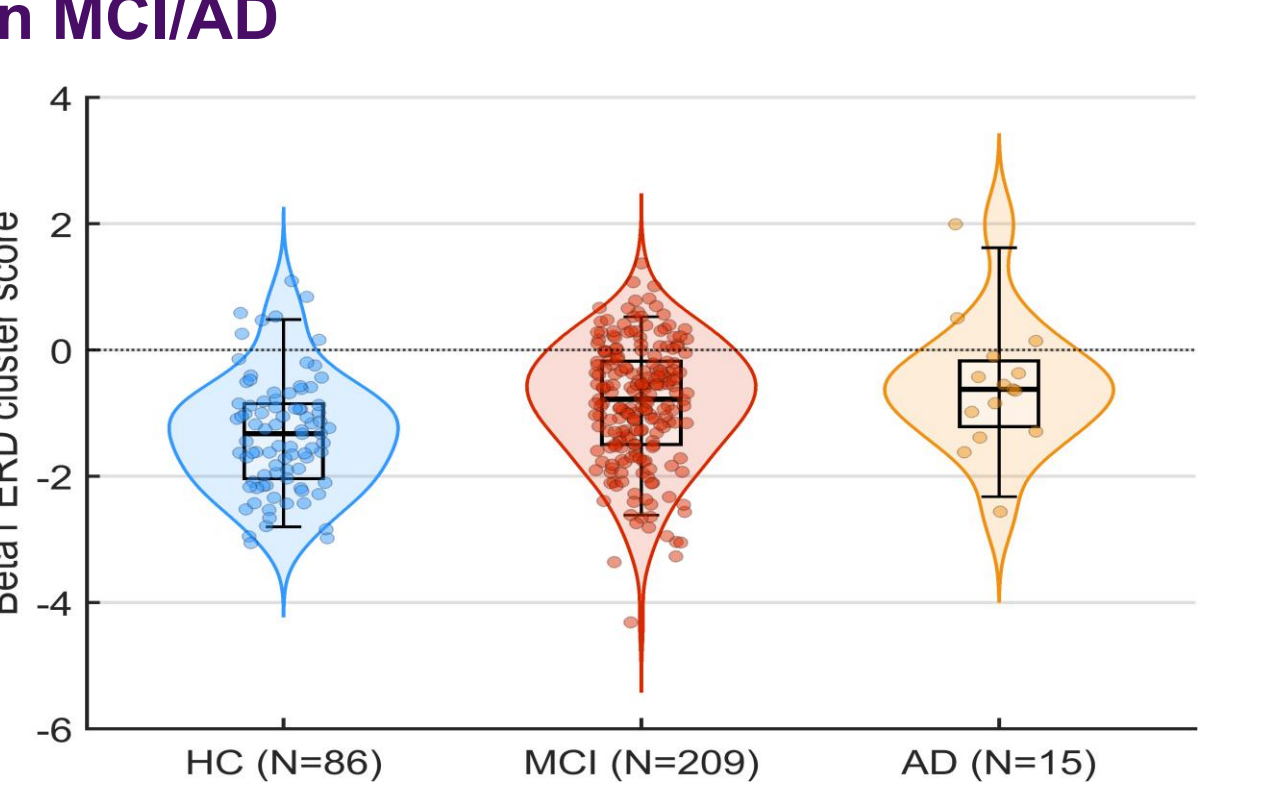
Delta–Theta ITC cluster scores by group. Lower values indicate reduced temporal consistency of stimulus-locked responses.

ERSP abnormalities

ERSP results. Cluster-based permutations identified two significant Beta1-band clusters (13–18 Hz). The primary cluster of interest showed reduced beta event-related desynchronization (ERD) in patients during the stimulus–response interval (~200–500 ms), indicating weaker task-related beta suppression. The second cluster showed attenuated post-response Beta1 rebound (~700–900 ms), suggesting reduced re-engagement of beta activity following response execution.



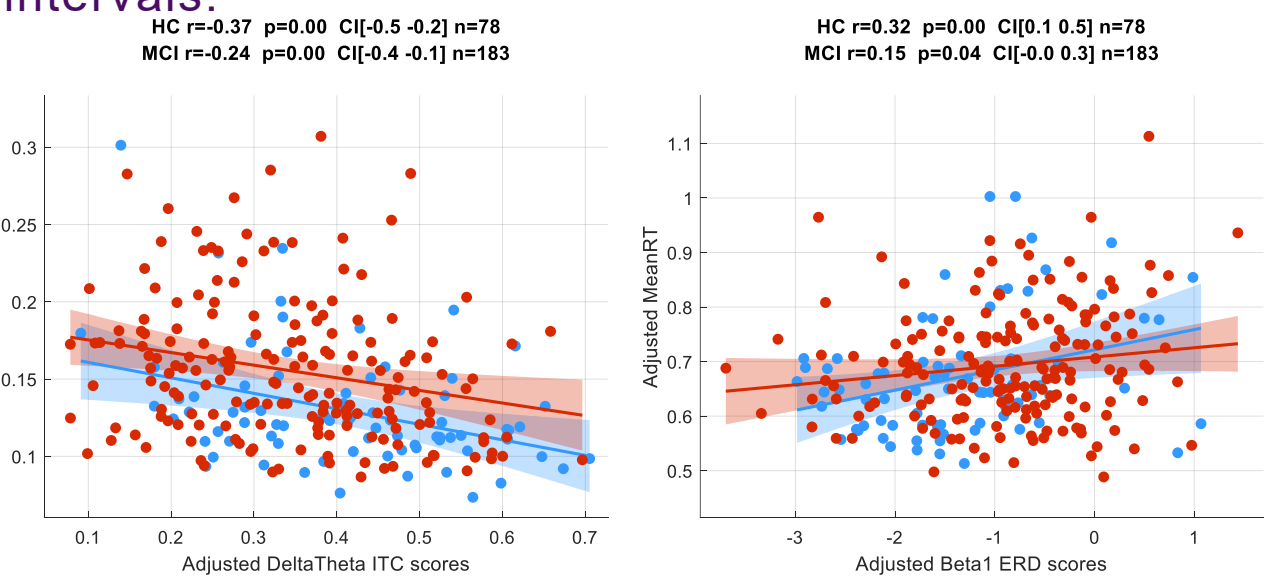
Reduced beta suppression during stimulus–response processing and reduced rebound after response execution in MCI/AD



Beta1 ERD cluster scores by group. More negative values indicate stronger Beta1 event-related desynchronization.

EEG vs BEHAVIOR

EEG–behavior associations. Age- and sex-adjusted scatterplots show that weaker Beta1 ERD was associated with slower mean RT, while higher delta–theta ITC was associated with lower RT variability, indicating more consistent responding. Lines show group-specific linear fits with 95% confidence intervals.



Although Beta1 ERD and Delta–Theta ITC showed partially distinct group-specific behavioral associations, their effects were not fully separable, suggesting overlapping contributions to task performance rather than a strict speed-versus-variability dissociation.

References

Meghdadi AH, et al. Resting state EEG biomarkers of cognitive decline associated with Alzheimer’s disease and mild cognitive impairment. *PLoS One*. 2021.

Güntekin B, et al. Are there consistent abnormalities in event-related EEG oscillations in patients with Alzheimer’s disease compared to other diseases? *Psychophysiology*. 2022.

Pfurtscheller G, Lopes da Silva FH. Event-related EEG/MEG synchronization and desynchronization: basic principles. *Clin Neurophysiol*. 1999.

Makeig S, Debener S, Onton J, Delorme A. Mining event-related brain dynamics. *Trends Cogn Sci*. 2004.

Phillips M, et al. Intra-individual reaction time variability in mild cognitive impairment and Alzheimer’s disease. *J Clin Exp Neuropsychol*. 2013.

CONCLUSIONS

MCI and AD were associated with reduced task-evoked delta–theta ITC and attenuated Beta1 modulation during the three-choice vigilance task. Reduced delta–theta ITC suggests less consistent stimulus-locked neural timing, while weaker Beta1 ERD/rebound indicates reduced task-related beta modulation during response processing. These EEG abnormalities were associated with slower and less stable behavioral performance, supporting their relevance as task-evoked markers of impaired sustained attention in cognitive impairment.

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