A real-world point of care EEG/ERP biomarker platform for assessment of the neurophysiological deficits in individuals with Mild Cognitive Impairment

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Key takeaway: Possible diagnostic role for point-of-care EEG/ERP assessment platforms to track the trajectory of cognitive decline at an individual level

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INTRODUCTION

Electroencephalogram (EEG) and event-related potential (ERP) biosignatures have shown promising potential for use in assessing cognition in neurodegenerative diseases such as Alzheimer's disease. Consistently reported findings include **increased EEG theta and decreased EEG alpha during resting state, slowing of the N100 and P300 ERP components and reduced amplitude of the P300.**

Methods currently being used are inadequate: cognitive tests (ex. MMSE) are subjective and not sensitive to subtle changes, cerebrospinal fluid analysis is invasive, and positron emission tomography (PET) scans are costly and not always easily available. Therefore, there is an important need for the development of alternative, more readily accessible neurophysiological biomarkers that can help to monitor disease progression and track cognition. In this work, we report preliminary results on the **real-world application of a point-of-care EEG/ERP platform (BEAM™) in a clinical setting** for the assessment of individuals with Mild Cognitive Impairment (MCI).

METHODS

With comprehensive neurological and memory evaluation in the Memory Disorders Clinic at Hawaii Pacific Neuroscience, individuals diagnosed with MCI (NIA-AA 2011 Criteria) were selected for this study (n=56, ages 51-87 (72±8 SD), 48% female).

BEAM™ platform (wireless, FDA-cleared EEG system integrated with time-synchronized computer-based neurocognitive testing) was used to assess resting state EEG (eyes-open and eyes-closed, 5-min each) and ERPs in auditory oddball (AO), image recognition memory (SIR), and sustained attention tasks (3 choice vigilance: 3CVT). Pre-defined EEG/ERP measures were reported for each patient in percentiles relative to age-matched normative data.

RESULTS – EEG data

100%, 84%, 82%, and 58% of the patients completed the resting state, auditory oddball, attention task, and memory task, respectively. In the AO task and compared to healthy controls, **MCI patients exhibited an average 12 ms delay** in early processing of auditory stimuli, as measured by **N1 latency** ($p<0.001$, ES=1.3, df = 87) and 2.7μV **reduction of the P300** amplitude ($p<0.03$, ES = 0.4, df=92). In resting state eyes closed, **MCI patients exhibited elevated theta power** (average ES=0.27) that reached statistical significance (uncorrected) in limited number of channels (e.g. $p<0.05$, ES=0.36 at F4).

These findings were confirmed in BEAM™ reports demonstrating **ERP deficits at an individual level,** presented in percentile values.

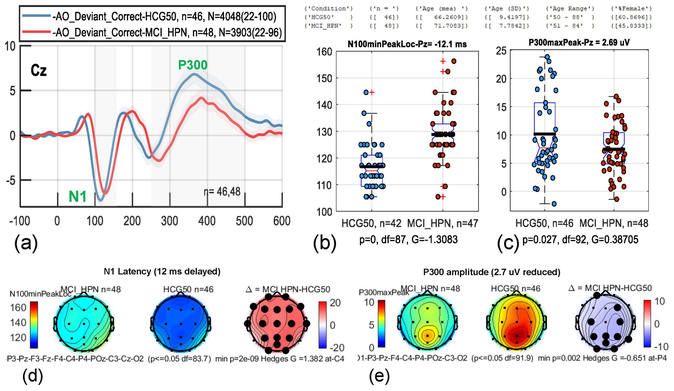

Figure 1. (a) Grand average ERP waveforms for the MCI patients (in red) compared to age-matched healthy controls (in blue) demonstrating the **delayed early processing of the auditory stimuli** as evident by the latency of N1 component. (b,c) N1 and P300 measured at channel Pz for patients and controls. (d,e) topographical maps of the **measured latency of N1 and amplitude of P300,** respectively, plotted for patients (left), controls (middle) and the difference between the groups (right).

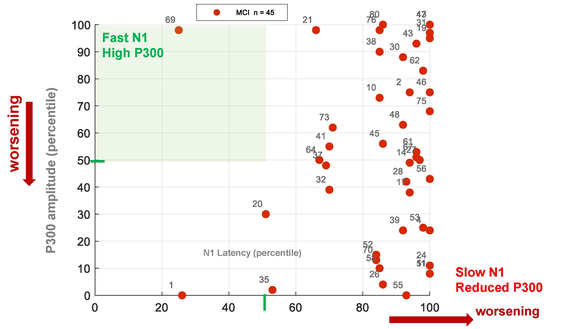

Figure 2. Scatterplot demonstrating the latency of N1 component (x-axis) and amplitude of the P300 component (y-axis) measured as percentile values compared to normative age match distribution for each individual. Most individuals with MCI are assessed outside of the 80% threshold of the normative range.

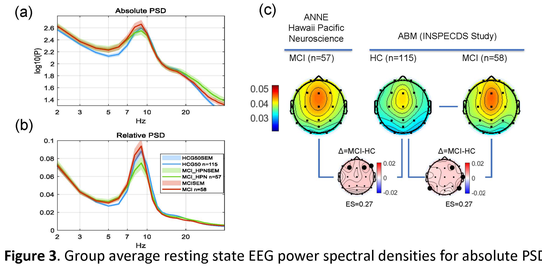

Figure 3. Group average resting state EEG power spectral densities for absolute PSD (a) and relative PSD (b) plotted for the MCI group (MCI_HPN: green color) compared to healthy (>50 years old) control group (HC: blue color), as well as another cohort of MCI participants in ABM's INSPECDS study (red). Topographical maps demonstrating group differences between each MCI cohort and the healthy controls (average normalized effect size across channels ES=0.27)

CONCLUSION

These results suggest a possible diagnostic role for point-of-care, rapid-setup EEG/ERP assessment platforms at an individual level. Unlike molecular diagnostic biomarkers of neurodegenerative disease, **EEG/ERP biosignatures could provide functional biomarkers** based on neural dysfunctions, which are the underpinnings of cognitive symptoms. As such, these methods could assist with **tracking the trajectory of cognitive decline** at an individual level. Future work includes longitudinal data collection and evaluating the prognostic value of these biosignatures.

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