

Brain Networks in Motion: EEG Signatures Distinguishing Amnestic and Non-Amnestic MCI in a Visual Short-Term Memory Binding Task

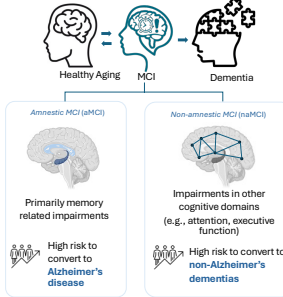
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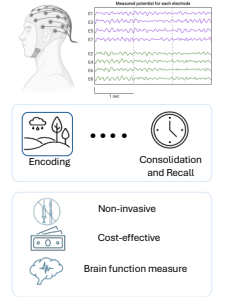


Introduction

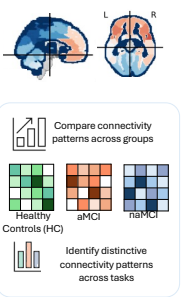
Mild Cognitive Impairment (MCI): a transitional state between healthy aging and dementia¹



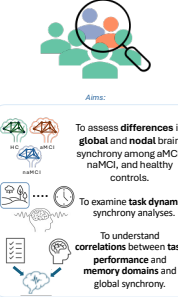
Task based electroencephalogram: brain activity during cognitive processes²⁻⁴



Source-space Analyses: functional connectivity patterns

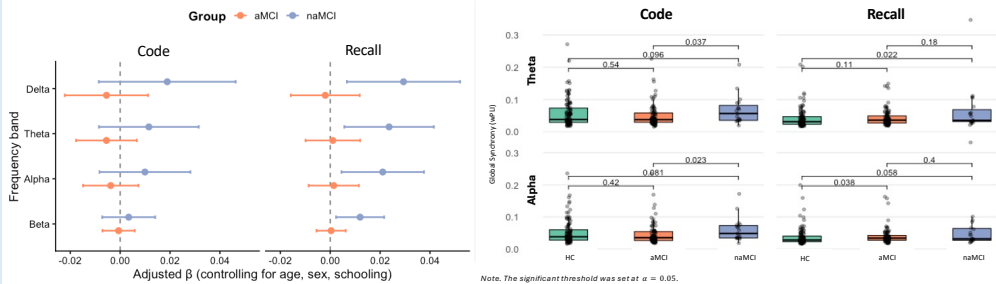


Goal: Early identification of at-risk individuals



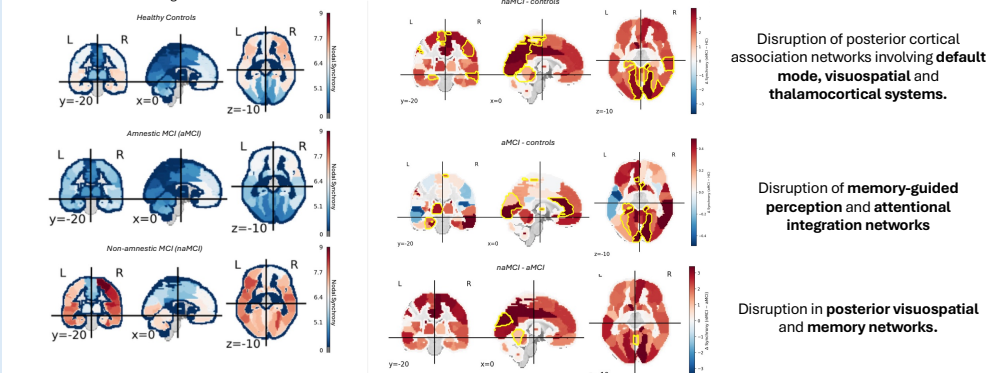
Global Synchrony

Figure 1: Generalized linear models show **higher global synchrony** in all canonical bands during recall in **naMCI** individuals compared to controls. **Figure 2:** Wilcoxon tests show **higher synchrony** in **naMCI** compared to during **encoding**, and **aMCI** and controls during recall in the **theta** band, and **aMCI** and controls in **alpha** band.



Nodal Synchrony

Figure 3: Nodal synchrony shows **higher activity** in **naMCI** individuals compared to controls and **aMCI** in **alpha** band during recall. **Figure 4:** Difference of activity across groups highlight disruption in cognition-specific functional pathways in **aMCI** and **naMCI** during recall in alpha band.

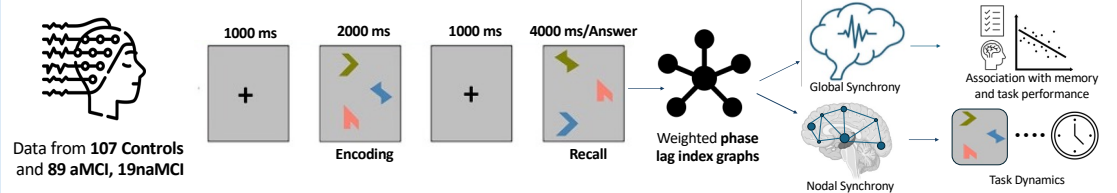


Note. The brain maps are represented as coronal, sagittal and transverse planes. Warm colours indicate greater activity, and cool colours indicate lower activity.

References

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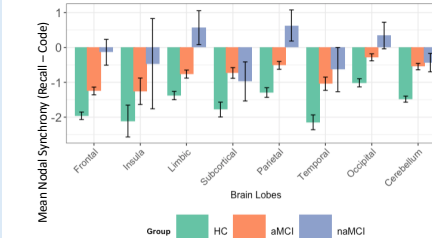
Methods



Data from 107 Controls and 89 aMCI, 19naMCI

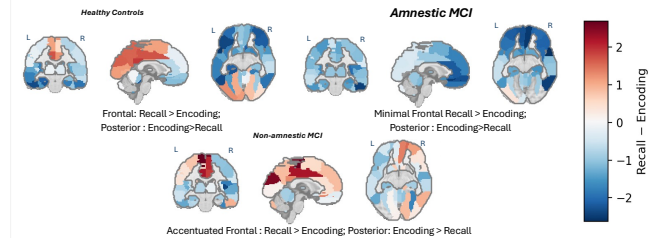
Task Dynamics

Figure 5: Nodal synchrony shows trends of **higher activity** in **naMCI** individuals in limbic, parietal and occipital regions during recall compared to **encoding** phase in **alpha** band



Note. Above zero = Recall > Encoding; Below zero: Encoding > Recall

Figure 6: Nodal synchrony showed **lower trends** during recall than encoding. Controls showed expected **prefrontal increase** during recall, while aMCI showed a **slight increase** and naMCI showed **widespread hypersynchrony**, especially in **medial and posterior regions** during recall.



Note. The brain maps are represented as coronal, sagittal and transverse planes. Warm colours indicate greater activity during recall relative to encoding and cool colours indicate greater activity during encoding relative to recall.

Association with Cognitive Domains and Task Performance

Figure 7: Increase in **global synchrony** during recall is associated with **lower memory** in individuals with **aMCI**.

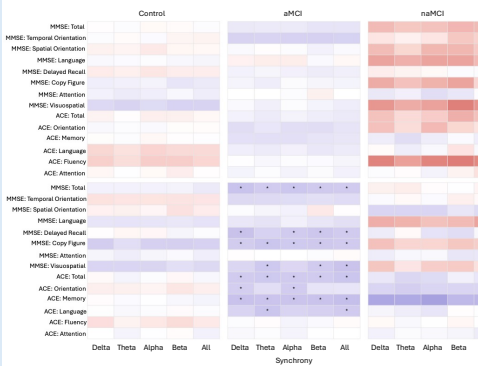
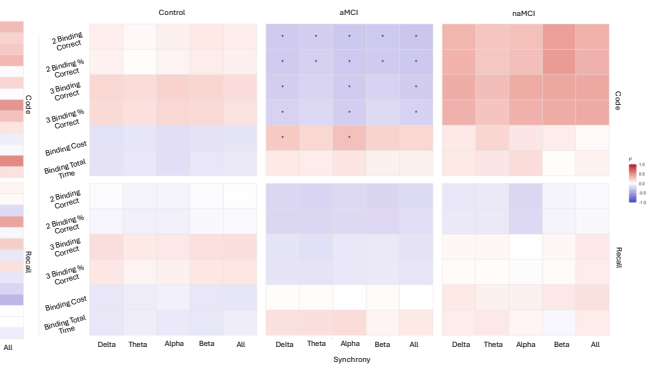


Figure 8: Individuals with **aMCI** shows **higher synchrony** is associated with **poorer task performance**, while **naMCI** showed trends of **higher synchrony** associated with **better performance**.



Discussion

- During recall, naMCI exhibited **global and nodal hypersynchrony**, consistent with **compensatory mechanisms** under **cognitive load**^{5,6}.
 - In the **alpha** band, **controls** showed expected **frontal recall > encoding** pattern, aMCI showed a slight increase, and naMCI showed **widespread increase**, focused in the limbic, parietal and occipital regions.
 - Nodal differences suggest that **naMCI** is characterised by **recall-related synchrony** changes focused on **posterior visuospatial and attentional systems**, while differences between controls and aMCI are consistent with **memory-related network disruptions**.
 - Higher synchrony** correlates **negatively** with **memory** during **recall**, and **task performance** during **encoding**, consistent with **inefficient compensation** in aMCI.
- Limitations:**
- Underpowered sample in naMCI group.
 - Source-space EEG estimation may lead to unreliable results within the deeper layers of the brain.

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