

The impact of Alzheimer's disease progression on unfamiliar face identity recognition ability: objective EEG evidence

Introduction

- Patients with Alzheimer's Disease (AD) typically fail to recognise familiar face identities¹.
- This impairment has been mainly investigated with neuropsychological tests that involve episodic or semantic memory.
- Whether the core ability to discriminate facial identities based on visual processes only is affected in AD**, and at which stage, remains unknown and debated.
- Here we use the combination of EEG and Fast Periodic Visual Stimulation (FPVS), **a powerful implicit and objective approach sensitive to AD cognitive deficits**^{2,3}.
- Thanks to the **high specificity** of this approach, **we assess unfamiliar face identity discrimination abilities in AD according to clinical stage**.

Method

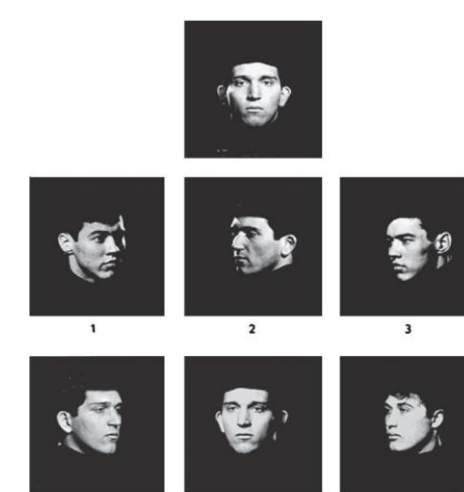
Participants :

30 control participants (CTR) (MMSE $\geq 27/30$ and cognitively normal (memory, executive, language and visuo-spatial z-scores > -1.5) & 30 AD patients including:

- 17 Mild Cognitive Impairment (MCI) due to AD patients** (MMSE ≥ 24 ; ≥ 1 cognitive z-score < -1.5 ; tau/amyloid Beta-42 ratio > 1.2)
- 13 dementia due to AD patients** (MMSE < 24 ; ≥ 2 cognitive z-scores < -1.5 ; tau/amyloid Beta-42 ratio > 1.2)

	Control subjects n=30	MCI due to AD patients n= 17	Dementia due to AD patients n=13	p-value
Age (Mean ($\pm$ SD))	71.8 $\pm$ 7	72.6 $\pm$ 7	74.1 $\pm$ 7	p=.58
Education level (Nb participants)				
Primary education	2	2	3	p=.38
Secondary education	2	1	2	
Post-secondary education	26	14	8	
Percentage of females (%)	66.67	64.71	61.54	p=.94
MMSE (Mean ($\pm$ SD))	28.9 $\pm$ 0.83	25.8 $\pm$ 1.95 *	20.8 $\pm$ 1.83 ***	p<.0001

Benton Face Recognition Test (computerised version): traditional behavioural face identity matching test.

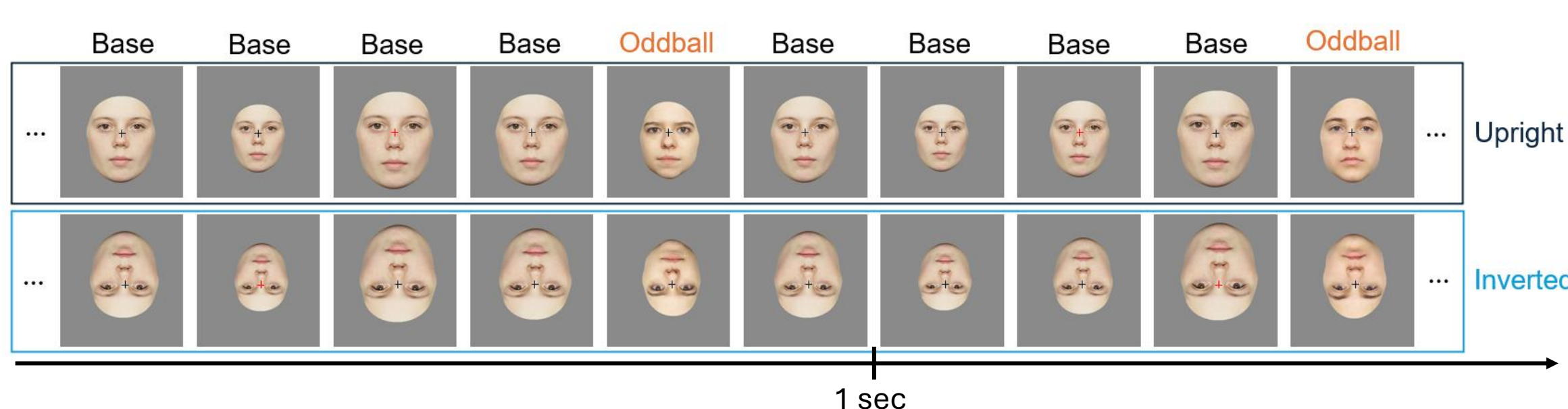


FPVS - EEG:

68-channel scalp EEG recording

FPVS paradigm⁴: - 6 presentation/sec of the same unfamiliar face (Base frequency: 6 Hz)

- variable other identities presented every fifth image (i.e., oddball frequency: 6/5=1.2Hz).
- 4 sequences with upright faces + 2 sequences with upside down faces (control condition).
- 60 sec visual stimulation sequence
- Participants' task: press a button when the centred cross briefly change colour



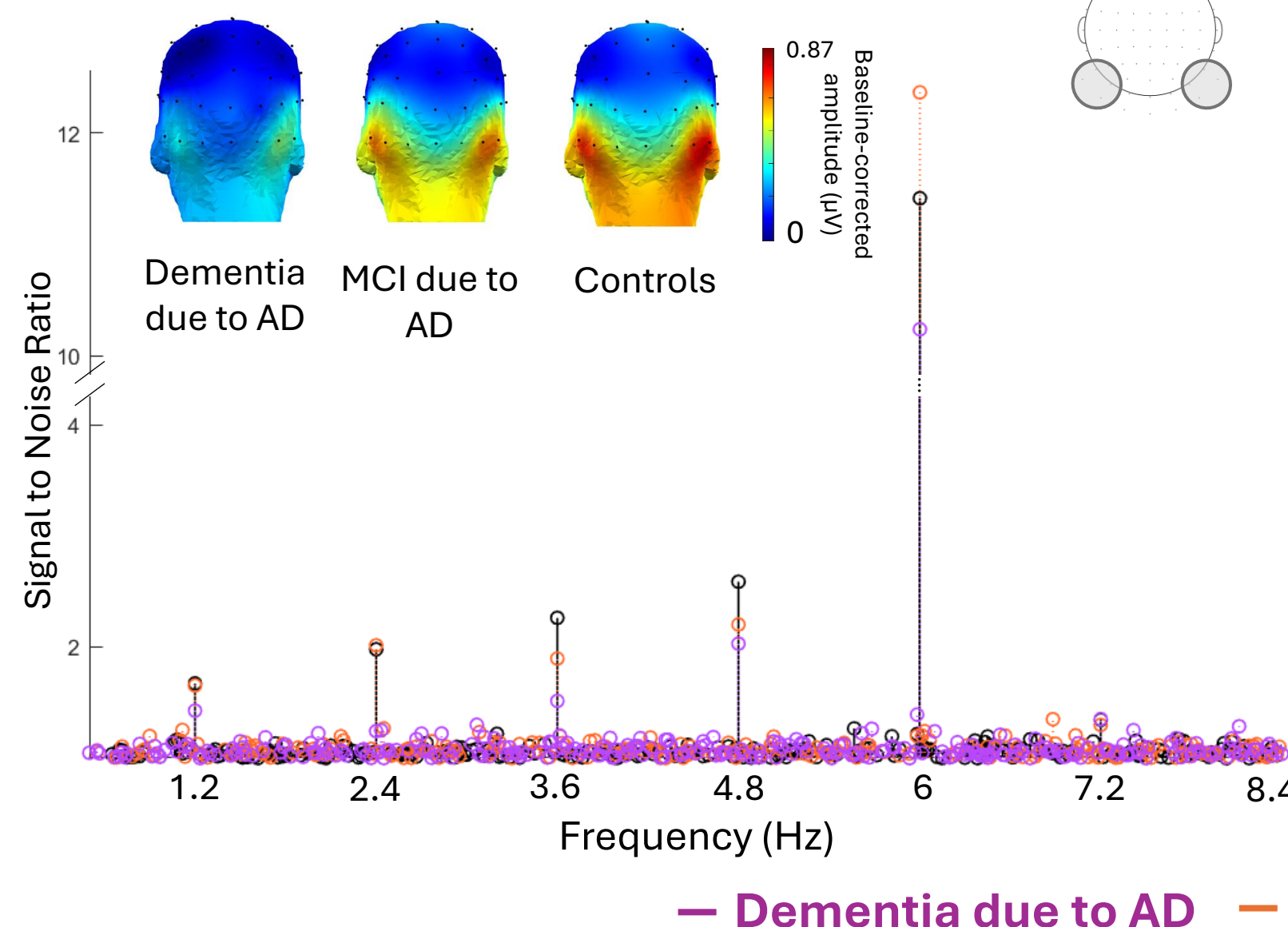
Analyses: EEG recordings are transformed in the frequency domain with Fast Fourier Transform (FFT). Z-score applied to define significant harmonics; amplitude response quantified as the sum of significant harmonics, subtracting (SBL, in μ V) or dividing (SNR) baseline EEG activity in neighbouring (noise) bins from the signal

If the participant is able to recognise unfamiliar face identities, a specific neural response is observed at 1.2 Hz and harmonics.⁴

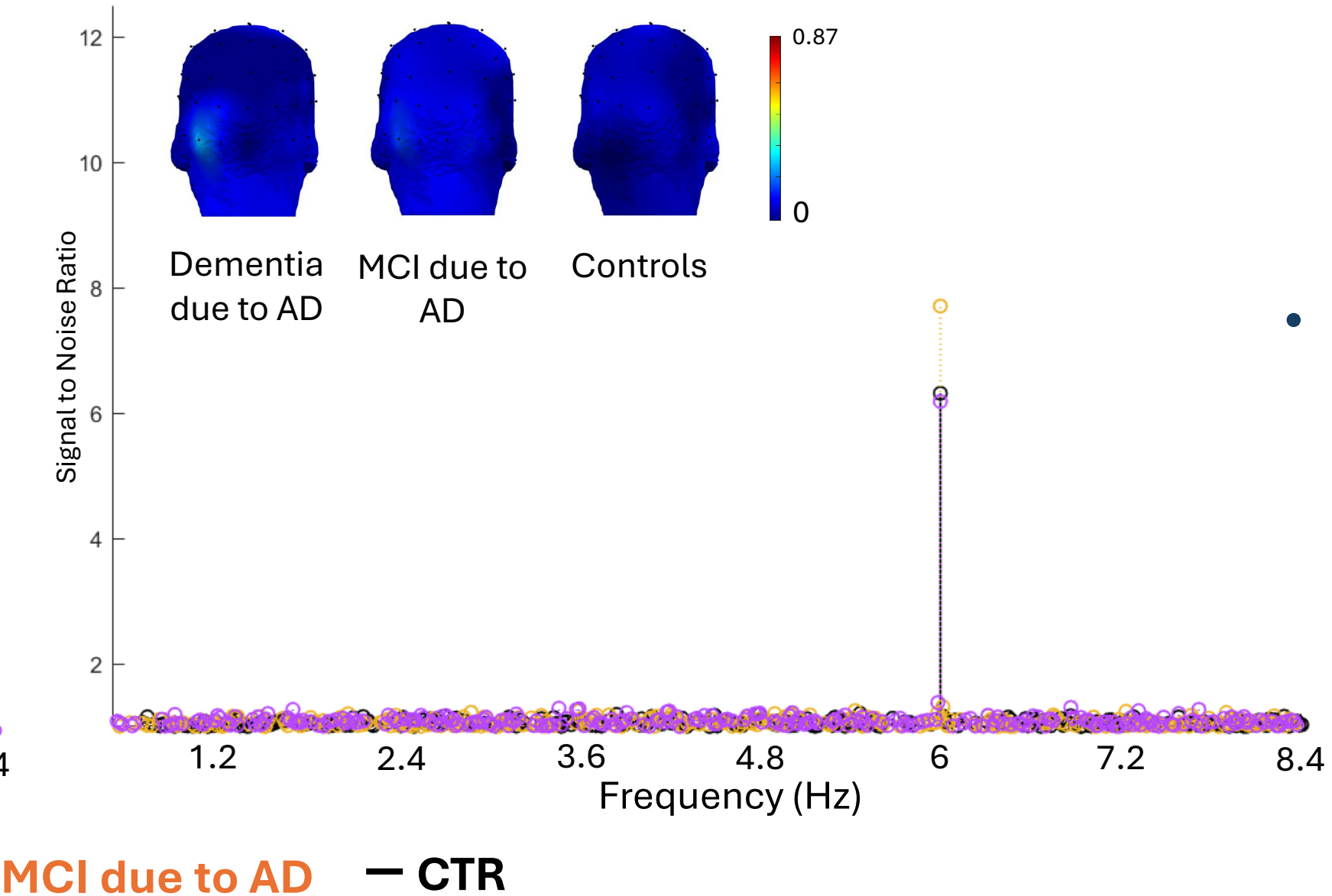
Results

Face Identity Recognition (FIR) EEG response (1.2 Hz and harmonics)

Upright Condition



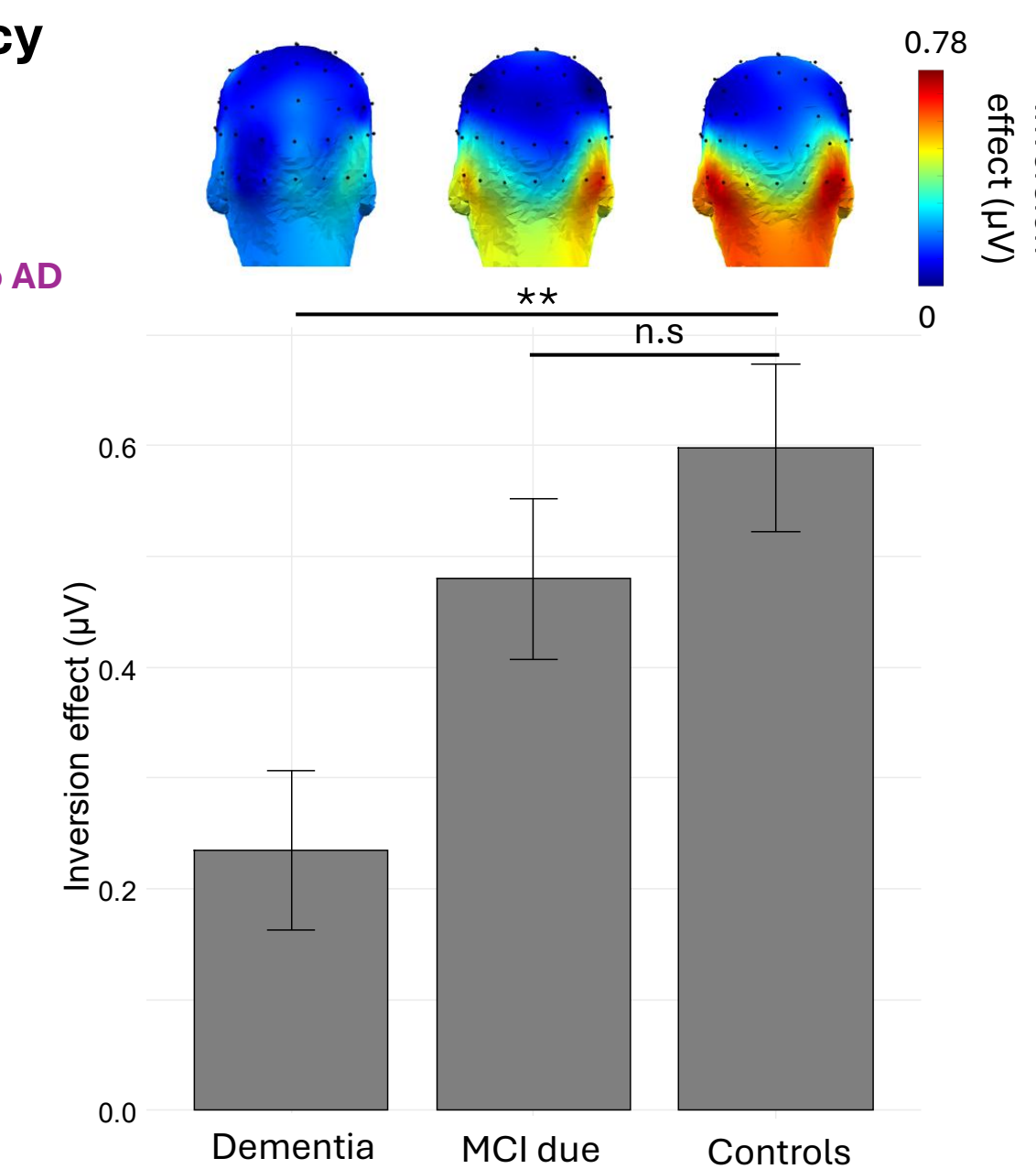
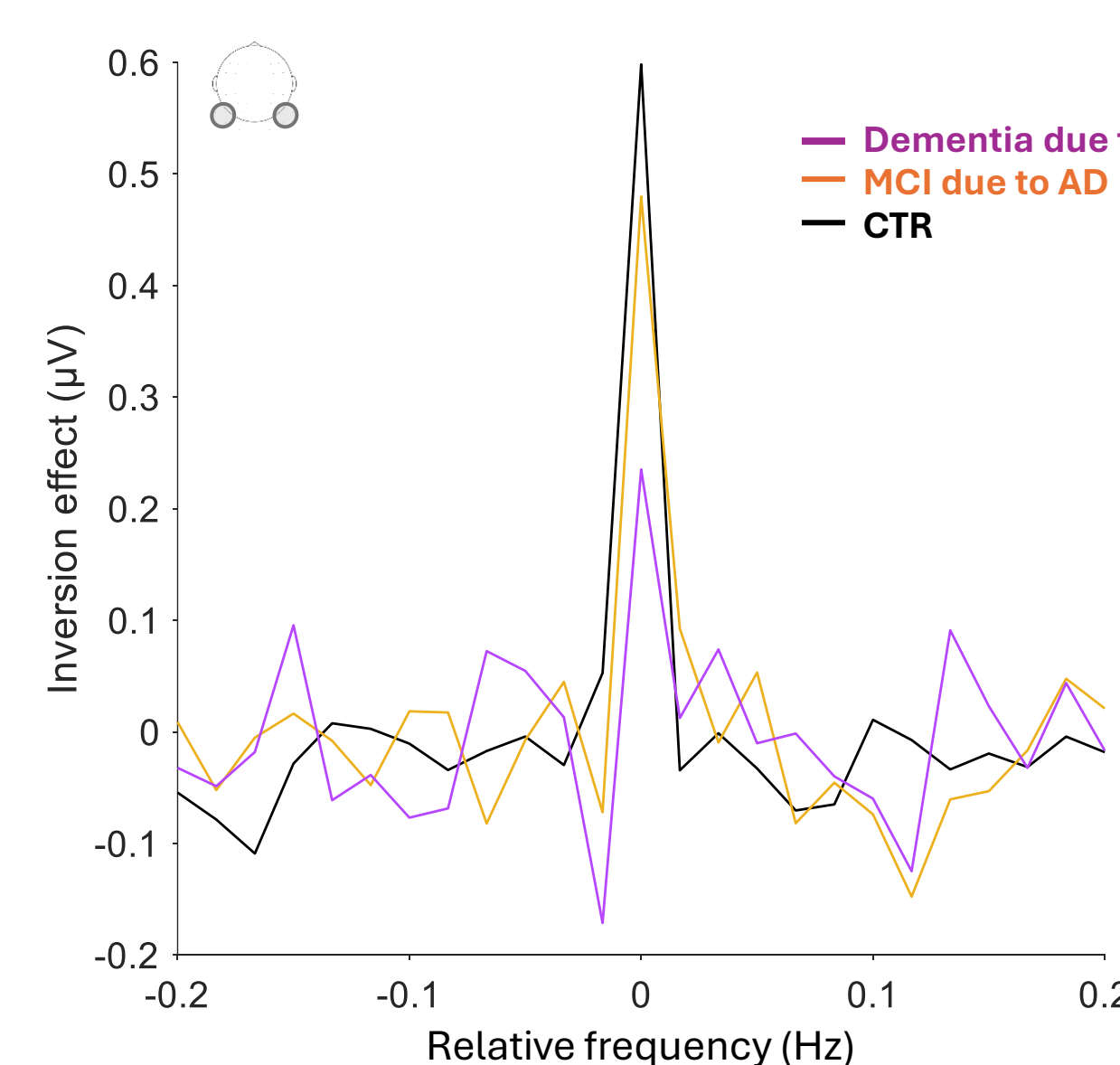
Inverted Condition



- Lower FIR responses in the Upright condition for dementia due to AD patients compared to controls** ($p=.048$), not present for the Inverted condition ($p=.57$).
- No significant difference between the MCI due to AD group and controls in either condition** (Upright: $p=0.87$, Inverted: $p=0.77$), nor between the two patient sub-groups (Upright: $p=.19$; Inverted: $p=0.94$).

Inversion effect (upright FIR EEG response minus inverted FIR EEG response)

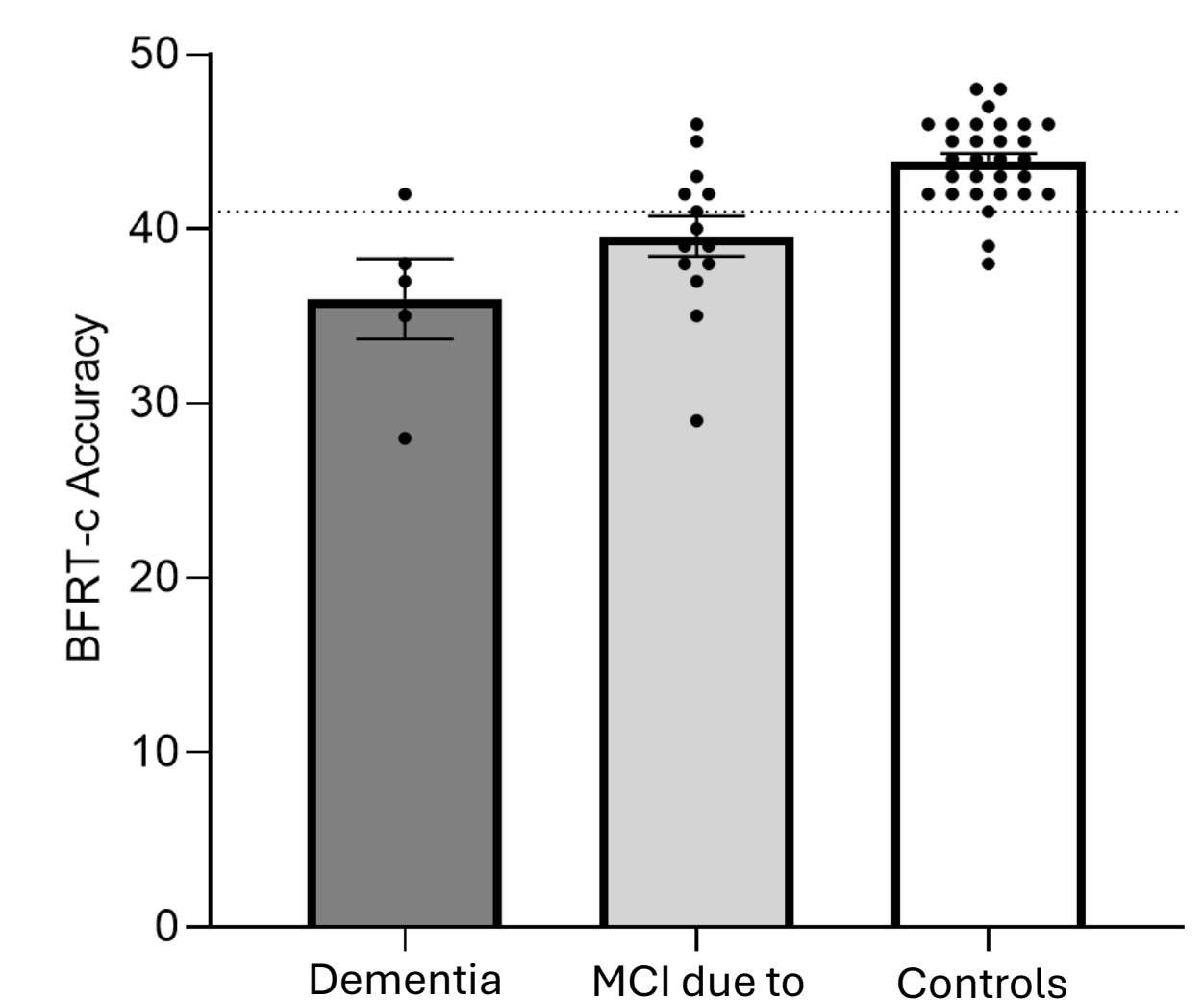
Inversion effect at the oddball frequency (1.2 Hz) sum across harmonics



Dementia due to AD patients have a significantly lower inversion effect than controls ($0.60 \pm 0.41 \mu$ V; $t_{57}=3.08$, $p=.009$, $d=1.02$). **Inversion effect of MCI due to AD patients was similar to controls** ($t_{57}=1.10$, $p=.52$, $d=0.33$).

BFRT-c results :

8 AD dementia patients and 3 AD MCI patients could not complete the BFRT-c until the end, complaining about its difficulty. Both **AD dementia and MCI due to AD patients showed reduced accuracy** compared to controls.



Discussion

- While previous behavioural study⁵ and BFRT-c results suggest impaired FIR abilities since the MCI stage, FPVS-EEG revealed **preserved FIR neural response in MCI due to AD patients, but a significant reduction of FIR EEG response in dementia due to AD**.
- The BFRT(-c) is not adapted to test specifically these abilities in patients with multiple major cognitive disorders.
- FIR difficulties observed in behavioural tasks in MCI arise from other cognitive processes rather than impaired visual discrimination, whereas dementia involves a genuine perceptual deficit.
- These results are important to adapt cognitive intervention and compensation strategies.
- FPVS-EEG could provide a complementary tool to easily and rapidly measure face recognition ability in neurodegenerative populations and to disentangle specific cognitive processes underlying impaired behavioural performances**

References

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