

Delta Phase Locking Differences Between Auditory and Visual Oddball Reduced in Alzheimer’s Disease with Posterior Cortical Atrophy



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INTRODUCTION

Posterior cortical atrophy (PCA) is a neurodegenerative syndrome marked by progressive visuospatial and perceptual impairments (Goldstein et. al., 2018).

While resting-state studies have reported oscillatory alterations in PCA, less is known about how event-related oscillatory responses are affected during sensory processing.

Auditory and visual oddball paradigms offer a robust framework for examining oscillatory activity related to attention and stimulus evaluation.

This study compared oscillatory power and phase-locking responses between PCA patients and healthy controls (HC) to identify frequency-specific differences across auditory and visual modalities.

METHODS

- Demographically-matched 14 PCA patients and 14 HC

Table 1: Comparison of Age, Education, and Cognitive/Clinical Measures Between Groups

	HC			PCA			t	df	p
	n	M	SD	n	M	SD			
Age	14	56.71	3.77	14	56.57	5.33	.082	26	.935
Education	14	13.50	2.85	14	10.29	3.81	2.527	26	.018
AU_Delta	14	35.43	4.07	14	35.07	5.12	.204	26	.840
AU_TAB	14	37.93	2.46	14	37.71	3.93	.173	26	.864
VI_Delta	14	36.93	4.55	14	34.57	5.39	2.312	26	.059
VI_TAB	14	38.79	2.26	14	36.29	5.04	1.692	18.01	.108
GDS	14	4.79	4.46	12	9.08	8.21	-1.621	16.38	.124
MMSE	14	29.00	.96	13	20.15	3.29	9.339	13.90	<.001

M = mean; SD = standard deviation; AU_Delta: Number of epochs for Auditory delta analysis; AU_TAB: Number of epochs for Auditory theta, alpha, beta analysis; VI_Delta: Number of epochs for Visual delta analysis; VI_TAB: Number of epochs for Visual theta, alpha, beta analysis; GDS: Geriatric Depression Scale; MMSE: Mini-Mental State Examination.

Table 2: Comparison of Gender and Handedness Distributions Between Groups

	HC n (%)	PCA n (%)	Total n	χ^2	df	p	Fisher's Exact p
Gender				.622	1	.430	.695
Male	6 (42.9)	4 (28.6)	10				
Female	8 (57.1)	10 (71.4)	18				
Handedness				.373	1	.541	1.000
Right	13 (92.9)	12 (85.7)	25				
Left	1 (7.1)	2 (14.3)	3				

HC: Healthy Controls; PCA: Posterior Cortical Atrophy

- ✓ EEG was recorded on Brain Vision Recorder
- ✓ Auditory and Visual oddball tasks(40 target/80nontarget)
- ✓ Mental counting for target
- ✓ Event-related spectral power (ERSP) and inter-trial coherence (ITC)
- ✓ Included electrodes: F3,Fz,F4,C3,Cz,C4,P3,Pz,P4,O1,Oz, O2
- ✓ 1.5-15 Hz frequency
- ✓ –3000 to 3000ms time window,
- ✓ Cluster-Based Permutation Test (Fieldtrip)
- ✓ Delta (1,5-4 Hz,0-1000ms), Theta(4-7 Hz,0-600ms), Alpha (8-13Hz,0-500ms)

RESULTS

There was a significant cluster in delta ITC in 146-776ms time window, including posterior electrodes(P3,Pz,P4,O1,Oz,O2) at 1.5-3.33Hz frequency band (p=.041). Another significant cluster in 0-108ms time range was found in Alpha ITC (p=.049). The cluster included F3, Fz, F4, C3, Cz, C4, P3, Pz, P4 in 10.33-13Hz.

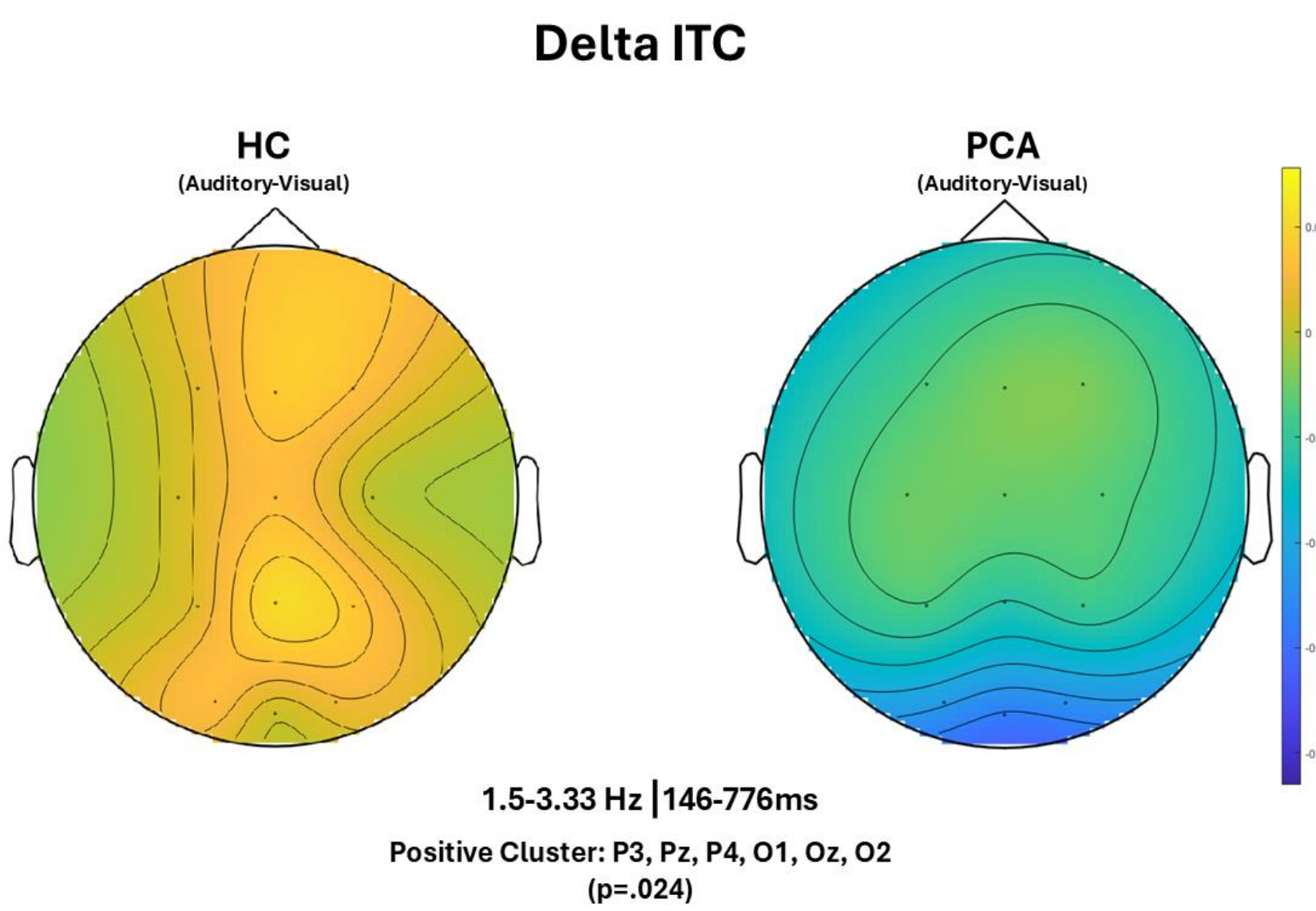


Figure 1: For both clusters, differences between the two modalities were reduced in the PCA group.

There were significant main group effects in visual delta and alpha power. The PCA group showed reduced visual delta total power in 250-536ms, whilst visual alpha total power increased in 272-500ms at frontal, central, parietal, and occipital sites.

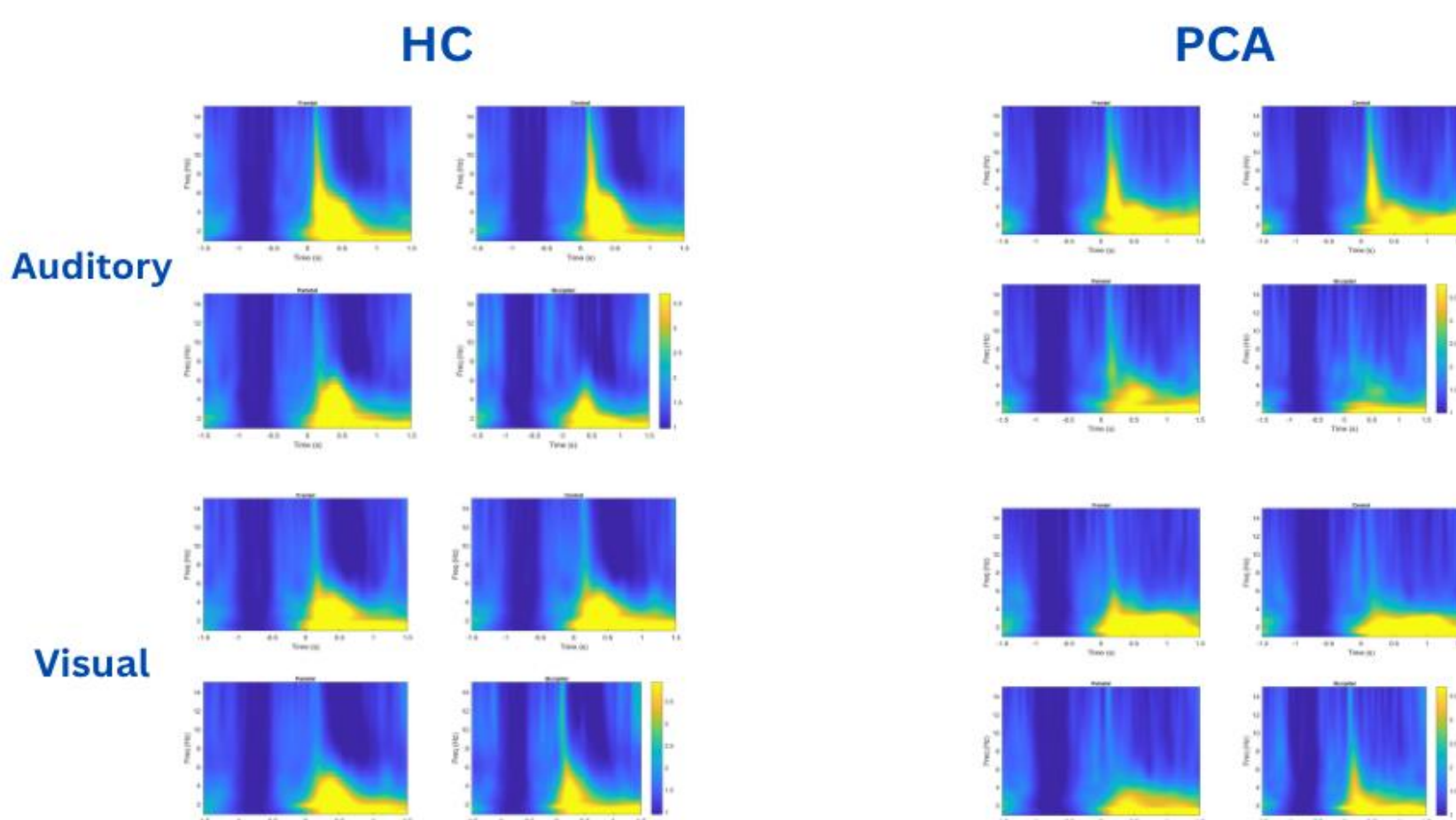


Figure 2: Comparison of groups across auditory and visual modalities

CONCLUSIONS

This is the first study to show that modality-specific differences in phase locking of delta and alpha frequency bands during auditory and visual oddball processing are reduced in posterior cortical atrophy.

Compared to healthy controls, PCA patients exhibit attenuated sensory differentiation, particularly in posterior delta and early alpha phase-locking responses. Reduced posterior delta phase locking is consistent with disrupted event-related oscillatory dynamics in PCA, suggesting impaired temporal coordination and diminished modality-specific oscillatory organization in posterior visual sensory networks. EROs can thus provide an objective method for demonstrating visual network impairment in PCA.

Previous studies have shown a reduction in posterior dominant alpha activity, along with decreased posterior and increased anterior functional connectivity hubs during resting-state EEG (Briels et al., 2020). In a visual ERP study using a reading task, decreased VEP responses were reported in PCA (Mares et al., 2015). However, there are not enough studies to fully characterize the electrophysiological profile of the PCA variant of AD. Further research in this area is clearly needed.

ALZHEIMER'S ASSOCIATION

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