

# TEMPORAL STABILITY OF POSTERIOR EEG ALPHA OVER TEN YEARS IN A STUDY OF FAMILIAL RISK FOR MAJOR DEPRESSIVE DISORDER

## Introduction

- Resting EEG alpha and theta activity have been identified as predictive of a positive response to a range of antidepressants.<sup>2,7</sup>
- The putative biomarkers (endophenotypes) of antidepressant treatment response are distinct from brain changes that underlie clinical depression or clinical outcome in that they precede the onset of the disorder and persist following treatment.
- While posterior EEG alpha exhibits test-retest reliability over the timespan required for a conventional treatment protocol,<sup>6,22</sup> some studies have suggested stability at longer time scales<sup>8,14,23</sup> (i.e., years rather than days or months).
- Here we evaluate test-retest reliability of posterior EEG alpha amplitude for 70 participants in a longitudinal study of familial risk of clinical depression with testing sessions separated by twelve years.

## Methods: Participants

- Participants were part of a multiwave three-generation longitudinal study of individuals at high and low risk for major depression based on family history.<sup>24, 25, 26</sup>
- Wave 1 probands recruited with moderate-to-severe major depressive disorder from greater New Haven area for psychopharmacologic treatment of mood disorders. Nondepressed, demographically-matched healthy controls from same community.
- Caucasian sample, working or middle class.
- $N = 70$  participants (41 female) selected based on joint availability of EEG at Wave 4 (20-yr timepoint) and Wave 6 (30-yr timepoint).
- Wave 4 ages:  $26 \pm 13.3$  yrs (5.2 – 47.6 yrs); Wave 6 ages:  $38 \pm 13.2$  yr (17.1 – 59.2 yrs).
- The time elapsed between test and retest was  $12 \pm 1.1$  y (range 9.4 - 15.5 yrs).**

## Methods: EEG Acquisition at Wave 4

- 13 EEG channels 10-20 montage (F7, F3, F4, F8; T7, C3, Cz, C4, T8; P7, P3, P4, P8; digital linked-ears; bipolar blink and horizontal eye channels; cf. 20)
- Electrode cap (Electro Cap International) using a Bioamplifier system (James Long Company; 0.01-30 Hz).
- Continuous EEG data at 200 samples/s (NeuroScan acquire) segmented off-line to consecutive 1.28-s epochs every .64 s (50% overlap).
- Epochs contaminated by blinks, eye movements, or movement-related artifacts excluded using via  $\pm 100 \mu V$  threshold (any channel), followed by interactive rejection of remaining artifacts.<sup>5</sup>

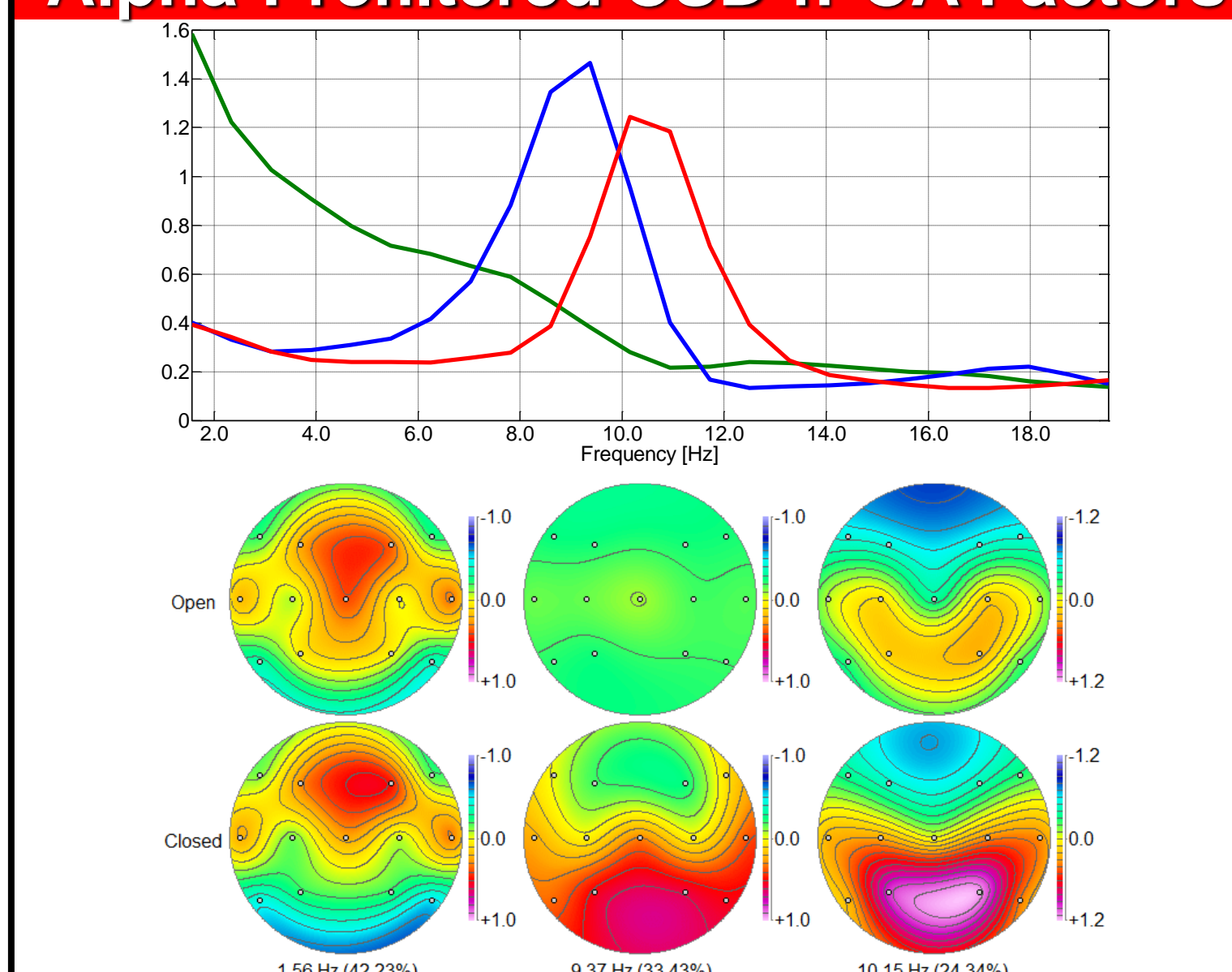
## Methods: EEG Acquisition at Wave 6

- 72 EEG channel 10-10 montage (nose reference<sup>9,17,21</sup>)
- Biosemi Active 2 system<sup>4</sup> (DC – 51.3 Hz).
- Continuous EEG at 256 samples/s segmented into 2-s epochs (75% overlap)
- Blink-corrected using spatial, singular value decomposition.<sup>15</sup> Epoched data screened for electrolyte bridges,<sup>1,18</sup> and affected channels interpolated via spherical splines.<sup>16</sup> Trial-by-trial artifact or noise identified via reference-free approach<sup>13,22</sup> and affected channels interpolated<sup>16</sup>
- Epochs exceeding  $\pm 100 \mu V$  were rejected to match Wave 4 methods.
- Wave 4 13-channel montage used

## Methods: CSD-fPCA Methods

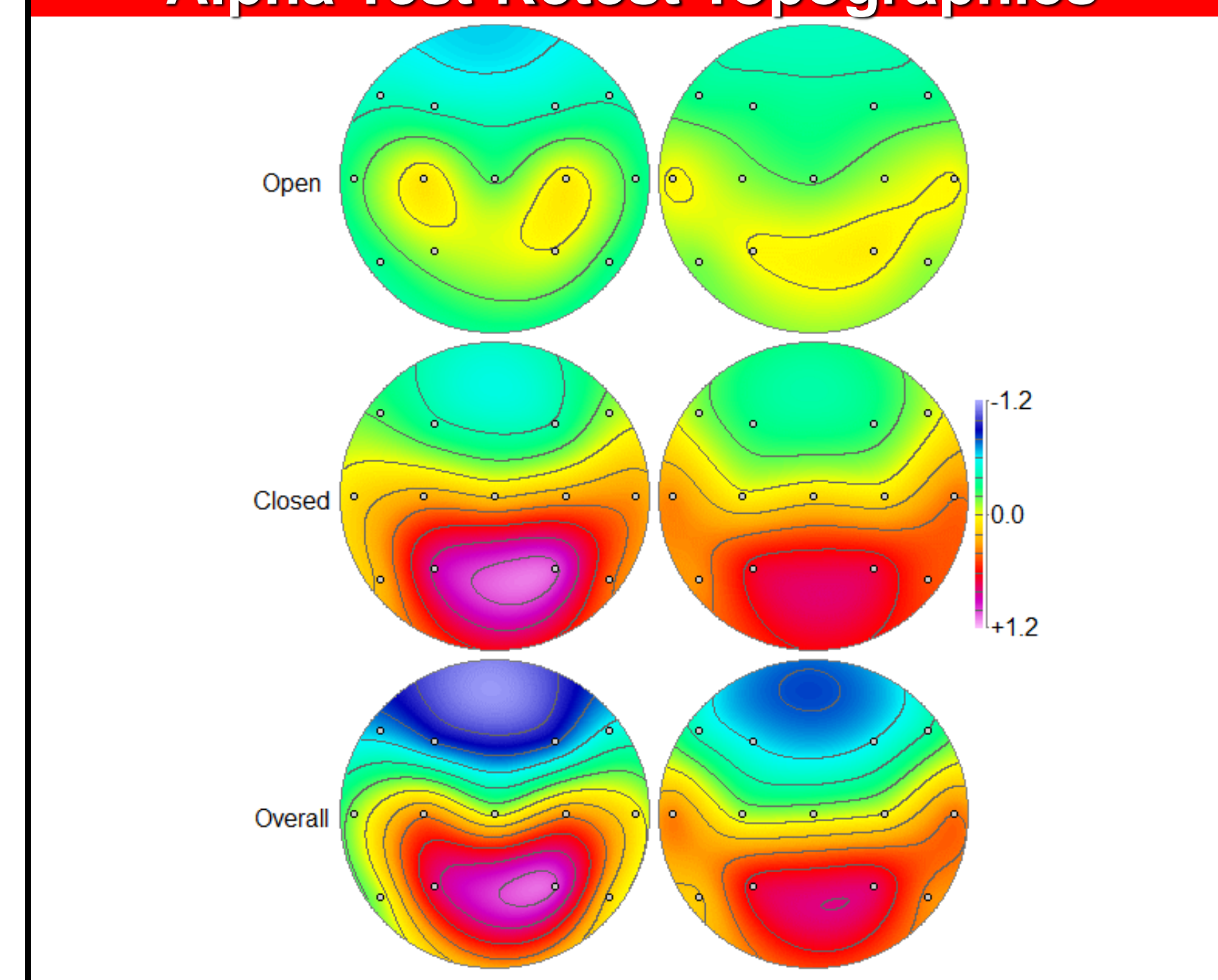
- Power Spectra.** EEG epochs transformed to CSD via spherical spline Laplacian ( $m = 4$ ;  $\lambda = 10^{-5}$ , 50 iterations; 10,12,16). DC offsets removed and Hanning tapered over entire epoch (Wave 4: 1.28-s; Wave 6: 2-s). Power spectra averaged for eyes-open and eyes-closed at 0.78 Hz for Wave 4<sup>20</sup> and 0.25 Hz for Wave 6 epochs (1-s zero-padded at both ends of epoch;<sup>21,22</sup>).
- Matching Wave 4 and Wave 6 Data.** Power spectra imported to Matlab over 0.0 – 50.0 Hz and Wave 6 interpolated to 0.78 Hz resolution. Spectral data scaled as recommended for multiple acquisition systems.<sup>22</sup>
- CSD-fPCA.** Power spectra converted to amplitude (square root), truncated to 0.78 - 39.8 Hz, and submitted to unrestricted, covariance-based frequency PCA (fPCA) with Varimax rotation of covariance loadings.<sup>11</sup> First four factors ( $> 5\%$  variance; total variance = 89.52%) peaked at 1.56 (delta), 25.00 (EMG beta), 10.15 (high alpha) and 9.37 Hz (Low alpha).
- Alpha Prefiltered CSD-fPCA.** To reduce factor overlap, amplitude spectra were reconstructed from factor score topographies of the two alpha factors and the overlapping delta factor. Data further truncated to 0.78 – 19.5 Hz, and submitted to a final covariance-based fPCA with Varimax rotation. cf. 19,21,22

## Alpha-Prefiltered CSD-fPCA Factors



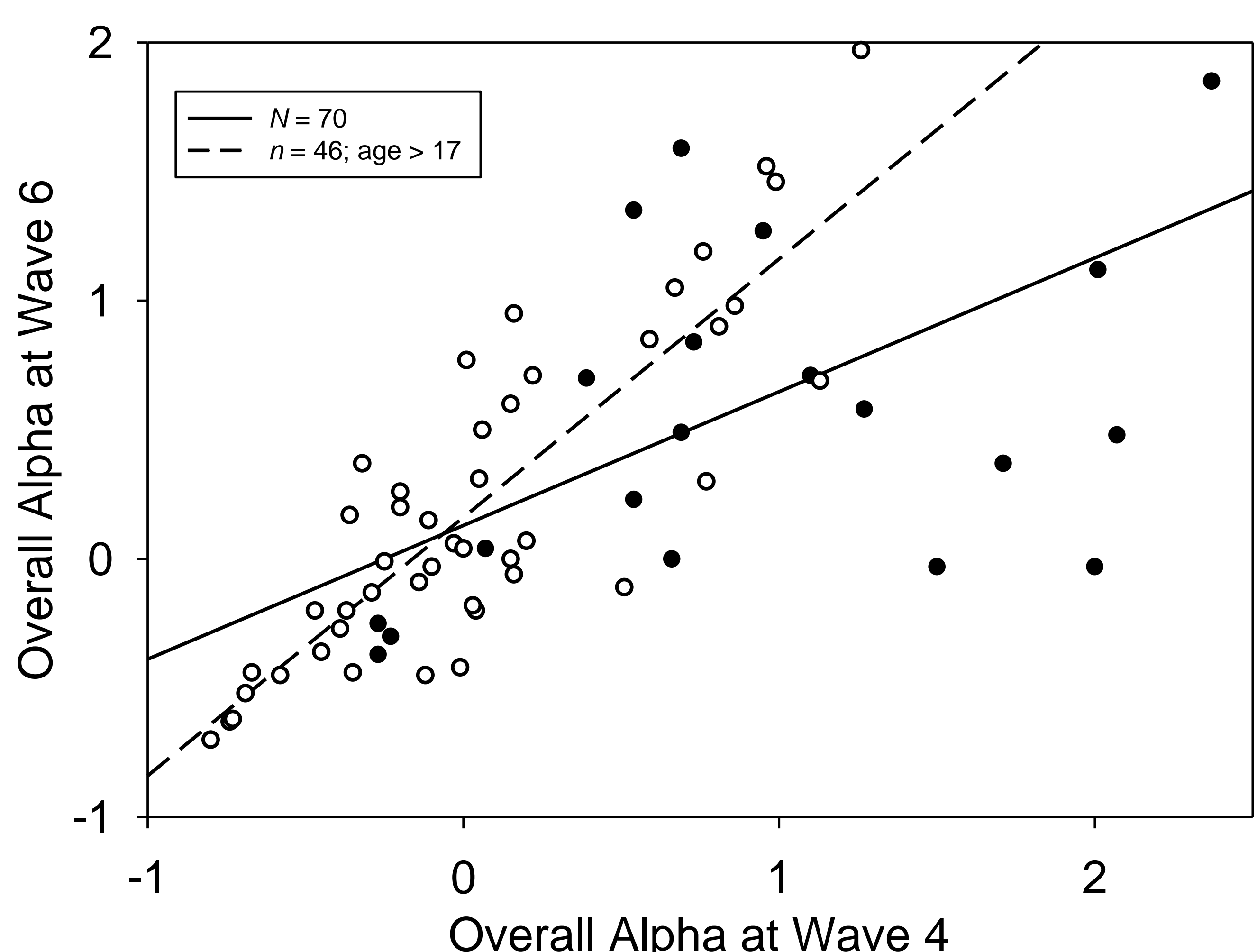
**Fig. 1:** Alpha-prefiltered CSD-fPCA factor loadings (top) and factor score topographies (bottom). Low-frequency alpha (blue; middle column maps) and high-frequency alpha (red; right column) are greatest for eyes-closed (bottom row).

## Alpha Test-Retest Topographies



**Fig. 2:** Averaged alpha score topographies for eyes-open, eyes-closed, and their overall mean at Waves 4 and 6 (means across low- and high-frequency alpha)

## Overall Posterior Alpha: Test-Retest Correlations



**Fig. 3:** Overall posterior alpha was remarkably stable across waves, with high correlations (Pearson's  $r = .718$ , all  $p < .001$ ) and good reliability (Spearman-Brown  $r_{SB} = .834$ ). However, as suggested by developmental studies,<sup>3,23</sup> reliability was even more robust for 46 participants who were 18 or older at both waves, with **Pearson's  $r = 0.848$ , corresponding to excellent reliability ( $r_{SB} = .918$ )**. For this subsample, reliability was good for eyes-closed ( $r_{SB} = .8932$ ), excellent for eyes-open ( $r_{SB} = .9065$ ), and acceptable for their difference (net alpha:  $r_{SB} = .7500$ ).

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## Conclusions

- Overall posterior alpha, as quantified by reference-free CSD-fPCA, showed excellent stability for resting EEG over a 9 - 16 yr time interval**
- Findings provide strong evidence that posterior alpha is a trait characteristic in adults**