Supplementary Methods

Cavanagh et al. Preprocessing.

Following Cavanagh et al., [see reference 18 in the main text] raw data were imported and epoched around feedback events, and baseline correction was applied across all time points. Each recording included 66 channels originally, but dropping non-EEG channels resulted in n = 60 channels used for analysis. EEG preprocessing was performed in MATLAB [1] using EEGLAB [2] and a custom pipeline developed by James F. Cavanagh called APPLE (Algorithmic Preprocessing Pipeline for EEG) [see reference 18 in the main text]. Following Cavanagh et al., [see reference 18 in the main text] the APPLE function detected and rejected bad channels and epochs in conjunction with EEGLAB and FASTER [3] (Fully Automated Statistical Thresholding for EEG artifact Rejection, loaded from FASTER1.2.4b folder [4]).

Participants 544, 571, and 572 were missing from the resting state dataset, so they were removed from the task-based dataset. Conversely, participants 599 and 600 were missing from the task-based dataset, so they were removed from the resting state data. Following data cleaning, participants 536 and 542 were found to have bad data (Figure S1), so they were removed from both datasets.

MATLAB v.25.1.0.2943329, R2025a and EEGLAB v2025.0.0 were used. MATLAB add-ons and plugins that were used included Image Processing Toolbox, Signal Processing Toolbox, Statistics and Machine Learning Toolbox, Bioinformatics Toolbox, and shadedErrorBar.

Supplementary Figures

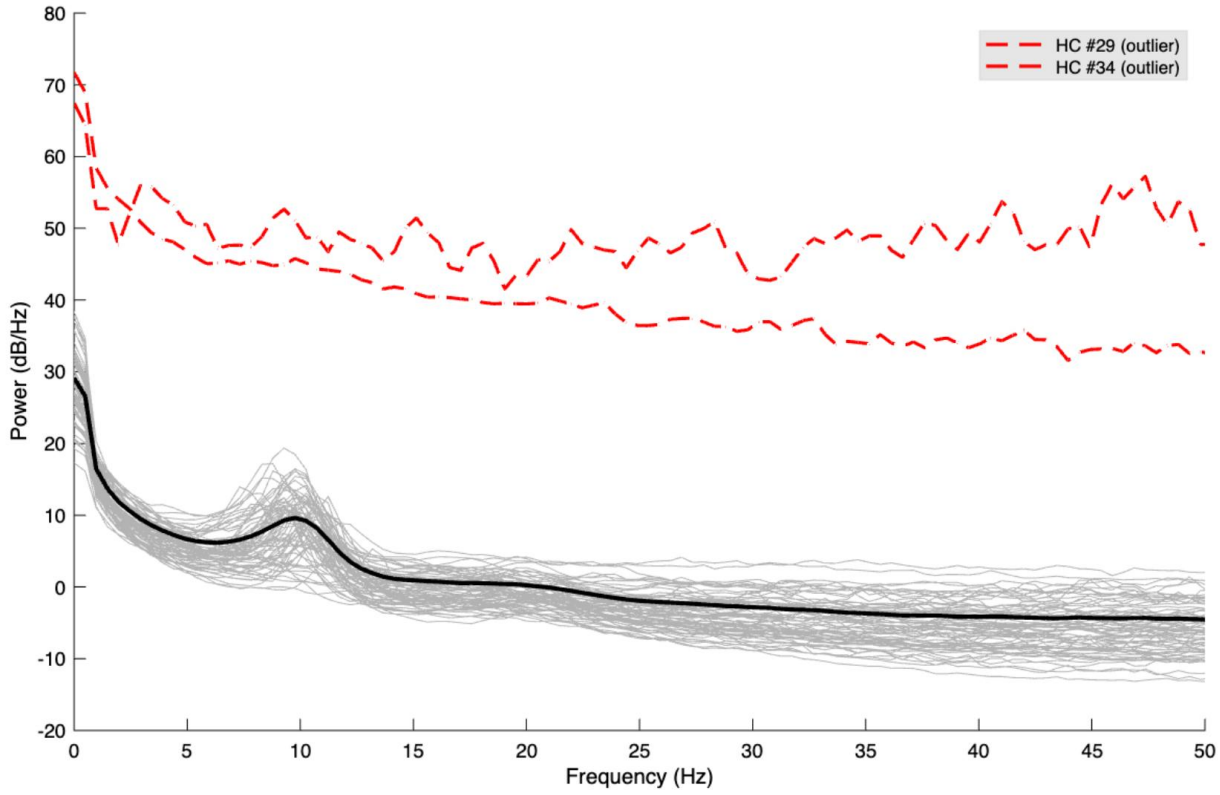

Figure S1. Average PSD Profiles of Individual HC_2 Participants Across All EEG Channels. Gray lines represent individual HC subjects, while red dashed lines highlight participants identified as statistical outliers. To identify outliers, we first computed each HC subject's average PSD across all EEG channels. Z-scores were then calculated for each subject's PSD at every frequency point relative to the HC group. Subjects were flagged as outliers if their PSD deviated by more than ±2.5 standard deviations at any frequency. This procedure identified HC #29 and HC #34 as outliers, which were then mapped back to the full dataset using their positions in the file list. This corresponded to subject IDs as 535 and 540, respectively. These participants contributed disproportionately to the large variance observed in group-level HC_2 PSD estimates and were thus removed from the dataset.

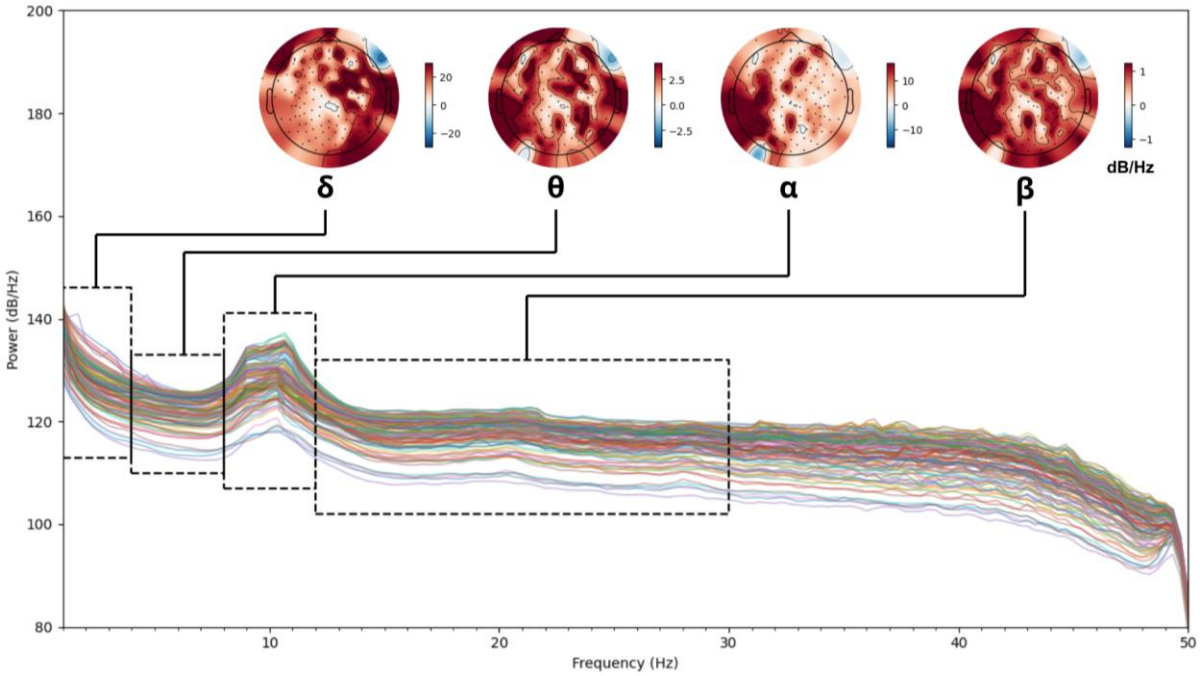

Figure S2.1. EEG PSD and topographic distributions across frequency bands of MDD_1 patients. PSD is the average of all channels (n = 128) across all MDD_1 patients (n = 24). Dashed black boxes highlight the frequency ranges delta (1–4 Hz), theta (4–8 Hz), alpha (8–13 Hz), and beta (13–30 Hz). Corresponding scalp topographies (top) illustrate the spatial distribution of power for each frequency band across the scalp. Warm colours indicate regions of higher spectral power. Figure created using Python and Canva.

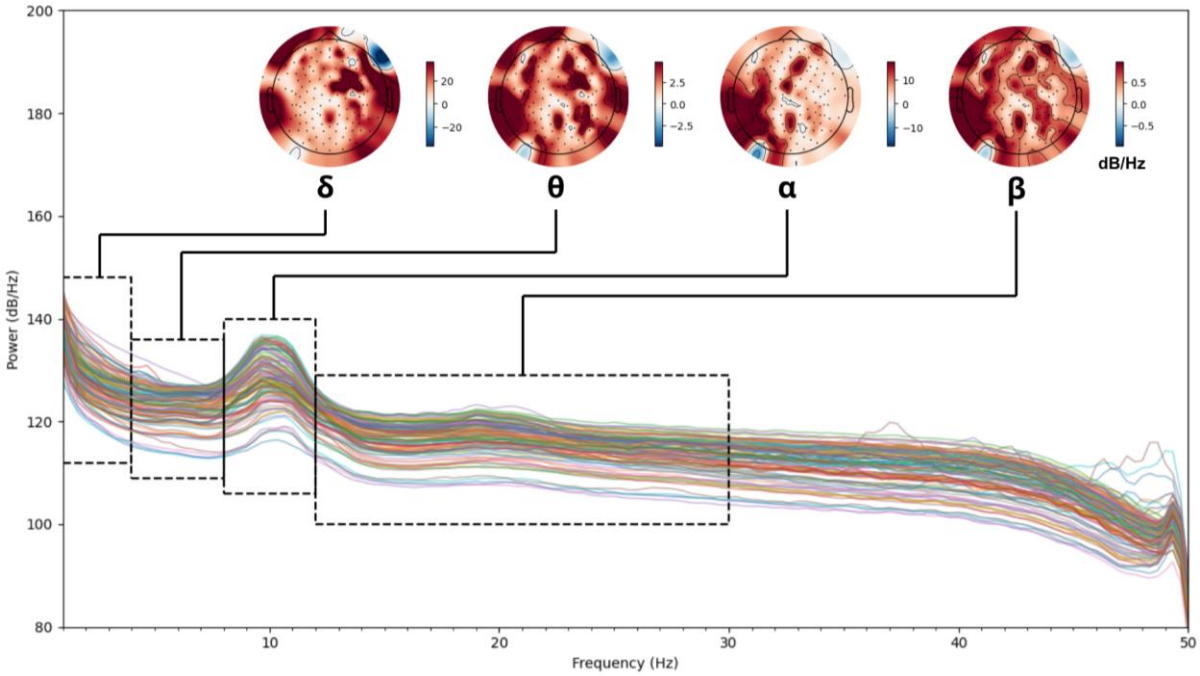

Figure S2.2. EEG PSD and topographic distributions across frequency bands of HC_1 patients. PSD is the average of all channels (n = 120) across all HC_1 patients (n = 29). Dashed black boxes highlight the frequency ranges delta (1–4 Hz), theta (4–8 Hz), alpha (8–13 Hz), and beta (13–30 Hz). Corresponding scalp topographies (top) illustrate the spatial distribution of power for each frequency band across the scalp. Warm colours indicate regions of higher spectral power. Figure created using Python and Canva.

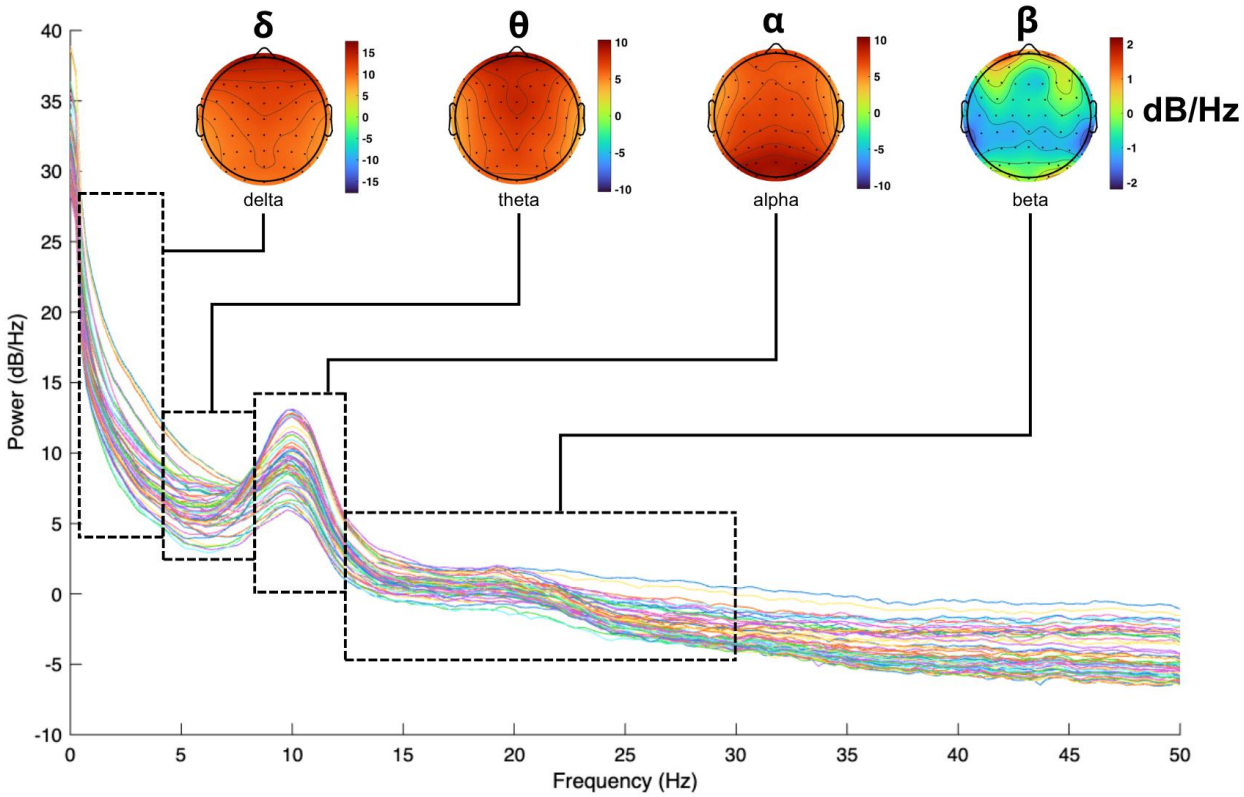

Figure S2.3. EEG PSD and Topographic Distributions Across Frequency Bands of HC_2 Patients. PSD is the average of all channels (n = 60) across all HC_2 patients (n = 71). Dashed black boxes highlight the frequency ranges delta (1–4 Hz), theta (4–8 Hz), alpha (8–13 Hz), and beta (13–30 Hz). Corresponding scalp topographies (top) illustrate the spatial distribution of power for each frequency band across the scalp. Warm colours indicate regions of higher spectral power. Figure created using MATLAB and Canva.

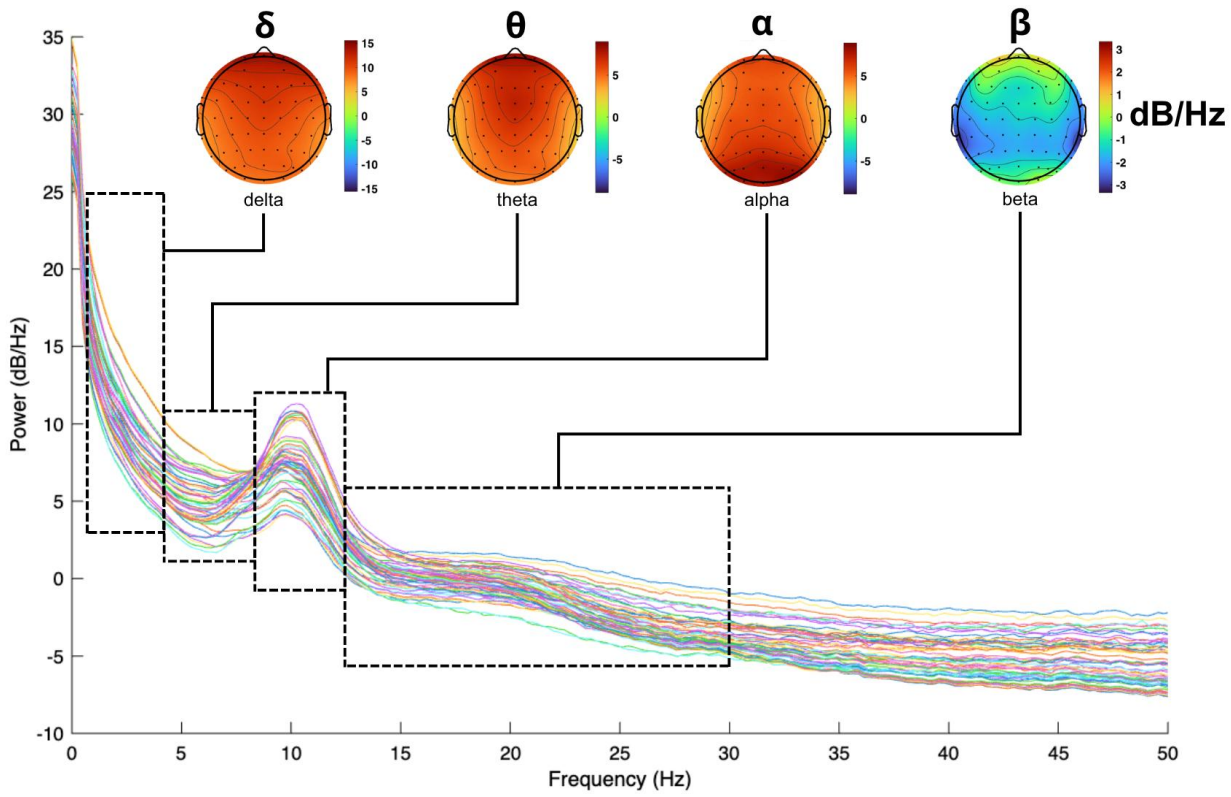

Figure S2.4. EEG PSD and Topographic Distributions Across Frequency Bands of MDD_2 Patients. PSD is the average of all channels (n = 60) across all MDD_2 patients (n = 46). Dashed black boxes highlight the frequency ranges delta (1–4 Hz), theta (4–8 Hz), alpha (8–13 Hz), and beta (13–30 Hz). Corresponding scalp topographies (top) illustrate the spatial distribution of power for each frequency band across the scalp. Warm colours indicate regions of higher spectral power. Figure created using MATLAB and Canva.

References

[1] MATLAB. Version 25.1.0.2943329 (R2025a) [software]. Natick (MA): The MathWorks, Inc.; 2025. Available from: https://www.mathworks.com/products/matlab.html

[2] Delorme A, Makeig S. EEGLAB: An open source toolbox for analysis of single-trial EEG dynamics including independent component analysis. J Neurosci Methods. 2004;134:9–21. https://doi.org/10.1016/J.JNEUMETH.2003.10.009

[3] Nolan H, Whelan R, Reilly RB. FASTER: Fully automated statistical thresholding for EEG artifact rejection. J Neurosci Methods. 2010;192:152–62. https://doi.org/10.1016/J.JNEUMETH.2010.07.015

[4] EEGLAB plugins [Internet]. San Diego (CA): Swartz Center for Computational Neuroscience, UC San Diego; [cited 2026 Jan 20]. Available from: https://sccn.ucsd.edu/eeglab/plugins