Periodic and Aperiodic Contributions to Theta-Beta Ratios Across Adulthood

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Abstract

The ratio of fronto-central theta (4–7 Hz) to beta oscillations (13–30 Hz), known as the theta-beta ratio, is negatively correlated with attentional control, reinforcement learning, executive function, and age. Although theta-beta ratios have been found to decrease with age in adolescents and young adults, theta has been found to increase with age in older adults. Moreover, age-related decreases in individual alpha peak frequency and flattening of the 1/f aperiodic component may artifactually inflate the association between theta-beta ratio and age. These factors lead to an incomplete understanding of how theta-beta ratio varies across the lifespan and the extent to which variation is due to a conflation of aperiodic and periodic activity. We conducted a partially preregistered analysis examining the cross-sectional associations between age and resting canonical fronto-central theta-beta ratio, individual alpha peak frequency, and aperiodic component (n = 268; age 36–84, M = 55.8, SD = 11.0). Age was negatively associated with theta-beta ratios, individual peak alpha frequencies, and the aperiodic exponent. The correlation between theta-beta ratios and age remained after controlling for individual peak alpha frequencies, but was non-significant when controlling for the aperiodic exponent. Aperiodic exponent fully mediated the relationship between theta-beta ratio and age, although beta remained significantly associated with age after controlling for theta, individual peak alpha, and aperiodic exponent. Results replicate previous observations and show age-related decreases in theta-beta ratios are not due to age-related decreases in individual peak alpha frequencies but primarily explained by flattening of the aperiodic component with age.

Keywords: Theta; Beta; Theta-Beta Ratio; Individual Peak Alpha Frequency; 1/f; Aging

1 Introduction

The use of spontaneous resting electroencephalographic (EEG) activity as an objective measure of individual differences in psychological functioning has a long history (Davidson, 1984; Klimesch, 1999; Knyazev, 2007; Schutter & Knyazev, 2012). Resting EEG has typically been divided into standardized bands based on canonical (i.e., fixed) spectral power bands, from the slowest frequencies in delta (0-4 Hz), through theta (4-7 Hz), alpha (7-13 Hz), beta (13-30 Hz), to the fastest frequencies in gamma (30+ Hz), but are also sometimes defined on an individual basis from the alpha peak frequency (Babiloni et al., 2020). A persistent but growing focus is on the use of these resting EEG measures (usually quantified from canonical bands) as biomarkers for optimal and sub-optimal executive function, particularly in the context of identifying healthy vs. unhealthy executive function development and decline with aging (Arns et al., 2013; Babiloni et al., 2006). Recent research suggests that individual and intra-individual differences in executive function broadly, and attentional control specifically, are associated with the ratio between fronto-central standard theta to beta oscillations, purported to represent differences in periodic activity within these frequency bands (Angelidis et al., 2016).

1.1 Theta-Beta Ratios

The ratio between fronto-central theta and beta oscillations has been promoted as a marker of executive [dys]function associated with Attention-Deficit Hyperactive Disorder (ADHD; Arns et al., 2013) where higher ratios – indicating relatively greater fronto-central theta than fronto-central beta – are characteristic of ADHD. In non-clinical populations, theta-beta ratio has been found to be strongly negatively correlated with self-report and behavioral measures of executive function, while theta and beta alone are not (Perone et al., 2018), and smaller theta-beta ratios are indicative of better cognitive control, executive control, and increased vigilance (Angelidis et al., 2016, 2018; Putman et al., 2010, 2014; van Son, Schalbroeck, et al., 2018). Several studies have shown that beyond being a marker of attentional control, theta-beta ratios are negatively correlated with response-inhibition by threatening stimuli (Putman et al., 2010) and are positively correlated with attentional capture by mildly threatening stimuli relative to highly threatening stimuli (van Son, Angelidis, et al., 2018). Theta-beta ratios have also been found to negatively correlate with advantageous decision making in reinforcement learning paradigms (Massar et al., 2014; Schutter & Van Honk, 2005). Other studies have reported that theta-beta ratios are positively associated with risk taking behavior, and that theta and beta alone do not (Massar et al., 2012). Recent studies have also shown that theta-beta ratios increase during mind-wandering (van Son, De Blasio, et al., 2019; van Son, de Rover, et al., 2019). Together, these studies suggest that theta-beta ratios are related to attentional control broadly, as well as to more specific emotional and rewarding contexts, such that lower theta-beta ratios are reflective of more control or focus.

Theta-beta ratios are argued to reflect the reciprocal regulation of bottom-up subcortical processes by top-down cortical processes (Knyazev, 2007; Schutter & Knyazev, 2012). Although much of the research supporting this subcortical-cortical model of theta-beta ratios and executive function has been indirect, a recent study has provided support for involvement of cortical networks (van Son, de Rover, et al., 2019). Specifically, van Son, de Rover, et al. (2019) showed that not only are theta-beta ratios lower when participants exert attentional control compared to when they engage in mind-wandering, but that these changes are associated with decreased functional connectivity between dorsolateral prefrontal cortex (DLPFC) and the dorsal anterior cingulate cortex (ACC) – regions which have been associated with executive function in multiple domains (Seeley et al., 2007).

Given age-related decline in executive function (Buckner, 2004; Lustig & Jantz, 2015) and in cortical integrity (Fjell et al., 2017; Madden et al., 2009, 2012), one would assume a straight-forward relationship between theta-beta ratio and age. The mapping between age and the theta-beta ratio is more complicated, however. First, theta has been observed to increase with age, potentially through a migration of alpha activity to the upper frequencies of theta, discussed in more detail below (Klimesch, 1999). Second, resting theta recorded from the same fronto-central scalp locations used in theta-beta ratio research has been positively correlated with cognitive function in older adults (73 adults ages 56-70, Finnigan & Robertson, 2011; 53 adults ages 18-89, Vlahou et al., 2014). Third, in child and young adult samples, theta-beta ratios have been reported to be negatively correlated with age (41 young adults ages 18-31 years, Angelidis et al., 2016; 41 children ages 8-12 years, Clarke et al., 2001; 101 children ages 7-16 years, Ogrim et al., 2012; 162 children ages 3-9 years, Perone et al., 2018; 28 young adults ages 19-28 years, Putman et al., 2010, but see Putman et al., 2014 for a non-replication in 77 young adults with a mean age of 19.9 years), and with cognitive function (Angelidis et al., 2016, 2018; Putman et al., 2010, 2014; 128 young adults with a mean age of 22.3 years, Schutte et al., 2017). Thus, it remains unclear what drives any association between age and theta-beta ratio, complicated in part by the reliance on canonical frequency bands for calculating theta-beta ratio in populations with shifts in individual alpha peak frequencies in the existing literature.

1.2 Individual Alpha Peak Frequencies

The frequency at which power in the alpha band (7-13 Hz) peaks, known as individual alpha peak frequency, has been found to be negatively correlated with age in adulthood (Clark et al., 2004; Klimesch, 1997), and is reduced in individuals with Alzheimer's disease (Klimesch, 1997). Higher individual alpha peak frequency across adulthood is associated with better working memory, better reading comprehension, and a larger general intelligence factor (Angelakis et al., 2004; Clark et al., 2004; Grandy et al., 2013; Klimesch, 1997), suggesting it is an indicator of cognitive capacity or preparedness.

Greater alpha power has been associated with reductions in blood flow across wide areas of the frontal and parietal cortex (Jensen & Mazaheri, 2010; Laufs et al., 2003). During working memory tasks, greater local alpha power during a trial was associated with better memory performance (Jensen & Mazaheri, 2010), and decreases in BOLD activation, particularly in areas of the default mode network (Anticevic et al., 2010; Daselaar et al., 2004). Together, these findings suggest that alpha power indexes the ability to inhibit task-irrelevant regions while performing cognitive tasks (Jensen & Mazaheri, 2010), processes which tend to decline with advancing age.

With regards to theta-beta ratios, because the peak alpha frequency is found in lower frequencies with age, some of the EEG power associated with the alpha band (commonly defined as 7-13 Hz) may be mistakenly attributed to power in the canonical theta band (commonly defined as 4-7 Hz) in older adults, driving increases in canonical theta band power with age and therefore changes in theta-beta ratios. While some work suggests that relative canonical theta in older adults may be positively correlated with measures of memory, attention, and executive functioning, the potential role of alpha leaking into the canonical theta band, as indexed by individual peak alpha frequency, remains unclear (Finnigan & Robertson, 2011). Therefore, understanding how resting canonical theta band power, canonical beta band power, theta-beta ratios calculated from canonical theta and beta band power, and individual peak alpha frequencies are cross-sectionally interrelated across the adult age-span is key to beginning to understand how these EEG metrics may relate to healthy aging, particularly since the existing literature on theta-beta ratios in age relies on canonical power band definitions.

1.3 Aperiodic and Periodic Neural Activity

The association between traditional EEG metrics and healthy aging is further complicated by recent observations that frequency band measures of periodic activity are influenced by aperiodic activity present across all frequencies (Donoghue, Dominguez, et al., 2020; Donoghue, Haller, et al., 2020; Keil et al., 2022; Voytek et al., 2015). In initial conceptualizations of aperiodic activity, steeper spectra were interpreted as indicating greater synchronization; flatter spectra were interpreted as indicating reduced synchronization (i.e., greater neural noise; Voytek & Knight, 2015). More recent data suggest that the slope of the EEG spectra is related to the ratio of excitatory to inhibitory neural activity, while the height of the spectra is related to neural spiking rates (Donoghue, Haller, et al., 2020; Waschke et al., 2021). Greater excitatory to inhibitory activity is reflected in flatter spectra (Gao et al., 2017), and greater spiking activity is reflected in greater overall spectral power (Manning et al., 2009; Miller et al., 2012). Aperiodic activity – in particular the slope of the spectra - has been associated with age, mediates cross-sectional associations between age and cognitive function (Voytek et al., 2015), and is associated with physiological markers of cognitive decline (Tran et al., 2020) and processing speed (Ouyang et al., 2020).

The impact of aperiodic activity on EEG metrics is particularly pronounced for theta-beta ratios. For example, the association between the exponent of aperiodic activity (i.e., the gradient of the spectra slope) and the theta-beta ratio has been found to be significantly stronger than the association between the periodic measures of both theta and beta (Donoghue, Dominguez, et al., 2020). Beyond suggesting that measures of both theta and beta are severely confounded by aperiodic activity, the strong association between theta-beta ratios and aperiodic activity found in prior work implies that the individual differences in the theta-beta ratio may primarily reflect individual differences in in excitatory to inhibitory neural activity (Donoghue, Dominguez, et al., 2020). Furthermore, in the case of the lack of definable peaks within a given power band, it is ambiguous whether group or individual differences are due to changes in periodic power or instead the aperiodic component.

1.4 The Present Study

Theta-beta ratios have been found to be negatively associated with age, such that larger ratios – indicating relatively greater theta power than beta power - are observed in samples of younger participants compared to older participants. However, child and young adult samples with restricted age ranges (e.g., children 3-9 years old in Perone et al., 2018; young adults 19-28 years old in Putman et al., 2010) that rely upon canonical band definitions, currently predominate the studies of age-related differences in theta-beta ratios. In the present study, we extend the research on fronto-central theta-beta ratios (calculated from canonical bands) by examining whether the negative association between age and canonical fronto-central theta-beta ratios is observed in a large sample featuring a wide adult age range (from 36-84 years). Additionally, we examine to what extent any associations between canonical fronto-central theta-beta ratios and age are accounted for by age-related differences in fronto-central individual alpha peak frequency and in the frontro-central aperiodic (1/*f*-like) component of the neural power spectrum. Finally, we examine the unique associations between age and canonical fronto-central theta band power and canonical fronto-central beta band power individually and controlling for fronto-central individual alpha peak frequency and the fronto-central aperiodic component.

We conducted a partially preregistered[1] secondary analysis of data from the Midlife in the US Study's Neuroscience Project (MIDUS 2, 2004-2009; http://midus.wisc.edu/), examining whether the correlation between canonical fronto-central theta-beta ratios and age is due to variation in associations between age and canonical fronto-central theta, age and canonical fronto-central beta, age-related decreases in individual peak alpha frequencies, or

[1] All analyses regarding the aperiodic 1/*f*-like components were suggested by a reviewer and are therefore not included in the preregistration. Preregistered hypotheses and analyses regarding theta-beta ratios, individual alpha peak frequencies, and age are explicitly denoted, and outlined in Table 1.

age-related flattening of the aperiodic component. Based on previous studies, we developed and tested two pre-registered hypotheses. First, we tested whether the negative association between canonical fronto-central theta-beta ratios and age is replicated in a large sample of older adults ranging in age from 36 to 84 years old, hypothesizing that greater age will be associated with lower canonical fronto-central theta-beta ratios (Table 1, confirmatory hypothesis 1). Second, we used the RestingIAF package (https://github.com/corcorana/restingIAF; Corcoran et al., 2018) to test whether there would be a pattern of fronto-central alpha peak frequency "slowing" with age, predicting that older age would be associated with lower fronto-central individual alpha peak frequencies (Table 1, confirmatory hypothesis 2). We examined whether the association between canonical fronto-central theta-beta ratios and age was preserved when statistically adjusting for individual differences in fronto-central individual alpha peak frequencies, and examined if the relationships held controlling for gender and race[2]. We explored the relationship between the aperiodic 1/*f*-like component of the power spectrum and age, and if the association between canonical fronto-central theta-beta ratios and age was preserved when statistically adjusting for changes in the aperiodic component. Additionally, we examined if fronto-central individual alpha peak frequencies or fronto-central aperiodic component could mediate the relationship between canonical fronto-central theta-beta ratios and age. Finally, we examined the extent to which canonical fronto-central theta power and canonical fronto-central beta power are uniquely associated with age at time of recording (Table 1, additional hypothesis E1). Additional analyses are included in the supplemental materials to ensure the findings are

[2] We did not explicitly register the exploratory analyses between canonical fronto-central theta-beta ratios and fronto-central individual alpha peak frequencies, nor did we explicitly register controlling for participant race.

not specific to analytical choices or specific EEG metric quantification methods described in the main manuscript.

Analyses and hypotheses regarding canonical fronto-central theta-beta ratio, fronto-central individual alpha peak frequency, and age (including the specific fronto-central ROI) were preregistered prior to the extraction of new EEG frequency metrics and their statistical analysis at https://osf.io/n57au. Additionally, the new EEG reprocessing pipeline for the extraction of canonical fronto-central theta power, canonical fronto-central beta power, and individual alpha peak frequencies was registered separately at https://osf.io/wfkmn. See Table 1 for a summary of the preregistration status of all analyses and exclusion criteria.

Table 1

Summary of preregistration status of analyses (from https://osf.io/n57au) and exclusion criteria

Analysis	Preregistration Status
Section 3.1: Pearson's Pairwise Correlations	Preregistered: Age with canonical fronto-central theta-beta ratio, with and without controlling for gender Age with RestingIAF defined fronto-central individual alpha peak frequencies, with and without controlling for gender Post hoc, determined to be a useful additional analytic strategy: Partial correlations controlling for gender and race Report all other additional pairwise correlation combinations and descriptive statistics Post hoc, reviewer suggested: Age with FOOOF defined fronto-central aperiodic exponent and offset Canonical fronto-central theta-beta ratio with FOOOF defined fronto-central aperiodic exponent and offset RestingIAF defined fronto-central individual alpha peak frequencies with FOOOF defined fronto-central aperiodic exponent and offset
Section 3.2: Partial Correlations	Implied in background of preregistration Due to author oversight, analyses regarding controlling for RestingIAF defined fronto-central individual alpha peak frequencies are implied in the preregistration introduction but not explicitly outlined Post hoc, reviewer suggested: Age with canonical fronto-central theta bet aeration, controlling separately for fronto-central aperiodic exponent and offset
Section 3.3 Mediational Analyses	Post hoc, determined to be a useful additional analytic strategy: Relationship between age and canonical fronto-central theta-beta ratio mediated by RestingIAF defined fronto-central individual alpha peak, FOOOF defined aperiodic offset, and/or FOOOF defined aperiodic exponent
Section 3.4 Hierarchical Regression Analyses	Preregistered: Step 1 (canonical fronto-central theta and canonical fronto-central beta regressed on age) and Step 2 (RestingIAF defined fronto-central individual peak alpha added) Post hoc, reviewer suggested: Step 3 (FOOOF defined aperiodic exponent)
Supplemental Material, S2 General Estimating Equation Analysis	Preregistered: GEE analyses repeating main correlational analyses, controlling for genetic dependencies within family
Supplemental Material, S3 Explore Non-Linear Age and Theta-Beta Ratio Relationships	Preregistered: Quadradic regression of canonical fronto-central theta-beta ratio with age
Supplemental Material, sections S4-S10	Post hoc, reviewer suggested: Repeat analyses on eyes closed only, with different theta-beta ratio and individual alpha peak specification methods

Preregistered Exclusion Criteria (reproduced from https://osf.io/n57au and https://osf.io/wfkmn)

1. 50% epochs retained for spectral power density metrics
2. 50% of channels resulting in definable alpha peaks

Posthoc Exclusion Criteria

1. Poor FOOOF model fit, defined as less than 3 standard deviations below the mean in R^2 model fit for the fronto-central composite

2. Method

2.1. Sensitivity power analysis

We used G*Power 3.1 (Faul et al., 2009) to conduct sensitivity power analysis prior to data processing for a sample of 300 participants as an estimate for the final usable sample size after applying our criteria for usable EEG data. This analysis indicated that we would have 95% power to detect a Pearson's correlation of .20, and 95% power to detect a small to medium sized effect in regression analyses ($f^2 = .06$).

2.2 Participants

The present study used data collected during the second wave of Midlife in the US (MIDUS) in the Neuroscience Project (2004-2009), consisting of 331 participants from the main MIDUS cohort. These respondents included three distinct subsamples: the Main Longitudinal (n = 135), Twin (n = 88), and Milwaukee (n = 108) subsamples (see http://midus.wisc.edu/midus2/project5/ for additional details about sampling strategies within these subsamples). The Main Longitudinal and Twin subsamples contained individuals who participated in the initial wave of MIDUS data collection approximately 10 years prior. The Milwaukee subsample contained individuals who participated in the baseline MIDUS Milwaukee study initiated in 2005. Demographic information is presented in Table 2.

All data collection procedures were approved by the UW-Madison Institutional Review Board, and informed consent was obtained for all participants. Participants with unusable resting spectral power EEG data (*n* = 12, 3.6%), without identifiable alpha peak frequencies (*n* = 48, 14.5%), and/or without adequate FOOOF model fit (*n* = 9, 2.7%) were excluded from analyses, yielding a final sample of n = 268 participants[3].

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[3] The listwise exclusion of participants failing to meet criteria for the number of epochs and identifiable fronto-central alpha peak frequency were specified in the preregistration. The listwise

Table 2
Sample demographics

	Sufficient EEG data (n = 268)	Insufficient definable fronto-central individual alpha peaks (n = 48)	Insufficient epochs for spectral power (n = 12)	Poor fronto-central FOOOF algorithm fit (n = 9)
Age in Years (SD)	55.8 (11.0) range = 36-84	52.5 (11.6) range = 38-82	58.8 (11.7) range = 44-81	59.8 (13.6) range = 40-82
Gender				
Male	122	18	7	4
Female	146	30	5	5
Race/Ethnicity				
White	172	33	6	5
Black	86	12	6	3
Hispanic/Black	4	-	-	-
Hispanic/White	1	-	-	-
Asian	2	-	-	-
Other	3	1	-	1
Handedness				
Right	252	43	10	9
Left	16	5	2	-
MIDUS Subsample				
Main	107	22	5	5
Twin	71	14	3	1
Milwaukee	90	12	4	3

Note: The sample sizes for each data quality exclusion criteria do not sum to the total $n = 331$ because six participants had both poor FOOOF algorithm fit at fronto-central sites and insufficient definable fronto-central individual alpha peaks.

2.3 Materials

2.3.1 Demographics

Demographic variables are publicly available via Colectica (http://midus.colectica.org/) and the Inter-university Consortium for Political and Social Research (ICPSR; https://www.icpsr.umich.edu/web/ICPSR/series/203). From the MIDUS 2 Neuroscience Project dataset, we used age at time of EEG data collection, gender, race

exclusion of participants with poor fronto-central FOOOF model fit metrics were decided after preregistration in response to reviewer suggested additional analyses. See Table 1 for additional details on preregistered and posthoc exclusion criteria. Analysis without any FOOOF model fit exclusions are presented in the supplemental materials and do not change the pattern of results.

(dichotomized as White/Black, Indigenous, and People of Color (BIPOC) for analyses) and Family ID. Family ID was used to account for genetic dependencies in follow-up analyses in the supplemental materials. See Table 2 for a breakdown of demographics[4].

2.4 Procedure

2.4.1 EEG Recording

EEG data were collected using a 128 channel geodesic net of Ag/AgCl electrodes in the GSN200 montage (see Figure 1 of the preprocessing preregistration, https://osf.io/wfkmn; Electrical Geodesics, Inc, 2007) encased in saline dampened sponges (Electrical Geodesics, Inc [EGI], Eugene, OR) with impedances reduced to less than 100 KΩ whilst ensuring that electrolyte "bridges" (see Greischar et al., 2004) had not formed. After the net was placed, participants were escorted into a soundproof booth where they were seated in front of a computer screen. A computer located outside the booth recorded the data. Signals were amplified and sampled at 500 Hz with an online bandpass filter from 0.1-100 Hz at 16-bit precision using an online vertex (Cz) reference. The participant was instructed to rest for six 1-minute periods. During three of the 1-minute periods they were asked to keep their eyes open; for the remaining three 1-minute periods they were asked to keep their eyes closed. The order of the eyes open/eyes closed was pseudorandomized, with two fixed orders counterbalanced across participants. Participants then completed an emotional picture viewing task (data not presented here), followed by another baseline resting recording for six 1-minute periods. Prior data processing was restricted to alpha asymmetry variables from the first baseline recording, collapsed across the entire 6-minute period (e.g., Hostinar et al., 2017). The current analyses focus on metrics extracted from this first resting recording, collapsed across eyes open and eyes closed periods. Additional analyses examining eyes

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[4] Additionally, a histogram of age is available in the supplemental materials.

closed only epochs are available in the supplemental material and do not change the interpretations of the analyses.

2.5 Data Reduction

2.5.1 EEG preprocessing

Offline the EEG data was filtered (60 Hz notch, 0.5 Hz high-pass), bad channels identified and removed, and bad sections of data identified and removed. EEGLab6 was originally used to conduct a PCA/ICA to identify 20 components (such that PCA was first applied for the reduction constrained to 20 components, followed by an ICA for the differentiation of components), which were visually inspected to identify components to remove obvious blink, eye movement, and other artifacts. No further PCA or ICA dimension reduction was conducted after artifactual components were removed. Bad channels were replaced using a spherical spline interpolation. These are the original preprocessing steps from the initial alpha asymmetry pipeline that were preserved in the reprocessing pipeline, detailed in Ryff et al. (2021). Data from the eyes open and eyes closed conditions were collapsed[5]. The fronto-central ROI was preregistered to comprise of the average composite of the F3/Fz/F4 analog channels[6].

2.5.2 Spectral power for canonical fronto-central theta-beta ratio

Data processing for spectral power for canonical fronto-central theta-beta ratios was completed using EEGLab 2019.1 scripts implemented in MATLab 2019b. Data was re-referenced to the average reference and Cz was imputed. Continuous resting data was

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[5] Alternative analyses on just the eyes closed conditions are available in the supplemental materials and do not change interpretations.

[6] As shown in the reprocessing pipeline registration (https://osf.io/wfkmn), the fronto-central composite of F3/Fz/F4 was comprised of the EGI GSN200 electrode montage (Electrical Geodesics, Inc, 2007) sensors 12, 20, 21, 25, 29 (comprising the analog for F3), sensors 4, 5, 118, 119, 124 (comprising the analog for F4), and sensor 11 (comprising the analog for Fz), and was selected based on existing theta-beta ratio literature. See Keil et al., 2022 for a discussion of the importance of preregistering ROIs in frequency-based EEG analyses.

epoched into 2 second segments with 50% overlap, and bad segments were rejected if there was a voltage deviation on any channel of ±100μV. As preregistered, participants with more than 50% of the total number of epochs rejected were excluded from analyses in a listwise fashion (n = 12). EEG spectral power at each predefined canonical spectral band (theta: 4-7 Hz; beta: 13-30 Hz) was extracted using a 2 second Hamming window padded by a factor of 2 with 50% overlap. Spectral power was extracted individually for each channel, then averaged over the fronto-central composite ROI and were transformed to a theta-beta ratio by dividing the former by the latter and subsequently log-normalized[7].

2.5.3 EEG reprocessing: Individual alpha peak frequency

Fronto-central individual alpha peak frequency from the initial baseline recording was extracted using the RestingIAF package (https://github.com/corcorana/restingIAF; Corcoran et al., 2018), using adjustments to the parameters based on our sample of older adults as recommended by Corcoran et al., (2018). The RestingIAF package algorithmically identifies the peak activity within the alpha band using the Savitzky-Golay filter (SGF), a nonparametric curve fitting technique, whereby the PSD estimates are smoothed using the SGF before estimating the first and second order derivatives. These derivatives are then used to identify a spectral peak, and the first derivative is additionally used to identify the individual alpha-band windows based upon where the "shoulders" of the alpha peak are located (see Corcoran et al., 2018 for additional information). We used a 2 second Hamming window with 50% overlap, as well as the following RestingIAF algorithm settings: F_w = 11 (SGF frame width, with larger numbers indicating more smoothing, results in a frequency span of ~2.69 Hz); k = 4 (SGF polynomial degree, higher values result in less smoothing and

[7] Alternative analyses using individually defined theta and beta bands based on individual alpha peak frequency to create the theta-beta ratio are available in the supplemental materials and do not change interpretations.

less peak height attenuation); W_α = [6, 14 Hz] (the frequency domain within which evidence for peak activity was searched); fRange = [1, 40 Hz] (range of frequencies used to fit the algorithm), mpow = 0.6 (the minimum power value a local maximum needed to exceed to qualify as a peak candidate), *pDiff* = 0.20 (the minimum proportion of peak height by which the highest peak candidate had to exceed other peaks within the search window W_α to be assigned as the alpha peak frequency), *cMin* = 3 (minimum number of channel estimates necessary for returning results). Estimates were extracted individually for each channel, then averaged over the fronto-central composite ROI. As preregistered, individuals who did not exhibit a definable fronto-central individual alpha peak value in 50% of the sensors used for the composites or 50% of the overall scalp were excluded from analyses in a listwise fashion ($n = 55$). Fronto-central individual alpha peak frequency for the current study was quantified as the average composite of the F3/Fz/F4 analog channels to assess the impact of age-related differences in individual peak alpha at fronto-central sites on canonical theta-beta ratio measured at the same fronto-central sites.

2.5.4 Modeling periodic and aperiodic power spectrum components

Spectral power density was extracted individually for each channel using a 2 second Hamming window padded by a factor of 2 with 50% overlap using EEGLab 2019.1 scripts implemented in MATLab 2019b from 0-250 Hz in 0.25 Hz increments for all sensors then analyzed using FOOOF 1.0.0 (Donoghue, Haller, et al., 2020; https://fooof-tools.github.io/) in Python (version 3.9) to fit aperiodic and periodic components from 2-40 Hz.

FOOOF algorithmically fits a model to estimate both the aperiodic (1/*f*-like) component of EEG spectral power density as well as overlying periodic oscillatory “peaks”, by first fitting an aperiodic component (modeled after a Lorentzian function) with a specific offset value (corresponding to the y-intercept of the aperiodic component) and exponent (corresponding to the “flatness” of the 1/*f* curve, equivalent to the sign-flipped slope of a linear fit in log-log space), which is then regressed out of the PSD, leaving behind periodic peaks. These peaks are then iteratively modelled by fitting a Gaussian around the central frequency of each peak, until the maximum number of peaks fit is reached or no more peaks meeting the algorithm's criteria are available (see Donoghue, Haller, et al., 2020 for additional details). Periodic and aperiodic components were estimated from the PSD ranging from 2-40 Hz, without a knee, with peaks limited in width from 1-6 Hz, a minimum peak height of 0.05, a relative peak threshold of 1.5 standard deviations, and a maximum number of 6 peaks fit. The resulting models were defined as having poor fit if they were less than 3 standard deviations below the mean in R^2 model fit for the fronto-central composite, resulting in n = 9 failing to meet the $R^2 = 0.862$ threshold and were excluded in a list-wise fashion. Finally, the aperiodic offset and exponent values for the frontal F3/Fz/F4 composite were extracted. Details regarding additional alternative EEG metrics are discussed in the supplemental materials[8].

3. Results

As our preregistered analyses focused on metrics extracted from the resting data collapsed across eyes open and eyes closed periods, we report all analyses below on metrics extracted from the combined recordings. Parallel analyses were conducted on alternative EEG metrics are reported in the supplemental materials (see Supplemental Materials section S3). Overall, the pattern of results remained the same regardless of the choice of EEG metric quantification (e.g., canonical and individual band power, metrics extracted from eyes closed

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[8] As detailed in the supplemental materials, use of the FOOOF defined individual alpha peak frequency instead of the RestingIAF defined individual alpha peak frequency did not change the analyses. Additionally, it was not possible to create a metric of aperiodic adjusted canonical theta-beta ratio using FOOOF defined aperiodic adjusted canonical fronto-central theta power and aperiodic adjusted canonical fronto-central beta power, as only $n = 42$ participants had a definable aperiodic adjusted canonical fronto-central theta peak. This results in a severe floor effect, with $n = 229$ participants with a FOOOF derived aperiodic adjusted canonical fronto-central theta-beta ratio of zero.

only data, etc.). All statistical analyses were performed in R (version 4.1.2). See Table 1 for a breakdown of which analyses were preregistered. We first report pair-wise correlational analyses, including our two preregistered analyses regarding our hypotheses that: 1) resting canonical fronto-central theta-beta ratios will be inversely associated with age, and 2) fronto-central individual alpha peak frequencies will be inversely associated with age. Next, we report our exploratory analyses examining partial correlations between canonical fronto-central theta-beta ratio and age controlling for fronto-central individual alpha peak frequency and the fronto-central aperiodic $1/f$ component. Then, we explore the extent to which fronto-central individual alpha peak frequencies and the fronto-central aperiodic component metrics mediate the relationship between canonical fronto-central theta-beta ratio and age. Finally, we explore the unique associations between canonical fronto-central theta and canonical fronto-central beta with age, with and without controlling for fronto-central individual alpha peak frequencies and the fronto-central aperiodic exponent. We report false discovery rate (FDR) corrected p-values for pairwise and partial correlations, because FDR corrections have been shown to have increased power over other correction methods, particularly in cases with many comparisons and when the number of non-null hypotheses increase (Benjamini & Hochberg, 1995). Given the expectation that EEG metrics would be significantly intercorrelated, we opted for FDR to preserve as much statistical power as was feasible while controlling for false discoveries.

3.1 Pairwise Pearson's Correlation Analyses

Our first confirmatory hypothesis was initially tested using Pearson's correlations between log-normalized theta-beta ratios and age. As shown in Table 3 and in Figure 1, resting canonical fronto-central theta-beta ratios were negatively correlated with age (r = -0.24, 95% CI [-0.35, -0.12], $p_{uncorrected} < 0.001$, $p_{fdr} < 0.001$), such that the ratio of slow-wave to fast-wave activity was lower for older participants. Consistent with our second confirmatory hypothesis, as well as consistent with a prior unpublished analysis of this data set and previous independent studies in adults (Clark et al., 2004; Klimesch, 1999), we also observed a significant negative correlation between individual alpha peak frequency and age (r = -0.17, 95% CI [-0.28, -0.05], $p_{uncorrected}$ = 0.006, p_{fdr} = 0.008), such that fronto-central peak alpha frequencies were lower in older participants (Table 2, Figure 1). Additionally, consistent with prior work (Voytek et al., 2015), the fronto-central aperiodic exponent was negatively correlated with age (r = -0.24, 95% CI [-0.35, -0.13], $p_{uncorrected}$ < 0.001, p_{fdr} < 0.001), consistent with a "flattening" of the aperiodic component with age. Finally, we replicated prior work (Donoghue, Dominguez, et al., 2020) by finding that canonical fronto-central theta-beta ratio is more strongly correlated with the fronto-central aperiodic exponent (r = 0.71, 95% CI [0.64, 0.76], $p_{uncorrected}$ < 0.001, p_{fdr} < 0.001) than with canonical fronto-central beta (r = -0.28, 95% CI [-0.38, -0.16], $p_{uncorrected}$ < 0.001, p_{fdr} < 0.001), *Fisher's z* = 6.90, p < 0.001, or canonical fronto-central theta (r = 0.50, 95% CI [0.41, 0.59], $p_{uncorrected}$ < 0.001, p_{fdr} < 0.001), *Fisher's z* = 3.89, p < 0.001, suggesting that canonical theta-beta ratios are highly confounded with the aperiodic exponent.

Generalized Estimating Equations (GEE) confirmed these relationships held when adjusting for genetic dependencies between twin and sibling participants in the sample ($n_{twin/sibling}$ = 71; Supplemental Table S6 for details of the GEE analyses). We also examined the partial correlations controlling for gender and race, and still observed a significant negative correlation between age and canonical fronto-central theta-beta ratio (r = -0.23, 95% CI [-0.34, -0.11], $p_{uncorrected}$ < 0.001, p_{fdr} < 0.001), a significant negative correlation between age and fronto-central individual alpha peak frequency (r = -0.18, 95% CI [-0.30, -0.06], $p_{uncorrected}$ = 0.003, p_{fdr} = 0.003), and a significant negative correlation between age and fronto-central aperiodic exponent (r = -0.23, 95% CI [-0.34, -0.11], $p_{uncorrected}$ < 0.001, p_{fdr} <

0.001), while the relationship between age and fronto-central aperiodic exponent remained nonsignificant (r = -0.09, 95% CI [-0.21, 0.03], $p_{uncorrected}$ = 0.155, p_{fdr} < 0.181).

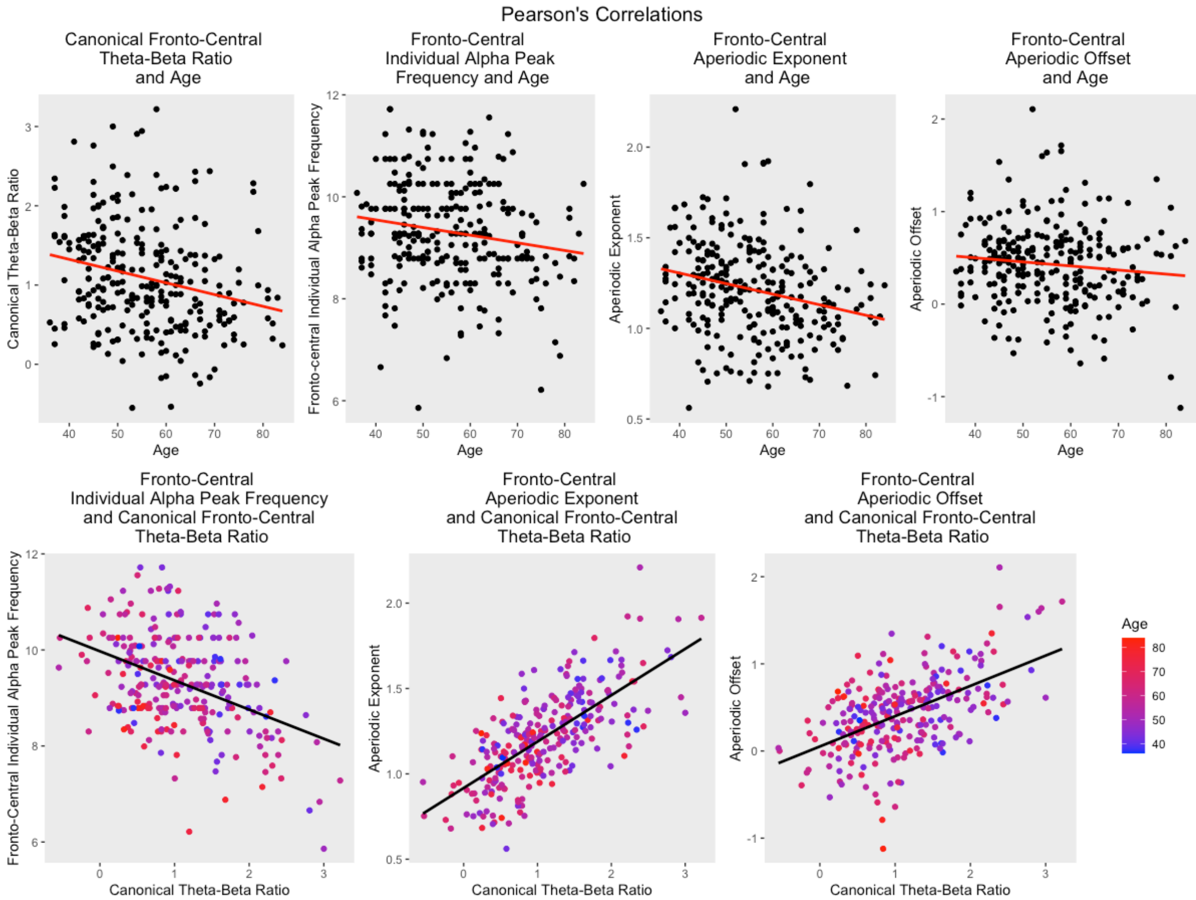
Table 3
Correlations and descriptive statistics between age and EEG metrics, collapsed across eyes open and eyes closed (n = 268).

	Mean (SD)	1. Age	2. Fronto-Central Theta	3. Canonical Fronto-Central Beta	4. Canonical Fronto-Central Theta-Beta Ratio	5. Fronto-Central Individual Alpha Peak Frequency	6. Fronto-Central Aperiodic Exponent
1. Age	55.8 (11.0)	--					
2. Canonical Fronto-Central Theta	0.77 (1.17)	0.01 [-0.11, 0.13] $p_{uncorr} = .849$ $p_{fdr} = .892$	--				
3. Canonical Fronto-Central Beta	0.22 (0.17)	0.23 [0.11, 0.34] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.42 [0.32, 0.52] $p_{uncorr} < .001$ $p_{fdr} < .001$	--			
4. Canonical Fronto-Central Theta-Beta Ratio	1.09 (0.)	-0.24 [-0.35, -0.12] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.50 [0.41, 0.59] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.28 [-0.38, -0.16] $p_{uncorr} < .001$ $p_{fdr} < .001$	--		
5. Fronto-Central Individual Alpha Peak Frequency	9.31 (0.98)	-0.17 [-0.28, -0.05] $p_{uncorr} = .006$ $p_{fdr} = .008$	-0.38 [-0.48, -0.27] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.07 [-0.19, 0.05] $p_{uncorr} = .257$ $p_{fdr} = .284$	-0.42 [-0.51, -0.31] $p_{uncorr} < .001$ $p_{fdr} < .001$	--	
6. Fronto-Central Aperiodic Exponent	1.23 (0.26)	-0.24 [-0.35, -0.13] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.44 [0.34, 0.53] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.0008 [-0.12, 0.12] $p_{uncorr} = .893$ $p_{fdr} = .893$	0.71 [0.64, 0.76] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.25 [-0.36, -0.14] $p_{uncorr} < .001$ $p_{fdr} < .001$	--
7. Fronto-Central Aperiodic Offset	0.43 (0.44)	-0.11 [-0.23, 0.01] $p_{uncorr} = .071$ $p_{fdr} = .083$	0.65 [0.58, 0.72] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.48 [0.38, 0.57] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.54 [0.45, 0.62] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.30 [-0.40, -0.19] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.75 [0.70, 0.80] $p_{uncorr} < .001$ $p_{fdr} < .001$

Note: 95% confidence intervals for pairwise correlations displayed in brackets followed by uncorrected and FDR corrected p-values.

Figure 1

Pearson's correlation scatterplots between EEG metrics and age.



3.2 Partial Correlation Analyses

Next, we examined the partial correlations between age and canonical fronto-central theta-beta ratio, controlling separately for fronto-central individual alpha peak, fronto-central aperiodic offset, and fronto-central aperiodic exponent. As shown in Table 4 and Figure 2, the partial correlation between canonical fronto-central theta-beta ratio and age becomes non-significant only when controlling for the fronto-central aperiodic exponent, $r_{partial}$ = -0.10, 95% CI [-0.21, 0.02], $p_{uncorrected}$ = 0.110, p_{fdr} = 0.110. This suggests that in adults, the flattening of the aperiodic curve with age, as denoted by the aperiodic exponent, may be largely driving the relationship between canonical theta-beta ratio and age.

Table 4

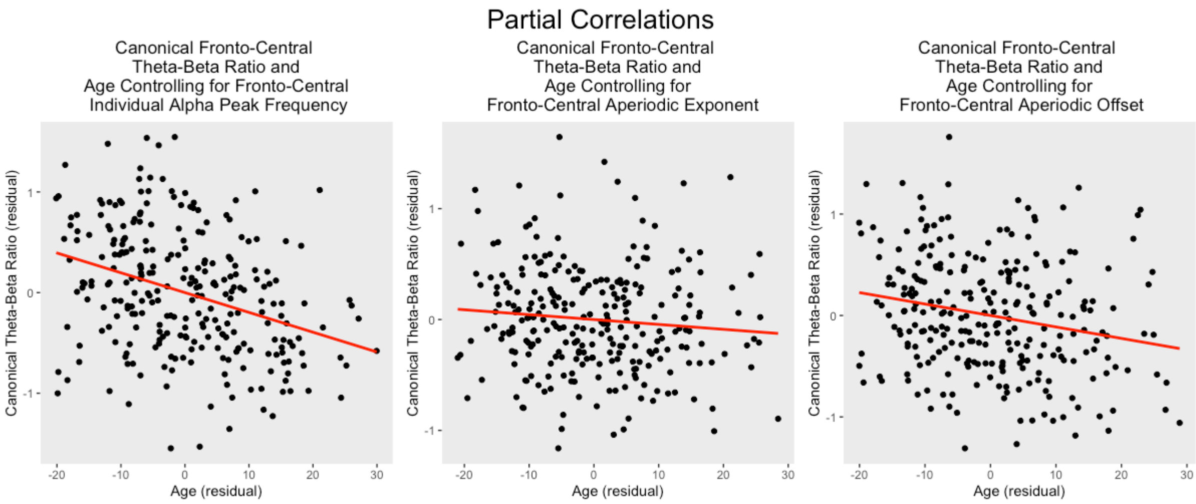
Partial correlations between age and canonical EEG metrics, controlling for fronto-central individual alpha peak frequency, fronto-central aperiodic exponent, or fronto-central aperiodic offset, collapsed across eyes open and eyes closed (*n* = 268).

	Pairwise Pearson's correlation	Partial correlation controlling for fronto-central individual alpha frequency	Partial correlation controlling for fronto-central aperiodic exponent	Partial correlation controlling for fronto-central aperiodic offset
Canonical fronto-central theta-beta ratio and age	-0.24 [-0.35, -0.12] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.35 [-0.45, -0.24] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.10 [-0.22, 0.02] $p_{uncorr} = .110$ $p_{fdr} = .110$	-0.22 [-0.33, -0.10] $p_{uncorr} < .001$ $p_{fdr} < .001$
Canonical fronto-central theta and age	0.01 [-0.11, 0.13] $p_{uncorr} = .849$ $p_{fdr} = .892$	-0.06 [-0.18, 0.06] $p_{uncorr} = .356$ $p_{fdr} = .356$	0.14 [0.02, 0.25] $p_{uncorr} = .025$ $p_{uncorr} = .030$	0.11 [-0.01, 0.23] $p_{uncorr} = .070$ $p_{uncorr} = .070$
Canonical fronto-central beta and age	0.23 [0.11, 0.34] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.22 [0.11, 0.33] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.23 [0.12, 0.34] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.32 [0.21, 0.43] $p_{uncorr} < .001$ $p_{fdr} < .001$

Note: 95% confidence intervals for pairwise correlations displayed in brackets followed by uncorrected p-values.

Figure 2

Partial correlation scatterplot between canonical fronto-central theta-beta ratio and age

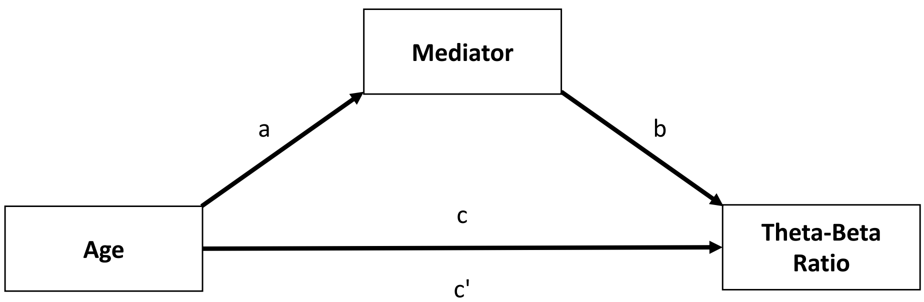


3.3 Mediational Analyses

To further understand the relationship between age and canonical fronto-central theta-beta ratio, we conducted a series of exploratory mediational analyses to see if fronto-central individual alpha peak frequency, fronto-central aperiodic offset, or fronto-central aperiodic exponent would fully mediate the relationship between age and canonical fronto-central theta-beta ratio. Mediation analyses were conducted using the processR package in R (Moon, 2021), with maximum likelihood estimation and 10,000 bootstrap estimates of standard error. See Figure 3.

Figure 3

Diagram of mediation analyses. The total effect is *c*, and is the relationship between age and canonical fronto-central theta-beta ratio without any mediator. The indirect effect is the path *ab*, and the direct effect *c'* is the remaining relationship between age and canonical fronto-central theta-beta ratio after accounting for the indirect effect of the mediator.



As shown in Table 5, only the fronto-central aperiodic exponent fully mediated the relationship between age and canonical fronto-central theta-beta ratio, such that the direct effect (*c'*) between age and canonical fronto-central theta-beta ratio was non-significant (*c'* = -0.004, 95% CI [-0.010, 0.001], $p = 0.121$). This suggests that the relationship between canonical fronto-central theta-beta ratio and age is driven primarily by the aperiodic exponent, not periodic activity in the canonical theta or beta band, and not from alpha power "leaking" into the canonical theta band as the individual alpha peak frequency shifts into lower frequencies with age.

Table 5
Mediation analyses examining the relationship between canonical fronto-central theta-beta ratio and age, collapsed across eyes open and eyes closed (*n* = 268).

	Mediator											
	Fronto-central Individual Alpha Peak Frequency				Fronto-central Aperiodic Offset				Fronto-central Aperiodic Exponent			
	Est	SE	95% CI	p-value	Est	SE	95% CI	p-value	Est	SE	95% CI	p-value
a (age to mediator)	-0.015	0.005	[-0.026, -0.005]	.006	-0.004	0.003	[-0.010, 0.001]	.092	-0.006	0.001	[-0.008, -0.003]	< .001
b (mediator to canonical fronto-central theta-beta ratio)	-0.324	0.039	[-0.398, -0.244]	< .001	0.801	0.090	[0.152, 0.232	< .001	1.787	0.111	[1.576, 2.013]	< .001
ab (indirect effect)	0.005	0.002	[0.002, 0.009]	.009	-0.004	0.002	[-0.008, < 0.001]	.081	-0.010	0.002	[-0.015, -0.006]	< .001
c (total effect)	-0.015	0.003	[-0.021, -0.008]	< .001	-0.015	0.003	[-0.021, -0.008]	< .001	-0.015	0.003	[-0.021, -0.008]	< .001
c' (direct effect)	-0.019	0.003	[-0.021, -0.008]	< .001	-0.011	0.003	[-0.021, -0.008]	.001	-0.004	0.003	[-0.010, 0.001]	.121
Proportion Mediated (indirect/total)	-0.328	0.226	[-0.922, -0.084]	.147	0.238	0.144	[-0.024, 0.548]	0.100	0.702	0.178	[0.458, 1.126]	< .001

3.4 Hierarchical Regression Analyses

Taken together, the correlational and mediational analyses suggest that the relationship between canonical fronto-central theta-beta ratio and age in older adults is due to the underlying aperiodic exponent, not periodic activity in the canonical theta and beta bands or leakage of alpha into the canonical theta band with age. However, we wanted to determine the extent to which canonical theta and beta have unique associations with age, if any, apart from the theta-beta ratio. Therefore, we conducted a hierarchical regression, regressing age on canonical theta and beta, adding individual alpha peak frequency in the second block and adding the aperiodic exponent in the third block. The first two blocks of the analysis were preregistered as exploratory analysis E1 in the preregistration (https://osf.io/n57au), and the third block was added as an exploratory step to include the aperiodic component. Because controlling for aperiodic offset did not substantially change the relationship between canonical theta-beta ratio and age or mediate the relationship between age and canonical theta-beta ratio, and because the aperiodic exponent and offset are highly intercorrelated (r = 0.75, 95% CI [0.70, 0.80], $p_{uncorr} < .001$ $p_{fdr} < .001$), we conducted the stepwise analyses with only the aperiodic exponent to avoid issues of multicollinearity.

As shown in Table 6, in Block 2 canonical fronto-central theta was significantly associated with age when controlling for fronto-central individual alpha peak frequency, b = -1.86, $t(264) = 2.84$, $p = 0.005$. However, canonical fronto-central theta was non-significantly associated with age when controlling for the fronto-central aperiodic exponent in block 3, b = -0.53, $t(264) = 0.75$, $p = 0.456$. In Block 3, there were significant relationships between canonical fronto-central beta and age, b = 14.75, $t(264) = 3.65$, $p < 0.001$, fronto-central individual alpha peak and age, b = -2.71, $t(264) = 3.96$, $p < 0.001$, and the fronto-central aperiodic exponent and age, b = -11.80, $t(264) = 4.32$, $p < 0.001$, suggesting that there is a significant increase in periodic activity in the canonical beta band with age, as well as the age-related flattening of the aperiodic component and "slowing" of the individual alpha peak frequency. The lack of unique variance associated with canonical theta power over and above the aperiodic component is consistent with the lack of definable peaks (with the FOOOF package) within the canonical theta band, as described in the supplemental materials.

Table 6
Hierarchical multiple regression, regressing age on canonical theta, canonical beta, individual alpha peak frequency, and aperiodic exponent,

	b	*SE*	*t*	*p*	Adj. R^2
Block 1					0.055
Canonical Fronto-central Theta	-0.98	0.62	1.58	.110	
Canonical Fronto-central Beta	17.23	4.13	4.17	< .001	
Block 2					0.093
Canonical Fronto-central Theta	-1.86	0.66	2.84	.005	
Canonical Fronto-central Beta	18.76	4.07	4.61	< .001	
Fronto-central Individual Alpha Peak Frequency	-2.47	0.71	3.50	< .001	
Block 3					0.150
Canonical Fronto-central Theta	-0.53	0.71	0.75	0.456	
Canonical Fronto-central Beta	14.75	4.05	3.65	< .001	
Fronto-central Individual Alpha Peak Frequency	-2.71	0.69	3.96	< .001	
Fronto-central Aperiodic Exponent	-11.80	2.73	4.32	< .001	

4. Discussion

In the preregistered portion of the current study, we aimed to replicate and extend previous observations that canonical fronto-central theta-beta ratios and fronto-central individual alpha peak frequency are associated with age in a large sample of 268 adults featuring a wide age range (36-84 years). Consistent with preregistered predictions and previous studies, we found that both canonical fronto-central theta-beta ratios and fronto-central individual alpha peak frequencies were negatively correlated with age. Exploratory analyses indicated that the association between canonical fronto-central theta-beta ratios and age remained when controlling for fronto-central individual alpha peak frequencies, demonstrating that age-related decreases in canonical fronto-central theta-beta ratios are not due to age-related decreases in fronto-central individual alpha peak frequencies. Instead, the relationship between canonical fronto-central theta-beta ratios and age were reduced when controlling for the fronto-central aperiodic exponent. Additionally, mediation analyses found that only the fronto-central aperiodic exponent fully mediated the relationship between age and canonical fronto-central theta-beta ratios. Furthermore, this effect appears to be robust against multiple ways of defining theta-beta ratios and individual alpha peaks, and consistent across eyes-closed only recordings, as described in the supplemental materials.

4.1 Understanding how aperiodic components, canonical theta-beta ratios and individual alpha peak frequencies change over the lifespan

Our results also reveal a complex pattern of associations between canonical fronto-central theta-beta ratios, fronto-central individual alpha peak frequency, fronto-central aperiodic activity, and age. Consistent with previous studies (Voytek et al., 2015), we observed that the aperiodic exponent was negatively associated with age, suggesting relatively synchronized aperiodic firing in younger vs. older adults. However, the age-related differences in aperiodic offset reported by prior research (Voytek et al., 2015) were not significant in our sample (p_{uncorr} = .071, p_{fdr} = .083). We observed that the age-related differences in the aperiodic exponent are preserved into older adulthood, and are not limited only to the younger (e.g., < 44 years of age) populations reported on in previous studies (Donoghue, Dominguez, et al., 2020), or the relatively small samples used in others (Voytek et al., 2015). We also observed that the association between age and canonical fronto-central theta-beta ratios is reduced when statistically adjusting for the fronto-central aperiodic exponent, consistent with the observation that individual differences in ratio metrics are likely confounded with individual differences in aperiodic activity, especially when there is no clear peak within the particular power band. Critically, the association between age and canonical fronto-central theta-beta ratio is fully mediated by the fronto-central aperiodic exponent.

4.2 Limitations of the current study

The current study has some methodological limitations, particularly regarding the preregistered decision to examine the data combined across eyes open and eyes closed periods and calculate individual alpha peak frequency from fronto-central ROI. Combining eyes open and eyes closed data results in unequal number of epochs between the two conditions. Additionally, alpha power is known to be strongest during eyes closed recordings from posterior sites, which may have impeded our ability to detect individual alpha peak frequency. However, additional analyses reported in the supplemental materials on only the eyes closed data, as well as from individual alpha peak frequency calculated from across all sensors, neither substantially increased the number of RestingIAF package definable peaks, nor changed the interpretation of the analyses. Using the FOOOF package to define individual alpha peak frequency did increase the number of definable individual alpha peaks to n = 302, but the results do not change with this alternative method of defining individual alpha peaks (see Supplemental Materials for full details). Additionally, the decision to use visual artifactual screening makes the pre-processing stream non-reproducible without getting a list of artifactual components. However, we decided to keep the original data preprocessing pipeline from the initial MIDUS 2 EEG data release the same to increase consistency with the publicly available MIDUS 2 alpha asymmetry metrics (http://midus.colectica.org/; https://www.icpsr.umich.edu/web/ICPSR/series/203). The current study is also limited by examining these relationships cross-sectionally across age. Additional longitudinal work is needed to tease apart the unique developmental trajectories of theta-beta ratio and individual peak alpha frequency.

4.2 Implications for fronto-central aperiodic activity, canonical fronto-central theta-beta ratio, and fronto-central individual alpha peak frequency as markers of executive function and healthy aging

Taken together, our findings complicate the interpretation of fronto-central theta-beta ratio as a marker of executive function. In adolescents and young adults, higher theta-beta ratios are associated with more executive dysfunction and related to ADHD (Arns et al., 2013), and lower theta-beta ratios are associated with better attentional control (Perone et al., 2018). Considering older age-related decline in executive function (Buckner, 2004; Lustig & Jantz, 2015), fronto-central theta-beta ratios may exhibit a curvilinear relationship with executive functioning, such that better executive functioning is related to a moderate level of fronto-central theta-beta ratio. Additionally, it may be that adolescence and younger adults are more prone to disruptions related to elevated theta-beta ratios and older adults are more prone to reductions in theta-beta ratios potentially driven by normative aging processes. The moderate level of theta-beta ratio may reflect an optimal balance in the bidirectional regulation of bottom-up subcortical processes by top-down cortical processes that theta-beta ratio is putatively suggested to index (Knyazev, 2007; Schutter & Knyazev, 2012).

However, considering recent data regarding the physiological mechanisms and functions of neural noise, the theta-beta ratio model advanced in previous studies is increasingly difficult to support. As Donoghue, Dominguez, et al. (2020) observed and we have replicated, the association between theta-beta ratios and age is confounded by age-related differences in aperiodic activity. Inter- and intra-individual differences in aperiodic activity have also been strongly and consistently associated with variation in cognitive function (Tran et al., 2020; Voytek et al., 2015), and provide a parsimonious and physiologically plausible mechanism for variation in cognitive function across the lifespan relating to the ratio of excitatory to inhibitory activity (Donoghue, Haller, et al., 2020; Gao et al., 2017; Waschke et al., 2021.

Given the relationships between aperiodic activity, individual alpha peak frequency, and theta-beta ratio with age, as well as existing research linking aperiodic activity to cognitive function (Tran et al., 2020; Voytek et al., 2015), individual alpha peak frequency with memory-related aspects of executive functioning (i.e., Clark et al., 2004) and theta-beta ratio with attention-related aspects of executive functioning (Angelidis et al., 2016), these markers appear to be promising, but potentially overlapping and redundant measures of healthy aging. Further research is needed to confirm the unique associations of aperiodic activity, individual alpha peak frequency and theta-beta ratio with memory, executive functioning, and measures of healthy and pathological aging.

5. Conclusion

Overall, we found that both fronto-central theta-beta ratios and fronto-central individual alpha peak frequencies were cross-sectionally negatively associated with age, and that age-related decreases in fronto-central theta-beta ratios are not due to age-related decreases in fronto-central individual alpha peak frequencies. This suggests that changes in both theta-beta ratios and individual alpha peak frequencies may index differential components of healthy aging. Critically, our findings highlight the confounds between theta-beta ratio and the aperiodic exponent, suggesting that both metrics should be considered in understanding power-based EEG metrics and aging. Future research should explicitly examine multiple facets of executive function (including working memory, attention control, and response inhibition) to determine how theta-beta ratios, aperiodic components, and individual alpha peak frequencies at rest relate to cognitive functioning in older adulthood, and if these measures are suitable as biomarkers for healthy and pathological aging.

Additionally, we are limited by the cross-sectional nature of the study from determining if these cross-sectional relationships between age and resting EEG metrics reflect an underlying developmental trajectory in aging. Future longitudinal research is needed to trace the developmental trajectory of theta-beta ratios, aperiodic components, and individual alpha peak across the lifespan.

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Supplemental Materials

To ensure our findings were not spuriously due to a particular analytic package or approach, we have added additional analyses that parallel the analyses described in the main manuscript but utilize only the data collected with eyes closed (excluding the eyes open epochs), define theta and beta based on individual peak alpha bands as defined by the RestingIAF package (https://github.com/corcorana/restingIAF; Corcoran et al., 2018), define individual alpha peaks using the FOOOF package peak metrics (https://fooof-tools.github.io/; Donoghue, et al., 2020), and define individual alpha peaks using data from across the whole scalp (instead of limiting the definition to the frontal composite sites). Additionally, we also conducted preregistered general estimating equation (GEE) analyses to ensure our findings were not due to genetic interdependencies due to the inclusion of 71 individuals from the MIDUS Twin subsample as well as non-twin siblings and family members within the sample.

The supplemental materials are organized into sections grouping each statistical analysis together across the various data extraction methodologies. First, we repeat all analyses reported in the main manuscript without excluding based on the FOOOF package fit to ensure the post hoc FOOOF fit exclusion criteria did not influence the results. Next, we conduct the preregistered general estimating equation (GEE) follow-up analyses on the correlational results reported in the main manuscript, followed by a preregistered exploratory analysis checking for curvilinear relationships between canonical fronto-central theta-beta ratio and age. Then, we detail the additionally defined EEG metrics extraction (e.g. individual band power, metrics extracted from eyes closed data only, etc.) and examine the demographic breakdowns of the sample based on each set of additional EEG metrics with usable data. Next, we examine the correlation within each metric (e.g., what are the correlations across the different individual peak alpha metrics), followed by repeating the analyses from the main manuscript in order with the alternative EEG metrics. The sections of the supplemental materials are outlined below in Table S1.

Table S1
Supplemental materials table of contents.

S1 Repeat analyses without excluding poor FOOOF fits (preregistered exclusions only)

Because we did not preregister our FOOOF model fit exclusion criteria, we wanted to check that the findings were robust to exclusion criteria. Therefore, we repeated the analyses on the combined eyes open and eyes closed data on all participants (n = 271) who met the preregistered exclusion criteria (at least 50% of epochs retained for the spectral power density and at least 50% of channels resulting in definable alpha peaks) with canonical fronto-central theta-beta ratios and RestingIAF fronto-central defined individual alpha peak frequency. See Table S7 for sample demographics. As in the main manuscript, we report false discovery rate (FDR) corrected p-values for pairwise and partial correlations (Benjamini & Hochberg, 1995) as well as uncorrected p-values.

S1.1 Pairwise Pearson's Correlation Analyses, Preregistered Exclusions Only. As shown in Table S2, the single-order correlations calculated using only preregistered criteria were consistent with the analyses reported in the main manuscript. Canonical fronto-central theta-beta ratios were negatively correlated with age (r = -0.23, 95% CI [-0.34, -0.12], p_{uncorr}

$< .001$, $p_{fdr} < .001$), as was fronto-central individual alpha peak frequency and age ($r = -0.18$, 95% CI [-0.29, -0.06], $p_{uncorr} = .004$, $p_{fdr} = .005$), and the fronto-central aperiodic exponent with age ($r = -0.22$, 95% CI [-0.33, -0.10], $p_{uncorr} < .001$, $p_{fdr} < .001$). The partial correlations controlling for gender and race were consistent with the analyses reported in the manuscript, such that there was still a significant negative correlation between age and canonical fronto-central theta-beta ratio ($r = -0.22$, 95% CI [-0.33, -0.10], $p_{uncorr} < .001$, $p_{fdr} < .001$), a significant negative correlation between age and fronto-central individual alpha peak frequency ($r = -0.19$, 95% CI [-0.30, -0.07], $p_{uncorr} = .002$, $p_{fdr} = .002$), and a significant negative correlation between age and fronto-central aperiodic exponent ($r = -0.21$, 95% CI [-0.32, -0.09], $p_{uncorr} = .001$, $p_{fdr} = .001$).

Table S2

Correlations between age and EEG metrics, collapsed across eyes open and eyes closed, only preregistered exclusions (*n* = 271).

	1. Age	2. Canonical fronto-central theta	3. Canonical fronto-central beta	4. Canonical fronto-central theta-beta ratio	5. Fronto-central RestingIAF individual alpha peak frequency	6. Fronto-central aperiodic exponent
2. Canonical fronto-central theta	0.01 [-0.11 0.13] p_{uncorr} = .817 p_{fdr} = .858	--				
3. Canonical fronto-central beta	0.23 [0.12, 0.34] p_{uncorr} < .001 p_{fdr} < .001	0.42 [0.32, 0.52] p_{uncorr} < .001 p_{fdr} < .001	--			
4. Canonical fronto-central theta-beta ratio	-0.23 [-0.34, -0.12] p_{uncorr} < .001 p_{fdr} < .001	0.50 [0.41, 0.59] p_{uncorr} < .001 p_{fdr} < .001	-0.27 [-0.37, -0.15] p_{uncorr} < .001 p_{fdr} < .001	--		
5. Fronto-central RestingIAF individual alpha peak frequency	-0.18 [-0.29, -0.06] p_{uncorr} = .004 p_{fdr} = .005	-0.38 [-0.48, -0.27] p_{uncorr} < .001 p_{fdr} < .001	-0.08 [-0.19, 0.04] p_{uncorr} = .211 p_{fdr} = .233	-0.41 [-0.51, -0.31] p_{uncorr} < .001 p_{fdr} < .001	--	
6. Fronto-central aperiodic exponent	-0.22 [-0.33, -0.10] p_{uncorr} < .001 p_{fdr} < .001	0.44 [0.34, 0.53] p_{uncorr} < .001 p_{fdr} < .001	0.007 [-0.19, 0.04] p_{uncorr} = .909 p_{fdr} = .909	0.71 [0.65, 0.76] p_{uncorr} < .001 p_{fdr} < .001	-0.26 [-0.36, -0.14] p_{uncorr} < .001 p_{fdr} < .001	--
7. Fronto-central aperiodic offset	-0.09 [-0.21, 0.03] p_{uncorr} = .123 p_{fdr} = .143	0.64 [0.57, 0.71] p_{uncorr} < .001 p_{fdr} < .001	0.48 [0.38, 0.57] p_{uncorr} < .001 p_{fdr} < .001	0.55 [0.46, 0.63] p_{uncorr} < .001 p_{fdr} < .001	-0.30 [-0.41, -0.19] p_{uncorr} < .001 p_{fdr} < .001	0.77 [0.72, 0.82] p_{uncorr} < .001 p_{fdr} < .001

Note: 95% confidence intervals for pairwise correlations displayed in brackets followed by uncorrected and FDR corrected p-values.

S1.2 Partial correlation analyses, preregistered exclusions only. Consistent with the exploratory analyses reported in the main manuscript, as shown in Table S3 the partial correlation between theta-beta ratio and age becomes non-significant only when controlling for the aperiodic exponent, $r_{\text{partial}} = -0.11$, 95% CI [-0.23, 0.008], $p_{uncorr} = .068$, $p_{fdr} = .068$.

Table S3

Partial correlations between age and EEG metrics, controlling for individual alpha peak frequency, aperiodic exponent, or aperiodic offset, collapsed across eyes open and eyes closed, preregistered exclusions only (*n* =271).

	Pairwise Pearson's correlation	Partial correlation controlling for fronto-central RestingIAF individual alpha frequency	Partial correlation controlling for fronto-central aperiodic exponent	Partial correlation controlling for fronto-central aperiodic offset
Canonical fronto-central theta-beta ratio and age	-0.23 [-0.34, -0.12] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.34 [-0.44, -0.23] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.11 [-0.23, 0.008] $p_{uncorr} = .068$ $p_{fdr} = .068$	-0.22 [-0.33, -0.10] $p_{uncorr} < .001$ $p_{fdr} < .001$
Canonical fronto-central theta and age	0.01 [-0.11 0.13] $p_{uncorr} = .817$ $p_{fdr} = .858$	-0.06 [-0.18, 0.06] $p_{uncorr} = .346$ $p_{fdr} = .346$	0.13 [0.006, 0.24] $p_{uncorr} = .039$ $p_{fdr} = .047$	0.10 [-0.02, 0.22] $p_{uncorr} = .107$ $p_{fdr} = .107$
Canonical fronto-central beta and age	0.23 [0.12, 0.34] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.22 [0.11, 0.35] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.24 [0.13, 0.35] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.32 [0.21, 0.42] $p_{uncorr} < .001$ $p_{fdr} < .001$

Note: 95% confidence intervals for pairwise correlations displayed in brackets followed by uncorrected p-values.

S1.3 Mediational Analyses, Preregistered Exclusions Only. As in the main manuscript, we conducted mediation analyses using the processR package in R (Moon, 2021), with maximum likelihood estimation and 10,000 bootstrap estimates of standard error. Consistent with the exploratory mediational analyses reported in the main manuscript, as shown in Table S4, only the fronto-central aperiodic exponent fully mediated the relationship between age and canonical fronto-central theta-beta ratio, such that the direct effect (c') between age and canonical fronto-central theta-beta ratio is non-significant ($c' = -0.005$, 95% CI [-0.010, 0.001], $p = 0.082$).

Table S4

Mediation analyses examining the relationship between canonical fronto-central theta-beta ratio and age, collapsed across eyes open and eyes closed, preregistered exclusions only (n = 271).

	Mediator											
	Fronto-Central Individual Alpha Peak Frequency				Fronto-Central Aperiodic Offset				Fronto-Central Aperiodic Exponent			
	Est	SE	95% CI	p-value	Est	SE	95% CI	p-value	Est	SE	95% CI	p-value
a (age to mediator)	-0.016	0.005	[-0.027, -0.005]	.004	-0.004	0.003	[-0.009, 0.001]	.143	-0.005	0.001	[-0.008, -0.003]	< .001
b (mediator to canonical fronto-central theta-beta ratio)	-0.324	0.039	[-0.398, -0.244]	< .001	0.808	0.085	[0.637, 0.973]	< .001	1.744	0.107	[1.543, 1.964]	< .001
ab (indirect effect)	0.005	0.002	[0.002, 0.009]	.007	-0.003	0.002	[-0.007, 0.000]	.132	-0.009	0.002	[-0.014, -0.005]	< .001
c (total effect)	-0.014	0.003	[-0.021, -0.007]	< .001	-0.014	0.003	[-0.021, -0.007]	< .001	-0.014	0.003	[-0.021, -0.008]	< .001
c’ (direct effect)	-0.020	0.003	[-0.026, -0.013]	< .001	-0.011	0.003	[-0.021, -0.007]	.001	-0.005	0.003	[-0.010, 0.001]	.082
Proportion mediated (indirect/total)	-0.353	0.241	[-1.01, -0.097]	0.144	0.216	0.160	[-0.081, 0.519]	0.178	0.655	0.176	[0.398, 1.085]	< .001

S1.4 Hierarchical Regression Analyses, Preregistered Exclusions Only. Consistent with the analyses reported in the main manuscript, as shown in Table S5, in Block 2 canonical fronto-central theta was significantly associated with age when controlling for fronto-central RestingIAF individual alpha peak frequency, $b = -1.88$, $t(267) = 2.89$, $p = 0.004$. Once again, theta was non-significantly associated with age when controlling for fronto-central aperiodic exponent in block 3, $b = -0.71$, $t(266) = 1.01$, $p = 0.33$. Again, in Block 3, there were significant relationships between canonical fronto-central beta and age, $b = 15.68$, $t(266) = 3.89$, $p < 0.001$, fronto-central RestingIAF individual alpha peak and age, $b = -2.78$, $t(266) = 4.07$, $p < 0.001$, and the fronto-central aperiodic exponent and age, $b = -10.22$, $t(266) = 2.61$, $p < 0.001$.

Table S5
Hierarchical multiple regression, regressing age on canonical fronto-central theta, canonical fronto-cental beta, fronto-central RestingIAF individual alpha peak frequency, and fronto-central aperiodic exponent ($n = 271$)

	b	*SE*	*t*	*p*	Adj. R^2
Block 1					0.056
Theta	-0.97	0.62	1.58	.110	
Beta	17.51	4.12	4.25	< .001	
Block 2					0.097
Theta	-1.88	0.65	2.89	.004	
Beta	18.99	4.05	4.69	< .001	
Individual Alpha Peak Frequency	-2.54	0.70	3.63	< .001	
Block 3					0.143
Theta	-0.71	0.70	1.01	.313	
Beta	15.68	4.03	3.89	< .001	
Individual Alpha Peak Frequency	-2.78	0.68	4.07	< .001	
Aperiodic Exponent	-10.22	2.61	3.92	< .001	

S2 Repeat correlational analyses with General Estimating Equation (preregistered follow-up analysis)

To ensure our findings were not spuriously due to genetic interdependencies due to the inclusion of 71 individuals from the MIDUS Twin subsample as well as siblings and other family relationships in the sample, we conducted parallel analyses controlling for families using general estimating equations with the R gee: Generalized Estimation Equation Solver package (Carey et al., 2019; https://cran.r-project.org/web/packages/gee/index.html). Specifically, we examined the relationship between age and each of the EEG metrics in separate models to mirror the correlational analyses, followed by an examination of the relationship between age and theta-beta ratio controlling separately for individual alpha peak frequency, aperiodic exponent, and aperiodic offset to mirror the partial correlation analyses. As shown in Table S6, age was still significantly negatively related theta-beta ratio, individual alpha peak frequency, and aperiodic exponent, and age and theta-beta ratio were significantly negatively related when controlling for individual alpha peak frequency and aperiodic offset. Consistent with the partial correlation analyses, the relationship between age and theta-beta ratio was reduced and became non-significant when controlling for the aperiodic exponent, $b = -2.17$, $p = 0.109$.

Table S6
General estimating equations, age and EEG metrics, controlling for genetic dependencies across twins.

	b	*Naïve SE*	*Naïve z*	*Naïve p*
Age and theta-beta ratio	-3.89	0.96	4.03	< 0.001
Age and individual alpha peak frequency	-1.86	0.67	2.76	0.006
Age and aperiodic offset	-2.77	1.53	1.81	0.070
Age and aperiodic exponent	-10.30	2.50	4.12	< 0.001
Relationship between age and theta-beta ratio, controlling for:				
Individual alpha peak frequency	-6.08	1.01	6.00	< 0.001
Aperiodic offset	-4.12	1.15	3.60	< 0.001
Aperiodic exponent	-2.17	1.36	1.60	0.109

S3 Explore non-linear age and canonical theta-beta ratio relationships (preregistered exploratory analysis).

To check for non-linear relationships between canonical theta-beta ratio and age, we ran a regression with age as the dependent variable and canonical fronto-central theta-beta ratio and the square of canonical fronto-central theta-beta ratio as the independent variables.

There was no significant effect of canonical fronto-central theta-beta ratio squared, $b = 1.41$, $t(265) = 1.35$, $p = 0.178$, suggesting the relationship between age and canonical fronto-central theta-beta ratio is linear.

S4 Alternative EEG metric quantifications.

To ensure our findings were not spuriously due to a particular analytic package or strategy, we have added additional analyses parallel to the analyses described in the main manuscript that utilize only eyes closed epochs, define theta and beta based on individual peak alpha bands defined by the RestingIAF package (Corcoran et al., 2018), define individual alpha peaks using the FOOOF package peak metrics (Donoghue, et al., 2020), and define individual alpha peaks using data from across the whole scalp (instead of limiting the definition to the frontal composite), as described below.

S4.1 Repeat data extraction from main manuscript sections 2.5.2, 2.5.3, and 2.5.4 on eyes closed epochs only. Data processing steps described in the main manuscript for canonical fronto-central theta-beta ratio, fronto-central alpha peak frequency (using RestingIAF package; Corcoran et al., 2018), and fronto-central aperiodic power spectrum (using FOOOF package; Donoghue, et al., 2020) were redone only on eyes-closed only epochs. The same fronto-central composite and exclusion criteria reported for each metric in the main manuscript were applied. See Table S7-S10 for demographic information of participants with usable eyes-closed only data for each EEG metric.

S4.2 Whole scalp and fronto-central composite RestingIAF individual alpha peak frequency, combined eyes-open and eyes-closed and eyes-closed only data. An additional metric of whole-scalp estimated individual alpha peak frequency was calculated using the RestingIAF (settings and method described in the main manuscript section 2.5.3), as well as the whole-scalp lower and upper boundary of the alpha peak as identified by the first derivative identifying the “shoulders” of the alpha peak for use in identifying individual theta and beta bands described in supplemental material section S4.4 (see Corcoran et al., 2018 for additional information on the RestingIAF package). This procedure was run twice, once on the combined eyes open and eyes closed data as well as on the eyes closed only data. Participants without a RestingIAF identifiable peak in at least 50% of the total number of sensors were excluded on a listwise basis for an eyes-closed only fronto-central RestingIAF peak *n* = 273, a combined eyes-open and eyes-closed whole scalp RestingIAF peak *n* = 273, and an eyes-closed only whole scalp RestingIAF peak *n* = 282. See Table S7-S10 for sample characteristics with usable frontal RestingIAF individual peak alpha frequency for eyes-closed only data, and whole scalp RestingIAF individual alpha peak frequencies by combined eyes-open and eyes-closed and eyes-closed only data.

S4.3 Fronto-central and whole scalp aperiodic adjusted FOOOF individual alpha peak frequency, combined eyes-open and eyes-closed and eyes-closed only data. To use a different approach to correct for the aperiodic component's influence on the measurement of periodic power, we extracted the central frequency of the highest FOOOF fitted peak above the aperiodic component within canonical bands for alpha (7-13 Hz), beta (13-30 Hz) and theta (4-7 Hz), using the settings and method described in the main manuscript section 2.5.4. We repeated this twice, both on the eyes-open and eyes-closed combined data as well as the eyes-closed only data.

We again defined a poor FOOOF model fit as less than 3 standard deviations below the mean in R^2 model fit for the frontal composite, resulting in listwise excluding *n* = 9 participants who failed to meet the $R^2 = 0.862$ threshold for the combined eyes-open and eyes-closed data, and listwise excluding *n* = 9 participants who failed to meet the $R^2 = 0.891$ threshold for the eyes-closed only data. Additionally, we applied the same 50% definable peak criteria as the individual alpha peak frequency metrics from the RestingIAF package. See Tables S7-S10 for breakdowns of participants with individual alpha peak frequency metrics defined by the RestingIAF package. Most participants had a FOOOF-identified peaks within the alpha band, both at the fronto-central composite (combined eyes-open and eyes-closed *n* = 302, eyes-closed only *n* = 303) and whole scalp composite (combined eyes-open and eyes-closed *n* = 305, eyes-closed only *n* = 306). See Tables S7-S10 for sample characteristics with usable FOOOF defined individual alpha peak frequencies.

Only *n* = 52 theta peaks were identifiable in the eyes-open and eyes-closed data and *n* = 62 theta peaks were identifiable in the eyes-closed only data, resulting in a severe floor effect with over two-thirds of the sample having a zero value for aperiodic adjusted theta-beta ratios. Therefore, we were unable to examine aperiodic adjusted theta-beta ratios. *Notably, a lack of definable aperiodic adjustable theta peak is consistent with the overall finding that theta-beta ratios are severely conflated with the aperiodic exponent, and consistent with power in the theta band in particular being attributed primarily to the aperiodic component.*

S4.2 Spectral power for individual fronto-central theta-beta ratio. EEG spectral power was defined on an individual basis using the upper and lower individual alpha peak bounds modeled by the RestingIAF package (Corcoran et al., 2018). Specifically, we defined theta as a 3 Hz band below the RestingIAF lower individual alpha peak boundary (i.e., individual alpha lower bound – 3 Hz to individual alpha lower bound) and beta as a 13 Hz bad above the RestingIAF upper individual alpha peak boundary (i.e., individual alpha upper bound to Individual alpha upper bound + 13 Hz). Otherwise, we extracted the spectral power for each channel in the same manner as the canonical bands described in the main manuscript section 2.5.2, then averaged over the fronto-central composite and were transformed to an individual theta-beta ratio by dividing the former by the latter and subsequently log-normalized. See Table S8 and S10 for demographics of participants with adequate individual fronto-central theta-beta ratio data.

S5. Demographics.

Demographics of each of the sub-samples with usable data for each of the alternative EEG metrics are described in Table S7 (preregistered exclusions only and canonical fronto-central theta-beta ratios with new individual alpha peak frequency metrics, combined eyes-open and eyes closed data), S8 (individual fronto-central theta-beta ratios with new individual alpha peak frequency metrics, combined eyes-open and eyes-closed data), S9 (canonical fronto-central theta-beta ratios with new individual alpha peak frequency metrics, eyes closed only data), and S10 (individual fronto-central theta-beta ratios with new individual alpha peak frequency metrics, eyes-closed only data). Additionally, histograms of the age distribution for the full MIDUS2 Neuroscience Project sample (*n* = 331) and the age distribution for the sample reported in the main manuscript analyses (*n* = 268) are available in Figure S1.

Figure S1

Histogram of age by whole sample (*n* = 331) and the sample reported in the analyses in the main manuscript (*n* = 268)

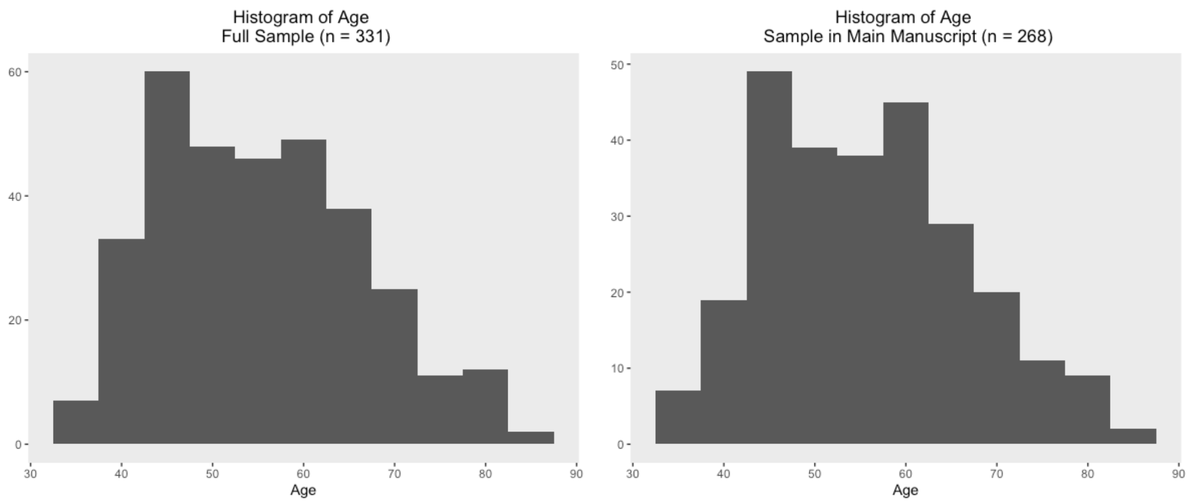

Table S7

Sample demographics for additional analyses in supplemental materials, describing breakdown of the sample with sufficient data for analyses, combined data only, canonical fronto-central theta-beta ratio

	Combined eyes open/closed, canonical fronto-central theta-beta ratios			
	Preregistered exclusions only (*n* = 271)	Sufficient FOOOF fit, whole scalp RestingIAF individual alpha peak frequency (*n* = 276)	Sufficient FOOOF fit, fronto-central FOOOF individual alpha peak frequency (*n* = 302)	Sufficient FOOOF fit, whole scalp FOOOF individual alpha peak frequency (*n* = 305)
Age in Years	55.8 (11.0) range = 36-84	55.6 (11.0) range = 36-84	55.4 (11.0) range = 36-84	55.3 (11.0) range = 36-84
Gender				
Male	123	124	132	134
Female	148	152	170	171
Race/Ethnicity				
White	173	175	198	199
Black	88	91	93	95
Hispanic/Black	4	4	1	4
Hispanic/White	1	1	4	1
Asian	2	2	2	2
Other	3	3	3	3
Handedness				
Right	255	258	281	284
Left	16	18	21	21
MIDUS Subsample				
Main	108	109	123	124
Twin	71	72	82	82
Milwaukee	92	95	97	99

Table S8

Sample demographics for additional analyses in supplemental materials, describing breakdown of the sample with sufficient data for analyses, combined data only, individual fronto-central theta-beta ratio

	Combined eyes open/closed, good FOOOF fit and frontal RestingIAF individual alpha peak frequency (*n* = 268)	Combined eyes open/closed, good FOOOF fit and whole scalp RestingIAF individual alpha peak frequency (*n* = 276)	Combined eyes open/closed, good FOOOF fit and fronto-central FOOOF individual alpha peak frequency (*n* = 276)	Combined eyes open/closed, good FOOOF fit and whole scalp FOOOF individual alpha peak frequency (*n* = 276)
Age in Years	55.8 (11.0) range = 36-84	55.57 (11.0) range = 36-84	55.57 (11.0) range = 36-84	55.57 (11.0) range = 36-84
Gender				
Male	122	124	124	124
Female	146	152	152	152
Race/Ethnicity				
White	172	175	175	175
Black	86	91	91	91
Hispanic/Black	4	4	4	4
Hispanic/White	1	1	1	1
Asian	2	2	2	2
Other	3	3	3	3
Handedness				
Right	252	258	258	258
Left	16	18	18	18
MIDUS Subsample				
Main	107	109	109	109
Twin	71	72	72	72
Milwaukee	90	95	95	95

Table S9

Sample demographics for additional analyses in supplemental materials, describing breakdown of the sample with sufficient data for analyses, eyes-closed data only, canonical fronto-central theta-beta ratio

	Eyes closed, good FOOOF fit and frontal RestingIAF individual alpha peak frequency (*n* = 273)	Eyes closed, good FOOOF fit and whole scalp RestingIAF individual alpha peak frequency (*n* = 282)	Eyes closed, good FOOOF fit and fronto-central FOOOF individual alpha peak frequency (*n* = 303)	Eyes closed, good FOOOF fit and whole scalp FOOOF individual alpha peak frequency (*n* = 306)
Age in Years	55.6 (11.0) range = 36-84	55.51 (10.9) range = 36-84	55.36 (11.0) range = 36-84	55.3 (11.0) range = 36-84
Gender				
Male	121	125	132	133
Female	152	157	171	173
Race/Ethnicity				
White	172	180	199	200
Black	90	91	93	94
Hispanic/Black	4	4	4	4
Hispanic/White	1	1	1	1
Asian	2	2	2	2
Other	3	3	3	3
Handedness				
Right	257	263	282	285
Left	16	19	21	21
MIDUS Subsample				
Main	107	111	123	124
Twin	72	76	83	84
Milwaukee	94	95	97	98

Table S10

Sample demographics for additional analyses in supplemental materials, describing breakdown of the sample with sufficient data for analyses, eyes closed data only, individual fronto-central theta-beta ratio

	Eyes closed, good FOOOF fit and frontal RestingIAF individual alpha peak frequency (*n* = 271)	Eyes closed, good FOOOF fit and whole scalp RestingIAF individual alpha peak frequency (*n* = 276)	Eyes closed, good FOOOF fit and fronto-central FOOOF individual alpha peak frequency (*n* = 276)	Eyes closed, good FOOOF fit and whole scalp FOOOF individual alpha peak frequency (*n* = 276)
Age in Years	55.6 (11.0) range = 36-84	55.6 (11.0) range = 36-84	55.6 (11.0) range = 36-84	55.6 (11.0) range = 36-84
Gender				
Male	121	123	123	123
Female	150	153	153	153
Race/Ethnicity				
White	171	175	175	175
Black	89	90	90	90
Hispanic/Black	4	4	4	4
Hispanic/White	1	1	1	1
Asian	2	2	2	2
Other	3	3	3	3
Handedness				
Right	255	259	259	259
Left	16	17	17	17
MIDUS Subsample				
Main	107	109	109	109
Twin	71	73	73	73
Milwaukee	93	94	94	94

S6. Correlations within alternative EEG metrics.

We examined the correlations between the alternative EEG metrics and those reported in the main manuscript. As shown in Tables S11-S16, all variants of a given EEG metric are highly intercorrelated, r's > 0.79.

Table S11

Correlations between various fronto-central theta measures.

	1. Canonical fronto-central theta, combined eyes-opened and eyes-closed	2. Canonical fronto-central theta, eyes-closed only	3. Individual fronto-central theta, combined eyes-opened and eyes-closed
2. Canonical fronto-central theta, eyes-closed only	0.99 [0.98, 0.99] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 268$	--	
3. Individual fronto-central theta, combined eyes-opened and eyes-closed	0.96 [0.95, 0.97] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 268$	0.95 [0.94, 0.96] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 268$	--
4. Individual fronto-central theta, eyes-closed only	0.96 [0.95, 0.97] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 265$	0.98 [0.97, 0.98] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 265$	0.98 [0.97, 0.98] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 265$

Note: 95% confidence intervals for pairwise correlations displayed in brackets followed by uncorrected and FDR corrected p-values.

Table S12
Correlations between various fronto-central beta measures.

	1. Canonical fronto-central beta, combined eyes-opened and eyes-closed	2. Canonical fronto-central beta, eyes-closed only	3. Individual fronto-central beta, combined eyes-opened and eyes-closed
2. Canonical fronto-central beta, eyes-closed only	0.99 [0.98, 0.99] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 268$	--	
3. Individual fronto-central beta, combined eyes-opened and eyes-closed	0.94 [0.93, 0.96] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 268$	0.92 [0.90, 0.93] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 268$	--
4. Individual fronto-central beta, eyes-closed only	0.94 [0.93, 0.95] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 265$	0.93 [0.92, 0.95] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 265$	0.98 [0.98, 0.99] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 265$

Note: 95% confidence intervals for pairwise correlations displayed in brackets followed by uncorrected and FDR corrected p-values.

Table S13

Correlations between various fronto-central theta-beta ratio measures.

	1. Canonical fronto-central theta-beta ratio, combined eyes-opened and eyes-closed	2. Canonical fronto-central theta-beta ratio, eyes-closed only	3. Individual fronto-central theta-beta ratio, combined eyes-opened and eyes-closed
2. Canonical fronto-central theta-beta ratio, eyes-closed only	0.98 [0.98, 0.99] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 268$	--	
3. Individual fronto-central theta-beta ratio, combined eyes-opened and eyes-closed	0.89 [0.86, 0.91] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 268$	0.86 [0.82, 0.89] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 268$	--
4. Individual fronto-central theta-beta ratio, eyes-closed only	0.90 [0.88, 0.92] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 265$	0.90 [0.87, 0.92] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 265$	0.96 [0.96, 0.97] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 265$

Note: 95% confidence intervals for pairwise correlations displayed in brackets followed by uncorrected and FDR corrected p-values.

Table S14

Correlations between various individual peak alpha frequency (IAF) measures.

	1. RestingIAF fronto-central IAF combined	2. RestingIAF whole scalp IAF combined	3. RestingIAF fronto-central IAF eyes closed only	4. RestingIAF whole scalp IAF eyes closed only	5. FOOOF fronto-central IAF combined	6. FOOOF whole scalp IAF combined	7. FOOOF fronto-central IAF eyes closed only
2. RestingIAF whole scalp IAF combined eyes-opened and closed	0.93 [0.92, 0.95] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 268$	--					
3. RestingIAF fronto-central IAF eyes closed only	0.98 [0.98, 0.99] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 265$	0.94 [0.92, 0.95] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 265$	--				
4. RestingIAF whole scalp IAF eyes closed only	0.93 [0.91, 0.94] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 267$	0.99 [0.99, 0.99] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 267$	0.94 [0.93, 0.96] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 264$	--			
5. FOOOF fronto-central IAF combined eyes-opened and closed	0.89 [0.87, 0.92] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 268$	0.91 [0.89, 0.93] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 268$	0.90 [0.87, 0.92] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 265$	0.91 [0.89, 0.93] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 267$	--		
6. FOOOF whole scalp IAF combined eyes-opened and closed	0.79 [0.75, 0.84] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 268$	0.86 [0.83, 0.89] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 268$	0.83 [0.79, 0.86] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 265$	0.87 [0.84, 0.90] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 267$	0.90 [0.88, 0.92] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 268$	--	
7. FOOOF fronto-central IAF eyes closed only	0.84 [0.81, 0.88] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 268$	0.90 [0.87, 0.92] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 268$	0.86 [0.83, 0.89] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 265$	0.90 [0.88, 0.92] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 267$	0.95 [0.94, 0.96] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 268$	0.90 [0.87, 0.91] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 268$	--
8. FOOOF whole scalp IAF eyes closed only	0.82 [0.78, 0.85] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 268$	0.87 [0.84, 0.90] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 268$	0.83 [0.79, 0.87] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 265$	0.88 [0.85, 0.90] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 267$	0.90 [0.88, 0.92] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 268$	0.92 [0.90, 0.94] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 268$	0.92 [0.90, 0.94] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 268$

Note: 95% confidence intervals for pairwise correlations displayed in brackets followed by uncorrected and FDR corrected p-values.

Table S15
Correlations between various aperiodic component measures.

	Fronto-central aperiodic offset, combined eyes-open and eyes-closed
Fronto-central aperiodic offset, eyes-closed only	0.99 [0.98, 0.99] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 268$
	Fronto-central aperiodic exponent, combined eyes-open and eyes-closed
Fronto-central aperiodic exponent, eyes-closed only	0.97 [0.96, 0.97] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 268$

Note: 95% confidence intervals for pairwise correlations displayed in brackets followed by uncorrected and FDR corrected p-values.

S7 Pairwise Pearson's correlation analyses (parallel to Section 3.1).

We examined the correlations amongst age and the EEG metrics by each alternative EEG metric. As shown in Tables S16-S30, the results mirror Section 3.1 of the main manuscript, such that resting theta-beta ratios were negatively correlated with age (*r*'s range from -0.30 to -0.20), individual alpha peak frequencies were negatively correlated with age (*r*'s range from -0.28 to -0.17), aperiodic exponent was negatively correlated with age (*r*'s range from -0.25 to -0.17), and the theta-beta ratio is strongly correlated with the aperiodic exponent (*r*'s range from 0.61 to 0.72).

Table S16

Correlations between age and EEG metrics, collapsed across eyes open and eyes closed, good FOOOF fit, valid RestingIAF scalp individual alpha peak frequency, canonical fronto-central theta and beta bands (*n* = 276).

	1. Age	2. Canonical fronto-central theta	3. Canonical fronto-central beta	4. Canonical fronto-central theta-beta ratio	5. Whole scalp RestingIAF individual alpha peak frequency	6. Fronto-central aperiodic exponent
2. Canonical fronto-central theta	0.00 [-0.12, 0.12] $p_{uncorr} = .993$ $p_{fdr} = .993$	--				
3. Canonical fronto-central beta	0.23 [0.12, 0.34] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.41 [0.31, 0.51] $p_{uncorr} < .001$ $p_{fdr} < .001$	--			
4. Canonical fronto-central theta-beta ratio	-0.25 [-0.36, -0.13] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.51 [0.42, 0.60] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.28 [-0.38, -0.16] $p_{uncorr} < .001$ $p_{fdr} < .001$	--		
5. Whole scalp RestingIAF individual alpha peak frequency	-0.21 [-0.32, -0.09] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.35 [-0.45, -0.25] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.07 [-0.19, 0.05] $p_{uncorr} = .225$ $p_{fdr} = .248$	-0.40 [-0.50, -0.30] $p_{uncorr} < .001$ $p_{fdr} < .001$	--	
6. Fronto-central aperiodic exponent	-0.25 [-0.35, -0.13] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.45 [0.35, 0.54] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.01 [-0.13, 0.10] $p_{uncorr} = .810$ $p_{fdr} = .850$	0.71 [0.65, 0.77] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.27 [-0.37, -0.15] $p_{uncorr} < .001$ $p_{fdr} < .001$	--
7. Fronto-central aperiodic offset	-0.11 [-0.23, 0.01] $p_{uncorr} = .065$ $p_{fdr} = .076$	0.66 [0.59, 0.72] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.47 [0.38, 0.56] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.54 [0.45, 0.62] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.32 [-0.42, -0.20] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.76 [0.70, 0.80] $p_{uncorr} < .001$ $p_{fdr} < .001$

Note: 95% confidence intervals for pairwise correlations displayed in brackets followed by uncorrected and FDR corrected p-values.

Table S17

Correlations between age and EEG metrics, collapsed across eyes open and eyes closed, good FOOOF fit, valid RestingIAF fronto-central individual alpha peak frequency, individual fronto-central theta and beta bands (n = 268).

	1. Age	2. Individual fronto-central theta	3. Individual fronto-central beta	4. Individual fronto-central theta-beta ratio	5. Fronto-central RestingIAF individual alpha peak frequency	6. Fronto-central aperiodic exponent
2. Individual fronto-central theta	0.04 [-0.08, 0.16] p_{uncorr} = .542 p_{fdr} = .542	--				
3. Individual fronto-central beta	0.25 [0.13, 0.36] p_{uncorr} < .001 p_{fdr} < .001	0.67 [0.60, 0.73] p_{uncorr} < .001 p_{fdr} < .001	--			
4. Individual fronto-central theta-beta ratio	-0.30 [-0.40, -0.18] p_{uncorr} < .001 p_{fdr} < .001	0.40 [0.30, 0.50] p_{uncorr} < .001 p_{fdr} < .001	-0.20 [-0.32, -0.09] p_{uncorr} < .001 p_{fdr} < .001	--		
5. Fronto-central RestingIAF individual alpha peak frequency	-0.17 [-0.28, -0.05] p_{uncorr} = .006 p_{fdr} = .007	-0.35 [-0.45, -0.24] p_{uncorr} < .001 p_{fdr} < .001	-0.20 [-0.31, -0.08] p_{uncorr} = .001 p_{fdr} = .001	-0.23 [-0.34, -0.12] p_{uncorr} < .001 p_{fdr} < .001	--	
6. Fronto-central aperiodic exponent	-0.24 [-0.35, -0.13] p_{uncorr} < .001 p_{fdr} < .001	0.47 [0.37, 0.55] p_{uncorr} < .001 p_{fdr} < .001	0.14 [0.02, 0.25] p_{uncorr} = .026 p_{fdr} = .029	0.62 [0.54, 0.69] p_{uncorr} < .001 p_{fdr} < .001	-0.25 [-0.36, -0.14] p_{uncorr} < .001 p_{fdr} < .001	--
7. Fronto-central aperiodic offset	-0.11 [-0.23, 0.01] p_{uncorr} = .071 p_{fdr} = .075	0.71 [0.64, 0.76] p_{uncorr} < .001 p_{fdr} < .001	0.58 [0.50, 0.66] p_{uncorr} < .001 p_{fdr} < .001	0.44 [0.33, 0.52] p_{uncorr} < .001 p_{fdr} < .001	-0.30 [-0.40, -0.19] p_{uncorr} < .001 p_{fdr} < .001	0.75 [0.70, 0.80] p_{uncorr} < .001 p_{fdr} < .001

Note: 95% confidence intervals for pairwise correlations displayed in brackets followed by uncorrected and FDR corrected p-values.

Table S18

Correlations between age and EEG metrics, collapsed across eyes open and eyes closed, good FOOOF fit, valid RestingIAF whole scalp individual alpha peak frequency, individual fronto-central theta and beta bands (*n* = 276).

	1. Age	2. Individual fronto-central theta	3. Individual fronto-central beta	4. Individual fronto-central theta-beta ratio	5. Whole scalp RestingIAF individual alpha peak frequency	6. Fronto-central aperiodic exponent
2. Individual fronto-central theta	0.03 [-0.09, 0.15] p_{uncorr} = .636 p_{fdr} = .636	--				
3. Individual fronto-central beta	0.24 [0.13, 0.35] p_{uncorr} < .001 p_{fdr} < .001	0.67 [0.60, 0.73] p_{uncorr} < .001 p_{fdr} < .001	--			
4. Individual fronto-central theta-beta ratio	-0.30 [-0.40, -0.19] p_{uncorr} < .001 p_{fdr} < .001	0.41 [0.30, 0.50] p_{uncorr} < .001 p_{fdr} < .001	-0.20 [-0.31, -0.09] p_{uncorr} = .001 p_{fdr} = .001	--		
5. Whole scalp RestingIAF individual alpha peak frequency	-0.21 [-0.32, -0.09] p_{uncorr} < .001 p_{fdr} < .001	-0.34 [-0.44, -0.23] p_{uncorr} < .001 p_{fdr} < .001	-0.22 [-0.33, -0.10] p_{uncorr} < .001 p_{fdr} < .001	-0.20 [-0.341 -0.08] p_{uncorr} = .001 p_{fdr} = .001	--	
6. Fronto-central aperiodic exponent	-0.25 [-0.35, -0.13] p_{uncorr} < .001 p_{fdr} < .001	0.47 [0.38, 0.56] p_{uncorr} < .001 p_{fdr} < .001	0.14 [0.03, 0.26] p_{uncorr} = .017 p_{fdr} = .019	0.61 [0.53, 0.68] p_{uncorr} < .001 p_{fdr} < .001	-0.27 [-0.37, -0.15] p_{uncorr} < .001 p_{fdr} < .001	--
7. Fronto-central aperiodic offset	-0.11 [-0.23, 0.01] p_{uncorr} = .065 p_{fdr} = .068	0.71 [0.64, 0.76] p_{uncorr} < .001 p_{fdr} < .001	0.58 [0.50, 0.66] p_{uncorr} < .001 p_{fdr} < .001	0.44 [0.33, 0.53] p_{uncorr} < .001 p_{fdr} < .001	-0.32 [-0.42, -0.21] p_{uncorr} < .001 p_{fdr} < .001	0.76 [0.70, 0.80] p_{uncorr} < .001 p_{fdr} < .001

Note: 95% confidence intervals for pairwise correlations displayed in brackets followed by uncorrected and FDR corrected p-values.

Table S19

Correlations between age and EEG metrics, collapsed across eyes open and eyes closed, good FOOOF fit, FOOOF fronto-central individual alpha peak frequency, canonical fronto-central theta and beta bands (*n* = 302).

	1. Age	2. Canonical fronto-central theta	3. Canonical fronto-central beta	4. Canonical fronto-central theta-beta ratio	5. Fronto-central FOOOF individual alpha peak frequency	6. Fronto-central aperiodic exponent
2. Canonical fronto-central theta	0.00 [-0.11, 0.12] $p_{uncorr} = .970$ $p_{fdr} = .990$	--				
3. Canonical fronto-central beta	0.23 [0.12, 0.33] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.42 [0.32, 0.51] $p_{uncorr} < .001$ $p_{fdr} < .001$	--			
4. Canonical fronto-central theta-beta ratio	-0.25 [-0.35, -0.14] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.50 [0.41, 0.58] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.28 [-0.39, -0.18] $p_{uncorr} < .001$ $p_{fdr} < .001$	--		
5. Fronto-central FOOOF individual alpha peak frequency	-0.24 [-0.35, -0.13] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.28 [-0.38, -0.17] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.12 [-0.23, -0.01] $p_{uncorr} = .040$ $p_{fdr} = .047$	-0.25 [-0.35 -0.14] $p_{uncorr} < .001$ $p_{fdr} < .001$	--	
6. Fronto-central aperiodic exponent	-0.23 [-0.34, -0.12] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.45 [0.36, 0.54] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.00 [-0.11, 0.11] $p_{uncorr} = .990$ $p_{fdr} = .990$	0.70 [0.63, 0.75] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.16 [-0.27, -0.05] $p_{uncorr} = .004$ $p_{fdr} = .005$	--
7. Fronto-central aperiodic offset	-0.09 [-0.19, 0.03] $p_{uncorr} = .135$ $p_{fdr} = .149$	0.65 [0.58, 0.71] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.50 [0.41, 0.58] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.50 [0.41, 0.58] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.25 [-0.35, -0.14] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.75 [0.69, 0.79] $p_{uncorr} < .001$ $p_{fdr} < .001$

Note: 95% confidence intervals for pairwise correlations displayed in brackets followed by uncorrected and FDR corrected p-values.

Table S20

Correlations between age and EEG metrics, collapsed across eyes open and eyes closed, good FOOOF fit, FOOOF whole scalp individual alpha peak frequency, canonical fronto-central theta and beta bands (*n* = 305).

	1. Age	2. Canonical fronto-central theta	3. Canonical fronto-central beta	4. Canonical fronto-central theta-beta ratio	5. Whole scalp FOOOF individual alpha peak frequency	6. Fronto-central aperiodic exponent
2. Canonical fronto-central theta	0.00 [-0.11, 0.12] $p_{uncorr} = .977$ $p_{fdr} = .977$	--				
3. Canonical fronto-central beta	0.23 [0.12, 0.34] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.42 [0.32, 0.51] $p_{uncorr} < .001$ $p_{fdr} < .001$	--			
4. Canonical fronto-central theta-beta ratio	-0.26 [-0.36, -0.15] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.50 [0.41, 0.58] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.29 [-0.39, -0.18] $p_{uncorr} < .001$ $p_{fdr} < .001$	--		
5. Whole scalp FOOOF individual alpha peak frequency	-0.23 [-0.33, -0.12] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.30 [-0.40, -0.19] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.13 [-0.23, -0.02] $p_{uncorr} = .024$ $p_{fdr} = .028$	-0.25 [-0.35 -0.14] $p_{uncorr} < .001$ $p_{fdr} < .001$	--	
6. Fronto-central aperiodic exponent	-0.23 [-0.34, -0.12] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.45 [0.36, 0.54] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.00 [-0.11, 0.11] $p_{uncorr} = .977$ $p_{fdr} = .977$	0.69 [0.63, 0.75] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.15 [-0.26, -0.04] $p_{uncorr} = .009$ $p_{fdr} = .011$	--
7. Fronto-central aperiodic offset	-0.09 [-0.20, 0.02] $p_{uncorr} = .127$ $p_{fdr} = .140$	0.65 [0.58, 0.71] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.50 [0.41, 0.58] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.50 [0.41, 0.58] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.25 [-0.35, -0.14] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.74 [0.69, 0.79] $p_{uncorr} < .001$ $p_{fdr} < .001$

Note: 95% confidence intervals for pairwise correlations displayed in brackets followed by uncorrected and FDR corrected p-values.

Table S21

Correlations between age and EEG metrics, collapsed across eyes open and eyes closed, good FOOOF fit, FOOOF fronto-central individual alpha peak frequency, individual fronto-central theta and beta bands (n = 276).

	1. Age	2. Individual fronto-central theta	3. Individual fronto-central beta	4. Individual fronto-central theta-beta ratio	5. Fronto-central FOOOF individual alpha peak frequency	6. Fronto-central aperiodic exponent
2. Individual fronto-central theta	0.03 [-0.09, 0.15] p_{uncorr} = .636 p_{fdr} = .636	--				
3. Individual fronto-central beta	0.24 [0.13, 0.35] p_{uncorr} < .001 p_{fdr} < .001	0.67 [0.60, 0.73] p_{uncorr} < .001 p_{fdr} < .001	--			
4. Individual fronto-central theta-beta ratio	-0.30 [-0.40, -0.19] p_{uncorr} < .001 p_{fdr} < .001	0.41 [0.30, 0.50] p_{uncorr} < .001 p_{fdr} < .001	-0.20 [-0.31, -0.09] p_{uncorr} = .001 p_{fdr} = .001	--		
5. Fronto-central FOOOF individual alpha peak frequency	-0.26 [-0.36, -0.14] p_{uncorr} < .001 p_{fdr} < .001	-0.26 [-0.37, -0.15] p_{uncorr} < .001 p_{fdr} < .001	-0.22 [-0.33, -0.10] p_{uncorr} < .001 p_{fdr} < .001	-0.08 [-0.20, 0.03] p_{uncorr} = .162 p_{fdr} = .171	--	
6. Fronto-central aperiodic exponent	-0.25 [-0.35, -0.13] p_{uncorr} < .001 p_{fdr} < .001	0.47 [0.38, 0.56] p_{uncorr} < .001 p_{fdr} < .001	0.14 [0.03, 0.26] p_{uncorr} = .017 p_{fdr} = .020	0.61 [0.54, 0.68] p_{uncorr} < .001 p_{fdr} < .001	-0.17 [-0.28, -0.05] p_{uncorr} = .005 p_{fdr} = .006	--
7. Fronto-central aperiodic offset	-0.11 [-0.23, 0.01] p_{uncorr} = .065 p_{fdr} = .072	0.71 [0.65, 0.76] p_{uncorr} < .001 p_{fdr} < .001	0.58 [0.50, 0.66] p_{uncorr} < .001 p_{fdr} < .001	0.44 [0.33, 0.53] p_{uncorr} < .001 p_{fdr} < .001	-0.23 [-0.34, -0.12] p_{uncorr} < .001 p_{fdr} < .001	0.76 [0.70, 0.80] p_{uncorr} < .001 p_{fdr} < .001

Note: 95% confidence intervals for pairwise correlations displayed in brackets followed by uncorrected and FDR corrected p-values.

Table S22

Correlations between age and EEG metrics, collapsed across eyes open and eyes closed, good FOOOF fit, FOOOF whole scalp individual alpha peak frequency, individual fronto-central theta and beta bands (*n* = 276).

	1. Age	2. Individual fronto-central theta	3. Individual fronto-central beta	4. Individual fronto-central theta-beta ratio	5. Whole scalp FOOOF individual alpha peak frequency	6. Fronto-central aperiodic exponent
2. Individual fronto-central theta	0.03 [-0.09, 0.15] $p_{uncorr} = .636$ $p_{fdr} = .636$	--				
3. Individual fronto-central beta	0.24 [0.13, 0.35] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.67 [0.60, 0.73] $p_{uncorr} < .001$ $p_{fdr} < .001$	--			
4. Individual fronto-central theta-beta ratio	-0.30 [-0.40, -0.19] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.41 [0.30, 0.50] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.20 [-0.31, -0.09] $p_{uncorr} < .001$ $p_{fdr} = .001$	--		
5. Whole scalp FOOOF individual alpha peak frequency	-0.26 [-0.37, -0.15] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.29 [-0.40, -0.18] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.23 [-0.34, -0.12] $p_{uncorr} < .001$ $p_{fdr} = .001$	-0.08 [-0.20, 0.03] $p_{uncorr} = .160$ $p_{fdr} = .168$	--	
6. Fronto-central aperiodic exponent	-0.25 [-0.35, -0.13] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.47 [0.38, 0.56] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.14 [0.03, 0.26] $p_{uncorr} = .017$ $p_{fdr} = .020$	0.61 [0.54, 0.68] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.16 [-0.27, -0.04] $p_{uncorr} = .009$ $p_{fdr} = .012$	--
7. Fronto-central aperiodic offset	-0.11 [-0.23, 0.01] $p_{uncorr} = .065$ $p_{fdr} = .072$	0.71 [0.64, 0.76] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.58 [0.50, 0.66] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.44 [0.33, 0.53] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.23 [-0.34, -0.12] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.76 [0.70, 0.80] $p_{uncorr} < .001$ $p_{fdr} < .001$

Note: 95% confidence intervals for pairwise correlations displayed in brackets followed by uncorrected and FDR corrected p-values.

Table S23

Correlations between age and EEG metrics, eyes closed only, good FOOOF fit, fronto-central RestingIAF individual alpha peak frequency, canonical fronto-central theta and beta bands (*n* = 273).

	1. Age	2. Canonical fronto-central theta	3. Canonical fronto-central beta	4. Canonical fronto-central theta-beta ratio	5. Fronto-central RestingIAF individual alpha peak frequency	6. Fronto-central aperiodic exponent
2. Canonical fronto-central theta	0.01 [-0.11, 0.12] $p_{uncorr} = .919$ $p_{fdr} = .919$	--				
3. Canonical fronto-central beta	0.19 [0.07, 0.30] $p_{uncorr} =.002$ $p_{fdr} = .002$	0.40 [0.29, 0.49] $p_{uncorr} < .001$ $p_{fdr} < .001$	--			
4. Canonical fronto-central theta-beta ratio	-0.20 [-0.31, -0.08] $p_{uncorr} < .001$ $p_{fdr} = .001$	0.55 [0.46, 0.63] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.26 [-0.37, -0.14] $p_{uncorr} < .001$ $p_{fdr} = .001$	--		
5. Fronto-central RestingIAF individual alpha peak frequency	-0.23 [-0.34, -0.11] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.40 [-0.50, -0.30] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.04 [-0.16, -0.07] $p_{uncorr} = .465$ $p_{fdr} = .514$	-0.45 [-0.54, 0.35] $p_{uncorr} < .001$ $p_{fdr} < .001$	--	
6. Fronto-central aperiodic exponent	-0.20 [-0.32, -0.09] $p_{uncorr} < .001$ $p_{fdr} = .001$	0.49 [0.40, 0.58] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.01 [-0.13, 0.11] $p_{uncorr} = .823$ $p_{fdr} = .865$	0.72 [0.66, 0.77] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.30 [-0.41, -0.19] $p_{uncorr} < .001$ $p_{fdr} < .001$	--
7. Fronto-central aperiodic offset	-0.11 [-0.22, 0.01] $p_{uncorr} = .077$ $p_{fdr} = .090$	0.68 [0.60, 0.74] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.45 [0.35, 0.54] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.58 [0.50, 0.65] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.21 [-0.42, -0.21] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.78 [0.73, 0.82] $p_{uncorr} < .001$ $p_{fdr} < .001$

Note: 95% confidence intervals for pairwise correlations displayed in brackets followed by uncorrected and FDR corrected p-values.

Table S24

Correlations between age and EEG metrics, eyes closed only, good FOOOF fit, whole scalp RestingIAF individual alpha peak frequency, canonical fronto-central theta and beta bands (*n* = 282).

	1. Age	2. Canonical fronto-central theta	3. Canonical fronto-central beta	4. Canonical fronto-central theta-beta ratio	5. Whole scalp RestingIAF individual alpha peak frequency	6. Fronto-central aperiodic exponent
2. Canonical fronto-central theta	0.00 [-0.11, 0.12] $p_{uncorr} = .939$ $p_{fdr} = .939$	--				
3. Canonical fronto-central beta	0.19 [0.07, 0.30] $p_{uncorr} < .001$ $p_{fdr} = .002$	0.40 [0.30, 0.49] $p_{uncorr} < .001$ $p_{fdr} < .001$	--			
4. Canonical fronto-central theta-beta ratio	-0.20 [-0.31, -0.09] $p_{uncorr} < .001$ $p_{fdr} = .001$	0.54 [0.46, 0.62] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.27 [-0.37, -0.16] $p_{uncorr} < .001$ $p_{fdr} = .001$	--		
5. Whole scalp RestingIAF individual alpha peak frequency	-0.23 [-0.33, -0.11] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.37 [-0.47, -0.27] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.05 [-0.17, 0.07] $p_{uncorr} = .396$ $p_{fdr} = .438$	-0.43 [-0.52, -0.33] $p_{uncorr} < .001$ $p_{fdr} < .001$	--	
6. Fronto-central aperiodic exponent	-0.21 [-0.32, -0.10] $p_{uncorr} < .001$ $p_{fdr} = .001$	0.49 [0.39, 0.57] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.02 [-0.14, 0.10] $p_{uncorr} = .746$ $p_{fdr} = .783$	0.72 [0.66, 0.77] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.32 [-0.42, -0.21] $p_{uncorr} < .001$ $p_{fdr} < .001$	--
7. Fronto-central aperiodic offset	-0.11 [-0.23, 0.003] $p_{uncorr} = .057$ $p_{fdr} = .066$	0.67 [0.60, 0.73] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.45 [0.35, 0.54] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.57 [0.49, 0.64] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.34 [-0.44, -0.23] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.78 [0.73, 0.82] $p_{uncorr} < .001$ $p_{fdr} < .001$

Note: 95% confidence intervals for pairwise correlations displayed in brackets followed by uncorrected and FDR corrected p-values.

Table S25

Correlations between age and EEG metrics, eyes closed only, good FOOOF fit, fronto-central RestingIAF individual alpha peak frequency, individual fronto-central theta and beta bands (*n* = 271).

	1. Age	2. Individual fronto-central theta	3. Individual fronto-central beta	4. Individual fronto-central theta-beta ratio	5. Fronto-central RestingIAF individual alpha peak frequency	6. Fronto-central aperiodic exponent
2. Individual fronto-central theta	0.01 [-0.11, 0.13] $p_{uncorr} = .837$ $p_{fdr} = .870$	--				
3. Individual fronto-central beta	0.20 [0.08, 0.31] $p_{uncorr} = .001$ $p_{fdr} = .001$	0.63 [0.56, 0.70] $p_{uncorr} < .001$ $p_{fdr} < .001$	--			
4. Individual fronto-central theta-beta ratio	-0.25 [-0.36, -0.13] $p_{uncorr} < .001$ $p_{fdr} = .001$	0.47 [0.38, 0.56] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.16 [-0.27, -0.04] $p_{uncorr} = .011$ $p_{fdr} = .011$	--		
5. Fronto-central RestingIAF individual alpha peak frequency	-0.22 [-0.33, -0.10] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.36 [-0.46, -0.26] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.18 [-0.29, -0.06] $p_{uncorr} = .003$ $p_{fdr} = .013$	-0.27 [-0.38, 0.16] $p_{uncorr} < .001$ $p_{fdr} < .001$	--	
6. Fronto-central aperiodic exponent	-0.20 [-0.31, -0.08] $p_{uncorr} = .001$ $p_{fdr} = .001$	0.51 [0.42, 0.59] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.15 [0.03, 0.27] $p_{uncorr} = .013$ $p_{fdr} = .003$	0.63 [0.55, 0.70] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.31 [-0.41, -0.19] $p_{uncorr} < .001$ $p_{fdr} < .001$	--
7. Fronto-central aperiodic offset	-0.11 [-0.22, 0.01] $p_{uncorr} = .069$ $p_{fdr} = .072$	0.71 [0.64, 0.76] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.56 [0.48, 0.64] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.49 [0.39, 0.58] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.31 [-0.42, -0.20] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.79 [0.74, 0.83] $p_{uncorr} < .001$ $p_{fdr} < .001$

Note: 95% confidence intervals for pairwise correlations displayed in brackets followed by uncorrected and FDR corrected p-values.

Table S26

Correlations between age and EEG metrics, eyes closed only, good FOOOF fit, whole scalp RestingIAF individual alpha peak frequency, individual fronto-central theta and beta bands (*n* = 276).

	1. Age	2. Individual fronto-central theta	3. Individual fronto-central beta	4. Individual fronto-central theta-beta ratio	5. Whole scalp RestingIAF individual alpha peak frequency	6. Fronto-central aperiodic exponent
2. Individual fronto-central theta	0.01 [-0.11, 0.13] $p_{uncorr} = .869$ $p_{fdr} = .869$	--				
3. Individual fronto-central beta	0.20 [0.08, 0.31] $p_{uncorr} = .001$ $p_{fdr} = .001$	0.63 [0.55, 0.70] $p_{uncorr} < .001$ $p_{fdr} < .001$	--			
4. Individual fronto-central theta-beta ratio	-0.25 [-0.36, -0.13] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.47 [0.37, 0.56] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.17 [-0.28, -0.05] $p_{uncorr} = .006$ $p_{fdr} = .007$	--		
5. Whole scalp RestingIAF individual alpha peak frequency	-0.22 [-0.33, -0.11] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.34 [-0.44, -0.23] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.20 [-0.32, 0.09] $p_{uncorr} < .001$ $p_{fdr} = .001$	-0.22 [-0.32, -0.10] $p_{uncorr} < .001$ $p_{fdr} < .001$	--	
6. Fronto-central aperiodic exponent	-0.20 [-0.31, -0.08] $p_{uncorr} < .001$ $p_{fdr} = .001$	0.51 [0.42, 0.59] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.15 [0.03, 0.27] $p_{uncorr} = .011$ $p_{fdr} = .012$	0.62 [0.54, 0.69] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.32 [-0.42, -0.21] $p_{uncorr} < .001$ $p_{fdr} < .001$	--
7. Fronto-central aperiodic offset	-0.12 [-0.23, 0.001] $p_{uncorr} = .052$ $p_{fdr} = .055$	0.71 [0.64, 0.76] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.56 [0.48, 0.64] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.48 [0.38, 0.57] $p_{uncorr} < .001$ $p_{fdr} < .001$	-0.33 [-0.43, -0.22] $p_{uncorr} < .001$ $p_{fdr} < .001$	0.78 [0.74, 0.83] $p_{uncorr} < .001$ $p_{fdr} < .001$

Note: 95% confidence intervals for pairwise correlations displayed in brackets followed by uncorrected and FDR corrected p-values.

Table S27
Correlations between age and EEG metrics, eyes closed only, good FOOOF fit, fronto-central FOOOF individual alpha peak frequency, canonical fronto-central theta and beta bands (*n* = 303).

	1. Age	2. Canonical fronto-central theta	3. Canonical fronto-central beta	4. Canonical fronto-central theta-beta ratio	5. Fronto-central FOOOF individual alpha peak frequency	6. Fronto-central aperiodic exponent
2. Canonical fronto-central theta	0.01 [-0.10, 0.13] p_{uncorr} = .863 p_{fdr} = .906	--				
3. Canonical fronto-central beta	0.19 [0.08, 0.30] p_{uncorr} < .001 p_{fdr} = .001	0.41 [0.31, 0.50] p_{uncorr} < .001 p_{fdr} < .001	--			
4. Canonical fronto-central theta-beta ratio	-0.20 [-0.30, -0.09] p_{uncorr} < .001 p_{fdr} = .001	0.54 [0.45, 0.61] p_{uncorr} < .001 p_{fdr} < .001	-0.26 [-0.37, -0.16] p_{uncorr} < .001 p_{fdr} = .001	--		
5. Fronto-central FOOOF individual alpha peak frequency	-0.25 [-0.35, -0.14] p_{uncorr} < .001 p_{fdr} < .001	-0.31 [-0.41, -0.20] p_{uncorr} < .001 p_{fdr} < .001	-0.12 [-0.22, -0.003] p_{uncorr} = .044 p_{fdr} = .051	-0.29 [-0.39, 0.19] p_{uncorr} < .001 p_{fdr} < .001	--	
6. Fronto-central aperiodic exponent	-0.18 [-0.32, -0.09] p_{uncorr} = .002 p_{fdr} = .002	0.49 [0.40, 0.57] p_{uncorr} < .001 p_{fdr} < .001	0.00 [-0.11, 0.11] p_{uncorr} = .997 p_{fdr} = .998	0.71 [0.66, 0.77] p_{uncorr} < .001 p_{fdr} < .001	-0.22 [-0.33, -0.12] p_{uncorr} < .001 p_{fdr} < .001	--
7. Fronto-central aperiodic offset	-0.08 [-0.19, 0.04] p_{uncorr} = .184 p_{fdr} = .204	0.66 [0.60, 0.72] p_{uncorr} < .001 p_{fdr} < .001	0.47 [0.38, 0.56] p_{uncorr} < .001 p_{fdr} < .001	0.55 [0.46, 0.62] p_{uncorr} < .001 p_{fdr} < .001	-0.26 [-0.36, -0.2115] p_{uncorr} < .001 p_{fdr} < .001	0.77 [0.73, 0.82] p_{uncorr} < .001 p_{fdr} < .001

Note: 95% confidence intervals for pairwise correlations displayed in brackets followed by uncorrected and FDR corrected p-values.

Table S28

Correlations between age and EEG metrics, eyes closed only, good FOOOF fit, whole scalp FOOOF individual alpha peak frequency, canonical fronto-central theta and beta bands (*n* = 306).

	1. Age	2. Canonical fronto-central theta	3. Canonical fronto-central beta	4. Canonical fronto-central theta-beta ratio	5. Whole scalp FOOOF individual alpha peak frequency	6. Fronto-central aperiodic exponent
2. Canonical fronto-central theta	0.01 [-0.10, 0.12] p_{uncorr} = .840 p_{fdr} = .882	--				
3. Canonical fronto-central beta	0.20 [0.09, 0.30] p_{uncorr} < .001 p_{fdr} = .001	0.41 [0.31, 0.50] p_{uncorr} < .001 p_{fdr} < .001	--			
4. Canonical fronto-central theta-beta ratio	-0.20 [-0.31, -0.09] p_{uncorr} < .001 p_{fdr} = .001	0.53 [0.45, 0.61] p_{uncorr} < .001 p_{fdr} < .001	-0.27 [-0.37, -0.16] p_{uncorr} < .001 p_{fdr} < .001	--		
5. Whole scalp FOOOF individual alpha peak frequency	-0.28 [-0.38, -0.17] p_{uncorr} < .001 p_{fdr} < .001	-0.31 [-0.41, -0.21] p_{uncorr} < .001 p_{fdr} < .001	-0.10 [-0.21, 0.01] p_{uncorr} = .067 p_{fdr} = .078	-0.29 [-0.39, -0.18] p_{uncorr} < .001 p_{fdr} < .001	--	
6. Fronto-central aperiodic exponent	-0.17 [-0.28, -0.06] p_{uncorr} < .001 p_{fdr} = .001	0.49 [0.40, 0.57] p_{uncorr} < .001 p_{fdr} < .001	0.00 [-0.11, 0.12] p_{uncorr} = .957 p_{fdr} = .957	0.71 [0.64, 0.76] p_{uncorr} < .001 p_{fdr} < .001	-0.22 [-0.33, -0.11] p_{uncorr} < .001 p_{fdr} < .001	--
7. Fronto-central aperiodic offset	-0.07 [-0.18, 0.04] p_{uncorr} = .210 p_{fdr} = .232	0.66 [0.60, 0.72] p_{uncorr} < .001 p_{fdr} < .001	0.47 [0.38, 0.56] p_{uncorr} < .001 p_{fdr} < .001	0.54 [0.45, 0.61] p_{uncorr} < .001 p_{fdr} < .001	-0.28 [-0.38, -0.17] p_{uncorr} < .001 p_{fdr} < .001	0.78 [0.73, 0.82] p_{uncorr} < .001 p_{fdr} < .001

Note: 95% confidence intervals for pairwise correlations displayed in brackets followed by uncorrected and FDR corrected p-values.

Table S29
Correlations between age and EEG metrics, eyes closed only, good FOOOF fit, fronto-central FOOOF individual alpha peak frequency, individual fronto-central theta and beta bands (*n* = 276).

	1. Age	2. Individual fronto-central theta	3. Individual fronto-central beta	4. Individual fronto-central theta-beta ratio	5. Fronto-central FOOOF individual alpha peak frequency	6. Fronto-central aperiodic exponent
2. Individual fronto-central theta	0.01 [-0.11, 0.13] p_{uncorr} = .869 p_{fdr} = .869	--				
3. Individual fronto-central beta	0.20 [0.08, 0.31] p_{uncorr} =.001 p_{fdr} = .001	0.63 [0.55, 0.70] p_{uncorr} < .001 p_{fdr} < .001	--			
4. Individual fronto-central theta-beta ratio	-0.25 [-0.36, -0.13] p_{uncorr} < .001 p_{fdr} = .001	0.47 [0.38, 0.56] p_{uncorr} < .001 p_{fdr} < .001	-0.17 [-0.28, -0.05] p_{uncorr} = .006 p_{fdr} = .007	--		
5. Fronto-central FOOOF individual alpha peak frequency	-0.26 [-0.37, -0.15] p_{uncorr} < .001 p_{fdr} < .001	-0.27 [-0.37, -0.15] p_{uncorr} < .001 p_{fdr} < .001	-0.21 [-0.32, -0.09] p_{uncorr} < .001 p_{fdr} = .001	-0.12 [-0.23, 0.001] p_{uncorr} = .053 p_{fdr} = .055	--	
6. Fronto-central aperiodic exponent	-0.20 [-0.31, -0.09] p_{uncorr} = .001 p_{fdr} = .001	0.51 [0.42, 0.59] p_{uncorr} < .001 p_{fdr} < .001	0.15 [0.03, 0.27] p_{uncorr} = .011 p_{fdr} = .013	0.62 [0.54, 0.69] p_{uncorr} < .001 p_{fdr} < .001	-0.24 [-0.35, -0.13] p_{uncorr} < .001 p_{fdr} < .001	--
7. Fronto-central aperiodic offset	-0.12 [-0.23, 0.001] p_{uncorr} = .053 p_{fdr} = .055	0.71 [0.64, 0.76] p_{uncorr} < .001 p_{fdr} < .001	0.56 [0.48, 0.64] p_{uncorr} < .001 p_{fdr} < .001	0.48 [0.38, 0.57] p_{uncorr} < .001 p_{fdr} < .001	-0.25 [-0.36, -0.14] p_{uncorr} < .001 p_{fdr} < .001	0.79 [0.74, 0.83] p_{uncorr} < .001 p_{fdr} < .001

Note: 95% confidence intervals for pairwise correlations displayed in brackets followed by uncorrected and FDR corrected p-values.

Table S30
Correlations between age and EEG metrics, eyes closed only, good FOOOF fit, whole scalp FOOOF individual alpha peak frequency, individual fronto-central theta and beta bands (*n* = 276).

	1. Age	2. Individual fronto-central theta	3. Individual fronto-central beta	4. Individual fronto-central theta-beta ratio	5. Whole scalp FOOOF individual alpha peak frequency	6. Fronto-central aperiodic exponent
2. Individual fronto-central theta	0.01 [-0.11, 0.13] p_{uncorr} = .869 p_{fdr} = .869	--				
3. Individual fronto-central beta	0.20 [0.08, 0.31] p_{uncorr} = .001 p_{fdr} = .001	0.63 [0.55, 0.70] p_{uncorr} < .001 p_{fdr} < .001	--			
4. Individual fronto-central theta-beta ratio	-0.25 [-0.36, -0.13] p_{uncorr} < .001 p_{fdr} < .001	0.47 [0.37, 0.56] p_{uncorr} < .001 p_{fdr} < .001	-0.17 [-0.28, -0.05] p_{uncorr} = .006 p_{fdr} = .007	--		
5. Whole scalp FOOOF individual alpha peak frequency	-0.28 [-0.38, -0.16] p_{uncorr} < .001 p_{fdr} < .001	-0.27 [-0.38, -0.16] p_{uncorr} < .001 p_{fdr} < .001	-0.21 [-0.32, 0.09] p_{uncorr} < .001 p_{fdr} = .001	-0.10 [-0.21, 0.02] p_{uncorr} = .110 p_{fdr} = .115	--	
6. Fronto-central aperiodic exponent	-0.20 [-0.31, -0.09] p_{uncorr} < .001 p_{fdr} = .001	0.51 [0.42, 0.59] p_{uncorr} < .001 p_{fdr} < .001	0.15 [0.03, 0.27] p_{uncorr} = .011 p_{fdr} = .013	0.62 [0.54, 0.69] p_{uncorr} < .001 p_{fdr} < .001	-0.21 [-0.32, -0.10] p_{uncorr} < .001 p_{fdr} < .001	--
7. Fronto-central aperiodic offset	-0.12 [-0.23, 0.001] p_{uncorr} = .053 p_{fdr} = .058	0.71 [0.64, 0.76] p_{uncorr} < .001 p_{fdr} < .001	0.56 [0.48, 0.64] p_{uncorr} < .001 p_{fdr} < .001	0.48 [0.38, 0.57] p_{uncorr} < .001 p_{fdr} < .001	-0.25 [-0.35, -0.13] p_{uncorr} < .001 p_{fdr} < .001	0.79 [0.74, 0.83] p_{uncorr} < .001 p_{fdr} < .001

Note: 95% confidence intervals for pairwise correlations displayed in brackets followed by uncorrected and FDR corrected p-values.

S8 Partial correlation analyses (parallel to Section 3.2).

Next, we examined the partial correlations between age and the alternative theta-beta ratio metrics, controlling separately for the alternative individual alpha peak metrics, aperiodic offset metrics, and aperiodic exponent metrics. As shown in Tables S31-S32, the results mirror Section 3.2 of the main manuscript, such that controlling for aperiodic exponent reduced the correlation between age and theta-beta ratio (*r*'s range from -0.10 to -0.19), whereas controlling for individual alpha peak frequencies did not (*r*'s range from -0.29 to -0.37, nor did controlling for aperiodic offset (*r*'s range from -0.19 to -0.28).

Table S31

Partial correlations between age and EEG metrics, controlling for individual alpha peak frequency, aperiodic exponent, or aperiodic offset, collapsed across eyes open and eyes closed.

	Pairwise Pearson's correlation	Partial correlation controlling for fronto-central RestingIAF individual alpha frequency	Partial correlation controlling for whole scalp RestingIAF individual alpha frequency	Partial correlation controlling for fronto-central FOOOF individual alpha frequency	Partial correlation controlling for whole scalp FOOOF individual alpha frequency	Partial correlation controlling for aperiodic exponent	Partial correlation controlling for aperiodic offset
Canonical theta-beta ratio and age	-0.24 [-0.35, -0.12] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 268$	-0.35 [-0.45, -0.24] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 268$	-0.37 [-0.47, -0.26] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 276$	-0.33 [-0.43, -0.23] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 302$	-0.33 [-0.43, -0.23] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 305$	-0.10 [-0.22, 0.02] $p_{uncorr} = .\ 110$ $p_{fdr} = .110$ $n = 268$	-0.22 [-0.33, -0.10] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 268$
Individual theta-beta ratio and age	-0.30 [-0.40, -0.18] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 268$	-0.35 [-0.45, -0.24] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 268$	-0.35 [-0.45, -0.25] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 276$	-0.33 [-0.43, -0.22] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 276$	-0.33 [-0.44, -0.22] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 276$	-0.19 [-0.30, 0.027] $p_{uncorr} = .\ 002$ $p_{fdr} = .003$ $n = 268$	-0.28 [-0.39, -0.16] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 268$
Canonical theta and age	0.01 [-0.11, 0.13] $p_{uncorr} = .849$ $p_{fdr} = .892$ $n = 268$	-0.06 [-0.18, 0.06] $p_{uncorr} = .356$ $p_{fdr} = .356$ $n = 268$	-0.08 [-0.20, 0.04] $p_{uncorr} = .180$ $p_{fdr} = .180$ $n = 276$	-0.07 [-0.18, 0.04] $p_{uncorr} = .230$ $p_{fdr} = .230$ $n = 302$	-0.07 [-0.18, 0.04] $p_{uncorr} = .219$ $p_{fdr} = .219$ $n = 305$	0.14 [0.02, 0.25] $p_{uncorr} = .025$ $p_{uncorr} = .030$ $n = 268$	0.11 [-0.01, 0.23] $p_{uncorr} = .070$ $p_{uncorr} = .070$ $n = 268$
Individual theta and age	0.04 [-0.08, 0.15] $p_{uncorr} = .542$ $p_{fdr} = .542$ $n = 268$	-0.02 [-0.14, 0.10] $p_{uncorr} = .704$ $p_{fdr} = .704$ $n = 268$	-0.05 [-0.16, 0.07] $p_{uncorr} = .441$ $p_{fdr} = .441$ $n = 276$	-0.04 [-0.16, 0.08] $p_{uncorr} = .486$ $p_{fdr} = .486$ $n = 276$	-0.05 [-0.17, 0.07] $p_{uncorr} = .397$ $p_{fdr} = .397$ $n = 276$	0.18 [0.06, 0.29] $p_{uncorr} = .004$ $p_{uncorr} = .005$ $n = 268$	0.16 [0.04, 0.28] $p_{uncorr} = .007$ $p_{fdr} = .009$ $n = 268$
Canonical beta and age	0.23 [0.11, 0.34] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 268$	0.22 [0.11, 0.33] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 268$	0.22 [0.11, 0.33] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 276$	0.20 [0.10, 0.31] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 302$	0.21 [0.10, 0.31] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 305$	0.23 [0.12, 0.34] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 268$	0.32 [0.21, 0.43] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 268$
Individual beta and age	0.25 [0.13, 0.36] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 268$	0.22 [0.10, 0.33] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 268$	0.21 [0.09, 0.32] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 276$	0.20 [0.08, 0.31] $p_{uncorr} < .001$ $p_{fdr} = .001$ $n = 276$	0.19 [0.08, 0.31] $p_{uncorr} = .001$ $p_{fdr} = .001$ $n = 276$	0.29 [0.18, 0.40] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 268$	0.38 [0.28, 0.48] $p_{uncorr} < .001$ $p_{fdr} < .001$ $n = 268$

Note: 95% confidence intervals for pairwise correlations displayed in brackets followed by uncorrected p-values.

Table S32

Partial correlations between age and EEG metrics, controlling for individual alpha peak frequency, aperiodic exponent, or aperiodic offset, eyes closed only.

	Pairwise Pearson's correlation	Partial correlation controlling for fronto-central RestingIAF individual alpha frequency	Partial correlation controlling for whole scalp RestingIAF individual alpha frequency	Partial correlation controlling for fronto-central FOOOF individual alpha frequency	Partial correlation controlling for whole scalp FOOOF individual alpha frequency	Partial correlation controlling for aperiodic exponent	Partial correlation controlling for aperiodic offset
Canonical theta-beta ratio and age	-0.20 [-0.30, -0.09] $p_{uncorr} < .001$ $p_{fdr} = .001$ *n* = 303	-0.34 [-0.44, -0.24] $p_{uncorr} < .001$ $p_{fdr} < .001$ *n* = 273	-0.34 [-0.44, -0.24] $p_{uncorr} < .001$ $p_{fdr} < .001$ *n* = 282	-0.29 [-0.39, -0.18] $p_{uncorr} < .001$ $p_{fdr} < .001$ *n* = 303	-0.30 [-0.40, -0.20] $p_{uncorr} < .001$ $p_{fdr} < .001$ *n* = 306	-0.10 [-0.21, 0.01] $p_{uncorr} =$. 085 $p_{fdr} = .085$ *n* = 303	-0.19 [-0.29, -0.07] $p_{uncorr} = .001$ $p_{fdr} = .002$ *n* = 303
Individual theta-beta ratio and age	--0.25 [-0.36, -0.13] $p_{uncorr} < .001$ $p_{fdr} < .001$ *n* = 276	-0.33 [-0.43, -0.22] $p_{uncorr} < .001$ $p_{fdr} < .001$ *n* = 271	-0.33 [-0.41, -0.20] $p_{uncorr} < .001$ $p_{fdr} < .001$ *n* = 276	-0.29 [-0.39, -0.18] $p_{uncorr} < .001$ $p_{fdr} < .001$ *n* = 276	-0.29 [-0.39, -0.17] $p_{uncorr} < .001$ $p_{fdr} < .001$ *n* = 276	-0.16 [-0.27, 0.04] $p_{uncorr} =$. 008 $p_{fdr} = .010$ *n* = 276	-0.22 [-0.33, -0.10] $p_{uncorr} < .001$ $p_{fdr} < .001$ *n* = 276
Canonical theta and age	0.01 [-0.10, 0.13] $p_{uncorr} = .863$ $p_{fdr} = .906$ *n* = 303	-0.09 [-0.21, 0.02] $p_{uncorr} = .100$ $p_{fdr} = .100$ *n* = 273	-0.09 [-0.20, 0.03] $p_{uncorr} = .143$ $p_{fdr} = .143$ *n* = 282	-0.07 [-0.18, 0.04] $p_{uncorr} = .214$ $p_{fdr} = .214$ *n* = 303	-0.078 [-0.19, 0.03] $p_{uncorr} = .158$ $p_{fdr} = .158$ *n* = 306	0.11 [0.001, 0.22] $p_{uncorr} = .048$ $p_{uncorr} = .058$ *n* = 303	0.08 [-0.03, 0.19] $p_{uncorr} = .158$ $p_{uncorr} = .158$ *n* = 303
Individual theta and age	0.01 [-0.11, 0.13] $p_{uncorr} = .869$ $p_{fdr} = .869$ *n* = 276	-0.07 [-0.19, 0.05] $p_{uncorr} = .222$ $p_{fdr} = .222$ *n* = 271	-0.057 [-0.19, 0.05] $p_{uncorr} = .233$ $p_{fdr} = .233$ *n* = 276	-0.06 [-0.18, 0.05] $p_{uncorr} = .292$ $p_{fdr} = .292$ *n* = 276	-0.07 [-0.19, 0.05] $p_{uncorr} = .238$ $p_{fdr} = .238$ *n* = 276	0.13 [0.02, 0.25] $p_{uncorr} = .026$ $p_{uncorr} = .026$ *n* = 276	0.13 [0.01, 0.25] $p_{uncorr} = .029$ $p_{fdr} = .029$ *n* = 276
Canonical beta and age	0.19 [0.08, 0.30] $p_{uncorr} < .001$ $p_{fdr} = .001$ *n* = 303	0.18 [0.06, 0.28] $p_{uncorr} = .002$ $p_{fdr} = .003$ *n* = 273	0.18 [0.07, 0.29] $p_{uncorr} < .001$ $p_{fdr} < .001$ *n* = 282	0.17 [0.06, 0.28] $p_{uncorr} = .003$ $p_{fdr} = .004$ *n* = 303	0.18 [0.06, 0.28] $p_{uncorr} = .002$ $p_{fdr} = .003$ *n* = 306	0.19 [0.08, 0.30] $p_{uncorr} < .001$ $p_{fdr} = .001$ *n* = 303	0.26 [0.15, 0.36] $p_{uncorr} < .001$ $p_{fdr} < .001$ *n* = 303
Individual beta and age	0.20 [0.08, 0.31] $p_{uncorr} = .001$ $p_{fdr} = .001$ *n* = 276	0.17 [0.05, 0.28] $p_{uncorr} = .005$ $p_{fdr} = .006$ *n* = 271	0.16 [0.04, 0.27] $p_{uncorr} = .008$ $p_{fdr} = .000$ *n* = 276	0.15 [0.03, 0.27] $p_{uncorr} = .011$ $p_{fdr} = .014$ *n* = 276	0.15 [0.03, 0.26] $p_{uncorr} = .014$ $p_{fdr} = .016$ *n* = 276	0.24 [0.12, 0.34] $p_{uncorr} < .001$ $p_{fdr} < .001$ *n* = 276	0.32 [0.21, 0.43] $p_{uncorr} < .001$ $p_{fdr} < .001$ *n* = 276

Note: 95% confidence intervals for pairwise correlations displayed in brackets followed by uncorrected p-values.

S9 Mediational analyses (parallel to Section 3.3).

Next, we repeated the mediational analyses reported in the main manuscript (see also main manuscript Figure 3) on the additional EEG metrics. As shown in Table S33-S36, only aperiodic exponent mediated the relationships between age and theta-beta ratio, with full mediation for the canonical theta-beta ratio models (*c'* ranged from -0.003 to -0.004, *p*'s > .220; proportion mediated ranged from 0.702 to 0.735, *p*'s < .001) and partial mediation for the individual theta-beta ratio models (*c'* ranged from -0.006 to -0.007, *p*'s < .007; proportion mediated ranged from 0.478 to 0.486, *p*'s < .001). Given that individual theta-beta ratio measures slightly different portions of the underlying 1/*f* for each individual, it is not surprising that the mediation effect is reduced as the individual theta-beta ratio is a nosier measure of the underlying 1/*f* slope than canonical theta-beta ratio. Additionally, the mediation analyses for the FOOOF whole scalp canonical theta-beta ratio on combined eyes open and eyes closed and RestingIAF whole scalp canonical theta-beta ratio on combined eyes open and eyes closed were significant and consistent with a suppressor effect, such that the direct effect ($c'_{ScalpFOOOF}$ = -0.020, $c'_{ScalpRestingIAF}$ = -0.017) was larger than the total effect ($c_{ScalpFOOOF}$ = -0.016, $c'_{ScalpRestingIAF}$ = -0.014), resulting in a significant negative proportion mediated for the FOOOF whole scalp canonical theta-beta ratio on combined eyes open and eyes closed analysis, p = 0.048, and and RestingIAF whole scalp canonical theta-beta ratio on combined eyes open and eyes closed analysis, p = 0.047. This is consistent with the correlation analyses which found a stronger relationship between age and theta-beta ratio when controlling for individual alpha peak frequency.

Table S33

Mediation analyses examining the relationship between canonical theta-beta ratio and age, collapsed across eyes open and eyes closed.

	Mediator: Fronto-central RestingIAF Individual Alpha Peak Frequency (*n* = 268; reported in main manuscript)				Whole Scalp RestingIAF Individual Alpha Peak Frequency (*n* = 276)				Fronto-central FOOOF Individual Alpha Peak Frequency (*n* = 302)			
	Est	SE	95% CI	p-value	Est	SE	95% CI	p-value	Est	SE	95% CI	p-value
a (age to mediator)	-0.015	0.005	[-0.026, -0.005]	.006	-0.018	0.005	[-0.029, -0.008]	.001	-0.022	0.002	[-0.032, 0.012]	< .001
b (mediator to canonical theta-beta ratio)	-0.324	0.039	[-0.398, -0.244]	< .001	-0.341	0.039	[-0.417, -0.263]	< .001	-0.221	0.040	[-0.300, -0.142]	< .001
ab (indirect effect)	0.005	0.002	[0.002, 0.009]	.009	0.006	0.002	[0.003, 0.011]	.002	0.005	0.002	[0.002, 0.008]	.001
c (total effect)	-0.015	0.003	[-0.021, -0.008]	< .001	-0.015	0.003	[-0.021, -0.008]	< .001	-0.015	0.003	[-0.022, -0.009]	< .001
c' (direct effect)	-0.019	0.003	[-0.021, -0.008]	< .001	-0.022	0.003	[-0.028, -0.015]	< .001	-0.020	0.003	[-0.026, 0.014]	< .001
Proportion Mediated (indirect/total)	-0.328	0.226	[-0.922, -0.084]	.147	-0.339	0.234	[-1.016, -0.136]	0.100	-0.319	0.162	[-0.748, -0.014]	.050

	Scalp FOOOF Individual Alpha Peak Frequency (*n* = 305)				Aperiodic Offset (*n* = 268; reported in main manuscript)				Aperiodic Exponent (*n* = 268; reported in main manuscript)			
	Est	SE	95% CI	p-value	Est	SE	95% CI	p-value	Est	SE	95% CI	p-value
a (age to mediator)	-0.023	0.006	[-0.034, -0.012]	< .001	-0.004	0.003	[-0.010, 0.001]	.092	-0.006	0.001	[-0.008, -0.003]	< .001
b (mediator to canonical theta-beta ratio)	-0.197	0.037	[-0.268, -0.125]	< .001	0.801	0.090	[0.152, 0.232]	< .001	1.787	0.111	[1.576, 2.013]	< .001
ab (indirect effect)	0.005	0.001	[0.002, 0.008]	.002	-0.004	0.002	[-0.008, < 0.001]	.081	-0.010	0.002	[-0.015, -0.006	< .001
c (total effect)	-0.016	0.003	[-0.022, -0.009]	< .001	-0.015	0.003	[-0.021, -0.008]	< .001	-0.015	0.003	[-0.021, -0.008]	< .001
c' (direct effect)	-0.020	0.003	[-0.027 -0.014]	< .001	-0.011	0.003	[-0.021, -0.008]	.001	-0.004	0.003	[-0.010, 0.001]	.121
Proportion Mediated (indirect/total)	-0.287	0.145	[-0.683, -0.115]	.048	0.238	0.144	[-0.024, 0.548]	0.100	0.702	0.178	[0.458, 1.126]	< .001

Table S34
Mediation analyses examining the relationship between individual theta-beta ratio and age, collapsed across eyes open and eyes closed.

	Mediator											
	Fronto-central RestingIAF Individual Alpha Peak Frequency (*n* = 268)				Whole Scalp RestingIAF Individual Alpha Peak Frequency (*n* = 276)				Fronto-central FOOOF Individual Alpha Peak Frequency (*n* = 276)			
	Est	SE	95% CI	p-value	Est	SE	95% CI	p-value	Est	SE	95% CI	p-value
a (age to mediator)	-0.015	0.005	[-0.026, -0.005]	.006	-0.018	0.005	[-0.028, -0.008]	.001	-0.022	0.005	[-0.033, -0.011]	< .001
b (mediator to individual theta-beta ratio)	-0.153	0.029	[-0.210, -0.095]	< .001	-0.148	0.030	[-0.208, -0.087]	< .001	-0.94	0.033	[-0.159, -0.028]	.004
ab (indirect effect)	0.002	0.001	[0.001, 0.005]	.018	0.003	0.001	[0.001, 0.005]	.007	0.002	0.001	[0.001, 0.004]	.022
c (total effect)	-0.014	0.003	[-0.019, -0.008]	< .001	-0.014	0.003	[-0.019, -0.009]	< .001	-0.014	0.003	[-0.019, -0.009]	< .001
c' (direct effect)	-0.016	0.003	[-0.021, -0.011]	< .001	-0.017	0.003	[-0.022, -0.012]	< .001	-0.016	0.003	[-0.022, 0.011]	< .001
Proportion Mediated (indirect/total)	-0.164	0.094	[-0.423, -0.045]	.080	-0.118	0.095	-0.437, -0.066]	0.047	-0.143	0.082	[-0.364, -0.040]	.069
	Scalp FOOOF Individual Alpha Peak Frequency (*n* = 276)				Aperiodic Offset (*n* = 268)				Aperiodic Exponent (*n* = 268)			
	Est	SE	95% CI	p-value	Est	SE	95% CI	p-value	Est	SE	95% CI	p-value
a (age to mediator)	-0.025	0.006	[-0.036, -0.014]	< .001	-0.004	0.003	[-0.010, 0.001]	.090	-0.006	0.001	[-0.008, -0.003]	< .001
b (mediator to individual theta-beta ratio)	-0.086	0.030	[-0.146, -0.026]	.004	0.482	0.069	[0.152, 0.234]	< .001	1.149	0.093	[0.968, 1.334]	< .001
ab (indirect effect)	0.002	0.001	[0.001, 0.005]	.024	-0.002	0.001	[-0.005, < 0.001]	.079	-0.007	0.002	[-0.010, -0.004	< .001
c (total effect)	-0.014	0.003	[-0.019, -0.009]	< .001	-0.014	0.003	[-0.019, -0.009]	< .001	-0.014	0.003	[-0.019, -0.009]	< .001
c' (direct effect)	-0.016	0.003	[-0.021 -0.011]	< .001	-0.012	0.003	[-0.019, -0.009]	<.001	-0.007	0.002	[-0.012, -0.003]	.002
Proportion Mediated (indirect/total)	-0.153	0.097	[-0.383, -0.041]	.115	0.151	0.090	[-0.012, 0.348]	0.091	0.478	0.110	[0.299, 0.733]	< .001

Table S35

Mediation analyses examining the relationship between canonical theta-beta ratio and age, eyes closed only.

	Mediator											
	Fronto-central RestingIAF Individual Alpha Peak Frequency (n = 273)				Whole Scalp RestingIAF Individual Alpha Peak Frequency (n = 282)				Fronto-central FOOOF Individual Alpha Peak Frequency (n = 303)			
	Est	SE	95% CI	p-value	Est	SE	95% CI	p-value	Est	SE	95% CI	p-value
a (age to mediator)	-0.021	0.006	[-0.033, -0.010]	< .001	-0.020	0.005	[-0.030, -0.009]	< .001	-0.022	0.005	[-0.032, -0.012]	< .001
b (mediator to canonical theta-beta ratio)	-0.367	0.040	[-0.444, -0.288]	< .001	-0.374	0.039	[-0.451, -0.298]	< .001	-0.258	0.041	[-0.339, -0.176]	< .001
ab (indirect effect)	0.008	0.002	[0.004, 0.013]	< .001	0.007	0.002	[0.004, 0.012]	.001	0.006	0.002	[0.003, 0.010]	.001
c (total effect)	-0.013	0.004	[-0.020, -0.005]	< .001	-0.013	0.004	[-0.020, -0.006]	< .001	-0.012	0.003	[-0.019, -0.006]	< .001
c' (direct effect)	-0.020	0.003	[-0.027, -0.014]	< .001	-0.021	0.003	[-0.028, -0.014]	< .001	-0.018	0.003	[-0.025, -0.012]	< .001
Proportion Mediated (indirect/total)	-0.606	1.602	[-1.874, -0.284]	.705	-0.559	0.515	[-1.633, -0.199]	.278	-0.458	0.335	[-1.281, -0.182]	.172
	Scalp FOOOF Individual Alpha Peak Frequency (n = 306)				Aperiodic Offset (n = 273)				Aperiodic Exponent (n = 273)			
	Est	SE	95% CI	p-value	Est	SE	95% CI	p-value	Est	SE	95% CI	p-value
a (age to mediator)	-0.027	0.005	[-0.037, -0.016]	< .001	-0.004	0.003	[-0.010, 0.001]	.104	-0.005	0.001	[-0.008, -0.002]	< .001
b (mediator to canonical theta-beta ratio)	-0.242	0.039	[-0.319, -0.165]	< .001	0.870	0.089	[0.690, 1.040]	< .001	1.817	0.105	[1.614, 2.025]	< .001
ab (indirect effect)	0.006	0.002	[0.004, 0.010]	< .001	-0.004	0.002	[-0.009, < 0.001]	.093	-0.009	0.002	[-0.014, -0.005]	< .001
c (total effect)	-0.013	0.003	[-0.019, -0.006]	< .001	-0.013	0.004	[-0.020, -0.006]	< .001	-0.013	0.004	[-0.020, -0.006]	< .001
c' (direct effect)	-0.019	0.003	[-0.026 -0.013]	< .001	-0.009	0.003	[-0.015, -0.002]	.009	-0.003	0.003	[-0.009, 0.002]	.230
Proportion Mediated (indirect/total)	-0.505	0.448	[-1.402, -0.219]	.259	0.306	0.216	[-0.043, 0.729]	.157	0.735	0.279	[0.450, 1.298]	< .001

Table S36
Mediation analyses examining the relationship between individual theta-beta ratio and age, eyes closed only.

	Mediator											
	Fronto-central RestingIAF Individual Alpha Peak Frequency (*n* = 271)				Whole Scalp RestingIAF Individual Alpha Peak Frequency (*n* = 276)				Fronto-central FOOOF Individual Alpha Peak Frequency (*n* = 276)			
	Est	SE	95% CI	p-value	Est	SE	95% CI	p-value	Est	SE	95% CI	p-value
a (age to mediator)	-0.020	0.006	[-0.031, -0.009]	< .001	-0.019	0.005	[-0.030, -0.009]	< .001	-0.023	0.005	[-0.033, -0.013]	< .001
b (mediator to individual theta-beta ratio)	-0.189	0.033	[-0.252, -0.124]	< .001	-0.170	0.033	[-0.236, -0.104]	< .001	-0.112	0.035	[-0.183, -0.042]	.002
ab (indirect effect)	0.004	0.001	[0.002, 0.007]	.003	0.003	0.001	[0.001, 0.006]	.006	0.003	0.001	[0.001, 0.005]	.012
c (total effect)	-0.013	0.003	[-0.018, -0.007]	< .001	-0.013	0.003	[-0.018, -0.007]	< .001	-0.013	0.003	[-0.018, -0.007]	< .001
c' (direct effect)	-0.016	0.003	[-0.022, -0.011]	< .001	-0.016	0.003	[-0.021, -0.010]	< .001	-0.015	0.003	[-0.021, -0.009]	< .001
Proportion Mediated (indirect/total)	-0.303	0.170	[-0.756, -0.113]	.074	-0.262	0.248	[-0.658, -0.093]	.291	-0.203	0.135	[-0.528, -0.065]	.134
	Scalp FOOOF Individual Alpha Peak Frequency (*n* = 276)				Aperiodic Offset (*n* = 271)				Aperiodic Exponent (*n* = 271)			
	Est	SE	95% CI	p-value	Est	SE	95% CI	p-value	Est	SE	95% CI	p-value
a (age to mediator)	-0.026	0.005	[-0.036, -0.015]	< .001	-0.005	0.003	[-0.010, 0.001]	.093	-0.005	0.001	[-0.008, -0.002]	< .001
b (mediator to individual theta-beta ratio)	-0.098	0.035	[-0.166, -0.030]	.005	0.564	0.074	[0.419, 0.708]	< .001	1.205	0.094	[1.019, 1.387]	< .001
ab (indirect effect)	0.003	0.001	[0.001, 0.005]	.019	-0.003	0.001	[-0.006, < 0.001]	.081	-0.006	0.002	[-0.009, -0.003]	< .001
c (total effect)	-0.013	0.003	[-0.018, -0.007]	< .001	-0.013	0.003	[-0.018, -0.007]	< .001	-0.013	0.003	[-0.018, -0.007]	< .001
c' (direct effect)	-0.015	0.003	[-0.021 -0.009]	< .001	-0.010	0.003	[-0.015, -0.005]	< .001	-0.006	0.002	[-0.011, -0.002]	.006
Proportion Mediated (indirect/total)	-0.201	0.181	[-0.547, -0.055]	.267	0.208	0.125	[-0.017, 0.474]	.094	0.486	0.140	[0.283, 0.809]	.001

S10 Hierarchical regression analyses (parallel to Section 3.4).

Next, we repeated the hierarchical regression analyses reported in the main manuscript on the additional EEG metrics. As shown in Table S37-S51, in Block 2 theta (regardless of how it was defined) was consistently significantly associated with age when controlling for theta and individual peak alpha frequency (regardless of how both were defined), *b*'s ranged from -1.53 to -3.93, *p*'s < 0.005, and in Block 3 theta (regardless of how it was defined) was non-significantly associated with age when controlling for aperiodic exponent, individual peak alpha frequency, and theta, *b*'s ranged from -0.34 to -1.62, *p*'s > 0.110. As discussed in the main manuscript, this suggests that there is a significant increase in periodic activity in the beta band with age, as well as the age-related flattening of the aperiodic component and "slowing" of the individual alpha peak frequency. The lack of unique variance associated with canonical theta power over and above the aperiodic component is consistent with the lack of definable peaks (with the FOOOF package) within the canonical theta band, as described in the supplemental materials.

Table S37
Hierarchical multiple regression, regressing age on canonical fronto-central theta, canonical fronto-central beta, whole scalp RestingIAF individual alpha peak frequency, and aperiodic exponent, combined eyes open and eyes closed (n = 276).

	b	*SE*	*t*	*p*	Adj. R^2
Block 1					0.059
Canonical Theta	-1.10	0.60	1.82	.069	
Canonical Beta	17.94	4.09	4.39	< .001	
Block 2					0.117
Canonical Theta	-2.06	0.63	3.30	.001	
Canonical Beta	19.42	3.97	4.89	< .001	
Scalp RestingIAF Individual Alpha Peak Frequency	-3.03	0.70	4.33	< .001	
Block 3					0.175
Canonical Theta	-0.68	0.68	1.00	0.320	
Canonical Beta	15.12	3.96	3.82	< .001	
Scalp RestingIAF Individual Alpha Peak Frequency	-3.36	0.68	4.95	< .001	
Aperiodic Exponent	-12.02	2.66	4.51	< .001	

Table S38

Hierarchical multiple regression, regressing age on individual fronto-central theta, individual fronto-central beta, fronto-central RestingIAF individual alpha peak frequency, and aperiodic exponent, combined eyes open and eyes closed (n = 268).

	b	SE	t	p	Adj. R^2
Block 1					0.084
Individual Theta	-2.77	0.94	2.95	.004	
Individual Beta	16.41	3.22	5.09	< .001	
Block 2					0.113
Individual Theta	-3.69	0.97	3.81	<.001	
Individual Beta	16.96	3.18	5.34	< .001	
Fronto-Central RestingIAF Individual Alpha Peak Frequency	-2.16	0.69	3.15	< .001	
Block 3					0.170
Individual Theta	-1.49	1.07	1.40	0.163	
Individual Beta	13.29	3.19	4.16	< .001	
Fronto-Central RestingIAF Individual Alpha Peak Frequency	-2.45	0.67	3.67	< .001	
Aperiodic Exponent	-12.07	2.77	4.36	< .001	

Table S39

Hierarchical multiple regression, regressing age on individual fronto-central theta, individual fronto-central beta, scalp RestingIAF individual alpha peak frequency, and aperiodic exponent, combined eyes open and eyes closed (n = 276).

	b	SE	t	p	Adj. R^2
Block 1					0.086
Individual Theta	-2.94	0.93	3.16	.002	
Individual Beta	16.78	3.20	5.24	< .001	
Block 2					0.130
Individual Theta	-3.93	0.94	4.17	<.001	
Individual Beta	17.01	3.12	5.45	< .001	
Scalp RestingIAF Individual Alpha Peak Frequency	-2.65	0.69	3.86	< .001	
Block 3					0.190
Individual Theta	-1.62	1.04	1.56	0.120	
Individual Beta	13.11	3.13	4.19	< .001	
Scalp RestingIAF Individual Alpha Peak Frequency	-3.04	0.67	4.54	< .001	
Aperiodic Exponent	-12.43	2.69	4.62	< .001	

Table S40

Hierarchical multiple regression, regressing age on canonical fronto-central theta, canonical fronto-central beta, fronto-central FOOOF individual alpha peak frequency, and aperiodic exponent, combined eyes open and eyes closed (n = 302).

	b	*SE*	*t*	*p*	Adj. R^2
Block 1					0.057
Canonical Theta	-1.12	0.60	1.85	.065	
Canonical Beta	17.83	3.98	4.49	< .001	
Block 2					0.12
Canonical Theta	-1.82	0.60	3.01	.003	
Canonical Beta	17.78	3.85	4.62	< .001	
Fronto-Central FOOOF Individual Alpha Peak Frequency	-2.88	0.62	4.64	< .001	
Block 3					0.163
Canonical Theta	-0.48	0.67	0.72	0.474	
Canonical Beta	14.01	3.85	3.64	< .001	
Fronto-Central FOOOF Individual Alpha Peak Frequency	-3.00	0.61	4.95	< .001	
Aperiodic Exponent	-10.85	2.60	4.17	< .001	

Table S41

Hierarchical multiple regression, regressing age on canonical fronto-central theta, canonical fronto-central beta, whole scalp FOOOF individual alpha peak frequency, and aperiodic exponent, combined eyes open and eyes closed (n = 305).

	b	*SE*	*t*	*p*	Adj. R^2
Block 1					0.059
Canonical Theta	-1.14	0.60	1.90	.059	
Canonical Beta	18.10	3.95	4.58	< .001	
Block 2					0.110
Canonical Theta	-1.85	0.61	3.51	.003	
Canonical Beta	18.01	3.84	4.69	< .001	
Scalp FOOOF Individual Alpha Peak Frequency	-2.45	0.56	4.37	< .001	
Block 3					0.154
Canonical Theta	-0.55	0.67	0.82	0.415	
Canonical Beta	14.36	3.85	3.73	< .001	
Scalp FOOOF Individual Alpha Peak Frequency	-2.49	0.55	4.55	< .001	
Aperiodic Exponent	-10.45	2.60	4.02	< .001	

Table S42
Hierarchical multiple regression, regressing age on individual fronto-central theta, individual fronto-central beta, fronto-central FOOOF individual alpha peak frequency, and aperiodic exponent, combined eyes open and eyes closed (n = 275).

	b	*SE*	*t*	*p*	Adj. R^2
Block 1					0.086
Individual Theta	-2.94	0.93	3.16	.002	
Individual Beta	16.78	3.20	5.24	< .001	
Block 2					0.142
Individual Theta	-3.58	0.91	3.93	.001	
Individual Beta	16.04	3.11	5.17	< .001	
Fronto-Central FOOOF Individual Alpha Peak Frequency	-2.89	0.67	4.34	< .001	
Block 3					0.196
Individual Theta	-1.30	1.02	1.27	0.203	
Individual Beta	12.27	3.12	3.93	< .001	
Fronto-Central FOOOF Individual Alpha Peak Frequency	-3.09	0.65	4.78	< .001	
Aperiodic Exponent	-11.78	2.67	4.41	< .001	

Table S43
Hierarchical multiple regression, regressing age on individual fronto-central theta, individual fronto-central beta, scalp FOOOF individual alpha peak frequency, and aperiodic exponent, combined eyes open and eyes closed (n = 275).

	b	*SE*	*t*	*p*	Adj. R^2
Block 1					0.086
Individual Theta	-2.94	0.93	3.16	.002	
Individual Beta	16.78	3.20	5.24	< .001	
Block 2					0.145
Individual Theta	-3.69	0.92	4.04	< .001	
Individual Beta	16.05	3.10	5.18	< .001	
Scalp FOOOF Individual Alpha Peak Frequency	-2.70	0.61	4.46	< .001	
Block 3					0.196
Individual Theta	-1.47	1.03	1.43	0.150	
Individual Beta	12.42	3.12	3.98	< .001	
Scalp FOOOF Individual Alpha Peak Frequency	-2.79	0.59	4.75	< .001	
Aperiodic Exponent	-11.39	2.67	4.27	< .001	

Table S44

Hierarchical multiple regression, regressing age on canonical fronto-central theta, canonical fronto-central beta, fronto-central RestingIAF individual alpha peak frequency, and aperiodic exponent, eyes closed only (n = 273).

	b	*SE*	*t*	*p*	Adj. R^2
Block 1					0.035
Canonical Theta	-0.67	0.52	1.28	.201	
Canonical Beta	13.80	4.00	3.45	< .001	
Block 2					0.117
Canonical Theta	-1.81	0.56	3.25	.001	
Canonical Beta	16.42	3.88	4.23	< .001	
Fronto-Central RestingIAF Individual Alpha Peak Frequency	-3.33	0.69	4.85	< .001	
Block 3					0.155
Canonical Theta	-0.65	0.62	1.05	.295	
Canonical Beta	12.60	3.91	3.22	.001	
Fronto-Central RestingIAF Individual Alpha Peak Frequency	-3.58	0.67	5.34	< .001	
Aperiodic Exponent	-10.34	2.64	3.91	< .001	

Table S45

Hierarchical multiple regression, regressing age on canonical fronto-central theta, canonical fronto-central beta, scalp RestingIAF individual alpha peak frequency, and aperiodic exponent, eyes closed only (n = 282).

	b	*SE*	*t*	*p*	Adj. R^2
Block 1					0.035
Canonical Theta	-0.68	0.52	1.32	.188	
Canonical Beta	13.76	3.94	3.50	< .001	
Block 2					0.101
Canonical Theta	-1.66	0.54	3.07	.002	
Canonical Beta	15.81	3.82	4.14	< .001	
Scalp RestingIAF Individual Alpha Peak Frequency	-3.30	0.70	4.71	< .001	
Block 3					0.155
Canonical Theta	-0.43	0.60	0.73	.469	
Canonical Beta	11.65	3.82	3.04	.003	
Scalp RestingIAF Individual Alpha Peak Frequency	-3.72	0.69	5.42	< .001	
Aperiodic Exponent	-11.24	2.60	4.32	< .001	

Table S46

Hierarchical multiple regression, regressing age on individual fronto-central theta, individual fronto-central beta, fronto-central RestingIAF individual alpha peak frequency, and aperiodic exponent, eyes closed only (n = 271).

	b	*SE*	*t*	*p*	Adj. R^2
Block 1					0.056
Individual Theta	-1.82	0.72	2.52	.012	
Individual Beta	12.73	3.01	4.23	< .001	
Block 2					0.115
Individual Theta	-2.88	0.74	3.88	< .001	
Individual Beta	13.59	2.92	4.66	< .001	
Fronto-Central RestingIAF Individual Alpha Peak Frequency	-2.92	0.67	4.34	< .001	
Block 3					0.160
Individual Theta	-1.27	0.83	1.52	.129	
Individual Beta	10.72	2.93	3.66	< .001	
Fronto-Central RestingIAF Individual Alpha Peak Frequency	-3.28	0.66	4.96	< .001	
Aperiodic Exponent	-10.58	2.69	3.94	< .001	

Table S47

Hierarchical multiple regression, regressing age on individual fronto-central theta, individual fronto-central beta, whole scalp RestingIAF individual alpha peak frequency, and aperiodic exponent, eyes closed only (n = 276).

	b	*SE*	*t*	*p*	Adj. R^2
Block 1					0.054
Individual Theta	-1.82	0.72	2.52	.012	
Individual Beta	12.53	2.98	4.21	< .001	
Block 2					0.108
Individual Theta	-2.67	0.73	3.67	< .001	
Individual Beta	12.75	2.89	4.641	< .001	
Scalp RestingIAF Individual Alpha Peak Frequency	-2.92	0.70	4.19	< .001	
Block 3					0.160
Individual Theta	-0.97	0.81	1.19	.236	
Individual Beta	9.65	2.90	3.32	.001	
Scalp RestingIAF Individual Alpha Peak Frequency	-3.44	0.69	5.01	< .001	
Aperiodic Exponent	-11.30	2.68	4.21	< .001	

Table S48

Hierarchical multiple regression, regressing age on canonical fronto-central theta, canonical fronto-central beta, fronto-central FOOOF individual alpha peak frequency, and aperiodic exponent, eyes closed only (*n* = 303).

	b	*SE*	*t*	*p*	Adj. R^2
Block 1					0.036
Canonical Theta	-0.69	0.52	1.32	.189	
Canonical Beta	13.86	3.82	3.62	< .001	
Block 2					0.100
Canonical Theta	-1.40	0.53	2.67	.008	
Canonical Beta	14.05	3.69	3.80	< .001	
Fronto-Central FOOOF Individual Alpha Peak Frequency	-3.05	0.64	4.74	< .001	
Block 3					0.133
Canonical Theta	-0.34	0.60	0.57	.571	
Canonical Beta	10.74	3.75	2.87	.004	
Fronto-Central FOOOF Individual Alpha Peak Frequency	-3.26	0.63	5.13	< .001	
Aperiodic Exponent	-9.05	2.56	3.53	< .001	

Table S49

Hierarchical multiple regression, regressing age on canonical fronto-central theta, canonical fronto-central beta, whole scalp FOOOF individual alpha peak frequency, and aperiodic exponent, eyes closed only (*n* = 306).

	b	*SE*	*t*	*p*	Adj. R^2
Block 1					0.038
Canonical Theta	-0.70	0.52	1.34	.182	
Canonical Beta	14.26	3.81	3.74	< .001	
Block 2					0.121
Canonical Theta	-1.53	0.52	2.94	.004	
Canonical Beta	14.76	3.64	4.05	< .001	
Scalp FOOOF Individual Alpha Peak Frequency	-3.18	0.59	5.43	< .001	
Block 3					0.152
Canonical Theta	-0.49	0.59	0.83	.408	
Canonical Beta	11.59	3.69	3.14	.002	
Scalp FOOOF Individual Alpha Peak Frequency	-3.35	0.58	5.80	< .001	
Aperiodic Exponent	-8.85	2.53	3.50	< .001	

Table S50

Hierarchical multiple regression, regressing age on individual fronto-central theta, individual fronto-central beta, fronto-central FOOOF individual alpha peak frequency, and aperiodic exponent, eyes closed only (n = 276).

	b	SE	t	p	Adj. R^2
Block 1					0.054
Individual Theta	-1.82	0.72	2.52	.012	
Individual Beta	12.53	2.98	4.21	< .001	
Block 2					0.100
Individual Theta	-2.38	0.71	3.36	< .001	
Individual Beta	11.84	2.89	4.10	< .001	
Fronto-Central FOOOF Individual Alpha Peak Frequency	-2.98	0.67	4.46	< .001	
Block 3					0.163
Individual Theta	-0.67	0.81	0.84	.404	
Individual Beta	8.74	2.91	3.01	.003	
Fronto-Central FOOOF Individual Alpha Peak Frequency	-3.36	0.66	5.13	< .001	
Aperiodic Exponent	-10.82	2.66	4.07	< .001	

Table S51

Hierarchical multiple regression, regressing age on individual fronto-central theta, individual fronto-central beta, scalp FOOOF individual alpha peak frequency, and aperiodic exponent, eyes closed only (n = 276).

	b	SE	t	p	Adj. R^2
Block 1					0.054
Individual Theta	-1.82	0.72	2.52	.012	
Individual Beta	12.53	2.98	4.21	< .001	
Block 2					0.126
Individual Theta	-2.45	0.70	3.48	< .001	
Individual Beta	11.82	2.87	4.12	< .001	
Scalp FOOOF Individual Alpha Peak Frequency	-3.06	0.63	85	< .001	
Block 3					0.170
Individual Theta	-0.80	0.80	1.00	.320	
Individual Beta	8.88	2.89	3.07	.002	
Scalp FOOOF Individual Alpha Peak Frequency	-3.32	0.62	5.37	< .001	
Aperiodic Exponent	-10.34	2.64	3.92	< .001	

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