1 SUPPLEMENTARY MATERIALS

1.1 EEG recording specifications

Nap/ night	Subsample	Original setting/aim	Nr. of subjects (females)	Age range (ys)	Available EEG derivations (10-20 system)	Recording apparatus	Precision (bit)	Hardware prefiltering (Hz)	Sampling rate (Hz/channel)	Recording software
Night sleep	**MPIP[1] – I**	Lab/sleep & IQ	95 (43)	18–69	Fp1, Fp2, Fpz, AF1, AF2, F3, F4, Fz, F7, F8, C3, C4, Cz, P3, P4, Pz, T3, T4, T5, T6, O1, O2	Comlab 32 Digiltal SleepLab	8	0.53–70	250	Brainlab 3.3
	MPIP[1] – II		20 (12)		Fp1, Fp2, F3, F4, C3, C4, P3, P4, O1, O2					
	PPCU[2] – I	Home/Williams syndrome study (controls included here)	20 (14)	6–28	Fp1, Fp2, Fpz, F3, F4, F7, F8, Fz, C3, C4, Cz, T3, T4, T5, T6, P3, P4, Pz, O1, O2, Oz	SD-LTM 32BS (Micromed Ltd, Italy)	22	0.15-250 (plus <463.3 Hz digital antialising filtering before downsampling from 4096 to 1024 Hz)	1024	BRAIN QUICK System PLUS (Micromed)
	PPCU[2] – II	Home/Adolescent sleep	23 (12)	15–22						
	SU[3] – I	Lab/sleep & IQ, sleep spindle methodology, wake-sleep transition analysis	49 (19)	17–55	Fp1, Fp2, F3, F4, F7, F8, Fz, C3, C4, Cz, T3, T4, T5, T6, P3, P4, O1, O2	Flat Style SLEEP La Mont Headbox, HBX32-SLP preamplifier (La Mont Medical)	12	0.5–70	249	Datalab (Medcare)
	SU[3] – II	Lab/nightmare study (controls included here)	16 (7)	19–21	Fp1, Fp2, F3, F4, Fz, F7, F8, C3, C4, Cz, P3, P4, Pz, T3, T4, T5, T6, O1, O2	Brain-Quick BQ132S (Micromed)	12	0.33–1500 (plus <450 Hz anti-aliasing digital filtering before downsampling from 4096 to 1024 Hz)	1024	System 98 (Micromed)
	SU[3] – III	Lab/home/ children's dreaming	29 (15)	3.84–8.42		Brain-Quick BQ132S/ SD LTM 32BS (Micromed)	12/22	0.33–1500/0.15-250 (plus <450/<463.3 Hz anti-aliasing digital filtering before downsampling from 4096 to 1024 Hz)		System 98/System Plus Evolution (Micromed)

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Table 1. Detailed information regarding the EEG recording institution, setting, hardware and software.

1.2 Alternative intercept rationale and definition

One of the biggest advantages of adopting a parametric model for describing EEG power spectra is that we can capture the spectral phenomena using significantly fewer variables compared to the original spectral data (2 aperiodic parameters + 3 per peak, whereas the minimal number of bins in the power spectra is generally around 256), however we found that the slope and the intercept parameters provided by the FOOOF method are correlated with an average correlation of: $< r >= 0.47$ (Pearson correlations were calculated between the two variables for all the corresponding sleep stages and EEG channels, then averaged in the Fisher z-space and inverse transformed). The alternative intercept was defined as the value of the power-law component at the frequency of the peak with the highest power, as suggested in an earlier study, in order to achieve the least correlation with the slope. The average correlation between slope and the alternative intercept was $< r >= -0.03$.

1.3 Between-stage correlations in the spectral slope

The strongly subject-specific nature of the spectral slope had been demonstrated before, however only in the wake, resting state. In order to test this specificity in the domain of sleep, we compared spectral slopes values between sleep stages and found that in general there is a positive correlation between all stages within individuals, furthermore that the correlation is stronger between subsequent sleep stages, see Figure 1. Correlations coefficients between non-identical stages were in the range of $0.2 < r < 0.8$, with overall average correlation of $< r >= 0.49$, while p-values were between 10^{-58} and 10^{-2}.

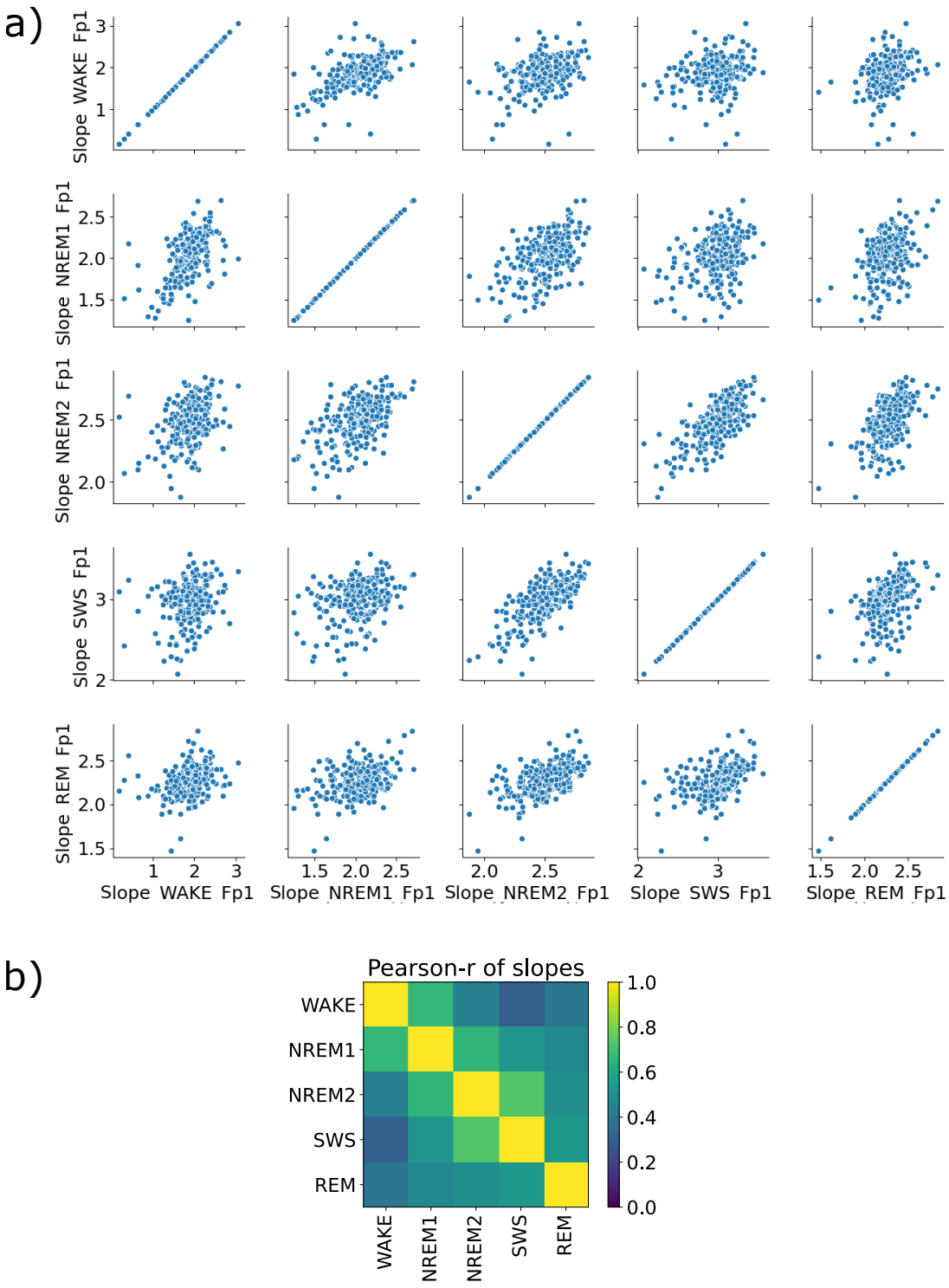

Figure 1. a) Covariance plot of spectral slopes between different sleep stages, each point corresponding to a subject. b) Pearson correlations of spectral slopes between sleep stages in the case of the Fp1 channel. It can be noted that the values closer to the main diagonal are higher, suggesting that there is more correlation between subsequent sleep stages.

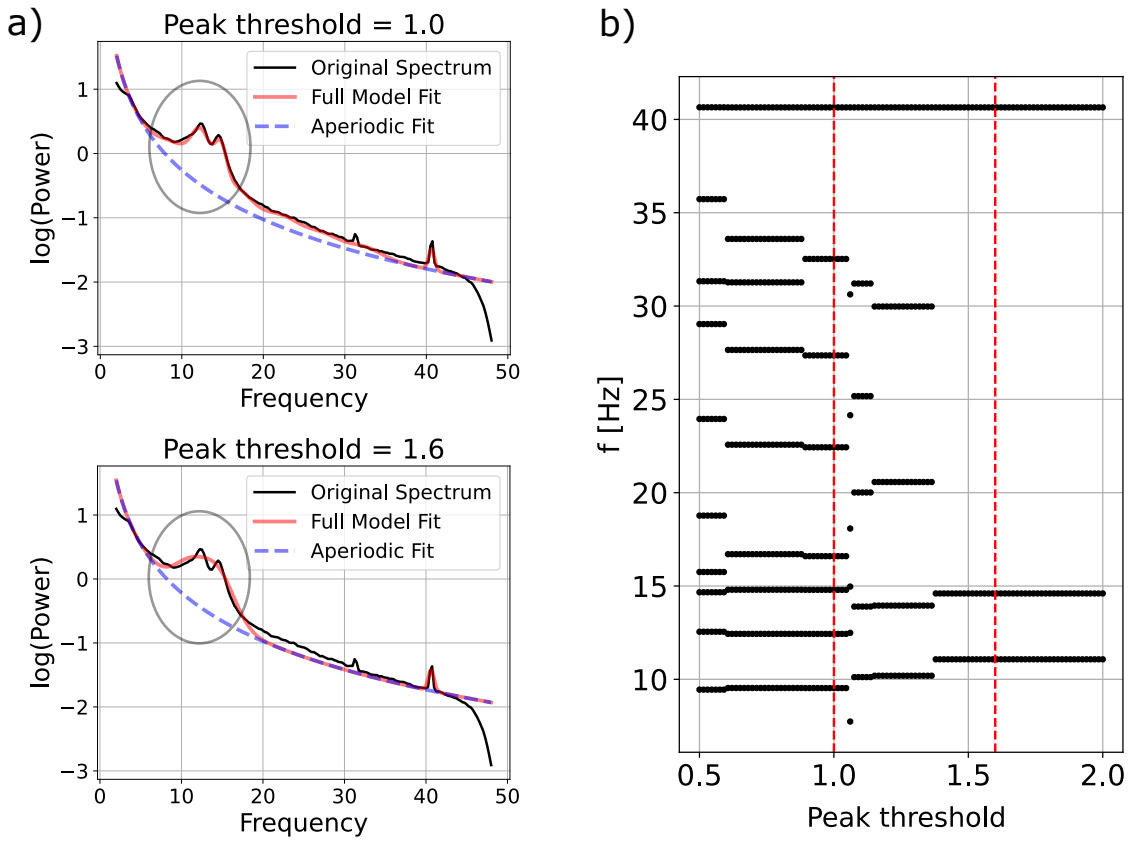

Figure 2. a) Two examples of fitting the same power spectrum using the FOOOF method with different peak threshold parameters, the model detects the double peak only for lower peak thresholds. b) Dependence of fitted peak frequencies on the peak threshold parameter. The vertical dashed lines represent the two cases on the left.

1.4 Challenges using the FOOOF method

Applying the FOOOF method to spectral data is straightforward, however by looking more closely at certain cases some undesired effects were noticed regarding the periodic component. In some instances when power spectra contained 'double' peaks, the model fitted them wrongly as a single wide peak (see below on Figure 2 a) subfigure's lower row). In order to eliminate this issue the peak threshold parameter was decreased, which ultimately resulted in an acceptable fit, yet it was also an indication that more careful choice of control parameters might be needed than primarily expected. (The peak threshold determines the minimal deviation in power from the aperiodic component that is necessary for the data point to be considered as a peak candidate.) In order to investigate the effect of the peak threshold the same power spectrum had been fitted multiple times while varying the peak threshold quasi-continuously. On Figure 2 b) the frequencies of the found peaks were plotted in function of the peak threshold parameter, it had been expected that the number of found peaks increases as the threshold value descreases (as smaller irregularities in the power spectrum have a higher chance to be above this threshold), however a frequncy shift was also discovered in function of the peak threshold parameter. Knowing that the central peak frequencies are sensitive to this parameter choice a supervision of the fitting is advised.

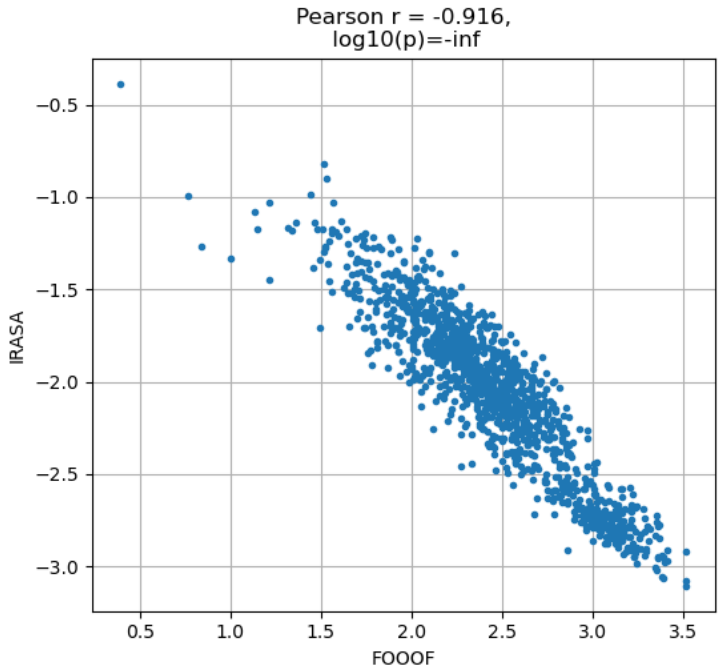

Figure 3. Pearson correlation of slope values calculated using the FOOOF and IRASA method.

1.5 Comparison of FOOOF slope values with IRASA

Another method that separates the aperiodic component of the spectrum is the irregular-resampling auto-spectral analysis (IRASA) [Wen and Liu, 2015]. As a partial validation of our results, we used an already available implementation of the IRASA method [Vallat and Walker, 2021] to calculate spectral slopes for the C3 EEG channel. A strong correlation was found between the slopes calculated with the two methods, see Figure 3.

1.6 Statistical results

1.6.1 Spectral slope

Effect	Repeated Measures Analysis of Variance with Effect Sizes Sigma-restricted parameterization Effective hypothesis decomposition					
	SS	df	MS	F	p	η_p^2
Intercept	37765.20	1	37765.20	30064.52	0.00E+00	0.993
{1}sex	0.18	1	0.18	0.15	7.02E-01	0.001
{2}age_group	24.38	3	8.13	6.47	3.32E-04	0.086
sex*age_group	3.00	3	1.00	0.80	4.97E-01	0.011
Error	258.76	206	1.26			
{3}STAGE	882.03	4	220.51	770.29	0.00E+00	0.789
STAGE*sex	1.27	4	0.32	1.11	3.49E-01	0.005
STAGE*age_group	23.71	12	1.98	6.90	5.37E-12	0.091
STAGE*sex*age_group	3.79	12	0.32	1.10	3.54E-01	0.016
Error	235.88	824	0.29			
{4}REGION	22.42	4	5.60	113.33	0.00E+00	0.355
REGION*sex	0.36	4	0.09	1.83	1.21E-01	0.009
REGION*age_group	3.86	12	0.32	6.51	3.50E-11	0.087
REGION*sex*age_group	1.05	12	0.09	1.76	4.98E-02	0.025
Error	40.75	824	0.05			
{5}LEFT-RIG	0.08	1	0.08	2.56	1.11E-01	0.012
LEFT-RIG*sex	0.07	1	0.07	2.13	1.46E-01	0.010
LEFT-RIG*age_group	0.17	3	0.06	1.82	1.45E-01	0.026
LEFT-RIG*sex*age_group	0.27	3	0.09	2.95	3.39E-02	0.041
Error	6.32	206	0.03			
STAGE*REGION	5.54	16	0.35	55.23	0.00E+00	0.211
STAGE*REGION*sex	0.13	16	0.01	1.27	2.10E-01	0.006
STAGE*REGION*age_group	1.49	48	0.03	4.95	0.00E+00	0.067
STAGE*REGION*sex*age_group	0.47	48	0.01	1.55	9.54E-03	0.022
Error	20.68	3296	0.01			
STAGE*LEFT-RIG	0.05	4	0.01	1.52	1.93E-01	0.007
STAGE*LEFT-RIG*sex	0.11	4	0.03	3.42	8.82E-03	0.016
STAGE*LEFT-RIG*age_group	0.18	12	0.02	1.87	3.41E-02	0.027
3*5*1*2	0.30	12	0.02	3.09	2.75E-04	0.043
Error	6.66	824	0.01			
REGION*LEFT-RIG	0.49	4	0.12	10.09	5.60E-08	0.047
REGION*LEFT-RIG*sex	0.20	4	0.05	4.07	2.82E-03	0.019
REGION*LEFT-RIG*age_group	0.40	12	0.03	2.75	1.13E-03	0.039
4*5*1*2	0.38	12	0.03	2.65	1.75E-03	0.037
Error	9.95	824	0.01			
STAGE*REGION*LEFT-RIG	0.03	16	0.00	1.27	2.04E-01	0.006
STAGE*REGION*LEFT-RIG*sex	0.04	16	0.00	1.70	3.96E-02	0.008
3*4*5*2	0.08	48	0.00	0.98	5.08E-01	0.014
3*4*5*1*2	0.17	48	0.00	2.11	1.48E-05	0.030
Error	5.42	3296	0.00			

1.6.2 Intercept

Effect	Repeated Measures Analysis of Variance with Effect Sizes Sigma-restricted parameterization Effective hypothesis decomposition					
	SS	df	MS	F	p	η_p^2
Intercept	318113.41	1	318113.41	23895.92	0.00E+00	0.991
{1}sex	19.18	1	19.18	1.44	2.31E-01	0.007
{2}age_group	1053.33	3	351.11	26.37	1.65E-14	0.275
sex*age_group	20.79	3	6.93	0.52	6.69E-01	0.007
Error	2782.30	209	13.31			
{3}STAGE	96.09	4	24.02	35.73	0.00E+00	0.146
STAGE*sex	3.18	4	0.80	1.18	3.17E-01	0.006
STAGE*age_group	38.72	12	3.23	4.80	1.19E-07	0.064
STAGE*sex*age_group	10.06	12	0.84	1.25	2.46E-01	0.018
Error	562.12	836	0.67			
{4}REGION	0.81	4	0.20	0.76	5.49E-01	0.004
REGION*sex	2.43	4	0.61	2.29	5.81E-02	0.011
REGION*age_group	13.69	12	1.14	4.30	1.23E-06	0.058
REGION*sex*age_group	5.45	12	0.45	1.71	5.99E-02	0.024
Error	221.99	836	0.27			
{5}LEFT-RIG	0.09	1	0.09	0.23	6.32E-01	0.001
LEFT-RIG*sex	0.92	1	0.92	2.44	1.19E-01	0.012
LEFT-RIG*age_group	1.89	3	0.63	1.68	1.72E-01	0.024
LEFT-RIG*sex*age_group	0.30	3	0.10	0.27	8.49E-01	0.004
Error	78.34	209	0.37			
STAGE*REGION	17.31	16	1.08	9.18	0.00E+00	0.042
STAGE*REGION*sex	3.96	16	0.25	2.10	6.27E-03	0.010
STAGE*REGION*age_group	14.03	48	0.29	2.48	8.57E-08	0.034
STAGE*REGION*sex*age_group	6.93	48	0.14	1.22	1.39E-01	0.017
Error	394.21	3344	0.12			
STAGE*LEFT-RIG	0.06	4	0.01	0.17	9.53E-01	0.001
STAGE*LEFT-RIG*sex	0.09	4	0.02	0.27	8.97E-01	0.001
STAGE*LEFT-RIG*age_group	1.39	12	0.12	1.38	1.67E-01	0.019
3*5*1*2	0.36	12	0.03	0.36	9.77E-01	0.005
Error	69.74	836	0.08			
REGION*LEFT-RIG	0.78	4	0.19	2.36	5.18E-02	0.011
REGION*LEFT-RIG*sex	0.26	4	0.07	0.79	5.30E-01	0.004
REGION*LEFT-RIG*age_group	1.29	12	0.11	1.30	2.10E-01	0.018
4*5*1*2	1.08	12	0.09	1.09	3.65E-01	0.015
Error	68.88	836	0.08			
STAGE*REGION*LEFT-RIG	0.59	16	0.04	0.77	7.26E-01	0.004
STAGE*REGION*LEFT-RIG*sex	0.76	16	0.05	0.99	4.64E-01	0.005
3*4*5*2	3.60	48	0.07	1.56	8.59E-03	0.022

1.6.3 Peak center frequency

Effect	Repeated Measures Analysis of Variance with Effect Sizes Sigma-restricted parameterization Effective hypothesis decomposition					
	SS	df	MS	F	p	η_p^2
Intercept	969134.83	1	969134.83	3540.34	0.00E+00	0.945
{1}sex	11.71	1	11.71	0.04	8.36E-01	0.000
{2}age_group	14124.78	3	4708.26	17.20	5.25E-10	0.200
sex*age_group	116.45	3	38.82	0.14	9.35E-01	0.002
Error	56390.64	206	273.74			
{3}STAGE	4795.75	4	1198.94	15.58	2.68E-12	0.070
STAGE*sex	284.57	4	71.14	0.92	4.49E-01	0.004
STAGE*age_group	4351.01	12	362.58	4.71	1.79E-07	0.064
STAGE*sex*age_group	903.02	12	75.25	0.98	4.68E-01	0.014
Error	63391.51	824	76.93			
{4}REGION	5802.22	4	1450.55	58.14	0.00E+00	0.220
REGION*sex	87.81	4	21.95	0.88	4.75E-01	0.004
REGION*age_group	787.97	12	65.66	2.63	1.85E-03	0.037
REGION*sex*age_group	459.39	12	38.28	1.53	1.06E-01	0.022
Error	20559.03	824	24.95			
{5}LEFT-RIG	8.56	1	8.56	1.09	2.98E-01	0.005
LEFT-RIG*sex	11.49	1	11.49	1.46	2.28E-01	0.007
LEFT-RIG*age_group	23.17	3	7.72	0.98	4.03E-01	0.014
LEFT-RIG*sex*age_group	28.16	3	9.39	1.19	3.14E-01	0.017
Error	1622.61	206	7.88			
STAGE*REGION	5388.42	16	336.78	23.31	0.00E+00	0.102
STAGE*REGION*sex	349.72	16	21.86	1.51	8.58E-02	0.007
STAGE*REGION*age_group	1936.19	48	40.34	2.79	8.17E-10	0.039
STAGE*REGION*sex*age_group	780.69	48	16.26	1.13	2.57E-01	0.016
Error	47611.82	3296	14.45			
STAGE*LEFT-RIG	40.02	4	10.00	1.49	2.03E-01	0.007
STAGE*LEFT-RIG*sex	87.58	4	21.89	3.27	1.14E-02	0.016
STAGE*LEFT-RIG*age_group	63.51	12	5.29	0.79	6.62E-01	0.011
3*5*1*2	72.32	12	6.03	0.90	5.48E-01	0.013
Error	5523.86	824	6.70			
REGION*LEFT-RIG	58.20	4	14.55	2.48	4.25E-02	0.012
REGION*LEFT-RIG*sex	19.45	4	4.86	0.83	5.06E-01	0.004
REGION*LEFT-RIG*age_group	100.43	12	8.37	1.43	1.47E-01	0.020
4*5*1*2	60.64	12	5.05	0.86	5.86E-01	0.012
Error	4829.67	824	5.86			
STAGE*REGION*LEFT-RIG	104.52	16	6.53	1.33	1.72E-01	0.006
STAGE*REGION*LEFT-RIG*sex	72.92	16	4.56	0.92	5.40E-01	0.004
3*4*5*2	303.60	48	6.32	1.28	9.19E-02	0.018
3*4*5*1*2	206.51	48	4.30	0.87	7.19E-01	0.013
Error	16244.15	3296	4.93			

1.6.4 Peak power

Effect	Repeated Measures Analysis of Variance with Effect Size Sigma-restricted parameterization Effective hypothesis decomposition					
	SS	df	MS	F	p	η_p^2
Intercept	2909.38	1	2909.38	3215.24	0.00E+00	0.940
{1}sex	0.09	1	0.09	0.09	7.58E-01	0.000
{2}age_group	12.00	3	4.00	4.42	4.89E-03	0.060
sex*age_group	0.77	3	0.26	0.28	8.36E-01	0.004
Error	186.40	206	0.90			
{3}STAGE	112.52	4	28.13	88.77	0.00E+00	0.301
STAGE*sex	0.64	4	0.16	0.50	7.34E-01	0.002
STAGE*age_group	18.58	12	1.55	4.88	8.01E-08	0.066
STAGE*sex*age_group	5.52	12	0.46	1.45	1.37E-01	0.021
Error	261.12	824	0.32			
{4}REGION	19.08	4	4.77	97.65	0.00E+00	0.322
REGION*sex	0.32	4	0.08	1.64	1.61E-01	0.008
REGION*age_group	2.41	12	0.20	4.11	2.93E-06	0.056
REGION*sex*age_group	0.26	12	0.02	0.44	9.47E-01	0.006
Error	40.25	824	0.05			
{5}LEFT-RIG	0.00	1	0.00	0.01	9.40E-01	0.000
LEFT-RIG*sex	0.01	1	0.01	0.68	4.09E-01	0.003
LEFT-RIG*age_group	0.05	3	0.02	1.37	2.52E-01	0.020
LEFT-RIG*sex*age_group	0.01	3	0.00	0.17	9.17E-01	0.002
Error	2.63	206	0.01			
STAGE*REGION	14.20	16	0.89	47.27	0.00E+00	0.187
STAGE*REGION*sex	0.10	16	0.01	0.33	9.95E-01	0.002
STAGE*REGION*age_group	5.95	48	0.12	6.60	0.00E+00	0.088
STAGE*REGION*sex*age_group	1.01	48	0.02	1.12	2.58E-01	0.016
Error	61.90	3296	0.02			
STAGE*LEFT-RIG	0.10	4	0.03	4.89	6.67E-04	0.023
STAGE*LEFT-RIG*sex	0.02	4	0.01	1.04	3.88E-01	0.005
STAGE*LEFT-RIG*age_group	0.17	12	0.01	2.71	1.31E-03	0.038
3*5*1*2	0.03	12	0.00	0.49	9.21E-01	0.007
Error	4.33	824	0.01			
REGION*LEFT-RIG	0.04	4	0.01	1.18	3.18E-01	0.006
REGION*LEFT-RIG*sex	0.03	4	0.01	1.03	3.92E-01	0.005
REGION*LEFT-RIG*age_group	0.13	12	0.01	1.29	2.17E-01	0.018
4*5*1*2	0.11	12	0.01	1.08	3.72E-01	0.016
Error	6.92	824	0.01			
STAGE*REGION*LEFT-RIG	0.13	16	0.01	2.46	9.93E-04	0.012
STAGE*REGION*LEFT-RIG*sex	0.07	16	0.00	1.29	1.91E-01	0.006
3*4*5*2	0.29	48	0.01	1.85	3.70E-04	0.026
3*4*5*1*2	0.22	48	0.00	1.38	4.48E-02	0.020
Error	10.82	3296	0.00			

1.6.5 Adjusted spectral slope

Effect	Repeated Measures Analysis of Variance with Effect Sizes Sigma-restricted parameterization Effective hypothesis decomposition					
	SS	df	MS	F	p	η_p^2
Intercept	1688.622	1	1688.622	492.449	0.00E+00	0.702045
{1}sex	0.664	1	0.664	0.194	6.60E-01	0.000925
{2}age_group	36.531	3	12.177	3.551	1.53E-02	0.048501
Error	716.667	209	3.429			
{3}STAGE	552.469	3	184.156	1198.557	0.00E+00	0.851516
STAGE*sex	0.240	3	0.080	0.520	6.68E-01	0.002484
STAGE*age_group	16.050	9	1.783	11.607	1.11E-16	0.142812
Error	96.338	627	0.154			
{4}REGION	8.766	4	2.191	43.498	0.00E+00	0.172270
REGION*sex	0.321	4	0.080	1.592	1.74E-01	0.007559
REGION*age_group	1.485	12	0.124	2.456	3.76E-03	0.034051
Error	42.117	836	0.050			
{5}LEFT-RIG	0.066	1	0.066	1.086	2.98E-01	0.005171
LEFT-RIG*sex	0.241	1	0.241	3.936	4.86E-02	0.018485
LEFT-RIG*age_group	0.411	3	0.137	2.241	8.45E-02	0.031172
Error	12.782	209	0.061			
STAGE*REGION	3.834	12	0.319	62.999	0.00E+00	0.231614
STAGE*REGION*sex	0.080	12	0.007	1.316	2.02E-01	0.006255
STAGE*REGION*age_group	1.201	36	0.033	6.577	0.00E+00	0.086263
Error	12.718	2508	0.005			
STAGE*LEFT-RIG	0.027	3	0.009	1.295	2.75E-01	0.006156
STAGE*LEFT-RIG*sex	0.005	3	0.002	0.260	8.54E-01	0.001241
STAGE*LEFT-RIG*age_group	0.055	9	0.006	0.869	5.52E-01	0.012326
Error	4.402	627	0.007			
REGION*LEFT-RIG	0.098	4	0.024	1.729	1.42E-01	0.008204
REGION*LEFT-RIG*sex	0.013	4	0.003	0.236	9.18E-01	0.001128
REGION*LEFT-RIG*age_group	0.129	12	0.011	0.762	6.90E-01	0.010826
Error	11.830	836	0.014			
STAGE*REGION*LEFT-RIG	0.010	12	0.001	0.621	8.26E-01	0.002964
STAGE*REGION*LEFT-RIG*sex	0.015	12	0.001	0.967	4.79E-01	0.004603
3*4*5*2	0.046	36	0.001	0.997	4.75E-01	0.014104
Error	3.220	2508	0.001			

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