

Processed Electroencephalogram Normative Values In Neonates

Georgia Georgostathi, Bioengineering & Biology 2024, Ian Yuan, Perelman School of Medicine

Study Objectives

1. Determine normative values for awake vs asleep state for neonates
2. Determine which method discriminates best between awake and asleep state

Methods

- 32 healthy full-term neonates between 40-44 weeks old.
 - 5min normal EEG annotated into awake, quiet, or active sleep
 - NEURAL* in MATLAB
 - Fp1-C3 (left frontal) and Fp2-C4 (right frontal) channels analyzed
 - Sliding window size: 8 sec
 - Artifact Removal Threshold: 1500 μ V
 - Calculated:
 - Power spectrum/power ratio
 - Spectral Edge Frequency (SEF)
 - Coherence
 - Entropy
 - Mean and Standard Deviation
 - T-test
- Frequency Bands:**
- ✓ Delta 1 (δ 1): 0.5-1 Hz
 - ✓ Delta 2 (δ 2): 1-4 Hz
 - ✓ Theta (θ): 4-8 Hz
 - ✓ Alpha (α): 8-13 Hz
 - ✓ Beta (β): 13- 30Hz

Conclusions

Parameter	Differentiation	Band
Power Ratio	Awake vs. Quiet Awake vs. Active	Delta 1 & Theta
Coherence	Awake vs. Active	Delta 2
Entropy	Awake vs. Quiet Awake vs. Active	Beta

- SEF 50 can differentiate between Awake vs Quiet and Awake vs Active
- No processed EEG method can differentiate between Quiet and Active

Results

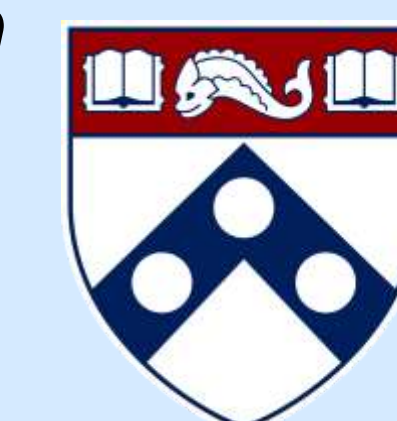
Fp1- C3 Left							Fp2- C4 Right						
Power Ratio													
		δ 1 %	δ 2 %	θ %	α %	β %			δ 1 %	δ 2 %	θ %	α %	β %
Awake	Mean	0.51	0.39	0.06	0.02	0.03	Awake	Mean	0.47	0.42	0.06	0.02	0.03
	Stdev	0.18	0.12	0.04	0.01	0.03		Stdev	0.14	0.10	0.03	0.01	0.03
Quiet	Mean	0.39	0.47	0.10	0.02	0.02	Quiet	Mean	0.37	0.48	0.10	0.02	0.03
	Stdev	0.10	0.08	0.04	0.01	0.01		Stdev	0.09	0.06	0.04	0.01	0.04
Active	Mean	0.39	0.49	0.08	0.02	0.02	Active	Mean	0.39	0.49	0.08	0.02	0.02
	Stdev	0.15	0.13	0.03	0.01	0.01		Stdev	0.13	0.11	0.03	0.01	0.01
Awake vs. Quiet		<0.01	0.02	<0.001	0.1	0.16	Awake vs. Quiet		<0.01	0.02	<0.001	0.09	0.47
Awake vs. Active		0.02	0.01	0.03	0.28	0.14	Awake vs. Active		0.06	0.04	0.04	0.28	0.05
Quiet vs. Active		0.93	0.57	0.09	0.52	0.98	Quiet vs. Active		0.6	0.72	0.08	0.53	0.49
Entropy													
Awake	Mean	0.93	0.84	0.96	0.98	0.98	Awake	Mean	0.95	0.86	0.95	0.98	0.98
	Stdev	0.06	0.09	0.02	0.01	0.02		Stdev	0.04	0.07	0.02	0.02	0.02
Quiet	Mean	0.98	0.90	0.96	0.98	0.94	Quiet	Mean	0.98	0.90	0.96	0.98	0.95
	Stdev	0.03	0.04	0.01	0.01	0.03		Stdev	0.03	0.04	0.01	0.01	0.02
Active	Mean	0.97	0.89	0.96	0.98	0.95	Active	Mean	0.96	0.89	0.96	0.98	0.96
	Stdev	0.04	0.06	0.01	0.01	0.02		Stdev	0.04	0.05	0.01	0.01	0.02
Awake vs. Quiet		<0.001	<0.01	0.24	0.09	<0.001	Awake vs. Quiet		<0.01	<0.01	0.06	0.91	<0.001
Awake vs. Active		<0.01	0.05	0.34	0.49	<0.001	Awake vs. Active		0.2	0.07	0.06	0.95	<0.001
Quiet vs. Active		0.3	0.4	0.77	0.22	0.51	Quiet vs. Active		0.12	0.43	0.94	0.78	0.18

		Fp1 -C3 Left		Fp2-C4 Right	
		SEF 50 (Hz)	SEF 90 (Hz)	SEF 50 (Hz)	SEF 90 (Hz)
Awake	Mean	0.92	3.99	0.95	4.64
	Stdev	0.33	3.22	0.29	3.99
Quiet	Mean	1.20	4.63	1.21	5.39
	Stdev	0.32	1.20	0.27	3.59
Active	Mean	1.14	4.11	1.11	4.21
	Stdev	0.32	1.09	0.26	1.29
Awake vs. Quiet		< 0.01	0.38	< 0.01	0.52
Awake vs. Active		0.03	0.86	0.05	0.63
Quiet vs. Active		0.59	0.16	0.25	0.17

Coherence Left vs. Right		δ 1 %	δ 2 %	θ %	α %	β %
Awake	Mean	0.35	0.36	0.27	0.3	0.33
	Stdev	0.25	0.20	0.19	0.27	0.24
Quiet	Mean	0.41	0.48	0.33	0.28	0.21
	Stdev	0.18	0.16	0.15	0.15	0.15
Active	Mean	0.46	0.56	0.4	0.34	0.39
	Stdev	0.19	0.18	0.25	0.32	0.35
Awake vs. Quiet		0.39	0.03	0.29	0.7	0.04
Awake vs. Active		0.11	<0.001	0.07	0.66	0.54
Quiet vs. Active		0.38	0.14	0.27	0.42	0.04

Co-authors: Rachit Kumar, Ashley S. Hodges, Olivia Nelson, Shavonne Massey, Nicholas S. Abend, Alexis A. Topjian

***Citations:** Toole JM, Boylan GB. NEURAL: quantitative features for newborn EEG using Matlab. arXiv:170405694. 2017.



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