

Periodic and aperiodic components of resting-state electroencephalography in Alzheimer’s and Lewy body diseases with cognitive decline

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- **Periodic and aperiodic resting-state EEG components jointly differentiate cognitive decline due to Alzheimer’s disease from Lewy body disease and cognitively unimpaired aging**
- **Higher aperiodic exponent and offset characterize Lewy body disease, with Alzheimer’s disease showing intermediate values**

INTRODUCTION	METHODS	RESULTS	CONCLUSIONS	REFERENCES
Resting-state electroencephalography (rsEEG) slowing is a well-established feature of Alzheimer’s disease (AD) [1], yet conventional spectral analyses conflate narrowband oscillatory rhythms with broadband background activity [2]. Spectral parameterization approaches enable decomposition of rsEEG power spectra into periodic (oscillatory) and aperiodic (1/f-like) components, reflecting distinct neural processes and potentially refining neurophysiological biomarkers of neurodegeneration and cognitive decline [3,4]. However, the relative contribution of these components in AD, and their specificity compared to Lewy body disease (LBD), remains underexplored. Fig 1. Group-mean rsEEG spectral parameterization.	Eyes-closed rsEEG recordings were obtained from an international multicenter cohort (https://pdwaves.eu/) including patients with cognitive decline due to AD (ADCD; $n=135$, mean age=74.4 ± 7.4, 73 women), LBD (LBCD; $n=140$, mean age=75.2 ± 6.9, 52 women), and cognitively unimpaired older adults (Nold; $n=118$, mean age=68.9 ± 8.1, 70 women). Power spectra (1–30 Hz) were parameterized through specparam (https://specparam-tools.github.io/) to extract periodic features (individual alpha frequency [IAF], IAF power and individual beta peak power) and aperiodic parameters (exponent and offset). Measures were derived at global scalp level and electrode level. Group differences were assessed using linear mixed models controlling for age, sex, education, and recording site. Associations with global cognition were examined within the ADCD group using Mini-Mental State Examination (MMSE) scores.	Both clinical groups showed significant rsEEG slowing relative to Nold, characterized by reduced IAF and decreased periodic alpha (6–14 Hz) and beta activity (14–22 Hz), with greater power attenuation in ADCD and more pronounced frequency slowing in LBCD (Fig 1 and Fig 2). Aperiodic parameters also differed across diseases: exponent and offset were significantly increased in LBCD, while ADCD showed intermediate values (Fig 3). Within the ADCD group, lower MMSE scores were associated with slower IAF ($p=0.04$, $\beta=0.18$), reduced beta peak power ($p=0.01$, $\beta=0.22$), and higher aperiodic exponent ($p=0.001$, $\beta=-0.25$) and offset ($p=0.01$, $\beta=-0.24$). Fig 2. Group-mean rsEEG aperiodic-corrected spectra.	Periodic and aperiodic rsEEG markers jointly discriminate AD from LBD and Nold. In AD, cognitive impairment is associated with slowing of dominant IAF, reduced beta activity, and increased broadband aperiodic components. These findings highlight the complementary role of frequency-specific and background EEG markers in characterizing AD-related cognitive decline and support the integration of periodic-aperiodic decomposition to refine rsEEG biomarkers in dementia research. Fig 3. Estimated marginal means ($\pm 95\%$ confidence intervals) from linear mixed models comparing periodic and aperiodic resting-state EEG (rsEEG) parameters across groups.	[1] Babiloni C, Blinowska K, Bonanni L, et al. What electrophysiology tells us about Alzheimer's disease: a window into the synchronization and connectivity of brain neurons. <i>Neurobiol Aging</i>. 2020;85:58-73. doi:10.1016/j.neurobiolaging.2019.09.008 [2] Donoghue T, Dominguez J, Voytek B. Electrophysiological Frequency Band Ratio Measures Conflate Periodic and Aperiodic Neural Activity. <i>eNeuro</i>. 2020;7:ENEURO.0192-20.2020. doi:10.1523/ENEURO.0192-20.2020 [3] Donoghue T, Haller M, Peterson EJ, et al. Parameterizing neural power spectra into periodic and aperiodic components. <i>Nat Neurosci</i>. 2020;23(12):1655-1665. doi:10.1038/s41593-020-00744-x [4] Pani SM, Saba L, Fraschini M. Clinical applications of EEG power spectra aperiodic component analysis: A mini-review. <i>Clin Neurophysiol</i>. 2022;143:1-13. doi:10.1016/j.clinph.2022.08.010
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