

Interdependent Scaling Exponents in the Human Brain

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We apply the phenomenological renormalization group to resting-state fMRI time series of brain activity in a large population. By recursively coarse graining the data, we compute scaling exponents for the series variance, log probability of silence, and largest covariance eigenvalue. The scaling exponents clearly exhibit linear interdependencies in the form of scaling relations and inherent variability of values closely related to the structure of correlations of brain activity. The scaling relations between the exponents are derived analytically. We find a significant correlation of exponents with clinical (gray matter volume) and behavioral (cognitive performance) traits. Akin to scaling relations near critical points in thermodynamics, our results suggest that this interdependency is intrinsic to brain organization, and may also exist in other complex systems.

Reference:

Castro, D. M., Raposo, E. P., Copelli, M., & Santos, F. A. (2025). Interdependent scaling exponents in the human brain. *Physical Review Letters*, 135(19), 198401.