Bibliographical references

Frolov et al. (2020) proposed a novel approach to analyze multiplex brain networks using recurrence quantification analysis (RQA) on EEG data. The authors demonstrated how recurrence-based synchronization indices can effectively capture both within-frequency (intralayer) and cross-frequency (interlayer) functional connectivity during cognitive tasks. Their work showed that RQA is particularly suitable for analyzing non-stationary EEG signals and revealed important insights about the evolution of functional connectivity patterns during prolonged cognitive tasks.

Kang et al. (2023) [2], in their study investigate the periodic dynamics of the Default Mode Network (DMN) in schizophrenia using RQA and Cross-Recurrence Quantification Analysis (CRQA) on resting-state fMRI data. Findings include decreased determinism (DET) between key DMN regions (vMPFC-PCC and vMPFC-precuneus) in first-episode schizophrenia patients, indicating disrupted predictability of functional interactions. The study highlights the potential of RQA/CRQA as tools for capturing nonlinear brain dynamics and their utility in distinguishing schizophrenia patients from healthy controls with 77% classification accuracy.

Researchers in [3], have applied RQA on resting-state fMRI data from TgF344-AD rats in order to detect early stage of Alzheimer's disease biomarkers. Analysis has been conducted on the Default Mode-Like Network (DMLN) using RQA metrics(entropy, recurrence rate, determinism and average diagonal line length) and revealed significant changes in regions like the basal forebrain (BFB), hippocampal fields (CA1, CA3), and visual cortices (V1, V2). On the study's findings are included reduced predictability in wild-type (WT) rats with aging, while AD rats exhibited less decline in predictability, suggesting compensatory mechanisms. The study highlights RQA's sensitivity to nonlinear dynamics in preclinical AD, offering potential for early diagnosis. Also the code of the research is publicly available.

Lameu et al. [4] investigated burst phase synchronization in neural networks using RQA. The authors employed coupled Rulkov maps to model bursting neurons in both single small-world networks and clustered network-of-networks architectures. Their spatial RQA approach successfully identified synchronized neuron groups and quantified their sizes during synchronization transitions. The study demonstrated that RQA measures (recurrence rate, laminarity, and structure size) provide complementary information to traditional order parameters, particularly for detecting localized synchronization patterns. This work is significant for EEG analysis as it shows RQA's capability to detect phase synchronization in complex networks - a key feature in functional brain connectivity studies.

Lombardi et al. [5] investigate the nonlinear properties of fMRI BOLD signals during a working memory task in schizophrenic patients and healthy controls. Using RQA, analysis has been performed on the recurrence plots for the quantification of determinism (D), trapping time (TT), and maximal vertical line length ($V_{\max}$) in functionally relevant brain clusters. Outcome revealed differences in nonlinear dynamics among the groups, and more specific in working memory and default mode network areas. This study highlights the potential of RQA for discriminating pathological brain states and understanding functional connectivity in complex systems. While their work focused on fMRI, the methodology is adaptable to EEG, which offers higher temporal resolution for capturing rapid neural dynamics.

In [**?**], investigated changes related to aging in brain sensorimotor systems using RQA and theta-band functional connectivity in EEG signals. In the study a VR experimental paradigm was utilized with auditory stimuli across different age groups. Key findings revealed that elderly subjects showed decreased EEG complexity during motor preparation stages as measured by RQA metrics (ΔRR and ΔRTE), and had increased theta-band functional connectivity highlighting the potential of RQA in detecting age-related biomarkers that were not evident in conventional spectral analysis.

Table 1: Comparison among the retrieved studies using recurrence analysis

#	Reference	Modality	Analysis Methods	Network Type
1	Frolov et al. (2020)	EEG	RQA, CRQA	Multiplex functional networks
2	Kang el al. (2023)	fMRI	RQA, CRQA	Default mode network
3	Rezaei el al. (2023)	fMRI	RQA	Default model like network
4	Lameu et al. (2018)	—	RQA	Small-world & clustered networks
5	Lombardi et al. (2014)	fMRI	RQA	schizophrenia,working memory
6	Pitsik E. (2025)	EEG	RQA	aging

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