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Peer Review

Review of: "Deep Learning Modeling for Prediction of Cognitive Task Related Features from Resting-state fMRI Data"

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This study presents a technically sophisticated and methodologically innovative attempt to predict cognitive task performance (Kohs block-design scores) from resting-state fMRI using a modified connectivity-based graph convolutional network combined with LSTM (cGCN-LSTM). Strengths include the relatively large sample size (n=615), careful prevention of data leakage (group FC computed from training folds), comparison with a classical baseline (LASSO), and the introduction of a leave-two-out occlusion approach to probe network-level interactions. The finding that cGCN-LSTM retains predictive signal from rs-FC even after removing age—while LASSO performance collapses—suggests that temporal and graph-structured modeling captures higher-order information not represented by simple FCS features. The network-level interpretations (DMN, cerebellum, cross-network connectivity) are neurobiologically plausible and consistent with aging and visuospatial processing literature.

However, several limitations temper the strength of the conclusions. First, predictive performance without age remains modest ($r \approx 0.34$), meaning that the majority of variance in cognitive scores remains unexplained; claims regarding practical applicability should therefore be moderated. Second, the fixed k=5 graph structure based on group-average FC may constrain individual variability and potentially bias feature extraction; testing adaptive or subject-specific graph constructions would strengthen the framework. Third, the occlusion approach—especially leave-two-out—identifies sensitivity rather than causal importance and may be influenced by correlated feature structures; complementary explainability methods (e.g., permutation importance, SHAP, gradient-based attribution) would enhance interpretability robustness. Fourth, potential confounders beyond age (education level, vascular factors, motion, sex effects) are not deeply examined. Finally, external validation on an independent dataset is lacking, limiting generalizability.

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Overall, the manuscript offers a meaningful contribution at the intersection of connectomics and deep learning by adapting cGCN to regression and demonstrating graph-temporal modeling advantages. With stronger external validation, deeper confound control, and expanded interpretability analyses, the approach could become a valuable tool for task-free cognitive phenotyping.

Declarations

Potential competing interests: No potential competing interests to declare.