Robust Functional Connectivity from MEG using Network Localized Granger Causality: Directional Connectivity Results in Physiological Frequency Bands

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Introduction

Goal: directly localize GC influences without an intermediate source localization step
Method: Network Localized Granger Causality (NLGC)

Granger Causality

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\(E_{ij} \) is the covariance between variables \( i \) and \( j \) at time \( t \). The covariance is calculated as the dot product of the standardized versions of \( x_i(t) \) and \( x_j(t) \). The standardized version of \( x_i(t) \) is obtained by subtracting the mean of \( x_i(t) \) from each value in \( x_i(t) \) and dividing by the standard deviation of \( x_i(t) \). The standardized version of \( x_j(t) \) is obtained in the same way.

Statistical Inference

Two hypothesis for link \( i \rightarrow j \): \( H_0: \Delta R_{ij}^{(NLGC)} = 0 \) vs. \( H_1: \Delta R_{ij}^{(NLGC)} > 0 \). Table 1 gives the summary of the hypotheses.

Results: Tone Processing vs. Resting State

13 younger and 9 older adults
100 repetitions of tone pips presented at the end of resting state recordings

Results: Synthetic Data

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Parameter Estimation

Hypothesis of no change in GRGM across groups: \( H_0: R_{ij}^{(NLGC)} = 0 \) vs. \( H_1: R_{ij}^{(NLGC)} > 0 \).

Results: Difficult Listening Experiment

1-minute-long speech segments from an audio book in two conditions: 1) Clean speech (easy) 2) Mixed speech: two talker speech, male vs. female speaker (difficult): task: attend to pre-specified speaker

Results: Minor Stroke Patients

6 minor stroke patients undergoing clinical recovery and 6 controls
60 seconds resting state data recorded in two 6-month apart visits
Frontoparietal (FPC) and non-FPC areas considered for connectivity analysis in beta band (13-25 Hz)

Reference


For details and more explanations, please check the paper.