

Predictive regression modeling with MEG/EEG: From source power to signals and cognitive states

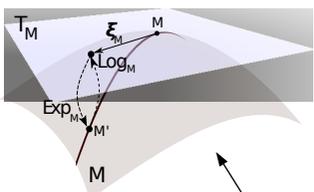
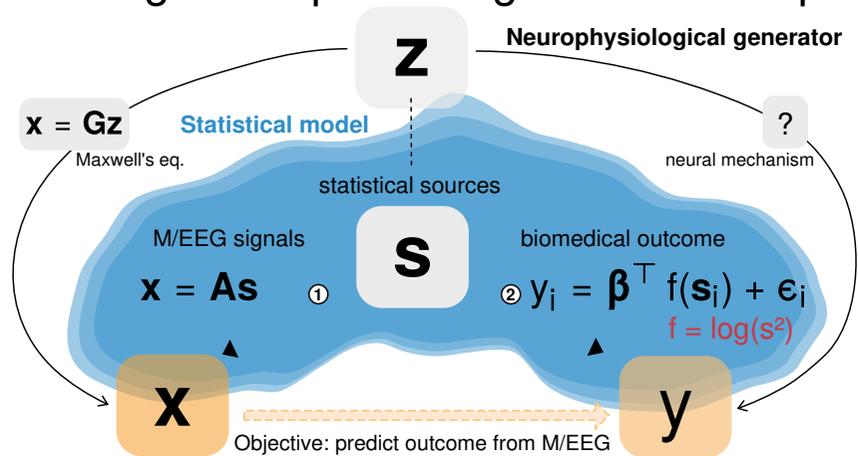


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Volume conduction prevents classical linear modeling when predicting from source power.

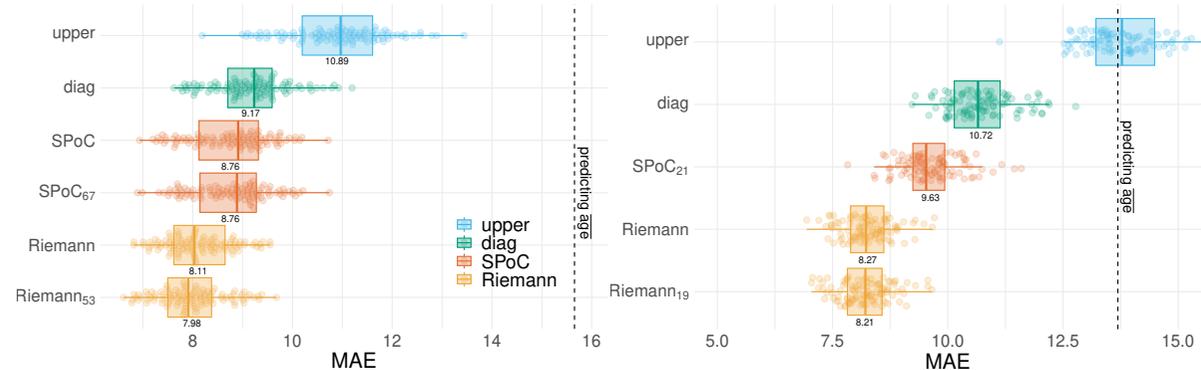


Idea: When using a linear model like Ridge regression to predict outcomes (y) from M/EEG (X), replace biophysical source model with mathematical-statistical transformation to regress out volume conduction. We considered spatial filters (SF) and Riemannian embeddings (RE). Baseline: sensor space power (*upper*) and log-power (*diag*).

Riemannian embeddings perform best on real data.

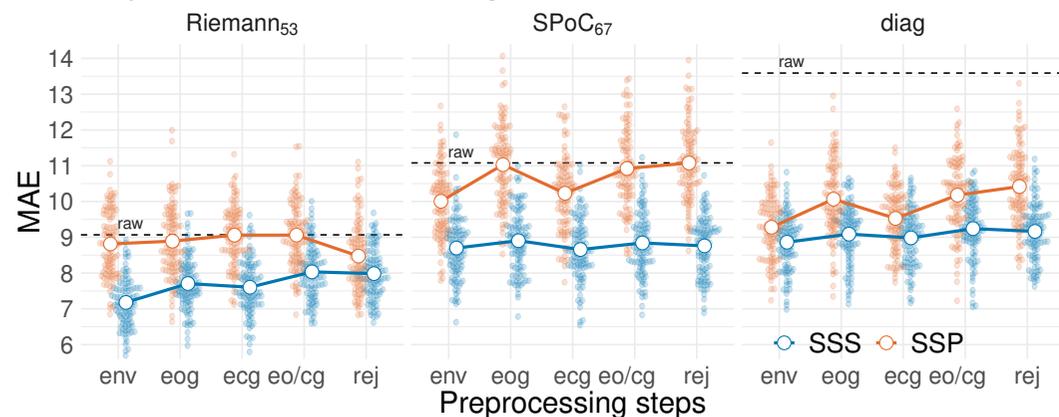
MEG - Cam-CAN (n = 600)

EEG - Temple Univ. Hospital (n = 1385)



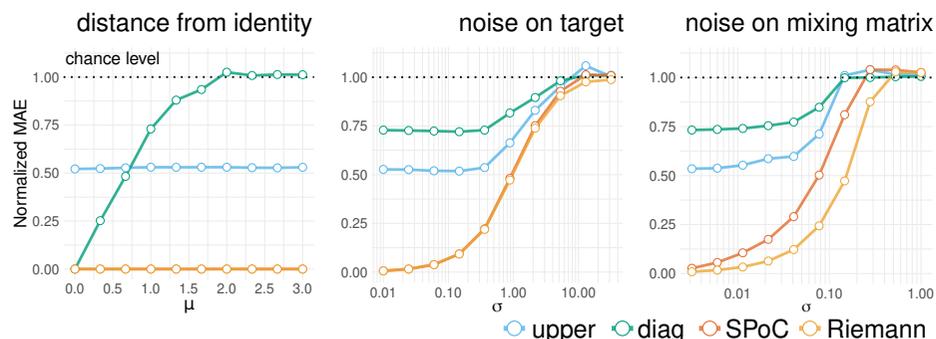
Note: We benchmarked methods against age-prediction with ridge regression. With source localization (MNE) as transformation, *diag* performed best ~ 7.7 yrs mean absolute error (MAE)!

RE yielded robust regression models.



Note: We compared regression models across different combinations of preprocessing steps: denoising (SSP/SSS), ECG/EOG artifacts, rejection of bad segments. We even ran models with no preprocessing at all. RE is a clear winner. Caveat: Additional analyses also suggest that RE is most influenced by anatomical factors.

Simulations: SF & RE yield consistent regression. RE were more robust to model violations.



Note: For prediction at the subject-level we encounter severe model violations as each individual has her own head and brain. This breaks mathematical guarantees. (See QR code for NeurIPS paper)

When prediction performance is the priority, Riemannian embeddings may beat source localization.