

Online Resource 4

Microscopic calculations and reproducibility limits

Article

The Syncytial Mesh Model: glial spatial control, neuronal response geometry, and the limits of local EEG reduction

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Scope of six-ion electrodiffusive reference checks and the fixed EEG observation analysis.

S4 Text. Numerical reproduction and frozen EEG provenance

Scope of the independent checks

The analytical mode sensitivity and seven-domain spatial calculations are executable using the supplied NumPy/SciPy scripts and the fixed local eight-state Jacobian. Initial conditions, parameters and numerical inputs are specified. Replaying these scripts is a computational reproducibility check, not biological validation.

The source material for the high-fidelity electrodiffusive work includes `martejulie/fluid-flow-in-astrocyte-networks` pinned at commit `99bfe1671d9c5735333fa24c2406aa32bde010fc`. The original nonlinear six-ion FEniCS R1/R2 simulations and their fluid-flow parent solver were **not** independently reproduced. A later finite-volume, zero-fluid-flow approximation reconstructed R1 central potassium pulses. For 2.5×10^{-8} mol/m²/s and 5.0×10^{-8} mol/m²/s the 31-cell peaks were 0.13705955 and 0.27776327 mM, respectively. The latter rounds to 0.278 rather than the historical 0.277 mM. Grid refinement from 31 to 41 cells produced variability exceeding a sub-percent numerical agreement criterion. Thus the finite-volume comparison supports agreement at the grid-discretization scale, not high-precision numerical equivalence. The nonlinear coupled fluid-flow calculations remain unverified.

A held-out reduced-mode calculation exceeded its nominal 10% normalized RMSE bound, with error 10.47%. This check failed. Exploratory phase-gradient fits reported in prior preprint material were not independently reproduced as part of this study.

Observation-model audit

The local frozen EEG implementation was `ipsissima/SMM` at scientific head `20fab272edf33d2513470c60ac9398754535cacb`. The two-pole potassium transfer, forward source projection, and spectral-likelihood path were transcribed and checked numerically; the frozen executable contains no glial spatial coupling parameter. The coefficient D_g has zero derivative in that executable, not because data estimate it at zero but because it is not present in the model. This statement must not be generalized to a spatially explicit EEG realization.

The original untouched primary run is 37752719639, status **NOT EVALUABLE**. Its later completion is a separately identified **POST_OPEN_AMENDED** analysis following declared channel provenance and structural-eligibility repairs. Relevant runs: fit 37787000597, recovered-subject fit 37968393249, final assembly 38134531967. Primary assigned N=565, included N=535, ordinary frozen QC N=27, structural exclusions N=3. M3 won over M2 for only 24 included subjects. Mean M3 minus M2 score -0.009178406703493526; participant bootstrap 95% interval [-0.010157929439651986, -0.008234006418224695], participant SD 0.011355538448319177, one-sided sign-flip superiority $p=1.0$. The statistical result was rerun from archived subject-level outputs. The original complete 535-subject raw EDF fitting was not independently repeated by this synthesis.

Transfer scale and interpretation

The isolated local K filter poles are approximately -0.11373549 and -12.32001106 per second, with slow time constant 8.79233054 s and corner frequency about 0.0181 Hz. The human EEG code scored 1–40 Hz cross-spectral matrices. A direct inference about infraslow transport or glial spatial organization from the observed negative 1–40 Hz score would be unjustified. The shared full-recording preprocessing prior to A/B split is an additional limitation on raw-signal independence. Numerical embedding of M3 in generic M2 was verified in the frozen implementation; nesting does not entail M2 superior *test* likelihood as a mathematical necessity.

Computations available for independent checking

Online Resource 3 contains the seven-domain spatial simulation, mode analysis, exact numerical outputs, the amended participant-level score table and the fixed EEG source code with provenance. Spatial calculations run with standard Python/SciPy. Complete refitting of all raw EEG recordings was not independently reproduced. Neither exploratory preprint fits nor the nonlinear FEniCS solver are presented as independently replicated results.