Volume of Activated Tissue (VAT)

The Volume of Activated Tissue (VAT) refers to the estimated region of brain tissue that is modulated or influenced by the electrical field generated during deep_brain_stimulation (DBS). It is a critical concept in DBS research and programming, helping correlate anatomical stimulation sites with clinical outcomes.

Definition and Modeling

VAT is calculated using biophysical models that incorporate:

Electrode type and contact configuration

Stimulation parameters (amplitude, pulse width, frequency)

Tissue conductivity and impedance

Patient-specific or normative neuroanatomy

Modern tools such as Lead-DBS or SimBio simulate VAT using finite element models (FEM) and overlay it onto brain imaging data.

Clinical Relevance

Mapping clinical effects: The extent and location of the VAT can explain the patient's therapeutic response or side effects.

Target optimization: Adjusting parameters to maximize the VAT's overlap with desired networks or tracts (e.g., the ocd_response_tract) improves efficacy.

Comparative studies: VATs from different patients or targets (e.g., anteromedial_subthalamic_nucleus vs. superolateral_medial_forebrain_bundle) can be compared to identify common therapeutic regions.

In Research

In the Coenen et al. (Mol Psychiatry, 2025) study:

VATs were reconstructed for 26 patients with DBS targeting amSTN or slMFB.

These were used to correlate anatomical activation with improvements on the yale_brown_obsessive_compulsive_scale.

VATs were mapped onto normative connectomes to assess structural convergence.

Limitations

VAT is a model-based estimate, not a directly measurable biological entity.

Precision depends on the accuracy of electrode localization and tissue modeling.

Does not account for dynamic physiological changes or long-term plasticity.

Visualization

Most VATs are visualized as 3D volumetric fields centered around the active contacts on the DBS lead. These can be overlaid onto:

T1/T2-weighted MRI

Diffusion tractography (to analyze fiber engagement)

Functional connectivity maps