Il Gatto Sta Ingrassando: Novel connectivity tools and additions in AFNI-FATCAT

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TARGET AUDIENCE: You.

PURPOSE

AFNI-FATCAT[1,2] (Functional And Tractographic Connectivity Analysis Toolbox):

- Combine **functional** and **structural** connectivity analyses quantitatively
  - FMRI may be task-based or resting state
  - Diffusion-based imaging may be DTI or HARDI (HARDI modeling using Diffusion Toolkit[3], DSI Studio[4], Dipy[5], etc.)
- Combined viewing and tracking in AFNI and SUMA[6].

Recent FATCAT additions

1) Enhance deterministic tracking using model uncertainty → *mini-probabilistic*
2) Limit tracks with *anti-ROIs*
3) *Interactive* investigation with multiple data sets in SUMA.

1) MINI-PROBABILISTIC TRACKING

In both DTI and HARDI, noise sources get included in voxelwise fits.

- Deterministic tracking ignores these uncertainties
  → making them susceptible to error accumulation.
- Probabilistic methods account for model uncertainty
  → but generate voxelwise maps without linear track structure.
- **New 'mini-probabilistic' tracking both includes voxelwise uncertainty *and* retains track structure (Fig. 1)**
  → **more robust** and **fewer false negatives** than deterministic tracking
  → false positives tend to be isolated/obvious
  → fast way to view more representative track fibers
  → example use: initial viewing of data; highlight locations to place ROIs

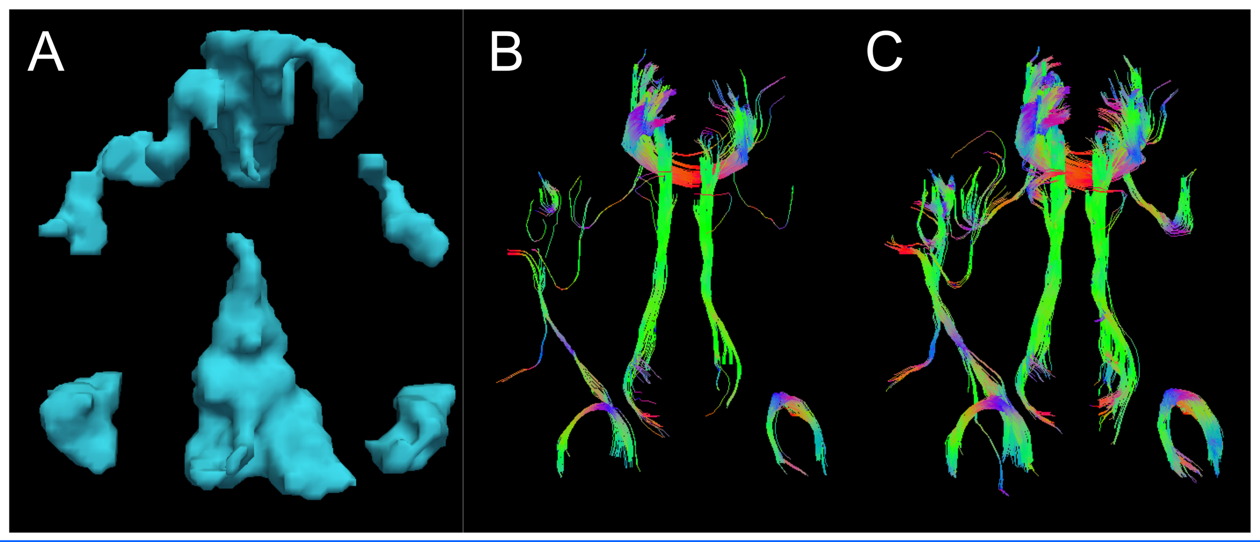


Figure 1: *For the GM ROIs in (A), (B) shows deterministic AND-logic tracts, while the new "mini-probabilistic" option is used in (C). Note the greater extent and robustness of bundles in (C).*

2) ANTI-ROI MASKS

WM tract patterns are complicated:

- they contain smoothing, crossing/kissing fibers in voxels and noise
- all tracking algorithms are prone to false negatives and positives.

Using anti-ROIs to:

- **control for false positives** ('overtracking')
- **limit a tract, trim known error paths, investigate network subsets**
- **halts tract propagation** when OR logic is being used

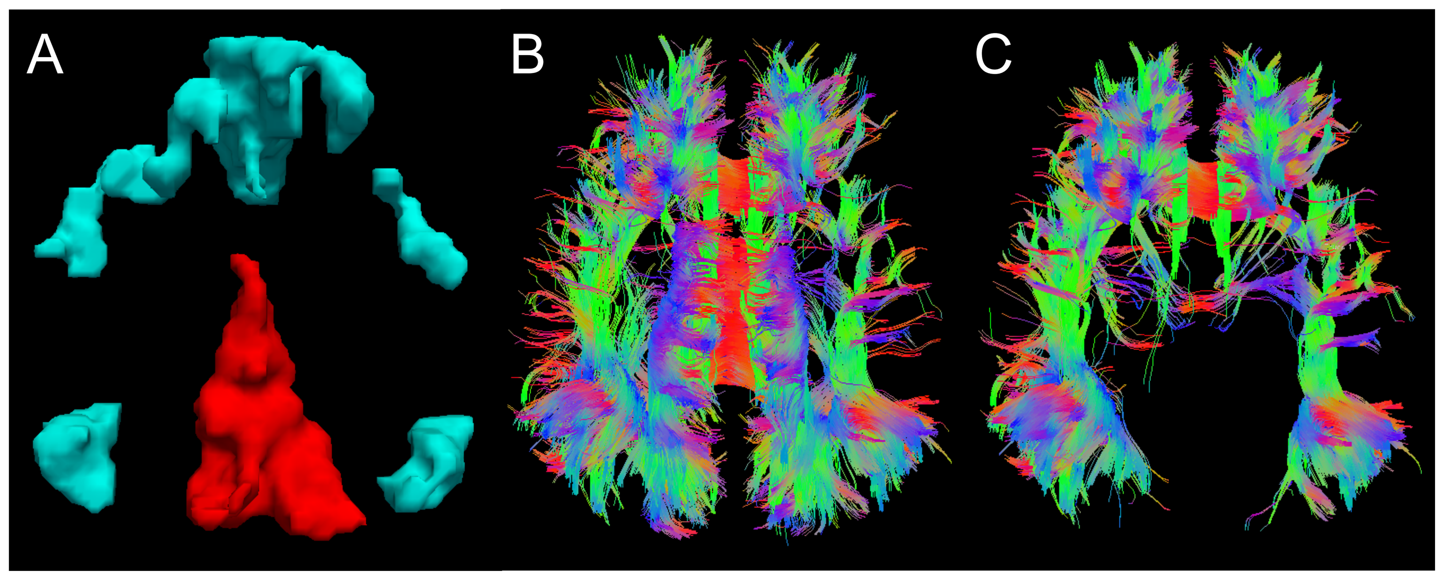


Figure 2: *(A) GM ROIs. (B) OR-logic with all ROIs in (A). (C) OR-logic when the red region in (A) is anti-masking, allowing controlled specificity of intra-network connections.*

3) VISUALIZATION IN SUMA

Visualization and interaction is important for **both research and clinical** usage.

- FATCAT can be used interactively with AFNI and SUMA
- generate anatomical and functional connectivity simultaneously
  → AFNI's InstaCorr for functional correlation
  → SUMA rendering of tracts, surfaces, volumes, and graphs
- Fig. 3 shows FATCAT track and ROI viewing with SUMA+AFNI.
- Fig. 4 shows interactive usage of InstaCorr and ROI selection with SUMA

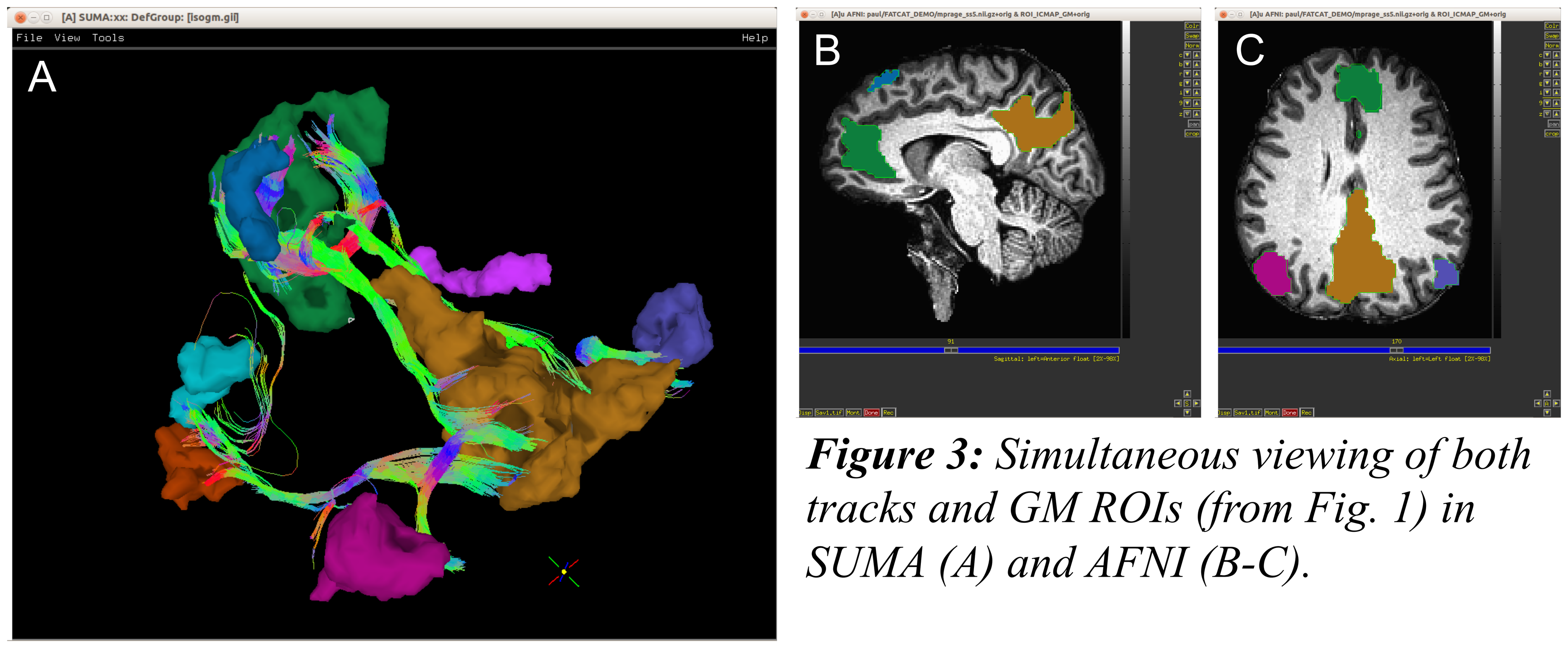
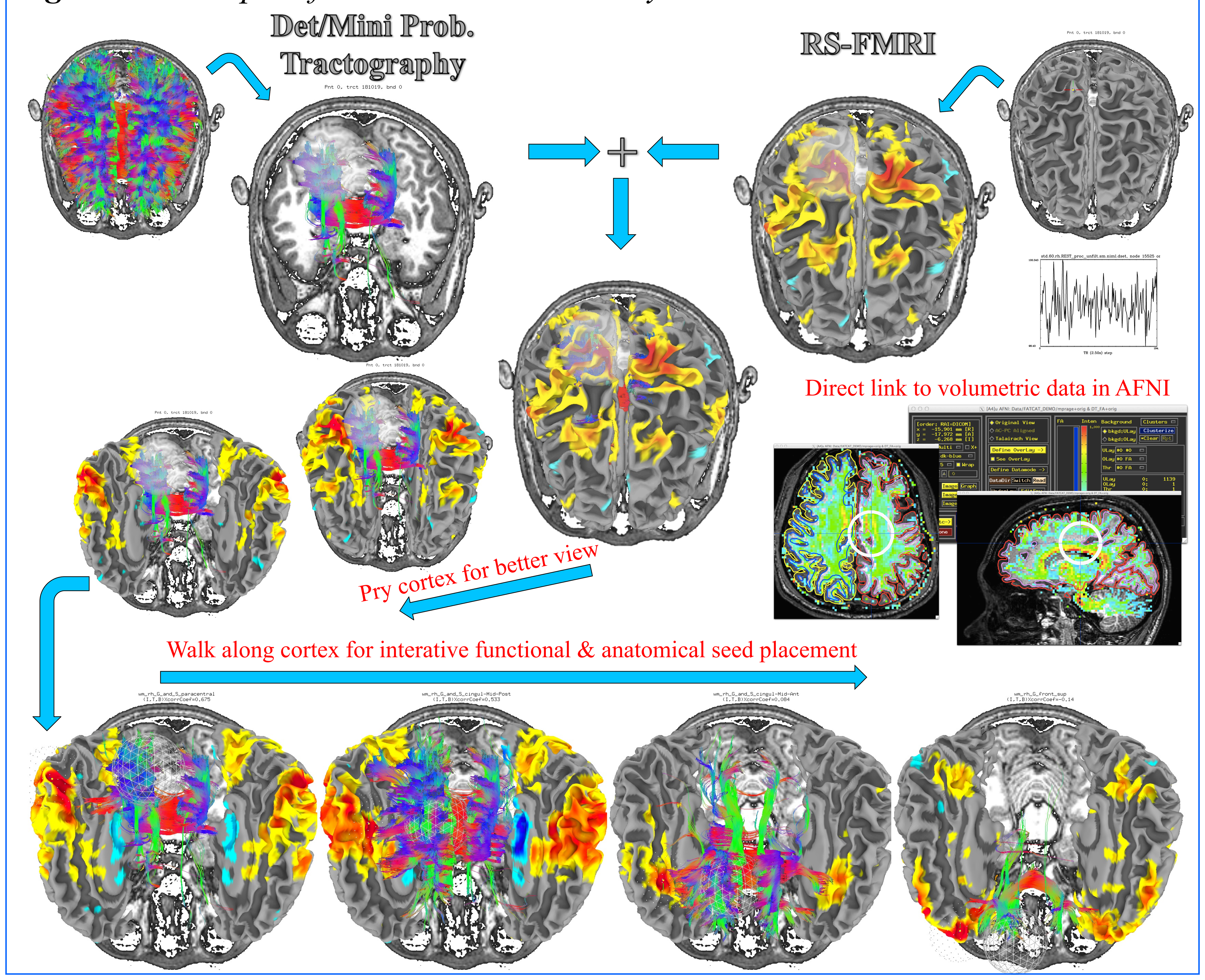


Figure 3: *Simultaneous viewing of both tracks and GM ROIs (from Fig. 1) in SUMA (A) and AFNI (B-C).*

Figure 4: *Example of interactive connectivity in SUMA.*



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