# The Effect of Local Fiber Model On Population Studies

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## Overview

Most common voxel model in population studies is the single diffusion tensor.

*Problem:*
Single tensor known to be poor fit in regions of crossing and branching.

*Method:*
Perform same study with single-tensor and two-tensor models.

*Result:*
Two-tensor model appears more sensitive to population differences.

## Method

*Summary:* Select three paired regions of cortex. Run two-tensor filtered tractography to find inter-hemispheric connections (see other poster). Fit single-tensor model along those same paths. Perform tract-based study. Compare areas of significance reported by each model.

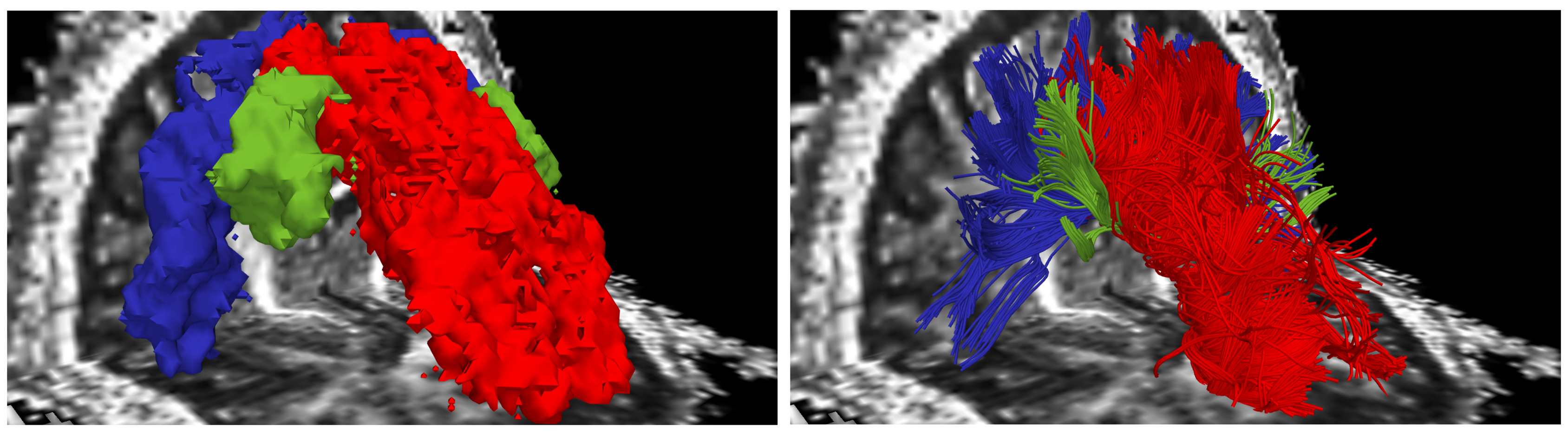
*Single-Tensor Model:*

$$S(\mathbf{u}) = s_0 e^{-b\mathbf{u}^T D \mathbf{u}} \qquad D = \lambda_1 \mathbf{m}\mathbf{m}^T + \lambda_2 \mathbf{p}\mathbf{p}^T + \lambda_3 \mathbf{q}\mathbf{q}^T$$

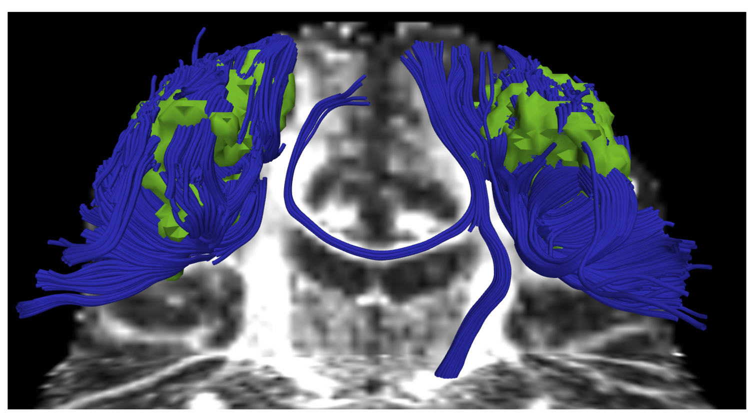
*Two-Tensor Model:* filtered tractography (see other poster)

$$S(\mathbf{u}) = 0.5\, s_0 e^{-b\mathbf{u}^T D_1 \mathbf{u}} + 0.5\, s_0 e^{-b\mathbf{u}^T D_2 \mathbf{u}} \qquad D_1 = \lambda_{11} \mathbf{m}_1\mathbf{m}_1^T + \lambda_{21}(\mathbf{p}\mathbf{p}^T + \mathbf{q}\mathbf{q}^T)$$

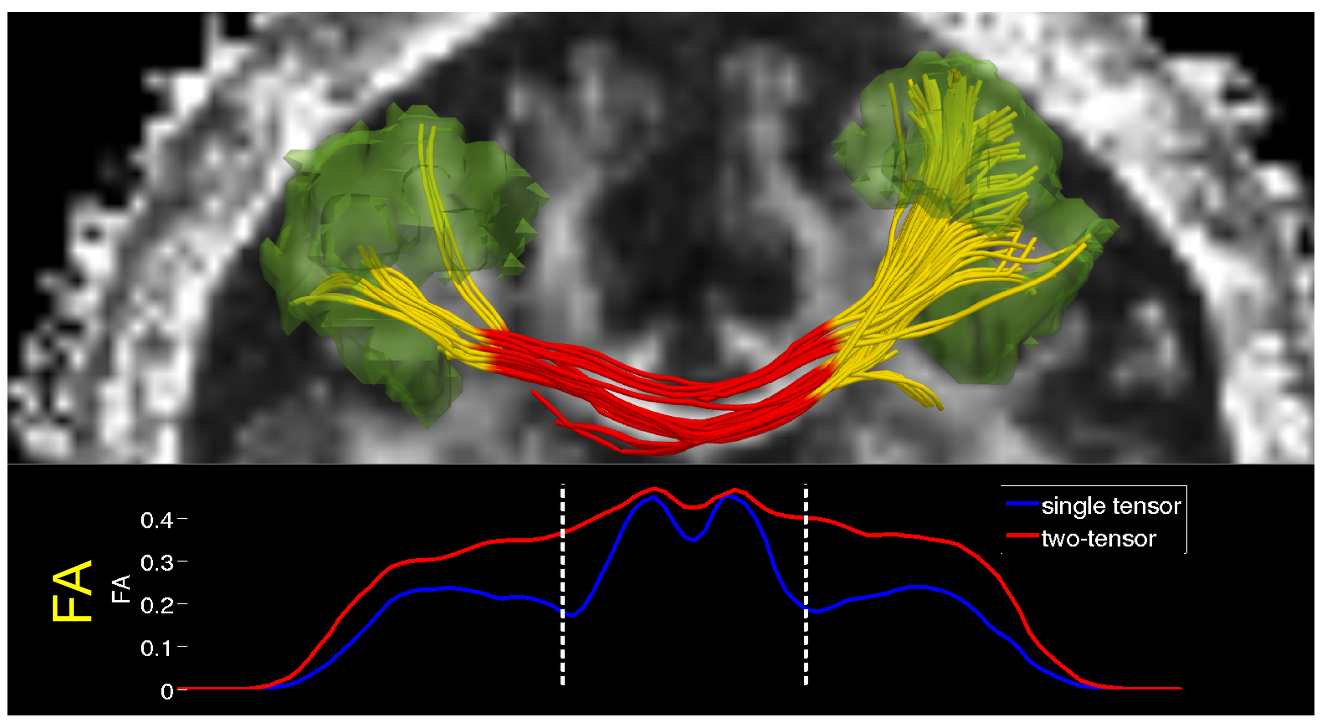
*Regions and Fibers:* fibers from two-tensor filtered tractography



single-tensor streamline fails



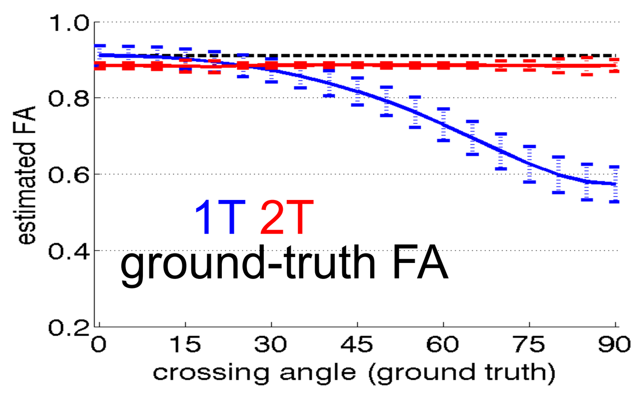
*Tract-based study:* arc-length parameterization




## Experiments

Before looking at in vivo, explore the differences we might expect to see between the two models. Use synthetic tractography, compare to ground-truth.

*Experiment:* fixed eigenvalues, vary crossing angle
*Result:* single-tensor underestimates FA up to 0.3 in 90 crossing while two-tensor provides accurate and consistent estimates

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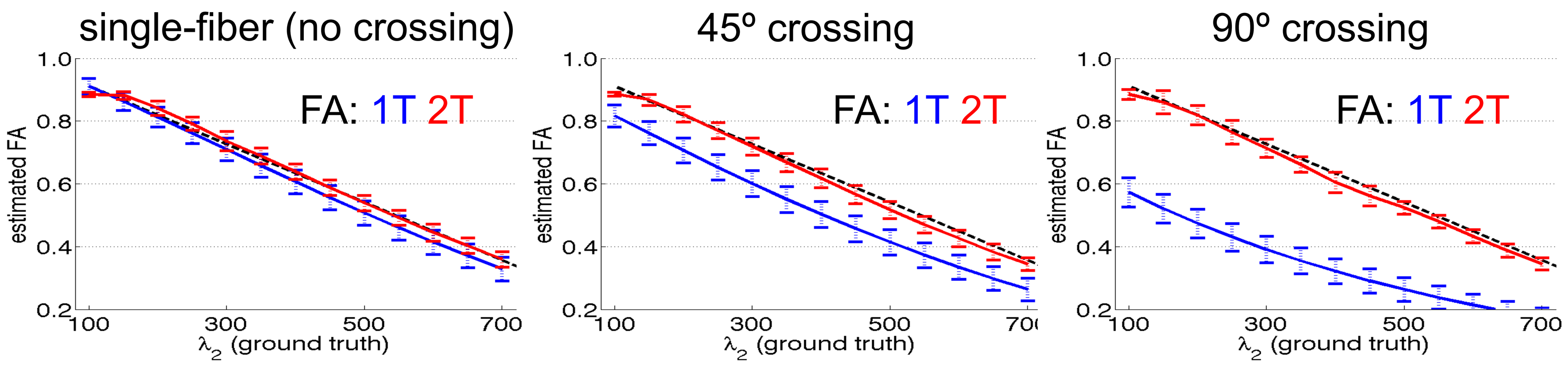
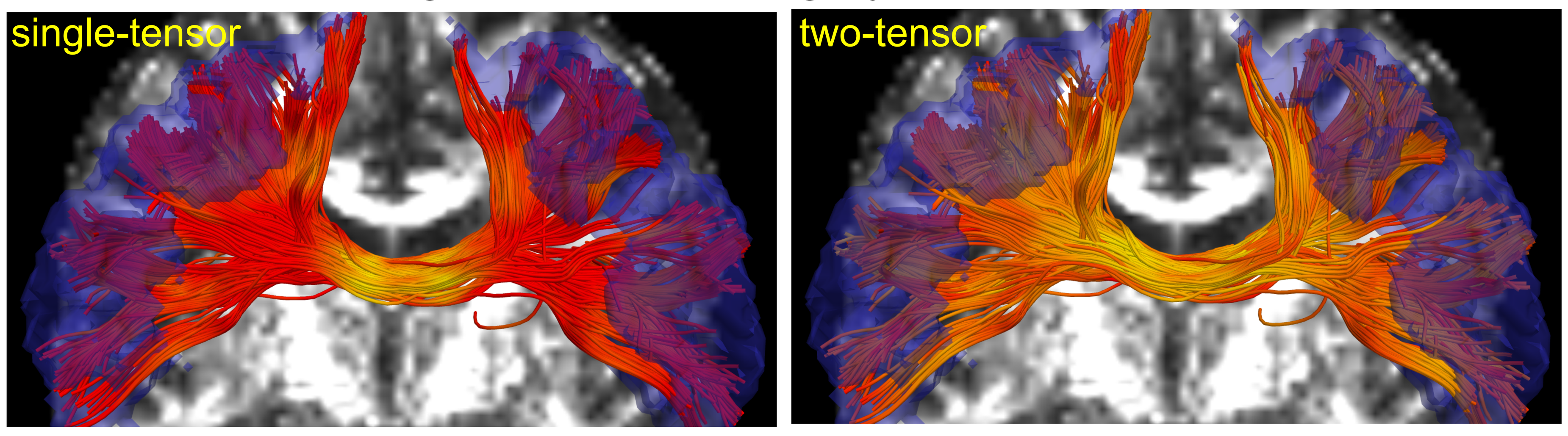
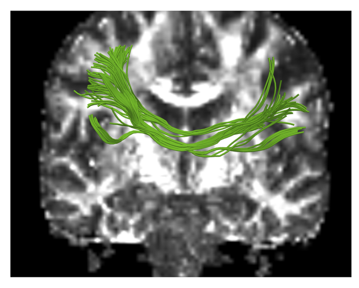


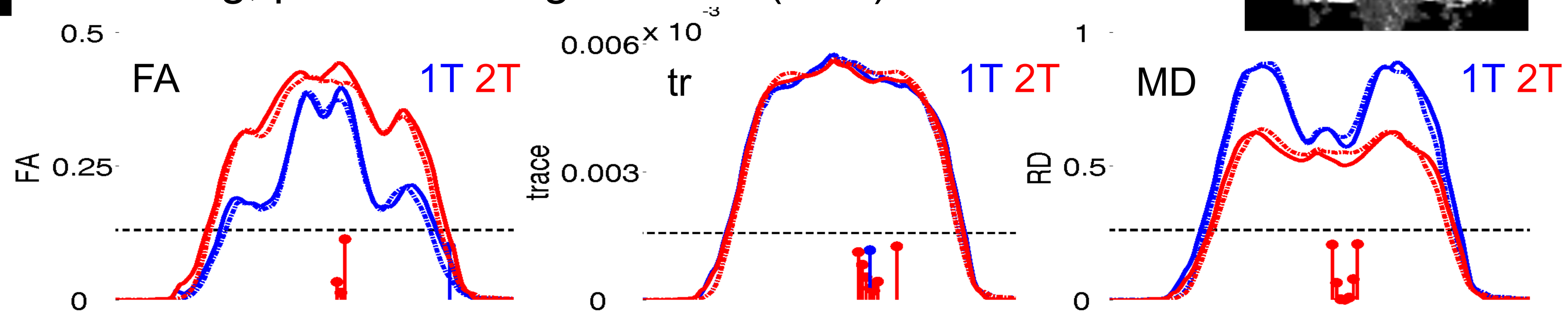

## Results

*Experiment:* look at FA superimposed on two-tensor fibers
*Result:* single-tensor FA drops outside corpus callosum while two-tensor maintains higher FA on out to gray-matter

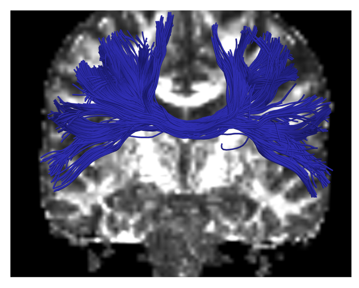


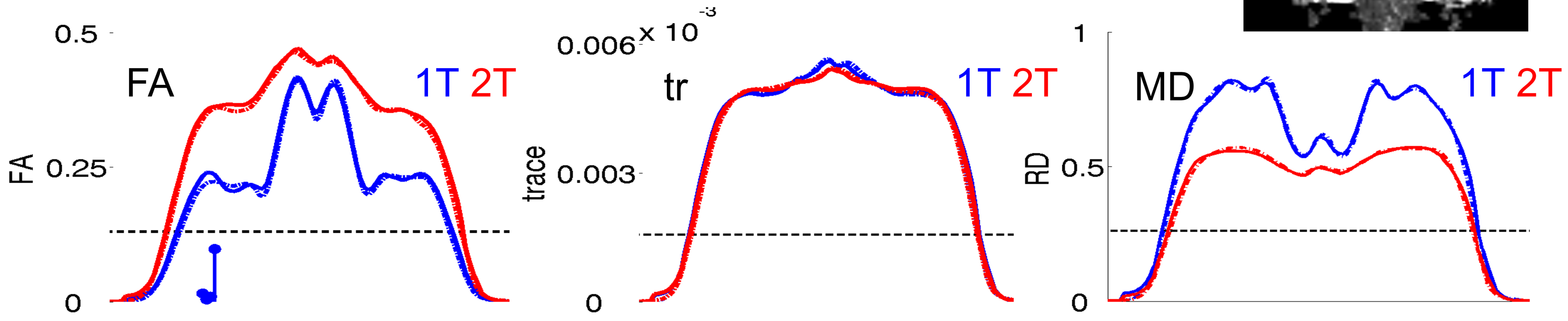

*Experiment:* caudalmiddle central, statistical analysis as function of arc-length (FA, trace, radial diffusivity)
*Result:* two-tensor (red) detects differences near the branching, poor fit of single-tensor (blue) misses this






*Experiment:* precentral region, statistical analysis as function of arc-length (FA, trace, radial diffusivity)
*Result:* neither method finds consistent differences






*Experiment:* superiorfrontal region, statistical analysis as function of arc-length (FA, trace, radial diffusivity)
*Result:* both methods find differences along sides of corpus callosum where less crossing/branching occrs