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Diffusion MRI modelling of the cortex informed by macro- and myelo-architecture

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Transforming brain research.

Project **Summary**

KNOWLEDGE MOBILIZATION & IMPACT

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Background

The cerebral cortex is the largest part of the cerebrum. Its surface is folded into the recognizable ridges and furrows of the brain, which increase surface area within the confined space of the cranium.

The internal, cellular structure of the cerebral cortex is highly complex. Investigation of the architecture at the scale necessary has required microscopic techniques up to this point - the intrinsic limitations in resolution of non-invasive imaging such as MRI has prevented its use for this purpose in living organisms.

The Problem

One area of focus in trying to improve the diagnosis of brain disorders such as epilepsy and schizophrenia is our ability to detect subtle abnormalities in the structure of the cerebral cortex. Recent advances in a specific technique known as computational diffusion MRI, which allows measurement and modelling of microscopic properties of structures in the cerebral cortex, is becoming possible.

A major challenge of diffusion modeling techniques is in fitting complex micro-structural models with a relatively small number of samples.

The Project

The overall goal of this transformative program is to develop novel imaging and analysis techniques for evaluating cortical architecture, providing a means to characterize and quantify structural features that have been invisible to MRI until now.

The novel approach we are taking will fuse complementary measurements of macro-anatomical structure to model the complex architecture of neuronal bodies in the cortex.

This technique could have wide-ranging applications, not only in mapping tissue composition for neuroscientific questions, but in improving our ability to detect subtle abnormalities in regions of the brain as part of the diagnosis of brain disorders.

The critical, foundational milestone that must be achieved first is the development and validation of this technique, using simulations, phantom experiments and human post-mortem tissue imaging.

Funding Program

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