Zhou Lan
Ph.D Student
Department of Statistics, NCSU

Brian Reich
Associate Professor
Department of Statistics, NCSU

Joseph Guinness
Assistant Professor
Department of Statistics, NCSU

Dipankar Bandyopadhyay
Associate Professor
Massey Cancer Center, VCU

STATISTICS IMPROVES BRAIN SCIENCE

Recent advances in imaging techniques have triggered a rapid development of Brain Science in recent years. One of these new techniques is Diffusion Tensor Imaging, which is used for mapping white matter tractography (brain structure) in the brain. This study is the first time that statisticians have introduced a spatial model, a model considering the spatial correlation of variables, for modeling DTI data, which provides an appropriate statistical modeling and increases power for detecting group differences. We applied our model on the DTI data for studying white matter alteration in cocaine use disorder subjects. The result demonstrates a significant contribution to brain science in understanding brain structure alteration among cocaine users.

Statistical SIGNIFICANCE

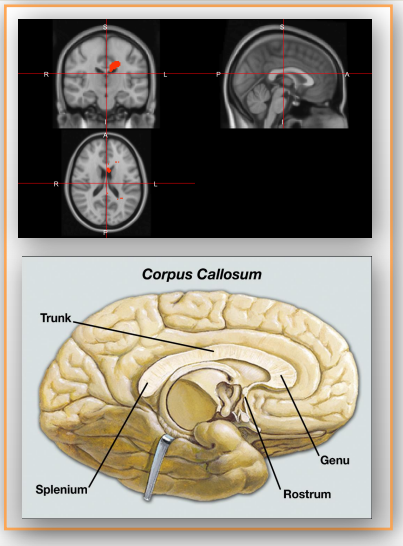
STUDY OF WHITE MATTER ALTERATION IN COCAINE USE DISORDER SUBJECTS

In 2017, *Institute for Drug and Alcohol Studies of Virgina Commonwealth University* published a study of white matter alteration in cocaine use disorder subjects. The study recruited 11 subjects with cocaine use disorder and 11 healthy subjects for analyzing their white matter alteration via DTI.

The researchers used a fractional anisotropy (a scalar for quantifying the micro-structure of brain white matter) based method for finding brain regions that showed group differences.

The result of their research did not find white matter alteration between cocaine use disorders and healthy controls, especially in corpus callosum, an important region in the brain which connects the left and right cerebral hemispheres and facilitates interhemispheric communication.

This finding is inconsistent with previous studies of other researchers. Also, the researchers admitted that the small sample size made their results be treated as preliminary, as stated in the publication on *Drug and Alcohol Dependence*.



IMPROVEMENTS BROUGHT FROM NOVEL SPATIAL MODEL

Statisticians are working to develop appropriate statistical models that respect the DTI data and are proposing a powerful testing methodology based on the model. We proposed a "Spatial Wishart Processes" for DTI and the details of this model have been illustrated on the poster. Briefly speaking, we define a novel spatial model repspecting the correlation among matrices for modeling DTI.

From the result fitted by the model we proposed, our model is capable of successfully detecting a region of difference between the 11 cocaine use disorders and the 11 healthy controls. On the figures on the left panel, we detect a spatially continuous region on left splenium shown group difference. This is consistent with previous findings both on animal and human studies.

The improvement is significant because the powerful detection is based on their small sample size and the region is spatially continuous, providing reliable clinical evidence for further diagnostics.

BRAIN SCIENCE AND STATISTICS:

The human brain is the most complex piece of organized matter in the known universe. This piece is one of the research interests of scientists from medical scientists, physiologists, imaging scientists to statisticians . The transition comes along with the development of techniques applied, from anatomy, chemistry to modern medical imaging techniques such as magnetic resonance imaging (MRI) producing complicated data in scale, dimension and etc.

Standing on the contribution made by pioneers of brain scientists with concentrations on anatomy, physiology, imaging science and computations, Statisticians now play a significant role in brain science at the best time for data analysis and computational improvement.

Well-established brain imaging techniques facilitate brain scientists to have imaging data for measuring the human brain in functional activities and micro-structures. However the analysis comes to a halt when encountered with large scale complex data. Other than preliminary data exploration, modern statistical models with feasible inference and fast computation provides a more robust statistical prediction and accurate statistical description for revealing the information in those datasets.

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