Developing an fMRI test battery for preoperative planning of brain surgeries

Tyrone Ly\textsuperscript{1,2}, Mariana Mascarenhas\textsuperscript{1,3}, John Shahi\textsuperscript{1,2}, Solana Redway-Ziola\textsuperscript{1,4}, and Todd Woodward\textsuperscript{1,2}

\textsuperscript{1}BC Mental Health and Substance Use Services Research Institute, Vancouver, BC, Canada; \textsuperscript{2}Department of Psychiatry, University of British Columbia, Vancouver, BC, Canada; \textsuperscript{3}Department of Psychology, University of British Columbia, Vancouver, BC, Canada; \textsuperscript{4}Department of Psychology, University of Waterloo, Waterloo, ON, Canada

Introduction

In pre-surgical planning for treating certain neurological conditions such as brain tumour and epilepsy, functional magnetic resonance imaging (fMRI) has excellent potential to be chosen for identifying essential brain regions which must be preserved during surgery [1, 2]. Besides having a high spatial resolution, fMRI can also map the whole brain with probability values for a range of possible impairments in neurological functions that may result from each surgical plan option being considered [3]. However, there are currently no clinical standards for such powerful application of fMRI [4]. The goal of our study is to develop a battery of fMRI tests which can be incorporated into a universal pre-surgical planning procedure. This will help patients avoid unnecessary cognitive and behavioral impairments due to surgery-associated injuries.

Hypothesis

We hypothesize that this fMRI test battery will elicit activity of the 11 functional brain networks established in previous research [5-11]:

1. Multiple Demand
2. Initiation
3. Focus on Visual Features
4. Auditory Perception
5. Auditory Attention for Response
6. Maintaining Internal Attention
7. Re-evaluation
8. Language
9. Response
10. Default Mode A
11. Default Mode B

Methods

- fMRI data of 1158 healthy adults aged 18-87 performing a variety of fMRI tests have been obtained from open science sources and preprocessed to optimize signal-to-noise ratio.
- Constrained Principal Component Analysis for fMRI (fMRI-CPCA) is then applied to characterize functional brain networks which emerged during test performance and their activity profiles [12].

Future Directions

These tests produced brain networks which matched strongly with the standard templates of previously discovered networks. Their results will be entered into a merge analysis to demonstrate the feasibility of uniting them into a final fMRI test battery for pre-surgical planning. Meaningful correlations will be established between patterns of network activity and individual differences in demographics, personality, behavior, cognitive performance, and symptoms of mental illnesses.

Preliminary Results

**Synonyms/Antonyms Task**
Choose word most similar/dissimilar to probe word [13].

**Picture Naming Task**
Vocally identify image [13].

**Dig. Symbol Task**
Number-symbol pair present in code key [13].

**Letter Comparison Task**
Letter strings same or different? [13].

**Pattern Comparison Task**
Figures same or different? [13].

References


Acknowledgements

This research was supported by the Canadian Institute of Health Research via the Canada Graduate Scholarship – Master’s Program. The fMRI data used in this research project was shared from the Reference Ability Neural Network (RANN) study and the Cambridge Centre for Ageing and Neuroscience (Cam-CAN) study. TL would like to thank all study team members and volunteers of the CNOS Lab for their amazing supports and contributions in this project.