Module Introduction

PCHN62121
Image Analysis

Dr Martyn McFarquhar

Module Overview

- Image Analysis is one of the **most important** modules that you will need going forward on this course

- So far, you have learned about the techniques and methods we can use to **create** and **manipulate** images

- Image Analysis takes this one step further to show you how we can **answer scientific questions** using images

- Image Analysis is about taking **raw fMRI** and **raw M/EEG** data and turning them into results that allow us to **reach conclusions** about our experiment
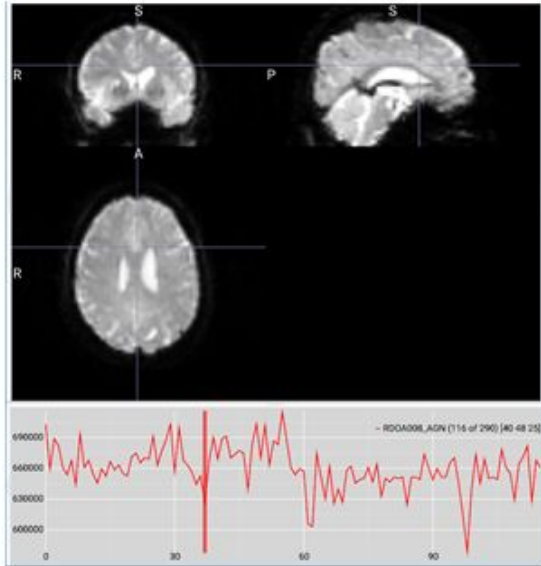
Raw Data → Image Analysis → Results
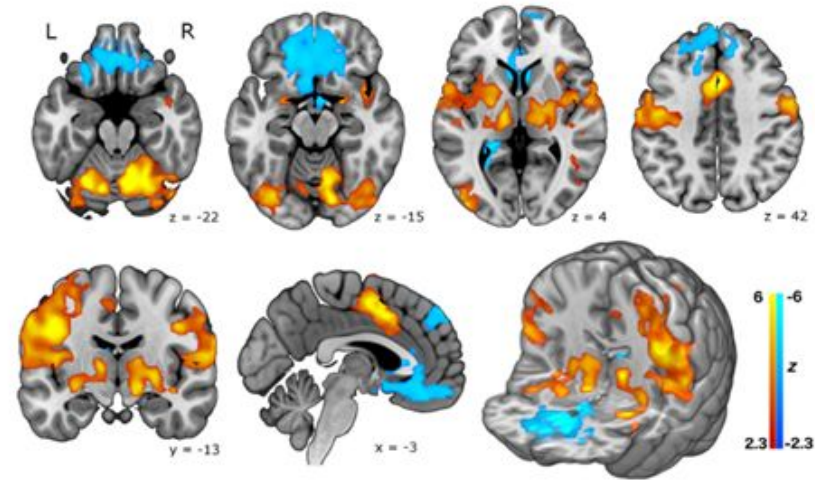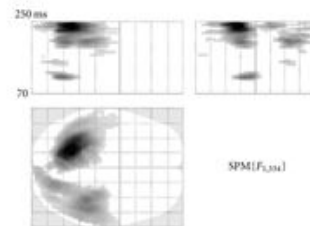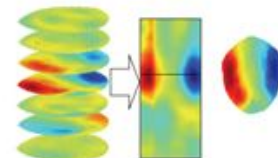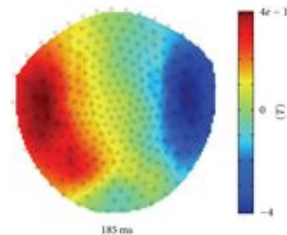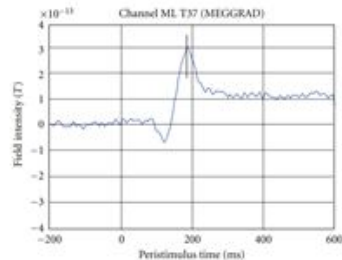
- The process of analysing fMRI and M/EEG data is a combination of **image processing** and **statistical modelling**

- We will be learning the **theory** behind all the analysis steps as well as how to **implement them** using SPM

- By the end of the module you should know how to **fully analyse** both an **fMRI** and **M/EEG** dataset

- This is **essential** for your **dissertations** and will help you to understand the application of fMRI and M/EEG in Semester 2

- Image Analysis is a **technical subject** that may contain **concepts** and **ideas** that are new and unfamiliar to you

- During your time on this module, you will need to try your best to **understand** and **embrace** these ideas

- We do not want you to complete this module viewing SPM as a **black box**

- You may not understand everything while this module is running - you may need to come back **several times** over the rest of the course in order to fully understand everything we will be covering

Module Timetable

Date	Time	Synchronous Session	Asynchronous Lesson 1	Asynchronous Lesson 2
14/11/2023	13:00-15:00	Module Introduction Statistics Review	fMRI: Image Preprocessing	fMRI: Statistical Modelling of a Single-subject
21/11/2023	13:00-15:00	fMRI Preprocessing in SPM fMRI 1st-level Models in SPM	fMRI: Statistical Inference on Images	fMRI: Statistical Modelling of Groups
28/11/2023	13:00-15:00	fMRI Inference in SPM fMRI Group Models in SPM	M/EEG: Time-domain Analysis	M/EEG: Artefact Detection, Rejection and Projection
05/12/2023	13:00-15:00	M/EEG Time-domain in SPM M/EEG Artefacts in SPM	M/EEG: Frequency-domain Analysis	M/EEG: Statistical Analysis
12/12/2023	13:00-15:00	M/EEG Frequency-domain in SPM M/EEG Stats in SPM	fMRI: Visualising, Localising and Reporting Results	M/EEG: Visualising and Reporting Results
16/01/2024	13:00-15:00	fMRI Advanced Visualisations M/EEG Visualisations	Transparency and Reproducibility in Neuroimaging	

Lab Report
- Analyse an fMRI dataset and write the results up as a data analysis report
- Worth 50% of the module grade

Exam
- Short answer questions
- fMRI and M/EEG - heavier focus on the M/EEG content
- Worth 50% of the module grade

- The Lab Report assessment is based on analysing an fMRI data set and writing it up as a **data analysis report**

- The purpose is to demonstrate your **practical skills** using SPM as well as your **understanding** of the **analysis steps** and **interpretation** of results

- A **data analysis** report is similar to an academic journal article, but serves a slightly different purpose as this type of writing is designed to share the results of a data analysis **with other colleagues**

- For instance, imagine you were working as an **assistant** on a research project and the researcher in charge of the project has asked you to **analyse the data set** and **produce a report**

- The purpose of the report would be to provide them with a **summary** of what you did to process the data and what you found - it is meant to start an **organised conversation** between you and your collaborators

- Released: **Tuesday 14th November 2023**
- Deadline: **9th January 2024**

- Because the Lab Report assessment is very practical, the exam aims to test your **theoretical** knowledge of both **fMRI** and **M/EEG** data analysis

- The format will be very similar to the NT and FN exams

- Because the Lab Report is exclusively fMRI, the exam will be **more heavily weighted towards the M/EEG content**

- Date is currently set for **Tuesday 23rd January 2024** (this needs to be confirmed by the assessments team)
  - **Two weeks** after the deadline for the Lab Report

- **Bare minimum** is that you know how to click the buttons in SPM to analyse fMRI and M/EEG data - make sure you do the **practical** elements

- We want you to do better and understand **what** SPM is doing and **why**

- The assessments lean on different elements of this:
  - Lab Report is largely about **what** to do and how to **interpret** results
  - The exam will test more theoretical knowledge about **why** we perform certain analysis steps and **how** they work

- We also want you to understand the **limitations** of the analysis approaches - SPM is far from perfect

How to approach this module

- Some of you will find the content in this module a **challenge** - unfortunately, there is no way around this as the methods **are what they are**

- As a general plan, read through each lesson from **start** to **finish** - If you get to something you do not understand, **push through it** and **get to the end** so you can see the **big picture**

- If there is a practical demonstration, make sure you **have a go at doing it** and try to **connect** the **theoretical content** to what is being shown in the video

- Once you have done that, **go over the content again**. This time **focus** on the parts you **do not understand** and work on understanding them now you can see the **big picture** and the **practical application**

How to approach this module

- If you feel like you are **struggling** with a concept - that is the first step to understanding it. You need to just **keep wrestling** with it **until it clicks**

- While you are trying to get to grips with it, remember all the **resources** at your disposal to help.
  - You can discuss with your **fellow students**
  - Talk to the teaching team **directly** during the **synchronous sessions**
  - Use the **discussion boards** on **Blackboard** (make sure you *subscribe*)

- You will not be the first or last person to ask that question - you will also be helping your fellow students by getting an answer on something they may be struggling with - why the **discussion boards** are so valuable

Additional resources

- The **SoftChalk** content is **self-contained** and will indicate where you could do additional reading to enhance your understanding

- It can be helpful to have some specific extra resources available that cover most of the content from this module.
  - **The Handbook of Functional MRI Data Analysis** (Poldrack, Mumford & Nichols, 2011)
  - **An Introduction to the Event-related Potential Technique** (Luck, 2005)

- You may also come across slides and videos from the **official SPM course** that runs every year in London, as well as the official SPM textbook. These should be considered **advanced resources**.

- You may also come across the videos and online textbook of **Andrew Jahn** - generally, these are quite good resources, but can be a bit limited in detail and will likely cover much the same ground as the SoftChalk content