UNIVERSITY OF SUSSEX
SCHOOL OF PSYCHOLOGY

Functional Magnetic Resonance Imaging
Code 954C8
15 Credits
Spring Term 2017

Course Convenor: Dr Chris Bird

NOTE: Most of the questions you need answers to about this course are in this document. Please read it fully and carefully before your first seminar.

NOTE: This document concerns the structure and content of the course. If you have questions about procedures, please consult the Department of Psychology Administration Office in Pev1 1B2 or via psychology@sussex.ac.uk.

COURSE INFORMATION & REQUIREMENTS

Course Structure, Aims and Objectives

This course provides an advanced level of theoretical and practical knowledge in the technique of functional magnetic resonance imaging (fMRI). Topics covered include the physics of MRI; the physiological basis of MRI and fMRI; different study designs; stages of pre-processing and analysis of data; and interpretation of results. It is expected that students will be able to make a contribution to a real, ongoing fMRI study in terms of observing and/or participating in its execution and contributing to the analysis of the study. Students will gain hands-on experience of Statistical Parametric Mapping (SPM) software for analysing fMRI data that is invaluable for future research in this area.

Course Learning Outcomes.

By the end of the course, a successful student should be able to:	
1	demonstrate an understanding of the usefulness and limitations of fMRI
2	evaluate current research in the field in terms of their methodological adequacy and soundness of their interpretations
3	design an fMRI experiment
4	perform the main stages of pre-processing and statistical analysis of fMRI data

Pre-Requisites

None;

Course Contact Information

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Teaching and Learning

- **Lectures**

There will be 12 teaching sessions, each around 2 hours long (with a short break in the middle) on **Fridays**. There will be 7 lectures or seminars which will cover most of the theoretical content of the module (weeks 1-7; 14:00-16:00 in Pevensey 1 1B2). In weeks 8, 9 and 10 there will be practical classes where you will analyse a set of fMRI data (14:00-16:00 in Pevensey 1 1B4). These practical sessions will teach you more about fMRI methods as well as give you skills in hands-on analysis of fMRI data. After the Easter break there will be a final practical class (week 11) and the final session in week 12 will be a review of what you have learnt. **Please check Sussex Direct for detailed timetabling information and in case of any alternations to these times / locations**.

To avoid disruption to the majority, please try to arrive at least 5 minutes before the start time of the lecture. There will often be a chance for discussion during the lectures which will be facilitated by reading of key articles.

Learning at university is not and should not be a competitive exercise. Your learning will benefit to the extent that you share your insights and problems with others and support and encourage them to do the same with you.

It is **CRUCIAL** for you to understand that formal examination on this course will be based on material covered in the lectures, seminars **and** your "essential reading" for each week. It is also important for you to understand that lectures will **NOT** attempt to 'cover' all such material (and nor will seminars). That is, lectures and seminars are not intended to provide an alternative to you learning the material in your essential reading. Any attempt to rely solely on learning material presented in lectures and seminars will severely restrict your ability to do well during formal assessment of this course. Lectures (and seminars) are intended to fulfil functions other than repeating or précising material covered in the essential readings.

Lectures on this course are intended to perform several functions. First, they will provide another 'channel' of communication, allowing you to hear as well as read about (selected) material relevant to the course.

A second function of the lectures is to allow you to review material you have learned so far. If you have already done the essential reading associated with the lecture, ask yourself how well the lecturer has covered that material.

A third function of the lectures is to illustrate the nature of a critical approach to students. The lecturer will sometimes simply explain material. At other times, however, the lecturer will criticise the material in some way. University education is about learning how to constructively criticise as well as simply absorb information. Evaluate your lecturer's criticisms. Are they simply personal prejudices (e.g., "I don't like this") and, if so, are they presented as such? Or are reasons given for criticisms made (e.g., "I don't like this because…)?

You should note that all the study skills advice in existence suggests that straightforward 'absorption' of material (i.e., reading, listening, rote-learning and memorising) should take up about 20% of learning time. The other 80% should come from 'interrogating' that information (e.g., looking for links, attempting to summarise and synthesise, looking for strengths and weaknesses and possible improvements, applying to different areas, etc.).

- **Independent study** The difference between studying at university and study you may have done previously is that at university the emphasis is on you finding out things for yourself. Just as fitness clubs attempt to foster and facilitate (but cannot impose) fitness, universities attempt to foster and facilitate (but cannot impose) academic excellence. Results will (and can only) come as a direct result of *you* making appropriate use of the facilities at your disposal. Lectures, seminars and the like are there to support and guide your independent learning – they are not there to "pass information from tutors' heads to students' notebooks without passing through the brains of either." Not everything you will need or want to know will be covered in the lectures, seminars or essential readings. You need to become familiar with the material you are guided towards, but you also need to learn to 'manipulate' that material: apply it to new domains, compare and contrast across topics, synthesise it, evaluate it, consider its relevance to issues of interest to you, supplement it, etc. This can only be done by being interested and working hard because you want to. As we shall learn below, an exclusive focus on passing exams will *undermine* that motivation and will make you perform less well as a result. Thus, study because you want to learn and stop when you have answers to your own satisfaction for the questions you care about. Finally, note that independent study is study you engage in outside of formal contact hours with faculty – it does not have to be solitary (see under 'seminars' above).

- **Student feedback sessions** Chris Bird's student feedback sessions are from 12:00-13:00 on Tuesday and 11:00-12:00 on Thursday (see www.sussex.ac.uk/profiles/280383). Feel free to come along to discuss or ask about anything course-related.

- **Study Direct** You are encouraged to access course materials and use the course forum in Study Direct. This is the best way to share ideas amongst your fellow students and ask questions about the course.

Books and Reading

- The first half of the course is closely modelled on the following text.

Huettel, S.A., Song, A.W., McCarthy, G. (2009): *Functional magnetic resonance imaging (2nd Edition)*. Sinauer Associates.

The third edition is just as useful but the library does not have copies. Selected portions of this book will be available to you via Sussex Direct in advance of each session. If you have a serious interest in further pursuing fMRI, then you may wish to consider buying the book (the third edition of it). Additional reading will also be available via Study Direct.

Assessment

Formal assessment for *Functional Magnetic Resonance Imaging* comprises a *research proposal* (100%), consisting of a 3000 word project report. There is no unseen exam.

Assessments deadlines and methods of submission can be found on your assessment timetable via Sussex Direct.

Information on the following can be found at the link below:

- Submitting your work
- Missing a deadline
- Late penalties
- Exceptional circumstances
- Exams
- Help with managing your studies and competing your work
- Assessment Criteria

http://www.sussex.ac.uk/psychology/internal/students/examinationsandassessment

In line with University regulations, every effort will be made to ensure that one marked copy of coursework is returned with feedback within 15 working days of the relevant submission deadline.

Attendance, Absence and Engagement

You are expected to be 'in attendance' at the University for the full duration of the published term dates for your course of study. That means you should be regularly attending lectures, seminars, labs etc. and committing time to your studies to be in a position to comply with academic and administrative expectations.

The university has an 80% attendance policy in place, so it's really important that you let us know if you are ill or cannot attend classes so that we can register this as a notified absence.

If you are unable to attend your seminars or workshops, you need to send an email to psychologyabsence@sussex.ac.uk setting out the following information:

- Seminar(s) / workshop(s) that you will be absent from (list all of them)
- Tutor name
- Brief reason for absence

Please see the following link for further information:
http://www.sussex.ac.uk/psychology/internal/students/attendance

Student Evaluation

The module convenor will create opportunities for you to provide feedback (online, on paper, and/or in person) on your experience of the module during the term. In addition, you will be asked to complete an online course evaluation questionnaire at the end of every term, and this will provide an opportunity for you to comment on each module as well as the course overall.

Lecture Overview

Lecture 1 – Week 1

The physics of magnetic resonance imaging

Guest lecture delivered by Dr Nick Dowell from the Clinical Imaging Sciences Centre on campus. Nick will introduce to you the physics principles that underpin MRI scanning and explain how the MRI scanner is able to take pictures of your brain. The lecture will cover different types of MRI scans and how they are sensitive to different tissues in the brain – and ultimately how we are able to use this to look at brain "activity".

Key Reading
Huettel, S.A., Song, A.W., McCarthy, G. (2009): *Functional magnetic resonance imaging (2nd Ed)*. Sinauer Associates. Chapter 3 – read the "Conceptual Path" pages 57-67. Chapter 4 – read the "Conceptual Path" pages 89-97.

Additional Reading
Huettel, S.A., Song, A.W., McCarthy, G. (2009): *Functional magnetic resonance imaging (2nd Ed)*. Sinauer Associates. Chapter 3 & 4 – if you have a good grasp of maths/physics, then feel free to read the "Quantitative Path" sections of these chapters.

Huettel, S.A., Song, A.W., McCarthy, G. (2009): *Functional magnetic resonance imaging (2nd Ed)*. Sinauer Associates. Chapter 1 – read this for a quick review of the history of MRI

Lecture 2 – Week 2

Using MRI to measure blood flow and the relationship between this and neuronal activity

Guest lecture delivered by Dr Catherine Hall from the School of Psychology. Cognitive operations are underpinned by the firing of neurons. These neurons require energy to function, which in turn requires oxygen to be delivered by local changes to the blood supply supplying a brain region. It is these changes in oxygenated and de-oxygenated blood flow that are measured using functional MRI. In this session, Catherine will review the complex relationship between neuronal activity and blood flow. We will then discuss the implications of this for using fMRI to study the neural underpinnings of cognitive functions.

Key Reading
Huettel, S.A., Song, A.W., McCarthy, G. (2009): *Functional magnetic resonance imaging (2nd Ed)*. Sinauer Associates. Chapter 6 – read for an overview, but do not worry about understanding all of the details and you do not need to read the "Primer on Neuroanatomy" (Box 6.1). Chapter 7 – again, read for an overview, but do not worry about understanding all of the details.

Lecture 3 – Week 3

Experimental design (part 1)

In this first of two lectures will outline some of the principles of designing a good fMRI study. We shall evaluate blocked versus event-related designs. In the second part of the session we will discuss two influential papers that illustrate blocked and event-related designs.

Key Reading – check for updates to this list on Study Direct
Huettel, S.A., Song, A.W., McCarthy, G. (2009): *Functional magnetic resonance imaging (2nd Ed)*. Sinauer Associates. Chapter 9

Willed action and the prefrontal cortex in man: a study with PET. Frith CD, Friston K, Liddle PF, Frackowiak RS. (1991) *Proc Biol Sci.* **244**(1311):241-6

Recollection and familiarity in recognition memory: an event-related functional magnetic resonance imaging study. Henson RN, Rugg MD, Shallice T, Josephs O, Dolan RJ. (1999) *J Neurosci.* **19**(10):3962-72

Lecture 4 – Week 4

Experimental design (part 2)

This lecture is an extension of the previous lecture. We will evaluate more complex experimental designs such as parametric designs and fMRI adaptation. We will discuss two papers that have used these designs. In the second session, you will be asked to design your own fMRI experiment in small groups. You will also be told about your assessment essay for this module.

Key Reading – check for updates to this list on Study Direct
Establishing the boundaries: the hippocampal contribution to imagining scenes. Bird CM, Capponi C, King JA, Doeller CF, Burgess N. (2010) *J Neurosci.* **30**(35):11688-95

fMRI-adaptation reveals dissociable neural representations of identity and expression in face perception. Winston JS, Henson RN, Fine-Goulden MR, Dolan RJ. (2004) *J Neurophysiol.* **92**(3):1830-9

Lecture 5 – Week 5

Multivariate pattern analysis

This will be a guest lecture delivered by Dr James Keidel. James will talk to you about novel ways of analysing fMRI data that do not rely on finding average increases or decreases in BOLD activity within regions. Instead, these analysis investigate the pattern of BOLD changes within specific regions.

Key Reading – check for updates to this list on Study Direct
Norman KA, Polyn SM, Detre GJ, Haxby JV (2006). Beyond mind-reading: multi-voxel pattern analysis of fMRI data. *Trends in cognitive sciences*, *10*, 424-430

Bird CM, Keidel JL, Ing LP, Horner AJ, Burgess N. (2015). Consolidation of Complex Events via Reinstatement in Posterior Cingulate Cortex. *The Journal of Neuroscience*, *35*, 14426-14434

Lecture 6 – Week 6

Structural and functional connectivity and voxel-based morphometry

This will be a guest lecture delivered by Dr James Keidel. James will talk about how MRI can investigate not just regions of the brain that are involved in different cognitive processes but also how these regions combine to act as a functional network. James will discuss the methods for determining whether activity in one brain region causes activity changes in another region.

Key Reading – check for updates to this list on Study Direct
Stephan KE, *et al*. (2010). Ten simple rules for dynamic causal modeling. *Neuroimage*, *49,* 3099-3109

Lecture 7 – Week 7

This session will comprise a series of presentations from the students

Practical 1 – Week 8

Preprocessing data (part 1)

The practical classes will be led by Dr James Keidel from the School of Psychology. In the first part of this session James will introduce some of the steps of analysis that have to be taken before fMRI data can be analysed. This will focus on motion correction and slice time correction. In the second part of the session you will have an opportunity to carry out these preprocessing steps on a individual participant's data.

Key Reading
Huettel, S.A., Song, A.W., McCarthy, G. (2009): *Functional magnetic resonance imaging (2nd Ed)*. Sinauer Associates. Chapter 8 – section on preprocessing (pages 267-291; focus on pages 269-277)

Practical 2 – Week 9

Preprocessing data (part 2)

This session will be a continuation of Practical 1 where you will focus on spatial normalisation and smoothing.

Key Reading
Huettel, S.A., Song, A.W., McCarthy, G. (2009): *Functional magnetic resonance imaging (2nd Ed)*. Sinauer Associates. Chapter 8 – section on preprocessing (pages 267-291; focus on pages 280-289)

Practical 3 – Week 10

Statistical analyses (1st level analysis)

The first part of this session will comprise a brief lecture detailing the background to the experiment that we are analyzing. We will then outline the processing steps needed to look at task related BOLD response in a single participant (1st level analysis). In the second part of the session, you will carry out these analyses.

Key Reading – check for updates to this list on Study Direct
Huettel, S.A., Song, A.W., McCarthy, G. (2009): *Functional magnetic resonance imaging (2nd Ed)*. Sinauer Associates. Chapter 10

Practical 4 – Week 11
Statistical analyses (2nd level analysis) In this final practical session, we will continue to analyze the experimental data at the individual level (1st level analysis) and also at the group level (2nd level analysis).

Lecture 12 – Week 12
Revision workshop The aim of this session is simply to review what has been covered in the course and to discuss any outstanding topics. In particular, we might focus on how MRI studies are reported in the media and what the ethical implications for MRI research might be.