Part I PBS Tripos
PBS 2: Psychological Enquiry and Methods
2016/2017 Paper Guide

Course organiser: Professor Jeff Dalley
(jwd20@cam.ac.uk)

Brief description of the paper and a guide for supervisions

This course covers the foundations of psychological study, including the mathematical and biological knowledge and skills required to engage with the research literature. The material on this course provides a foundation for all later study of psychology, providing students with the intellectual tools required to evaluate psychological material in later years.

In the first (Michaelmas) Term, morning lectures will teach the basics of human brain anatomy, synaptic transmission and psychopharmacology, genetics, brain imaging (MRI, fMRI, PET), electrophysiology, interventions commonly used in humans to infer causal brain mechanisms in cognitive processing, and the fundamentals of neuropsychology. Lectures will be interspersed with interactive practical classes to consolidate the lecture material.

In the second (Lent) Term, morning lectures will focus on experimental design and the communication and interpretation of research, with an introduction to descriptive and inferential statistics. Practical sessions (and exercise classes) will consolidate this material and focus on research design and interpretation, statistical analysis, and issues arising from both quantitative and non-quantitative research.

It is recommended that students are supervised once a week during full Term with an estimated workload expectation of approximately 12-14 hours a week in term time. A list of qualified supervisors will be provided during the introductory Lecture on October 14th. A guide for supervisors can be found at the following link:

http://www.pbs.tripos.cam.ac.uk/Documents/supervisorguide

As the PBS2 paper consists of a number of components students may well require more than one supervisor to cover the breadth of the course. For example, a particular supervisor may be competent in supervising material from the Michaelmas term (biological psychology) but not material from the Lent term (statistics and experimental design), and vice versa.

Mode of Assessment

Please refer to the PBS2 Moodle site for a sample paper. The examination will consist of a three-hour written paper, involving four sections: Section A - short answer questions on material taught throughout the course but mainly material taught during Michaelmas term; Section B – short answer questions assessing the ability to apply taught material on mathematical and statistical problems; Section C – one 30 minute essay on experimental design; Section D – one 30 minute question on the application of knowledge from across the course to critically evaluate and discuss psychological research.

You are required to answer all questions in Sections A and B, one question from Section C, and one question from section D. Two-thirds of the marks are available in Section A and B; the remaining one third of marks are available in Section C and D. Candidates are advised to divide their time accordingly. Only University-approved calculators are permitted in this examination. It is extremely important that you familiarise yourself with your calculator well before the examination and refer to extra information on this topic on the Moodle site.
Specific information

Lectures (Michaelmas term)

1. Introduction to PBS2 (Wed 12th Oct) – Dr Sharon Morein-Zamir

This lecture provides an overview of the course, principles of the scientific method, and how to distinguish science from pseudoscience. We will discuss the importance of operational definitions in psychological research, and examples of reliability and validity and their importance.

Recommended reading


Questions for supervisions

- Give an example of an alternative medicine and argue whether or not it is pseudoscience.
- Select a set of studies supporting a psychological theory and discuss which operational definitions were used and why. Can you identify any potential problems with this approach?
- Which is more important – reliability or validity?

2. Introduction to the Brain (Fri 14th Oct) – Professor Jeff Dalley

The basic anatomical organisation of the human brain will be introduced together with (i) its main functional sub-divisions and (ii) the neural representation of the primary sensory systems and how these integrate with 'motor' regions of the brain to enable goal-directed behaviour. The neural bases of learning, memory, motivation, and attention will also be discussed.

Recommended reading


Questions for supervisions

- Discuss the functional significance of the frontal (temporal, parietal, occipital) lobes
- Compare the functional organisation of the sensory and motor regions of the brain
- Discuss the concept of the limbic system
- To what extent can memory be localised to different brain regions?
- What general functions are mediated by the prefrontal cortex? How might these be expressed in humans?
3. **Molecules and Synapses** (Wed 19th Oct) – Professor Jeff Dalley

The concept of synaptic transmission will be introduced from processes controlling the excitability of neurons to the propagation of electrical signals and release of neuroactive substances from nerve terminals in the brain. The lecture will focus on the most widely studied neurotransmitters and neuromodulators in the brain – glutamate, GABA, dopamine, serotonin, noradrenaline and acetylcholine.

**Recommended reading**


**Questions for supervisions**

- Separating neurotransmission and neuromodulation: does it really matter?
- Discuss the advantages and limitations of chemical neurotransmission
- Compare neurotransmission at dopaminergic and cholinergic synapses
- What information is conveyed by action potentials?

4. **Brain Imaging 1** (Fri 21st Oct) – Professor Zoe Kourtzi

What is the neural basis of behaviour? We can now answer this question that has puzzled philosophers and psychologists for centuries using non-invasive imaging methods to map the human brain and its functions. But have we moved beyond phrenology? Learn about advanced brain imaging methods their advantages and limitations.

**Recommended reading**


**Questions for supervisions**

- Is brain imaging modern phrenology?
- What does fMRI measure and what is it good for? Is fMRI an appropriate method for studying the neural basis of cognitive functions and why?
- What are the spatial and temporal limitations of fMRI?
- Is fMRI a direct measure of neural activity? Which methods can be used in combination to study the causal link between neural activity and behaviour?
5. Brain Imaging 2 (Wed 26th Oct) – Professor Zoe Kourtzi

How do you design a successful brain imaging experiment? How do you analyse brain imaging data and link it to behavioural measures? Learn about the classics and recent advances in fMRI design and analysis methods, how to control for possible confounds and combine imaging techniques to overcome the limitations of fMRI.

Recommended reading

- SA Huettel, AW Song, G McCarthy, Functional magnetic resonance imaging, Sinauer Associates.

Questions for supervisions

- Describe the main design protocols used for fMRI experiments? What are their advantages and limitations?
- What are the main steps of analysis for anatomical and functional MRI data? What are the possible sources of noise in these analyses (artefacts) and how can they be corrected for?
- You are interested in studying interactions between cortical areas. Which methods would you use and why?
- Discuss the advantages and disadvantages of fMRI compared to brain lesion studies.
- Is brain imaging of neuropsychological patients worth pursuing and why?

6. Human Electrophysiology 1 (Fri 28th Oct) – Dr Denes Szucs

This lecture provides an introduction to the basic theory and practice of human, non-invasive electro-encephalography (EEG) research. We will review how EEG signals are generated in the brain, their information content, and how they can be detected over the human scalp. We will review the steps of simple EEG analysis and how event-related brain potentials (ERP) are computed. We will also discuss opportunities and pitfalls in interpreting ERPs.

Recommended reading

- Further guideline papers for psycho-physiological research can be found at: http://sprweb.org/journal/index.cfm.
Questions for supervisions

- Compare the strengths and weaknesses of EEG and fMRI
- Explain the rationale for basic EEG processing steps
- What can and cannot be determined from EEG signals?
- Illustrate the major pitfalls in ERP analysis

7. Human Electrophysiology 2 (Wed 2nd Nov) – Dr Denes Szucs

This lecture will provide insight into more advanced aspects of human EEG research such as time-frequency analysis, source localization, single trial analysis and integration with other imaging methodologies. In addition, we review the most frequently encountered ERP components/waves.

Recommended reading

- You can download a free Matlab based EEG analysis programme (EEGLab) here: [http://sccn.ucsd.edu/eeglab/](http://sccn.ucsd.edu/eeglab/). Here you can also find sample data to practice with.
- Further reference papers can be found here: [http://sccn.ucsd.edu/eeglab/refs.html](http://sccn.ucsd.edu/eeglab/refs.html).

Questions for supervisions

- Explain the differences and similarities between ERPs, ERSP and ITC
- How are the P300 and N400 ERP waves related?
- What major psychological factors affect the behaviour of the P300 wave?
- Explain how the Lateralized Readiness Potential can measure movement planning in the motor cortex.

8. Genes/individual differences 1 (Fri 4th Nov) – Professor John Mollon

Classical and molecular genetics; the genetic code; polymorphisms; the role of non-coding DNA in determining behavioural variation; evidence from animals.

Recommended reading


Questions for supervisions

- What are genetic polymorphisms and how might they be maintained in a population?
- To what extent is variation in behaviour determined by non-coding DNA?

9. Genes/individual differences 2 (Wed 9th Nov) – Professor John Mollon

The definition of heritability; classical twin studies; whole genome association studies; the heritability of intelligence and of personality. How are polymorphisms maintained in a population?

Recommended reading


Questions for supervisions

- What is the evidence that behavioural variations can be inherited?
- What is heritability? What difficulties arise in estimating heritability from twin studies?
- ‘The heritability of intelligence is high, but there is no single gene that accounts for as much as 1% of the variation in performance on IQ tests’. Discuss.

10 & 11. Brain Interventions 1 & 2 (Fri 11th Nov and Wed 16th Nov) – Dr Chiara Giuliano

How and why can we change brain function? In these lectures, you will learn about different methods that can be used to change the way the brain controls behaviour. In the first lecture, you will see how we can measure changes in brain function and how important it is to consider correlation and causation when studying such changes in the brain. I will introduce some of the methods used to change brain activity. The second lecture will focus on how drugs, both medical and recreational, can effect changes within the brain that subsequently change behaviour.

Recommended reading


General background reading

Questions for supervisions

- Should we attempt to make changes in brain function if we don’t understand the mechanisms underlying the changes?
- What are the advantages of Transcranial Magnetic Stimulation (TMS) over Deep Brain Stimulation (DBS) as techniques for changing brain function?
- Is it ethical to use potentially addictive drugs to treat disorders such as ADHD?

12 & 13. Neuropsychology 1 & 2 (Fri 18th and Wed 23rd Nov) - Dr Georgina Browne

How do we assess cognition in the clinical setting? Do low test scores always reflect neurological damage or might they indicate psychological factors such as anxiety and depression? How can we tell? Some patients would like us to believe they have cognitive difficulties where there are none - can we discern fact from fiction?

These lectures will provide an insight into neuropsychology in the clinical setting. You will learn about the kinds of patients we see, the different domains of cognition we are interested in, and the kinds of tests we use. We will think about how to interpret test results and the various factors that can influence test performance. You will discover how we piece together a neuropsychological profile and what this tells us about any underlying pathology.

Recommended reading


Questions for supervisions

- What are the main domains of cognition that are assessed during a neuropsychological assessment?
- What are the strengths and weaknesses of this approach?
- What factors influence test performance?
- How do psychological factors influence cognition?
Practical Sessions (Michaelmas Term)

1. Brain Anatomy (Mon 10th Oct; Mon 17th Oct) – Professor Jeff Dalley

Students will have the opportunity to handle human brains and identify key landmark features and brain regions. By comparing the brains of humans with other mammalian species students will appreciate why human brains are considered to be so special. The class will also involve self-directed learning and a 3D demonstration of the main functional sub-divisions of the human brain.

Recommended reading

- In addition to the references given above (Introductory Lecture on the Human Brain) students are advised to view the Open University DVD uploaded on Moodle (‘The Human Brain’). The first 30 minutes of this film provides an excellent overview in terms of the gross anatomy and functional systems of the human brain.

Questions for supervisions

- Comment on the structural similarities and differences between the brains of humans, non-human primates, and rodents
- To what extent do these similarities and differences explain the superiority of the human brain in terms of higher cognitive functions?

2. Brain imaging (Mon 24th Oct; Mon 31st Oct) – Dr Denes Szucs and Dr Kirstie Whitaker

This 1-hour fMRI session will enable students to appreciate how functional MRI can be applied to psychological research. Using a simulated dataset, particular tasks will be identified in terms of the global pattern of brain activation. During the 1-hour EEG practical class students will work in small, supervised groups to set up a ‘dummy’ EEG experiment from scratch. In addition, we will review simple EEG/ERP analysis steps.

Recommended reading


Questions for supervisions

- What does fMRI (EEG) measure?
- Outline examples of experimental designs in fMRI and EEG research. What challenges need to be overcome in designing such experiments?
- What regions of the brain are most likely to be activated while: (i) listening to music; (ii) writing a letter; (iii) jumping up and down; and (iv) revising for an exam?
3. Genes/individual differences (Mon 7th Nov; Mon 14th Nov) – Professor John Mollon

Within the human population, there are many genetic variations – 'polymorphisms' - that are not pathologies but reflect the normal variation of mankind. Examples are the ability to taste phenylthiocarbamide; the ability to roll the tongue; eye and hair colour; and variations in colour perception. How are such polymorphisms maintained in the population? One possibility is that the minority phenotype enjoys an advantage under particular environmental conditions. In this practical we test whether dichromatic colour vision gives an advantage in recognising camouflaged texture. Special glasses are available that allow the normal observer to experience the world approximately as it is experienced by dichromatic people.

Recommended reading


Questions for supervisions

- Briefly explain the nature of colour blindness and its genetic basis.
- How are polymorphisms maintained in a population?

4. Interventions (Mon 21st Nov; Mon 28th Nov) – Dr Dawn Eagle and Dr Chiara Giuliano

Students will have the opportunity to assess components of behaviour and cognition using questionnaire and computerised cognitive tests. We will also investigate the ethical and practical issues associated with procedures and drugs that change brain function.

For Questions for supervisions and Recommended reading, see Lectures 10 & 11.

5. Neuropsychology (Wed 23rd Nov; Wed 30th Nov) – Dr Georgina Browne

This session will take place in the Hershel Smith Building at Addenbrooke’s Hospital and will provide students with a practical demonstration of neuropsychological assessment in a clinical setting.

For Questions for supervisions and Recommended reading, see Lectures 12 & 13.
Lectures (Lent term)

1. Study design 1 (Wed 18th Jan) – Dr Sharon Morein-Zamir

We will consider the different types of studies and research designs a researcher can perform to address questions in psychology, and their respective strengths and weaknesses. When would you consider using one method of research, and not another? Does it make sense to combine them?

Recommended reading


Questions for supervisions

- What are the advantages of examining a psychological construct at different levels of analysis? What are the pitfalls?
- What is the value of case studies, use examples to justify your answer

2. Study design 2 (Fri 20th Jan) – Dr Sharon Morein-Zamir

What are the characteristics of ‘good’ research? What are different types of problems that researchers encounter when planning and conducting their studies? How can these be addressed or possibly avoided altogether? In this lecture we will revisit the concepts of reliability and validity, and consider confounds, artefacts and biases.

Recommended reading

  See also Henrich et al (2010) Most people are not WEIRD. Nature. Jul 1;466(7302):29
  http://neuroanthropology.net/2010/07/10/we-agree-its-weird-but-is-it-weird-enough/

Questions for supervisions

- What are the benefits and disadvantages of correlational studies?
- All studies are flawed. Discuss this statement.

3. Study design 3 (Wed 25th Jan) – Dr Sharon Morein-Zamir

From the past, to the future of collecting data about people, their inner lives and overt behaviours. How are surveys and questionnaires designed? How have smart phones, the
internet and big data influenced this and related research? What paradigm shifts may be around the corner?

**Recommended reading**

- Schueller et al (2013) Realizing the potential of behavioural intervention technologies. Perspectives on Psychological Science 22(6) 478-83

**Questions for supervisions**

- Discuss some of the ethical, legal and social implications arising from the use of big data in consumer psychology
- How might mental health research benefit from employing smart phone technology?
- Review an established questionnaire (e.g., Beck depression inventory or the Barratt impulsiveness scale), and consider its strengths and weaknesses.

**4. Communicating Research** (Fri 27th Jan) – Dr Sharon Morein-Zamir

What are the ways in which we can (mis)-communicate and (mis)-interpret research? How does current science dissemination and communication work (peer review, publication bias, ethics and the media)? Can we tell when data are being misinterpreted – either through sloppy thinking, sloppy statistics or deliberate fraud?

**Recommended reading**

- May 2012 of The Psychologist (publication of the British Psychological Society) vol 25 (5) 346-357
Questions for supervisions

- Is there a reproducibility crisis in psychology? What about related disciplines in biology?
- What are some of the difficulties in disseminating research findings?
- Find a newspaper article reporting the findings of a published study of interest to you. Discuss what outstanding issues are apparent in the coverage.

5. Qualitative Research 1 & 2 (Wed 1st Feb; Fri 3rd Feb) – Dr Juliet Foster

These two lectures will introduce some of the basics of qualitative analysis in psychological research, starting with a consideration of when qualitative analysis is appropriate and helpful in addressing research questions, before moving on to an introduction of some of the common methods that are used and the ways we approach qualitative analysis of data that results from these. Different forms of interviews will be considered as an example of a suitable research method. The important issues of how we evaluate qualitative analysis, and ensure that it is systematic and rigorous will also be addressed.

Recommended reading

- Willig, C. (2008). Introducing Qualitative Research in Psychology. Maidenhead: Open University Press. *Chapters 1 and 2 are especially useful, but other chapters are also very informative.*

Questions for supervisions

- There are numerous ways of analysing interview data. What are the similarities and differences between them?
- How do researchers ensure that qualitative analysis is rigorous?
- Critically evaluate the following paper: http://onlinelibrary.wiley.com/doi/10.1348/135910708X397160/pdf Consider, in particular
6. Statistics – 10 lectures; 5 exercise classes (Professor Jeff Dalley and Dr Rory Devine)

This series of lectures and exercise classes provides an introduction to statistical analysis and hypothesis testing. It begins by explaining the ways in which experimental data from samples can be explored, summarized, and visualized. We next describe common sample statistics in terms of central tendency and dispersion and the mathematics of probability and uncertainty as a prelude to hypothesis testing. Common parametric and non-parametric tests of significance will be discussed, including one- and two-sample t-tests, related and unrelated t-tests, Chi-squared analysis of categorical data, Mann-Whitney U-test, and the Wilcoxon signed ranked test. Methods to determine the relationship between variables will be introduced together with the assumptions and limitations of statistical hypothesis testing.

Recommended reading


Questions for supervisions

Supervisors should refer to previous examination papers for NST 1A Elementary Mathematics for Biologists (EMB) and PBS2 for the style of questions asked for this component of the course. Question and answer sheets are also provided for the 5 exercise classes.

Practical Sessions (Lent term)

1. Study design (Mon 23rd Jan; Mon 30th Jan) – Dr Sharon Morein-Zamir

This practical will cover: identifying independent and dependent variables with operational definitions; assessing studies for strengths and weaknesses; the development of research designs to address specific research questions.

Recommended reading

Questions for supervisions

- Suggest and design three different types of studies to investigate whether playing video games promotes violent behaviour.
- Discuss the study and its implications: http://www.nature.com/news/male-researchers-stress-out-rodents-1.15106

2. Communication of Research (Mon 6th Feb; Mon 13th Feb) – Dr Sharon Morein-Zamir

How can data be visually (mis)represented in graphs and figures, and what principles give rise to 'good' representations? We will also review methods of dissemination of scientific findings; and how to communicate research and related results. I will argue for why a critical and thoughtful attitude should be adopted when reading research papers, and what this means in practice.

Recommended reading


Questions for supervisions

- Write a newspaper article/blog post communicating a classic study in psychology to a lay audience. How did you adapt your writing?
- Discuss any recent controversy in psychology. How was it handled in different media (blogs, twitter, journal, newspaper etc.)?

3. Statistics 1 & 2 (Feb 20th, 27th; Mar 6th, 13th) – Professor Jeff Dalley and Dr Rory Devine

These two 1-hour sessions will involve computer-based exercises to summarise and analyse experimental data, the collective purpose of which is to consolidate the main learning objectives of the statistics lectures and to provide practical transferrable skills.