Department of Psychology

PBST Part IB PBS4: Cognitive Neuroscience and Experimental Psychology

Course Guide and Schedule of Lectures

Academic Year 2017 - 2018

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The information contained in this Course Guide is correct at the time of going to press (04/10/2017), but all matters covered are subject to change from time to time.
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Introduction

Welcome to the Department of Psychology!

This booklet contains useful information about the course, including a description of the lectures we offer together with the related practical classes, and details of the examination. The booklet also includes useful practical information about the Department.

The PBS 4 course is a subset of the NST IB Experimental Psychology course. It introduces Experimental Psychology with a lecture examining its historical roots, its philosophical basis and the methods used in modern Experimental Psychology and Cognitive Neuroscience. You will then learn about topics in perception and then gradually introduce you to the mental and brain processes involved in attention, learning and memory, language, action, awareness and thinking and reasoning.

Some of you may well be surprised by the 'openness' of the subject. There are plenty of 'hard facts' but there are also many theories, some of them, indeed, of a highly speculative nature. This is because, even after more than 100 years of its scientific study, many of the capacities of the mind and the brain remain mysterious.
Aims and Objectives of the Part IB Course

Aims

The academic aims of this course are as follows:

- To introduce students to a broad range of key topics in Experimental Psychology and Cognitive Neuroscience and to provide the opportunity to learn about experimental procedures through practical classes.
- To prepare students for the Part II course.

Learning Outcomes

At the end of the course students should possess:

- Elementary skills of arguing towards theoretical conclusions about mental and brain processes from empirical evidence, and a knowledge base from which to argue.
- An appreciation of the principles of behavioural experimentation, acquired through participation in practical classes (and from videos and films).
- The ability to write a report of a psychology experiment, developed through writing practical reports.
- An elementary understanding of experimental methodology, design, and statistical analysis.

Professional Outcomes

This course provides one step toward obtaining a professionally recognised qualification in Psychology. For full details of the study requirements for receiving a recognised qualification, see our web page at https://www.pbs.tripos.cam.ac.uk/prospective/career

Structure of the Course

The course is taught by means of three lectures per week (Tue, Thu, Sat 11am), in combination with up to two practical classes. A detailed summary of each lecture and practical class is given in the final part of this booklet.

Topics covered in the first term include: sensory processes and perception with special emphasis on vision and hearing; attention, consciousness and the control of action; and learning, memory and motivation. The remainder of the PBS 4 course covers language processing; and reasoning and decision-making.

If you wish, you may come to the lectures on the remaining topics which are taught to the NST students. These are cognitive and social development; personality (and its measurement); and atypical psychology; and social psychology. However, please note that you will not be examined on lecture material from these topics.

During the practical classes, students will learn research techniques and skills necessary for measuring brain and behaviour, the importance of experimental design including the difficult problem of appropriate control conditions and the relationship between experimental
hypotheses, experimental design and statistical analysis. Students are required to write reports on five of these classes (see below).

**Practical Class Registration**

**PBST students** are assigned practical classes before the start of term.

**Supervisions**

Typically, students receive a weekly supervision on this course. Supervisions are the responsibility of College Directors of Studies (DoS). Your DoS will appoint one or more supervisors who will advise students about the topics for supervisions and preparation for the examinations.

**Advice to Students**

Students are strongly advised to familiarise themselves with the format of the examination papers (see below) and the types of questions by referring to the examination papers from previous years.

The material taught in practical classes is helpful and relevant for all parts of the examination.

The course is divided into three main themes for the purpose of teaching and learning, and is as follows:

- Perception and Cognitive Psychology – how we perceive, remember, learn, reason, speak and control our actions
- Biological Psychology – how the brain works, how it can be affected by drugs, the effects of hormones, and biological models and treatment of mental disorders
- Individual Differences – how we try to measure differences between people in personality or intelligence, and what those differences might mean

These themes do not always coincide precisely with the topics areas for the examination sections (which are described in detail below). Lectures will often contain information relevant to more than one section in the examination. The marking criteria used in the School of Biology give particular credit to answers that integrate a variety of relevant sources of information.
Assessment

Assessment for the full course is through:

- One unseen three-hour written paper (40% of the total mark each)
- A written practical of an hour and a half (20% of the total mark)
- Three practical class reports (each failure to pass one of the five required reports will result in the deduction of 1.5 marks from the total examination mark)

Written Paper

The 3hr written paper consists of three sections (A, B & C), each assessing a certain topic area from the course (see below). In each section, candidates will be required to provide: (1) a short account of two topics from a choice of four, and (2) one essay from a choice of two. The essay carries two thirds of the marks in each section. The sections of these papers address the following topics:

Section A  Perception
Section B  Cognitive Psychology
Section C  Biological Psychology

Written Practical

The 1.5hr written practical is divided into two sections, A and B. In Section A, candidates will respond to a compulsory statistics question requiring data analysis. In Section B, candidates will be required to answer one question from a choice of at least three on designing an experiment.

Further information on examinations arrangements for reports of Part IB practicals and guidelines for written reports can be found on the following webpage:

http://www.library.psychol.cam.ac.uk/part-ib-teach-res

NB PAST PAPERS:
1) Be careful to ensure that you are referring to the relevant Paper for your Tripos (PBS4) as the NST students sit an additional written paper (Paper 2).
2) You should use last year’s Paper 1 (2017) as the sample for your examination. Papers prior to 2017 distributed topics differently across Paper 1 and Paper 2.
3) A sample Written Practical exam paper will be provided at the start of Lent term to reflect the statistics teaching this year. However, you may use stats questions on past papers for general statistics practice.
Practical reports

You are required to submit reports for three of the practical classes, each drawn from one of the themes of the course. A satisfactory report is required for each of the three practical classes listed below.

1. Biological Psychology
   - Prof Dalley
   - Neural Measurement

2. Cognitive Psychology
   - Dr Simons
   - Behavioural Measurement 1

3. Individual Differences
   - Dr Rentfrow
   - Psychometric assessment: Personality

Reports are marked as either (a) satisfactory, (b) failed, or (c) revision required (these reports have an indication of how they must be improved to be satisfactory; the student may submit a revised report for re-marking.)

The deadline dates for all reports that may be submitted will be posted outside the Practical Classroom at the beginning of Michaelmas term.

Details of the preparation, submission and evaluation of these reports will be given in each relevant practical class. You may also ask your Supervisors for more guidance about your reports.
Student Input to Teaching and Course Management

Questionnaires
At the middle and end of each term you will receive an email announcing a web-based questionnaire concerning the course. You are strongly invited to give your feedback, as your comments and views are instrumental for evaluating the quality of our lectures and implementing any changes that would improve the quality of the course. You will also be invited to complete a final questionnaire at the end of the year.

Please click on the link in the email and complete the short questionnaire, rating and commenting on various aspects of the course and associated supervisions. Please note that your reply is entirely confidential and no one can identify the author of a particular comment.

Staff/Student Committee
Each year, we need student volunteers taking our PBS4 course to join the staff/student committee. The main purpose of this Committee is to raise and discuss any issues about our courses and Departmental arrangements for students. The Committee consists of the Department’s Director of Undergraduate Education, academics responsible for each course the Department contributes to, and student representatives from these courses.

The Committee normally meets towards the end of the Michaelmas Term and at start of the Lent and Easter Terms, when questionnaire feedback on the previous term’s lecture courses is available. Comments from the Committee are discussed at the subsequent Departmental meetings.

The Secretary of the Committee is Dr Jeanne Estabel (je353@cam.ac.uk). Anyone wishing to have an item of business discussed should contact her or the appropriate student representatives.

Other Channels
Students are encouraged to bring suggestions about the teaching or management of the Part IB Course to the Department’s attention via:

- the Head of Department (Prof Mark Johnson, mj492@cam.ac.uk)
- the Teaching Administrator (Ms Jo Simmonds, jms311@cam.ac.uk)
- the Part IB Course Organiser (Dr Amy Milton, alm46@cam.ac.uk)
- the Director of the PBS Tripos (Dr Will Skylark, wjm22@cam.ac.uk)
- their Directors of Studies.

This provides another route by which your reactions to our courses can influence our future provision.
The Department of Psychology

General

One of the oldest psychology departments in the country, we celebrated the centenary of our establishment in 1997. We accommodate many Post-Doctoral Research Scientists and Postgraduate Research Students who serve as supervisors for lecture courses.

The Department occupies three adjacent buildings on the Downing Site and a building on the New Museums Site (Department of Psychology, Free School Lane, CB2 3RQ). The main Psychological Laboratory building (CB2 3EB) was built for the Department in the 1950s. Its first two floors house most of the facilities used by students: our lecture theatre, our practical classroom with a Macintosh network, a well-stocked library (and helpful Librarian), technical workshops, and two common rooms for Part II Students (containing photocopiers, a snack machine and drinks machines, and computers) in addition to Reception and some staff offices. The remaining floors contain offices and laboratories.

Immediately to the west is the Craik-Marshall building where further laboratories and offices occupy the ground and the top floors. There is also the Kenneth Craik seminar room on the ground floor. Immediately to the south is the William Hardy building, of which we occupy most of the ground, second and third floors. The Centre for Speech and Language is located on the second floor of the William Hardy building.

The Department houses the University of Cambridge Behavioural and Clinical Neuroscience Institute (BCNI) funded by a consortium grant from the Medical Research Council and Wellcome Trust.

The Centre for Family Research and the Cambridge Laboratory for Research into Autism are located in the Old Cavendish Building, Free School Lane (CB2 3RQ).

We are fortunate in having nearby on Chaucer Road (CB2 7EF) the MRC Cognition and Brain Sciences Unit (CBU), which is a major research centre for cognitive psychology and cognitive neuroscience. Some of its members provide lectures and supervisions for our courses. The Department also has links with the Department of Psychiatry at Addenbrooke’s Hospital on Hills Road (CB2 0QQ) and its Autism Research Centre on Trumpington Road (CB2 8AH).

Department Contact Details

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Website: www.psychol.cam.ac.uk

Library

The Library website is an essential source of information about the Department Library and the services it provides (www.library.psychol.cam.ac.uk). There are guides to other useful libraries in Cambridge and the information services offered via the University Library website (www.lib.cam.ac.uk). Our Librarian (Ms Judith Brown: jab202@cam.ac.uk) will be pleased to assist you if needed.
All classified books are available for loan but journals are for use in the library only. However, almost all journal articles are available to students on-line. Please note that a record must be made of all items removed from the library even for a short period.

**Photocopying, Scanning and Printing**

There is a scanner /printer/ photocopier available for your use. The machine is situated in the Student Computer Room, next door to the Library. The printer charges printing jobs to your Desktop Services Common Balance at a cost of 7p per page. The machine can also be used to scan items and either email them or save them to a USB data stick.

**Health and Safety in the Department**

The Head of Department is responsible for health and safety provision. You should ensure that you familiarise yourself with the various fire exits and routes to them: all are clearly signed. For areas that you do not visit frequently (e.g. a supervisor’s office) the members of the Department that you are visiting will be happy to show you the emergency exits if you ask. In the event of the fire alarms sounding, you should leave the building immediately by the nearest safe exit and assemble outside the Department of Geography. Do not delay to collect your belongings and do not use the lift.

If you are unfortunate enough to have an accident in the Department, a first- aider can be contacted via Reception (telephone 33550). If Reception is closed, contact should be made with the security control room (31818). Any accident must be reported to the Departmental Office (Room 100). In case of serious emergency, telephone 1999 for the Emergency Services.

If you have any general concerns about safety in the Department, please contact the Departmental Safety Officer, Professor Jeff Dalley (jwd20@cam.ac.uk).
Michaelmas Term - Lectures

Lists of suggested readings are provided for each lecture series. Asterisks denote texts suitable for reading before the course begins. Texts marked with + provide useful reference sources for one or more lectures. The handouts distributed during the lectures will provide further readings on particular topics.

Introduction

Dr K Plaisted-Grant

1 Historical background to Experimental Psychology:

Wundt introspection and structuralism, compared to William James, functionalism, behaviourist psychology and reductionism. The rise of cognitive psychology. Modern approaches to the study of consciousness: the relationship between cognitive psychology and cognitive neuroscience.

Visual Perception

Dr G Davis

Recommended Reading:


2 Visual Perception 1: Sensory Coding (Dr G Davis)

Attributes of perception and their relation to the physical characteristics of stimuli. Neural coding of sensory information. Characteristics of neurones - receptor and action potentials.

3 Visual Perception 2: The eye, perception of contrast and adaptation (Dr G Davis)

Snowden, Thompson & Troscianko, Chs. 1&2; Barlow & Mollon, Chs. 6, 11.

4 Visual Perception 3: Pattern coding, colour and orientation (Dr G Davis)

Ambiguity in neural signals and the need for groups of neurones to code visual features cooperatively; principles of univariance and adaptive independence; perception of colour; perception of orientation.

Snowden, Thompson & Troscianko, Chs. 4&5; Coren, Ward & Enns, Chs. 4, 5 and 11.

5 Visual Perception 4: Spatial frequency, depth and motion (Dr G Davis)

Perceiving edges at different spatial scales; neural channels involved in spatial frequency perception; cues to an object’s depth; mechanisms for perceiving motion.

Snowden, Thompson & Troscianko, Chs. 4, 6, 7; Barlow & Mollon, Ch. 12.

6 Visual Perception 5: Constancy, cortex and conscious vision (Dr G Davis)

Pathways in the visual system. Perceptual constancy. Aspects of high-level vision and underlying mechanisms. Limitations of conscious vision.

Goldstein, Chs. 3, 4; Coren, Ward & Enns, Ch. 11.

Selective Attention

Dr G Davis

Recommended Reading:

Snowden, Thompson & Troscianko, Ch. 9.


7 Selective Attention 1 (Dr G Davis)

Historical perspectives and conceptual issues. The need for selection. Inattentional blindness. Spatial orienting. The flanker paradigm and spotlight/zoom Lens metaphors.

8 Selective Attention 2 (Dr G Davis)

Visual Search and Feature-Integration Theory; Attention to auditory stimuli. Attention to objects. Late versus early selection. Single unit recordings from primate visual cortex.

Audition
Dr S Flanagan

Recommended Reading:


9 Audition 1: What’s that noise? (Dr S Flanagan)

Where does sound come from? How does this information reach the ear? How do we measure and characterize sound? How do physical vibrations get translated into nerve impulses? Goldstein Chapter 11; Moore Chapter 1.

10 Audition 2: Heat, light, sounds and linear systems (Dr S Flanagan)

How can complex sounds be broken down into simpler elements? How does linear systems theory help us understand the processing of elemental stimuli and allow us to make predictions for complex sounds? How can we measure and assess the filtering properties of the human auditory system? What are the practical benefits from this approach?

Moore Chapters 1, 3; Plack chapters 2, 5.11

11 Audition 3 Perceiving sound (Dr S Flanagan)

How does the basilar membrane in the cochlea respond to sound? How do the hair cells of the inner ear encode and relay sound information? How is information encoded by the cochlea used to determine pitch and loudness? Moore Chapter 4; Plack, Chapter 7

12 Audition 4: Where did that come from? (Dr S Flanagan)

How does encoded sound information progress from the cochlea to the cortex? How do we use binaural signals (from the two ears) to localize sounds? What is the role of monaural information? Moore Chapter 7; Plack Chapter 9

13 Audition 5: Seeing through the ears (Dr S Flanagan)

How do sight and sound interact to determine what we perceive? What are the principles that govern interactions between our senses? How can we characterize the brain’s processing of information within and between sensory modalities?


Learning
Recommended Reading:


14 Learning 1 (Dr D Belin)

Predictive learning: biological preparedness, neurobiological dissociations; Pavlovian conditioning: dopamine and reinforcement; the Rescorla Wagner rule.

15 Learning 2 (Dr D Belin)

Conditioned inhibition and blocking. Temporal contiguity; Surprise and prediction error; Preventative and superlearning.

16 Learning 3 (Dr D Belin)

Instrumental conditioning, habits and goal directed learning. The role of motivation and incentive learning.

17 Learning 4 (Dr K Plaisted-Grant)


Memory

Dr J Simons

18 Memory 1 (Dr J Simons)


19 Memory 2 (Dr J Simons)
The evidence for different types of working memory. Verbal and spatial working memory systems: the phonological loop and visuospatial sketchpad. The episodic buffer and central executive.

20 Memory 3 (Dr J Simons)

Medial temporal lobe amnesia; Declarative memory; Non-declarative memory; Consolidation and retrograde amnesia.

21 Memory 4 (Dr J Simons)

Memory retrieval: semantic memory, episodic memory (remembering and knowing, recall and recognition, encoding specificity); forgetting.

**Higher Cognition**

Dr T Bekinschtein

**Recommended Reading:**


22 Higher Cognition 1: Executive Functions (Dr T Bekinschtein)

Parsing the central executive into cognitive functions such as control, organisation, planning, sequencing and monitoring. Disorders of executive function (e.g., following frontal lobe damage). The supervisory attentional system.

23 Higher Cognition 2: Consciousness 1 (Dr T Bekinschtein)

Attention and awareness, commonalities and differences, neural underpinnings and psychological dissociations.

24 Higher Cognition 3: Consciousness 2 (Dr T Bekinschtein)

Conscious access, binding consciousness techniques, implications of sub and supraliminal cognition, theories of integrated cognition.
Michaelmas Term - Practicals

1 Introduction to Psychophysics (Dr W Skylark)

This practical will revisit some of the earliest work in experimental psychology. We will test how well people can detect changes in magnitude, and explore methods for determining the subjective magnitude of a stimulus. We will also describe attempts to provide ‘laws’ (similar to the laws describing the physical world) that describe how stimulus discrimination changes with stimulus magnitude (Weber’s Law), and the relationship between subjective and physical magnitudes (Fechner’s law and Steven’s power law). Discussion of these laws will include the opportunity for students to revise the (small amounts) of mathematics needed for the experimental study of the mind.

4 Signal Detection Theory (Dr D Szucs)

The probability of a subject reporting detection of a near-threshold stimulus is influenced by non-sensory factors including motivation, instructions and payoffs. This practical will show how we can apply signal detection theory, a simple mathematical model of noisy decision making, to this type of situation, and how this allows us to measure sensory discriminability separately from non-sensory response biases.

6 Visual Thresholds and Adaptation I (Prof J Mollon)

Using an optical system, we measure the thresholds for brief flashes on steady background fields of increasing luminance. In our first experiment, the test and background are of the same wavelength and we investigate how well Weber’s Law holds over a range of luminances. Also shown in this practical are demonstrations of the change of visual time constants with adaptation and the independent adaptation of different classes of cone. (Note: The instruction sheet for this practical, and the next one, will be available the previous week. Please read over it in advance. Students from PPS or Philosophy are invited to go through it with their supervisors)

7 Visual Thresholds and Adaptation II (Prof J Mollon)

In our second experiment, we ask to what extent Weber's Law holds independently for the different classes of retinal cone. Important concepts for interpreting your data are: Trichromacy; the Principle of Univariance; and the Principle of Adaptive Independence. For the theoretical background to this practical, see Barlow and Mollon (1989) *The Senses*, pp 165-172. A more advanced treatment (which may recommend itself to physicists) is that by Marriott (1962) in H. Davson *The Eye*, vol 2, ch 17.

9 Neural Measurement (Prof J Dalley)

This practical must be written up and submitted for assessment

This practical continues our tour of the human brain from the prospective of human brain imaging, specifically magnetic resonance imaging (MRI) and positron emission tomography (PET) and considers how these imaging modalities can be used to infer functional brain activity in humans. The basic principles of MRI, fMRI and PET will be described using examples from recent imaging studies, all of which will be relevant to your lectures and course work. The primary aim of this practical is to gain an appreciation of contemporary
brain imaging techniques and to understand how they can be applied to investigate functional brain activity in humans.

10 Prediction Error Learning (Dr D Belin)

This practical provides students with the opportunity to explore the predictions of a simple associative model of learning, based upon the concept of prediction error. Students will simulate simple experiments on a computer implementation of the model.

11 Data Analysis 1 (Dr B Chryst)

Details to follow.

12 Data Analysis 2 (Dr B Chryst)

Details to follow.

13 Behavioural Measurement 1 (Dr J Simons)

This practical must be written up and submitted for assessment

This practical illustrates some of the classic methods for measuring mental processes, including measuring reaction times and errors in responses. It explores how reaction time and error data may be used to infer the nature of mental processes. In a formal, randomized experiment, using the classroom computer system, undergraduates judge the identity of a form that is rotated by varying amounts from its standard orientation.

14 Assessing Memory (Dr J Garrison)

This practical class demonstrates important principles in assessing human learning and memory. As some students will be acting as participants, details of the procedures will not be announced before the practical sessions.

15 Data Analysis 3 (Dr B Chryst)

Details to follow.
Lent Term – Lectures

Language and the Brain

Dr M Bozic

Recommended Reading:


1 Language and the Brain 1: Introduction

Major themes and issues in language research. Methods used to study language processing. Language building blocks (phonemes, syllables, morphemes, words). Serial vs interactive models of language processing. Preliminaries about language in the brain.

2 Language and the Brain 2: Reading


3 Language and the Brain 3: Spoken word recognition

Properties of the spoken signal. Word segmentation: the problem of detecting when spoken words begin and end; strategies for speech segmentation. Lexical selection and the cohort model. Access to meaning; the role of context in spoken word recognition. Speech processing in the brain.

4 Language and the Brain 4: Sentence processing


5 Language and the Brain 5: Second language acquisition and bilingualism

6 Language and the Brain 6: Language and Communication

Language in the wider context of multimodal communication. The role of gesturing. Use of pauses, intonation, and prosody for communicative purposes. Conversation convergence. Speech-vision integration. The neural correlates of communication; the hypothesis about neural coupling.

Reasoning and Decision Making

Dr W Skylark

Recommended Reading:


7 Reasoning and Decision Making 1: Judging Probabilities

We often try to estimate how likely it is that some outcome will occur, or how frequently it has occurred in the past. Such probability judgments are fundamental to decision-making, but they often deviate from the dictates of formal probability theory. This lecture explores some of the “errors” in our estimates of probability, and discusses what these results tell us about the underlying mental processes.

8 Reasoning and Decision Making 2: Reasoning

Reasoning is one of the most sophisticated and challenging cognitive operations, and has been studied since antiquity. This lecture examines the psychology of syllogistic and propositional reasoning, and shows how careful experimentation can illuminate complex thought processes.

9 Reasoning and Decision Making 3: Decision Making

Would you rather have a 90% chance of £20 or a 50% chance of £50? Why? This lecture shows how people’s social and economic decision-making deviates from “rational” behaviour, and critically evaluates one of the most influential accounts of these data.

10 Reasoning and Decision Making 4: Emotions and Decision-Making

This lecture will examine the role of emotions on decision-making. We will examine the interplay between emotion, physiology, and cognition, and will critically evaluate some ideas about how this interplay shapes our decisions.
Lent Term - Practicals

2  Behavioural Measurement 2 (Dr M Bozic)

The practical is aimed at demonstrating priming, a classical method for investigating the mechanisms of language processing. It focuses on the effects of prior exposure on the recognition of written words. Students will take part in a short experiment, followed by a basic data analysis and a discussion of experimental design in psycholinguistics, including control of word variables, participants’ strategic approaches to the task, and sources of response variability. The results will be discussed in the context of relevant theories, aiming to demonstrate how priming data can inform language processing models, in both behavioural and neural domain.

3  Data Analysis 4 (Dr B Chryst)

Details to follow.

4  Data Analysis 5 (Dr B Chryst)

Details to follow.

5  Measuring effects of arousal on performance (Dr T Bekinschtein)

How does wakefulness and arousal modulate cognition? By changing emotional and physical states this practical aims to understand the relationship between the physiological state and the cognitive capacities in humans. With short experiments and analyses online we will build a series of models incorporating neuroanatomical and functional information.

6  Data Analysis 6 (Dr B Chryst)

Details to follow.

7  Data Analysis 7 (Dr B Chryst)

Details to follow.

9  Psychometric assessment: Personality (Dr J Rentfrow)

This practical must be written up and submitted for assessment

In this practical, students will gain experience collecting and analysing survey data using Internet-based methods. During the practical session, students will learn basic techniques for scoring surveys and computing variables using Excel and SPSS. For the practical report, students must formulate a set of research questions, conduct an independent analysis of the data to address the questions, and provide an interpretation of the results.

10  Data Analysis 8 (Dr B Chryst)

Details to follow.

11  Data Analysis 9 (Dr B Chryst)
Details to follow.

13 Data Analysis 10 (Dr B Chryst)
Details to follow.

Easter Term - Practicals

1  Statistics Revision Class (Dr B Chryst)
Details to follow.