THE UNIVERSITY OF NEW SOUTH WALES

FACULTY OF MEDICINE

SCHOOL OF MEDICAL SCIENCES

DEPARTMENT OF PHYSIOLOGY

NEUROPHYSIOLOGY

NEUR3221

SESSION 2, 2013

COURSE OUTLINE

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COURSE STAFF

Course Coordinators

Course Coordinator	Dr. John Power Translational Neuroscience Facility, Level 3 Wallace Wurth Building phone 938 52910 e-mail john.power@unsw.edu.au
Co Coordinator	Dr. Ann Wong Translational Neuroscience Facility, Level 3 Wallace Wurth Building phone 9385 2443 e-mail acy.wong@unsw.edu.au

Consultations

Dr Power is responsible for all academic and administrative matters regarding the course. Students should feel free to approach him with any questions or problem concerning the course either before or after scheduled class activities. Outside of these times, students are strongly encouraged to arrange an appointment in advance by email. In Dr. Power's absence, enquiries can be directed to Dr Wong.

Other information of an administrative nature may also be obtained from the combined Student Office for SOMS, BABS, BEES (Room G27, Biosciences Building). This is also where reports are turned in.

Other Teaching Staff

Prof Gary Housley	g.housley@unsw.edu.au
Dr Arun Krishnan	arun.krishnan@unsw.edu.au
Dr Richard Vickery	richard.vickery@unsw.edu.au
Prof Cyndi Shannon-Weickert	c.weickert@neura.edu.au
Dr. Matthias Klugmann	m.klugmann@unsw.edu.au
Dr Janet Taylor	j.taylor@neura.edu.au
Dr Andrew Moorhouse	a.moorhouse@unsw.edu.au

COURSE INFORMATION

Course Structure and Teaching Strategies

Units of credit: This course is worth 6 units of credit.

Contact hours: The course structure is:

- Three x 1 hour lectures (or tutorials) per week.
- One x 3 hour practical classes (or tutorial) per week.

Practical Class assignment:
Students are enrolled in a single practical class.

Class Times and Locations:
The course runs on Monday, Wednesday and Friday.

Lectures run for 1 hour will be held at: 11 am on Monday in Wallace Wurth LG03, 9 am on Wednesday in Wallace Wurth LG02 and 1 pm on Wednesday in the Wallace Wurth LG02..

Practical classes are run from 9 - noon on Friday in room 120 on the first floor of the Wallace Wurth Building. Students will be split into two practical groups (A & B). Groups A & B will attend practical classes on alternate weeks.

Course schedule

The course timetable is included at the end of this section (page 13). Any updates to the timetable will be announced in lectures and on Blackboard.

Blackboard

This course will rely extensively on Blackboard for communication and resources. To access the course site, point your browser to:

lms-blackboard.telt.unsw.edu.au

At the left enter your UNSW User ID (z<student-number> and your zPass). After logging on to Blackboard, look for the course NEUR3221 on the right. You should have access to it if you are properly enrolled.

On Blackboard you will be able to access lecture notes, posted shortly before each lecture, as well as iLecture recordings of the lecture (posted after the lecture). Students are strongly encouraged to attend the lectures in person instead of relying on notes and recordings.

Blackboard forums are also available for students to discuss the course with each other and with the lecturers and tutors. In particular, specific forums allow lecturers to answer questions about the lecture material. There is also a forum in which students can provide anonymous feedback on the course while the course is being conducted. Please use the forum wisely - abusive or offensive posts will be removed and will result in the forum being shut down.

Requirements for Practical Classes

Practicals involving the use of animal specimens are a privilege, and must be treated with respect and professionalism. Students are expected to adhere to NH&MRC guidelines for ethics in animal studies (available at the course site, or via www.nhmrc.gov.au/publications/synopses/_files/ea16.pdf).

Students must take due care with biological and hazardous material and make sure all equipment is left clean and functional. Those unwilling to follow these basic laboratory rules will be marked absent. Enclosed shoes are compulsory in all practical classes. Punctual arrival is expected, and mobile phones must be switched off before entering the class. Practical classes involving your participation as a subject may require you to sign a witnessed, informed consent form.

Attendance Requirements

Attendance at practical classes is compulsory. Satisfactory completion of the work set for each class is essential. It should be noted that non-attendance for other than documented medical or other serious reasons, or unsatisfactory performance, for more than 1 practical class during the session may result in an additional practical assessment exam or ineligibility to pass the course.

Medical Certificates

Students who miss practical classes or exams due to illness or for other reasons must submit a copy of medical certificates or other acceptable documentation to the course co-ordinator. **Certificates should be lodged no more than 7 days after an absence.** Certificates lodged after 7 days will not be accepted. The following details must be attached: Name, Subject number, Date of the class, Name of class missed.

Official Communication by Email

All students in the course NEUR3221 are advised that e-mail is now the official means by which the School of Medical Sciences at UNSW will communicate with you. All e-mail messages will be sent to your official UNSW e-mail address (e.g. z1234567@student.unsw.edu.au) and, if you do not wish to use the University e-mail system, you MUST arrange for your official mail to be forwarded to your chosen address. The University recommends that you check your mail at least every other day. Facilities for checking e-mail are available in the School of Medical Sciences and in the University library. Further information and assistance is available from the Service Counter on 9385 1777. Free e-mail courses are run by the UNSW Library (Level 2).

Approach to Learning and Teaching

The philosophy underpinning this course and its Teaching and Learning Strategies is based on "Guidelines on Learning that Inform Teaching at UNSW". These guidelines may be viewed at: www.guidelinesonlearning.unsw.edu.au. The teaching of neurophysiology covers both the physiology of neurons and brain function, and how these data were derived, as a full understanding of neurophysiology requires an appreciation of both what is known and of the limitations imposed by our study tools.

Lectures will provide you with the concepts and theory essential for understanding neurophysiology. The practical classes will assist you in the development of research and analytical skills. The practical classes are relatively small and not too tightly structured, so they allow you to engage in more interactive learning than is possible in lectures. The tutorials will be run by someone in addition to the lecturer on the topic, providing you with the opportunity to obtain another perspective on the material under review.

Although the primary source of information for this course is the material delivered in lectures and practical classes, effective learning can be enhanced through self directed use of other resources such as textbooks. Your practical classes will be directly related to the lectures and it is essential to prepare for practical classes before attendance. It is up to you to ensure you perform well in each part of the course; preparing for classes; completing assignments; studying for exams and seeking assistance to clarify your understanding.

Aims of the Course

To gain an understanding of the principles of neurophysiology by:

- using molecular, synaptic and cellular processes to explain brain function
- grasping the relationship between experimental techniques and the data they produce

Student Learning Outcomes

UNSW Learning outcomes:
UNSW aims to provide an environment that fosters students achievement of the following generic graduate attributes:

1. the skills involved in scholarly enquiry
2. an in-depth engagement with the relevant disciplinary knowledge in its interdisciplinary context
3. the capacity for analytical and critical thinking and for creative problem-solving
4. the ability to engage in independent and reflective learning
5. information literacy the skills to appropriately locate, evaluate and use relevant information
6. the capacity for enterprise, initiative and creativity
7. an appreciation of, and respect for, diversity
8. a capacity to contribute to, and work within, the international community
9. the skills required for collaborative and multidisciplinary work
10. an appreciation of, and a responsiveness to, change
11. a respect for ethical practice and social responsibility
12. the skills of effective communication

Not every course addresses all these attributes evenly. Neurophysiology is weighted most heavily towards attributes 1-4; attributes 5, 9 and 12 are also specifically addressed.

Specific Learning outcomes:
By the end of this course students are expected to have gained:

- a demonstrable knowledge of the scope of neurophysiology, and detailed knowledge in some areas including somatosensory system and synaptic plasticity.
- experience in applying basic physical and physiological principles to resolve questions related to brain and behaviour.
- experience and expertise in critical enquiry by contributing to scientific discussion.
- by practical experience and critical review, an appreciation of the relationship between the experimental techniques that provide neurophysiological data, and the constraints on interpretation that the techniques impose.

ASSESSMENT

Assessment tasks

Online quizzes	**5%**
Progress Test 1 (50 minute duration)	**12.5%**
Progress Test 2 (50 minute duration)	**12.5%**
Practical report	**20%**
Final exam (2 hour duration)	**50%**

Material pertaining to the both the lectures and practical classes will be examined in both the progress tests and the final exam.

You must complete two multiple choice quizzes online. Questions are similar to those on the progress tests and final exam. The quizzes will go up on Blackboard on the Monday of week 4 (19/8) and the Monday of week 9 (23/9) and will be taken down 1 week later. You must complete these quizzes by the due date to receive credit. They will be made available a few days before the exams for revision purposes. Together, the quizzes will contribute **5%** to your final mark for the course (2.5% each). You will receive the full 5% if you correctly complete all questions on both quizzes. **You may attempt the quiz as many times as you like in order to achieve a perfect score of 100% correct.**

The Practical report must be submitted electronically as a .DOC or .PDF using Blackboard and on paper to the SOMS office. In the folder "Extra Stuff" will be a Turnitin submission box for each of these reports which will then process them via the Turnitin system. Please see the report guidelines on page 11 of this manual.

There will be two progress exams throughout the course. These exams will be comprised of short answer questions, multiple choice and/or short calculations. The questions will be based on the material covered in the lectures and practical classes. The purpose of these progress exams is to provide feedback to students on their understanding and application of the concepts developed in the course and to prepare students for the final exam.

The end of session exam will be comprised of short answer questions, multiple choice and/or short calculations that may include some simple calculations. The short answer questions will be based on the material covered in the lectures and practical classes. Material covered in the progress exams may be again examined in the final exam. The lecturer who provided the question will mark the short answer questions. Students are advised to use the list of previous exam questions provided to self-evaluate their progress during the course, although questions from year to year may vary as the content of the course is developed.

Missed In-Course Assessment

If you unavoidably miss an assessment task in Neurophysiology, you must inform the Course Co-ordinator immediately. You must supply adequate documentation (such as a medical certificate) to be considered for any supplementary assessment.

Missed Exams

If in any circumstances you unavoidably miss an examination, you must inform the Registrar and also contact the Course Co-ordinator immediately. Normally, if you miss an exam (without medical reasons) you will be given an absent fail. If you arrive late for an exam no time extension will be granted. It is your responsibility to check timetables and ensure that you arrive with sufficient time.

PLEASE NOTE that if you miss any examinations for medical reasons you must lodge a medical certificate with New South Q within **3 DAYS** (refer to UNSW Student Gateway @ www.student.unsw.edu.au for further details). Your request for consideration will be assessed and a deferred exam MAY be granted. You cannot assume you will be granted supplementary assessment. The deferred exam may include a significant oral element.

Special Consideration

If you believe that your performance in a course, either during session or in an examination, has been adversely affected by sickness or for any other reason, you should notify NewSouth Q and ask for special consideration in the determination of your results. Such requests should be made as soon as practicable after the problem occurs. **Applications made more than three days after an examination in a course will only be considered in exceptional circumstances**. Please note that an application for special consideration is no guarantee you will be able to make up an exam; each case is determined on its own merits. Information regarding special consideration can be found here:

https://my.unsw.edu.au/student/atoz/SpecialConsideration.html

ACADEMIC HONESTY AND PLAGIARISM

Students should be aware of UNSW's policy on academic and student misconduct: my.unsw.edu.au/student/academiclife/assessment/AcademicMisconductStudentMisconduct.html

Student assignments may be submitted to the Turnitin plagiarism detection engine. In addition students should be familiar with the following:

Plagiarism is the presentation of the thoughts or work of another as one's own. Examples include:*

- *direct duplication of the thoughts or work of another, including by copying work, or knowingly permitting it to be copied. This includes copying material, ideas or concepts from a book, article, report or other written document (whether published or unpublished), composition, artwork, design, drawing, circuitry, computer program or software, web site, Internet, other electronic resource, or another person's assignment without appropriate acknowledgement;*
- *paraphrasing another person's work with very minor changes keeping the meaning, form and/or progression of ideas of the original;*
- *piecing together sections of the work of others into a new whole;*
- *presenting an assessment item as independent work when it has been produced in whole or part in collusion with other people, for example, another student or a tutor; and,*
- *claiming credit for a proportion a work contributed to a group assessment item that is greater than that actually contributed.†*

Submitting an assessment item that has already been submitted for academic credit elsewhere may also be considered plagiarism. The inclusion of the thoughts or work of another with attribution appropriate to the academic discipline does not amount to plagiarism.

Students are reminded of their Rights and Responsibilities in respect of plagiarism, as set out in the University Undergraduate and Postgraduate Handbooks, and are encouraged to seek advice from academic staff whenever necessary to ensure they avoid plagiarism in all its forms.

The Learning Centre website is the central University online resource for staff and student information on plagiarism and academic honesty. It can be located at: www.lc.unsw.edu.au/plagiarism

The Learning Centre also provides substantial educational written materials, workshops, and tutorials to aid students, for example, in:

- *correct referencing practices*
- *paraphrasing, summarising, essay writing, and time management*
- *appropriate use of, and attribution for, a range of materials including text, images, formulae and concepts*

Individual assistance is available on request from The Learning Centre.

Students are also reminded that careful time management is an important part of study and one of the identified causes of plagiarism is poor time management. Students should allow sufficient time for research, drafting, and the proper referencing of sources in preparing all assessment items.

* Based on that proposed to the University of Newcastle by the St James Ethics Centre. Used with kind permission from the University of Newcastle

† Adapted with kind permission from the University of Melbourne.

RESOURCES FOR STUDENTS

Student Support Services

Those students who have a disability that requires some adjustment in their teaching or learning environment are encouraged to discuss their study needs with the course co-ordinator prior to, or at the commencement of, their course, or with the Equity Officer (Disability) in the EADU 9385 4734. Issues to be discussed may include access to materials, signers or note-takers, the provision of services and additional exam and assessment arrangements. Early notification is essential to enable any necessary adjustments to be made.

Student Rights and Responsibilities & Appeal Procedures

To have a result reviewed (checking of mark and/or reassessment):

https://my.unsw.edu.au/student/academiclife/assessment/Results.html

To appeal academic standing or ability to progress:

https://my.unsw.edu.au/student/academiclife/assessment/finalisation_results.html

Grievance Resolution Officer

In case you have any problems or grievance about the course, you should try to resolve it with the Course Organizer. If the grievance cannot be resolved in this way, you should contact the School of Medical Sciences Grievance Officer, Dr P. Pandey (9385 2483, P.Pandey@unsw.edu.au).

Textbook and Reading List

Required textbook:
Neuroscience: Exploring the Brain. 3rd edition, 2006
Bear, Connors & Paradiso
Williams & Wilkins

Recommended reading:
Principles of Neural Science
Kandel, Schwartz & Jessell
McGraw-Hill

Medical Physiology, a cellular and molecular approach.
Boron & Boulpaep
Saunder

Neuroscience.
Purves, Augustine, Fitzpatrick et al.
Sinaur

The books are available from the UNSW Bookshop, and limited copies are held by the UNSW library.

CONTINUAL COURSE IMPROVEMENT

Feedback from students about this course is one of the main ways of ensuring the continual development and improvement of this course. We invite students to provide online anonymous course evaluation to academic staff via Blackboard throughout the session to enable immediate feedback. The end-of-session Course and Teaching Evaluation and Improvement [CATEI] process of UNSW is another way in which student feedback is evaluated, and we ask for your assistance in completing this survey at the appropriate time. Part of the CATEI process is to communicate significant changes to the course to subsequent cohorts of students.

Changes to the course for this year based on feedback from 2012 include:

- Reduction in the number of assessments
- Reduction in the number topics covered in course. Each topic will be covered in more depth
- Increased emphasis on translational neurophysiology

ADMINISTRATIVE INFORMATION

General Information

The Department of Physiology is part of the School of Medical Sciences and is within the Faculty of Medicine. It is located in Wallace Wurth building. General enquiries can be made at the School of Medical Sciences Reception, located in the Wallace Wurth building (office hours are 9.00 am - 5:00 pm).

Professor Gary Housley is Head of the Department of Physiology and appointments to see him may be made through his Administrative Assistant on 9385 2804.

There are two honours programs available through the School of Medical Sciences. The School of Medical Sciences Honours program is coordinated by Dr Andrew Moorhouse (ph: 9385 2575). In addition, the School of Medical Sciences and the School of Psychology jointly run the Neuroscience Honours program which is coordinated by Dr John Power <john.power@unsw.edu.au>. Any students considering an Honours year should discuss the requirements with the coordinator. Outstanding students may be considered for scholarships offered by the University and School. Please see:

SOMS
http://medicalsciences.med.unsw.edu.au/students/soms-honours/overview

Neuroscience
http://medicalsciences.med.unsw.edu.au/students/undergraduate/neuroscience/honours

Postgraduate research degrees
The School of Medical Sciences offers students the opportunity to enter into a Masters (MSc) or Doctorate (PhD) program in Physiology. For further information contact the Postgraduate Coordinator, Dr David Simar <d.simar@unsw.edu.au>. Please see:
http://medicalsciences.med.unsw.edu.au/students/postgraduate-research/overview

Summer research awards: The School of Medical Sciences supports several summer vacation scholarships each year to enable good students to undertake short research projects within the school. Please see:
http://medicalsciences.med.unsw.edu.au/students/undergraduate/summer-research-awards

The School Student Adviser is able to provide additional information on any courses offered by the School. Please contact Carmen Robinson (9385 2464) or (carmen.robinson@unsw.edu.au).

DO-IT-YOURSELF PRACTICAL

Design your own practical and further explore topics of interest

Requirement: Your group must design and then complete a practical of your own.

Format: You will have the all the equipment from the previous four practicals available for your use. You will be responsible for writing up a sensible series of experiments, complete with your aim and protocol (i.e., Methods). Once your protocol has been approved by a demonstrator, you can begin your experiments and collect data. Further rules for this practical class will be available on Blackboard prior to the scheduled time.

Aims of the exercise: To give you experience in designing a good scientific experiment and allowing you do further explore topics of interest.

Contribution to assessment: This practical is not graded separately, but it is ideal for writing up your Practical Report as all elements will be unique to you and your group (see page 12).

Dates: The DIY practical will take place in weeks 10 & 11 during the normal practical time.

How to choose a prac: All the equipment from the previous four practicals will be available; however, some of the more complex setups may be limited in number. I will set up a Discussion on Blackboard to allow you to pre-book the more complicated setups (e.g., the cockroach setup).

Practical Report guidelines for Neurophysiology NEUR3221

Requirement: You must submit a practical report based on your DIY prac.

Aims of the exercise: To help you to plan and carry-out a scientific experiment, report on your results and place the significance of your results in context of the literature.

Contribution to assessment: The Practical Report will contribute **20%** to your final mark for the course.

Due date: The last day on which the practical report can be submitted is **Wednesday the 30th of October (30/10) at 10am**. Reports submitted after this time will lose 3% from the grade per day (i.e., 0.45% of your final mark/day). Reports can be submitted any time <u>before</u> the deadline.

Where to lodge: Students must submit BOTH a <u>paper copy</u> and an <u>electronic copy</u>.

Paper copy: Submit your paper copy to the Student Office in Biological Sciences (Room G27). Ensure that your name, student number, Course and Convener are written on the submission form.

Electronic copy: Submit your electronic copy as a .DOC, .DOCX or .PDF. If you upload a Word doc, don't worry if the generated PDF looks odd (e.g., tables misaligned), I can access the original document and I will mark that.

In Blackboard, in the folder “Extra Stuff” will be a Turnitin submission box. Ensure that your name and student number, number of words, as well as the Course and Convener are clearly written on the cover page of your report. Contact Dr Power (john.power@unsw.edu.au) if you have any problems submitting your assignment.

Word limit: 2500 words (excluding tables, figures, figures legends and references).

Format: Arial font, double-spaced with 2.5 cm margins and four equal length sections: Introduction, Methods, Results, Discussion.
Introduction: You should aim to provide the context and rationale for the experiment.
Methods: Try and write the Methods in your own words, provide enough detail that someone could reproduce your experiment, and clearly describe any differences between your procedures and those in the Prac Manual.
Results: You data are usually best conveyed by figures or tables, and should indicate number of repetitions of each measurement.
Discussion: You should include an attempt to interpret the significance of your results, as well as suggestions for future experiments.

In addition, you should include the following sections which do not count against your total word limit:

- At the beginning of your report a Title page with your name, class and student number.
- At the end, you should put up to 20 references which you have cited (i.e., the Bibliography).
- Throughout the document, you may place your figures, tables and appropriate legends.

Marking: Each of the four sections is worth 25% of the Practical Report grade. We are looking for clarity of thinking (logical consistency, thoroughness, etc.) and clarity of expression (clear sequencing, and presentation of information). The data that you obtained in the practical class are important in terms of how you present them, and how they are discussed; this means that “wrong” results you may have obtained are perfectly acceptable provided you present them clearly, and discuss what may have to lead to these results.

Naming: Before you upload, please name your file "LASTNAME_studentnumber_DIY_PRAC.doc".

Neurophysiology NEUR3221 - Timetable 2013

Wk	Week starting	MONDAY (11 am - noon) Lecture – WW LG03	WEDNESDAY (9 – 10 am) Lecture - WW LG02	WEDNESDAY (1 – 2 pm) Lecture - WW LG02	FRIDAY (9 - noon) Lab - WW120
1	29/7	Neurophysiology Scope I [Power]	Neurophysiology Scope II [Power]	Neurophysiology Scope III [Power]	**NO PRAC**
2	5/8	Synaptic Transmission I [Power]	Synaptic Transmission II [Power]	Neural Coding [Vickery]	PRAC-1A - Tactile psychophysics POWER and VICKERY
3	12/8	Tactile Coding [Vickery]	Tactile Coding II [Vickery]	Pain [Moorhouse]	PRAC-1B - Tactile psychophysics POWER and VICKERY
4 Online Quiz	19/8	Kinaesthesia I [Taylor]	Kinaesthesia II [Taylor]	Tutorial [Power]	PRAC-2A – kinaesthesia [Taylor]
5	26/8	Progress Test 1	Autonomic Nervous System [Power}	Enteric Nervous System [Power]	PRAC-2B – kinaesthesia [Taylor]
6	2/9	Neurodevelopment [Fath]	Glia [Klugmann]	Auditory Nervous System I [Housley – Wong]	PRAC-3A Nerve Recording POWER and VICKERY
7	9/9	Auditory Nervous System II [Housley – Wong]	Auditory Nervous System III [Housley – Wong]	Auditory Nervous System IV [Housley – Wong]	PRAC-3B Nerve Recording POWER and VICKERY
8	16/9	Memory, Emotion & Addiction I [Power]	Memory, Emotion & Addiction II [Power]	Memory, Emotion & Addiction III [Power]	PRAC-4A – Auditory [Housley – Wong]
9 Online Quiz 2	23/9	Memory, Emotion & Addiction IV [Klugmann]	Tutorial – DIY Prac POWER and VICKERY	CNS Development [Shannon-Weickert]	PRAC-4B – Auditory [Housley – Wong]
Midsession Break					
10	7/10	LABOUR DAY	Progress test 2	Neurobiology of Mental Illness [Shannon-Weickert]	PRAC-5A - DIY POWER and VICKERY
11	14/10	Neural Interface I [Power - Vickery]	Neural Interface II [Power - Vickery]	Clinical Neurophysiology I [Krishnan]	PRAC-5B - DIY POWER and VICKERY
12	21/10	Clinical Neurophysiology II [Krishnan]	Clinical Neurophysiology III [Klugmann]	Tutorial	**NO PRAC**

Physiology Teaching Laboratory Student Risk Assessment	UNSW THE UNIVERSITY OF NEW SOUTH WALES	PRAC # PHSL-24 Title Psychophysics of Tactile Sensation (NEUR 3221) DOC:PHSLSRA----

Hazards	Risks	Controls
Students use sandpaper against the skin	scratches leading to infection	Finer grades of sandpaper are used. The students are instructed to press and move their fingers gently against the sandpaper

Personal Protective Equipment			
none			

Emergency Procedures

n/a

Clean up and waste disposal

n/a

Ethics Approval

n/a

Declaration

I have read and understand the safety requirements for this practical class and I will observe these requirements.

Signature:………………………………………………………………Date:……………………………

PRAC# PHSL-24 relates to RA # RA-PHSL-24 related documents (SWP's/RA) …………………

P1: PSYCHOPHYSICS OF TACTILE SENSATION

Introduction

Psychophysics is that area of perceptual psychology dealing with the relationships between sensation and the physical stimuli responsible for the sensation. This discipline had its origins in the 19th century work of Fechner and earlier, Weber, two German psychophysicists who sought to measure sensations and relate those measures to the corresponding physical stimuli.

In sensory physiology one of the aims is to account for subjective sensory capacities, as revealed by psychophysical studies, in terms of the features of neural responses. Thus, the neurophysiologist attempts to correlate stimulus values with differences in neural responses while the psychophysicist tries to correlate stimulus values with sensation magnitude. One of the difficulties for the neurophysiologist is in deciding which neural response is the appropriate one to measure. This can usually only be done by measuring neural activity in a number of ways while the particular stimulus is varied. In this way it may be possible to discover which scale or measure of neural activity provides a relationship with the stimulus variations that matches the relation between the same stimulus variations and psychophysical measures of sensation. Once one finds a functional relation between the neural responses and the stimulus variations of the same form as that relating stimulus to sensation then the neural response may qualify as the neural code for the stimulus attribute under study.

Aspects of psychophysics

Psychophysical studies are normally concerned with one of four aspects of sensory performance:

(i) Detection
(ii) Recognition
(iii) Discrimination
(iv) Scaling or ranking

Sensory detection

The detection problem deals with the minimum amount of energy necessary for the subject to say that the stimulus is present. Although it was originally thought that this threshold should have a fixed value, it is now known to vary from trial to trial. These variations may be associated with changes in attention, fatigue or other factors. Thus, the neural signals generated by stimuli are presumably superimposed on a background of 'noise' generated by the nervous system. Only when they emerge sufficiently from that noise will they generate a subjective response.

Assessment of detection thresholds

Two ways of assessing threshold are by

(i) the method of Limits
(ii) the method of Constant Stimuli

With the method of Limits the stimulus is initially set to a strength which is very faint and undetectable and is gradually increased until the subject says 'I detect it'. On alternate trials the experimenter starts with the stimulus at a high, obviously perceptible level and progressively reduces its intensity until the subject says 'I no longer detect it'. The mean level can then be obtained as the threshold for detection.

The second method relies on a series of fixed stimulus intensities being delivered, usually in random order, and a graph plotted of the proportion detected at each intensity. The Detection Threshold is then usually taken as the value where the probability of detection is 0.5.

Signal detection theory

Because stimuli are at low intensities in detection studies the subject may be uncertain about whether a stimulus has occurred. Different subjects, or even the one subject at different times may react differently in these cases of uncertainty. For example, the subject may indicate that the stimulus was present whenever he/she was uncertain, or at the other extreme may indicate that none was present whenever he/she was uncertain. Thus, the subject's decision-making behaviour will influence the assessment of threshold. This *uncertainty* is the decision process and the variability in the subject's choice of *decision criterion* are recognized in that aspect of psychophysics known as *signal detection theory*.

The uncertainty about the presence of the stimulus is presumably related to moment-to-moment variations in 'noise' level within the sensory system, which may be considered to have a certain *probability distribution* ('signal absent' in Fig. 1). When the stimulus is present it will create a new distribution ('signal present' in Fig. 1) which is a level of activity representing an addition of 'noise' and stimulus-evoked 'signals'. As the two distributions may overlap (Fig. 1) it is clear that there must be some uncertainty about the presence of the stimulus.

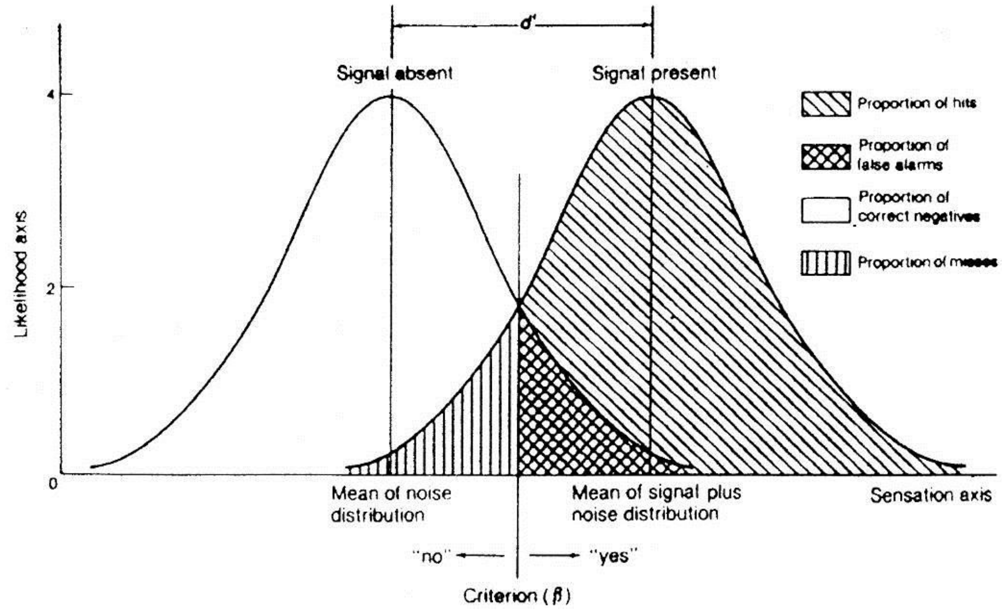

Fig. 1 (from *Sensation and Perception*, Coren et al., 1978, Academic Press)

The subject's *criterion level* (b) determines the proportion of signal-present trials for which the subject gives a correct positive response, represented by the proportion of the 'signal present' distribution that exceeds the criterion level, b. Similarly, the proportion of false alarms is given by how much of the 'signal absent' distribution is over the criterion level.

The subject's placement of the criterion level will be influenced by the context of the detection task and the subject's motivation and expectation. For example a radiologist trying to decide whether an X-ray film shows signs of a tumour should set the criterion low, since this means all cases with a tumour would be investigated. A number of false alarms would arise, but this would be preferable to setting the criterion level too high and missing some actual tumours. The effect of a 'lax' or 'strict' criterion is shown by the distributions of Fig. 2.

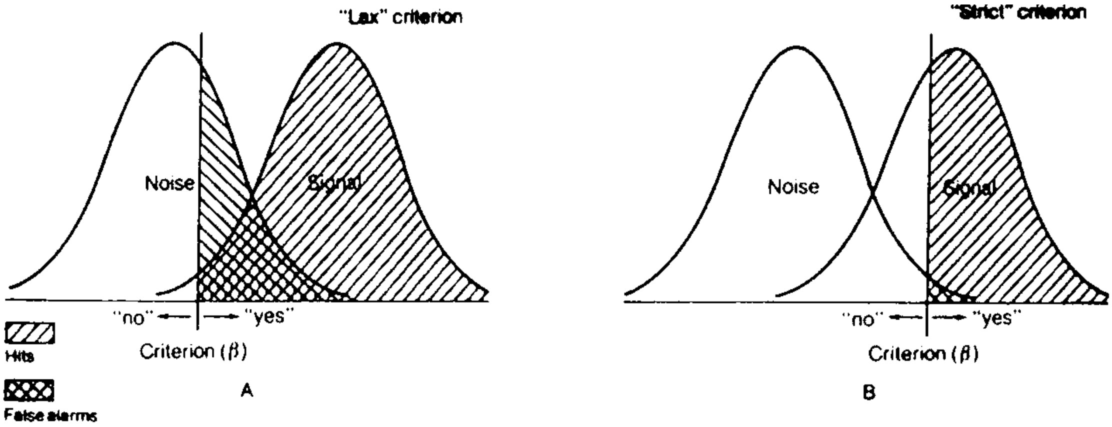

Fig. 2 (from *Sensation and Perception*, Coren et al., 1978, Academic Press)

Recognition of sensory stimuli

Apart from the problem of detecting a stimulus, one of the major tasks for the sensory system is that of *recognition* of the stimulus. This differs from the discrimination task considered below in that the recognition problem involves identification of a particular stimulus from a range of possible stimuli presented whereas in a discrimination task (see below) the subject has to judge whether one stimulus, a *comparison stimulus*, is different from or the same as the *reference* stimulus. The recognition or identification problem is concerned with how many different stimuli within a continuum (for example, recognition of pitch or loudness or brightness) the subject can reliably identify. For any one sensory continuum this turns out to be rather small, usually a set of only about 7 stimuli within the range can be perfectly recognized.

The discrimination task

In a discrimination task the subject is presented with paired stimuli, the first being the *reference stimulus*, the second being the *comparison stimulus*. These differ normally in a single stimulus dimension (for example loudness; brightness; frequency of vibration on the skin). In a *same-different design* the subject is required to decide whether the comparison stimulus is different from or the same as the reference. An alternate experimental design called a *two-alternative forced choice* uses paired stimuli, but the subject is required to say whether the comparison stimulus is greater or less than the reference stimulus. If the comparison stimulus can take a series of values and is presented repeatedly at each of these values the experimenter can then record the proportion of deliveries on which the subject called the comparison stimulus 'different' or 'greater' for each of its different values. A graph can be constructed plotting this proportion (ordinate) against the value (abscissa) of the comparison stimulus. From the resulting curve, often known as a *psychometric function curve*, a quantitative measure of the subject's discriminative ability may be derived. For a same-different design the value of the comparison stimulus that is called 'different' 50% of the time represents the *just noticeable difference*, or JND for the subject for that reference stimulus. In a two-alternative forced choice (2AFC) design, the 50% ordinate value represents chance performance, and the value of the comparison stimulus that results in 75% of responses being called 'greater' is known as the difference limen. If the 50% value in a 2AFC experiment occurs at a value where reference stimulus ≠ comparison stimulus, the subject exhibits *bias*. Bias need not be deliberate, but represents an inherent tendency of the system or subject towards a particular response, and may be related to the time interval between presenting the reference and comparison stimuli. Subjects in a same-different experiment may also exhibit bias, by using lax or strict criteria for calling 'same' or 'different' for cases where they are unsure.
The stimulus increment needed for discrimination is not a fixed value for different values of the reference stimulus, but rather, as the reference stimulus increases, the JND and difference limen also increase. This relation between the size of the JND and the size of the reference stimulus is called *Weber's Law*, given by:

$$\Delta S = KS$$

where ΔS is the size of the JND
S is the value of the reference stimulus

K is a constant, therefore: $K = \Delta S / S$

where ($\Delta S / S$) is known as the *Weber fraction*. Weber's Law indicates that the increment in the stimulus (ΔS or the JND) needed for discrimination is a function of the reference stimulus intensity. Thus, with a low intensity reference stimulus, a small increment is needed for discrimination; with a more intense stimulus a bigger increment is needed.

Although Weber's Law indicates that the Weber fraction is independent of the stimulus strength this is not true for all sensory continua. One case in which a departure is seen from Weber's Law is for the discrimination of vibration frequency on the skin. For this sensory continuum the capacity for discrimination falls off steeply at higher vibration frequency, so that a plot of the *Weber fraction* $\Delta f/f$, (where f represents the reference vibration frequency and Δf the frequency increment needed for discrimination) against f, the reference frequency, is not a horizontal line as predicted by Weber's Law, but increases at higher values of f. However, for a weight discrimination task, there is a closer adherence to Weber's Law.

Scaling or ranking in psychophysics

In studies of sensation the issue of *scaling* arises where the subject is judging how intense the stimulus is. This problem obviously applies only to those aspects of sensation which vary in intensity or magnitude, such as brightness, weight, pressure, or loudness, but not for sensory continua where changes in the physical stimulus lead to changes in quality rather than quantity, such as colour. A sensory continuum which can change in quantity is known as a *prosthetic continuum*, e.g. changes in pressure or indentation on the skin. A sensory continuum which varies qualitatively, such as the *location* of a skin stimulus, is a *metathetic continuum*.

One of the ways of scaling stimuli along a sensory continuum is by allocating the stimuli to a number of different categories, for example 1 to 8, and plotting the relation between the average category allocation on the ordinate against the actual stimulus intensity on the abscissa. The form of the relation obtained in this type of plot will vary somewhat from one sensory continuum to another but, as demonstrated by Stevens' work the relation is usually described by a *power function* or *power law* relation given by:

$$R = K S^n$$

where R represents the subject's scaling estimate, S represents the intensity of the stimulus, K a constant; n is the value of the exponent, which will vary for different sensory continua.

EXERCISE 1: TEXTURE DISCRIMINATION

Design an experiment to test the ability of the subject to discriminate different grades of sandpaper. Factors you might consider in your study include:

1) static discrimination (press the finger tip onto the sandpaper) compared with discrimination with movement permitted;
2) active versus passive movement (subject moves finger or experimenter moves sandpaper);
3) the role of contact force;
4) whether a barrier such as a glove or a sheet of paper enhances discrimination.

Protocol:

EXERCISE 2: CUTANEOUS SENSIBILITY FOR THERMAL STIMULI

Closely clip the hairs from the back of a subject's hand over an area just bigger than the rubber stamp with the grid pattern used to outline the area of study. The thermal probes are brass rods kept in water of a pre-set temperature before the tip is placed briefly in contact with the skin.

Design an experiment to test whether:

1) there are non-uniformly distributed, thermal receptors in the skin
2) there are separate hot and cold receptors in the skin.

Protocol:

EXERCISE 3: WEIGHT DISCRIMINATION

Design an experiment to test the ability of a subject to discriminate weights held in the hand (small jars with a range of weights are used as the test material). Be careful to specify whether proprioreceptors are intended to contribute to your subject's judgment, and how you will control for this.

Protocol:

EXERCISE 4: SCALING/RANKING STIMULI ALONG A SENSORY CONTINUUM

Steady indenting stimuli to the skin will be delivered with a graded series of eight von Frey hairs.

Design an experiment to test the subject's magnitude estimation for different intensities of skin indentation.

Protocol:

EXERCISE 5: REGIONAL DIFFERENCES IN TACTILE SPATIAL RESOLUTION: TESTS OF TWO- POINT DISCRIMINATION

Design an experiment to determine the two point discrimination limit at various body sites. The 'two-point' limit measured in mm should plotted as a vertical line on Fig. 3 below.

Protocol:

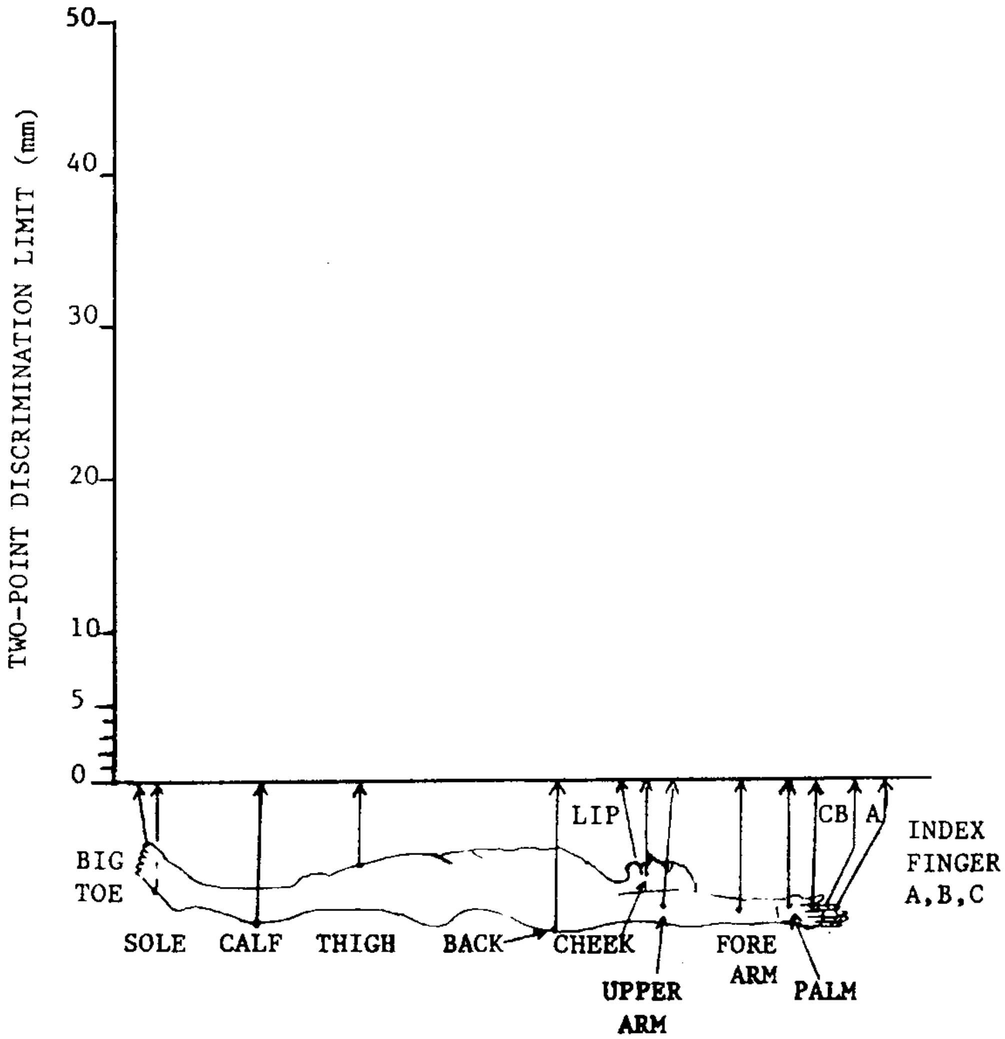

Fig. 3

Neural code underlying the perceptual response

For two of the experiments you have conducted, describe:

1) **the form of the stimulus-response relationship?**

2) **the probable neural mechanisms for coding information about the tactile stimulus.**

Notes

Physiology Teaching Laboratory Student Risk Assessment	UNSW THE UNIVERSITY OF NEW SOUTH WALES	PRAC # **PHSL-25** Title Kinaesthesia (NEUR 3221) DOC:PHSLSRA----

Hazards	Risks	Controls
A vibrator is used which may be an electrical hazard	Electrical hazard - Shock	The vibrators are used by a demonstrator, and the students are not allowed to use them without supervision. All electrical cords are tagged. Check tags on electrical cords for servicing details. RCD connected to the electrical circuit.
The student may be deprived of sensation and movement by an anoxic/pressure block using a sphygmomanometer cuff	Loss of sensation/blood flow	The experiment is done under constant supervision by an experienced teacher. This procedure is well established in research, and occlusions of up to 2 hours are known to be readily reversed without complications

Personal Protective Equipment			
n/a			

Emergency Procedures

n/a

Clean up and waste disposal

n/a

Ethics Approval

Declaration

I have read and understand the safety requirements for this practical class and I will observe these requirements.

Signature:……………………………………………………………Date:……………………………

PRAC# **PHSL-25** relates to RA # **RA-PHSL-25** related documents (SWP's/RA) SWP-GEN-33 (Working with electric equipment)

P2: KINAESTHESIA
Proprioception in alignment of elbow joints

This class has been approved by the Committee on Experimental Procedures involving Human Subjects (CEPHIS), and has Project No:99066. **STUDENTS ACTING AS SUBJECTS ARE REQUIRED TO SIGN CONSENT FORMS.**

TESTS OF PROPRIOCEPTION

The apparatus for this simple test is a Perspex screen marked out in degrees. The screen is placed vertically on a table between the subjects elbows. The subject rests his/her elbows on the table top and extends the forearms forward to rest on the table top also. The wrists are kept stiff, and the fingers closed into a loose fist except for the index fingers which point towards the mid-line.

The subject, blindfolded, is instructed to touch the fingertips together at some point on the board. Fine lines are drawn along the tips of the index fingers to aid observations by the experimenters. Choose the placement of the left index finger on the board as an arbitrary reference, and record the placement of the right index finger in degrees of rotation too flexed (positive), too extended (negative), or on target (zero error). Disregard misalignments due to wrist and finger angulations (i.e. misalignments along a radius of the forearm movement).

Always take 10 readings for each experimental situation. Calculate mean, and standard error of the mean.

Experiments

1. An experimenter gently lifts the subject's left hand and places it so that the index finger is against the Perspex. Precisely 10 seconds later, the subject bends his/her right elbow to move the right hand to the board in an attempt to align the fingers. The subject is not to be hurried in his/her choice, but must not touch the board until alignment is satisfactory. After each reading the subject places the hands back to their starting position on the table top.
    (a) Is there any difference in the subject's accuracy when attempting alignments in mid-range or at extreme range? (10 readings each).

    Q: Why?

    Devise another experiment to examine your reasons further.

(b) Is the subject more accurate when allowed to move both arms voluntarily, and at once, to a self chosen point in the middle of the range of excursion.

Comment:

2. (a) Apply a physiotherapy vibrator firmly over the biceps tendon of the left arm and repeat experiment 1.

(b) Take another set of readings with the vibrator over the triceps tendon of the left arm.

Do 2(a) and 2(b) differ from control 1? What might be the mechanism of this?

PERCEPTION OF HEAVINESS

Arrange for a blindfolded subject to lift weights with corresponding body parts on each side of the body. Arbitrarily choose one side as the reference (or experimental) side. Present a weight on that side.

Ask the subject to choose a weight to be lifted by one side of the body (the indicator side), which seems of the same heaviness as that on the experimental side. To permit this choice, present weights on the indicator side and adjust them up or down between lifts in the direction requested by the subject. Always add or subtract as instructed, but "overshoot" from time to time. When both sides seem the same, record the weight on the indicator side as the perceived heaviness of the weight on the reference side.

Make 10 readings, and calculate means and standard errors of the mean.

Q: How accurately can the subject estimate the heaviness of a lifted object?

Devise an experiment of your own on the perception of heaviness (10 more readings, compare with control).

PROPRIOCEPTIVE ILLUSIONS INDUCED BY MUSCLE VIBRATION

Apply a physiotherapy vibrator over a prominent muscle tendon, and ask your blindfolded subject to align the unvibrated side, with vibrated side. This experiment should reveal a proprioceptive illusion.

Examine and discuss it, with special reference to its possible physiological basis.

Q: How long does it last?

Q: What is it? (an illusory position? an illusory acceleration? an illusory force?)

Q: Does it occur when the stimulus applied to the tendon when the joint is at the end of the range which lengthens the muscle acting through that tendon? If so, what does this tell us about CNS processing?

[A demonstration will be given of the effect of applying vibration to the Achilles tendons of a standing subject].

Notes

Physiology Teaching Laboratory Student Risk Assessment	UNSW THE UNIVERSITY OF NEW SOUTH WALES	PRAC # **PHSL-26** Title Sensory nerve recording (NEUR 3221) DOC:PHSLSRA----

Hazards	Risks	Controls
Student use the power lab which could be an electric hazard.	Shock	The PowerLab is already connected and the students are not required to connect or disconnect the power supply. The PowerLab units are tested and certified to be used on Human subjects.
Students use computers.		Refer to SWP-GEN-34 (Working with Computer)
Students use sugar and salt solutions which could be chemical hazard.		
Students use feeder roaches which may be environmental pests.	Could cause infection.	The Feeder Roaches are kept in boxes and are anaesthetised by cooling by the technical staff before the practical, and the students quickly cut off one of the back legs. Correct PPE (lab coat, covered shoes, gloves).
Students use dissection microscopes.		No power cords are used. Refer to SWP-GEN-03 (Working with Microscopes)

Personal Protective Equipment			
Correct PPE (lab coat, covered shoes, gloves).			

Emergency Procedures
n/a

Clean up and waste disposal
n/a

Ethics Approval
n/a

Declaration
I have read and understand the safety requirements for this practical class and I will observe these requirements. Signature:……………………………………………………………Date:……………………………

PRAC# **PHSL-26** relates to RA # **RA-PHSL-26** related documents (SWP's/RA) SWP-GEN-34, SWP-GEN-04, SWP-GEN-03, SWP-GEN-33.

P3: SENSORY & MOTOR NERVE RECORDING

Part 1. Sensory Nerves

In the first part of this experiment you will be recording single action potentials from sensory axons. You will be able to demonstrate the exquisite sensitivity of the tactile system and study how tactile information is coded. The preparation is the cockroach leg, and you will record from joint afferents and from afferents associated with the spines on the cockroach leg.

Equipment

- Computer, PowerLab with BioAmp cable and headphones, 2 leads for grounding
- Retort stand with 2 micromanipulators providing 2 axes of positional control
- Recording electrodes embedded in a rubber stopper, clamped in the arm of the retort stand
- Speaker cone stimulator
- Dissecting microscope with light
- Fine forceps and scissors to dissect cockroach and position leg on recording pins
- Mechanical probe (insect pin), thermal probe (soldering iron shared between groups)
- Pasteur pipettes, 2% sugar solution, 2% salt solution

Set up

The cockroaches will be anaesthetised by cooling them and keeping them in a CO_2 atmosphere for 15 minutes. **They will eventually wake up, so work quickly.**

Each group will be given a cockroach and you will carefully cut off one of the back legs as close to the abdomen as possible. Then return the cockroach to its storage cage.

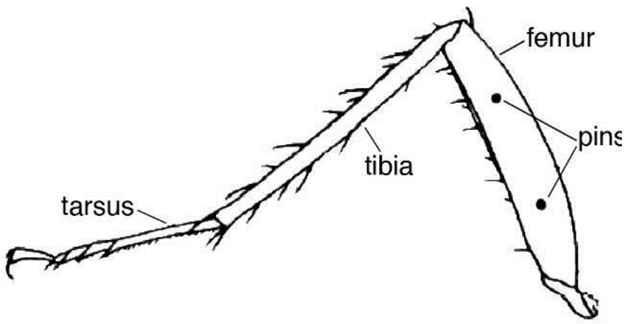

Fig 1 adapted from: *Advan Physiol Educ, 1992; 262: 18 - 22.*

The isolated leg needs to be impaled on the pins as shown in Figure 1. The pins function as extracellular recording electrodes and are connected to the BioAmp, which is a differential input amplifier in the PowerLab. The pins should go right through the leg and should suspend it above the cork. Use the fine forceps to hold the leg while you push it through the pins.

Turn on the PowerLab (switch is on the rear). Then switch on your computer and click on **LabChart7** then click open and find PowerLab-> Chart Settings -> **Sensory nerve** on the network drive.

Plug the headphones into the jack on the rear of the PowerLab. Choose "Start" on the PowerLab and you should begin to see and hear your recorded trace, possibly with some clear spontaneous action potentials.

Watch *and* listen

Electrophysiologists consider it desirable to both hear the amplified signal from a recording electrode, and to see a trace on a screen. Your ears will often discern signals which are not easily picked up on the screen, whereas the visual appearance of action potentials can be used to tell the activity of different cells or fibres apart, even when the APs sound more or less the same.

For each of the following experiments, make sure you listen to the activity through headphones as well as observing the PowerLab traces.

EXPERIMENT 1.1: AFFERENT FIBRE TYPES

Objective: To characterise the classes of afferent fibres in the cockroach leg

Test the leg for tactile, joint, thermal and chemical receptors.
Run Chart and while watching and listening to the neural response try the following types of stimulation.

- Use an insect pin to carefully move single spines and look for an increase in activity.
- Bend the joint, trying to avoid activating spines if possible.
- Let the soldering iron heat up, then disconnect it and bring it close to the leg to try and activate warm receptors.
- Many insects have sensory hairs or sensillae, some of which have a pore at the top and contain chemosensors. Use the Pasteur pipettes to apply a drop of solution to the leg while trying to avoid tactile activation and determine if there is any change in activity.

Q: How many classes of sensory receptor were you able to confirm?

EXPERIMENT 1.2: ACTION POTENTIALS OF SENSORY AXONS

Objective: To characterise single axon responses in the cockroach leg, and explain the basis for the shape and size of the recorded action potentials.

Find two spines some distance apart along the leg that each give a good response. Capture a segment of the response to activation of each spine, and then stop Chart.

Q: How big (in mV) are the action potentials in each response?

Q: Are the shapes of the action potentials from one spine all the same?

Q: Are the shapes of the action potentials from the two spines the same?

Q: Explain the size of the action potential (given that each action potential represents a shift in axon membrane potential from about –70 mV to about +20 mV) and the differences in shape.

Q: Do any other parameters, such as the maximum action potential rate, differ between the responses recorded from the two spines?

Q: What evidence do you have to support the idea that the action potentials you record when you stimulate a single spine originate from a single axon?

EXPERIMENT 1.3: DIRECTIONAL CODING

Objective: To use qualitative mechanical stimulation to study the neural coding of tactile information about direction of hair displacement.

Find a spine that gives a good response. Test the response to moving the spine in different directions.

Q: Is the response to an equal sized movement of the spine about the same in each direction of displacement?

Q: If the response differs depending on direction, can you compensate in the weakly stimulating direction by giving a bigger deflection?

EXPERIMENT 1.4: CONDUCTION VELOCITY

Objective: To determine conduction velocity of cockroach spine sensory afferent fibres.

You have been provided with a mechanical stimulator that uses a speaker cone plugged into the stimulus output of the PowerLab. We will use this to make controlled deflections of a single spine where we can precisely control the timing and size of the stimulus. Go to the menu options "Set-up -> Stimulator" and familiarise yourself with the stimulus options. Initially you will deliver a single pulse of variable duration and amplitude. Later you will also deliver trains of stimuli.

Use the manipulators holding your cockroach leg to bring a single spine into close contact with the bent pin tip on the stimulator. If you like, you can use a bit of wax or superglue to ensure good contact between the spine and the pin.

Set up a brief, strong stimulus pulse (5 V amplitude; 1 ms duration) with a delay of 1 ms.

Measure the latency of the earliest action potential in response to the stimulus. The latency is taken from the start of the stimulus to the start of the recorded action potential. *Also measure the distance from the spine to the first of your recording pins.*

Q: Using the formula* (speed = distance / time) *work out the conduction velocity for your afferent. Remember to express measurements as metres and seconds.

Q: Is the actual conduction velocity likely to be slower or faster than your calculated value? Why?

EXPERIMENT 1.5: NEURAL CODING

Objective: To use quantitative mechanical stimulation to study the neural coding of tactile information by cockroach spine receptors.

Determine a stimulus response relation by comparing the effectiveness of different stimulus amplitudes in eliciting spikes

stimulus voltage (V)	number of spikes elicited
2	
4	
6	
8	
10	

If all the stimulus voltages elicited a spike, continue decreasing the stimulus until you reach threshold.

Q: What is happening at the receptor when the stimulus is just below threshold?

If you have glued the spine to the pin tip, or if you can slip the tip behind the spine, measure the response of the spine to deflections of the stimulator in the opposite direction.

stimulus voltage (V)	number of spikes elicited
-2	
-4	
-6	
-8	
-10	

EXPERIMENT 1.6: ADAPTATION OF SENSORY SIGNALS

Objective: To use quantitative mechanical stimulation to study adaptation of sensory signals.

Use a stimulus amplitude that elicited several spikes in experiment 5, and vary the stimulus duration to study adaption.

stimulus duration (ms)	number of spikes elicited
1	
10	
50	
100	
500	

Q: Is there a fixed rate of firing of the afferent (i.e. is the number of spikes in 100 ms equal to 10 x the number in 10 ms)? If not, why not?

Q: Does the rate of firing change throughout the 500 ms stimulus?

Q: How long do you need to stimulate the spine before the afferent ceases to fire?

Q: What is the peak rate of firing you observed? What does this indicate about the refractory period?

Test the effect of using 1 ms pulses at 10 V to regulate firing – first give a train of 5 impulses at 10 Hz.

Q: How many spikes does each pulse generate?

Now try a train of 20 impulses at 100 Hz.

Q: How many spikes does each pulse generate? How does the spike pattern differ from that caused by a steady deflection?

Now try a train of 20 impulses at 500 Hz.

Q: How many spikes does each pulse generate? What is the peak firing rate achieved here?

Repeat the adaptation experiment on a different spine.

Q: Does its rate of adaptation differ from the first spine you tested?

P4: AUDITORY (Available online)

P5: DO-IT-YOURSELF PRACTICAL

Design your own practical and further explore topics of interest

Requirement: Your group must design and then complete a practical of your own.

Format: You will have the all the equipment from the previous four practicals available for your use. You will be responsible for writing up a sensible series of experiments, complete with your aim and protocol (i.e., Methods). Once your protocol has been approved by a demonstrator, you can begin your experiments and collect data. Further rules for this practical class will be available on Blackboard prior to the scheduled time.

Aims of the exercise: To give you experience in designing a good scientific experiment and allowing you to further explore topics of interest.

Contribution to assessment: This practical is to be written up for your Practical Report as all elements will be unique to you and your group (see page 11).

Dates: The DIY practical will take place in week 10 & 11 during the normal practical time.

How to choose a prac: All the equipment from the previous four practicals will be available; however, some of the more complex setups may be limited in number. I will set up a Discussion on Blackboard to allow you to pre-book the more complicated setups (e.g., the cockroach setup).