Proseminar in vision science – the brain

Brief course description
This seminar gives a basic introduction to post-retinal visual processes and perception. The emphasis will be to provide a background to the functional neurobiology of the cortex. The seminar is aimed at students in the Ph.D. program. Lecturers will impart basic information and ideas, stress current foci of research interest, and introducie research methods and their pitfalls. These topics will then be further pursued in the tutorial program.

Learning goals
The main goal of the proseminar is didactic. Students from varied backgrounds should be able to learn basic facts about the visual system. However, the goal is to achieve this in a thoughtful manner so that important issues in current research are brought to the fore. Additional goals are to inculcate a way of looking at experimental data in a critical manner so as to be able to assess the strength of results and conclusions. To this end, some sessions are devoted to experimental and computational methods.

Prerequisutes:
Admission to the Ph.D. program. Other students may audit the course with approval of the IOR.
Contact hours: 2-3 hrs per week, dates are provisional and times to be announced.

Student requirements
Background readings will be assigned for each lecture. On occasion selected students will be required to discuss topics assigned by the lecturer. Grades will be based on student participation and performance on a midterm and a final examination, which will consist of essay-style questions, requiring students to think critically and integrate materials.

INTRODUCTION TO VISION SCIENCE II

Lectures (and lecturers) for Spring 2011. Two 1.5 hour sessions/week, Monday & Wednesday 3-5 pm (or by arrangement with instructor).

Since this is the only course requirement for 1st year PhD students, a considerable amount of effort is expected. It is very important that the students know the readings beforehand and come prepared to discuss the material and ask questions. Exams will test students on all the material, so they should engage with faculty in understanding the material in every lecture.

This syllabus is provisional: lecture and exam dates, lecturers and lecture titles, and readings will change when considered appropriate by the faculty.

Jan 3: Psychophysical techniques (including photometry) (Schwartz)
Chapters 11 (Psychophysical Methodology) and 4 (Photometry) in Schwartz (2004). *Visual Perception: A Clinical Orientation*.

Jan 5 & 10: Structure and function in striate cortex (Alonso)
Principles of Neural Science (Kandel, Schwartz and Jessell, 4th edition). Chap 27

Jan 12 : Color perception (Zaidi)
Color Vision: From Genes to Perception, Gegenfurtner, K. and Sharpe, L. (eds.), Cambridge University Press, New York, 1999, Chapters 16, 17, 19 (Krauskopf, Zaidi, D'Zmura).

Jan 19: Visual adaptation (Zaidi)
Fitting the Mind to the World, Clifford and Rhodes (eds.), Oxford University Press, New York, 2005, Chapters 2, 4, 9 (Clifford, Zaidi, Webster et al).

Jan 24 & 26: Linear systems and Fourier analysis (Pola)
Handouts.

Jan 31 & Feb 3: Bayesian statistical models (and reasoning) (Backus)
A. Required reading:

1. Economist1.pdf (basic background)
2. Yudkowsky web intro (basic theory)
3. Attached selection from Chapter 2 of "Spikes"
   (an application of Bayesian inference to neural coding)

B. Highly recommended:

1. http://en.wikipedia.org/wiki/Bayesian_statistics
2. http://en.wikipedia.org/wiki/Naive_Bayes_classifier

C. We will also touch on Bayes Nets. Prepare by reading as far as you can into:

1. Andrew Moore's introduction to Bayes Nets, attached. Great introduction.
2. http://en.wikipedia.org/wiki/Bayes_net (Concise, accurate last time I looked).

D. Additional links and info (optional for now):

1. The attached paper by Kersten et al. gives an account of one aspect of perception, under the assumption that the visual system uses sense data to do Bayesian inference.
2. Netica tutorial to Bayes Nets is here, may help understand them:
http://www.norsys.com/tutorials/netica/nt_toc_A.htm

Feb 7 & 9: Signal detection (Backus)

1. Michael Levine (2000). Fundamentals of Sensation and Perception, pp 21-27.

2. Coombs, Dawes, & Tversky (1970). Mathematical Psychology. Chapter6: Theory of Signal Detection.
Required: pp 165-180.
Recommended: pp 193-201.
Optional: pp 180-193.

Feb 16: 3-D Shape perception (Zaidi)

Li, A., & Zaidi, Q. (2004). Three-dimensional shape from non-homogeneous textures: Carved and stretched surfaces. Journal of Vision, 4(10):3, 860-878 (http://www.journalofvision.org/4/10/3/)
Fleming, R. W., Torralba, A., & Adelson, E. H. (2004). Specular reflections and the perception of shape. Journal of Vision, 4(9):10, 798-820 (http://www.journalofvision.org/4/9/10/)
Tse, P. U. (2002). A contour propagation account of surface filling-in and volume formation. Psychological Review, 109, 1, 91-115.

Feb 21: Motion perception (Zaidi & Jain)

Adelson & Bergen Spatiotemporal energy models for the perception of motion J. Opt. Soc. Am. A/Vol. 2, No. 2 February 1985 (http://www.klab.caltech.edu/cns186/papers/adelson-bergen-85.pdf)
Movshon, Adelson, Gizzi, Newsome, The analysis of moving visual patterns, Pattern Recognition Mechanisms, 1985 (http://www-bcs.mit.edu/people/adelson/./publications/postscript/pattern85.ps.Z)
Cohen, E. Jain, A and Zaidi, Q. The utility of shape attributes in deciphering movements of non-rigid objects Journal of Vision, 10(11):29, 1–15, 2010.

Feb 23: 3-D Shape from motion cues (Zaidi & Jain)

Koenderink, Optic flow, Vision Research, Vol 26(1), 1986, 161-179.
Domini & Caudek, 3-D structure perceived from dynamic information: a new theory, Trends in Cognitive Sciences, 2003.
Jain, A and Zaidi, Q. Discerning non-rigid 3-D shapes from motion cues PNAS (In press).

Feb 28: Mid-term Exam

March 14 & 16: Binocular vision (Backus)

March 21 & 23: Space and scene perception (Sedgwick)

Sedgwick, H. A. Visual space perception. In E. B. Goldstein (Ed.) *Handbook of Perception*. Oxford: Blackwell, 2001,128-167.
Gillam, B. (1995) The perception of spatial layout from static optical information. In Epstein & Rogers (Eds.) *Perception of space and motion*. Academic Press, 1995, 23-67.

March 28 & 30: Control and consequences of eye-movements (Pola)

Eye Movements Basics for the Clinician, Kenneth Ciuffreda & Barry Tannen
Chap. 1: p. 1 - 9
Chap. 2: p. 10 -19
Chap. 3: p. 36 - 44, p. 53 - 60
Chap. 4: p. 72 - 78, p. 91 - 92
Chap. 5: p. 102 - 108
Chap. 6: p. 127 - 129

April 4 & 6: Extra-striate cortex and perception (Alonso)

Principles of Neural Science (Kandel, Schwartz and Jessell, 4th edition). Chap 28

April 11 & 13: Disorders of central vision (Ciuffreda)

SJ Anderson and JB Swettenham, Neuroimaging in human amblyopia, Strabismus, 14: 21-35, 2006.

April 18 & 20: Perceptual learning (Backus)

April 25 & 27: Attention and the control of neural processing (Alonso)

Posner, M.I. & Petersen, S.E. The attention system of the human brain. Annu Rev Neurosci 13, 25-42 (1990).
Desimone, R. & Duncan, J. Neural mechanisms of selective visual attention. Annu Rev Neurosci 18, 193-222 (1995).
Kastner, S. & Ungerleider, L.G. Mechanisms of visual attention in the human cortex. Annu Rev Neurosci 23, 315-341 (2000).

Reynolds, J.H. & Chelazzi, L. Attentional modulation of visual processing. Annu Rev Neurosci 27, 611-647 (2004).

May 3 & 5: Higher level control of saccades and attention (McPeek)
1) pages 792-795 from Principles of Neural Science (Kandel, Schwartz, Jessell), 4th edition, 2000.
2) pages 3-16 from Cognitive Neuroscience of Attention, edited by John E. Richards, 1998.
3) Lee C, Rohrer WH, and Sparks DL. (1988). Population coding of saccadic eye movements by neurons in the superior colliculus. Nature 332: 357-360.
4) Moore T and Armstrong KM. (2003). Selective gating of visual signals by microstimulation of frontal cortex. Nature 421: 370-373.

May 10: Final written examination