**Interdepartmental Vision Course**
Psych 131A (68175) = BioSci N182 (06051)
Spring, 2007. SSPA-1100. Tu, Th 11:00-12:20
Class website: www.socsci.uci.edu/HIPLab/Vision_Class/

**Prof. George Sperling**
Discussion Sections
Mon 2:00p SSTR 100
Tue 12:30p SSTR 101
Wed 3:00p SST 220A
Fri 1:00p PCB 1300

SYLLABUS

Recommended (not required) textbook:

Title: Vision Science -- Photons to Phenomenology
Author: Stephen E. Palmer
Publisher: MIT Press, Cambridge, MA. (hardcover, 810 pp).

Other textbooks on Vision or on Sensation and Perception would also be OK. Exams are based on materials presented IN CLASS. A textbook is useful for supplementing the class lectures when students have difficulty following, for review, or to learn more. Notes outlining the lecture materials will be provided on the internet.

Lectures

1. Overview: (i) . Algorithms of visual perception: how to compute range compression (light adaptation), color, form & lightness, depth, motion, how to create spatial frequency channels, object recognition, decision mechanisms; (ii) neural mechanisms that implement the algorithms; (iii) phenomena of vision including demos and self experiments; (iv) experimental methods for studying vision.
   Sample of some phenomena introduced in Chapter 1 of Palmer (plus related phenomena). Veridical perception vs illusions, adaptation and aftereffects, afterimage, visual spatial illusions, interpretive active versus passive perception, multistable representations, visual completion, impossible objects, classification, attention, consciousness, mentalism, optical array.
   Reading: Palmer: Chapter 1 (Introduction to Visual Science), pp. 4-15.

2. Physics of Light. Photons (waves & particles), wavelength, polarization angle, speed = wavelength x freq, refraction, absorbtion, reflection, chromatic aberration & prism, how to measure wavelength, pinhole camera, visual angles. Cameras, lenses, lens law, diopters.
   Reading: Palmer, Ch. 1, Pp. 15-23, 616-618; Yellott, Optics and Visual Acuity, pp 1-10.
   Problem set 1: Visual angles; measure blind spot

3. Structure of the eye. Refraction, camera and the human eye compared, structure of the eye, problems with the pinhole & pupil size; How to measure the power of lenses, diopters, accommodation, myopia, acquired myopia, presbyopia refraction and spectacles; aberrations. Demonstration: spherical and cylindrical corrections, additive +- lens powers (with overhead projector).
   Reading: Palmer, pp 24-34; Yellott, Optics and Visual Acuity, 11 pp;
   Problem set 2: Diopters, refraction; measure range of accommodation.

4. Photometry: point-source, illuminance, luminance, retinal illuminance. Rods & cones, light & dark adaptation, experimental methods (brief introduction), Demonstration: Luminance is not brightness. Gelb (importance of surround).
   Reading: Review Palmer Ch. 1; Photometry summary page (Sperling)
   Problem set 3: Photometry

5. Visual anatomy and physiology 1. Review dark adaptation; Neurons (Hodgkin-Huxley), pumps, dendrites, axons, nerve impulse, saltatory conduction, synapses, transmitters (Acetyl cholne, GABA, ...) Optic nerve, optic tract, overview of anatomy (van Essen), what & where systems. How to experimentally determine receptive fields, receptive fields in retinal ganglion cells (Kuffler), LGN, V1-4c; simple cells (Hubel & Wiesel). M- P- K- cells, LGN structure, cortical unfolding, Retinotopic maps, cortical magnification, globe, Mercatur, conformal map (e+z)^-1; computational specialization (color, space, time).
   Reading: Palmer, pp 35-43, 64-70, 115-117, 143-158

6. Visual anatomy and physiology 2. models (mathematical, computational, physical, neural) neuronal computation, (neuron = Mississippi). Channels: characterizing a neuron by the spatial frequency of the sinewave to which it is maximally sensitive, tiling a space with neurons of a particular kind, push-pull, Cortical architecture, columns, visual system anatomy/architecture. Brain imaging (EEG, MEG, PET, fMRI). parallel computation.

7. Color Vision 1. Color, color matching. Trichromacy, dimensionality, metameres, Grassman's Laws; demonstrating quanta psychophysically. Absorption, difference, and action spectra, spectral sensitivity. Color versus reflectance. CIE Color space. The algorithmic problem: Extracting surface reflectance and illumination in natural scenes.

   Reading: Palmer, Ch. 5, Color Vision, pp. 95-139; Appendix C. Color Technology, pp 689-699.

8. Color Vision 2. Young-Helmholtz vs Hering, physiological representation, color blindness, How to make color films, prints, achieve perfect reproductions (feedback). Review.

9. Exam 1.

10 & 11. Spatial vision. Contrast senstivity functions, sinewaves, channels: [Superposition, sinewaves, impulses], Fourier theorem; application to receptive fields; channels, and the algorithmic consequences of multiresolution representation; Mach bands and related illusions; failures of simple center-surrouond computations; lightness illusions (Mach card; Craik-O'Brian, Gilchrist, Adelson). Review visual angles and logarithms, if necessary.

   Reading: Palmer, pp 125-132 (review), 158-171.

12. Psychophysical methods and sensory scaling. Constant stimuli, method of limits, adjustment, adaptive methods, JND. Sensory scaling, magnitude estimation, power law, scale types. Weber, Fechner, psychophysical laws; objective versus subjective methods (Type 1 versus Type 2 experiments). Type A and type B expts; perceptual experience (consciousness) within a scientific framework. Signal detection theory, 2AFC.[Noise as the ultimate limiting factor].

   Reading: Palmer, Appendix A. Psychophysical Methods, 666-673; Sperling, Type 1 and 2 Experiments, 2 pp

13. Depth Perception 1. Convergence, accommodation, binocular disparity. Pictoral cues: Retinal image size, linear perspective, texture gradients, shading, occlusion, atmospheric perspective, familiarity. Movement Parallax. Kepler diagram, horopter, Panum.

   Reading: Palmer, Ch. 5. Perceiving Surfaces Oriented in Depth, pp 200-253.

14. Depth Perception 2. Random-dot stereograms, making a "seeing eye" picture. Size as combination of retinal size and perceived distance, cue combination & early decision processes. Illusions. Perceptual recalibration, prism expts.

15. Motion Perception 1. Space-time representation, computational equivalence to depth and texture; sampled versus continuous motion, correlation model, motion aftereffects, traditional observations. Structure from motion, flowfields, algorithms. Relation to texture and receptive fields.

   Reading: Palmer, Ch. 10. Perceiving Motion and Events, pp. 467-517

16. Exam 2.

17 & 18. Motion Perception 2 (concluded). Second- and third-order motion. Why don't we see motion when the eye moves? How to create virtual reality. Object recognition. Figure-ground = segmentation: Rules, Gestalt grouping phenomena, shadows, T-junctions (again), texture segregation and visual search; pop-out, parallel versus serial search; Mach card, Necker cube, binary perceptions, top-down versus bottom up--inverted faces. Computational approaches: template vs feature matching; pandemonium system; cartooning versus gray scale; generic viewpoints.

19. Perceptual development; neurological disorders. Cone redirection; critical period, deprivation, V1 re-organization Visual cliff, snakes, restored sight, Descarte's paradox (circle, square), Prism and inverting lens adaptation (Stratton, Harris, Ramachandran). Blindsight, split brain, Balint syndrome, prosopagnosia, parallel visual computation. Reading, eye movements in reading, chess board skills, 10^4 hrs, letter-word phenomenon. Why doesn't the world seem blurred with poor peripheral vision.

Readings. Palmer, pp 249-253 (review), pp 631-638.

20. Miscellaneous issues in object perception. Review (10 min Hamlet - Tom Stoppard).

UCI Spring, 2007 Psych 131A, Bio N182
Apr 03 (Tue) 11:00a SSPA 1100 Vision L01
Apr 05 (Thu) 11:00a SSPA 1100 Vision L02
Apr 10 (Tue) 11:00a SSPA 1100 Vision L03
Apr 12 (Thu) 11:00a SSPA 1100 Vision L04
Apr 17 (Tue) 11:00a SSPA 1100 Vision L05
Apr 19 (Thu) 11:00a SSPA 1100 Vision L06
Apr 24 (Tue) 11:00a SSPA 1100 Vision L07
Apr 26 (Thu) 11:00a SSPA 1100 Vision L08
May 01 (Tue) 11:00a SSPA 1100 Vision L09 MIDTERM 1
May 03 (Thu) 11:00a SSPA 1100 Vision L10
May 08 (Tue) 11:00a SSPA 1100 Vision L11
May 10 (Thu) 11:00a SSPA 1100 Vision L12
May 15 (Tue) 11:00a SSPA 1100 Vision L13
May 17 (Thu) 11:00a SSPA 1100 Vision L14
May 22 (Tue) 11:00a SSPA 1100 Vision L15
May 24 (Thu) 11:00a SSPA 1100 Vision L16 MIDTERM 2
May 29 (Tue) 11:00a SSPA 1100 Vision L17
May 31 (Thu) 11:00a SSPA 1100 Vision L18
Jun 05 (Tue) 11:00a SSPA 1100 Vision L19
Jun 07 (Thu) 11:00a SSPA 1100 Vision L20
Jun 12 ?? TBA FINAL EXAMINATION