

Vision Course

Psych 217 (68730)

Spring, 2008. SSPB-3218. Wed 2:00-4:50p

Class website: www.socsci.uci.edu/HIPLab/Vision_Class_Psych217/

Prof. George Sperling

SYLLABUS

Recommended (not required) textbook:

Title: Vision Science -- Photons to Phenomenology

Author: Stephen E. Palmer

Publisher: MIT Press, Cambridge, MA. (hardcover, 810 pp).

Alternative textbook (less complete):

Title: Sensation and Perception.

Author: Goldstein, E. B.

Publisher: Belmont, CA: Wadsworth

*** For each lecture, a listing of the corresponding pages in Goldstein, both for the 5th and 6th editions, is given at the end of this document.

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 class web page.

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, absorption, 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. 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 2: Photometry
4. 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 3: Diopters, refraction; measure range of accommodation.
5. Visual anatomy and physiology 1. Review dark adaptation; Neurons (Hodgkin-Huxley), pumps, dendrites, axons, nerve impulse, saltatory conduction, synapses, transmitters (Acetyl choline, 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. 3, Color Vision, pp. 94-139; 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 & 10. Spatial vision. Contrast sensitivity 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-surround 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.
11. 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
12. Depth Perception 1. Convergence, accommodation, binocular disparity. Pictorial 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.
- 13, 14. MIDTERM
15. 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.
16. 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
- 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: holograms ... 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, sign language, V1 re-organization Visual cliff, snakes, restored sight, Descarte's paradox (cube, sphere), 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).

SCHEDULE UCI Spring, 2008 Psych 217

Apr 02 2:00p SSPB 3218 Vision L01
 Apr 02 3:30p SSPB 3218 Vision L02
 Apr 09 2:00p SSPB 3218 Vision L03
 Apr 09 3:30p SSPB 3218 Vision L04
 Apr 16 2:00p SSPB 3218 Vision L05
 Apr 16 3:30p SSPB 3218 Vision L06
 Apr 23 2:00p SSPB 3218 Vision L07
 Apr 23 3:30p SSPB 3218 Vision L08
 Apr 30 2:00p SSPB 3218 Vision L09
 Apr 30 3:30p SSPB 3218 Vision L10
 May 07 2:00p SSPB 3218 Vision L11
 May 07 3:30p SSPB 3218 Vision L12
 May 14 2:00p SSPB 3218 Vision L13-14 VSS; MIDTERM
 May 21 2:00p SSPB 3218 Vision L15
 May 21 3:30p SSPB 3218 Vision L16
 May 28 2:00p SSPB 3218 Vision L17
 May 28 3:30p SSPB 3218 Vision L18
 Jun 04 2:00p SSPB 3218 Vision L19
 Jun 04 3:30p SSPB 3218 Vision L20

Goldstein, 5th edition

Lecture - Chapter, pages
 number

1. Goldstein (5th), Chapter 1, Introduction to Perception, p. 1-26.
2. None. See other readings.
3. Goldstein (5th), p. 36-39, 42-49.
4. Goldstein (5th), p. 31-36.
5. Goldstein (5th), p. 14-20, 51-54, 71-79, 88-97, 104-123.
6. Continue readings from previous lecture.
7. Goldstein (5th), Chapter 5, Perceiving Color, p. 131-152.
8. Continue readings from previous lecture.
9. Goldstein (5th), p. 54-60, 79-88.
10. Goldstein (5th), Appendix, p. 553-561, 8-13.
11. Goldstein (5th), Chapter 8, Perceiving Visual Space, p. 215-241.

12. Goldstein (5th), Chapter 9, Size, Illusions, and Ecological Aspects of Perception, p. 245-267.

13-14. MIDTERM

15. Goldstein (5th), Chapter 10, Perceiving Movement, p. 273-300.

16. Continue readings from previous lecture.

17. Goldstein (5th), Chapter 16, Perceptual Development, p. 469-501, 233-238.

 6th edition

Lecture - Chapter, pages
 number

2. Goldstein (6th), Chapter 2, Receptors and Neural Processing, p. 35-48.

3. Goldstein (6th), Chapter 16, Clinical Aspects, p. 547-551

4. Goldstein (6th), Chapter 2, Receptors and Neural Processing, p. 35-48.

5. Goldstein (6th), Chapter 2, Receptors and Neural Processing, p. 58-71.

6. Goldstein (6th), Chapter 4, Higher-Level Visual Processing, p. 109-123.

7. Goldstein (6th), Chapter 6, Perceiving Color, p.185-200, p.206-215.

8. Goldstein (6th), Chapter 2, Receptors and Neural Processing.
 Goldstein (6th), Chapter 3, Visual Processing: LGN and Striate Cortex

10. Review Goldstein (6th), Chapter 3, Visual Processing: LGN and Striate Cortex, p.88-94

11. Review Goldstein (6th), Chapter 1, p.11-18. Appendix p.583-590.

12. Goldstein (6th), Chapter 7, Perceiving Depth and Size, p.225-227, p.233-244.

13. Goldstein (6th), Chapter 7, Perceiving Depth and Size, p.227-233, p.244-260.

14. Goldstein (6th), Chapter 8, Perceiving Movement.

17. Goldstein (6th), Chapter 15, Perceptual Development, p.510-528.
 Review Goldstein (6th), Chapter 7, Depth, p.261-263.

19. Goldstein (6th), Chapter 5, Perceiving Objects.
