The Human Visual System
Syllabus

IMGS–620, Fall 2015
TuTh 14:00–15:15, CAR–XXXX

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Background

The Human Visual System[1] describes the underlying structure of the human visual system and psychophysical ($\Phi \rightarrow \Psi$, or better,$\Phi \rightleftarrows \Psi$) techniques used to measure its performance. The visual system's optical and neural systems responsible for collecting and detecting spatial, temporal, and spectral signals from the environment are described. The sources and extent of limitations in the subsystems are described and discussed in terms of the "enabling limitations" that allow practical imaging systems. Some laboratory/homework projects are included.

Goals & Objectives

The primary objective of this class is for the student to gain an understanding of the overall structure and function of the human visual system, and how the structure and function inform the design of imaging systems. A related objective is an overview of fundamental experimental techniques and data analysis used in *psychophysics* – the scientific study of the relationship between stimuli (specified in physical terms) and the sensations and perceptions evoked by these stimuli.

Specifically,

- The human visual system and its evolution.

[1] Notice! I have cribbed much of this from Dr. Pelz' syllabus from last year. It's best that I do it that way, I suppose, so that I cover the material he would cover. It won't be *precisely* the same, because I am a different human-being. But I'll do the best I can.

- Experimental processes in visual neuroscience.
- Analysis techniques in visual neuroscience.

Assessment will be via

- n examinations.
- m laboratory / homework projects.
- Final project.
- Class participation.

Materials

Readings

Readings will be available on your CMS as soon as I can figure out how to get them there. Otherwise I'll put them on Dropbox or some other convenient place. The bibliography at the end of this document specify the sources of these readings.

Software

We'll be using *PsychoPy* to create experiments for the class[2]. You can get it from www.psychopy.org. I'll warn you ahead of time, it can be a little wonky (it's FOSS after all) but, I am a contributor to the project and know the main authors pretty well. We'll get things to work.

[2] Actually — you are welcome to use whatever you'd like, writing code from scratch if you wish, using Python, Matlab (with the Psychophysics Toolkit for example), *Mathematica*, or IBM 360 assembly or JCL (`google` that) as far as I'm concerned.

Schedule

Part	Topic	Readings
0.	Introduction	Palmer, ch 1
1.	Psychophysical and Signal Detection Methods	Gescheider Cornsweet Sweet
2.	Early Vision: Anatomy, Optics & Physiology	Hubel, ch 3 & 4 Levine
3.	Color	Koenderink Hubel, ch 8
4.	Motion	Palmer, ch 10
5.	Space	Hubel, ch 7
6.	Biologically Inspired Vision	TBD

Assessment and Grading

- Exams — 50%
- Labs / projects / homework — 20%
- Final project — 20%
- Participation — 10%

Exams

Exams will take a variety of forms, including, but not limited to: multiple guess, essay, and short answer. If you are going to miss one, let me know. I reserve the right to deal with re-taking, re-scheduling, &c. at my discression.

My hunch is that $n = 3$. We'll solidify this the first day of class.

Labs / Homework

We will do a few exercises with *PsychoPy* to create psychophysical experiments and to analyze psychophysical data. These should be useful and inform your work on the final paper / project.

Final Paper / Project

The final project is an in-depth examination of some aspect of visual psychophysics. This is intentionaly broad. The goal is for you to identify an area related to the visual system that is relevant to your research interests and that you wish to explore in more depth. A written proposal for the project is due in Week 7, it should be a 1/2 page statement of your objective and plan. We'll spend a little bit of class to run through them with each other and crituque them. Final writeups are due Week 12, along with a *five minute, five slide* 'pitch' that you'll present to the class. The final writeup should be approximately 2,500–4,000 words. You may use MLA, APA, ACM, or IEEE style.

Participation

Participation can take many forms. Feel free to do so as you feel comfortable, but do participate.

Late Work

Unless arrangements are made prior to the due date / time, late work will not be accepted and will receive a 0.

Warning

> "In this class, you could be exposed, at any moment, without warning, to ideas, comments, readings, or other materials that you find shocking, offensive, absurd, annoying, racist, sexist, homophobic, discriminatory, or generally obnoxious. We call this education." - after Jonathan Rauch

Slack

However — generous swaths of slack shall be cut to those who provide respect to the learning process and the class in general.

Some Books and Readings on Vision

Cornsweet, T. (2012). *Visual perception*. Academic Press.

Gescheider, G. A. (2013). *Psychophysics: the fundamentals*. Psychology Press.

Gibson, J. J. (1950). *The perception of the visual world*. Houghton-Mifflin.

Gibson, J. J. (1966). *The senses considered as perceptual systems*. Houghton-Mifflin.

Gibson, J. J. (1979). *The ecological approach to visual perception*. Psychology Press.

Green, D. M. & Swets, J. A. (1989). *Signal detection theory and psychophysics*. Peninsula Pub.

Hubel, D. H. (1995). *Eye, brain, and vision*. W. H. Freeman.

Koenderink, J. J. (2010). *Color for the sciences*. MIT Press.

Lee, H.-C. (2005). *Introduction to color imaging science*. Cambridge University Press.

Levine, M. W. (2000). *Levine and Shefner's fundamentals of sensation and perception*. Oxford University Press.

Lu, Z.-L. & Dosher, B. (2013). *Visual psychophysics: from laboratory to theory*. MIT Press.

Macmillan, N. A. & Creelman, C. D. (2004). *Detection theory: a user's guide*. Routledge.

Palmer, S. E. (1999). *Vision science: photons to phenomenology*. Bradford Books.

Purves, D. & Lotto, R. B. (2003). *Why we see what we do: an empirical theory of vision*. Sinauer Associates Incorporated.

Rodieck, R. W. (1998). *The first steps in seeing*. Sinauer Associates Incorporated.

Rubin, M. L. (1993). *Optics for clinicians*. Triad Publishing Company.

Chester F. Carlson Center for Imaging Science Shared Expectations for Ethics and Professional Integrity

Overview: The Chester F. Carlson Center for Imaging Science is dedicated to a challenging and collaborative educational experience in imaging science that is grounded in the integrity of the students, faculty, and staff. That integrity is expressed by our actions, individually, as well as by our actions collectively, including those in research; on laboratory, programming, and homework assignments; on examinations; and in our collaborations and interactions with one another. RIT has a policy on academic dishonesty, which is maintained at: www.rit.edu/ w-policy/sectionD/D8.html

The shared expectations described in this document build on, and are in addition to, the RIT policy. The purpose of this shared expectations document is to assure that we in CIS are taking an active and engaged approach to maintaining the highest possible levels of scientific and professional ethics and integrity and that the students, faculty, and staff of CIS have a common code of ethics and integrity and a common understanding of the consequences of violating that code.

Research : It is unethical to falsify any data in an experiment, or computational or theoretical results, whether the data or results are to be submitted to internal or external review (e.g., in a thesis or dissertation or for a conference or journal paper or a grant proposal). Similarly data and results cannot be plagiarized. If data are demonstrated to have been falsified or plagiarized on a graduate thesis or dissertation, the graduate faculty has discretion to determine the penalty, up to and including expulsion from the program. If data have been falsified on a paper submission, the paper shall be withdrawn and the graduate faculty shall have discretion to determine the penalty.

Examinations: Students must not plagiarize the work of others nor allow others to plagiarize their work on written examinations. The faculty will try to arrange the room in such a manner to remove or discourage such temptation. Faculty may require students to attest to their conduct on any submitted material by signing a statement such as, "I have neither given nor received unauthorized assistance on this examination". The faculty member has discretion to determine the penalty for violations of this policy.

Homework: The faculty member has the obligation to specify the conditions to be fulfilled on homework submissions (e.g., can be done collaboratively, must be done alone etc.). As a rule, students may not submit the work of others as their own. In many, if not most, homework scenarios, collaborative effort on homework is part of the learning process and is therefore useful, but students may be asked to reference any assistance that they have received. Similarly, group planning and/or checking of final answers may be permissible, but both are examples of collaborative efforts that must be attributed if required by the

professor. Faculty may require students to attest to their conduct on any submitted material (e.g., laboratory reports, computer programs, term papers) by signing a statement such as, "I have followed all guidelines and requirements and have attributed all assistance received".

Collaboration: Collaboration among students is often encouraged as an integral part of the learning experience, be it in the classroom or for research. Some examples include group projects, laboratory assignments, and test preparation. Whenever submitted work is the result of such collaboration, clearly crediting all who contributed will eliminate the possibility that the collaboration is in violation of RIT's Academic Honesty Policy, which states, "Any act of improperly representing another person's work as one's own is construed as an act of academic dishonesty".

Incoming students will discuss this Shared Expectations for Ethics and Professional Integrity, and the RIT Academic Dishonesty Policy and after having an opportunity to ask questions, will sign a copy of the Expectations indicating that they have read and discussed it and are aware of the consequences of policy violations. In some cases, the penalties for violation of the policy are stipulated; in others they are not rigidly defined, giving the faculty discretion in specifying the consequences. Those consequences may include failure in a course, suspension of funding for a term, or expulsion from the program in severe cases such as falsifying research data or multiple violations. In all cases, academic honesty violations should be reported to the CIS Director, so that the Director can maintain an overview of instances of academic dishonesty and the consequences that occur within the Center.

This document is subject to random changes at my sole discression or via *vis major*.

Last updated: August 30, 2016