PSY801 Sensation and Perception
Fall 2017

Instructor: Taosheng Liu
Meetings: Tuesday 1:50-4:40, Room 287 Psychology Bldg
Office hours: By appointment
Readings:

1. Palmer, S. *Vision Science: Photons to Phenomenology* (MIT Press 1999), available as E-book at MSU library website, online erratum: http://socrates.berkeley.edu/~plab/corrections.html
2. Additional original research articles (see reading list below).

Course description and objectives

This course focuses on visual perception. Vision is arguably the most important sense for humans and it has been studied since the very beginning of psychology and physiology. Today, vision science is an interdisciplinary effort of investigation that spans several fields: psychology, neuroscience, and computer science. Scientists from these various disciplines address the same question from different perspectives: how do we see? As you will discover, the answer to this seemingly innocent and simple question is far from simple. Underneath the apparent ease of seeing is an amazingly complex and intricate machinery and associated computations. Although far from complete, our knowledge of vision is by far the most comprehensive among all cognitive functions, and vision remains the "best shot" for scientists to gain a true understanding of how (a piece of) the mind works. This course will survey our current understanding of visual processes from the psychological, physiological, and computational perspectives. The goal is to provide an appreciation of our increasingly integrated, coherent understanding of visual perception from multiple levels of analysis.

Prerequisite: It is not necessary to have specific preparation for this course. Indeed it is hard to have all the relevant preparation for a diverse topic such as vision science. However, some knowledge about the following will be useful: psychophysics, perception (undergraduate level), cognitive psychology, neuroanatomy and neurophysiology, math (calculus, linear algebra, probability and statistics).

Course requirement and assessment

Class participation	15%
Weekly write-ups	20%
Presentations	15%
Mid-term exam	25%
Final exam	25%

Participation and write-ups: I fully expect everyone will attend every class session, and actively participate in the discussion. To facilitate our discussion, you are to write a short reaction paper every week (except the first week). Feel free to write (some of) your thoughts about that week's reading. Some examples of what to write about: what are the most important/interesting things you learned from the reading? Is the reading clear, or something needs to be explained in more detail? How does the information fit with your previous knowledge? What are the outstanding questions that remain to be addressed? At the end of your paper, you should write down 2-5 questions for group discussion, things that you think are interesting and you would like to hear other's opinion. Aim for somewhere around 500 words (but definitely no more than 1000 words). Submit your paper on D2L by 1 day prior to class (i.e., **by 12 noon on Mondays**).

Presentations: Students are expected to present readings of research articles and lead the discussion of those readings.
Exams: There will be two take-home exams, with mostly essay type of questions.

Class schedule

Wk	**Date**	**Topic**	**Reading** (VS: Palmer)
1	Sept 5	Introduction	VS Ch 1; linear system intro
2	Sept 12	Theoretical frameworks	VS Ch 2; (1-4)
3	Sept 17	Signal detection	VS appendix A; SDT handout; (5-7)
4	Sept 26	Image structure	VS Ch 4; (8, 9)
5	Oct 3	Color and Motion	VS Ch 3, Ch 10; (10)
6	Oct 10	Depth	VS Ch 5; (11, 12)
7	Oct 17	Crowding	(13-15)
8	Oct 24	*No class, mid-term exam due*	*mid-term exam due*
9	Oct 31	Dorsal vs. ventral streams	(16-19)
10	Nov 7	Perceptual organization	VS Ch 6; (20-22)
11	Nov 14	Object properties and shape	VS Ch 7, Ch 8; (23, 24)
12	Nov 21	Function and category	VS Ch 9; (25, 26)
14	Nov 28	Attention & Awareness	VS Ch 11, Ch13; (27)
15	Dec 5	Memory & Imagery	VS Ch 12; (28-30)
16	Dec 11	*Final exam due*	

Reading List (papers will be posted on D2L)

1. Gibson JJ (1979) in *The ecological approach to visual perception.* (Houghton Miflin Co., Boston), pp. 238-263.
2. Helmholtz H (1896/1925) *Concerning the perceptions in general.*
3. Marr D (1982) in *Vision: A Computational Investigation into the Human Representation and Processing of Visual Information* (MIT Press, Cambridge, MA), pp. 8-38.

4*. Zhaoping, L. (2014). Understanding vision: Theory, models, and data. Oxford University Press, USA. Chapter 1, "Approach and Scope"

5. Tanner WP, Jr. & Swets JA (1954) A decision-making theory of visual detection. *Psychol Rev* **61,** 401-409.
6. Britten KH, Shadlen MN, Newsome WT, & Movshon JA (1992) The analysis of visual motion: a comparison of neuronal and psychophysical performance. *J Neurosci* **12,** 4745-4765.

7*. Ress D & Heeger DJ (2003) Neuronal correlates of perception in early visual cortex. *Nat Neurosci* **6,** 414-420.

8. Olshausen, B. A., & Field, D. J. (1997). Sparse coding with an overcomplete basis set: A strategy employed by V1? *Vision Research,* 37(23), 3311–3325.
9. Vinje, W. E., & Gallant, J. L. (2000). Sparse coding and decorrelation in primary visual cortex during natural vision. *Science*, 287(5456), 1273-1276.
10. Palmer, S. E., Schloss, K. B., & Sammartino, J. (2013). Visual aesthetics and human preference. *Annual Review of Psychology*, 64, 77-107.
11. Landy MS, Maloney LT, Johnston EB, & Young M (1995) Measurement and modeling of depth cue combination: in defense of weak fusion. *Vision Res* **35,** 389-412.
12. Cumming BG & DeAngelis GC (2001) The physiology of stereopsis. *Annu Rev Neurosci* **24,** 203-238.
13. Whitney, D., & Levi, D. M. (2011). Visual crowding: A fundamental limit on conscious perception and object recognition. *Trends in cognitive sciences*, 15(4), 160-168.
14. Freeman, J., & Simoncelli, E. P. (2011). Metamers of the ventral stream. *Nature Neuroscience*, 14(9), 1195–201.
15. Rosenholtz, R. (2016). Capabilities and Limitations of Peripheral Vision. *Annual Review of Vision Science*, 2(1), 437–457.
16. Mishkin M, Ungerleider LG, & Macko KA (1983) Object vision and spatial vision: Two cortical pathways. . *Trends Neurosci* **6,** 414-417.
17. Goodale MA & Milner AD (1992) Separate visual pathways for perception and action. *Trends Neurosci* **15,** 20-25.
18. Schenk T (2012) No dissociation between perception and action in patient DF when haptic feedback is withdrawn. *J Neurosci* **32,** 2013-2017.
19. Whitwell, R. L., Milner, A. D., Cavina-Pratesi, C., Barat, M., & Goodale, M. A. (2015). Patient DF's visual brain in action: visual feedforward control in visual form agnosia. *Vision research,* 110, 265-276.
20. Li W, Piech V, & Gilbert CD (2006) Contour saliency in primary visual cortex. *Neuron* **50,** 951-962.
21. Roelfsema PR (2006) Cortical algorithms for perceptual grouping. *Annu Rev Neurosci* **29,** 203-227.
22. Zhou H, Friedman HS, & von der Heydt R (2000) Coding of border ownership in monkey visual cortex. *J Neurosci* **20,** 6594-6611.
23. Pasupathy, A., & Connor, C. E. (2002). Population coding of shape in area V4. *Nature neuroscience*, 5(12), 1332.
24. Riesenhuber M & Poggio T (1999) Hierarchical models of object recognition in cortex. *Nat Neurosci* **2,** 1019-1025.

25. DiCarlo JJ, Zoccolan D, & Rust NC (2012) How does the brain solve visual object recognition? *Neuron* **73,** 415-434.
26. Huth AG, Nishimoto S, Vu AT, & Gallant JL (2012) A continuous semantic space describes the representation of thousands of object and action categories across the human brain. *Neuron* **76,** 1210-1224.
27. Tononi, G., Boly, M., Massimini, M., & Koch, C. (2016). Integrated information theory: from consciousness to its physical substrate. *Nature Reviews Neuroscience*, 17(7), 450–61.
28. Alvarez, G. A., & Cavanagh, P. (2004). The capacity of visual short-term memory is set both by visual information load and by number of objects. *Psychological science*, 15(2), 106-111.
29. Awh, E., Barton, B., & Vogel, E. K. (2007). Visual working memory represents a fixed number of items regardless of complexity. *Psychological science*, 18(7), 622-628.
30. Ma, W. J., Husain, M., & Bays, P. M. (2014). Changing concepts of working memory. *Nature Neuroscience*, 17(3), 347–356.