PSY801 Sensation and Perception (tentative)
Fall 2021

Instructor: Taosheng Liu PhD
Meetings: Tuesday 9:00-noon
Office hours: By appointment
Readings:

1. Palmer, S. *Vision Science: Photons to Phenomenology* (MIT Press 1999), also available as E-book at MSU library website.
2. Additional original research articles (see reading list, pdfs will be posted).

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 probably 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 indeed somewhat difficult to have all the relevant preparation for a diverse topic such as vision science. 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 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 1-2 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. Submit your paper on D2L at least **by 12 noon on Mondays**. This allows time for me to read these reaction papers and give feedback.
Presentations: Students are expected to present the original research articles in the reading list and lead the discussion of those readings.
Exams: There will be two take-home exams, with essay type of questions.

Class schedule

Wk	**Date**	**Topic**	**Reading** (VS: Palmer text)
1	Sept 7	Introduction	VS Ch 1
2	Sept 14	Theoretical frameworks	VS Ch 2; (1-3, 4^)
3	Sept 21	Signal detection	VS appendix A; (6, 5^, 7^)
4	Sept 28	Color and Motion	VS Ch 3, Ch 10; (8)
5	Oct 5	Image structure	VS Ch 4; (9, 10^)
6	Oct 12	Depth	VS Ch 5 (skip 5.5.7); (11, 12^)
7	Oct 19	Dorsal vs. ventral streams	(13-16)
8	Oct 26	*Fall break days*	*mid-term exam due*
9	Nov 2	Perceptual organization	VS Ch 6; (17^, 18)
10	Nov 9	Object properties and shape	VS Ch 7, Ch 8 (8.1 & 8.2); (20, 19^, 21^)
11	Nov 16	Function and category	VS Ch 9; (22-23, 24^)
12	Nov 23	Attention & Awareness	VS Ch 11, Ch13; (25^, 26)
13	Nov 30	Oscillations	(27-29) [or another topic]
14	Dec 7	Memory & Imagery	VS Ch 12; (30^, 31^, 32)
15	Dec 14	*Final exam due*	

Reading List (^: optional supplementary papers, gsc: Google scholar citation)

1. Helmholtz H (1896/1925) *Concerning the perceptions in general. [gsc=1126]*
2. Gibson JJ (1979) in *The ecological approach to visual perception. Chapter 14 "The theory of information pickup and its consequences" [gsc=44356]*
3. Marr D (1982) in *Vision: A Computational Investigation into the Human Representation and Processing of Visual Information* (MIT Press, Cambridge, MA), Chapter 1, pp. 8-38.

4^. Zhaoping, L. (2014). Understanding vision: Theory, models, and data. Oxford University Press. Chapter 1, "Approach and Scope" [gsc=130]

5. Tanner WP, Jr. & Swets JA (1954) A decision-making theory of visual detection. *Psychol Rev* **61,** 401-409. [gsc=1668]
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. [gsc=2098]

7^. Ress D & Heeger DJ (2003) Neuronal correlates of perception in early visual cortex. *Nat Neurosci* **6,** 414-420. [gsc=391]

8. Regier, T., & Kay, P. (2009). Language, thought, and color: Whorf was half right. *Trends in Cognitive Sciences*, 13(10), 439–446. [gsc=396]
9. 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. [gsc=4187]
10. Vinje, W. E., & Gallant, J. L. (2000). Sparse coding and decorrelation in primary visual cortex during natural vision. *Science*, 287(5456), 1273-1276. [gsc=1326]
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. [gsc=1161]
12. Ernst, M. O., & Banks, M. S. (2002). Humans integrate visual and haptic information in a statistically optimal fashion. *Nature*, *415*(6870), 429-433. [gsc=4396]
13. Mishkin M, Ungerleider LG, & Macko KA (1983) Object vision and spatial vision: Two cortical pathways. *Trends Neurosci* **6,** 414-417. [gsc=3257]
14. Goodale MA & Milner AD (1992) Separate visual pathways for perception and action. *Trends Neurosci* **15,** 20-25. [gsc=7138]
15. Schenk T (2012) No dissociation between perception and action in patient DF when haptic feedback is withdrawn. *J Neurosci* **32,** 2013-2017. [gsc=113]
16. 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. [gsc=24]
17. Wagemans, J., Elder, J. H., Kubovy, M., Palmer, S. E., Peterson, M. A., Singh, M., & von der Heydt, R. (2012). A century of Gestalt psychology in visual perception: I. Perceptual grouping and figure–ground organization. *Psychological Bulletin*, 138(6), 1172–1217. [*long paper*] [gsc=1153]
18. Wagemans, J., Feldman, J., Gepshtein, S., Kimchi, R., Pomerantz, J. R., Van der Helm, P. A., & Van Leeuwen, C. (2012). A century of Gestalt psychology in visual

perception: II. Conceptual and theoretical foundations. Psychological Bulletin, 138(6), 1218–1252. [*long paper*] [gsc=381]
19. Pasupathy, A., & Connor, C. E. (2002). Population coding of shape in area V4. *Nature neuroscience*, 5(12), 1332. [gsc=581]
20. Riesenhuber M & Poggio T (1999) Hierarchical models of object recognition in cortex. *Nat Neurosci* **2,** 1019-1025. [gsc=3815]
21.^ DiCarlo JJ, Zoccolan D, & Rust NC (2012) How does the brain solve visual object recognition? *Neuron* **73,** 415-434. [gsc=1310]
22. 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. [gsc=754]
23. Grill-Spector, K., & Weiner, K. S. (2014). The functional architecture of the ventral temporal cortex and its role in categorization. *Nature Reviews Neuroscience*, 15(8), 536. [gsc=524]
24.^ Yamins, D. L., & DiCarlo, J. J. (2016). Using goal-driven deep learning models to understand sensory cortex. *Nat Neurosci*, 19(3), 356. [gsc=901]
25.^ Buschman, T. J., & Kastner, S. (2015). From Behavior to Neural Dynamics: An Integrated Theory of Attention. *Neuron*, 88(1), 127–144. [gsc=223]
26. 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. [gsc=766]
27. Busch, N. A., Dubois, J., & Vanrullen, R. (2009). The Phase of Ongoing EEG Oscillations Predicts Visual Perception. The Journal of Neuroscience, 29(24), 7869–7876. [gsc=999]
28. Fiebelkorn, I. C., Saalmann, Y. B., & Kastner, S. (2013). Rhythmic sampling within and between objects despite sustained attention at a cued location. Current Biology, 23(24), 2553–2558. [gsc=279]
29. Lakatos, P., Gross, J., & Thut, G. (2019). A New Unifying Account of the Roles of Neuronal Entrainment. Current Biology, 29(18), R890–R905. [gsc=106]
30. 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. [gsc=1489]
31. 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. [gsc=766]
32. Ma, W. J., Husain, M., & Bays, P. M. (2014). Changing concepts of working memory. *Nature Neuroscience*, 17(3), 347–356. [gsc=823]

Total: 32, optional: 12, → 20 discussed