Physics and Perception, Spring 2020.
Psych 89
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Visual perception is the oldest branch of Experimental Psychology and one of the oldest branches of the Natural Sciences. Perception, in general and visual perception in particular, is an essential cognitive ability simply because **perception informs the observer about what is "out there."** When you look at a natural, everyday life scene, say a dinner table with 6 chairs arranged around it, you surely see the table and the 6 chairs. This means that you have acquired accurate information about this physical scene. Furthermore, when you walk around this table, you continue to see the table as the same table and the chairs as the same chairs despite the fact that the sensory information available in the retinal images inside your eyes continuously changes. These intuitively obvious, commonsensical observations require an explanation that relates a three-dimensional (3D) ***mental*** representation of the environment to the ***geometrical and physical*** characteristics of this environment. This relationship is far from trivial because the sensory data that forms the basis of our 3D percepts is only two-dimensional (2D), like the camera image formed by your smartphone.

Physical objects and scenes are characterized by permanent (***constant***) characteristics such as the direction of gravity, the orientation of the ground's surface, the symmetry of objects, their shapes, sizes, masses, elasticities, as well as surface reflectances (aka colors). These permanent characteristics are best described by what physicists call ***invariants of transformations***. Studying invariants in Math and Physics began fairly recently, only about a century and a half ago. Incidentally, this is also when the modern study of Perception, called ***Psychophysics***, began. It did not take long for students of Perception to start studying ***perceptual invariants***, which is the formal label for ***perceptual constancy***. Perceptual constancy refers to the fact that your percept of an object is constant despite changes in the object's retinal image caused by changes in the viewing conditions.

This course will review the basic concepts underlying the perceptual constancies, including shape, size, motion and color constancy. The emphasis will be on understanding the psychophysical experiments that led to contemporary theories of perception. Many of the examples used will illustrate similarities in the formalisms used by Physicists and Psychophysicists.

Lectures will be posted on-line on "Canvas". The official times for the lectures (MWF, 9-9:50am) will be used for questions, answers and discussions by using Zoom. The course's grade will be based on two exams, a midterm and a final.

Topics:

1. History of visual perception. Nativism vs. empiricism. Vision vs. touch.
2. Three-dimensional vision: what is the problem? The role of symmetry of objects.
3. The reflection and refraction of light. Fermat's least-time principle. Image formation.
4. Transformation groups in geometry and physics, and their invariants.
5. Experimental methods in perception: The Method of Adjustment and the Signal Detection experiment.
6. Perceptual constancies in the history of perception, specifically, shape, size, lightness, color and speed.
7. 3D shape perception based on the simplicity (least-action) principle.
8. Elementary presentation of Noether's Theorem and its role in a modern theory of perceptual constancy.