Special Topics Graduate Seminar in Neural Science (G80.3042)

Perceptual Bi-stability: Psychophysics, Neural Mechanisms and Modeling

Fall 2011, Fridays 1:30-3:30pm, Meyer 815

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Research on bi-stability and multi-stability has grown dramatically in recent years. The reasons are varied: some view it as a means to study the neural basis of consciousness; others use it as a conveniently encapsulated system of (perceptual) decision-making; and yet others take advantage of the detailed temporal data it can yield to construct and test models of neural dynamics. For all these researchers and more, perceptual bi-stability has offered a multitude of rich phenomenology, extensive psychophysical data and, more recently, neural data. This course will bring together and synthesize results from old and new research on the topic, focusing on emerging insights about the underlying neural and computational mechanisms of bi-stability.

Course outline & list of topics:

Part 1: The diversity of bi-stable and multi-stable perceptual phenomena
Binocular rivalry; Reversible Figure/Ground images; Ambiguous drawings; Apparent motion quartets and extended displays; Ambiguous motion segmentation/integration displays; Ambiguous structure-from-motion; 'Motion-induced Blindness' (MiB); Auditory streaming; Multi-stable displays.
Theoretical issues: Rivalry between low-level vs. high-level stimulus representations ("What is Rivaling?"); Why alternate?

Part 2: Common characteristics of different bi-stable phenomena
Mutual Exclusivity; Stationarity of mean dominance durations; Other statistical properties of the distributions of dominance durations; stimulus parameters and their effect on fraction dominance; Levelt's laws in binocular rivalry, amendments and generalization to other bi-stable phenomena: mean durations at equi-dominance and at unequal fraction dominance values.
Theoretical issues: Alternations driven by adaptation versus by noise; how the absolute durations away from equi-dominance are determined by relative (fraction) dominance;

Part 3: Brain mechanisms of perceptual bi-stability
Mutual exclusivity and neural suppression: converging and diverging evidence from electrophysiology versus BOLD signal; Low-level vs. high-level loci of suppression, and the role of feedback ("What is Rivaling?" revisited); evidence for neural suppression in bi-stable phenomena other than binocular rivalry; inference of perceptual states from pattern classification of distributed BOLD activity.
Theoretical issues: Tests of noise-based vs adaptation-based models; Tests of hypothesis of separable mechanisms for relative (fraction) dominance and absolute alternation rate.

Part 4: Mechanistic neural models, emerging consensuses and open questions
Categories of basic architectures; Mutual inhibition: direct versus indirect; Alternations driven by adaptation vs noise: oscillatory versus attractor-based models; Implications for dynamical behavior and comparison with experimental data;
Theoretical issues: Alternatives to mutual inhibition as a mechanism to implement mutual exclusivity -- the possible roles of coherence and synchrony.