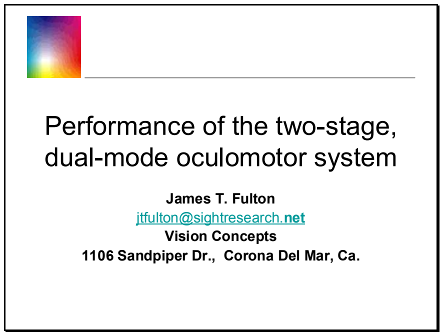
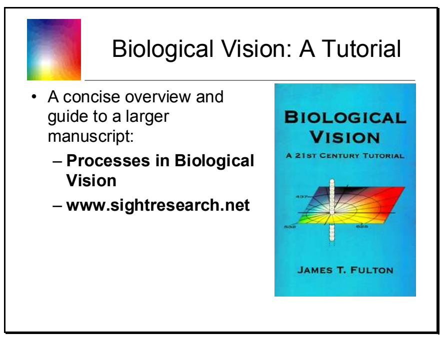
Slide 1



I am a physiologist trained as an engineer. My work is inter-disciplinary. I would like to share some recent results that might affect you're field.

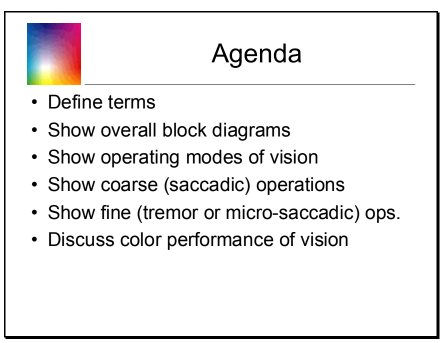
The Oculomotor system is more complex than most realize—3 sets of muscles, 2-separate and distinct muscle systems

Slide 2



This talk will extract information from a much larger analysis of vision contained within the manuscript, "Processes in Biological Vision." A condensation of this manuscript (and a guide to it) has been published as "Biological Vision: A 21st Century Tutorial." References to everything presented here are included in these works.

Slide 3



I want to take a moment to define some terms and scope the operating range of the oculomotor system, then move through some material on ocular motions followed by some material on the color performance of the visual system that might affect your next protocol

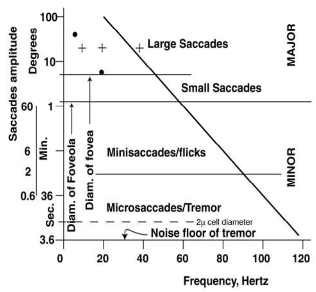
Slide 4

Points to be made

- Oculomotor system
  - Is dual mode – Is included within a servo loop
  - Includes a computational element
  - Operates at a very fine level – Seconds of arc
- Fine “random noise” isn’t noise or random
- The Perceptual Chromaticity Diagram
  - Quantifies the Munsell Color Space
  - Is useful – defines complements precisely
- Monitors do not cover visual spectrum

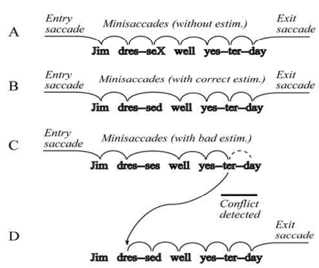
This chart summarizes the material to be discussed in this presentation.

Slide 5



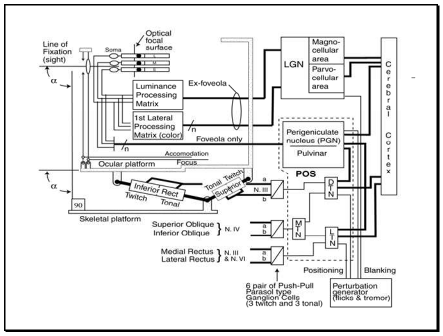
While earlier eye tracking investigations focused on the large saccades of the eye, finer motions play a key role in the operation of the visual system. Motions down to the level of less than 0.5 minutes of arc are important in the creation of the percepts used by the cognitive processes.

Slide 6



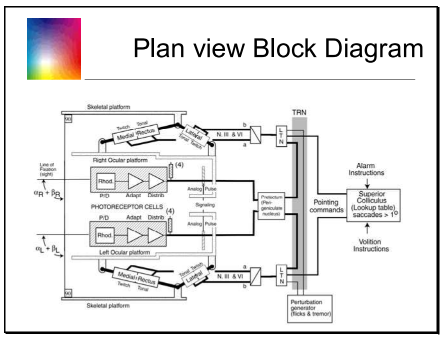
This figure highlights the multiple phases of oculomotor operation associated with the process of reading. The entry and exit saccades are significantly different from the inter-syllable saccades. The role of cognition within the oculomotor servo loop is highlighted by the need to rescan following an estimation error.

Slide 7



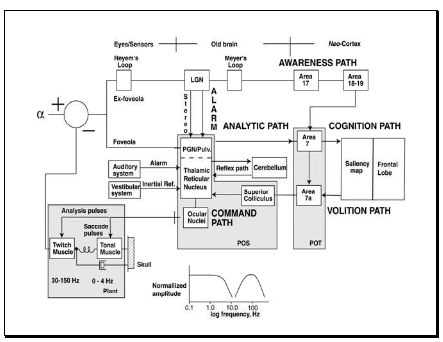
This figure appears in the paper. It shows the complexity of the visual system associated with just the oculomotor system (the Precision Optical Servo).

Slide 8



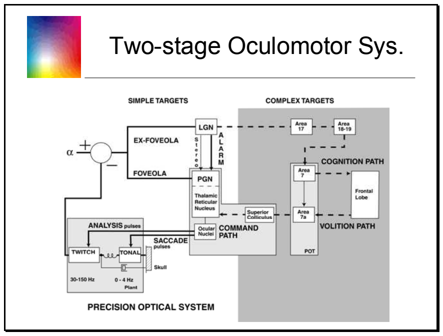
This figure highlights the independence of the servomechanisms controlling the two eyes. Alarm mode operation is predominantly to the left of the shaded line (unless a multi-target situation is presented. Volition mode operation involves the Superior Colliculus.

Slide 9



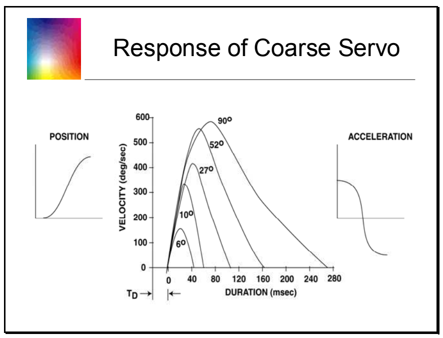
This figure highlights the six operating modes of the visual system, alarm, analytic, awareness, cognition, volition & command. It also shows the dual character of the physical plant controlling the eyes. Signals between engines are propagated as phasic signals (action potentials). Within engines, analog signal processing is employed.

Slide 10



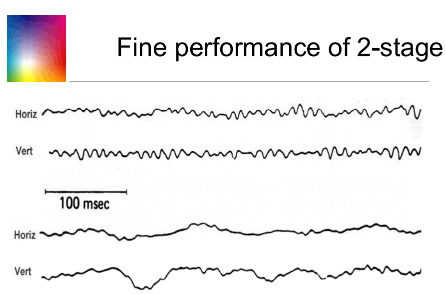
The character of the stimulus determines how the oculomotor system performs. Simple targets do not involve cognition and the response can be quite rapid. Complex targets involve more signal processing. The Analysis path within the foveola operates as a Type 1 (velocity) servomechanism. The Alarm path, involving the peripheral retina, operates as a Type 0 (position) servomechanism.

Slide 11



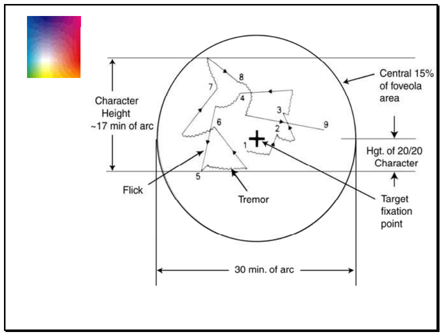
This expanded figure, based on Baloh (1975), shows the velocity of the eye versus time for various amplitude saccades under "Alarm" conditions. The motions are clearly not ballistic. While the profile of the velocity approaches a parabola, it is the position of an object that is described by a parabola in ballistic motion. The time delay is dominated by the round-trip travel time of signals within the Precisions Optical Servo loop.

Slide 12



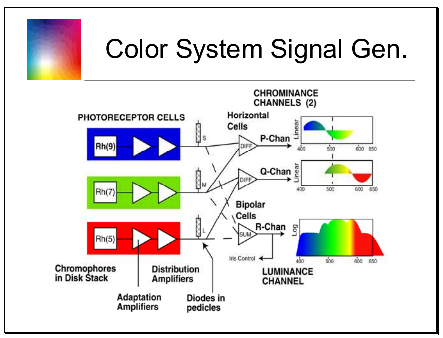
The waveforms show the vertical and horizontal motions of one eye over a period of about 1.2 seconds. The waveforms are obviously not random.

Slide 13



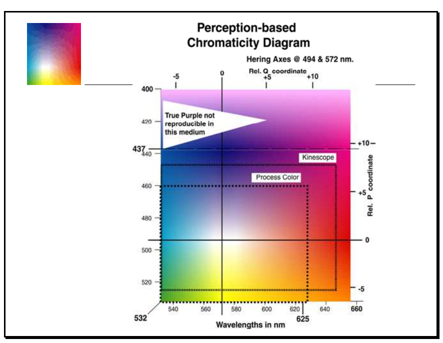
This figure plots the orthogonal microsaccades of the eye to show their time sequence. The 17 min of arc height is a comfortable one for reading compared to the 20/20 (6/6) size character height shown on the right. The microsaccadic or "tremor" intervals are easily differentiated from the minisaccadic or "flick" intervals.

Slide 14



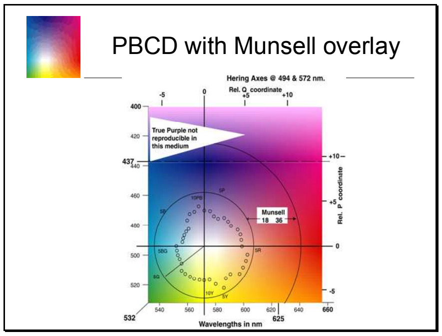
The retina converts the three spectral absorption channels into three different signaling channels. The brightness channel represents the logarithmic sum of the three spectral channels. The P & Q channels represent the logarithmic difference between pairs of spectral channels

Slide 15



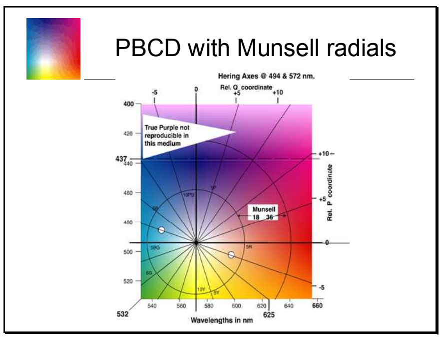
By plotting the P & Q channels orthogonally, a new perception-based Chromaticity Diagram is obtained. The PBCD provides a physiological basis for the Hering "opponent" color axes. It also illustrates the extent to which monitors and process color represent the human visual color space.

Slide 16



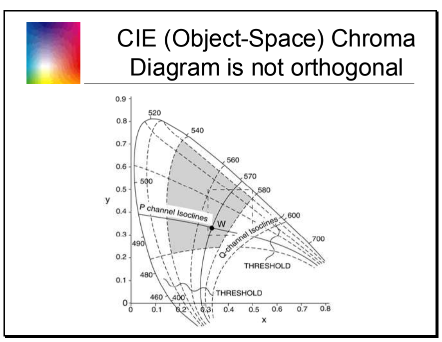
The PBCD provides a physiological framework for the Munsell Color Space. The circles illustrate the maximum saturation of the chips in the Munsell Color Atlas.

Slide 17



Complements are defined at equal distances from the white point along any radial. Complements have equal “saturation.”

Slide 18



The non-orthogonal CIE Chromati
does not show saturated complem
Complements are not on a straigh
the white point. Complements wit
rectangular are frequently approxi
drawing tangents until they interse
locus.

Slide 19

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