Introduction

- Aspects of visual function
  - Eye Movements
  - Pupil Responses
  - Visual Acuity
  - Contrast Sensitivity
  - Accommodation
  - Flicker Sensitivity
  - Stereovision
  - Vernier Acuity
  - Motion Sensitivity
  - Color Vision
  - Light Adaptation
  - Dark Adaptation
  - Visual Field

Eye Movements & Driving

- Scanning Roadway
  - 35-45 deg
  - 40-50 deg

- Viewing in Mirrors
  - 35-45 deg

- Observing Traffic Signs & Signals
  - 40-50 deg
Eye Movements & Driving

- Reading Dashboard Indicators

- Identifying Peripheral Objects

Eye Movements & Driving

- Dilated Pupils in Daytime

- Constricted Pupils at Night

Anatomy & Physiology: The Eye & Related Structures

- Extraocular Muscles

- Horizontal eye movements – L & R
Anatomy & Physiology: The Eye & Related Structures

- Vertical eye movement - Elevation
  - Superior R.
  - Inferior O.

- Vertical eye movement - Depression
  - Superior O.
  - Inferior R.

- Rotation eye movement - Incycloduction
  - Superior R.
  - Superior O.

- Rotation eye movement - Exycloduction
  - Inferior O.
  - Inferior R.

Anatomy & Physiology: The Eye & Related Structures

- Intraocular Muscles – Pupil
  - Iris Dilator & Sphincter

- Intraocular Muscles – Accommodation
  - Ciliary Muscle (Body)
Anatomy & Physiology: The Eye & Related Structures

- Photoreceptors
  - Location & Visual Acuity
    - Fovea - 20/20
    - 5 deg - 20/60
    - 10 deg - 20/100
    - 20 deg - 20/200

Anatomy & Physiology: Central Nervous System

- Major Components
  - Cortex (Cerebrum)
  - Brainstem
  - Cerebellum
  - Cerebrospinal Fluid

Anatomy & Physiology: Central Nervous System

- Cortex

Anatomy & Physiology: Central Nervous System

- Visual Cortex

Anatomy & Physiology: Central Nervous System

- Brainstem

Anatomy & Physiology: Central Nervous System

- Visual Pathway
Anatomy & Physiology: Central Nervous System

- Pupillary Light Reflex

Anatomy & Physiology: Central Nervous System

- Cerebellum – Neural Integrator

  - Loss of Accurate Position Feedback Control

  - Control Signal
  - Position Feedback Input

  - Normal “Integrator”
  - Leaky “Integrator”

Anatomy & Physiology: Central Nervous System

- Other Sensory Inputs

  - Vestibular System

  - Mechanical Action of Semicircular Canals

  - AT REST

  - COP Position

  - Discrepancy: No angular acceleration

  - COP is detected

- Other Sensory Inputs

  - Mechanical Action of Otolith Organs

  - Proprioception
**Anatomy & Physiology: Other Sensory Inputs**

- Exercise: Vision, Balance & Proprioception
  1. Stand with feet together and fixate a small object or detail across the room
  2. Raise either leg, record time until loss of balance
  3. Construct two narrow tubes using loose pages
  4. Stand with feet together and fixate small object across room while looking through tubes (one in front of each eye)
  5. Raise either leg, record time until loss of balance

**Development & Control of Eye Responses**

- Version Eye Movements
  - Saccades
  - Smooth Pursuits

- Vergence Eye Movements
  - Convergence
  - Divergence

- Pupil Size & Age

- Pursuit Pathway

- Vestibulo-Ocular Reflex (VOR)
Development & Control of Eye Responses

- Doll’s-Head Reflex
  - Vertical eye position change with head tilt
  - Mediated (primarily) by otolith organs

Development & Control of Eye Responses

- Near Triad
  - Accommodation – near focus
  - Convergence – single vision
  - Miosis – pupil constriction

Effects of Drugs on the Eyes

- Eye Movements
  - Saccades & Smooth Pursuits
  - Convergence
  - Nystagmus

Effects of Drugs on the Eyes

- Pupils

Effects of Drugs on the Eyes

- Conjunctiva
  - Vasoconstriction

- Vasodilation / Injection / Hyperemia
Effects of Drugs on the Eyes

- Eyelids
  - Ptosis (droopy lids)
  - Tremors
  - Retracted lids

- Tears

Effects of Environmental Conditions on the Eyes

- HGN / VGN Stimulus Conditions
  - Size
  - Speed of Movement
  - Distance from Subject
  - Contrast
  - Background

- Pupil Response Conditions
  - Lighting
  - Room Size

Effects of Environmental Conditions on the Eyes

- Subject Posture

Effects of Environmental Conditions on the Eyes

- HGN Subject Posture
Effects of Environmental Conditions on the Eyes

- VGN Subject Posture

![Graph showing VGN Subject Posture with different conditions and outcomes.]

Effects of Environmental Conditions on the Eyes

- Fatigue – Lack of Sleep

![Graph showing BAC levels with different conditions and outcomes.]

HGN & Fatigue

- Citek, Arlien, Jons, Krezelok, Neron, Plummer, Tannenbaum (in preparation)

Pacific Lack of Sleep Study

- 29 healthy adult subjects
  - 14 females, 15 males
  - Average age 26.3 years, range 21-52
  - Average BMI 23.7, range 19-40
  - 9 Specs, 9 Cls, 11 No Rx
  - 2 alcohol workshops each
  - Normal sleep: awake 4.1 hrs, range 1.5-8
  - Sleep deprived: awake 29.8 hrs, range 24-32
  - Max BAC: 0.115%
  - 4 test periods: Baseline, 1 hr, 2 hrs, 1 hr post
Summary

- Sleep deprivation does NOT affect HGN, VGN, LOC, FOV, EN, WAT, OLS clues, Romberg sway & time estimate, BP, and Pulse regardless of level of intoxication.
- Sleep deprivation may affect OLS count, Romberg tremor, and Pupil size in sober individuals.
- BOTTOM LINE: Sleep deprivation will NOT be confused for intoxication by police officers!

Effects of Environmental Conditions on the Eyes

- Nystagmus
  - Voluntary
  - Rotatory
  - Rotational / Post-rotational
  - Caloric
    - Horizontal – COWS
    - Vertical – CUWD
- Fatigue
- Optokinetic
## Effects of Environmental Conditions on the Eyes

- **Nystagmus**
  - **Positional Alcohol Nystagmus (PAN)**
    - PAN I – rising BAC; endolymph ETOH concentration *lower* than BAC
    - Intermediate – endolymph ETOH concentration *equals* BAC
    - PAN II – falling BAC; endolymph ETOH concentration *higher* than BAC; may sustain for 6-10 hours after BAC returns to zero

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THANK YOU!!

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