



•  
•  
•

# Introduction to Functional Visual System

- Interactive oriented system with multiple **synthesizing** pathways
- Does not occur in isolation
- Complex
- Contributes to behavioral adaptive response

# Functional Vision

## What is functional vision?

- Beyond 20/20 eyesight
- Visual system integrates with entire sensorimotor system
- Integration of visual input with postural movements for adaptive postural response

⋮

# Consider The Interactive Process Of Vision

Light rays project onto the *retina*

Information travels through *optic nerve*

Info traverses *optic chiasm* along *optic tracts*

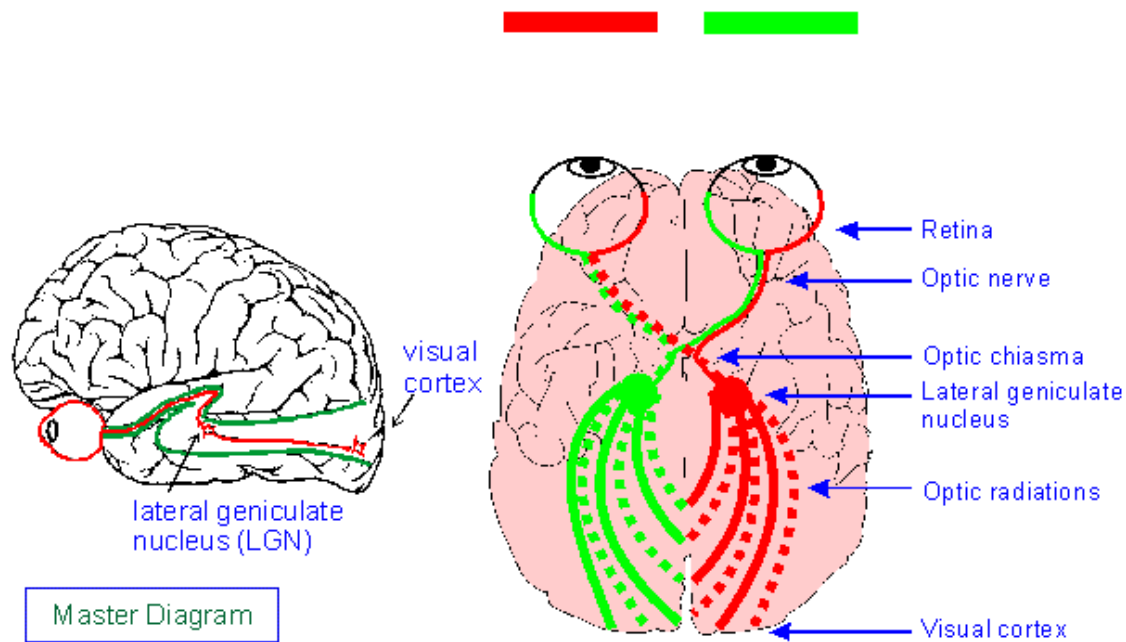
Info travels on to *geniculocalcarine tracts*

Info is processed in *primary visual cortex*

Info travels to *lateral geniculate nucleus*

⋮

<http://www.yorku.ca/eye/brain2.htm>



Master Diagram

More detailed look  
at LGN & cortex

Table of Contents

Electrophysiology

⋮

## Key Relay Station SC with "Systems"

Superior Colliculus---> visual, auditory,  
vestibular, kinetic, reticular, synergic,  
somatosensory systems--> Brainstem

Cerebellar relays and pathways -->SC--->  
12 Brainstem Nuclear Centers=

# Superior Colliculus

## Motor Response:

- Protective reflex reactions
- Coordinate ocular movements with body movements

Cognitive Response Cortical systems  
connections with SC

Adaptive response!

# Adaptive Response

- Direct eye gaze
- Promote visual vigilance (attention)
- Ability to mentally manipulate concepts or objects
- Make a decision
- Provide the response



# Vision: Dynamic Process

The visual system is a kind of meeting ground... where the electrodynamic forces that culminate in adaptive behavior... are organized.

Arnold Gesell



# Functional Visual Skills

*Fixation:* simultaneous direction of gaze with both eyes

*Pursuits/Tracking:* eyes ability to follow moving target

*Saccades:* eyes ability to switch from target to target

*Stereopsis:* depth perception



# Functional Visual Skills

*Binocular Vision:* input of both eyes

*Vergence:* eyes ability to medially or laterally deviate for near/far target focus

*Accommodation:* ability to bring near object into clear focus

*Field of Vision:* total vision available



# Functional Visual Skills

## *Spatiotemporal orientation:*

- Ability to orient and move in space
- Foundation of *all* human behavior (Moore,J)
- Critical pathways include peripheral, vestibular and proprioceptive systems
  - involves reflexes and voluntary movements (VOR, COR, CVR, etc.)

# Spatiotemporal Orientation

## Vestibulo-Oculo-Cervical Triad

Vestibulocerebellum: provides foveation, gravity detection, balance & m. tone

Ocular: central & esp. peripheral= orientation in space, movm't detection

Cervical: orients head with above systems, links body with head for postural response

# Spatiotemporal Orientation

## What Key Visual Skills Integrate for Spatiotemporal Sense?

- 1) ability to maintain foveated gaze
- 2) ability to compare incoming data with speed and direction of head movement
- 3) ability to compare body movem't to incoming visual data

•  
•  
•

# FUNCTIONAL VISUAL SKILLS CON'T

Well performed visual skills are the result of an integrated proprioceptive, kinesthetic, tactile and vestibular system that also integrates with memory and auditory pathways

# Oculomotor Purpose?

Provide Foveation- what is foveation?

**Highest level of acuity**

*What has to occur for foveation?*

1. Stabilization of gaze

-conjugate eye movements, coordinate

-vestibular-ocular reflex(VOR)

•  
•  
•

# Foveation

*What has to occur for foveation?*

2. stabilization of focus

-smooth pursuits

3. direction of eye movements

# Oculomotor Control

Five Neural Control systems keep the fovea on target

- 1) *Vestibular*- holds images of “seeing world” on retina during movements (VOR, COR)
- 2) *Optokinetic*- holds images of seeing world on retina during sustained movement and motion (of head)

# Oculomotor Control

## Five Neural Systems

3. *Saccades*- brings image of object onto fovea for quick, rapid speed
4. *Smooth pursuits*- hold image on fovea when the image is moving
5. *Vergence*

# Oculomotor Evaluation

Evaluation is to answer 2 basic questions

Do the eyes work together?

How well do the eyes work together?

-where is visual control the most efficient /least efficient?

-what kinds of eye movements are most efficient/least efficient?

# Oculomotor Evaluation

- 1) Previous visual history
  - 2) Observations of patient behavior
    - reading causes headaches, dizziness
    - difficulty concentrating when reading
    - eye strain or fatigue on certain tasks
    - turning away from task, as it comes closer
-

# Oculomotor Evaluation

## 2) Observations con't

— -squinting

-c/o double or blurry vision, being “out of focus”

-shutting an eye to focus

-c/o objects, words moving=oscillopsia



# Patient Observations Con't

- dizziness, nauseated
- increased muscle tone in neck, shoulders, or TMJ
- rigid posture
- ”off balance”, wide base of support

# Oculomotor Evaluation

## 3) Ocular movements:

### a. Range of motion

Patient seated, binocular testing with glasses (if wears for distance)

-Hold penlight or red object vertically

-Ask pt to focus on tip of target

-Keep a distance of 16", slowly move target through 9 cardinal positions

# Oculomotor Evaluation

Range of Motion Continued:

What are you looking for?:

Strabismus (impaired muscle or nerve)

phoria (weakness)

tropia (paralysis, or deviation)

*Does the patient's head or body  
move during ROM?*

*What direction does it move?*

# Common Types of Strabismus

Tropia: marked deviation of ocular movement

*Exotropia*: one eye turns out

*Esotropia*: one eye turns in

*Hypertropia*: one eye moves up

*Hypotropia*: one eye moves down

# Strabismus Con't

Phoria: subtle or mild deviation of eye

Terms: *exophoria*, *esophoria*, *hypophoria*,  
*hyperphoria*

Occurrence may be constant, intermittent  
or alternating from one eye to the other

# Strabismus Con't

## Observations of a Strabismus?

- eye may wander in/out/up/down
- pt may or may not c/o double vision
- difficulty judging distances
- head tilt or turn
- pt closes an eye to see better

# • • •

## CN Impairments

### CN III- Oculomotor

- ptosis
- dilated pupil
- eye positions with lateral deviation
- ROM limited with MR,SR, IR
- pt c/o double vision near, may have light sensitivity

•  
•  
•

# CN Compensatory Head Positions

## CN IV Superior Oblique

- Head tilt and turn to sound side
- Bielschowsky Head Tilt Test -evaluates Presence of SO impairment
- Ask pt to tilt head to involved side
- Results: involved side positions in hypertopia

⋮

# CN Compensatory Head Positions

## CN III- Inferior Oblique Muscle

-Head tilt to involved side, head turn to sound side, chin elevated

## CN III- Superior or Inferior Rectus

-Chin up or down

## CN IV (Abducens)- Lateral Rectus Muscle

-Head turn to involved

⋮

•  
•  
•

# Internuclear Ophthalmoplegia

## What is INO?

- disruption in MLF
- common with MS, brainstem involvement

## How does it present?

- on horizontal gaze- MR unable to ADD,  
opp eye abducts with nystagmus
- able to converge

# Evaluation of Stereopsis

If strabismus is present depth perception is likely to be impaired.

## Two Pencil Test:

- Hold pencil vertically in front of pt
- Ask pt to touch upper tip of pencil with one swift movement from above

Results: if accurately hits target- passes

# Functional Impact

## 1) Mobility

A. shortened, uncertain route

B. decrease in balance

C. sense of disorientation when moving

## 2) Reading

A. misread words (80% accuracy)

B. poor page navigation, slow reading

## 3) ADL's and IADL's

⋮

# Treatment Approach to Visual Impairments

Three approaches:

1) Educate: pt/family(provide insight)

2) Remedial/Restorative:

-visual skill impairments

3) Adaptive:

-change the environment

⋮

# Management of Visual Impairments

- 1) Referral to (neuro)ophthalmologist
- 2) Sensitivity to light and glare
  - recommend or provide pt with UV filters, glasses
- 3) Use input from other senses
  - tactile (markers on objects)
  - vestibular, proprioceptive etc.



# Vision: Dynamic Process

The visual system is a kind of meeting ground... where the electrodynamic forces that culminate in adaptive behavior... are organized.

Arnold Gesell

