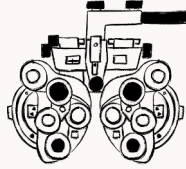


## Visual Assessment: More Than a Refraction



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## Disclosures



- The content of this course was developed independently without commercial bias or influence
- We are the founding partners of SightLine Ophthalmic Consulting, LLC
- Our presentation contains images from the Visionix VX40 lens analyzer
- Essilor, Visionix - Consulting



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## Course Objectives

- Review visual pathway
- Discuss common tests performed during comprehensive visual evaluation, the purpose and norms of tests
- Review refractive errors, accommodation and vergence conditions
- Discuss treatments for common visual conditions
- Describe components of a spectacle prescription and how to explain them to a patient using layman's terms.



3

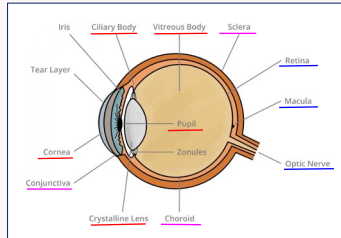
## Visual Pathway

4

## Ocular Anatomy Review

### The Eye

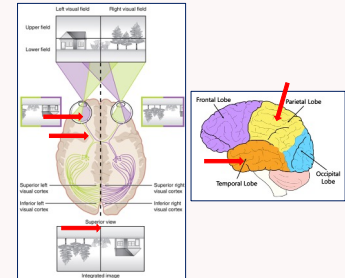
- **Refracting Tissues/Structures**
  - Cornea
  - Pupil
  - Crystalline Lens
  - Ciliary Muscle
  - Aqueous & Vitreous Humor
- **Light Sensitive Tissues**
  - Retina/Macula
  - Optic Nerve
- **Supportive Tissues**
  - Conjunctiva
  - Sclera
  - Choroid



5

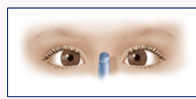
## Visual Perception Steps

- **Reception**  
Light>cornea>pupil
- ★ **Transduction**  
EME>rods/cones>ECI>ON>Brain
- **Transmission**  
ON>PVC (Occipital Lobe)
- **Selection**  
Feature Detectors break up image
- ★ **Organization**  
Reorganization in visual cortex
- **Interpretation**  
Meaning to visual stimulus/object

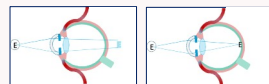


6

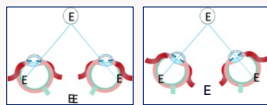
## Accommodative / Near Triad



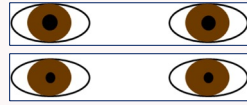
Near object



Accommodate



Converge



Constrict

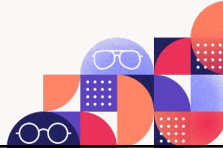
7

## Visual Assessment Tests

8

## Components of a Comprehensive Eye Examination

- Patient History
- Preliminary Examination
  - Visual Acuity
  - Autorefraction/Keratometry
  - Tonometry
  - Retinal Imaging
- Functional Vision Assessment
  - Visual Acuity, Color, Contrast Sensitivity
  - Refraction
  - Eye Focusing
  - Eye Teaming
  - Eye Movement
- Ocular Health Evaluation
  - Anterior Segment Evaluation
  - Posterior Segment Evaluation
- Supplemental Testing as Needed



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## Visual Function Tests

- Pre-examination Tests
- Case History
- Confrontation Tests
- Phoropter Tests
  - Refraction
  - Accommodation
  - Binocular Vision



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## Pre-exam Tests



- Multi Diagnostic Instrument**
- ★ ● Autorefraction / Keratometry
  - ★ ● Corneal topography
  - ★ ● Corneal pachymetry
  - ★ ● Aberrometry
  - ★ ● Non contact tonometry
  - ★ ● Anterior chamber assessment/angles
  - ★ ● Dry eye imaging

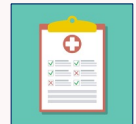
11

## Case History

**Chief Concern(s) (CC):** What brings you in today?

**HPI (History of Present Illness)**

- Onset:** When did the problem start?
- Location:** Where is the problem? One/both eyes, Distance or Near?
- Severity:** How bad are the symptoms? Mild, Moderate, Severe? Scale 1-10?
- Duration:** Are the symptoms constant or intermittent?
- Frequency:** How often do the symptoms occur? Only once or several times?
- Context:** Any others symptoms/conditions/activities related to this concern?
- Modifying Factors:** What makes the symptoms better? Worse?



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## Case History

### Personal and Family History

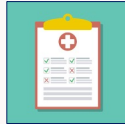
**Ocular conditions:** Eye injuries / surgeries, Glaucoma, Uveitis, Eye turn

**Medical conditions:** Diabetes, Hypertension, Cardiovascular, Autoimmune

### Medications

#### Prescribed, OTC, Recreational:

- What are they for?
- How long have you been taking?
- How often do you take them? Dosage/Frequency?



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## Ophthalmic Case History

### Optical Questions

How old is your eyewear?

How many pairs do you have/use?

What do you use them for?

- Distance / Near
- Computer
- Driving

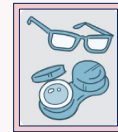
Are you having any problems?

- Vision
- Comfort

Is there anything you want to

change?

- Occupation
- Hobbies / Sports
- Digital device usage



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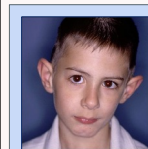
## Confrontation Tests

- External Observations
- Visual Acuities
- Cover Test
- Near Point of Convergence
- Near Point of Accommodation
- Accommodative Amplitude
- Pupils
- Versions and Ductions
- Stereopsis
- Color Vision
- Contrast Sensitivity

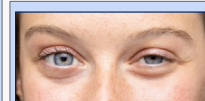


15

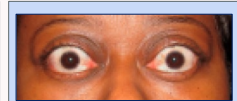
## External Observations



Head tilt d/t EOM palsy



Ptosis = Droopy eyelid



Exophthalmos d/t Thyroid Eye Disease



Red eye d/t subconjunctival hemorrhage

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## Visual Acuity

A threshold measurement of the eye's ability to distinguish an object correctly.



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## Snellen Acuity System

**What does 20/20 mean?**

The smallest letter a person can read from 20 feet away (test distance) is the 20-foot letter (8.87 mm tall).

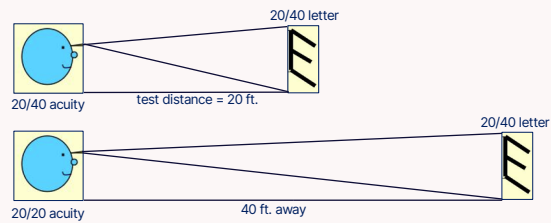


1862 Herman Snellen used the early astronomers' min. angle of 1 minute of arc to see the separation of 2 stars.

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## Snellen Acuity

A person with 20/40 acuity recognizes an object from 20 feet away that most people can see from 40 feet away.



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## Visual Acuity Testing

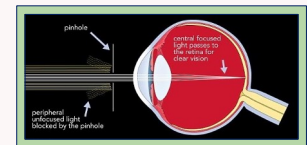


**Normal 20/8 to 20/20**

**Recording**

Ex.1 VAsc 20/60 OD, PH 20/25  
20/50\*2 OS, PH 20/25

Ex.2 VAcc 20/25 OD  
20/60 OS, PH 20/50<sup>-2</sup>

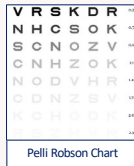


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## Contrast Sensitivity

**Contrast Sensitivity** = ability to detect an object from the background

Normal = 2.0  
 Moderate loss = 1.5  
 Severe loss = less than 1.0  
**Recording**  
 OD 2.0, OS 1.8

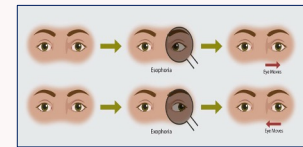


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## Cover Test



### Unilateral Cover Test



### Cover Test

- **Unilateral**
  - Presence or absence of a tropia
  - Unilateral or alternating tropia

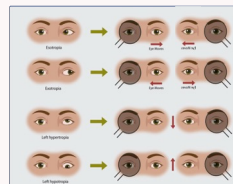
22

## Cover Test

### Cover Test

- **Alternating**
  - Amount of the deviation: tropia or phoria
  - Neutralize with prisms
- **Normal Findings**
  - Distance = 0-2 pD XP
  - Near = 0-6 pD XP
  - Tropias, Eso and Vertical deviations are **not** normal
- **Recording**
  - Tropia = Magnitude, Direction, Frequency, Laterality
  - Phoria = Magnitude, Direction
  - Examples
    - CT cc Ortho @D/N
    - CT sc 20 RX(TT)@D; 10 XP @N
    - CT cc 15 LET w/ 5 LHT@D/N

### Alternating Cover Test



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## NPC/NPA/AA

### Near Point of Convergence (NPC)

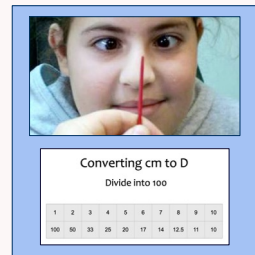
- Binocular convergence
- Norm: < or = 7 cm
- TTN = to the nose

### Near Point of Accommodation (NPA)

- Binocular focusing ability
- Minimum expected norm: 15 - (age/4)
- Ex. 8 year old = 15 - (8/4) = 13D

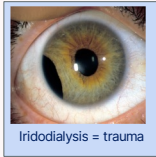
### Accommodative Amplitude (AA)

- Monocular focusing ability
- Not affected by convergence
- Minimum expected norm: 15 - (age/4)

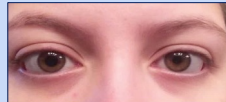


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## Pupils



Heterochromia = unequal iris color



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## Pupils

### PERRL

- Pupil Equal Round Reactive Light**
- Efferent pathway = to the brain

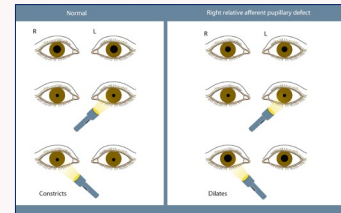
### RAPD

- Relative Afferent Pupillary Defect**
- Afferent pathway = from the brain
  - APD=Relative Afferent Pupillary Defect
  - MG=Marcus Gunn

### Causes

- Trauma
- Neurological disorders
- Eye drops/Medications
- Tumors/Cancers

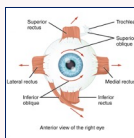
**Recording / Expected Norm**  
PERRL -APD



Examples of normal vs +APD

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## Extraocular Muscle Evaluation



### Extraocular Motilities (EOMs)

- 9 fields of gaze
- Smooth movements
- Over and under actions
- End Point Nystagmus

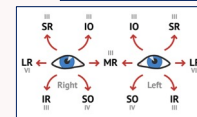


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## Extraocular Muscle Evaluation

### Recording

- Full
- FESA = Full Extensive Smooth Accurate



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## Stereo Acuity

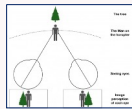
**Stereopsis** = Depth perception

**Stereo acuity** = Smallest amount of depth perceived

|            |                         |
|------------|-------------------------|
| Normal     | 20 sec of arc or better |
| Borderline | 25 - 40 sec of arc      |
| Reduced    | 50 - 400 sec of arc     |
| Gross      | 3000 sec of arc         |

### Recording

Randot 250 sec arc  
Animals 200 sec arc  
Circles 20 sec arc



Lateral offset = different images

Randot Test



Stereofly Test

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## Color Vision Testing

"anomaly" = difficulty with (less severe)

"anopia" = inability to (more severe)

Deuteranomaly = green red confusion

Protanomaly = red green confusion

Protanopia/Deuteranopia = red and green look alike

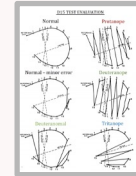
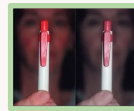
Tritanomaly: blue green confusion, yellow red confusion

Tritanopia: blue=green, purple=red, yellow=pink

Achromatopsia = see only shades of gray



D 15 Test



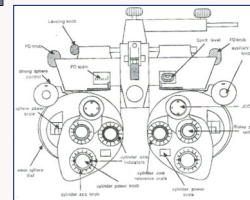
30

## Phoropter Testing



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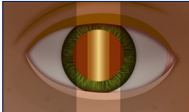
## The Phoropter



- 160 lenses
- Sphere -19.00 to +16.75
- Cylinder -0.25 to -6.00
- Maddox rods
- Filtered lenses
- Prisms
- Jackson Cross Cylinders

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## Refraction






**Retinoscopy**  
OD -2.00 DS 20/25  
OS -1.50 -0.75 x 180 20/20

**Monocular Subject**  
OD -2.50 -0.50 x 175 20/15  
OS -1.75 -0.75 x 005 20/15

**Binocular Balance**  
OD -2.00 -0.50 x 175 20/20  
OS -1.75 -0.75 x 005 20/15


**Final Rx**  
OD -2.25 -0.50 x 175 20/15  
OS -1.75 -0.75 x 005 20/15

|   |   |   |   |   |   |       |
|---|---|---|---|---|---|-------|
| P | E | C | F | D | S | 20/40 |
| P | E | C | F | D | S | 20/40 |

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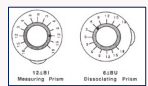
## Phoropter Functional Vision Tests



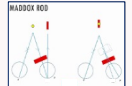
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## Binocular Vision Assessment

**Prism Dissociation**



**Maddox Rod**




**Normal Vergence Findings**

- Horizontal
  - Distance: BI x/5/3, BO 8/15/7
  - Near: BI 11/19/10, BO 14/18/7
- Vertical
  - BU: 3/1
  - BD: 3/1

**Normal Phoria Findings**

- Horizontal
  - Distance = 0-2 pd EXO,
  - Near = 0-6 pd EXO
- Vertical Ortho @ D/N

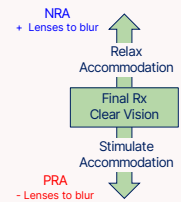
**Vergence Testing**



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## Accommodation Assessment


**NRA/ PRA Test**



**Normal NRA/PRA Findings**

- Non-presbyope: NRA +2.00, PRA -2.50

**Push Up Test**



**Push Up Amplitude of Accommodation**

- Monocular focusing ability
- Not affected by convergence
- Minimum expected norm: 15 - (age/4)

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## Refractive Conditions

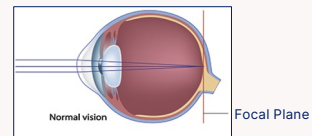
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## Refractive Error

**Refractive Error** = light is not focused clearly on the retina.

It is equal but opposite to the spectacle correction.

+2.00DS refractive error (eye)    **-2.00DS spectacle Rx**



**Emmetropia** = light is focused clearly on the retina = no refractive error

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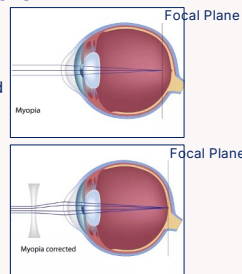
## Myopia

### Myopia

- Eye is too long / the image is focused in front of the retina
- Nearsighted

### Correction

- **Minus** or **Concave** lenses to push the image back onto the retina.



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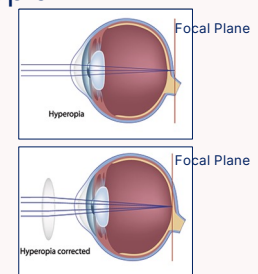
## Hyperopia

### Hyperopia

- eye is too short / the image forms behind the retina
- Farsighted

### Correction

- **Plus** or **Convex** lenses to pull the image forward on to the retina.

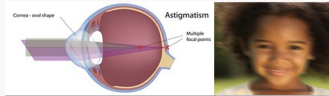


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## Astigmatism

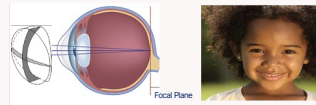
### Astigmatism

- Cornea / lens are ellipsoid shape
- Light rays focus at 2 different points



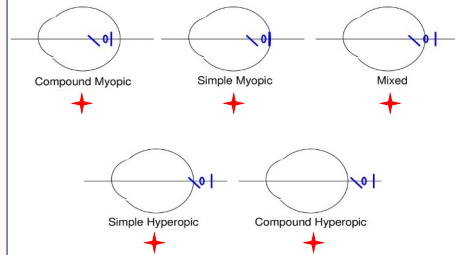
### Correction

- **Cylinder lens** has 2 different powers 90 degrees apart



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## Types of Astigmatism

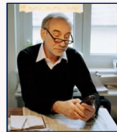


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## Presbyopia

- Loss of near focusing
- Associated with age

| Age | Acc. Amplitude (AA) | Tentative ADD (40cm) |
|-----|---------------------|----------------------|
| 35  | +5.50               | 0.00                 |
| 40  | +5.00               | Plano to +0.50       |
| 45  | +3.50               | +0.75 to +1.00       |
| 50  | +2.50               | +1.25 to +1.50       |
| 55  | +1.75               | +1.75 to +2.00       |
| 60  | +1.00               | +2.25 to +2.50       |



AA = 15 - (age/4)  
 AA = 15 - (48/4) = 3.00 D  
 Use Half = 3.00/2 = 1.50 D

Min. ADD = Demand - AA/2  
 Min. ADD @ 40cm = 2.50 - 3.00/2 = +1.00D



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## Elements of a Spectacle Rx

|   | Sph   | Cyl   | Axis | Add   | Prism |
|---|-------|-------|------|-------|-------|
| R | +1.25 | -0.50 | 004  | +2.25 |       |
| L | +0.50 | -1.00 | 177  | +2.25 |       |

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## Case 1 Bernie

**Bernie** 45 yo Software marketing and sales manager

**CC:** Difficulty reading up close

**Onset** ~3 months ago

**Location** At near (phone, ipad)

**Duration/Frequency/Context** With onset of near work

**Modifying Factors** Increases working distance

**Personal and Family History, Medications**

**Ocular conditions** None

**Medical conditions** None

**Optical History** LEE 2 years ago

SV glasses & CLs, distance vision is good with both

Enjoys tennis and racquetball, uses CL's for sports only



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## Bernie's Confrontation Tests

**Gross Observation:** normal

**DVA** cc 20/15, 20/15

**NVA** cc 20/30, 20/30

**CT** cc 2XP/3XP

**AA** 4D/4D

**NPA** 4D

**NPC** TTN

**Pupils:** PERRL -APD

**EOMS:** full

**Stereo:** Circles 20 sec arc

**Color vision:** Normal

### Data Norms

VA's 20/20 or better at D/N

CT Distance = 0-2 xp Near = 0-6XP

AA/NPA for 45 YO (15-45/4 = 3.75D)

NPC <7 cm



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## Bernie's 1 Treatment

### Refraction

OD -6.00 DS 20/15

OS -6.25 DS 20/15

100/30cm = 3.33D accommodative demand at 30cm

3.33D - 1/2 (4D AA) = 1.33 tentative add



|          | Sph   | Cyl | Axis | Add   | Prism |
|----------|-------|-----|------|-------|-------|
| <b>R</b> | -6.00 | DS  |      | +1.00 |       |
| <b>L</b> | -6.25 | DS  |      | +1.00 |       |

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## Common Focusing Conditions



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## Accommodative Disorders

**Accommodative insufficiency** = inability to focus based on the age  
Tx: (+) lenses, VT (vision therapy)

**Ill-sustained accommodation** = can focus, but can't hold the focus  
Tx: (+) lenses, VT

**Accommodative infacility** = slow to change focus  
Tx: (+) lenses with VT

**Accommodative spasm** = overstimulation; focusing "cramp"  
Tx: (+) lenses, VT, or cycloplegic agent (drops that relax focusing muscles)

**Paralysis of accommodation** = rare condition, eye can't focus  
usually secondary to trauma, systemic disease, drug toxicity, or medication  
Tx: Determine underlying cause, (+) lenses



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## Elements of a Spectacle Rx

|   | Sph   | Cyl   | Axis | Add   | Prism |
|---|-------|-------|------|-------|-------|
| R | +1.50 | -1.00 | 045  | +1.00 |       |
| L | +1.50 | -1.00 | 135  | +1.00 |       |

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## Common Eye Misalignments

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## Ocular Deviations

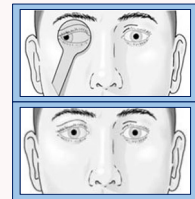
### Tropia

- Strabismus, lazy eye, eye turn
- 2-4% general population



### Phoria

- Natural resting position
- Under the cover paddle, eye moves to position of rest



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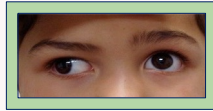
## Horizontal Misalignments

**Eso** = eye(s) turns **in** towards the nose

**Exo** = eye(s) turns **out** towards the ear



**Eso** = turns in  
Ex. Right Esotropia



**Exo** = turns out  
Ex. Right Exotropia

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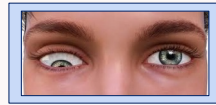
## Vertical Misalignments

**Hyper** = eye turns **upward**

**Hypo** = eye turns **downward**



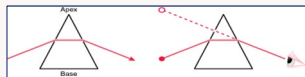
**Hyper** = Turns Up  
Ex. Right Hypertropia



**Hypo** = Turns Down  
Ex. Right Hypotropia

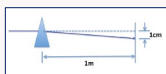
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## How Do Prisms Work?



Light bends  
around the base

The image shifts  
towards the apex



1.00 Base Down

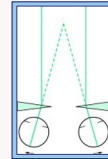


Where is the Apex of the prism?

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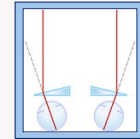
## Correcting for Misalignments

**Eso** = eye turns in



**Base Out Prism**  
Shifts the image IN

**Exo** = eye turns out

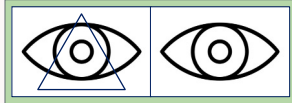


**Base In Prism**  
Shifts the image OUT

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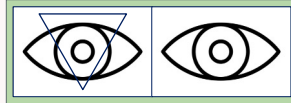
## Correcting for Misalignments

**Right Hyper** = OD turns up



**Base Down Prism**  
shifts the image UP

**Right Hypo** = OS turns down



**Base Up Prism**  
Shifts the image DOWN

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## Elements of a Spectacle Rx

|   | Sph   | Cyl   | Axis | Add   | Prism           |
|---|-------|-------|------|-------|-----------------|
| R | -1.25 | -0.50 | 004  | +1.00 | 2.00BI, 1.00BDn |
| L | +0.50 | -1.00 | 177  | +1.00 | 2.00BI, 1.00BUp |

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## Binocular Vision Conditions



| Condition          | Treatment         |
|--------------------|-------------------|
| Exo                | Prism, VT         |
| Eso                | (+) Lenses, Prism |
| Divergence Excess  | Prism, VT         |
| Convergence Excess | (+) Lenses, Prism |
| Vertical Phoria    | Prism             |

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## Case 2 John

**John** 31 yo Nursing school student

**CC:** Headaches and eye strain

**Onset** ~2 months ago

**Location** At near (reading, computer)

**Duration/Frequency/Context** With onset of near work

**Personal and Family History, Medications**

**Ocular conditions** None

**Medical conditions** Anxiety and depression, taking Zoloft 100mg daily x 3 months

**Optical History** First eye exam, no HX glasses, distance vision is good.  
Enjoys biking and hiking, uses sunglasses/UV protection outdoors



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## John's Confrontation Tests

**Gross Observation:** normal

**DVA** sc 20/25, 20/20

**NVA** sc 20/30, 20/30

**CT** sc Ortho/8xp

**AA** 6D/6D

**NPA** 5D

**NPC** 10cm

**Pupils:** PERRL -APD

**EOMS:** full

**Stereo:** Circles 20 sec arc

**Color vision:** Deuteranomaly = green red confusion



### Data Norms:

**VA's** 20/20 or better at D/N

**CT Distance** = 0-2 xp **Near** = 0-6XP

**AA/NPA** for 31 YO (15-31/4 = 7D)

**NPC** <7 cm

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## John's Treatment

### Refraction

OD +1.00-0.50x180 20/20

OS +0.75 DS 20/20

### Prism Dissociation cc 1xp/12xp

Norm: Distance = 0-2 XP, Near = 0-6XP



|   | Sph   | Cyl   | Axis | Add | Prism  |
|---|-------|-------|------|-----|--------|
| R | +1.00 | -0.50 | 180  |     | 2.00BI |
| L | +0.75 | DS    |      |     | 2.00BI |

DX = Compound hyperopia, accommodative insufficiency, divergence excess

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## Case 3 Sally

Sally 6 yo First grader

**CC:** Left eye turns in, tired when reading

**Onset** Beginning of school year

**Location** At near (reading, computer)

**Duration/Frequency/Context** With onset of near work

### Personal and Family History, Medications

**Ocular conditions** Father had an eyeturn

**Medical conditions** None

**Optical History** First eye exam, no HX glasses, vision is good.

Goalie on a soccer team, piano lessons



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## Sally's Confrontation Tests

**Gross Observation** eyes are straight at distance, left eye turns in at near

**DVA** sc 20/30, 20/50

**NVA** sc 20/30, 20/50

**CT** sc 2 EP/15 LET

**AA** 11D/11D

**NPA** 12D

**NPC** TTN

**Pupils** PERRL -APD

**EOMS** full

**Stereo** Animals 400 sec arc

**Color vision** normal

### Data Norms:

**VA's** 20/20 or better at D/N

**CT Distance** = 0-2 xp **Near** = 0-6XP

**AA/NPA** for 6 YO (15-6/4 = 13.50D)

**NPC** <7 cm

**Stereo** 20 sec arc or better

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## Sally's Treatment

**Auto-refraction**      **Retinoscopy**  
 OD +4.50 -0.75 x 005    OD +5.50 -0.75 x 180  
 OS +5.00 -0.50 x 178    OS +5.50 -0.50 x 180

**Cycloplegic (wet) Retinoscopy**  
 OD +6.50 -0.75 x 180  
 OS +7.50 -0.50 x 180



|          | Sph   | Cyl   | Axis | Add | Prism |
|----------|-------|-------|------|-----|-------|
| <b>R</b> | +6.50 | -0.75 | 180  |     |       |
| <b>L</b> | +7.50 | -0.50 | 180  |     |       |

DX = Compound hyperopia, Accommodative Esotropia

## Sally's Follow Up with Glasses

**Gross Observation** eyes appear straight at distance and near with glasses.

**DVA** cc 20/20, 20/25+

**NVA** cc 20/20, 20/25+

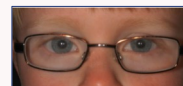
**AA** 14D/14D

**NPA** 15D

**NPC TTN**

**Stereo** cc 80 sec arc

**Cover Test** cc Ortho/Ortho



|          | Sph   | Cyl   | Axis | Add | Prism |
|----------|-------|-------|------|-----|-------|
| <b>R</b> | +6.50 | -0.75 | 180  |     |       |
| <b>L</b> | +7.50 | -0.50 | 180  |     |       |

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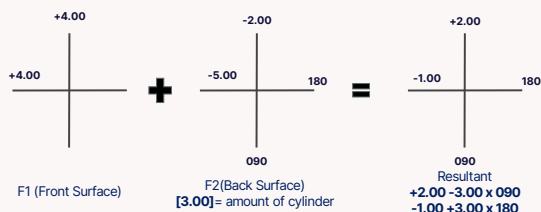
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## Patient Communication

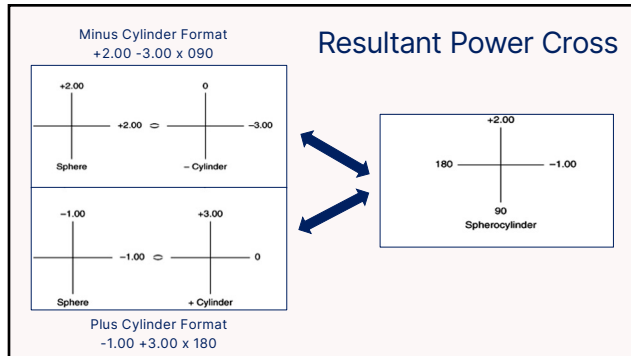


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## Power Crosses



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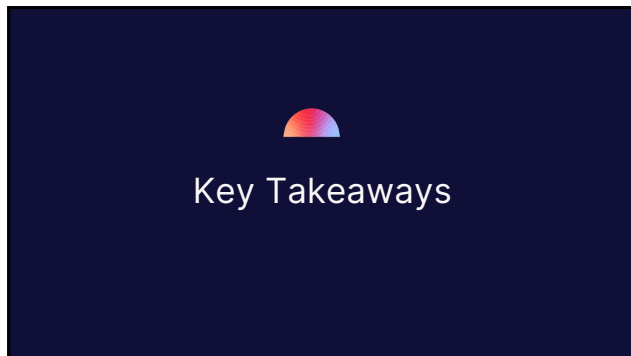


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**Patient Communication**

|   | Sph   | Cyl   | Axis | Add   | Prism            |
|---|-------|-------|------|-------|------------------|
| R | -1.25 | -0.50 | 004  | +1.00 | 2.00Bin, 1.00BDn |
| L | +0.50 | -1.00 | 177  | +1.00 | 2.00Bin, 1.00BUp |

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**Take Home Points**

- Understand how the visual system works
- Visual Assessment = Refractive Error, Accommodation, Binocular vision and Eye health
- Multiple data points affect the final spectacle Rx and ocular disease diagnosis
- Understand and communicate the treatment plan

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"I've learned that  
people will forget what  
you said, people will  
forget what you did, but  
people will never forget  
how you made them feel."  
- Maya Angelou



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**THANK YOU!**



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