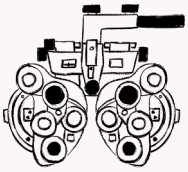
Visual Assessment: More Than a Refraction



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Disclosures

- The content of this course was developed independently without commercial bias or influence
- Consulting
  - Visionix
  - Essilor Instruments, USA
- Founding partners of SightLine Ophthalmic 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

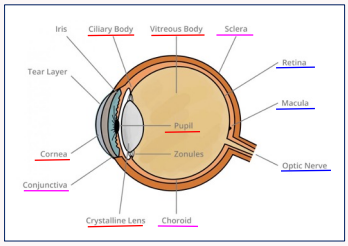
Visual Pathway

4

Ocular Anatomy Review

The Eye

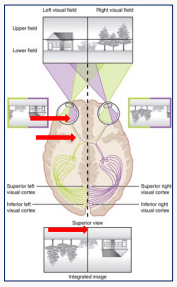
- Refracting Tissues/Structures
  - Cornea
  - Pupil
  - Crystalline Lens
  - Ciliary Muscle
  - Aqueous & Vitreous Humor
- Light Sensitive Tissues
  - Retina/Macula
  - Optic Nerve
- Supportive Tissues
  - Conjunctiva
  - Sclera
  - Choroid

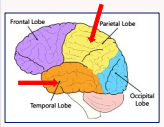


5

Visual Perception Steps

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





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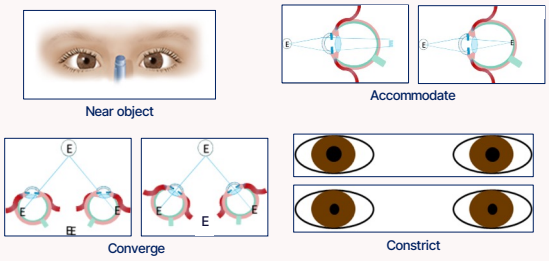
Accommodative / Near Triad



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Visual Assessment Tests

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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

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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?

Daily activities?

- 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

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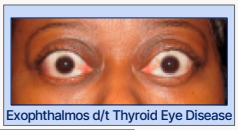
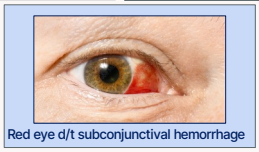
External Observations

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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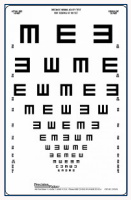
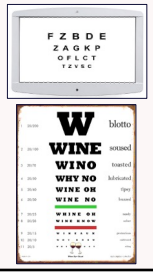
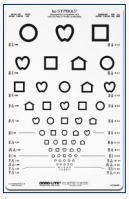
Visual Acuity

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







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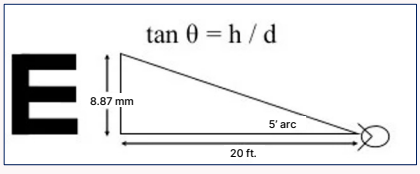
Snellen Acuity System

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).



Test Distance 20/20 Letter Size

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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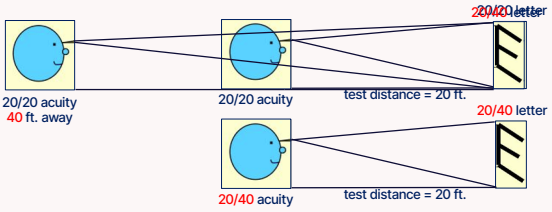
Snellen Acuity

A person with 20/20 acuity stands 40 feet away to read the 20/40 foot size letters.
20/20 = from 20 feet away the smallest letters read correctly are the 20 foot sized letters.



20/40= from 20 feet away the smallest letters read correctly are the 40 foot sized letters.

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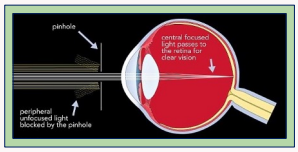
Visual Acuity Testing

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^{-2}



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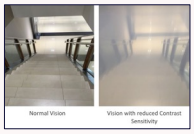
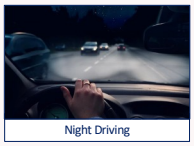
Contrast Sensitivity

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




Night Driving

Pelli Robson Chart

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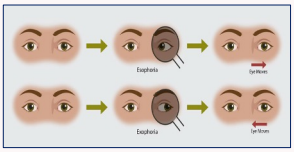
Cover Test

Cover Test = measures the alignment of the eyes and how well they work together


Unilateral Cover Test

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



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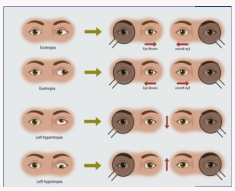
Cover Test

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
    - Ex. 1 CT cc Ortho @ D/N
    - Ex. 2 CT sc 20 RX(T)@ D; 10 XP @N
    - Ex. 3 CT cc 15 LET w/ 5 LHyperT@ D/N

Alternating Cover Test



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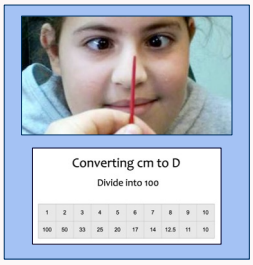
NPC/NPA/AA

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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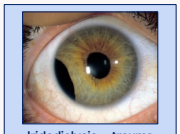
Pupils

Pupil Testing
- optic nerve disease
- retinal disease
- trauma


Iridodialysis = trauma

Anisocoria = unequal pupil sizes


Heterochromia = unequal iris color

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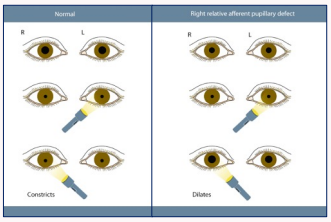
Pupil Testing

PERRL
Pupil **E**qual **R**ound **R**eactive **L**ight
- Efferent pathway = to the brain

RAPD
Relative **A**fferent **P**upillary **D**efect
- 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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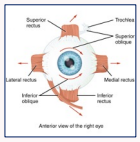
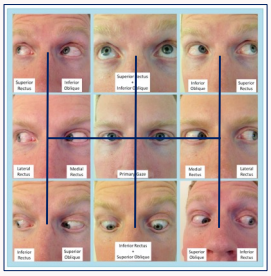
Extraocular Muscle Evaluation

EOMs = extraocular muscle integrity and innervating nerves





Extraocular Motilities (EOMs)
- 9 fields of gaze
- Smooth movements
- Over and under actions
- End Point Nystagmus

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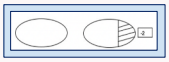
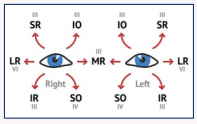
Extraocular Muscle Evaluation

Recording
- Full
- FESA = Full Extensive Smooth Accurate





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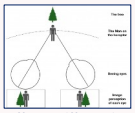
Stereo Acuity

Stereopsis = Depth perception


Lateral offset = different images

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

Randot Test


Stereofly Test

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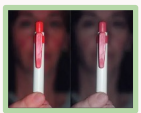
Color Vision Testing

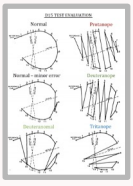
"anomaly" = difficulty with (less severe)
"anopia" = inability to (more severe)

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

Red Cap Test



D 15 Test



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Phoropter Testing

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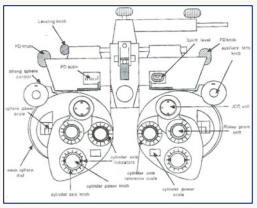
The Phoropter



- 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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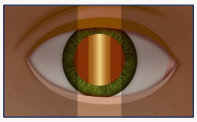
Refraction

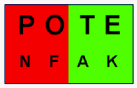


Objective:
Retinoscopy
OD -2.00 DS 20/25
OS -1.50 -0.75 x 180 20/20

Subjective:
Monocular Subjective
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 5 20/40
P E C F D 5 20/40

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Phoropter Functional Vision Tests

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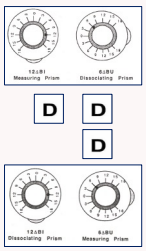
Binocular Vision Assessment

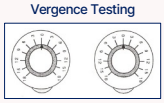
Prism Dissociation



Normal Phoria Findings
- Horizontal
  - Distance = 0-2 pD EXO,
  - Near = 0-6 pD EXO
- Vertical Ortho @ D/N

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

Vergence Testing



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Accommodation Assessment

NRA / PRA Test= ability to increase/decrease accommodation under binocular conditions
NRA = Negative Relative Accommodation
PRA = Positive Relative Accommodation

NRA
+ Lenses to blur

Relax Accommodation

Final Rx
Clear Vision

Stimulate Accommodation

PRA
- Lenses to blur

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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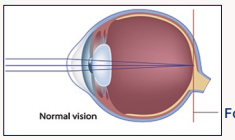
Refractive Error

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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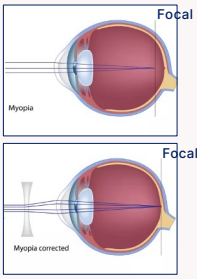
Myopia

Myopia
- Eye is too long / the image is focused in front of the retina
- Nearsighted
- 40% of U.S.

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



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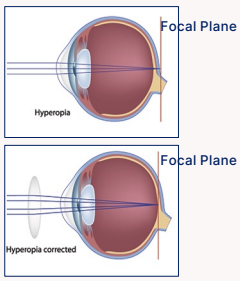
Hyperopia

Hyperopia
- eye is too short / the image forms behind the retina
- Farsighted
- 25% of U.S.

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



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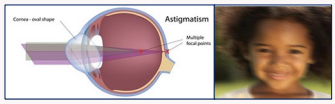
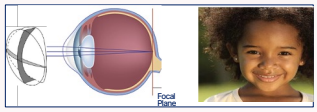
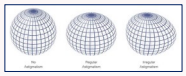
Astigmatism

Astigmatism
- Cornea / lens are ellipsoid shape
- Light rays focus at 2 different points
- 30% of U.S.



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





Keratoconus

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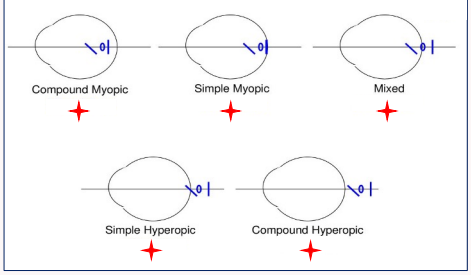
Types of Astigmatism



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Presbyopia

- Loss of near focusing
- Associated with age
- 39% pf U.S.

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

Myopia, Hyperopia

Astigmatism

Presbyopia

	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 46 yo Softwear 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 46 YO (15-46/4 = 3.50D)
NPC <7 cm

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Bernie's Treatment Plan

Refraction = Spectacle Rx
OD -6.00 DS 20/15
OS -6.25 DS 20/15

100/40 cm = 2.50D accommodative demand at 40cm
AA/NPA for 46 YO (15-46/4 = 3.50D), use ½ of 3.50 (1.75D)
2.50D - 1.75D = +0.75D tentative add

	Sph	Cyl	Axis	Add	Prism
R	-6.00	DS		+0.75	
L	-6.25	DS		+0.75	

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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

Hyperopia

Astigmatism

Presbyopia Accommodation

	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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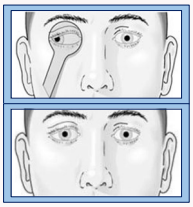
Ocular Misalignment

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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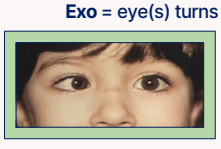
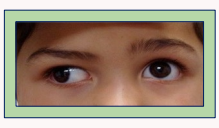
Horizontal Misalignments

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





Eso = turns in
Ex. Right Esotropia
- Infantile
- Accommodative
- Sixth Nerve Palsy

Exo = turns out
Ex. Right Exotropia
- Inherited
- Low Vision
- Stroke
- Convergence Insufficiency

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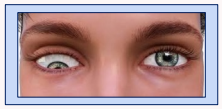
Vertical Misalignments

Hyper = eye turns **upward**
Hypo = eye turns **downward**



Hyper = Turns Up
Ex. Right Hypertropia

Hypo= Turns Down
Ex. Right Hypotropia

- Congenital
- Traumatic Brain Injury / Concussion

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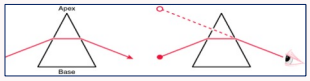
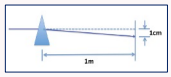
How Do Prisms Work?



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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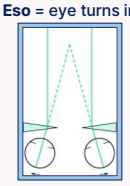
Correcting for Misalignments

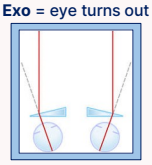
Prism base = opposite direction of the deviation

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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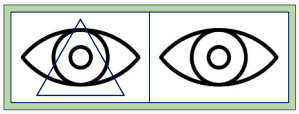
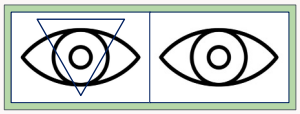
Correcting for Misalignments

Right Hyper = OD turns up



Base Down Prism
shifts the image UP

Right Hypo = OS turns down



Base Up Prism
Shifts the image DOWN

Prism base = opposite direction of the deviation

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Elements of a Spectacle Rx

Myopia, Hyperopia

Astigmatism

Presbyopia Accommodation

Binocular Vision

	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

Horizontal prisms add together when the bases are in the **same** directions
Vertical prisms add together when the bases are **opposite** directions

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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 Plan

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 hyperopic astigmatism OD, simple hyperopia OS, 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 Plan

Auto-refraction
OD +4.50 -0.75 x 005
OS +5.00 -0.50 x 178

Retinoscopy
OD +5.50 -0.75 x 180
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
R	+6.50	-0.75	180		
L	+7.50	-0.50	180		

DX = Compound hyperopia, Accommodative Esotropia

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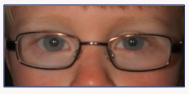
Sally's Follow Up with Glasses

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
R	+6.50	-0.75	180		
L	+7.50	-0.50	180		

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Patient Communication

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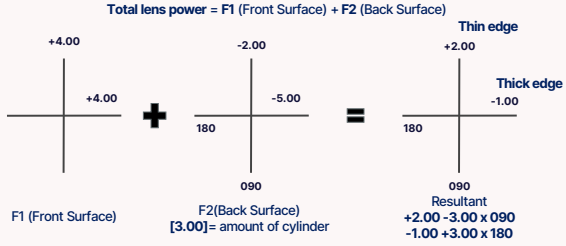
Power Crosses

Total lens power = **F1** (Front Surface) + **F2** (Back Surface)



F1 (Front Surface)

F2(Back Surface)
[3.00]= amount of cylinder

Resultant
+2.00 -3.00 x 090
-1.00 +3.00 x 180

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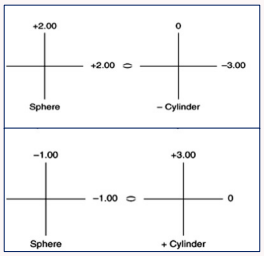
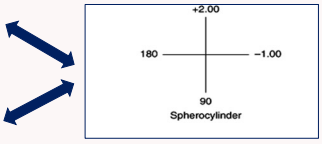
Resultant Power Cross

Minus Cylinder Format
+2.00 -3.00 x 090





Plus Cylinder Format
-1.00 +3.00 x 180

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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

Right eye Nearsighted
Left eye Farsighted

Causes blur at all distances

Added reading correction

Reduces strain on eye muscles

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Key Takeaways

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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 condition and treatment plan

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THANK YOU!

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