


Aniseikonia . . .
The Problem, The Solutions
 ABO/NCLE Level III - 2 hour



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Financial Disclosure Statement

Andrew Bruce provides consulting services for . . .

- VSP Optics/UUniversity
- Mitsui Chemicals

- All relevant relationships have been mitigated
- He has NO financial interest in any product presented in this course.

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Learning Objectives

Upon completion, the participant should be able to . . .

- Demonstrate a detailed understanding of aniseikonia, its clinical symptoms, and a variety of treatment options
- Discuss the factors that influence optical magnification
- Define binocular vision, retinal correspondence, the horopter, and Panum's area of fusion
- Explain Knapp's law and its connection to the treatment of aniseikonia
- Demonstrate the processes involved in designing iseikonic ophthalmic lenses
- Discuss the role contact lenses play in the treatment of aniseikonia.

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Hypothesis

Contact lenses are ALWAYS the best solution for managing aniseikonia.

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KNOW THE RULES!

Professional Liability

POINTS TO REMEMBER

- Always work within the limits of your scope of practice
- Remember, only doctors can diagnose aniseikonia
- Prior to treatment, consult with prescribing doctor, and document their "ok to proceed"
- Aniseikonia can present as symptoms that can be related to more serious, non-vision issues
- Incorrect treatment due to an incorrect diagnosis can result in masked or delayed treatment of the actual cause
- Good doctor-optician communication makes for a strong relationship.

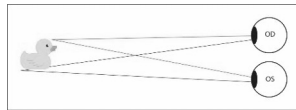
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Introduction to Aniseikonia

- Significantly different refractive states between each eye can result in complications from the disparities in image size/shape each eye receives
- Known as aniseikonia, a binocular condition defined as:
 "A relative difference in size and/or shape of the ocular images formed by the two eyes."
- Most patients experience < 1% aniseikonia
- > 2% clinically significant
- > 3-5%+ highly symptomatic
- Clinical significance can greatly influence stereopsis.

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Stereopsis



- Stereopsis provides realistic impression of environment - depth perception
- To produce a single mental percept of an object, retinal images from both eyes must undergo sensory fusion
- Significant disparity between right and left images interferes, resulting in *apparent* changes in environment
- To achieve sensory fusion, object points for each eye must fall within Panum's fusional space.

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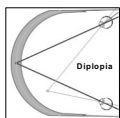
Horopter and Panum's Area

Horopter

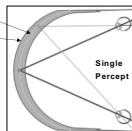
The locus of object points in space simultaneously stimulating corresponding retinal points of the two eyes to result in a single percept

Panum's Fusional Space

Region in space surrounding a horopter in which images that appear at different points on the two retinas result in a single percept



Visual targets outside Panum's fusional space (in front or behind), will result in diplopia.



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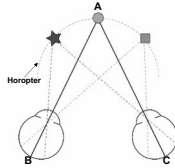
Binocular Vision and Retinal Correspondence

In simple terms . . .

In normal, single binocular vision, all objects on the horopter fall on corresponding retinal areas

All imaged on corresponding retinal points

- ★ Right of fovea on both eyes
- On fovea for both eyes - B & C
- Left of fovea on both eyes.



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Corrective Lenses and Magnification

- All lenses influence image size
- Plus vs. minus lenses
- Degree of influence depends on:
 - Lens thickness
 - Lens material
 - Base curve
 - Back vertex power
 - Back vertex distance.



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Refractive States

- Emmetropia
- Ametropia
 - Myopia - axial vs refractive
 - Hyperopia - axial vs refractive
 - Astigmatism - refractive.



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Etiology of Aniseikonia

- Naturally occurring, binocular differences in ametropia.
- Unintended consequence of ocular surgery
- Sudden-onset - unilateral pseudophakia.



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Symptoms of Aniseikonia

- Patients often describe how their eyes "feel"
- Tired or sore eyes, tearing, photophobia, induced prismatic effects, and overall fatigue
- Nervousness, headaches, diplopia, disorientation, dizziness, and nausea
- Compromised stereoscopic vision.



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Clinically Significant Aniseikonia

Many individuals function normally with subclinical levels

Red Flags for Clinical Significance

- Symptoms not helped by, or occur due to, the addition of corrective lenses
- High anisometropia or high astigmatism
- Physically altering factors, such as pseudophakia, monocular aphakia, scleral buckling, refractive surgery
- Complaints of distortion
- Improved visual comfort when one eye is occluded.

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Types of Aniseikonia

- Physiologic/non-symptomatic
- Anomalous
- Optical
 - Inherent
 - Induced.



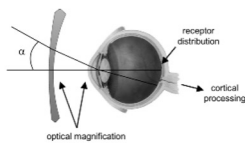
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Physiologic Aniseikonia NON-SYMPTOMATIC

- Occurs in individuals whose eyes are identical in both axial length and refractive properties
- Results from lateral gaze
- Expected and normal
- Serves to provide visual clues that enhance spatial awareness and eye-hand coordination.

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Anomalous Aniseikonia

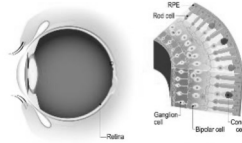


- Any other type than physiologic, often simply referred to as *aniseikonia*
- Indicates an anomaly in either the eye's anatomic structure, or it's caused by the optics of the eyes and/or corrective lenses.

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Associated Anatomic Anomalies

- Unequal distribution of rods and cones in retina of one eye vs. the opposite eye, and their representation in visual cortex
- Retinal conditions:
 - Epiretinal membrane
 - Macula edema
 - Re-attached RD
 - Macular holes.



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Optical Aniseikonia



Inherent Optical Aniseikonia

- Depends on the relative dioptric systems of the right and left eye

Induced Optical Aniseikonia

- Caused by magnification of corrective lenses
- Disparities in refractive states of both eyes
- Primarily: anisometropia and antimetropia
 - 1D anisometropia \approx 1% aniseikonia.

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Rx Anisometropia vs. Antimetropia

Anisometropia

A condition of unequal refractive state for both eyes
Ex. OD: +4.00 DS OS: +1.00 DS

Antimetropia

Mixed anisometropia
Ex. OD: +2.00 DS OS: -2.00 DS

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Anisometropia



- Generally considered clinically significant when spherical equivalent power difference $>1D$ exists
- Binocular phenomena, can have axial or refractive origin
- Origin can greatly influence theoretical sizes of retinal images, resulting in perceived aniseikonia
- Anisometropia and induced prism.

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Knapp's Law

"When a correcting lens is so placed before the eye that its second principal plane coincides with the anterior focal point of an axially ametropic eye, the size of the retinal image will be the same as though the eye were emmetropic."

To simplify . . .

If ametropia is axial related, the retinal image size will be larger or smaller than a normal emmetropic eye. So, ophthalmic lenses will provide the optimal solution to return the image sizes to normal.

Contact Lenses

Best corrective device for refractive aniseikonia

Ophthalmic Lenses

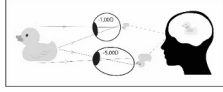
Best corrective devices for axial aniseikonia.

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Axial vs. Refractive Anisometropia

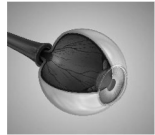
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Uncorrected Axial Anisometropia



- Refractive properties provided by cornea and crystalline lens considered same for both eyes
- Optical theory states image size will be different from emmetropic eye because axial length is different - larger for myope, smaller for hyperope
- Aniseikonia WILL exist when uncorrected axial ametropia differs between each eye.

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Uncorrected Refractive Anisometropia

- Axial lengths of each eye are considered equal
- Resulting image size essentially equal to that of an emmetropic eye
- Aniseikonia will NOT exist, when uncorrected.

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Managing Axial Anisometropia Per Knapp's Law

- Axial anisometropia WILL result in axial-related aniseikonia
- Magnification effects of ophthalmic lenses can offset this aniseikonia, returning image sizes to normal
- **AXIAL ANISOMETROPIA: Per Knapp's law, ophthalmic lenses are the most effective treatment option, NOT contact lenses!**



WHAT!!!

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Managing Refractive Anisometropia Per Knapp's Law

- Refractive anisometropia will NOT result in aniseikonia
- Magnification effects of ophthalmic lenses will induce optical aniseikonia
- *Spectacle Magnification* is at minimum when VD minimum
- Since contacts minimize VD, they minimize induced optical aniseikonia
- **REFRACTIVE ANISOMETROPIA: Clinical practice agrees with Knapp's law: Contact Lenses are the most effective treatment option.**

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Anisometropia and Aniseikonia Overview

	Presence or Absence of Aniseikonia in Uncorrected and Corrected Anisometropia		
	Uncorrected	Spectacle Correction	Contact Lens Correction
Axial Anisometropia	Present	Absent	Present
Refractive Anisometropia	Absent	Present	Absent

NOTE: Anisometropia can be related to both axial and refractive properties.


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The Influence of Axial Length on Aniseikonia

- The average axial length is approximately 23.30mm
- Axial lengths of each eye should differ no more than 0.3mm

Assuming central corneal power same for each eye at normal axial lengths

1mm axial length diff. ≈ 3D diff. in ametropia.



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Determining Source of Ametropia/Anisometropia

Optical Biometer



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Estimating Source of Ametropia / Anisometropia

Refractive Related

Significantly different k's, between each eye
Anisometropia due to development of a monocular cataract
Routine refractive changes in adults

Axial Related

Similar k's between each eye
Clinically significant anisometropia
Ametropia > +/-4D.


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Clinical Findings vs. Knapp's Law



- Clinical practice finds aniseikonia to still be present after ophthalmic lenses are used to correct *axial* ametropias
- So, *contrary to Knapp's law* . . .
- **CONTACTS** are **SUPERIOR** for correcting **ALL** types of aniseikonia
- **Proven Hypothesis!**

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Ophthalmic Lens Treatment of Aniseikonia

- Although contact lenses prove most effective treatment option for managing aniseikonia, could glasses be used?
- What if patient cannot, or doesn't want to wear contacts?
- Then what?
- An ophthalmic lens solution must be provided.

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Spectacle Magnification (SM)

Definition
A type of angular magnification brought about by a single spectacle lens

- Compares image size formed by a single eye wearing a corrective lens to image size in the same uncorrected eye
- $SM = \frac{\text{Retinal image size in corrected eye}}{\text{Retinal image size in same uncorrected eye}}$
- SM expressed as a ratio
- SM > 1.0 = positive magnification
- SM < 1.0 = minification.

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Calculating Spectacle Magnification Percentage

$$((M_s \times M_p) - 1) \times 100$$

Magnification Due To Shape

$M_s = 1 / (1 - (t/n)D_1)$

t = Lens center thickness, meters
*D*₁ = Front surface power or base curve, Diopters
n = Lens material refractive index

Influential Factors/Parameters

Base Curve (BC)
Center Thickness
Refractive Index

Magnification Due To Power

$M_p = 1 / (1 - (hD))$

D = Sphere equivalent lens power, Diopters
h = Vertex distance, meters

Influential Factors/Parameters

Dioptic Power
Vertex Distance (VD)

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Rx: OD: +1.00 DS OS: +5.00 DS

SM % = $((M_s \times M_p) - 1) \times 100$

t = center thickness D = Lens power h = vertex distance n = refractive index D_i = BC

OD

t = 3.0mm D = 1D h = 12mm (+3mm) n = 1.5 D_i = 6.00D

Mag OD = 2.7%

OS

t = 7.2mm D = 5D h = 12mm (+3mm) n = 1.5 D_i = 8.00D

Mag OS = 12.4%

Mag Difference = 9.7%

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How to Proceed

- The clinically significant 4D of anisometropia is likely refractive
- 9.7% difference in magnification would likely result in highly symptomatic aniseikonia, with little chance of sensory fusion
- So, how should you proceed if contact lenses are not an option?
- Design your patient a pair of iseikonic lenses.

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An Ophthalmic Solution

Iseikonic Lens Design

- Ophthalmic lens solution to minimize magnification differences between each eye and correct aniseikonia to an asymptomatic level
- Influential factors are manipulated, during design
- Factors influencing magnification:
 - Lens power
 - Base curve
 - Center thickness
 - Vertex distance
 - Material index of refraction
- Which can't opticians touch?

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Influence of BC and VD

Base Curve

- Flatter BCs produce less positive magnification
- For every 1D, VD also reduced by ≈ 0.6mm

Decreasing VD

- For a plus lens decreases magnification
- For a minus lens decreases minification

Example

- Anisometropic patient given flattest BC for most-plus eye, steepest for least-plus, reduction in VD alone will reduce aniseikonia by 2-3%.

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Ex. Modifications

Rx: OD: +1.00DS
OS: +5.00DS
Aniseikonia = 9.7%

- **OD:** steepen BC / **OS:** flatten BC
- **OD:** standard 1.5 index / **OS:** 1.74 index
- **OD:** match thickness (1.5 index) to new **OS** (1.74 index)

Vertex Distance

- **OD:** specify bevel placement towards back surface
- **OS:** specify bevel placement towards front surface
- Are you playing with fire?
- Process time consuming and labor intensive, but well-worth the satisfaction of making a difference for your patient.

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Ex. Iseikonic Lens

OD: +1.00DS
OS: +5.00DS
Aniseikonia = 9.7%

$$SM = M_s \times M_p = (1/1 - (t/n) D_1) \times (1/1 - (hD))$$

t = center thickness D = Lens power h = vertex distance n = refractive index D₁ = BC

New OD parameters

D = +1.00D t = 5.0mm h = 13mm (+3mm) n = 1.5 D₁ = +10.00D
Mag OD = 5.1%

New OS parameters

D = +5.00D t = 5.0mm h = 10mm (+3mm) n = 1.74 D₁ = +4.00D
Mag OS = 8.2%

Result: Aniseikonia reduced to **2.9%**

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Why Are Contacts Most Effective Treatment?

- Consider an infinitely thin lens, placed at the entrance of the pupil . . .
- Both factors used to calculate lens magnification would result in a spectacle magnification of 1x
- Closest we can get to this ideal, is by using either a contact lens or intraocular lens.



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Think Outside The Box

Contacts and Glasses

- Consider a presbyopic patient experiencing aniseikonia, unsuccessful with multifocal contacts
- Contacts will correct and balance distance vision, manage the aniseikonia, eliminate vertical imbalance induced by ophthalmic m/f
- Progressive would mostly just provide their near add power and any residual astigmatic correction.

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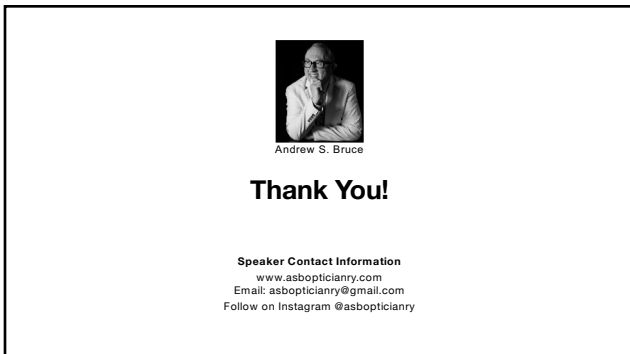
To Take Away . . .

- Symptomatic aniseikonia, when left unmanaged, can result in a wide range of complications
- Patients experiencing symptoms of induced aniseikonia, at final dispensing, might just need time to adapt
- Clinical practice continues to support contacts as the most effective for treating the aniseikonic patient
- If need be, put on your creative hat to design your patient iseikonic lenses as an ophthalmic solution
- Embrace the opportunity to demonstrate your expertise and training, enhancing your patient's quality of life.

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