جامعة المستقبل

كلية التقنيات الصحية والطبية

قسم تقنيات البصريات

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REFRACTIVE ERRORS 3

Lecture Title
**ANISOMETROPIA**

Lecture Number: 4 / course 1

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ANISOMETROPIA

1. Definition

Anisometropia: a clinically meaningful difference in refractive error between the two eyes (spherical equivalent and/or astigmatism). Most people have < 1.00 D difference; 0.25 D can be measured but is usually insignificant for everyday tasks. When the difference reaches approximately 1.00 D, spectacles typically produce ≈ 2% difference in retinal image size, which can trigger symptoms in some patients. Key tolerance guidance from your slide: ≈2.5 D (~5%) often tolerated; 2.5 – 4 D variable; >4 D commonly not tolerated with spectacles.

- **Antimetropia**: one eye is myopic and the fellow eye is hyperopic.
- **Aniso-astigmatism**: unequal cylinder power and/or axis between the eyes.
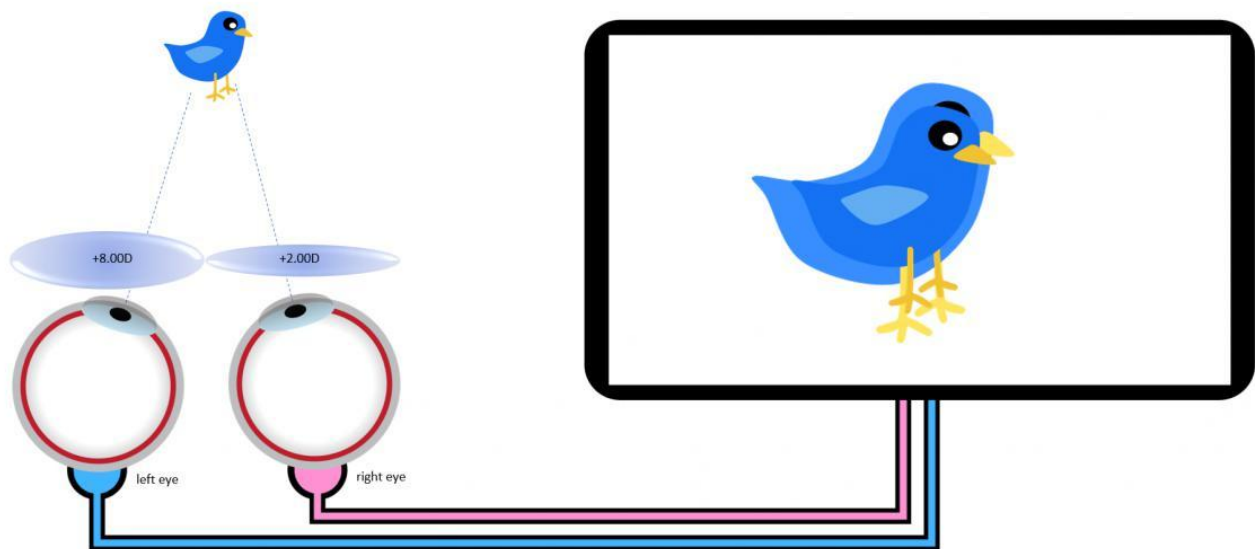
2. Why Lens Power Differences Matter (Position vs Size)

Spectacles sit at a **finite vertex distance** from the cornea.

- **Plus lenses** magnify; **minus lenses** minify.
- If each eye needs a different power, the perceived image size from each eye differs with spectacles. This is why patients may feel strain or distortion even when acuity is good.

- **Prisms** shift the position of images only; they do not correct size mismatch.
- **Contact lenses** reduce the vertex distance (≈0 mm), thereby reducing the size mismatch and often improving tolerance when the interocular difference is large.

3 Practical Tolerance with Spectacles

- **Rule of thumb: 1.00 D** difference → ≈2% image-size difference (with spectacles).
- **≈2.5 D (~5%)**: often tolerated.
- **2.5–4.0 D**: variable depends on tasks and individual reserves.
- **>4.0 D**: commonly not tolerated with spectacles → consider contact lenses or surgical options.

4. Spectacle Magnification (SM)

Spectacle magnification can be expressed as the product of a **power factor** and a **shape factor**:

$$SM = M_p \times M_s$$

Where:
- **Power factor**:

$$M_p = \frac{1}{1 - h.F_2}$$

- **Shape factor:**

$$M_s = \frac{1}{1 - \left(\frac{t}{n}\right).F_1}$$

Where:

h: vertex distance (the distance between the back surface of the spectacle lens and the cornea), measured in meters.

F_2: back vertex power of the lens, measured in diopters (D).

t: center thickness of the lens, in meters.

n: refractive index of the lens material (relative to air).

F_1: front surface power of the lens (the base curve), in diopters (D).

Worked Example

Suppose we have a +5.00 D spectacle lens made from a high-index material (n=1.60) with the following parameters:

- Vertex distance (h) = 0.012 m (12 mm)
- Center thickness (t) = 0.004 m (4 mm)
- Front surface power (F_1) = +6.00 D
- Back vertex power (F_2) = +5.00 D

$$M_p = \frac{1}{1-(0.012\times5)} = 1.064$$

$$M_s = \frac{1}{1-\left(\frac{0.004}{1.6}\right)\times6} = 1.015$$

$$\therefore SM = M_p \times M_s = 1.064 \times 1.015 \approx 1.080$$

- **Interpretation**
  - SM = 1.080 means the retinal image formed with the lens is **1.08 times larger** than the image without the lens.
  - In other words, the spectacle lens produces approximately **+8% magnification**.
- This example illustrates why high plus lenses can significantly enlarge the retinal image, and why, in anisometropia (different powers between the eyes), such magnification differences can cause symptoms like visual discomfort or double vision when corrected with spectacles.

To reduce interocular size difference in spectacles:

- Minimize vertex distance.

- Use higher index materials to reduce thickness.

- Flatten base curve where optical quality allows.

- Adjust center thickness (especially for high plus).

5. Epidemiology & Clinical Significance

- Occurs in children and adults. Even modest hyperopic or astigmatic asymmetries in children can affect development and increase the risk of amblyopia if left uncorrected.

- In adults, common complaints are spectacle intolerance, spatial distortion, reading fatigue, and headaches.

- Post-operative settings (e.g., unilateral cataract extraction) are frequent modern causes; differences can be temporary (between staged procedures) or persistent (residual refractive error).
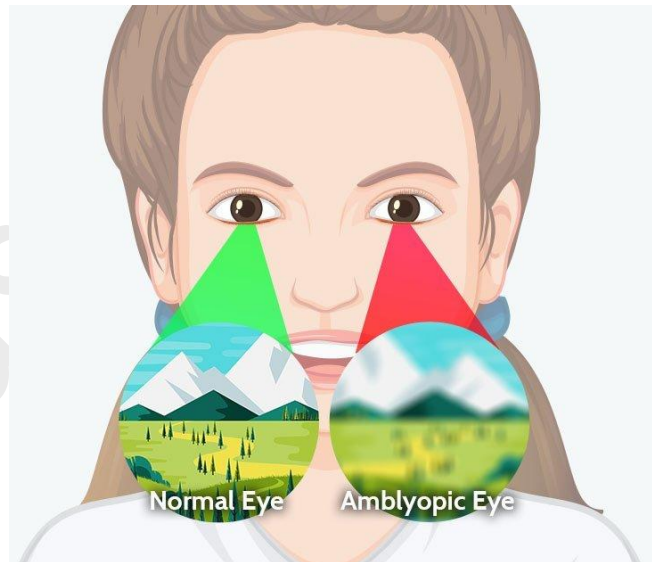
6. Etiology

5.1 Congenital

- Differential growth of ocular structures leading to axial length asymmetry.

- Developmental differences in corneal curvature or crystalline lens power.

5.2 Acquired

- Unilateral aphakia after crystalline lens removal.

- Incorrect intraocular lens (IOL) power (postoperative refractive surprise).

- Ocular trauma affecting the cornea or lens.

- Unilateral keratoplasty altering corneal power.

- Asymmetric age-related crystalline lens/corneal changes.

7. Classification

7.1 Relative Anisometropia

When the two eyes have similar overall refraction (i.e., not enough difference to be anisometropic) but different axial lengths, both eyes can form clear images. However, because the eyes differ in size, the retinal images ultimately differ in magnification.

7.2 Absolute Anisometropia

The total refractive power is unequal between eyes (most common).

- *Simple*: one eye emmetropic, the other myopic or hyperopic. Example: OD Plano, OS −3.00 DS.

- *Compound*: both eyes same sign, unequal magnitude. Example: OD −6.00 DS, OS −2.50 DS.

- *Mixed (antimetropia)*: one eye myopic, the other hyperopic. Example: OD −1.50 DS, OS +2.25 DS.

- *Simple aniso-astigmatism*: one eye emmetropic; the fellow has simple myopic or simple hyperopic astigmatism. Example: OS ±2.50 DC × 180.

- *Compound aniso-astigmatism*: both eyes are astigmatic to unequal degrees. Example: OD +0.50 DC × 180 ; OS +3.50 DC × 180

- *Mixed aniso-astigmatism*: one eye has hyperopic astigmatism; the other has myopic astigmatism. Example:
  OD +2.00/−1.00 ×180   ;   OS -2.00/+1.00 ×90.

8. Binocular Vision Status & Symptoms

8.1 Expected binocular patterns

- BSV present when anisometropia is small (<3 D).

- Uniocular vision when one eye's error is very high (habitual suppression).

- Alternate vision when one eye is emmetropic/moderately hyperopic and the other myopic: the hyperopic/emmetropic eye is used for distance, and the myopic eye for near
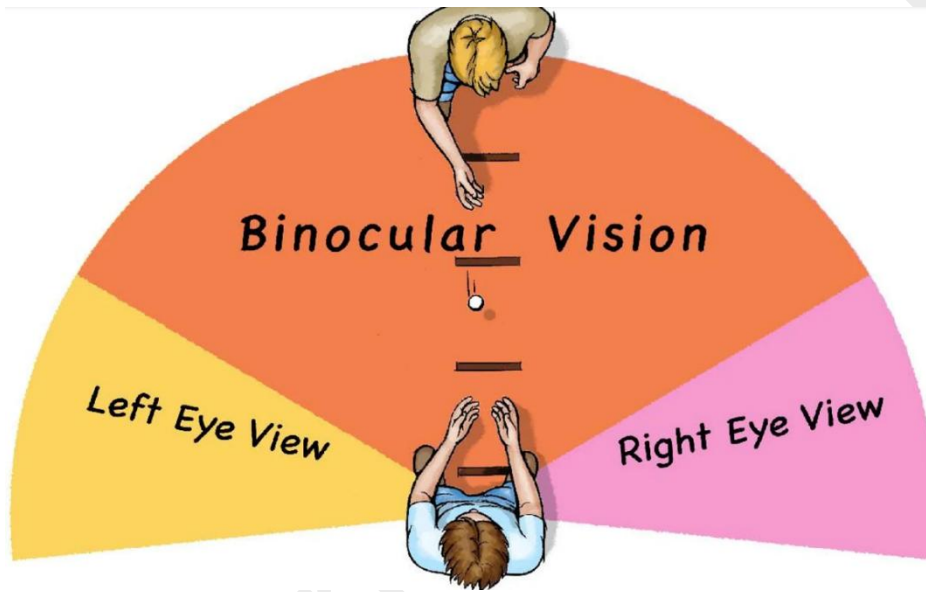
8.2 Symptom complex and mechanisms

- Eye strain

- Headaches

- Nausea

- Light sensitivity

- Tiredness

- Dizziness

- Sometimes diplopia (especially with large differences and spectacles).

HOME WORK

1. Define anisometropia. At what level of inter-ocular difference does it usually become clinically significant with spectacles?

2. Distinguish between anisometropia, antimetropia, and aniso-astigmatism.

3. True or False: Prisms are an effective solution to eliminate image-size differences in anisometropia.

4. A spectacle +4.00 D lens has the following parameters: h = 0.01 m, t = 0.005 m, n = 1.50, F1 = +5.00 D. Calculate the Power Factor (Mp), Shape Factor (Ms), overall Spectacle Magnification (SM), and interpret the clinical meaning of the result (What percentage magnification is produced? Why is this important in anisometropia?

5. Name two congenital causes of anisometropia.

6. Name two acquired causes of anisometropia in adults.

7. Match each prescription to the correct subtype:
   - OD Plano, OS −3.00 DS →
   - OD −6.00 DS, OS −2.50 DS →
   - OD −1.50 DS, OS +2.25 DS →
   - OD Plano, OS −2.00 DC × 180 →
   - OD +2.00/−3.00 × 90, OS −2.00/−1.00 × 85 →

8. What binocular vision pattern is usually present when anisometropia is <3 D?

9. Why might a patient with high anisometropia report dizziness or spatial distortion when wearing spectacles?

10. List four common symptoms of anisometropia.

11. A 6-year-old child presents with: OD +3.50 DS, OS +0.50 DS. What type of anisometropia is this? What is the risk if uncorrected?

12. An adult has: OD −5.00 DS, OS −1.00 DS. They complain of discomfort with glasses. Classify and suggest corrections.