



REFRACTIVE ERROR

AUTHOR (s)

Brien Holden Vision Institute Faculty: Jane Kierath, Sonja Cronjé, Neilsen de Souza, Shoshana Jackofsky, David Wilson, Mitasha Marolia, Gerd Schlenther, Naomi Freuden, Peter Mohlala Brien Holden Vision Institute, Sydney, Australia

REVIEWER (s)

Bob Chappell Past President: World Council of Optometry (WCO)

THINK

A woman tells you that she used to read the newspaper everyday, but now she is having a hard time seeing at close distances.

Why can she no longer see the newspaper? Can you do anything to help this woman?

WHAT YOU WILL LEARN

When you'll have worked through this unit you should be able to:

- Define the different types of refractive error (myopia, hyperopia, astigmatism, and presbyopia)
- Describe the visual symptoms of hyperopia, myopia, astigmatism and presbyopia
- Describe the different types of spectacle lenses available to correct refractive error
- Instruct people on how to care for their spectacles.

OPTICS

- Light from an object enters the eye in the form of light rays
- The ocular structures that light passes through are: the tear film, cornea, anterior chamber, pupil, crystalline lens, vitreous and retina
- Light rays are focused by the cornea and the crystalline lens
- If the light focuses correctly on the retina, a clear image will be formed
- In a normal eye, light that enters the eye is focused on the retina because:
 - the cornea and the lens are the correct shape, and
 - the eyeball is the correct length
- If an eyeball does not have the correct shape or is not of the correct length, it cannot focus light rays onto the retina to form a clear image, and is said to have refractive error
- People who have refractive error need spectacles to help them focus light on their retina so they can see clearly.

REFRACTIVE ERROR

- In order for us to be able to see clearly, light needs to focus at one point on the retina (the back of the eye) (Figure 1)
- When light does not focus on the retina (Figure 2), we cannot see clearly. This is called refractive error.

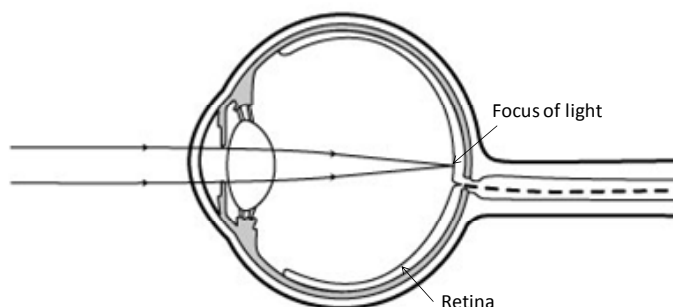


Figure 1: Light focussing on the retina (no refractive error)

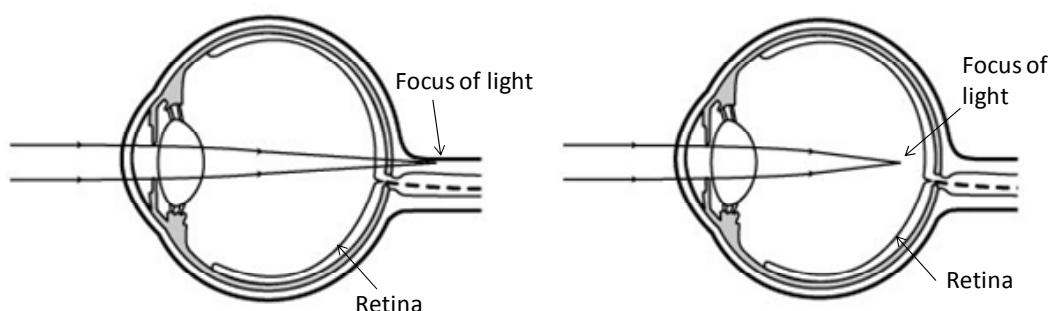


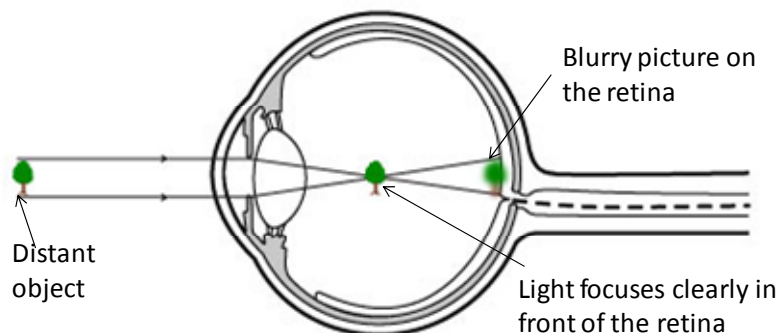
Figure 2: Refractive errors – light focussing behind or in front of the retina (not on the retina)

- An eye has refractive error if it is not the correct size and shape
- There are four main types of refractive error:
 - **Myopia**
 - **Hyperopia**
 - **Astigmatism**
 - **Presbyopia**
- A person with a refractive error will have eyes that look normal, but they will not see well unaided
- The symptoms of uncorrected refractive error will be different depending on the type of refractive error, as well as how big the refractive error is
- A person who has a refractive error will need to wear spectacles (glasses), so that they can see **clearly and comfortably**.

MYOPIA (“SHORTSIGHTEDNESS”)

WHAT IS MYOPIA?

- Myopia is when light from a distant object focuses in front of the retina
- A person who has myopia is called a ‘myope.’ Myopia is often called “shortsightedness” – because a person with myopia will have near vision that is better than their distance vision, no matter what age they are.

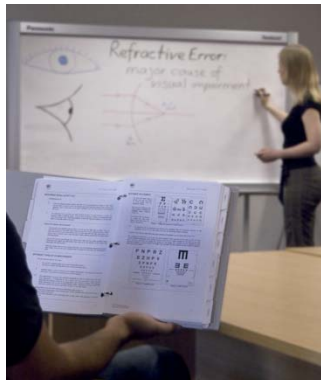


• **Figure 3:** Light in a myopic eye focussing in front of the retina

WHAT CAUSES MYOPIA?

- Myopia may be caused by:
 - an eyeball that is too long
 - a cornea and/or a crystalline lens that is curved too much and, therefore, too strong in power.

HOW DOES A PERSON WITH MYOPIA SEE?



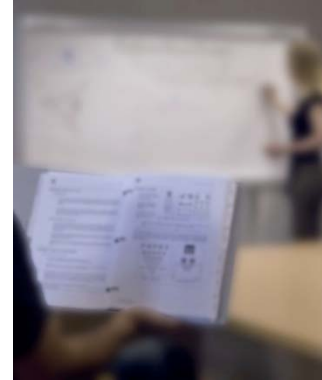
Low myopia:

Distance vision slightly blurred, but good near vision.



Moderate myopia:

Distance vision blurred, but good near vision.



High myopia:

Both distance and near vision blurred (distance vision is worse than near vision).

Figure 4: How a person with low, moderate and high myopia might see

WHAT WILL MYOPES COMPLAIN ABOUT?

- People with myopia usually complain of blurry distance vision
- They may tell you that they cannot recognise people who are far away
- They may also tell you (or you may notice) that they see better when they almost close their eyes (“screw up” or “squint” their eyes)
- Myopic people often find that their vision seems worse at night or in dim light.

WHAT CAN WE DO FOR PEOPLE WITH MYOPIA?

- Refraction (to determine the correct spectacle prescription required)
- People with myopia can be given spectacles to see more clearly in the distance
- Myopia is corrected with minus spherical lenses.

HYPEROPIA ("LONGSIGHTEDNESS")

WHAT IS HYPEROPIA?

- Hyperopia is when the light from a distant object focuses behind the retina
- A person who has hyperopia is called a 'hyperope'
- Hyperopia is sometimes also called "longsightedness" or "farsightedness".

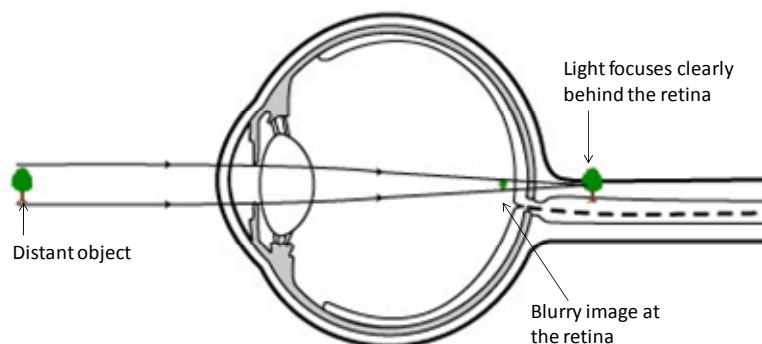


Figure 5: Light in a hyperopic eye focusing behind the retina

WHAT CAUSES HYPEROPIA?

- Hyperopia may be caused by:
 - an eyeball that is too short
 - a cornea and/or crystalline lens that is too flat (not curved enough) and, therefore, too weak in power.

AGE AND HYPEROPIA

Hyperopia in young people

- Young people with low levels of hyperopia can change the focus of the lens in their eye (we call this accommodation) to make an object focus on the retina
- This is similar to changing the focus of the lens of a camera
- See how the lens is thicker in figure 6b than 6a; this is the lens changing its shape ('accommodating') to make the light focus on the retina
- This is how young people with low to medium levels of hyperopia can still manage to have clear vision at most distances without spectacles. The effort required to do this however, is often very tiring on the eyes.

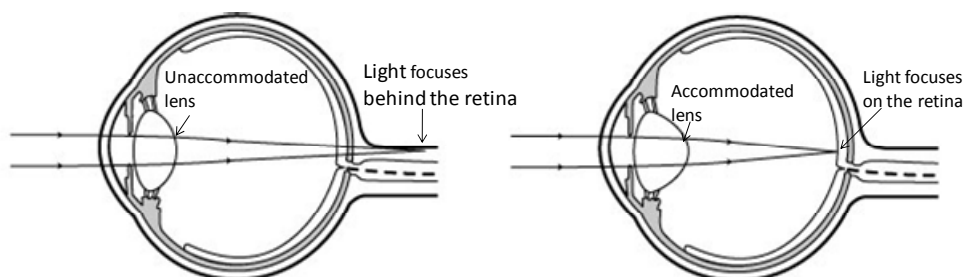
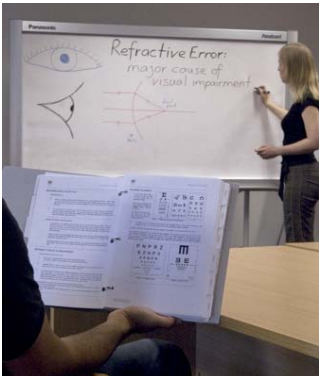
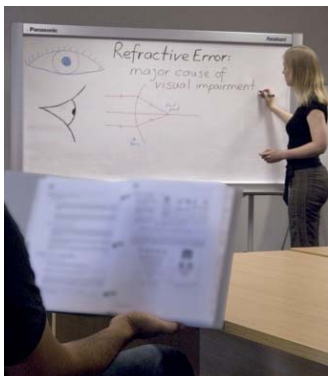



Figure 6: The lens changes in thickness from flatter (6a) to thicker (6b) to focus the light onto the retina (this process is called 'accommodation')

Hyperopia in older people

- The lens becomes harder as we become older making it more difficult to change focus (we lose our ability to accommodate)
- In older people with hyperopia who have lost their accommodation, the light will stay behind the retina and they will not be able to see clearly without spectacles (Figure 6).

| | |
|--|--|
| <p>WHAT DO PEOPLE WITH HYPEROPIA COMPLAIN OF?</p> | <ul style="list-style-type: none"> • The symptoms of hyperopia vary depending on how much accommodation can be used (how old the person is), and the amount of hyperopia they have • However, most people with hyperopia complain of difficulty seeing at near – often they tell you that their near vision is worse than their distance vision • People with hyperopia may also complain of: <ul style="list-style-type: none"> – Eyestrain (sore, tired, red, dry, or watery eyes) – Difficulty reading or doing near tasks – Poor distance vision, especially if they are older and have high hyperopia – Vision that seems worse at night or in dim light. |
| <p>HOW DO PEOPLE WITH HYPEROPIA SEE?</p> | <div style="display: flex; justify-content: space-around; align-items: flex-start;"> <div style="text-align: center;">  <p>Low hyperopia: May have good distance and near vision, but may have eyestrain and headaches with prolonged near work.</p> </div> <div style="text-align: center;">  <p>Moderate hyperopia: Near vision blurred, but good distance vision. May have eyestrain and headaches.</p> </div> <div style="text-align: center;">  <p>High hyperopia: Both distance and near vision blurred (near vision is worse than distance vision).</p> </div> </div> <p style="text-align: center;">Figure 7: How a person with low, moderate and high hyperopia might see</p> |
| <p>WHAT CAN WE DO FOR PEOPLE WITH HYPEROPIA?</p> | <ul style="list-style-type: none"> • Refraction (to determine the correct spectacle prescription they require) • People with hyperopia can be given spectacles to see more clearly up close and these spectacles may also be prescribed for distance • Hyperopia is corrected with plus spherical lenses. |

ASTIGMATISM

WHAT IS ASTIGMATISM?

- Astigmatism is when the cornea and/or lens is oval in shape, like an egg or a rugby ball (figure 8) instead of round, like a soccer ball
- A surface that is like that of a rugby ball or egg is called a toric surface
- A toric surface has a different curve in two directions (or meridians): one meridian is steeper (more curved), the other meridian is flatter (less curved)
- A toric surface causes light entering the eye to focus in two different places, rather than at one single point.

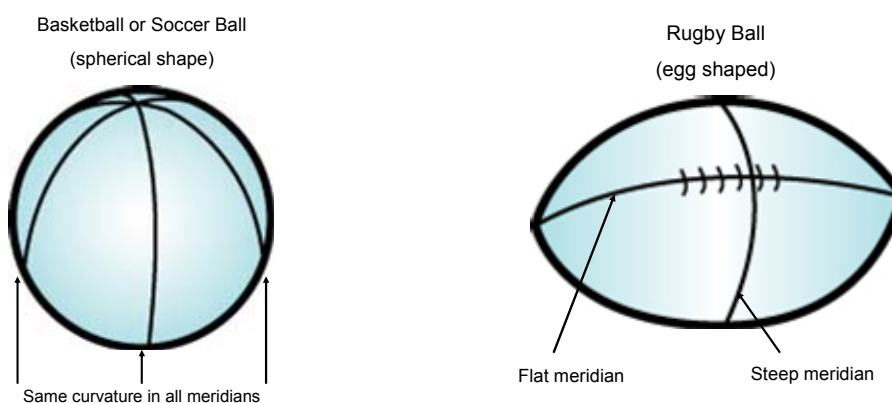
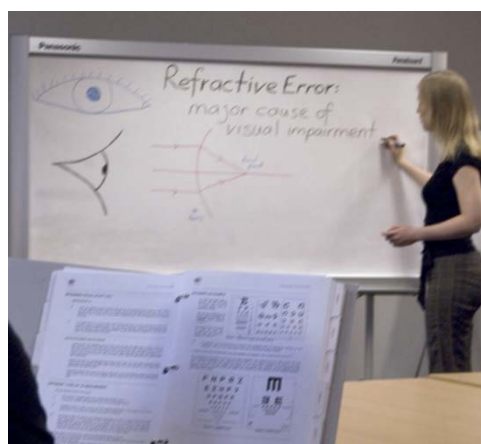


Figure 8: A soccer ball has a spherical surface.
A rugby ball (egg-shaped) has a toric surface

HOW DO PEOPLE WITH ASTIGMATISM SEE?



Moderate astigmatism:

Distance and near vision blurred. May complain of eyestrain and headaches.



High astigmatism:

Distance and near vision more blurred.

Figure 9: How a person with moderate and high astigmatism might see

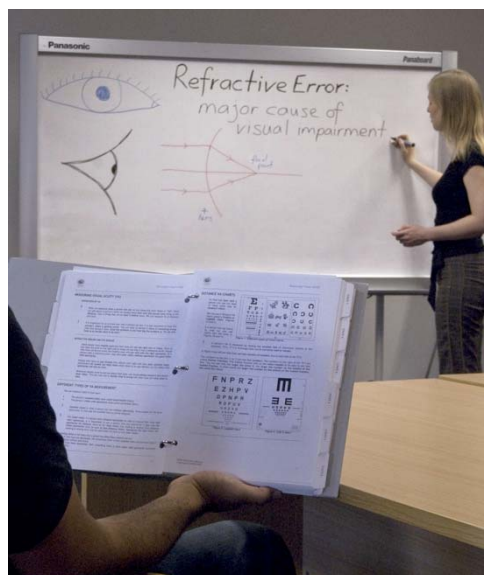
| | |
|---|---|
| WHAT WILL A PERSON WITH ASTIGMATISM COMPLAIN OF? | <ul style="list-style-type: none">• People with astigmatism may complain of:<ul style="list-style-type: none">– Eyestrain (sore, tired, red, dry, or watery eyes)– Headaches– Blurry vision at both distance and near. |
| WHAT CAN WE DO FOR PEOPLE WITH ASTIGMATISM? | <ul style="list-style-type: none">• Refraction (to determine the correct spectacle prescription they require)• People with astigmatism can be given spectacles for clear distance and near vision to stop the headaches and eyestrain• Because the two meridians of an astigmatic eye have different powers, the lens that is used to correct it must have different powers in each meridian• This is called a cylindrical or astigmatic lens• Ready-made spectacles use spherical lenses (not astigmatic lenses) and therefore will not be suitable for people with astigmatism. |

PRESBYOPIA

WHAT IS PRESBYOPIA?

- Gradual loss of the ability to focus on near objects (accommodate)
- Caused by a hardening of the crystalline lens due to age
- Both eyes affected
- Affects everyone over the age of 40–45 years
- Slowly gets worse until about age 60

HOW PEOPLE WITH PRESBYOPIA SEE?



Presbyopia – early:

May have good distance vision and good near vision, but may have eyestrain and headaches.



Presbyopia – later:

Near vision blurred, but good distance vision

Figure 10: How a person with presbyopia might see in the early and later stages

WHAT WILL PEOPLE WITH PRESBYOPIA COMPLAIN OF?

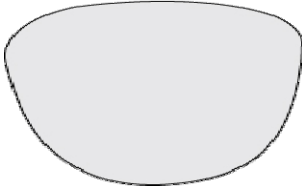
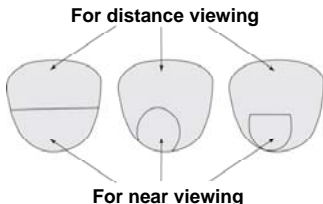
- People with presbyopia will have trouble with near tasks such as reading or sewing
- When presbyopia starts, they may say things like:
 - “I can read in good light but not in dim light”
 - “My arms are not long enough”
 - “My eyes feel strained when I do a lot of sewing”
 - “My eyes get tired when I read”
 - “The print in the newspaper is too small”
 - “I find it difficult to thread a needle”
 - “The distance looks blurred when I look up after I have been reading for a long time”.

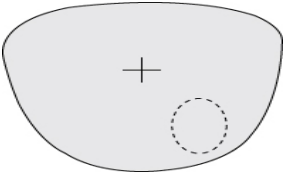
WHAT CAN WE DO FOR PEOPLE WITH PRESBYOPIA?

- Eye examination to check their spectacle prescription
- People with presbyopia can be given spectacles for near vision as well as to help with symptoms of headaches and eyestrain
- Ready-made spectacles are often used to correct presbyopia
- Presbyopia is corrected with a near addition (or “add”).

TYPES OF SPECTACLES

- People who have refractive errors need spectacles to see clearly
- There are three types of spectacle lenses available for correcting refractive errors:
 - Single vision
 - Bifocal
 - Progressive.

| TYPE OF SPECTACLE LENS | FOCUS OF THE SPECTACLE LENS | WHAT CAN I PRESCRIBE THESE FOR? | WHAT SHOULD I TELL THE PERSON? |
|--|--|---|--|
| SINGLE VISION LENS  | One distance → either far or near | <ul style="list-style-type: none"> • myopia, hyperopia, astigmatism and presbyopia | <p><u>Distance spectacles:</u> “You will see clearly when you look far away, but</p> <p>(for a person with myopia) you need to take off the glasses to see up close.”</p> <p>(for a person with hyperopia) you need a separate, stronger pair of glasses to see up close.</p> <p>(for a person with astigmatism) they will also help with your vision up close</p> <p><u>Near spectacles for a person with presbyopia who does not have a distance refractive error:</u> “You will see clearly when you read, but you need to take off the glasses to see far away.”</p> |
| BIFOCAL LENSES  | Provides clear vision at two distances only → usually at distance (∞ to 6m) → and near (a range where 40 cm is the midpoint) | <ul style="list-style-type: none"> • Presbyopia where there is also a distance refractive error • Or presbyopia where there may not necessarily be a distance refractive error but the person needs to be able to see clearly in the distance and close up without having to remove the spectacles to do so | <p>“You will see clearly when you look up close, and when you look into the distance. However, in-between distances may be blurry.”</p> |

| | | | |
|--|---|---|---|
| <p>PROGRESSIVE LENSES</p>  <p><i>The lens markings can only be seen when the spectacles are first received from the laboratory or optical workshop</i></p> <p><i>Once these markings are removed, progressive lenses look like single vision lenses.</i></p> | <p>All distances:</p> <p>→ distance</p> <p>→ near</p> <p>→ and in-between</p> | <ul style="list-style-type: none"> • Presbyopia where there is also a distance refractive error • These lenses are often preferred over bifocal lenses, as they give the person a better range of vision (at all distances) • Progressive lenses are also better looking (they look similar to single vision lenses) | <p><i>“You will see clearly when you look up close, at intermediate distances and when you look into the distance.”</i></p> |
|--|---|---|---|

WHAT TO TELL PEOPLE ABOUT LOOKING AFTER SPECTACLES

- Spectacles can be cleaned with water and soap or dishwashing detergent
- Rinse your spectacles with clean water and dry with a soft cloth
- Do not use very hot water
- Keep spectacles in their case or wrap them in soft cloth or make a small bag for them from cotton material (material from an old T-shirt is good for this purpose)
- Always use two hands when putting on your spectacles and taking them off
- Do not share your spectacles with another person
- Do not put spectacles face down on the table or any other surface – put them down with the lenses facing up so they do not get scratched
- Do not leave your spectacles in the hot sun, especially if the frames are made of plastic
- It may take a little time to get used to your spectacles (this is particularly true if the person has not used spectacles before)
- Go back to your eye care practitioner if your eyes are uncomfortable or your vision is blurry
- You should have your eyes checked regularly (about once every two years).

COMMON CONCERNS ABOUT WEARING SPECTACLES

Many people when they first start wearing spectacles will have concerns about them. This section will help you to answer some common questions people have about their spectacles.

Will wearing spectacles make my eyes worse?

- No
- Wearing spectacles that have been prescribed correctly will not make a person's eyes worse
- A person's spectacle prescriptions will often get worse over time, however this is not due to the spectacles.

Will wearing spectacles make the muscles in my eye lazy?

- No – wearing spectacles will not make the muscles in your eye lazy
- The muscles of the eye play very little role in myopia and astigmatism
- Correcting hyperopia with spectacles helps the muscles in the eye to do to the same amount of work as the muscles of an eye that does not have refractive error.

Will doing eye exercises stop me from having to wear spectacles?

- No
- In most cases, doing eye exercises will not prevent a person from having to wear spectacles
- Most refractive error occurs because the eye is not the correct length for the power of the cornea or lens, and this is something exercises cannot help
- It is still important, however, to look after our eyes and to prevent eyestrain.

Will my high spectacle prescription make me go blind?

- High refractive error usually does not cause blindness
- Although a person with a high prescription does not see very well when they are not wearing spectacles, if they wear a correct pair of spectacles they will usually see just as well as somebody without refractive error.

Will spectacles cure my refractive error?

- No
- Although spectacles will allow a person with refractive error to see better while they are wearing the spectacles, they will not 'cure' the eyes of refractive error
- A person who wears spectacles for refractive error will always need the spectacles to see clearly.

Can refractive error be cured with medication?

- There are currently no medicines that can cure refractive error.

TEST YOURSELF QUESTIONS

1. Name and briefly describe the four types of refractive error:

2. Describe the symptoms a person with a small amount of hyperopia may experience?

3. A 45-year old tailor complains that he can no longer thread a needle to sew people's clothes, and he is worried that he may have to stop working. What condition do you think this man has? Is there anything that can be done to help this man? What will you tell him?

4. Name at least 5 things you should tell a person about looking after their spectacles:
