BrienHoldenVisionInstitute

REFRACTIVE ERROR

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 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.

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OPTICS

- Light from an object enters the eye in the form of light rays
- The ocular structures that light passes through in the eye 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

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

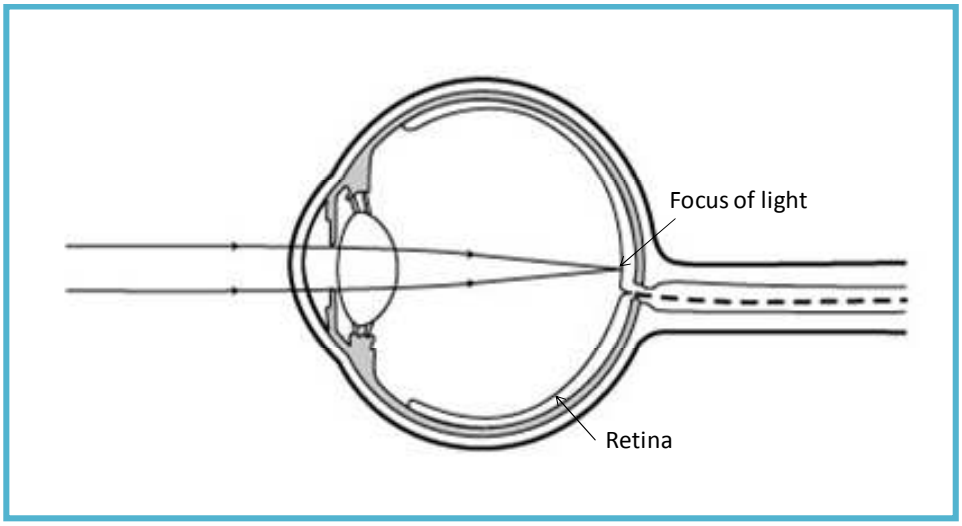

Figure 5-1: Light focusing on the retina (no refractive error)

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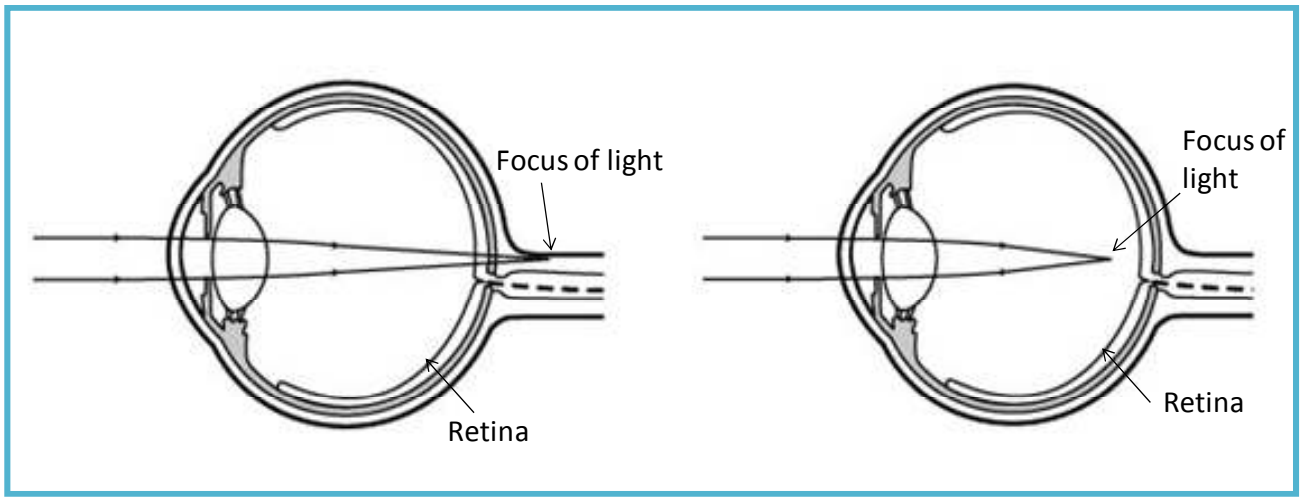

Figure 5-2: Refractive errors – light focusing behind or in front of the retina (not on the retina)

- 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
- 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.

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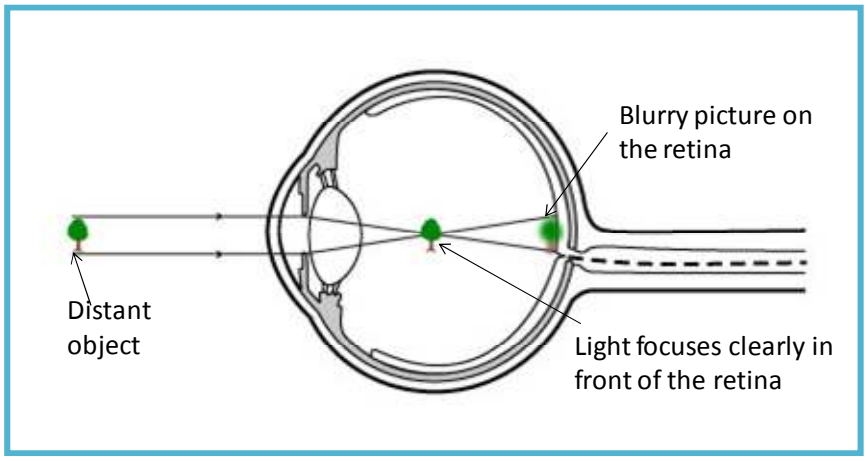
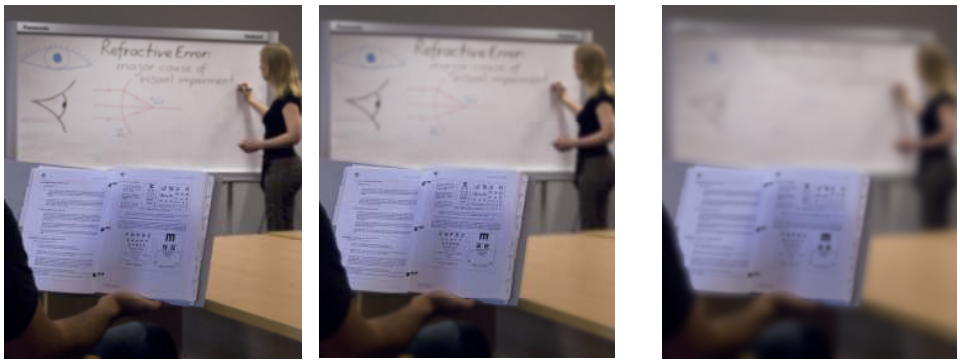
MYOPIA ("SHORTSIGHTEDNESS")

WHAT IS MYOPIA?	• Myopia is when light from a distant object focuses in front of the retina • A person who has myopia is sometimes 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 5-3: Light in a myopic eye focusing 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 MYOPE PERSON 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 5-4: How a person with low, moderate and high myopia might see***

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WHAT WILL MYOPES COMPLAIN ABOUT?	• People with myopia (also called myopes) 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 MYOPES?	• Refraction (to determine the correct spectacle prescription they require) • People with myopia can be given spectacles to wear to see better in the distance • Myopia is corrected with minus spherical lenses.

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HYPEROPIA ("LONGSIGHTEDNESS")

WHAT IS HYPEROPIA?

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

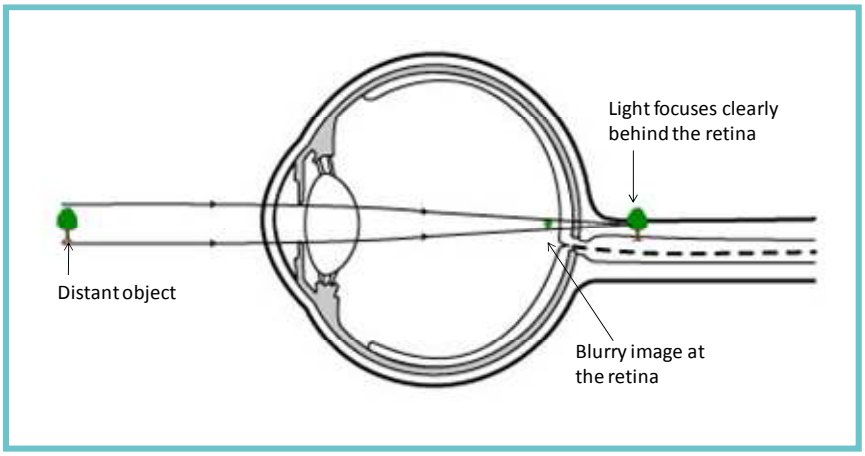

Figure 5-5: Light in a hyperopic eye focusing behind the retina

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 the objects focus on the retina
- This is like the way you can change 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.

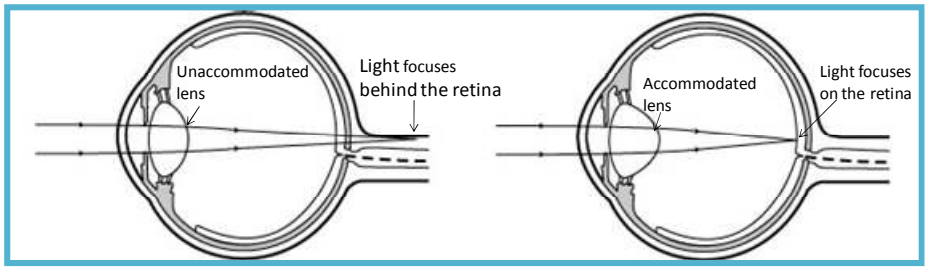

Figure 5-6: The lens changes in thickness to focus the light onto the retina (this process is called 'accommodation')

Hyperopia in older people

- The lens becomes harder as we become older and cannot change focus (we lose our ability to accommodate)
- In older hyperopes who have lost their accommodation, the light will stay behind the retina and they will not be able to see clearly (Figure 6a).

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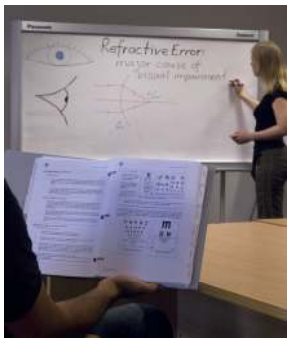
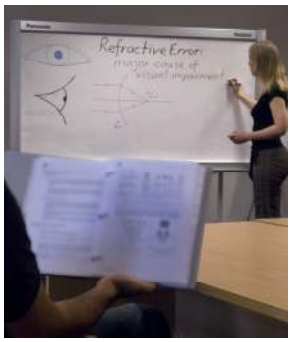
WHAT DO HYPEROPES COMPLAIN OF?	• The symptoms of hyperopia vary depending on how much accommodation can be used (how old the person is), and the amount of hyperopia they have • However, most people with hyperopia complain of difficulty seeing at near – usually they tell you that their near vision is worse than their distance vision • Hyperopes may also complain of: ○ Eyestrain (sore, tired, red, dry, or watery eyes) ○ Trouble 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.
HOW DOES A HyperOPE PERSON SEE?	 ***Low hyperopia:*** May have good distance and near vision, but may have eye strain and headaches.  ***Moderate hyperopia:*** Near vision blurred, but good distance vision. May have eye strain and headaches. ***High hyperopia:*** Both distance and near vision blurred (near vision is worse than distance vision). ***Figure 5-7: How a person with low, moderate and high hyperopia might see***
WHAT CAN WE DO FOR HYPEROPES?	• Refraction (to determine the correct spectacle prescription they require) • People with hyperopia can be given spectacles to wear to see better up close and/or in the distance • Hyperopia is corrected with plus spherical lenses.

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ASTIGMATISM

WHAT IS ASTIGMATISM?

- Astigmatism is when the cornea and/or lens is egg shaped, like 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.

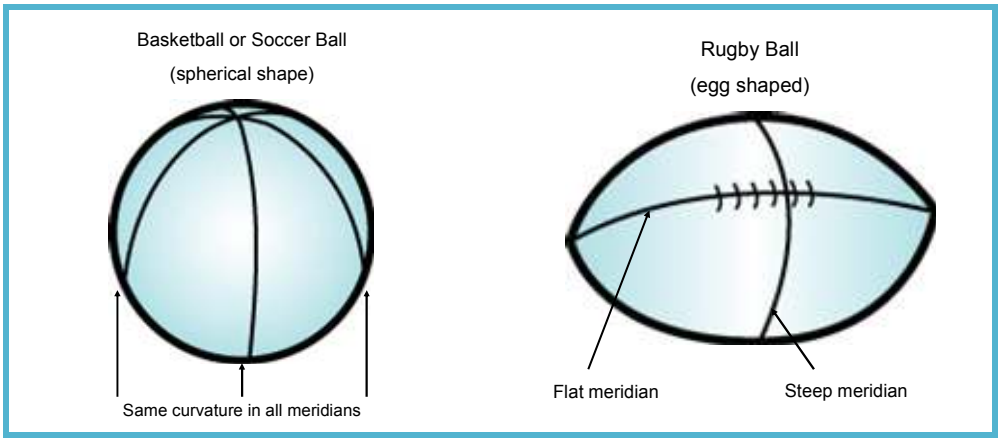
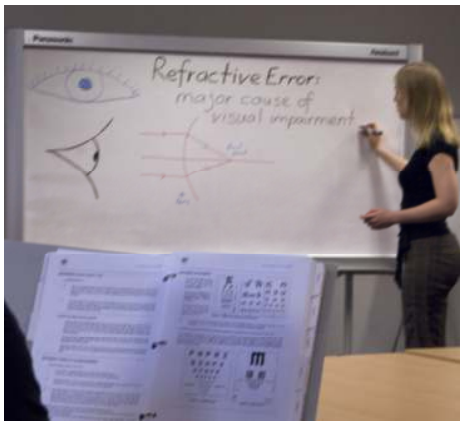


Figure 5-8: A soccer ball has a spherical surface. A rugby ball (egg-shaped) has a toric surface

HOW DO ASTIGMATS SEE?



Moderate astigmatism:
Distance and near vision blurred. May complain of eye strain and headaches.

High astigmatism:
Distance and near vision more blurred.

Figure 5-9: How a person with moderate and high astigmatism might see

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WHAT WILL AN ASTIGMAT COMPLAIN OF?	• Astigmats (people with astigmatism) may complain of: ○ Eyestrain (sore, tired, red, dry, or watery eyes) ○ Headaches ○ Blurry vision at both distance and near.
WHAT CAN WE DO FOR ASTIGMATS?	• Refraction (to determine the correct spectacle prescription they require) • People with astigmatism can be given spectacles for clear distance and near vision, as well as 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 • Readymade-spectacles use spherical lenses (not astigmatic lenses) and therefore will not be suitable for people with astigmatism.

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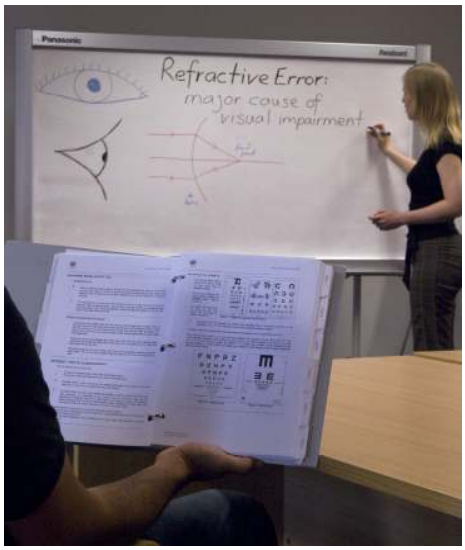
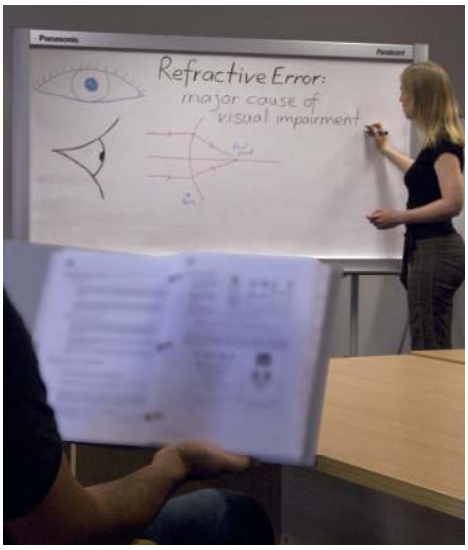
PRESBYOPIA

WHAT IS PRESBYOPIA?	• Presbyopia is the gradual loss of the ability to accommodate (to focus on near objects) as we get older • It is caused by the hardening of the lens in the eye as we age, which makes it more difficult, and eventually impossible, to accommodate • Everyone over the age of 40–45 years is affected by presbyopia, because everybody loses the ability to accommodate as they age • Presbyopia usually begins to be a problem after 40 or 45 years of age and slowly gets worse until about age 60 • Some people, especially those living in the tropics, get presbyopia even earlier than this • The loss of accommodation happens to both eyes at the same rate • People with presbyopia (also called 'presbyopes') usually find it difficult to read or do other near tasks • Sometimes an early presbyope (someone who is just starting to get presbyopia) will hold things further away from their eyes so that they can see it more clearly – because less accommodation is needed to see things that are further away from the eyes • Presbyopes require spectacles for near vision.
HOW WILL PRESBYOPES 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 5-10: How a person with presbyopia might see in the early and later stages***

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WHAT WILL PRESBYOPES 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 read for a long time".
WHAT CAN WE DO FOR PRESBYOPES?	• 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 • Readymade-spectacles are often used to correct presbyopia • Presbyopia is corrected with a near addition (or "add").

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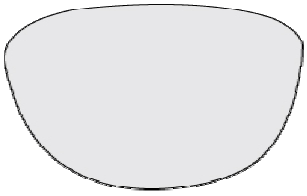
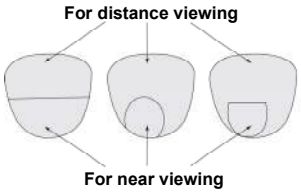
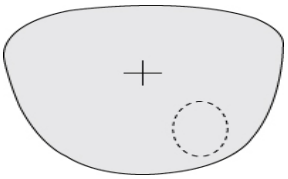
TYPES OF SPECTACLE LENSES

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

TYPE OF SPECTACLE LENSES	FOCUS OF THE SPECTACLE LENS	WHO SHOULD I USE THESE FOR?	WHAT SHOULD I TELL THE PERSON?
Single vision lenses 	One distance: • either distance or near	• A myope, hyperope or astigmat who is not presbyopic • A presbyope who does not have a distance refractive error	Distance spectacles: "You will see clearly when you look far away, but you need to take off the glasses to see up close." Near spectacles: "You will see clearly when you read, but you need to take off the glasses to see far away."
Bifocal lenses 	Two distances only: • usually at distance (6 m) • and near (40 cm)	• Presbyopes with a distance refractive error • Or presbyopes that need to be able to see clearly in the distance and close up	"You will see clearly when you look up close, and when you look into the distance. However, in-between distances may be blurry."
Progressive lenses  The lens markings can only be seen when the spectacles are first received from the laboratory or optical workshop. Once these markings are removed, progressive lenses look like single vision lenses.	All distances: • distance • near • and in-between	• Presbyopes with 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)	"You will see clearly when you look up close, at intermediate distances and when you look into the distance."

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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 some 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).

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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 without 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, therefore exercises will not help
- It is still important, however to look after our eyes and to prevent eye strain.

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.

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SUMMARY – REFRACTIVE ERROR

REFRACTIVE ERROR

- When an eye does not have the correct size or shape we say that the eye has a refractive error
- A person with refractive error will need to wear spectacles, so that they can see clearly and comfortably.

MYOPIA

- A person with myopia will see well up close, but will have difficulty seeing objects that are far away
- Myopia is also called 'shortsightedness'
- Myopes need spectacles for good distance vision.

HYPEROPIA

- A person with hyperopia will usually tell you that their near vision is worse than their distance vision
- A person with low amounts of hyperopia may have good vision, but get headaches and eyestrain, especially when doing close work
- Hyperopia is also called 'longsightedness'
- Hyperopes need spectacles for good vision at distance and near – especially as they get older.

ASTIGMATISM

- A person with astigmatism will have problems seeing both in the distance and up close
- This is because their eye is not spherical like a soccer ball, but has a toric shape like a rugby ball
- Astigmats need spectacles with astigmatic lenses to improve their vision.

PRESBYOPIA

- The slow loss of the ability of the lens to focus on near objects as we get older (after age 40 to 45 years)
- A person with presbyopia will have trouble seeing things up close, as they cannot accommodate anymore
- Presbyopes need spectacles to improve their near vision.

WHAT TO TELL PEOPLE ABOUT LOOKING AFTER SPECTACLES

- Keep spectacles in their case or wrapped in a soft cloth
- Can be cleaned with water and soap
- Always use two hands when putting on spectacles and taking them off
- Do not put spectacles face down on the table or any other surface
- Do not leave them in the hot sun
- Do not share your spectacles with someone else
- Have your eyes examined regularly.

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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 peoples' 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:**

_____
_____
_____
_____
_____
_____

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