

The Brain and Senses



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Welcome to the Brain and Senses!

Hi, we are Dr Ellen Poliakoff and Dr Luke Jones and we're experimental psychologists. This means that we find out how people think and how the brain works.

When we are not teaching – or lecturing as it's called at University! – we can be found doing experiments in the laboratory. Ellen is finding out about how we move and Luke is doing experiments about how we understand time.

Luke's research!

Do you find that time passes quickly when you are having fun, but crawls along slowly when you have to do something boring? Well, I'm interested in finding out why this is the case. I am trying to answer lots of questions about our sense of time.

We think that we have an internal clock in our brains that we use to answer questions like these:

How long did the event last for?

How long will it be until something happens?

How long ago did it happen?

How well do we remember how long something lasted for?

I'm particularly interested in finding out lots more about the latter.

Ellen's research!

We often take our movements for granted, because most of the time we don't have to think about what we are doing.

You probably find it quite easy to catch a ball or to tie your shoelace for example. If you do, then well done because controlling your movements is very complicated and people have still not been able to build robots that can move as well as a real human.

I am doing some research into Parkinson's disease – an illness that affects the brain and makes it difficult to move. People with Parkinson's disease often take a long time to begin a movement or make movements that are too small.

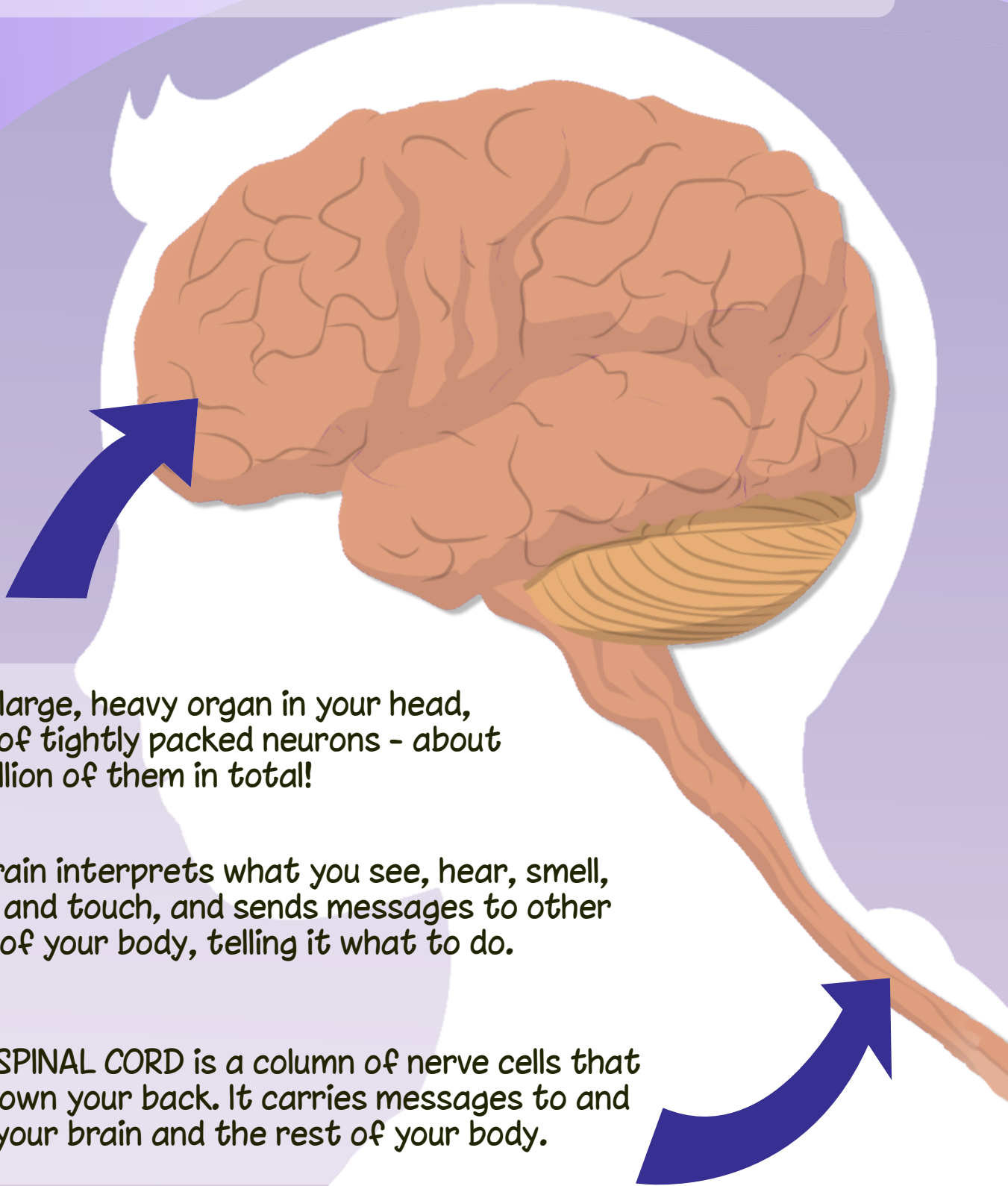
I am finding out whether what they see can help or hinder their movements, for example patients might find it harder to move in a crowd or somewhere cluttered – like a supermarket – where they can get distracted.

We hope you enjoy learning about the brain and senses with us – maybe one day you'd like to study at University and find out more....



All about the Brain

Your brain and central nervous system control everything you do, say, see, hear, smell and feel!

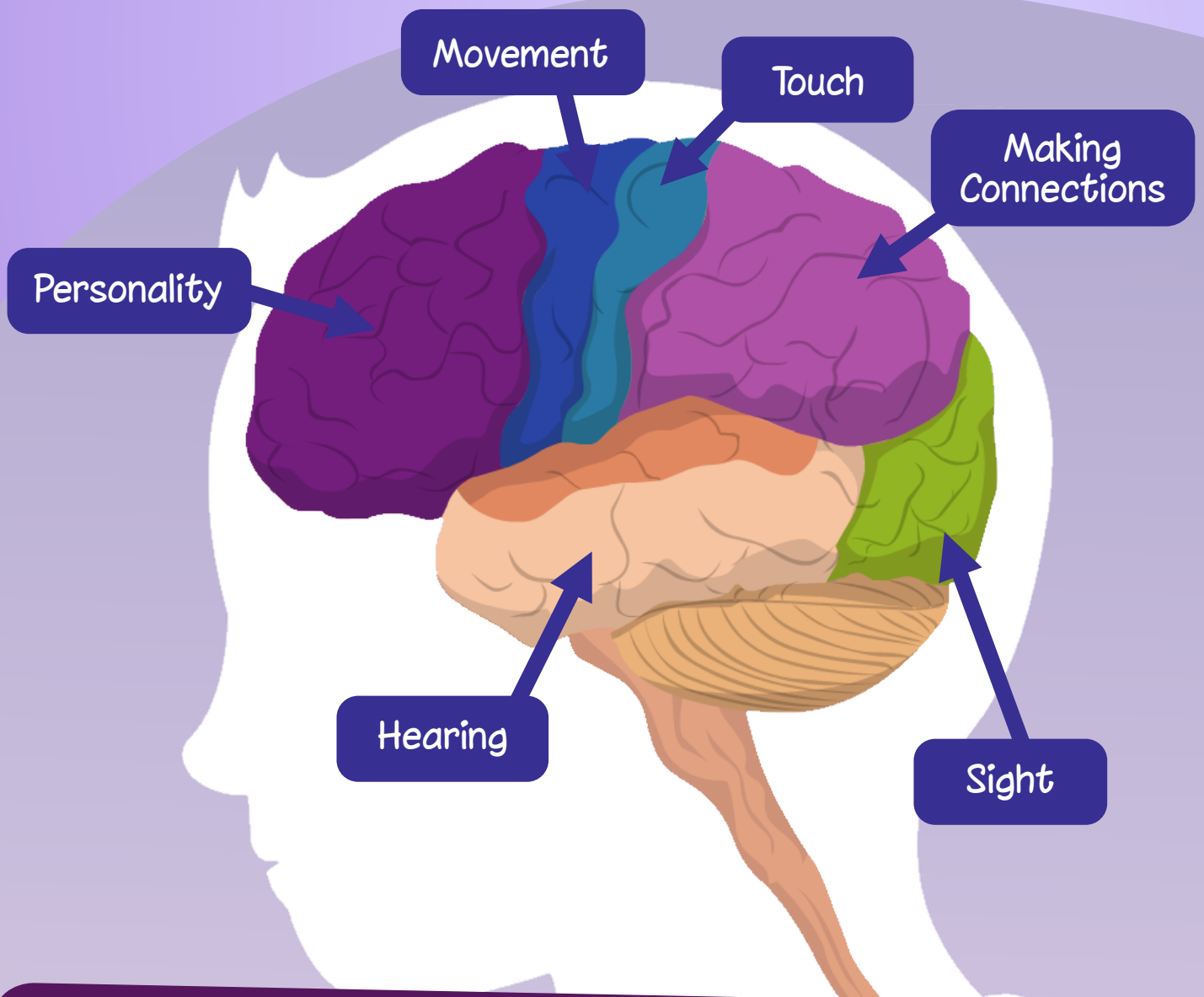


It is a large, heavy organ in your head, made of tightly packed neurons - about 100 billion of them in total!

The brain interprets what you see, hear, smell, taste and touch, and sends messages to other parts of your body, telling it what to do.

YOUR SPINAL CORD is a column of nerve cells that runs down your back. It carries messages to and from your brain and the rest of your body.

Different parts of the brain do different jobs. If your brain gets damaged, you will be affected in different ways, depending on exactly which bit stops working.



Personality

Phineas Gage was a shy family man. After he lost a big chunk of this brain area, his personality changed and he became a very angry and aggressive man.

Moving

Damage in this area makes it hard to control part of your body - like an arm or a leg. This is often caused by a stroke.

Touching

If you learn to read Braille the part of your brain that senses what your fingertip feels will get bigger.

Making Connections

This area is important for understanding the space around you. In fact, you bring together all your senses to do this. You would need this brain area to know where to move your hand to catch a ball.

Seeing

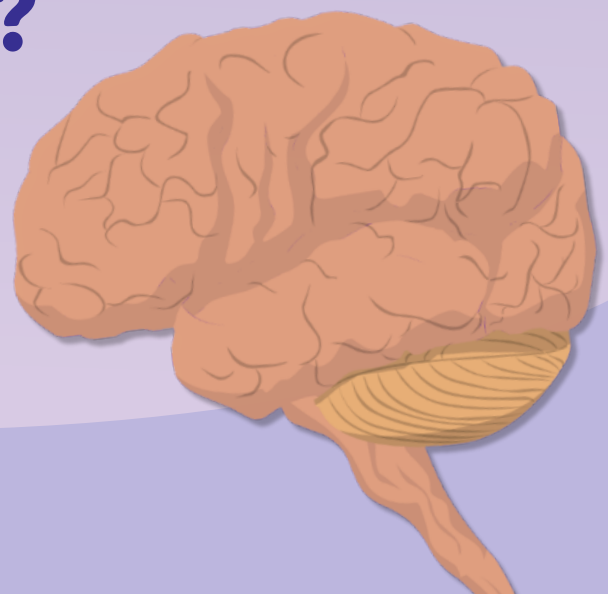
Boxers often damage this area of the brain - not from being punched but from falling backwards onto their head! This means they will have problems seeing properly.

Hearing

This part of the brain is used to hear things around you, but it is also used if you imagine a tune inside your head - like when you can't forget a song you've just heard!

Did you Know?

Researchers at the University of Manchester have found the first evidence that serotonin, the chemical our body makes to control moods, is also important in controlling how much pain we feel.



Quiztime!

1. Which organ controls everything you see, hear, smell and taste?

- A) The brain
- B) The spine
- C) The heart

2. How many nerve cells are there in the brain?

- A) 100 billion
- B) 100 million
- C) 100 thousand

3. Whose personality changed when he lost part of his brain?

- A) Phileas Fogg
- B) Phineas Gage
- C) Phineas Hog

4. What happens to part of your brain if you learn to read Braille?

- A) It gets bigger
- B) It gets smaller
- C) It becomes lumpy

5. Which sense do boxers often damage by falling over backwards?

- A) Hearing
- B) Taste
- C) Seeing

6. Which chemical is thought to control moods and pain?

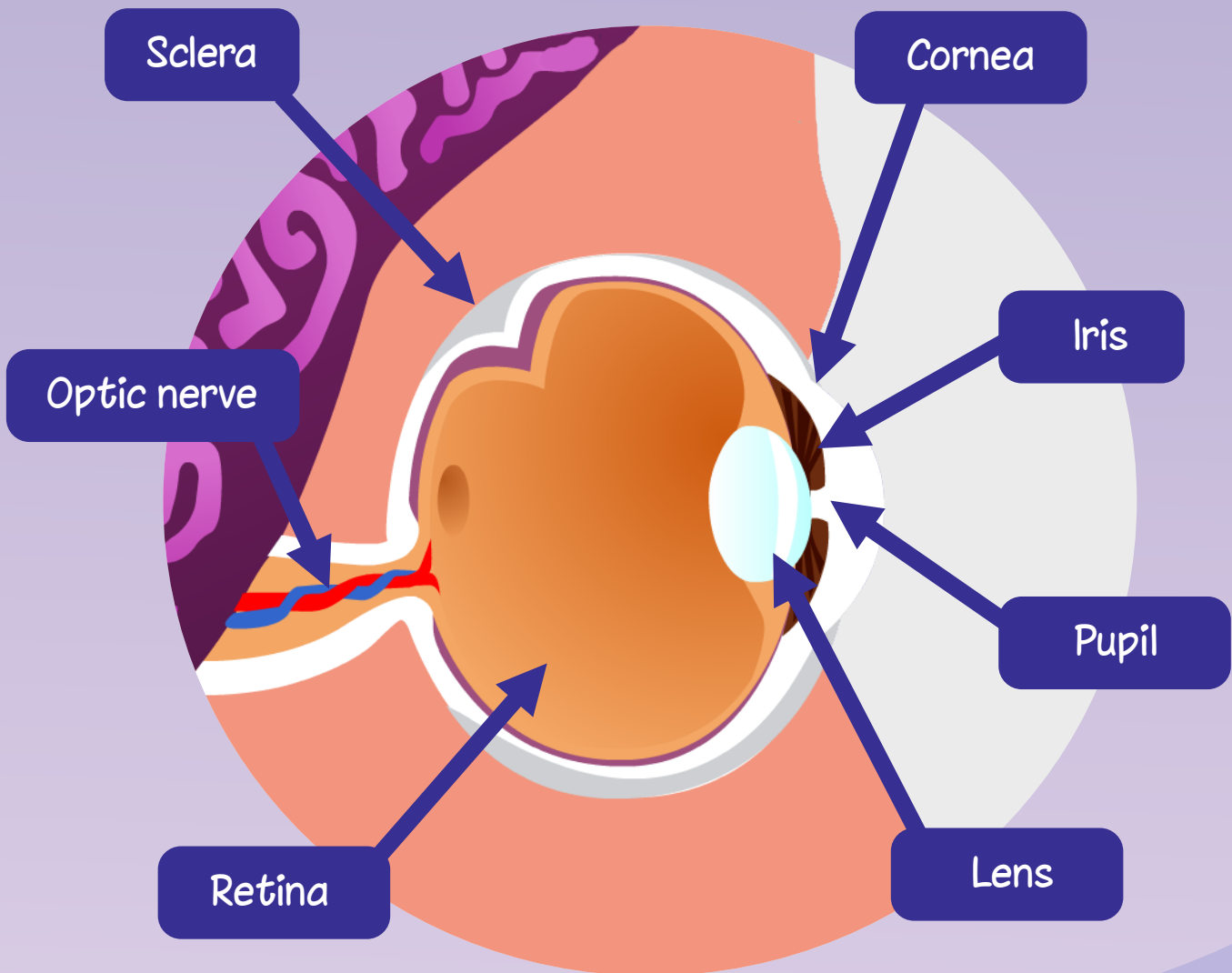
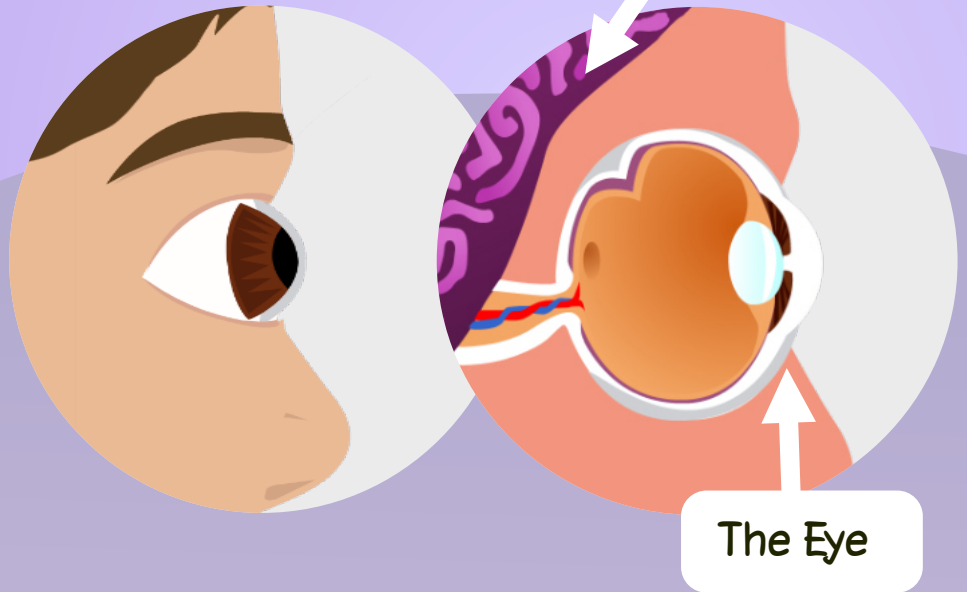
- A) Salt
- B) Serotonin
- C) Sulphuric acid

How do we See?

Which parts of your body are used to see? If your answer is the brain and the eye that's right.

Well done!

Did you know the eyeball really is spherical like a ball?



The anatomy of the Eye

Sclera

The sclera is "the white of the eye". The tough, opaque outer coating. Six tiny muscles are connected to it, which control the eye's movement.

Cornea

The cornea is the transparent coating which covers the iris and the pupil at the front of the eye. The cornea, together with the lens, refracts – that's changes the direction of – the light and helps the eye to focus.

Iris

The iris is the coloured part of the eye. Tiny muscles inside the iris control the amount of light which can enter the eye by opening and closing the hole in its centre. This hole is called the pupil. Look in the mirror in dim light – how big are your pupils? Now turn a light on – did you notice your pupils get smaller?

Pupil

Light enters the eye through the pupil – the black hole in the centre of the eye. The size of the pupil is controlled by the iris. When it is very bright and there is lots of light, the pupil is small. When it is dark, the pupil grows bigger to allow more light into the eye.

Lens

The purpose of the lens is to focus light onto the retina at the back of the eye. Because the lens refracts the light, the image which hits the retina is upside down!

Retina

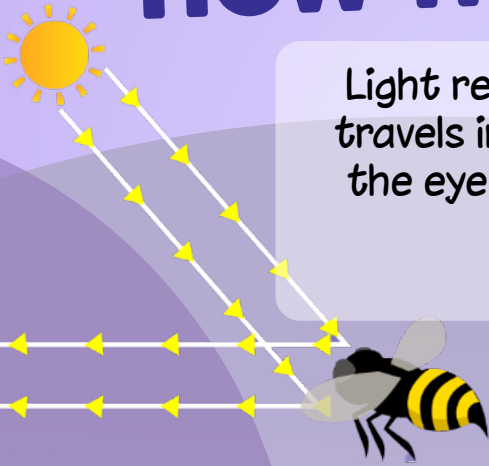
The retina contains millions of photoreceptors – that's sensors which convert light into electric impulses which are sent along the optic nerve to the brain. There are two types of photoreceptor: Rods which allow us to see in low light, and Cones which allow us to see colour and work best in brighter light.

Optic nerve

The optic nerve sends signals representing colour, light and dark, from the eye to the brain, which then interprets what we see. Where the optic nerve leaves the retina there are no sensory receptor cells, meaning we have a blind spot in our eye!



How it works



Light reflected off objects travels in a straight line into the eye through the cornea and the pupil.

The light travels through the lens, which focuses it on the back of the eye, projecting an upside-down image onto the retina.

Photoreceptors in the retina translate the image into electrical impulses, which travel along the optic nerve and into the brain. The brain makes sense of the signals and tell us what we can see...

WASP!

Did you Know?

Some things that we see grab our attention more strongly than others - something you are afraid of like a wasp or a spider is much harder to ignore.



Quiztime!

1. Which parts of your body are used to see?

- A) The ear and the brain
- B) The hand and the brain
- C) The eye and the brain

2. Which part of the eye lets light in?

- A) The iris
- B) The pupil
- C) The retina

3. What is the coloured part of your eye called?

- A) The iris
- B) The pupil
- C) The retina

4. Which part of the eye converts light into electrical messages?

- A) The iris
- B) The pupil
- C) The retina

5. Which part of the retina doesn't contain any receptor cells?

- A) Blind spot
- B) Nerve spot
- C) Hot spot

6. Which nerve carries messages from the eye to the brain?

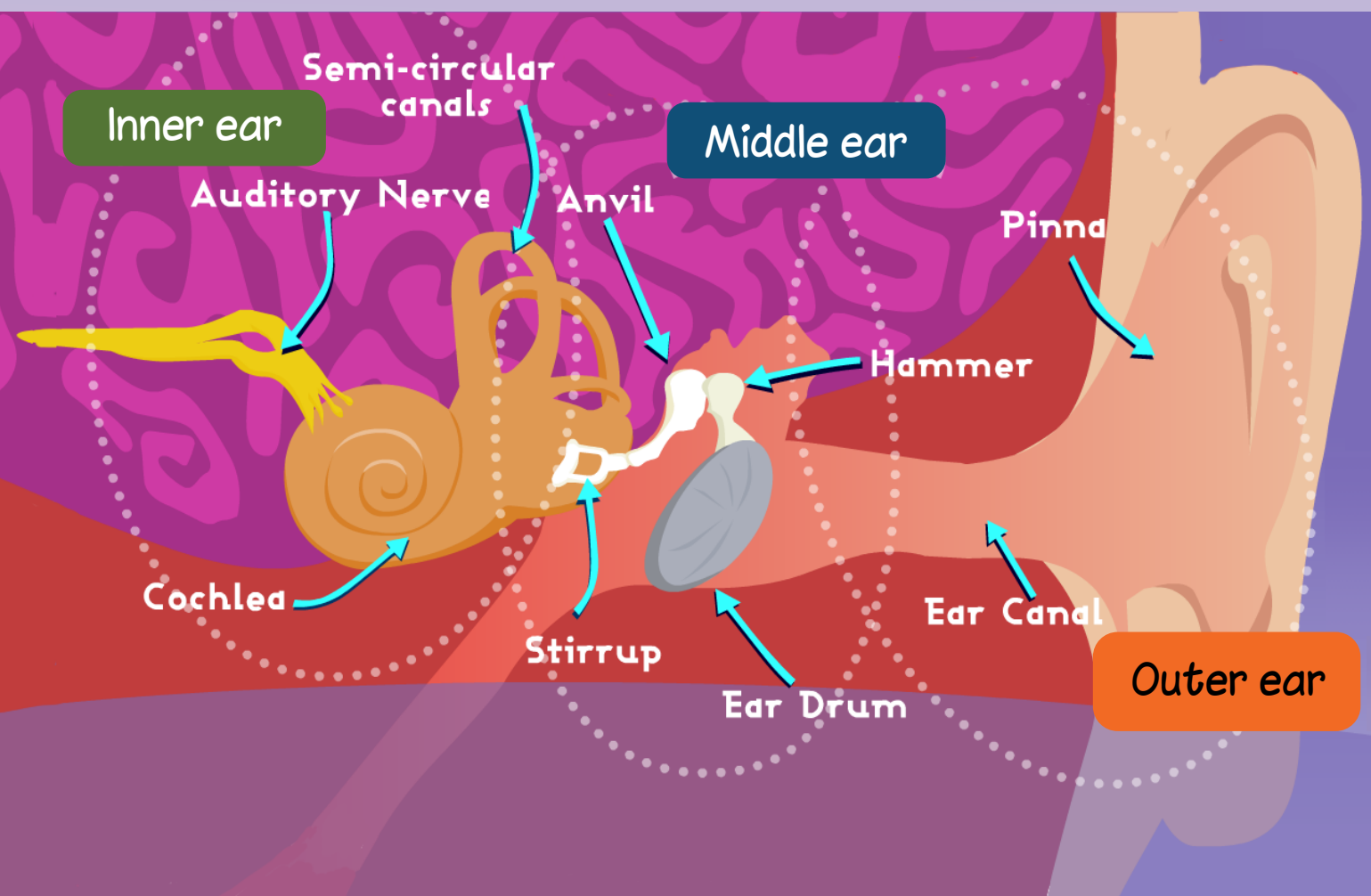
- A) Optic nerve
- B) Olfactory nerve
- C) Cranial nerve

How do we Hear?

Which parts of your body are used to hear? If your answer is the ear and the brain, well done! Did you know, most of your ear is hidden inside your head!

Anatomy of the Ear

The ear is divided into three parts:
The outer ear, middle ear, and inner ear.



Pinna

The ear flaps or pinnae, are the folds of skin and cartilage that we normally think of as ears. They collect sound waves and send them into the ear canal. Animals such as dogs and horses have bigger ears and can hear more. Try cupping your hands to your ear while watching television. What do you notice?

Ear Canal

The ear canal is a tube which connects the outer ear flap with the inner ear. Sound waves are reflected by the ear flap and travel down the ear canal to the ear drum.

Ear Drum

The ear drum is a thin layer of skin, or membrane, at the end of the ear canal. Sound waves travelling down the ear canal strike the ear drum, causing it to vibrate.

Hammer

The hammer is a tiny bone connected to the ear drum, and in turn the anvil. When sound waves cause the ear drum to vibrate, the ear drum moves the hammer, which then strikes the anvil.

Anvil

The anvil is a tiny bone located between the hammer and the stirrup. When the eardrum moves the hammer, the anvil is struck, and pushes against the stirrup, causing it to move. These tiny bones make the signal louder.

Stirrup

The stirrup is a tiny bone, the smallest in the human body, which is connected to the anvil and the cochlea. When the anvil moves, it in turn moves the stirrup against the cochlea, sending the sound waves to the inner ear.

Cochlea

The Cochlea is a snail shaped chamber which is filled with liquid and lined with cells that have tiny hairs on top, these are called hair cells. When the stirrup hits the cochlea it sends waves through the liquid inside it. These waves move the tiny sensitive hairs which make up the start of the auditory nerve.

Auditory Nerve

The auditory nerve begins in the cochlea as thousands of tiny hairs. These hairs sense movement in the liquid inside the cochlea and carry this information to the brain, which interprets the sounds that we're hearing.

Semi-circular Canals

The three semi-circular canals in the inner ear are the organs which control your balance. Each of the three canals detects a different movement; upwards, downwards or sideways. When you spin around quickly and then stop, the fluid in the semi-circular canals will keep moving for a little while making you feel dizzy.



How it works



Sound waves generated by rapid movement travel through the air and are reflected by the pinnae, or outer ear, into the ear canal.

Waves travel down the ear canal and strike the ear drum, causing it to vibrate and move the hammer, anvil and stirrup in the middle ear.

The stirrup vibrates against the cochlea, causing ripples to travel through the fluid inside. The hair cells detect the movement and send signals along the auditory nerve and into the brain.

The brain makes sense of the signals and tell us what we can hear...

WASP!



Did you know?

All babies have a type of hearing test at birth, called a newborn hearing screen. This world leading programme is led by scientists at The University of Manchester and tests to see whether the hair cells and hearing nerve are working.

Quiztime!

1. Which parts of your body are used to hear?

- A) The ear and the brain
- B) The hand and the brain
- C) The eye and the brain

2. Which part of the ear collects the sound waves?

- A) The pinnae
- B) The cochlea
- C) The ear drum

3. What happens if you cup your hands to your ears?

- A) You hear the same
- B) You hear less
- C) You hear more

4. Where are the hammer, anvil and stirrup found?

- A) Middle ear
- B) Cochlea
- C) Stable

5. Which part of the body controls balance?

- A) Outer ear
- B) Middle ear
- C) Inner Ear

6. Where does the auditory nerve begin?

- A) The ear drum
- B) The cochlea
- C) The pinnae

How do we Taste?

Which parts of the body are used to taste?

Did you say the tongue and the brain?

Well Done!

Did you know that without your nose and sense of smell, you would not be able to taste most of the things you eat?

Brain

Tongue

Try the taste test

More than 75% of what you taste actually comes from your sense of smell! That's why your food isn't as tasty when you have a cold, your smell cells are blocked with a thick mucous!

Did you notice that you can taste much less if you hold your nose?

That's because our sense of smell is very important to what we taste, and if you don't breathe in and out through your nose, the smell won't be carried to your smell cells. More about this later.

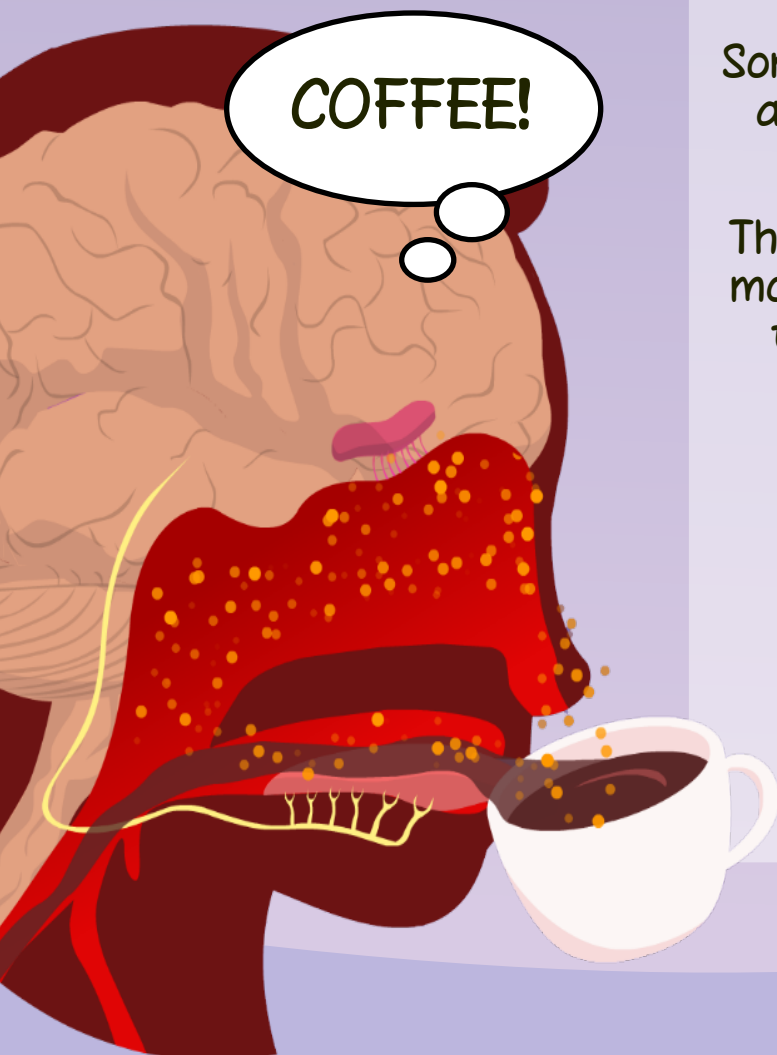
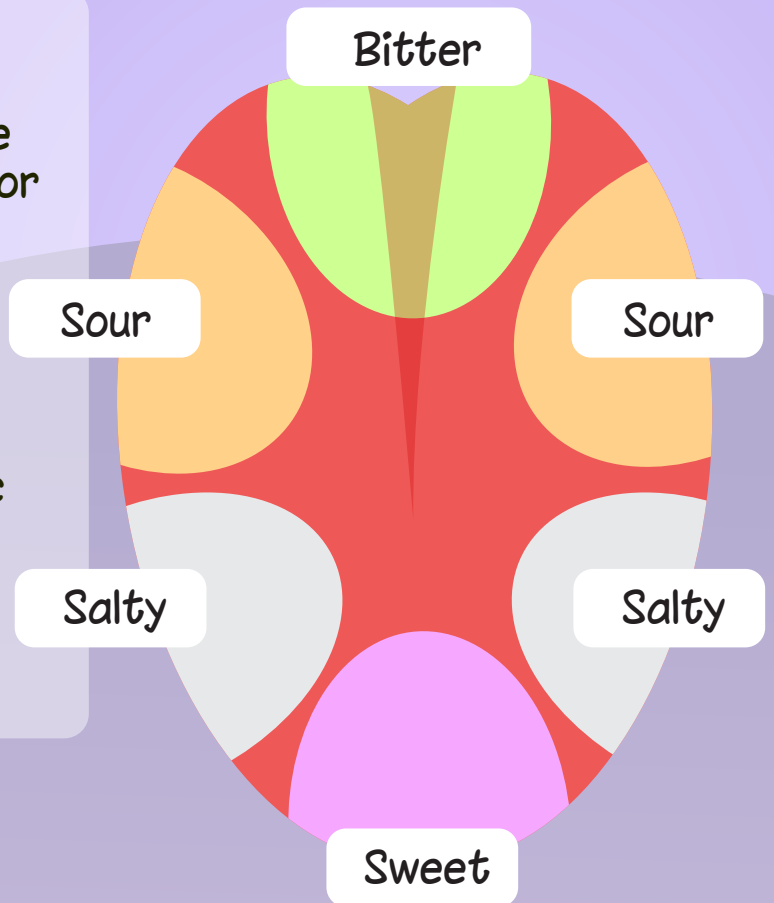
Blackcurrant
or lime?



Taste and smell are chemical senses, which means that our tongue and nose respond to the chemicals in our food and drink or in the air around us.

The taste cells, or gustatory cells, are found in the taste buds of your tongue.

They can only detect four basic tastes; sweet, sour, bitter and salty.



How does our nose help with taste?

Some of the molecules from the food and drink travel from the mouth, up the throat and into the nose.

These odour molecules land on special moist smell cells, or olfactory cells, in the nose. From there, a message is sent along the nerve cells to the brain which recognises the signal as a smell.

That's how it works.

The four basic tastes from the tongue together with the smell from the nose give us the sensation of flavour.

Did you Know?



We can tell the difference between 10,000 different molecules by smell but can't name them all. Expert smell and taste testers in the perfume and wine making industries can name more and are recruited for this skill.



Some people have no sense of smell at all. This is known as anosmia, not to be confused with insomnia, which is the inability to sleep!

Quiztime!

1. Which parts of your body are used to taste?

- A) Brain, nose and tongue
- B) Brain and tongue
- C) Brain and nose

2. What are the four basic tastes our tongues can detect?

- A) Sweet, soft, salty, moist
- B) Sweet, sour, salty, bitter
- C) Sweet, sour, salty, dry

3. What are the taste cells called?

- A) Gustatory cells
- B) Rhinatory cells
- C) Olfactory cells

4. What are smell cells called?

- A) Gustatory cells
- B) Rhinatory cells
- C) Olfactory cells

5. What is anosmia?

- A) Unable to smell
- B) Unable to sleep
- C) Unable to hear

6. In which job is an excellent sense of smell essential?

- A) Banking and Law
- B) Farming and Fishing
- C) Wine tasting and Perfume testing

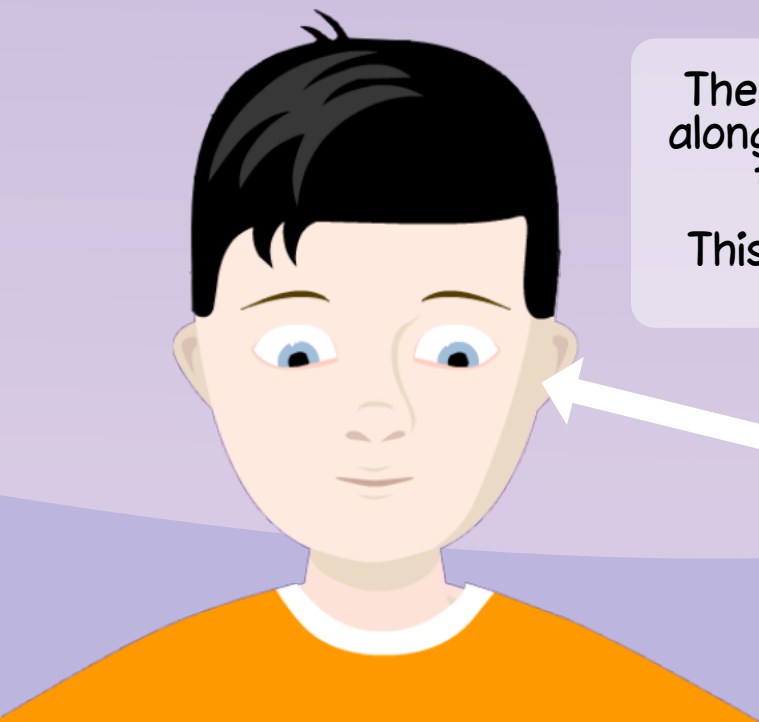


Making connections

Sounds are vibrations in the air. These sound waves hit the ear drums, which send nervous impulses along the auditory nerve to the brain. This is how you hear!

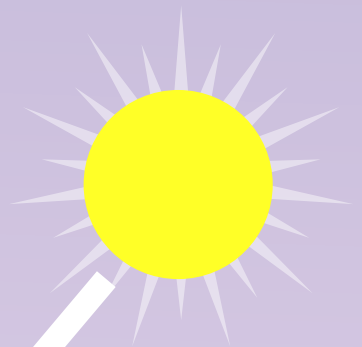


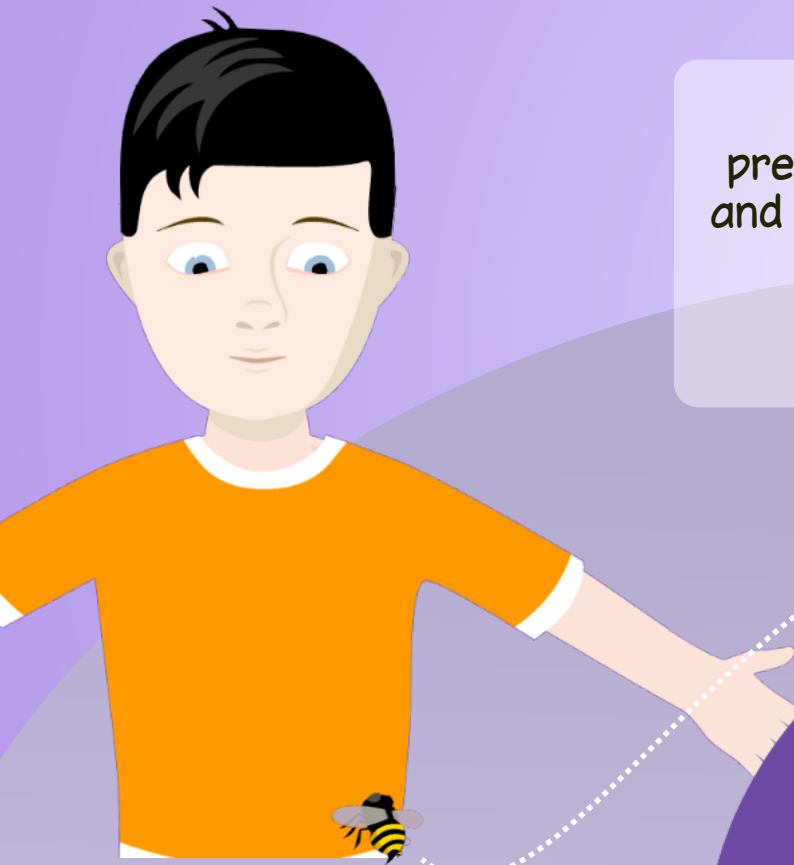
Light travels into the eyes and hits special photoreceptors in the eye called rods, which detect light & dark, and cones, which detect different colours.



These signals travel along the optic nerve to the brain.

This is how you see!

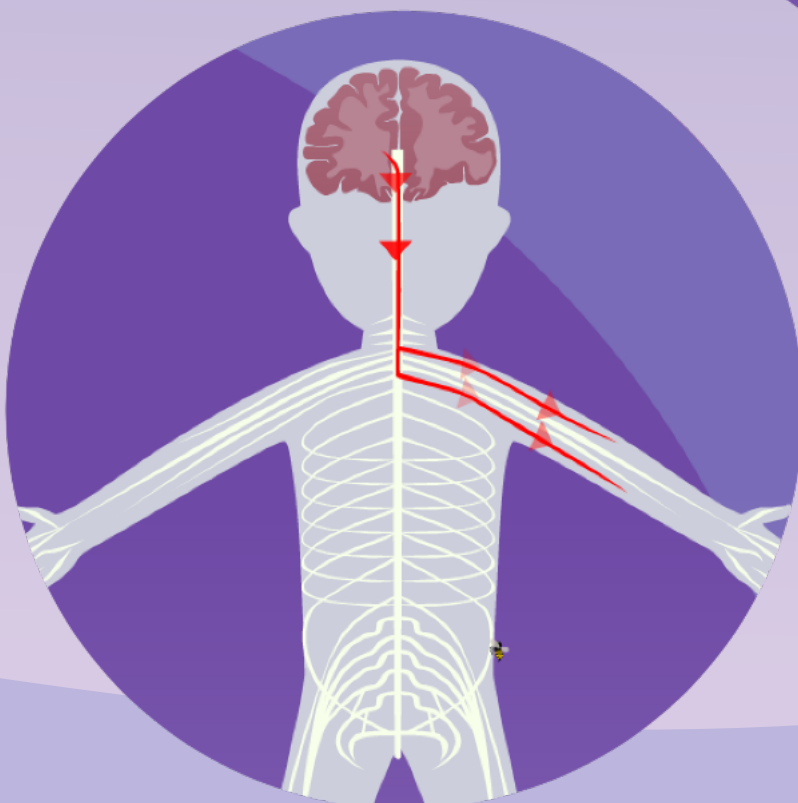
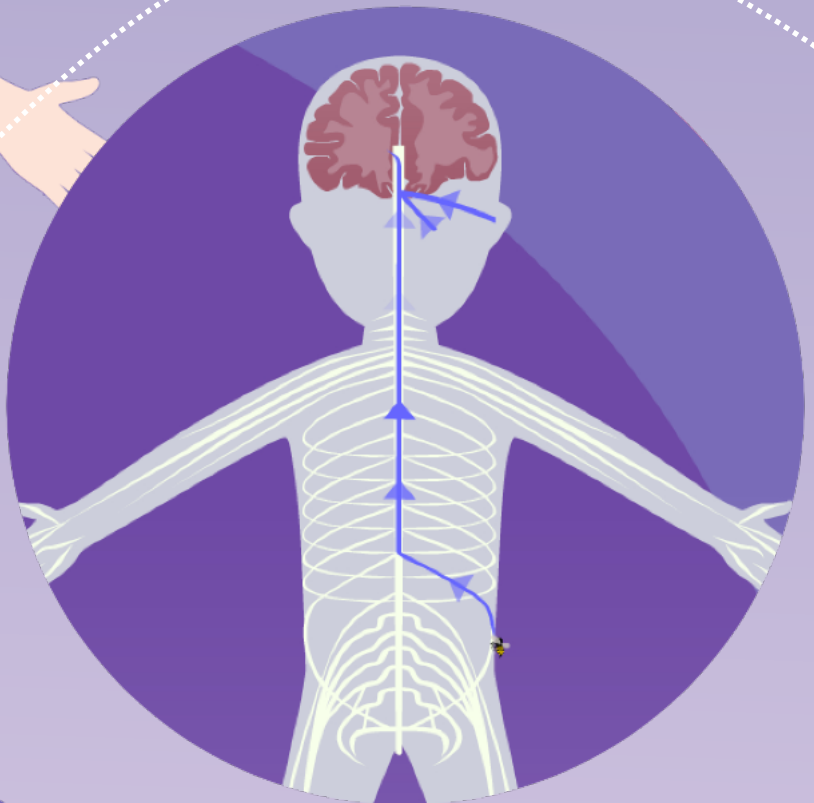




Receptors in the skin react to pressure, touch, pain, temperature and vibration, and send signals along sensory neurons to the brain.

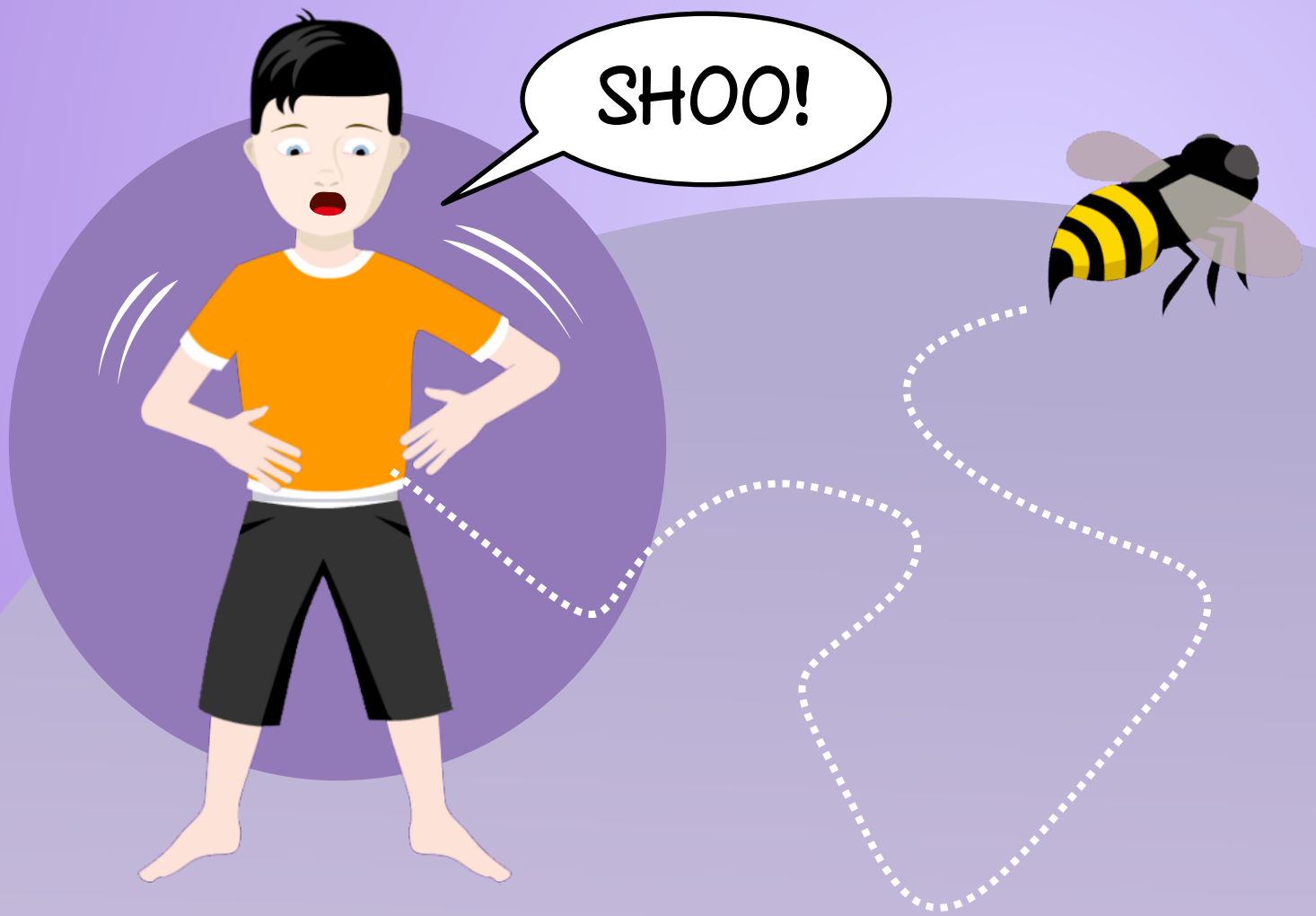
This is how you feel things!

The brain interprets these signals and responds to them.



Impulses are sent along another kind of nerve cell - motor neurons which tell muscles to contract.

This is how you move!



Did you Know?

Researchers at the University of Manchester have found that we feel less emotional and physical pain when it is noisy. This might explain why teenagers like loud music and clubbing!



Quiztime!

1. What causes sound?

- A) Vibrations
- B) Sensations
- C) Observations

2. Which receptors are found in the eye?

- A) Sticks and stones
- B) Rods and cones
- C) Flesh and bones

3. Which neurons allow us to feel things?

- A) Sensory neurons
- B) Motor neurons
- C) Super neurons

4. Which neurons allow us to move?

- A) Sensory neurons
- B) Motor neurons
- C) Super neurons

5. Which organ is the control centre for your body?

- A) The brain
- B) The stomach
- C) The heart

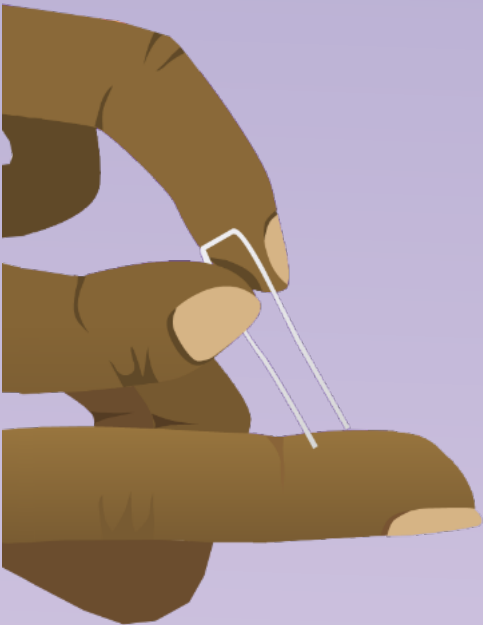


The sensitivity of your skin

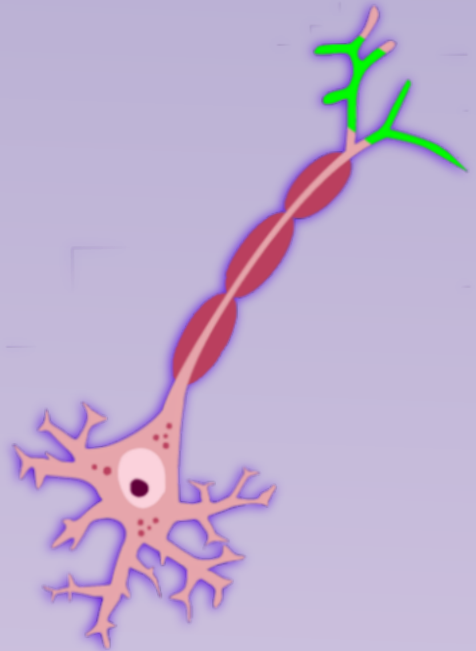
Which do you think are the most sensitive parts of your body?

When something touches your skin, special receptor cells under that part of your skin send a speedy message along your nerve cells and up to your brain.

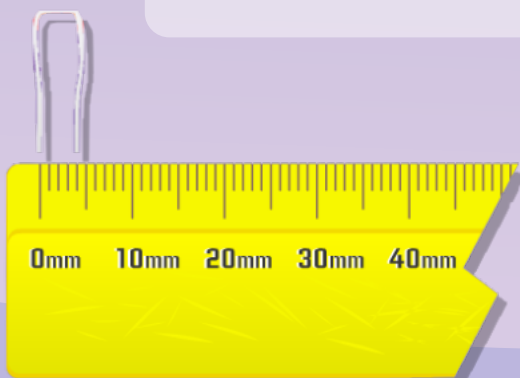
Not all parts of your skin are equally sensitive - more sensitive areas have lots more receptor cells and send more messages to the brain.



You can find out which parts are more sensitive if you open up a paperclip and touch your skin with the two points.



Start with the points really close together and then gradually open them up. What is the smallest distance that you feel the two points?





Really sensitive parts of your skin like the lips have lots of receptor cells and you can feel two points at a really small distance.



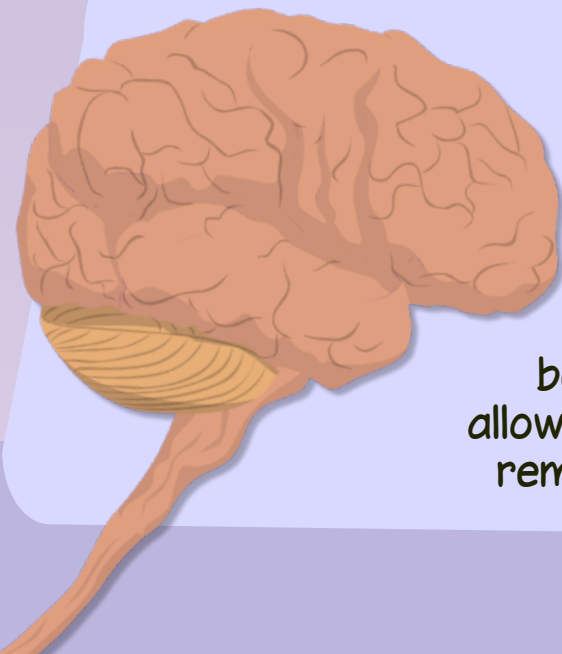
Less sensitive parts like the back have less receptor cells and can only feel two points when the points are wide apart.

Which do you think are the most sensitive parts of your body?

If the size of the different parts of your body was proportionate to their sensitivity, this is what you would look like!



Did you Know?



Researchers at the University of Manchester discovered that pain is interpreted in two different areas of the brain, one detects the location of the pain, the other tells us how bad the pain is.

This means that treatments can now be developed which reduce pain whilst still allowing us to sense where the pain is - so we remember to look after the damaged area.

Quiztime!

1. Which parts of your body are the most sensitive?

- A) Those with more receptor cells
- B) Those with less receptor cells
- C) Those that you can't see

2. Which of these is the most sensitive?

- A) Finger
- B) Forearm
- C) Shoulder

3. Which of these is the least sensitive?

- A) Lip
- B) Belly
- C) Back

Wordsearch

Can you find the following words?

Tastebuds

Stirrup

Cochlea

Optic nerve

Neuron

Olfactory

Tongue

Retina

Brain



Answers

All about the Brain

1. Which organ controls everything you see, hear, smell and taste?

- A) The brain ✓
- B) The spine
- C) The heart

The brain controls everything you do, see, hear, smell, touch and taste. It sends messages along the spinal cord to the rest of the body.

2. How many nerve cells are there in the brain?

- A) 100 billion ✓
- B) 100 million
- C) 100 thousand

There are about 100 billion tightly packed nerve cells in the brain. Nerve cells are also called neurons if you want to impress your teacher!

3. Whose personality changed when he lost part of his brain?

- A) Phileas Fogg
- B) Phineas Gage ✓
- C) Phineas Hog

Phineas Gage lost the part of his brain which controls personality in a railway accident in 1848. He changed from a shy family man to someone who was very angry and aggressive.

4. What happens to part of your brain if you learn to read Braille?

- A) It gets bigger ✓
- B) It gets smaller
- C) It becomes lumpy

The part of the brain which is used to sense what your fingertips feel gets bigger if you learn to read Braille.

5. Which sense do boxers often damage by falling over backwards?

- A) Hearing
- B) Taste
- C) Seeing



Boxers who fall over backwards after being punched often damage the back part of the brain. This means they will have problems seeing properly.

6. Which chemical is thought to control moods and pain?

- A) Salt
- B) Serotonin
- C) Sulphuric acid



Serotonin, the chemical our body makes to control moods, is also important in controlling how much pain we feel.



How do we See?

1. Which parts of your body are used to see?

- A) The ear and the brain
- B) The hand and the brain
- C) The eye and the brain ✓

The eye and the brain are the parts of the body we use to see. Messages are sent from the eye along the optic nerve and into the brain.

2. Which part of the eye lets light in?

- A) The iris
- B) The pupil ✓
- C) The retina

The pupil is the black hole in the centre of the eye. It gets bigger to let more light into the eye when it is dark and smaller to reduce the amount of light when it is bright.

3. What is the coloured part of your eye called?

- A) The iris ✓
- B) The pupil
- C) The retina

The iris is the coloured part of the eye. It is the tiny muscles in the iris which change the size of the pupil to allow the right amount of light into the eye.

4. Which part of the eye converts light into electrical messages?

- A) The iris
- B) The pupil
- C) The retina ✓

The retina contains millions of tiny photoreceptors called rods and cones which convert light into the electrical messages that are sent to the brain

5. Which part of the retina doesn't contain any receptor cells?

- A) Blind spot ✓
- B) Nerve spot
- C) Hot spot

There are no receptor cells where the optic nerve meets the retina. This is called the blind spot.

6. Which nerve carries messages from the eye to the brain?

- A) Optic nerve ✓
- B) Olfactory nerve
- C) Cranial nerve

The optic nerve carries messages about colour, light and dark from the eye to the brain. The brain interprets these messages and tells us what we can see!

How do we Hear?

1. Which parts of your body are used to hear?

- A) The ear and the brain ✓
- B) The hand and the brain
- C) The eye and the brain

The ear and the brain are the parts of the body we use to hear. Messages are sent from the ear along the auditory nerve and into the brain.

2. Which part of the ear collects the sound waves?

- A) The pinnae ✓
- B) The cochlea
- C) The ear drum

The pinnae or ear flaps collect the sound waves as they travel through the air and send them into the ear canal. Dogs and horses have bigger pinnae so they have better hearing.

3. What happens if you cup your hands to your ears?

- A) You hear the same
- B) You hear less
- C) You hear more ✓

That's right, if you cup your hands around your ears while you are watching television, you will send more sound waves into your ears, so the sounds should get louder.

4. Where are the hammer, anvil and stirrup found?

- A) Middle ear ✓
- B) Cochlea
- C) Stable

The hammer, anvil and stirrup are found in the middle ear and send the sound waves from the ear drum to the inner ear. The stirrup is the smallest bone in the body.

5. Which part of the body controls balance?

- A) Outer ear
- B) Middle ear
- C) Inner Ear ✓

The three semi-circular canals in the inner ear control your balance. If you spin round quickly then stop, the fluid in the semi-circular canals keeps moving making you feel dizzy!

6. Where does the auditory nerve begin?

- A) The ear drum
- B) The cochlea ✓
- C) The pinnae

The auditory nerve begins as thousands of tiny hairs in the cochlea. The auditory nerve sends messages which the brain interprets as sounds.

How do we Taste?

1. Which parts of your body are used to taste?

- A) Brain, nose and tongue ✓
- B) Brain and tongue
- C) Brain and nose

The brain, nose and tongue are all used to taste things we eat and drink, More than 75% of what you taste comes from your sense of smell!

2. What are the four basic tastes our tongues can detect?

- A) Sweet, soft, salty, moist
- B) Sweet, sour, salty, bitter ✓
- C) Sweet, sour, salty, dry

Our tongues have different areas which can detect sweet, sour, salty and bitter, In addition, scientists have found that we can detect umami, that's meaty, and fatty tastes.

3. What are the taste cells called?

- A) Gustatory cells ✓
- B) Rhinatory cells
- C) Olfactory cells

Taste cells are also known as gustatory cells which are found in the taste buds of your tongue.

4. What are smell cells called?

- A) Gustatory cells
- B) Rhinatory cells
- C) Olfactory cells ✓

Smell cells are also known as olfactory cells and are found right at the top of the inside of your nose.

5. What is anosmia?

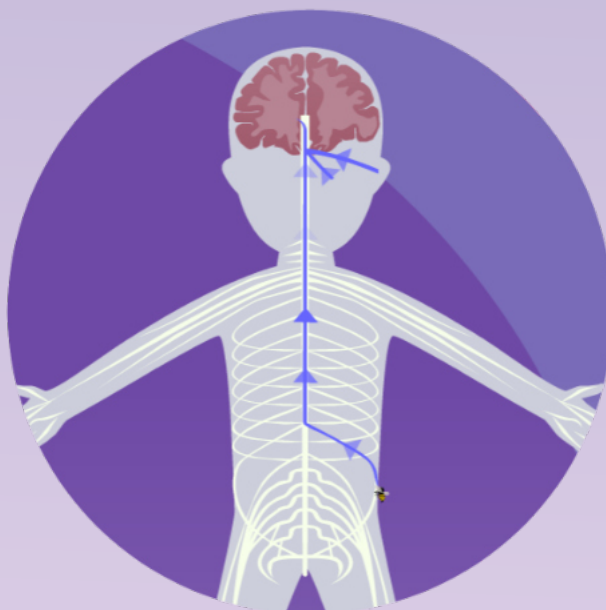
- A) Unable to smell ✓
- B) Unable to sleep
- C) Unable to hear

Anosmia is a loss of the sense of smell. Some people can't smell anything at all whilst others can't smell certain things.

6. In which job is an excellent sense of smell essential?

- A) Banking and Law
- B) Farming and Fishing
- C) Wine tasting and Perfume testing ✓

Expert smell and taste testers are recruited to the wine and perfume industries for their excellent sense of taste and smell.



Making connections

1. What causes sound?

- A) Vibrations ✓
- B) Sensations
- C) Observations

When objects move, they cause vibrations which in turn make sound waves. These sound waves travel into your ear and along the auditory nerve to the brain. Try clapping your hands and imagine the journey the sound waves make.

2. Which receptors are found in the eye?

- A) Sticks and stones
- B) Rods and cones ✓
- C) Flesh and bones

The two types of photoreceptor are rods, which allow us to see light and dark, and cones which allow us to see different colours.

3. Which neurons allow us to feel things?

- A) Sensory neurons ✓
- B) Motor neurons
- C) Super neurons

We feel things like touch, temperature and pain when receptor cells send messages along sensory neurons to the brain.

4. Which neurons allow us to move?

- A) Sensory neurons
- B) Motor neurons ✓
- C) Super neurons

The brain sends messages along motor neurons telling the muscles to contract and move that part of the body. This reaction is very useful when we are in danger!

5. Which organ is the control centre for your body?

- A) The brain ✓
- B) The stomach
- C) The heart

The brain is the control centre for your body. It makes sense of the messages that are sent to it from your five senses and decides what action to take.

The sensitivity of your skin

1. Which parts of your body are the most sensitive?

- A) Those with more receptor cells ✓
- B) Those with less receptor cells
- C) Those that you can't see

Your body is more sensitive in places where there are more receptor cells, These receptors send messages along the nerve cells and up to the brain.

2. Which of these is the most sensitive?

- A) Finger ✓
- B) Forearm
- C) Shoulder

Your fingers are more sensitive than your forearm and your shoulder.
Fingers have more receptor cells and send more messages to the brain.

3. Which of these is the least sensitive?

- A) Lip
- B) Belly
- C) Back



Your back is less sensitive than your belly and lips. It has less receptor cells and sends less messages to the brain.

Wordsearch (answers)

Did you find all these words?

Tastebuds

Stirrup

Cochlea

Optic nerve

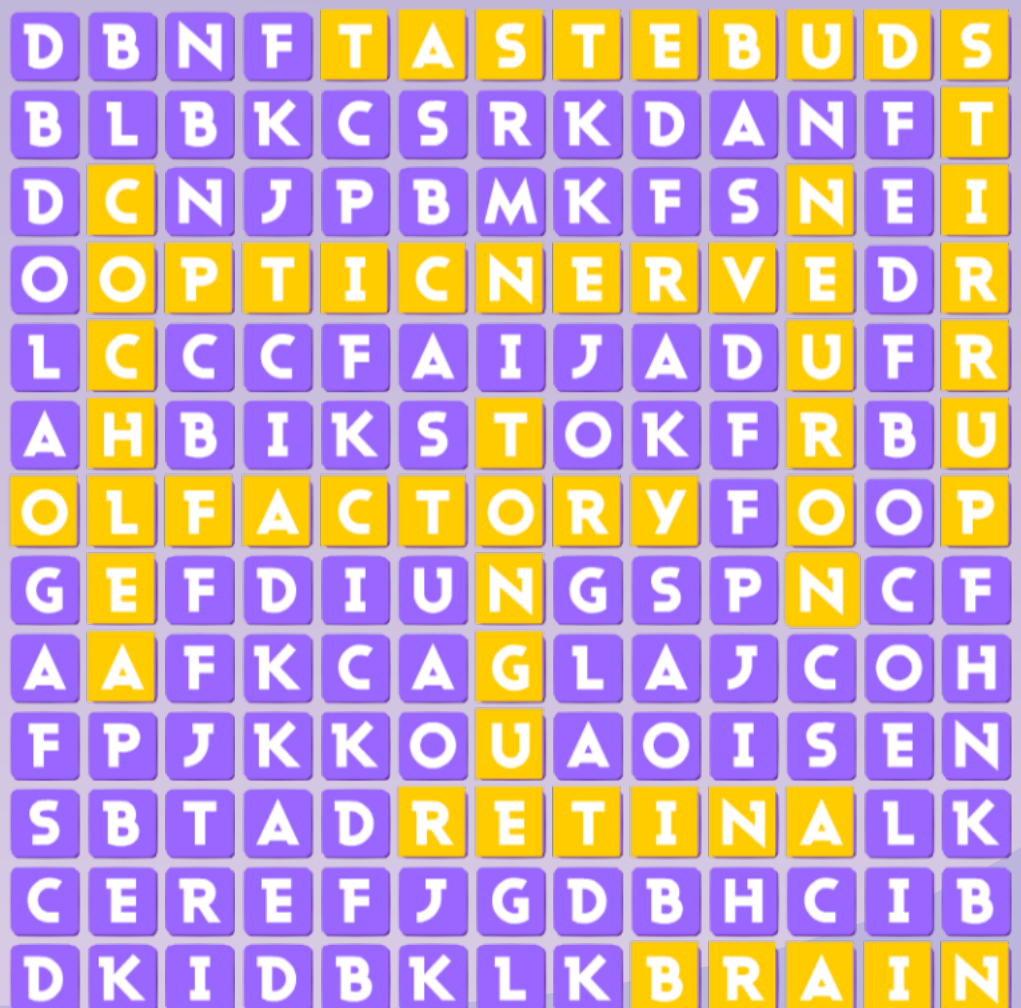
Neuron

Olfactory

Tongue

Retina

Brain



**Thanks for
completing
this module!**