

The brain doesn't stop working when you are asleep – and your senses don't stop either. Your ears can still hear sounds, but a part of the brain called the thalamus processes this information before it gets to the cerebrum. How important is it? Should you wake up? You don't need to hear the traffic outside the window when you are sleeping, so you don't wake up. But you wake up immediately when the telephone rings – it could be important.

In the same way, everything that you taste, smell, see, or touch is processed by the brain before you know about it. Your brain takes information from both eyes and turns them into one picture. Because the brain does this many times every second, you see movement. It takes the brain time to process signals from the eyes, but when you are in danger, your brain can do this faster than normal. Because of this, everything around you seems to slow down. It can give you time to think, and even save your life!

In February 2012, Canadian firefighters were inside a burning hotel when big pieces of the roof began to fall around them. The heat was terrible and they couldn't see much through the thick smoke, but they needed to think clearly. Where were the stairs? What was the best way out? Which way was the fire moving? As the men fought their way through the burning building, everything around them seemed to happen very, very slowly. Seconds seemed like minutes. Their brains were giving them time to think – and all of the firefighters got out alive!



3 The 'five' senses

You are walking on a beach, and the bright silver light hurts your eyes. You can feel the stones under your feet, and hear the children shouting as they play in the water. You breathe in deeply and smell the air, then run and jump into the sea. A big wave hits you as you come up for air, and the cool, salty water goes into your mouth. Your senses tell you everything that you know about this beautiful world. But how many senses have you got, and how do you use them?

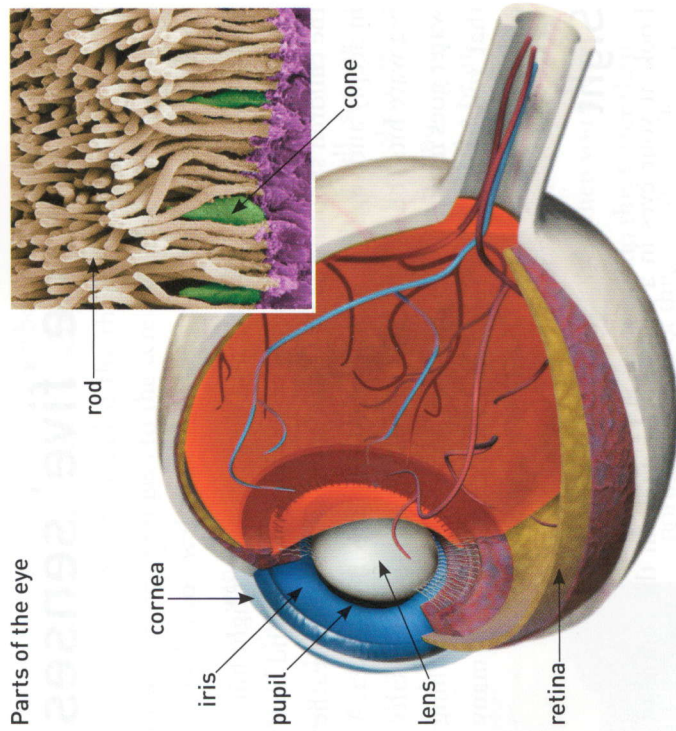
Sight

Look at your eyes in a mirror. The circle in the centre of each eye is your pupil, and the ring of colour around it is your iris. Surprisingly, the shapes and colours in *your* iris are different to everyone in the world! Light comes into the eye through the cornea and then passes through the pupil. On a sunny day, your pupils are very small, but at night, your irises let your pupils open and they become much bigger. This lets more light into your eyes, so you can see in the dark.

Behind the pupil, a lens focuses the light onto the retina, at the back of your eye. The lens can change shape very quickly. Muscles make it thicker to see things close to you, or thinner to focus on things that are far away.

On your retina, special cells called rods sense light, dark, and moving things. Other cells called cones sense colours. Together, about 140 million of these cells turn light into nerve signals and send them to your brain.

Parts of the eye



Most of the rods and cones in your eyes are in the centre of your retina. This part of the retina is only about 0.6 centimetres across, so you can only see clearly when you look straight at something. You never notice this because your eyes are moving all the time. Muscles move them up and down, left and right very fast – focussing about four times a second. This lets your brain make a clear picture of everything around you.

Your eyes work very hard, so your body needs to look after them. Eyelids stop things from getting into the eyes. Your eyes also make a fluid called tears – and you don't just do this when you cry. About once every ten seconds, you blink – your eyes open and close very quickly – and tears wash them.

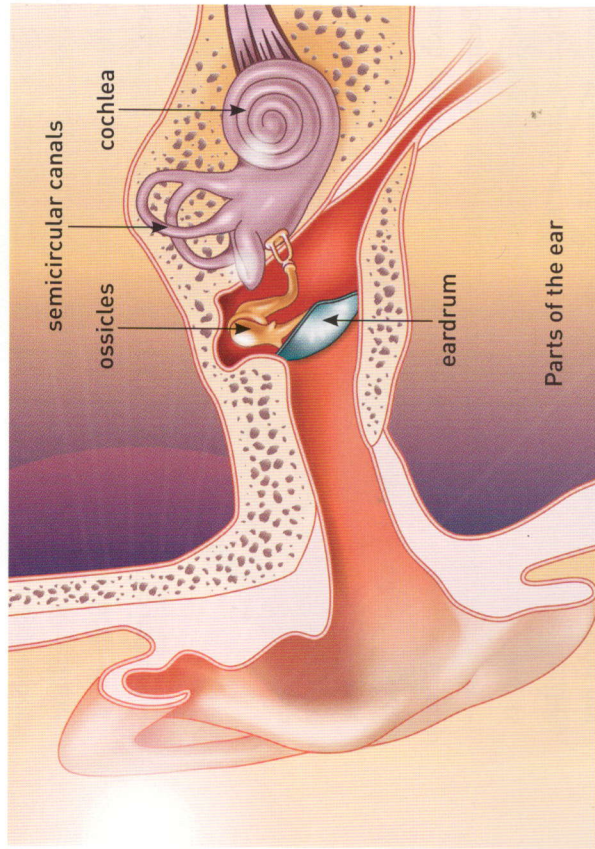
Your eyes tell you more about the world than any other sense, and they are truly amazing! They can sense 10 million different colours, and change their shape in a fifth of a second. And on a very dark night, they can see the light of a burning match 48 kilometres away!

Hearing and balance

In the dance school across the street, the music begins to play. It's a winter night, and my windows are closed, but the shape of my ears helps me to catch the sound. Inside each ear, my eardrum begins to move in and out, or vibrate. Behind the eardrum, the three smallest bones in my body – the ossicles – begin to vibrate too. Each of them is about as big as a piece of rice, but they make the vibration thirty-five times bigger before it gets to the cochlea, deep inside my head. Inside the cochlea, fluid moves past tiny receptors, and nerve signals go to my brain. The dance teacher is playing music by Tchaikovsky. Every time you hear a sound, your brain processes it. Have you heard this sound before? What is it? Amazingly, your brain can recognize about 400,000 different sounds, and it can even put them together to 'play' a favourite piece of music in your head.

Across the road, the dancers are moving to the music. It isn't easy to balance when you're dancing, but they can do it because of three tiny tubes called the semicircular canals. These are next to the cochlea, and as the dancers move, fluid inside the tubes moves up and down, left and right, or forwards and backwards. Receptors inside the semicircular canals tell the dancer's brains how their heads are moving, so they don't fall over.

This helps you to balance, but it's not enough. All over your body, more receptors tell your brain what your bones



and muscles are doing. In this way, dancers know where their arms and legs are without looking at them. Information from your eyes also helps you to balance. Stand on one leg, then close your eyes, and you will see what I mean!

Taste and smell

You buy a hot coffee and a sweet cake.

Why does it taste – and smell – so good? Small groups of cells on your tongue called taste buds sense everything that you eat. Babies have taste buds all over their mouths, but people lose most of these when they grow older. That's why



young children don't like some types of food. They still have extra taste buds, so the food tastes too strong for them.

Taste and smell are different senses, but when you eat, your brain uses information from both to decide if the food is nice. Find a vegetable with a strong smell, then hold your nose and put a piece on your tongue. You probably can't taste it very much. That's because about 75 per cent of the taste of food actually comes from its smell.

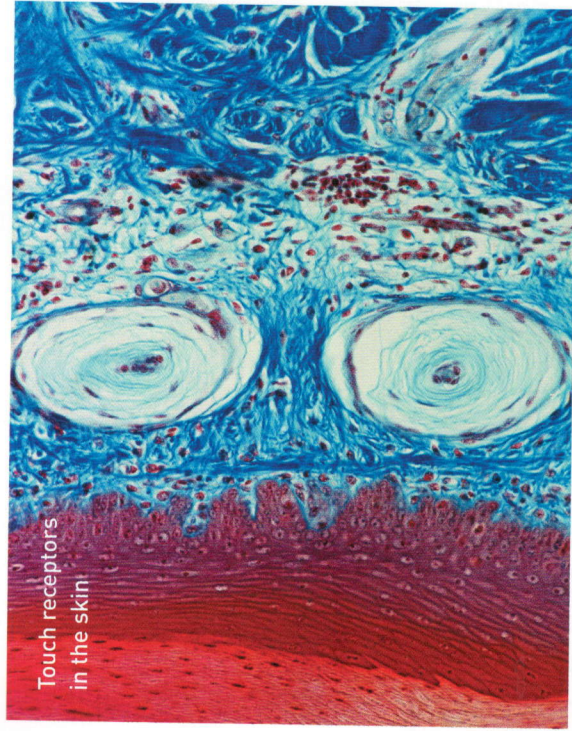
Every time you eat or breathe in, chemicals go into your nose. Receptors in your nose send information about these chemicals to a place in the brain called the olfactory bulb. The olfactory bulb can recognize about 10,000 different chemicals, and the brain uses this information to decide what you are smelling. Smells are made of lots of different chemicals – there are thirty-five different chemicals in the smell of coffee, and about twenty in the smell of a flower.

The olfactory bulb is very close to the hippocampus – the part of your brain which helps you to remember. That's why when people smell something unusual, they often remember things in the past.

Touch, pain . . . and more

There is an unusual family in the hills of Tuscany, Italy. Many of the women in the family – from the children to the grandmother – can't feel pain. It may sound great, but it's a kind of disease. They are a healthy family except for this problem, but they have to be very careful. Pain stops you from hurting yourself and from touching very hot things. Without it, the world can be a very dangerous place!

The nerves in your skin end in receptors for hot and cold things, for pain, touch and vibration. There are millions of these receptors all over your skin, but places like your fingers



Touch receptors
in the skin

and your lips have got more of them. There are also touch receptors in your mouth and other places, and there are pain receptors all over the inside of your body. Pain keeps you safe. It tells you when your stomach hurts or when you've hurt your muscles and bones – so you can get help or rest.

At school, children learn about the 'five senses': sight, hearing, taste, smell, and touch. But you can sense a lot of things inside your body too. You feel hungry and thirsty, and you know where your arms and legs are without looking at them. You know when your stomach is full, and when you need to go to the toilet. And there are senses that you don't know about too. Parts of your brain sense things like your body heat and how much sugar there is in your blood. We never think about these other senses, but we couldn't live without them.

4 Every beat and every breath

A few years ago in South Carolina, USA, an 11-year-old boy was standing on a sports field when a ball hit him hard in the chest. His heart stopped, and he fell to the ground. A doctor reached him quickly, and started to push and push on his chest. Suddenly, the boy's heart started again, and he opened his eyes. He was very, very lucky! You have about 5.6 litres of blood, and your heart pushes it all around your body about once a minute. If this stops – even for a short time – you can die.

Blood is full of nutrients and oxygen. Your cells work like tiny engines and use these things to live. They also produce waste, like carbon dioxide (CO₂). Trillions of round red blood cells carry oxygen to every other cell in your body, and they also take away carbon dioxide. Blood contains other chemicals that your body needs too, and other cells. White blood cells fight dangerous germs – foreign cells from outside your body. And when you cut yourself, special blood cells called platelets join together and close the cut. This stops you from bleeding.

The blood that leaves your heart goes into arteries. All over your body, these arteries divide and get smaller and smaller until they become tiny capillaries. They become so narrow that only one red blood cell can pass through them at a time! Oxygen passes from your blood through the capillary walls, and then into your cells, while carbon dioxide goes the other