

Dementia and the brain

Factsheet 456LP
April 2019



Knowing more about the brain and how it can change can help to understand the symptoms of dementia. It can help a person with dementia to live well, or to support a person with dementia to live well.

This factsheet explains which areas of the brain are responsible for certain skills and abilities, and how these are affected by dementia. It explains how changes to the brain relate to changes a person may notice as the condition progresses. It will be helpful for anyone who wants to find out more about how the brain is affected by dementia.

For more about how the brain works and the effects of dementia, see our film at [alzheimers.org.uk/braintour](https://www.alzheimers.org.uk/braintour)

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Dementia and the brain

Dementia is caused when the brain is damaged by diseases, such as Alzheimer's disease or a series of strokes. Alzheimer's disease is the most common cause of dementia, but not the only one. The specific symptoms that someone with dementia experiences will depend on the parts of the brain that are damaged and the disease that is causing the dementia. For more information see factsheet 400, **What is dementia?**

Parts of the brain

The cerebral cortex

The cerebral cortex is a thin layer of cells covering the outside surface of the brain. It is responsible for:

- memory
- reasoning
- decision-making
- language
- social skills.

It controls actions such as moving around or talking, as well as processing sight, hearing, taste, smell, touch and pain.

The cerebral cortex can be divided into four 'lobes' (regions). These are the:

- temporal lobes
- frontal lobes
- parietal lobes
- occipital lobes.

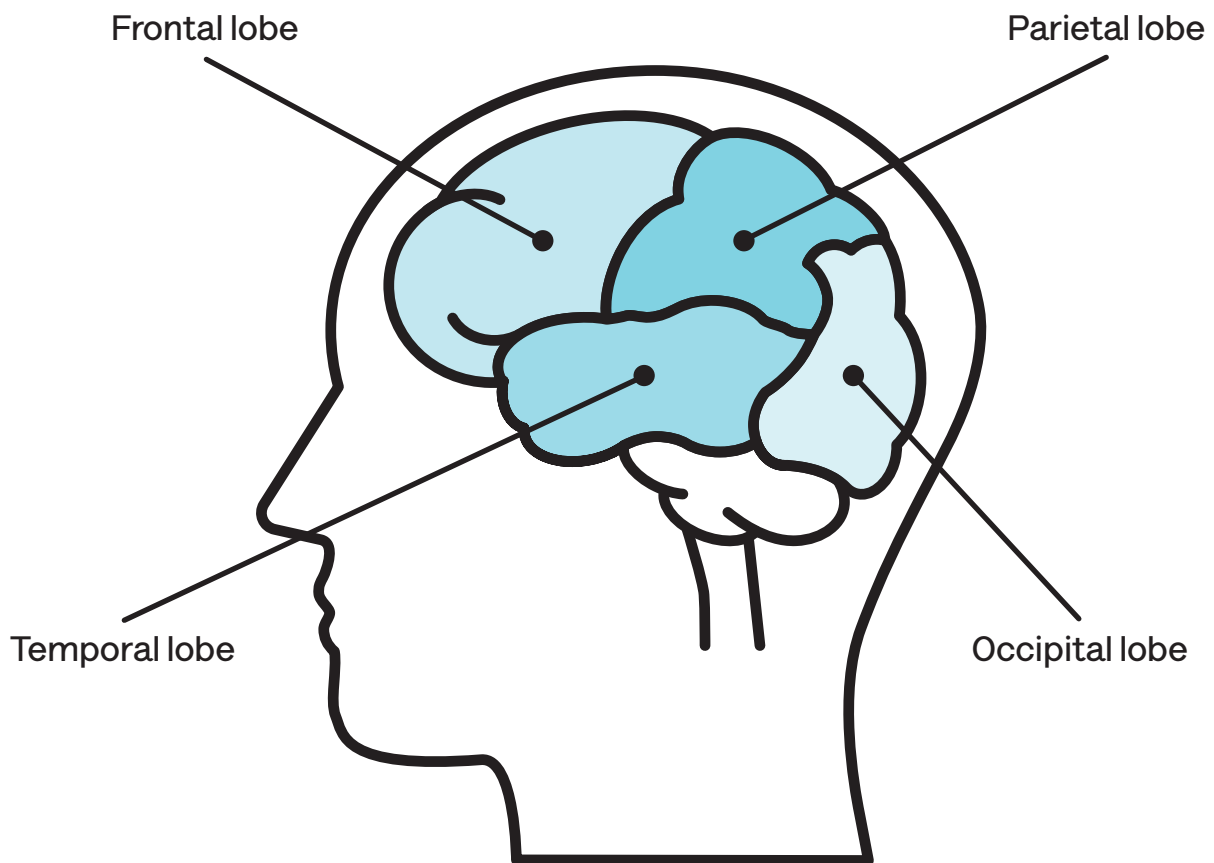


Illustration of the four lobes of the cerebral cortex

The brain is divided into two hemispheres (halves), the left and right side. Each lobe has a left and right side. Each lobe does different things, but they work closely together.

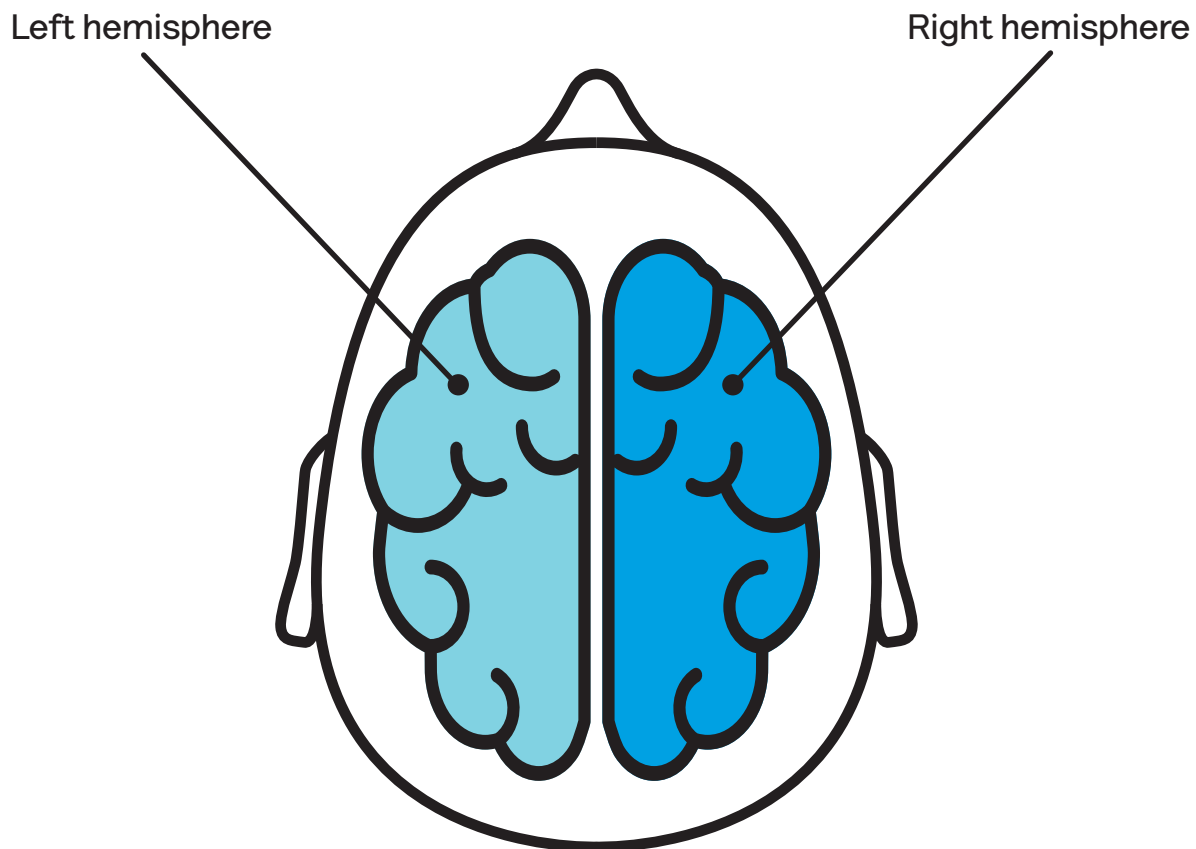


Illustration of the two hemispheres of the brain

The temporal lobes and the hippocampus

The temporal lobes are on either side of the brain, nearest to the ears. Their main roles involve memory processing, hearing and language.

Both temporal lobes store general knowledge. General knowledge (known as semantic memory) is different from the types of memory that relate to day-to-day experiences. The left temporal lobe helps to understand language, and usually stores facts and the meanings of words. The right temporal lobe deals with visual information, such as recognising familiar objects and faces.

Within each temporal lobe is a region called the hippocampus, which processes memories to allow them to be stored and found when needed. Damage to the hippocampus makes it difficult to learn new things. The hippocampus also sends important information to be stored in other parts of the cerebral cortex. It is important for memory of events and experiences (episodic memory).

The temporal lobes also help to understand what is being heard. Damage to the temporal lobes, particularly to an area called the auditory cortex, can make it more difficult for the hippocampus to form memories of what has just been heard.

Alzheimer's disease often starts in and around the hippocampus, before it spreads to other parts of the brain. This is why one of the first symptoms many people notice is memory loss.

The frontal lobes

The frontal lobes are at the front of the brain, behind the forehead. This part of the brain eventually becomes damaged in most types of dementia. They are where information is stored and processed, which allows a person to make rational decisions and judgements.

Frontotemporal dementia (FTD) is most closely linked to damage in the frontal lobes. Early symptoms of FTD can be changes in personality or behaviour. People may also experience difficulty with planning, organising and making decisions. For more information see factsheet 404, **What is frontotemporal dementia (FTD)?**

In other types of dementia, such as Alzheimer's disease, dementia with Lewy bodies and vascular dementia, the frontal lobes tend to be damaged later on.

Damage to the frontal lobes can make it hard to pay attention for very long, switch between tasks or do more than one thing at a time. A person with damaged frontal lobes may become easily distracted or easily lose focus, particularly if they are given too much information all at once.

The frontal lobes also control interest and motivation. As a result, damage to these parts of the brain may cause a person to become:

- apathetic (lacking interest in things, or motivation to do things)
- lethargic (lacking energy)
- much less interested in doing things they have enjoyed in the past.

The frontal lobes also control how a person acts in social situations. They may stop a person from saying inappropriate things. Damage to this part of the brain means people with dementia may say things that are hurtful or rude without meaning to. This can be difficult for people supporting them. For more information on supporting a person with dementia see factsheet 524, **Understanding and supporting a person with dementia.**

Within the frontal lobes is the motor cortex. This deals with planning and movement by controlling muscles. Damage to the motor cortex happens very late in most types of dementia.

Some people experience problems with movement in the early stages of dementia. This is normally caused by damage deeper in the brain and not the motor cortex.

The parietal lobes

The parietal lobes are located in the upper part of the back of the brain. In most people, the right-hand side helps them to understand the position of their bodies and objects in space. For example, it helps them bring a fork to their mouth when eating. The left parietal lobe allows a person to tell left from right, as well as to read, write and process numbers.

Damage to the parietal lobes is common in Alzheimer's disease. It can lead to problems with performing gestures and skilled movements (apraxia) when the person is trying to do things like tie shoelaces or put on clothes. It can also make doing tasks that involve reading or writing much more difficult.

The occipital lobes

The occipital lobes are located at the back of the brain and mostly deal with visual information. This region processes visual information and makes sense of it, including recognising colours and shapes. The resulting information can then be passed on to other areas of the brain.

Damage to the occipital lobes eventually occurs in most types of dementia, although not generally during the early stages. However, in posterior cortical atrophy (PCA), visual problems can be among the first symptoms.

When the occipital lobes become damaged, a person may experience difficulty working out what they see in front of them. Severe difficulties with visual perception can also contribute to visual hallucinations.

As well as making visual information more difficult to understand, damage to the visual cortex can contribute to deteriorating eyesight. For more information about sight and vision, see 'Vision' on page 15.

The sub-cortex

The sub-cortex is any part of the brain below the cerebral cortex. This region allows fast communication between the different parts of the brain. It also contains some areas that are important for movement, thinking and emotion such as:

- the basal ganglia
- the limbic system
- the cerebellum
- the brainstem.

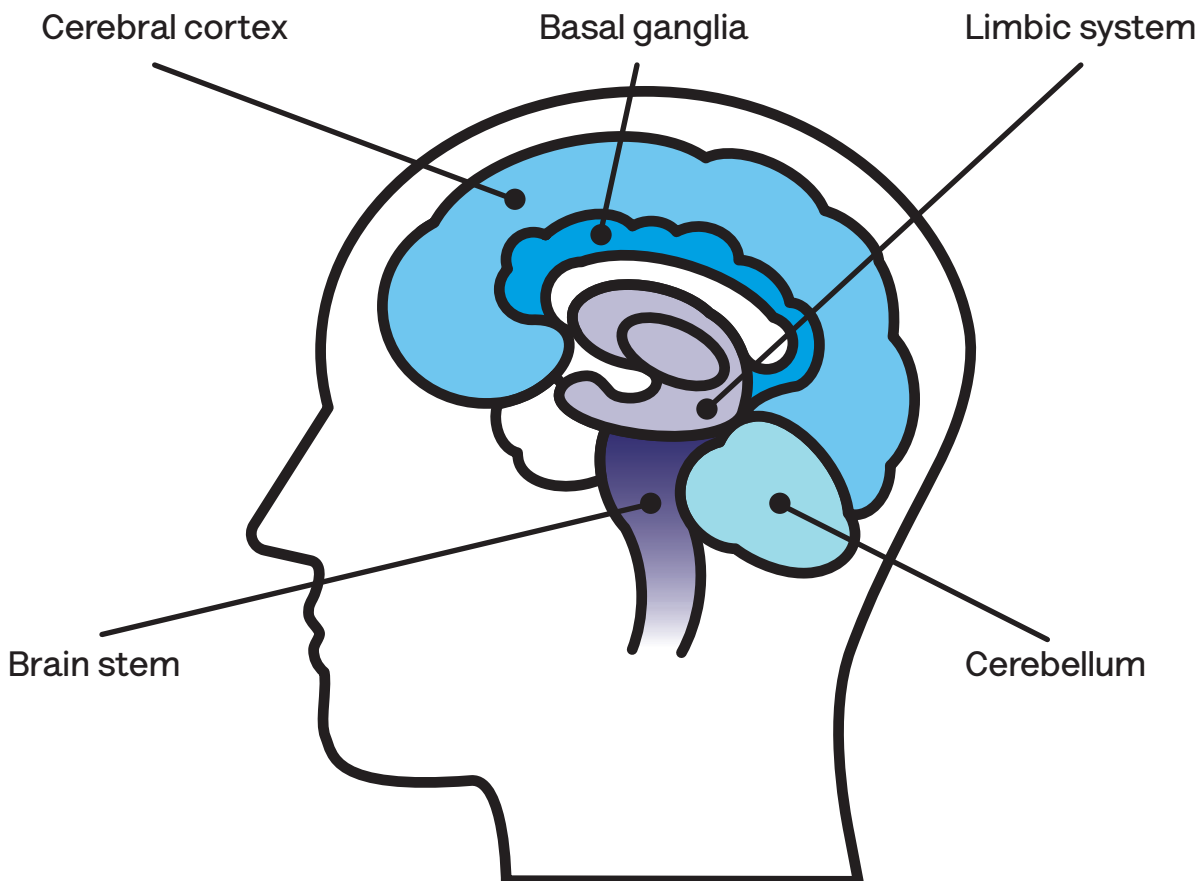


Illustration of the cerebral cortex and parts of the sub-cortex – the basal ganglia, the limbic system, the cerebellum and the brainstem

The basal ganglia

The basal ganglia are a group of small structures located deep within the sub-cortex. They are mostly involved in the control of movement. Damage to this part of the brain is common in types of dementia that are also movement disorders, such as Parkinson's disease dementia, dementia with Lewy bodies and Huntingdon's disease dementia. In dementia with Lewy bodies and Parkinson's disease movement can become very difficult, resulting in very slow movements or a person not being able to move at all sometimes. It can also cause involuntary movements, such as a tremor in the hands.

The limbic system

The limbic system is a collection of regions in the brain that are involved in processing emotions. It includes the amygdala, hippocampus, hypothalamus and thalamus.

Damage to the limbic system is common in most forms of dementia. It may change the way a person feels or would normally react to things. A person may feel more excited, anxious, sad or apathetic than before they developed dementia. It can also lead them to have delusions (strongly believing things that aren't true) – for example believing that a stranger is in the house, or that someone is stealing things from them.

The hypothalamus controls levels of:

- hunger
- thirst
- body temperature
- many of the hormones that control the body's metabolism.

Damage to the hypothalamus may lead to changes in a person's appetite and eating behaviour, particularly in frontotemporal dementia. These changes can include craving sweet foods, overeating, or becoming obsessed with particular foods. In some cases people may try to eat inedible objects.

Just above the hypothalamus is the thalamus, which works as an important ‘information hub’. It sends useful information to the cerebral cortex. It is heavily involved in consciousness, perception, attention, memory and movement. The thalamus is affected to some extent in most types of dementia.

The cerebellum

The cerebellum co-ordinates movements, balance and posture, and helps the eyes to work together. New evidence has shown significant tissue loss in the cerebellum in people with Alzheimer’s disease and frontotemporal dementia. However, few people with these conditions seem to experience symptoms from this damage.

The brainstem

The brainstem is at the bottom of the brain where it meets the spinal cord. It deals with survival functions, such as controlling:

- heartbeat
- breathing rate
- blood pressure
- sleep cycle
- swallowing
- states of consciousness (being awake, asleep and dreaming, or unconscious).

Several types of dementia affect the brainstem. However, people with dementia with Lewy bodies are particularly affected during the early stages. They may experience severe sleep problems for several years before being diagnosed (for example acting out their dreams while asleep), as well as fluctuating levels of consciousness, slowness of movement and visual hallucinations. They can also have problems regulating their blood pressure – causing dizziness and fainting, which can lead to falls.

A region of the brainstem is responsible for making an important chemical called dopamine. Dopamine is essential for many different functions in the brain, including movement and feelings of pleasure and reward. People with Parkinson's disease, Parkinson's disease dementia and dementia with Lewy bodies often have low levels of dopamine, which can make movement difficult. It can also affect their mood, causing depression or apathy.

Blood supply to the brain

The brain needs a constant supply of oxygen and nutrients. These are present in the blood, which is pumped up to the brain through a network of vessels called the 'vascular system'.

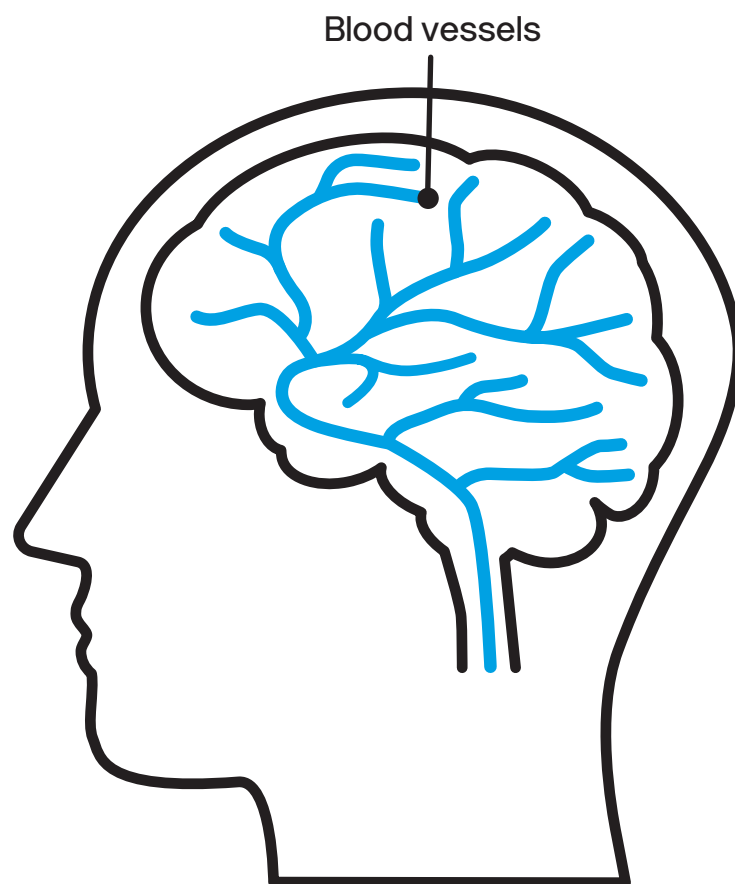


Illustration of the vascular system in the brain

If blood vessels in the brain's vascular system are damaged by disease, they can gradually become blocked or leak. This means they are not able to supply enough blood. When the cells don't get enough blood they eventually become starved of oxygen and nutrients, and they die. A reduced blood supply to the brain is a common cause of vascular dementia.

Vascular dementia

The most common type of vascular dementia is subcortical vascular dementia. This is caused by diseases of the small blood vessels that lie deep in the brain (known as small vessel disease). These blood vessels develop thick walls and become stiff and twisted which reduces the blood flow. This happens in the sub-cortex and often damages bundles of nerve fibres (known as white matter) that carry information from one area of the brain to another. It can also cause small infarcts (areas of dead tissue caused by loss of blood supply) near the base of the brain.

A person with subcortical vascular dementia may have slowed thinking, as well as problems with concentration and executive function (see page 14).

Sometimes people develop vascular dementia after having a major stroke, when a large area of tissue on one side of their brain dies because the blood supply is suddenly cut off.

A person with this type of dementia may often have problems with:

- planning
- concentrating
- thinking
- memory
- vision
- speech.

Vascular dementia can also follow several minor strokes that happen over a period of time. Each stroke creates a small area of dead brain tissue. Early symptoms depend on the location of the dead tissue in the brain. If one of the main blood vessels that supplies blood to the brain is affected by a stroke, the symptoms can be more severe.

For more information see factsheet 402, **What is vascular dementia?**

Functions of the brain

The brain carries out a huge variety of tasks every day. This includes receiving and processing information about the environment and taking actions based on thoughts, feelings and perceptions. The brain also handles a lot of tasks that a person is unaware of, such as telling the heart how fast to beat.

As dementia progresses, some tasks become much more difficult. Functions that are particularly affected in dementia include executive function (the ability to plan, organise and complete tasks), vision, language, emotion and behaviour, and memory.

Executive function

Executive function is the ability to plan, organise and complete tasks. It also includes solving problems, setting useful goals and making rational decisions. For executive function to happen, information needs to be held in working memory long enough for the person to be able to perform the task – for example, remembering how many teaspoons of sugar they have added to the cup so far, or the reason for going into a room.

Executive function includes organising and planning a sequence of actions. Things that most people might consider to be simple, everyday tasks involve a series of pre-planned steps, all of which need to be done in the correct order. For example, the task of getting dressed involves putting several layers of clothing on in the correct order.

Loss of executive function can make communication difficult, as a person may struggle to maintain their attention on what is being said. They may find it hard to hold a conversation while other things are going on in the background. For more information see factsheet 500, **Communicating**.

Vision

Vision is a complicated process that involves different parts of the brain, not just what is seen with the eyes. Different parts of the brain process different information to make sense of what a person is seeing. When the brain is damaged, although the eyes may be healthy, there may still be problems with vision. For example, the temporal lobes match up what is being seen with memories of things the person has seen before – such as a face. If dementia disrupts these processes the person may have problems recognising faces or objects (known as visual agnosia).

Problems with understanding what is being seen can also contribute to a person with dementia seeing things that are not real – known as visual hallucinations. Visual hallucinations occur frequently in dementia with Lewy bodies, often in the early stages. In most other types of dementia hallucinations tend to happen more during the later stages.

For more information see factsheet 527, **Changes in perception**.

Language

Language is a process that allows a person to understand and communicate thoughts and ideas, whether through spoken sounds (speech), visual patterns (writing), or gestures (including sign languages).

When a person listens to someone talking, reads words written on a page or reads sign language, the information is understood as language. If dementia disrupts this process, it can affect how a person uses language.

If a person's temporal lobes are damaged, they may not be able to understand the meaning of words – for example, that the word spelled 'K-E-T-T-L-E' means 'kettle' and also that its purpose is for boiling water. A person may understand the meaning of words but be unable to find them when needed – for example, they will know what a kettle is, but will be unable to find the word when talking or signing.

Less commonly used or more recently gained words tend to be lost first. Basic words that the person learned at an earlier age are kept for much longer. When a person speaks more than one language, they may go back to communicating in the language they first learned as a child.

For more information see factsheet 500, **Communicating**.

Emotion and behaviour

The way a person feels and behaves depends on communication between the limbic system (which deals with emotions) and the frontal lobes (which deal with rational thoughts and judgements).

If these parts of the brain are damaged by dementia, however, the person may feel anxious without good cause, or react aggressively to a threat which isn't really there. Problems with processing emotions may also lead to inappropriate or confusing behaviour – for example a person laughing when they are told about a sad event.

For more information on how a person's emotions or behaviours may change if they have dementia see factsheet 524, **Understanding and supporting a person with dementia**.

Memory

There are several types of memory – each involves different parts of the brain working together. As a result, different types of dementia can lead to different memory problems, depending on where the most damage has been caused in the brain.

- Working memory allows a person to hold information in their conscious thoughts and use it for a few seconds. This period can be extended by repeating the information to stop it from slipping away – for example, if a person repeats a telephone number until they are able to write it down.
- Episodic memory is the memory of events and experiences. For example, the first time a person met a close friend. These memories help people to understand who they are. Poor episodic memory can be upsetting.
- Semantic memory is the general knowledge about objects, word meanings, facts and people. For example – knowing that eggs have shells.
- Procedural memory is the memory of skills a person has learned. Examples include tying shoelaces, riding a bike or driving a car.

The extent to which dementia affects memory is different for everyone. This makes it difficult to know how dementia will affect any individual person, particularly during the earlier stages of the condition.

For more information on understanding memory, see our practical guide to living with memory problems booklet 1540, **The memory handbook**.

Working memory

The things a person experiences can only be held in their working memory for a few seconds. Working memory relies on different parts of the cerebral cortex – particularly the temporal and parietal lobes. Unlike other types of memory it doesn't seem to need the hippocampus.

Some types of dementia can cause serious problems with working memory during the early stages. It may be difficult for a person with dementia to hold and use information for very long, which makes it hard to grasp the meaning of long or complicated sentences. It also makes trying to do more than one task at a time more difficult.

Episodic memory

These are the memories of past events or experiences in a person's life. They are usually stored with reference to a certain time and place. The memory may have several parts – for example, where someone was, what they saw and how they felt at the time. These parts are assembled in the hippocampus to create a memory of the 'episode' and are stored for a little while. Memories that are selected for long-term storage are moved from the hippocampus to the cerebral cortex. Over time the memories get stronger when the person dreams, thinks and tells other people about them.

Finding older memories seems to involve the hippocampus less than finding newer memories. This is why remembering things from a long time ago can be easier for a person with Alzheimer's disease than recalling what happened last week. Older memories can sometimes be triggered by a strong association, such as a particular smell or piece of music. In advanced dementia, damage spreads to the cerebral cortex and even long-term memories may be lost.

Emotions have a large influence on memory. This is why people may remember how they feel about a person or a place, even if they don't know who the person is or where they are.

Semantic memory

Semantic memories are things that a person ‘knows’, rather than events that are fixed in time. This can include:

- general knowledge – for example knowing that Paris is the capital city of France
- language skills, including the meaning of words personal knowledge – for example whether your home has a garden.

Damage to the left temporal lobe can cause a person to slowly lose their understanding of language – whether in the form of speech, writing, or sign languages. The temporal lobes are among the first areas to be damaged in semantic dementia, which is why a person may lose their understanding of certain words. They are also affected early on in Alzheimer’s disease, which is why people may have problems finding the right word.

The person may also be unable to recognise the faces of people they have known for a long time. They may also struggle to recognise objects. Other types of dementia can cause similar problems with semantic memory, but this tends to happen in the later stages.

Procedural memory

Procedural memory is the memory of how to do everyday tasks.

Procedural memory enables a person to use a wide range of objects, from computers to cutlery. This type of memory is relatively well-preserved in most forms of dementia compared with episodic and semantic memory.

For more information on understanding memory, see our practical guide to living with memory problems booklet 1540, **The memory handbook**.

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Our information is based on evidence and need, and is regularly updated using quality-controlled processes. It is reviewed by experts in health and social care and people affected by dementia.

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This factsheet has also been reviewed by people affected by dementia.

To give feedback on this factsheet, or for a list of sources, please email publications@alzheimers.org.uk

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