UNIT 1

How are behaviour and mental processes shaped?

AREA OF STUDY 1
How does the brain function?

CHAPTER 3  Role of the brain in mental processes and behaviour
CHAPTER 4  Brain plasticity and brain damage

AREA OF STUDY 2
What influences psychological development?

CHAPTER 5  The complexity of psychological development
CHAPTER 6  Atypical psychological development

OUTCOME 1
- describe how understanding of brain structure and function has changed over time, explain how different areas of the brain coordinate different functions, and explain how brain plasticity and brain damage can change psychological functioning

OUTCOME 2
- identify the varying influences of nature and nurture on a person’s psychological development, and explain how different factors may lead to typical or atypical psychological development
CHAPTER 3
Role of the brain in mental processes and behaviour

KEY KNOWLEDGE
- the influence of different approaches over time to understanding the role of the brain, including the brain vs heart debate, mind-body problem, phrenology, first brain experiments and neuroimaging techniques
- the basic structure and function of the central and peripheral nervous systems as communication systems between the body’s internal cells and organs and the external world
- the role of the neuron (dendrites, axon, myelin and axon terminals) as the primary functional unit of the nervous system, including the role of glial cells in supporting neuronal function
- the basic structure and function of the hindbrain (cerebellum, medulla), midbrain (reticular formation) and forebrain (hypothalamus, thalamus, cerebrum)

- the role of the cerebral cortex in the processing of complex sensory information, the initiation of voluntary movements, language, symbolic thinking and the regulation of emotion, including localisation of function

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Nervous system: structure and function
Role of the neuron
Glial cells
Structure and function of brain areas
Roles of the cerebral cortex
INTRODUCTION
Consider some of what your brain is doing as you read this passage of text. In order to read, symbols are seen on the page, organised into words, and the words are connected with meanings from memory. Then these meanings are combined to form thoughts. While you focus your attention on reading, you are less aware of any background sounds, perhaps the whispers of people around you, the footsteps of someone outside the room or the engines of an overhead plane. You are also less aware of other types of sensory information, such as the pressure of your bottom on the chair and where your arms and legs are. Once you pay attention to any of these, you will become fully aware of them and your brain will start processing that information.

In addition to processing the information you are reading, your brain is performing numerous other functions to keep you alive, such as ensuring that you breathe oxygen, your heart beats, your core body temperature remains within a suitable range and that your digestive system processes any food you have eaten. You are generally unaware of these activities.

Your brain sends and receives messages through its extensive nervous system via the spinal cord to control your breathing, maintaining just the right amount of oxygen in your bloodstream, as well as adjusting your blood pressure to keep fresh oxygenated blood flowing throughout your entire body. Your brain continuously monitors and regulates almost all of the internal conditions in your body. For example, it regulates the nutrient content in your bloodstream, which provides one of the signals to eat again. It also regulates the amount of water your body needs to stay in chemical balance and the activity of the endocrine system that secretes hormones into your bloodstream to help regulate the normal functioning of bodily processes.

Your brain is one of the less obvious features that distinguish you from primates and all other living things. Everything that makes you who you are comes from the way your brain cells interact and connect. It is the source of your consciousness — your awareness of who you are, your state of being and your external environment. It stores all your knowledge and memories, enables you to experience emotions and gives you your personality. Ultimately, it shapes your hopes and dreams for the future. It is the ability of our brain to perform these types of functions that makes us human. But our brain may not look or feel as if it does all this.

If you cupped a human brain in your hands it would feel soft and squishy, like firm jelly. After a couple of minutes, if you turned the brain upside down, you would see a flattened bit left in the tissue from the weight of the brain resting in your hands. This would give you an idea of how delicate it is.

**FIGURE 3.1** The human brain is a complex structure that is involved in virtually everything we think, feel and do.
To protect and keep this fragile organ in place, the brain is covered by a layer of three, transparent membranes, or ‘casings’ (the meninges) and encased in a hard, bony skull. Also protecting the brain is a watery-like liquid (cerebrospinal fluid) that circulates between the membranes. This provides a cushion against knocks to the head, protecting the brain from injury unless the knock is quite hard. The many arteries you can see carry nutrients and oxygen-rich blood throughout the brain. Without this blood, brain tissue quickly dies.

If you peeled back the membranes you could touch the wrinkly looking surface and feel its many bulges and grooves. This outer layer of tissue (the cerebral cortex) covers the largest part of the brain (the cerebrum).

If you actually touched the brain of a living person they would not feel anything. Only if you stimulated some part beneath the surface with a low dose of electric current would the person react. The brain receives sensory messages from elsewhere in the body, but has no sensory receptors of its own. For example, there are no pain receptors in the brain tissue itself. That’s why surgeons can perform brain operations on patients who are awake.

If you sliced the brain in half, downward through the middle from side to side, you would see its inner features. Although not all features are distinctive to the untrained eye, you would notice that the inside does not all look the same. Both dark and light areas of tissue are visible and these represent different brain parts.

The darker areas, called grey matter, are largely composed of nerve cell bodies and their local connections to each other. The outer cerebral cortex layer is entirely made up of grey matter, although it would look more pinkish than grey in a fresh or living brain because of the presence of very thin blood vessels (capillaries). The lighter areas, called white matter, are mostly nerve fibres that connect distant brain areas to one another. They have a fatty coating that produces the whitish appearance. White matter is found in abundance beneath the cortex.

Two wing shaped cavities (ventricles) are also easily seen. These are in the cerebrum. They are the largest of the brain’s four ventricles which together form an inner communication network. All are filled with cerebrospinal fluid that flows between them.

Despite its fragile look and feel, the brain is the most complex organ in the body and perhaps the most complex natural or artificial structure in the known universe. Its remarkable complexity is largely invisible to the naked eye. You cannot see that it is densely packed with structures, systems, functions, connections and interconnections, many of which are still not fully understood. Within the brain’s tissue are roughly 86 billion individual nerve cells called neurons. Each neuron is connected to between 1000 and 15 000 or more other neurons, so there are trillions of connections.

These connections form numerous networks along which information is electro-chemically sent and exchanged. If there were no order to this complexity, it would be extremely difficult to understand brain function. Advances in brain imaging and recording technologies during the past 30 years or so have dramatically increased understanding of brain function. However, psychologists and neuroscientists still know only a fraction of what there is to know about how the brain works.

In this chapter we examine some of the approaches over time to understanding the brain and its role in mental processes in behaviour. We then examine the brain’s basic structure and function at the cellular level followed by the roles of specific brain areas.
By the nineteenth century, researchers were making progress in answering questions about the brain that philosophers could not. For example, researchers dissected the brains of dead animals or people whose bodies had been donated or sold to medical science. Autopsies were also conducted on people who had died from a brain injury. Living people and animals were also studied. Valuable information was obtained from studying living people who had experienced a brain injury in an accident or as a result of disease. There were also animal experiments in which parts of the brain were intentionally injured or removed to study the effects on behaviour. Most of the researchers throughout the nineteenth century were physicians, physiologists or anatomists, so research predominantly reflected a biological perspective.

Although early research provided useful information about the brain, this information was mainly limited to the structure of the brain, such as which part controlled a specific function. Relatively little was known about the actual function of the brain, such as how and when different brain structures and areas ‘work’, their relationships to other brain structures and areas, and nerve pathways linking them.

None of the early techniques for studying the brain enabled researchers to directly observe and study brain functioning as it normally does in a healthy, living person. Consequently, researchers had to rely on making assumptions about underlying brain function based on observations of participants’ responses in experimental tasks, or, in some cases, invasive medical procedures that would not be permissible according to the ethical standards all researchers must now follow.
BOX 3.1

Electrical stimulation of animal brains

In the early 1950s, Walter Hess, a Swiss neuroscientist and Nobel Prize winner, pioneered the use of electrode placement to electrically stimulate structures located deep in the brain. This research is unethical with humans, so Hess used cats because they have brains like those of humans, but with far less cerebral cortex.

Hess (1957) carefully recorded the behavioural consequences of stimulating each of 4500 brain sites in nearly 500 cats. For example, Hess inserted a radio-controlled electrode into a cat's hypothalamus, a tiny structure located just above the brainstem. By pressing a button, he could send a weak electrical current to the hypothalamus at the point of the electrode.

Hess found that, when the hypothalamus was electrically stimulated, an otherwise gentle cat made aggressive responses observed when fearful or threatened. As shown in figure 3.4, the cat spat and growled, lashed its tail, extended its paws, and its fur stood on end. Hess concluded that neuronal activity arising from the hypothalamus appeared to produce fear-provoked aggression. The press of a button would instantly turn on the aggression, and would turn it off just as abruptly.

An even more dramatic exhibition of electrical stimulation apparently affecting aggressive behaviour was staged by José Delgado, a Spanish physiologist. Delgado (1969) implanted a number of radio-controlled electrodes in the brain of a bull bred specifically to be aggressive in the bull ring. Delgado claimed stimulation would stop the charging bull. Standing in the bull ring himself at the moment of the bull's charge, Delgado activated the electrode, which made the bull stop abruptly (see figure 3.5). Although the popular media emphasised Delgado was able to control the bull's aggression, Delgado had actually implanted the electrodes in motor cortex areas. When activated, this forced the bull to stop moving forward and then caused it to turn to one side.

Delgado halting the attack of a bull by stimulating radio-controlled electrodes implanted in the motor areas of its brain.

Weblink
Video showing ESB with animals, including the Hess and Delgado experiments

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Weblink
Video showing animals in the Hess and Delgado experiments

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CHAPTER SUMMARY

Approaches over time to understanding the role of the brain

Brain versus heart debate
Mind–body problem
Phrenology
First brain experiments
Neuroimaging techniques

Brain ablation experiments
Electrical stimulation of the brain
Split-brain experiments

Computerised tomography (CT)
Magnetic resonance imaging (MRI)

Organisation of the nervous system
Central nervous system
Peripheral nervous system

Structural neuroimaging
Functional neuroimaging
Other neuroimaging techniques

Functional magnetic resonance imaging (fMRI)

Somatic nervous system
Autonomic nervous system

Dendrites
Soma
Axon
Axon terminals
Myelin
Sensory neurons
Motor neurons
Interneurons

Hindbrain
Medulla
Pons

Reticular formation

Hypothalamus
Thalamus
Cerebrum

Forebrain

Cerebral hemispheres

Left hemisphere specialisations
The frontal lobe

Right hemisphere specialisations
Parietal lobe
Occipital lobe
Temporal lobe

Cortical lobes of the cerebral cortex

StudyOn
Summary Unit 1
How are behaviour and mental processes shaped?
Area of study 1
How does the brain function?
Topic 1
Role of the brain in mental processes and behaviour
CHAPTER 3 TEST

SECTION A — Multiple-choice questions

Choose the response that is **correct** or that **best answers** the question. A correct answer scores 1, an incorrect answer scores 0. Marks will **not** be deducted for incorrect answers. No marks will be given if more than one answer is completed for any question.

**Question 1**
The outer layer of neural tissue covering the human brain is called the
A. corpus callosum.
B. cerebral cortex.
C. meninges.
D. association cortex.

**Question 2**
The relationship between the central nervous system and the peripheral nervous system is best described as
A. non-interactive.
B. autonomous.
C. interdependent.
D. outlying.

**Question 3**
A major function of the spinal cord is to
A. protect the vertebrae.
B. initiate voluntary muscle movements.
C. enable sensory neurons to connect directly with motor neurons.
D. connect the brain and peripheral nervous system.

**Question 4**
Experimental research using ablation involves _______ the brain to observe behavioural effects.
A. damaging
B. stimulating
C. inhibiting
D. stimulating and/or inhibiting

**Question 5**
The split-brain experiments on hemispheric specialisation were conducted by
A. Flourens.
B. Penfield.
C. Sperry.
D. Galen.

**Question 6**
The brain structure that is most prominently involved in regulation of eating, drinking and body temperature is the
A. cerebellum.
B. reticular formation.
C. thalamus.
D. hypothalamus.

**Question 7**
The brain structure that coordinates bodily movements to ensure precise and smooth execution is the
A. cerebellum.
B. cerebrum.
C. medulla.
D. hypothalamus.

**Question 8**
The brain area primarily involved in regulating bodily activities that are vital for survival is the
A. cerebral cortex.
B. hindbrain.
C. forebrain.
D. midbrain.

**Question 9**
Which of the following statements about hemispheric function is correct?
A. The left and right hemispheres control voluntary movements on both sides of the body and receive sensory information from both sides of the body.
B. The left and right hemispheres exchange and process sensory information before deciding which side of the body requires control of voluntary movements.
C. The right hemisphere controls voluntary movements on the right side of the body and receives sensory information from the right side of the body.
D. The left hemisphere controls voluntary movements on the right side of the body and receives sensory information from the right side of the body.
Question 10
A major function of the somatic nervous system is to
A. transmit information from the sensory receptor sites to the CNS.
B. carry neural messages between the CNS and internal organs and glands.
C. maintain the body’s internal states.
D. interpret information provided by sensory systems of the body.

Question 11
The division of the nervous system that is primarily self-regulating is called the ______ nervous system.
A. central
B. somatic
C. autonomic
D. peripheral

Question 12
Something gives you a sudden and unexpected fright. Which division of the nervous system will be activated when this happens?
A. sympathetic
B. parasympathetic
C. somatic
D. central

Question 13
Which structure screens then redirects incoming sensory information to the relevant cortical area?
A. thalamus
B. hypothalamus
C. medulla
D. cerebrum

Question 14
The brain vs heart debate
A. has its origins with the advent of neuroimaging techniques in the 1970s.
B. is about the source of human mental processes and behaviour.
C. was first proposed by the philosopher Descartes.
D. proposes that both the heart and brain contribute to human mental processes and behaviour.

Question 15
A main advantage of the PET scan when compared with the CAT scan is that
A. a PET scan provides information about brain movement, whereas a CAT scan provides only structural information.
B. a PET scan provides information about brain activity, whereas a CAT scan provides only structural information.
C. a PET scan provides magnetic brain images whereas a CAT scan provides computerised cross-sectional brain images.
D. a PET scan is non-invasive, whereas a CAT scan is invasive because radiation is used.

Question 16
Which of the following brain study techniques would provide the most precise information on brain function?
A. fMRI
B. PET
C. MRI
D. CT

Question 17
Three prominent hindbrain structures are the
A. cerebellum, reticular formation and hypothalamus.
B. thalamus, cerebrum and hypothalamus.
C. thalamus, reticular formation and pons.
D. cerebellum, medulla and pons.

Question 18
The largest part of the forebrain is the
A. reticular formation.
B. cerebellum.
C. cerebrum.
D. medulla.

Question 19
You will be able to move the muscles in your hand and fingers to answer this question through the specific action of your
A. sensory neurons.
B. motor neurons.
C. autonomic nervous system.
D. spinal cord.

Question 20
Which of the four lobes is primarily involved in vision?
A. occipital
B. frontal
C. parietal
D. temporal

Question 21
A neurosurgeon electrically stimulated parts of a patient’s primary somatosensory cortex. If the patient was conscious during the procedure, which of the following was probably experienced?
A. ‘hearing’ faint sounds
B. ‘seeing’ random visual patterns
C. a sense of having the skin touched
D. movement of one or more of the larger body parts

Question 22
The amount of primary motor cortex devoted to a specific body part reflects the
A. degree of stimulation required to activate the part.
B. degree of precise control required by the part.
C. sensitivity of the sensory receptors controlling the body part.
D. sensitivity of the body part to stimulation.
Question 23
Which of the following tasks is a specialised function of the right cerebral hemisphere?
A. reading a novel
B. logical reasoning
C. following the directions in a recipe
D. finding one’s way around a maze

Question 24
The area of the brain that, if injured, is more likely to adversely affect mental abilities such as symbolic thinking, planning and decision making, is the
A. forebrain.
B. midbrain.
C. hindbrain.
D. cerebellum.

Question 25
You have an itchy leg, so you scratch it. The sensation of the itch is processed by the ______, whereas the scratching movements are controlled by the ______.
A. frontal lobe; parietal lobe
B. parietal lobe; frontal lobe
C. primary somatosensory cortex; primary motor cortex
D. primary motor cortex; primary somatosensory cortex
SECTION B — Short-answer questions

Answer all questions in the spaces provided.

**Question 1** (2 marks)
Broca’s area is located in the __________________________ lobe; whereas, Wernicke’s area is located in the __________________________ lobe.

**Question 2** (1 mark)
Which division of the nervous system automatically restores bodily systems to their normal level of functioning after heightened activity has been suddenly initiated?

**Question 3** (1 mark)
Which cortical lobe directly receives then processes auditory information?

**Question 4** (1 mark)
Explain the meaning of ‘localisation’ in relation to brain function.

**Question 5** (4 marks)
Name the four parts of the neuron in the following diagram.

![Diagram of a neuron with labels 1, 2, 3, and 4]
Question 6 (4 marks)
Use the following brain image to indicate the approximate location of each of the following. Ensure you clearly mark and label each area.

- Medulla
- Occipital lobe
- Thalamus
- Forebrain

Question 7 (2 marks)
Use an example to describe the interactive nature of a motor neuron, sensory neuron and interneuron.

Question 8 (3 marks)
a. Name one type of glial cell and describe its role. (2 marks)

b. What is a vital role of neurons that glial cells cannot perform? (1 mark)

Question 9 (2 marks)
What is the mind–body problem?
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Question 10  (2 marks)

a. What is phrenology? (1 mark)

b. Why is phrenology best regarded as pseudoscience? (1 mark)

Question 11  (2 marks)

During a car accident, Stephen suffered a brain injury. Fortunately, he did not injure his spine. Afterwards, he found that he could not detect any sensations (such as touch, hot or cold changes) on both sides of his face between his cheekbones and lower jaw.

Which of Stephen’s cortical areas is likely to have been affected by the brain injury, and in which lobe is this cortical area located?

Question 12  (2 marks)

Explain the relationship between the brain and conscious experience of the world with reference to the thalamus and reticular formation.

Question 13  (2 marks)

Some psychologists refer to ‘the brain and its nervous system’ when discussing the brain. Briefly discuss the accuracy of this expression, with reference to an example of a relevant mental process or behaviour.

Question 14  (2 marks)

Popular magazines sometimes describe people as ‘left-brained’ or ‘right-brained’, suggesting that one hemisphere is entirely dominant over the other in certain activities or that we may be able to make one hemisphere more dominant and therefore improve or even excel in some abilities.

Write a counterargument to this view ensuring you refer to hemispheric function and a relevant example.

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The answers to the multiple-choice questions are in the answer section at the back of this book and in eBookPLUS.
The answers to the short-answer and research scenario questions are in eBookPLUS.
UNIT 2

How do external factors influence behaviour and mental processes?

AREA OF STUDY 1
What influences a person's perception of the world?

CHAPTER 7 Sensation and perception
CHAPTER 8 Distortions of perception

AREA OF STUDY 2
How are people influenced to behave in particular ways?

CHAPTER 9 Social cognition
CHAPTER 10 Social influences on behaviour

OUTCOME 1
- compare the sensations and perceptions of vision and taste, and analyse factors that may lead to the occurrence of perceptual disorders

OUTCOME 2
- identify factors that influence individuals to behave in specific ways, and analyse ways in which others can influence individuals to behave differently
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