Pearson Edexcel Level 1/Level 2 (9–1) GCSE Psychology

Topic Guide 4

The brain and neuropsychology – How does your brain affect you?

CONTENTS

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The brain and neuropsychology – How does your brain affect you?

Specification requirements

This topic is a compulsory topic and will be examined in Paper 1.

Candidates are expected to demonstrate and apply the knowledge, understanding and skills described in the content.

To demonstrate their **knowledge**, candidates should undertake a range of activities, including the ability to recall, describe and define, as appropriate.

To demonstrate their **understanding**, candidates should explain ideas and use their knowledge to apply, analyse, interpret and evaluate, as appropriate.

Candidates will be expected to demonstrate their understanding of the interrelationships between the core areas of psychology and **issues and debates** within them.

Candidates may be asked to consider the following issues when **evaluating** studies:
- validity
- reliability
- generalisability
- ethics
- objectivity
- subjectivity.

Candidates may be required to **apply** their understanding – for example by responding to scenarios that are drawn from the topic area and/or associated research – and in doing this they should use psychological concepts, theories and/or research from within their studies of the brain and neuropsychology.

Opportunities for practical activities

Candidates should gain hands-on experience of carrying out ethical, investigative activities to aid their understanding of this subject. To help centres identify opportunities for carrying out these activities, studies that can be replicated have been marked with an asterisk.

Research methods are delivered in Topic 11. However, as a way to aid candidates in evaluating the studies, centres can encourage them to consider the methodology of the key studies as they progress through each individual topic. For example, candidates could consider the generalisability of testing brain lateralisation in a small number of split-brain patients when studying **Sperry (1968)** (4.2.2).

Although candidates will not be directly assessed on practical activities, the experience they gain will give them a better understanding of this subject and may enhance their examination performance.

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Guidance

4.1 Content

4.1.1 Know the structure and function of the brain, including:
a. temporal lobe
b. occipital lobe
c. frontal lobe
d. parietal lobes
e. cerebellum

Candidates should be able to identify the areas of the brain and state the function of the brain areas. Candidates may benefit from using diagrammatic posters or models to explore the structure of the brain and could label these areas on a diagram of the brain. Connections between the brain areas could be considered in terms of their function and influence on human behaviour.

Candidates need to know the structure and function of the **temporal** (4.1.1a), **occipital** (4.1.1b), **frontal** (4.1.1c), and **parietal lobes** (4.1.1d), as well as the **cerebellum** (4.1.1e). The **temporal lobe** (4.1.1a) is the lateral portion of each hemisphere and is located near the temples. It is the primary target for auditory information, so is essential for understanding spoken language. It is involved in advanced visual processing and plays a part in emotional and motivational behaviours. The **occipital lobe** (4.1.1b) is located at the back of the brain and is the main target for visual information. The **frontal lobe** (4.1.1c) is located at the front of the brain and contains the primary motor cortex and the pre-frontal cortex. The frontal lobe is mainly involved in planning of movements, recent memory, and some aspects of emotion such as aggression. It is said to be crucial for planning and controlling thoughts and behaviour. The **parietal lobe** (4.1.1d) is located at the top of the brain between the frontal lobe and occipital lobe. It is responsible for bodily sensations and monitors all the information about eye, head and body positions before passing it on to the brain areas that control movement. The **cerebellum** (4.1.1e) is a large hindbrain structure located below the occipital lobe. It contributes to the control of movement and is important for balance and coordination.

Knowledge and understanding of the brain regions specified in 4.1.1 could be complimented by 1.1.1 where candidates need to understand early brain development, including the development of the forebrain (1.1.1a), midbrain (1.1.1b), hindbrain (1.1.1c), cerebellum (1.1.1d) and medulla (1.1.1e).

Application of the structure and function of the brain to stimulus materials would benefit candidates. Centres could develop scenarios and examples from which candidates can identify the key functions of the parts of the brain that are evident.

Kunal has damaged his cerebellum in a cycling accident. How might Kunal's behaviour be different to before the accident?

Kunal has been for a brain scan and the doctor tells him that he has damaged his frontal lobe. What functions is the frontal lobe responsible for?

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4.1.2 Understand the lateralisation of function in the hemispheres, including:
- **a. asymmetrical function**
- **b. role of the left hemisphere**
- **c. role of the right hemisphere**
- **d. role of the corpus callosum**
- **e. strengths and weaknesses of lateralisation as an explanation of sex differences between males and females**

Candidates need to understand the **lateralisation of function** (4.1.2) in the brain, which is the idea that the two hemispheres of the brain divide specialism of function. Candidates need to know that there is **asymmetrical function** (4.1.2a), which is where the right hemisphere controls the left side of the body and vice versa. The **left hemisphere** (4.1.2b) is specialised for language and the **right hemisphere** (4.1.2c) is specialised for spatial tasks such as recognising faces and recognising emotions in others. Whilst there is a division of labour between the hemispheres, they work together primarily via the **corpus callosum** (4.1.2d), which is one of the main bundles of fibres carrying information between the hemispheres.

Candidates need to be aware of **how lateralisation could explain sex differences in males and females, and the strengths and weakness of this explanation** (4.1.2e). Females appear to show less brain lateralisation for language abilities and more bilateral activity compared to males, who appear to show greater lateralisation on language and spatial tasks. Evaluation of lateralisation can be done through evidence such as that of **Sperry (1968)** (4.2.2), or other studies showing possible lateralisation in brain function such as studies of split-brain patients. Strengths and weaknesses can focus on sex differences, with evidence supporting or refuting any brain function disparities in males and females.

Application of the lateralisation of function in the hemispheres to stimulus materials would benefit candidates. Centres could develop scenarios and examples from which candidates can identify the role of the hemispheres evident in the scenario and offer strengths and weaknesses where relevant.

Kunal has damaged his left hemisphere. What tasks might Kunal struggle with?

4.1.3 Know what neurons and synapses are, including:
- **a. function of neurotransmitters**
- **b. synaptic functioning**
- **c. how neurons and synapses interact**
- **d. the role of the central nervous system**

Candidates need to know how to **define a neuron and a synapse**, and then be able to explain how they **interact** (4.1.3c). Candidates may find it useful to use diagrams and videos to see animations and modelled representations of the process of **synaptic functioning** (4.1.3b), involving the communication between the neurons using **neurotransmitters** (4.1.3a). Candidates may want to draw diagrams of each stage of the process and then look at some examples of neurotransmitters. It may be helpful to candidates to show how neurons and synapses affect human behaviour, using appropriate and suitable examples. Candidates need to understand the **role of the central nervous system** (4.1.3d) which could be delivered through pertinent examples, although they would not be expected to have a detailed understanding at this level. Those delivering the qualification should be encouraged to give candidates lots of applied examples to enhance their understanding of the concepts.

Application of the central nervous system to stimulus materials would benefit candidates. Centres could develop scenarios and examples from which candidates can identify the

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functions of neurotransmitters, synaptic functioning and the role of the central nervous system evident in the scenario.

Kunal takes some drugs. He feels happy and relaxed at first but later feels terrible. How could his central nervous system have been affected by the drugs?

4.1.4 Understand the impact of neurological damage on cognitions and behaviour, including:

- **a. the term 'visual agnosia'**
- **b. the term 'prosopagnosia'**
- **c. the symptoms of visual agnosia**
- **d. the symptoms of prosopagnosia**
- **e. the impact of damage to the pre-frontal cortex**

Candidates need to understand the **impact of neurological damage on cognitions and behaviour** (4.1.4). The conditions **visual agnosia** (4.1.4a, c) and **prosopagnosia** (4.1.4b, d) need to be understood in terms of their definition and their symptoms.

Visual agnosia (4.1.4a, c) is the inability to recognise a visual stimulus despite being able to see and describe it. Patients suffering from visual agnosia cannot recognise what they see and this is usually caused by damage to the **occipital lobe** (4.1.1b) or the rearmost part of the **parietal lobe** (4.1.1d). A patient with visual agnosia can often describe an object in terms of its shape, colour and texture but cannot recognise the object.

Prosopagnosia (4.1.4b, d) is a special type of agnosia and is the inability to recognise faces of familiar people, while other aspects of visual processing and intellectual functioning remain intact. Patients with prosopagnosia can read and recognise people's voices but their problem relates specifically to faces.

Centres may wish to give candidates case studies of people who have suffered with **visual agnosia** (4.1.4a, c) or **prosopagnosia** (4.1.4b, d) to aid their understanding. An example could be Dr. P. who was described by Oliver Sacks as 'The Man who Mistook his Wife for a Hat'.

Candidates need to understand the **impact of damage to the pre-frontal cortex** (4.1.4e). Emotional blunting can occur and there can be impaired decision-making with impulsive behaviours that can lead to outbursts of anger. The case of Phineas Gage (4.2.1) could be used to aid candidate's understanding of the **impact of neurological damage to the pre-frontal cortex** (4.1.4e).

Application of these concepts to stimulus materials would benefit candidates. Centres could develop scenarios and examples from which candidates can identify the damage suffered by an individual before explaining how it could affect their abilities and behaviour.

Kunal has visual agnosia. How might the condition affect Kunal?

Kunal has damaged his pre-frontal cortex in a motorbike accident. How might the damage affect Kunal?

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4.2 Studies

Candidates should understand the aims, procedures and findings (results and conclusions), and strengths and weaknesses of:

4.2.1 Damasio et al. (1994) The Return of Phineas Gage: Clues About the Brain from the Skull of a Famous Patient

4.2.2 Sperry (1968) Hemisphere Deconnection and Unity in Conscious Awareness

Study One

Damasio et al. (1994) The Return of Phineas Gage: Clues About the Brain from the Skull of a Famous Patient.

Background
In 1848, a 25-year-old construction worker called Phineas Gage was involved in an accident. He worked for a railroad company in the USA and was responsible for detonations to level uneven terrain so that they could lay new rail tracks. To carry out this task, a tamping iron would be used to prepare the ground for the detonation. A tamping iron is a 109 cm-long, 3 cm-thick fine-pointed iron rod. One day, Phineas Gage was distracted when preparing the ground for detonation and a powerful explosion sent the tamping iron through his face, skull and brain and then into the sky. Somehow Gage survived the accident, but changes to his character and behaviour suggested that the accident had had a long-lasting effect on him.

After the accident, Phineas Gage had no impairment of movement or speech and new learning was intact. His memory and intelligence appeared unaffected. However, he had become disrespectful and impulsive, and less responsible.

Aim(s)
To identify the location of damage in Phineas Gage using modern neuroimaging techniques.

The researchers also wanted to see if the proposed location of damage and Phineas Gage's reported changes were similar to other case studies, which may give more information about the function of certain parts of the brain.

Procedure
Initially, the researchers located Phineas Gage's skull and the tamping iron, which were being kept in a museum in the USA. They then performed a number of procedures to try to identify the location of damage in the brain and the trajectory that the tamping iron took as it went through Phineas Gage's head. This included:

- taking x-rays of the skull
- taking precise measurements of the skull
- deforming a 3D reconstruction of a human skull so that it matched Phineas Gage's skull
- using a coordinate system (Talairach's stereotactic space) to map out both skulls
- determining the likely trajectory and therefore entry points of the iron rod (20 points in total)
- narrowing down the possible trajectories using reports from the time and more recent research to five possibilities, which were modelled on a 3D reconstruction of a human brain that closely fit Phineas Gage's assumed brain dimensions.

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Results

One of the five acceptable trajectories appeared to be the best fit. This suggested that:

- all of the damage occurred in the frontal lobes
- Broca's area was undamaged (Broca's area is linked to language ability)
- the motor cortices were undamaged
- the ventromedial region of both frontal lobes were damaged, whilst sparing the dorsolateral region.

The researchers had studied other patients with brain damage in the regions that the iron rod had supposedly damaged in Phineas Gage. They stated that 12 of these patients had similar impairments in function to Phineas Gage, which they use as support for their proposed trajectory of the iron rod.

The patients and Phineas Gage had similarities in the following areas:

- They had difficulty making rational decisions about personal and social matters and in the processing of emotions.
- Their abilities to tackle abstract problems, perform calculations, and recall and attend to appropriate knowledge remained intact.

The researchers suggested that it is the dorsolateral region which is involved with the intact abilities, with the ventromedial region responsible for the abilities that Phineas Gage (and the other patients) had difficulties with.

Conclusions

The researchers concluded one proposed trajectory of the iron rod which was 'most likely' when compared to those with normal brains and those with damaged brains.

They hypothesised from this that the ventromedial frontal region was involved in emotion and the underlying 'neural machinery' that participates in decision making (and therefore that if this area was damaged then emotional regulation and decision-making would be compromised).

They also cited research with monkeys to support their conclusions – monkeys with a high concentration of serotonin (a neurotransmitter) receptors in the ventromedial area were socially adapted whereas those with low concentration were aggressive and socially uncooperative.

Candidates may be asked to consider the following issues when **evaluating** studies:

- validity
- reliability
- generalisability
- ethics
- objectivity
- subjectivity.

Information for centres

It is recommended that, wherever possible, centres combine the use of the summary of studies resource with the original study. However, where studies are not freely available or easily accessible, the summary resource is designed to help provide key starting points to enable teachers to deliver the content.

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Study Two

Sperry (1968) Hemisphere Deconnection and Unity in Conscious Awareness.

Background
Sperry reports on a number of patients who suffered from severe epilepsy that had led to them experiencing frequent debilitating seizures. They had undergone surgery for this that involved severing the corpus callosum and therefore separating the hemispheres. The surgery appeared to be successful, with all patients either experiencing no further seizures or some (two) suffering less frequently and severely than beforehand. Furthermore, the personality and cognitive-processing capacity was left relatively unchanged. There were some problems with short-term memory and concentration span but no impairments in intelligence.

The patients are called 'split-brain' patients as the two halves of their brains had effectively been split so that they could not communicate with one another anymore. Sperry reports in the study on the 'functional outcome' – or the behavioural, neurological and psychological effects the surgical disruption caused to the patients.

Aim(s)
To find out the cognitive functions that are linked to each hemisphere in the brain. The experiments aimed to assess the behavioural, neurological and psychological effects of the split-brain surgery on the patients.

Procedure
Sperry reports on 11 patients who had undergone surgery for severe epilepsy. Nine had surgery recently whereas two had surgery some time before and had an excellent recovery.

Sperry used a piece of apparatus that allowed testing of the right and left halves of the visual field separately or together (and the right and left hands and legs with the vision excluded).

Task 1 procedure
Sperry asked patients to fix their eye gaze on a particular spot and then projected words or pictures for 1/10th of a second (too fast for eye movements). This way he could be sure that the information only entered either the left or right hemisphere. The patient then had to feel for a particular object (hidden amongst others) behind a screen to identify what they had apparently seen with their eyes.

Task 2 procedure
In another test, Sperry asked patients to pick an item from a bag and name the object (without seeing it).

Task 3 procedure
Sperry showed a picture of a wall clock to the patient's right hemisphere (Sperry called this the 'minor hemisphere') and asked them to pick the object closest to what they had seen with their left hand.

Task 4 procedure
A sum was shown to the right hemisphere and patients were asked to use their left hand to point to what they thought was the correct answer to the sum.

Task 5 procedure
A picture of a nude was presented to the right hemisphere to see what the reaction would be.

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Task 6 procedure
Patients performed block design tests – a type of spatial task (this was described as 'work in progress').

Result(s)

Task 1 results
Sperry projected the words 'KEY' (left) and 'CASE' (right) and asked patients to identify the object they saw on each side. The patients could say 'case' and write it as normal, but reported not seeing anything to the left side. However, if asked to select the item they saw to the left with their left hand, they could choose the key correctly from either the items behind the screen or from an array of images. This indicated that the left visual field was being processed by the right hemisphere and the left hand by the right hemisphere, and vice versa.

Task 2 results
If patients used their right hand they could name the object with ease. If they used their left hand they were unable to name it, but were able to retrieve it from a grab bag (provided that the left hand was used).

Task 3 results
Patients were able to pick a wristwatch with their left hand. On another test they connected a 'piece of silverware' with a fork. This showed the limited language processing ability in the right hemisphere.

Task 4 results
Patients' left hands could point to the correct answer. This demonstrated that the right hemisphere was involved in basic calculations.

Task 5 results
The picture of a nude would produce blushing or giggling, with no report verbally of having seen the image. This demonstrated that the right hemisphere was involved in emotional processing.

Task 6 results
The right hemisphere was judged to be superior to the left hemisphere in tasks involving drawing spatial relationships and performing block design tests.

Conclusions
The left hemisphere was the primary hemisphere for the processing of language (although Sperry showed limited language processing in the right too).

The right hemisphere was able to read words (which enabled the patients to recognise objects), make mental associations, process emotional reactions and solve simple arithmetic, and was better than the left hemisphere at spatial skills.

Candidates may be asked to consider the following issues when **evaluating** studies:
- validity
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- ethics
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Information for centres

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4.3 Issues and debates

4.3.1 Understand how psychology has changed over time, including:

- **the use of content, theories and research drawn from studying the brain to explain how psychology has changed over time**

The issues and debates content in each compulsory topic, including research methods, is designed to enable candidates to understand the wider issues in psychology that underpin psychological knowledge and research. These are delivered within specific topic content. Candidates can, however, draw upon issues and debates in their evaluations and extended open essays across each topic area (compulsory and/or optional), and while this is not an expected feature of responses, it may – if appropriate, accurate and relevant – be creditworthy in examinations. For example, if they chose to evaluate the lateralisation of brain function by comparing research over time then this can be an acceptable response.

Issues and debates will be specifically assessed in Paper 1 through an extended open-response question.

The synoptic element included for topic 4 (the brain and neuropsychology) is for candidates to develop an understanding of how psychology has changed over time. Candidates could look at how explanations and research over time have informed knowledge of psychological concepts.

In topic 4, the use of content, theories and research drawn from studying the brain can be used to explain how psychology has changed over time.

Candidates could use the case of Phineas Gage and compare the original ideas of his deficits to the more recent findings from **Damasio et al. (1994)** (4.2.1). They could also include more recent research regarding Phineas Gage, such as that of Ratiu et al. (2004) and Van Horn et al. (2012).

Candidates could consider how knowledge of the **areas of the brain** (4.1.1) has been informed by research carried out over time with case studies of brain-damaged patients. The technological advances in techniques over time could also be considered, with the invention of EEG, brain scanning and more recently the procedures used in **Damasio et al. (1994)** (4.2.1).

Understanding **brain lateralisation** (4.1.2) over time could be considered by exploring how Sperry's ideas of lateralised function in the 1960s were built upon by more recent research into sex differences. For example, since Sperry's seminal work on lateralisation published in 1968, studies such as McGlone (1980), Voyer et al. (1995) and Bourne et al. (2010) investigated lateralisation specifically related to sex differences.

The use of different cases over time has also helped inform psychology about the impact of neurological damage, such as that of **prosopagnosia** (4.1.4b, d). Case studies from different time periods of patients who have experienced neurological damage could be examined to judge how knowledge has increased over time; for example, Bodamer's cases in the 1940s and the proposal of the term 'face-blindness' by Choisser in 1996–1997.

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Resources and references

Studies

4.2.1 Damasio et al. (1994) The Return of Phineas Gage: Clues About the Brain from the Skull of a Famous Patient

https://www.ncbi.nlm.nih.gov/pubmed/8178168

http://web.missouri.edu/~segerti/1000H/gage.pdf

https://www.researchgate.net/publication/15021430_The_Return_of_Phineas_Gage_Clues_About_the_Brain_from_the_Skull_of_a_Famous_Patient

4.2.2 Sperry (1968) Hemisphere Deconnection and Unity in Conscious Awareness

http://psycnet.apa.org/psycinfo/1969-07214-001

http://holah.co.uk/files/Sperry1968.pdf

http://people.uncw.edu/Puente/sperry/sperrypapers/60s/135-1968.pdf

Research into the brain and neuropsychology

Sources suggested here are additional guidance for centres to aid with teaching resources and ideas. These are not compulsory components and centres should select delivery content as appropriate to their candidates. Centres can draw upon any research evidence to support evaluations and explanations of topic areas. This list is not exhaustive.

Structure and function of the brain

http://www.livescience.com/29365-human-brain.html

https://www.mayfieldclinic.com/PE-AnatBrain.htm

http://humanbrainfacts.org/basic-structure-and-function-of-human-brain.php

Lateralisation of function in the hemispheres

http://www.holah.karoo.net/sperrystudy.htm

http://www.rightleftrightwrong.com/brain.html

http://course.sol.lu.se/FON218/Postrar_neurolingvistik_VT07/Frida_Maartensson.pdf

Neurons and synapses

http://www.bbc.co.uk/schools/gcsebitesize/science/add_ocr_pre_2011/brain_mind/informationrev2.shtml

http://www.bbc.co.uk/schools/gcsebitesize/science/add_ocr_21c/brain_mind/nervoussystemrev1.shtml

http://con-news.com/picalsd/neurons-and-synapses

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Teacher resource sharing

Further suggested resources can be found in the 'Getting Started' publication, where a scheme of work has been provided.

http://www.psychlotron.org.uk
http://www.psychteacher.co.uk
http://www.resourcd.com

Teacher and student resource sites

http://www.simplypsychology.org/ – this website gives an overview of many of the key areas.

https://www.psychologytoday.com/ – this is an online magazine (with an option to subscribe) that brings psychological theories into modern, contemporary issues.

https://play.google.com/store/search?q=psychology%20free%20books&c=books&hl=en – this site has a number of free short books about key areas of psychology.

http://www.open.edu/openlearn/body-mind/psychology – the 'OpenLearn' programme offers freely accessible resources provided by the Open University.

http://allpsych.com/ – a useful site with books, articles and summaries of some of the key concepts.

https://www.youtube.com/playlist?list=PL8dPuuaLjXtOPRKzVLY0jJY-uHOH9KVU6 – Psychology 'Crash Course' is a YouTube channel that provides 40 short overviews of psychological issues.

http://www.bbc.co.uk/programmes/b008cy1j – 'BBC Mind Changers' is a series of radio episodes (that can also be downloaded) about key psychologists, their work and the development of psychology over time.

http://www.bbc.co.uk/programmes/b006qxx9 – 'BBC In the Mind' is a series of radio episodes that focus on the human mind using the application of psychological concepts and theories.

**All weblinks included here have been checked as active at publication, however the nature of online resources is that they can be removed or replaced by webhosting services and so it cannot be guaranteed that these sites will remain available throughout the life of the qualification.*

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