PSY.BIO5 Localisation of Function and Hemispheric Lateralisation

Total Marks

AQA 7182 · Calculators not allowed · about 70 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 A simple labelled sagittal diagram of the left cerebral hemisphere is printed below for a student to label. The diagram shows the frontal, parietal, temporal and occipital cortical areas with boxes marking four small regions on the lateral surface near the Sylvian fissure and precentral/postcentral gyri. Label the four numbered boxes with the correct brain region from this list: motor cortex, somatosensory cortex, Broca's area, Wernicke's area.

Label the four numbered boxes on the lateral surface of the left cerebral hemisphere with the correct region: motor cortex, somatosensory cortex, Broca's area, Wernicke's area.

(Total for Question 1 is 3 marks)

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2 Describe the primary function of the motor cortex in the frontal lobe as taught in the localisation of function topic.

(Total for Question 2 is 2 marks)

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3 Outline the primary role of the somatosensory cortex in the parietal lobe within the cortical localisation framework.

(Total for Question 3 is 2 marks)

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4 State where the primary visual cortex is located when discussing localisation of function, and give one brief description of its role in vision.

(Total for Question 4 is 3 marks)

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5 Outline the location and one function of the primary auditory cortex in the temporal lobe as part of cortical localisation.

(Total for Question 5 is 3 marks)

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6 Outline the role of Broca's area in language and describe the typical symptoms of Broca's aphasia as used in localisation of function.

(Total for Question 6 is 3 marks)

7 Outline the role of Wernicke's area in language and describe the typical symptoms of Wernicke's aphasia as used in localisation of function.

(Total for Question 7 is 3 marks)

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8 Explain two differences between Broca's aphasia and Wernicke's aphasia, referring to speech fluency, comprehension and typical localisation.

(Total for Question 8 is 4 marks)

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9 Outline the method used by Sperry in his split-brain research to investigate hemispheric lateralisation. Include how visual field presentation and callosotomy patients were used.

(Total for Question 9 is 4 marks)

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10 State two key findings from Sperry's split-brain experiments about hemispheric differences in language and non-verbal processing.

(Total for Question 10 is 3 marks)

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11 A split-brain patient is shown the word 'KEY' in the left visual field and the word 'PEN' in the right visual field simultaneously. The patient is asked to name what they saw, and separately asked to pick up the corresponding object by touch with their left hand from a bag. Predict the likely responses and explain how this illustrates hemispheric lateralisation.

(Total for Question 11 is 4 marks)

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12 Give one strength and one limitation of using split-brain research as evidence for localisation of function. Each point should be briefly justified.

(Total for Question 12 is 4 marks)

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13 Discuss localisation of function in the cortex. In your answer, refer to split-brain evidence supporting localisation and to case-study evidence that challenges a strict localisation view. Make reasoned judgements about the extent to which the evidence supports localisation of function.

(Total for Question 13 is 12 marks)

Mark scheme · PSY.BIO5 Localisation of Function and Hemispheric Lateralisation

Question 1

- **B1** one correct label, any one of: motor cortex cao
- **B1** one correct label, any one of: somatosensory cortex cao
- **B1** one correct label, any one of: Broca's area or Wernicke's area cao
- **Answer: Any three correctly placed labels from: motor cortex; somatosensory cortex; Broca's area; Wernicke's area.**

Question 2

- **M1** states that the motor cortex controls voluntary movement of skeletal muscles cao
- **A1** refers to somatotopic organisation or the motor homunculus oe
- **Answer: The motor cortex controls voluntary movement of skeletal muscles; it is organised somatotopically so different cortical areas control different body parts.**

Question 3

- **B1** states it processes sensory information from the body such as touch, pressure, pain and temperature cao
- **B1** may mention somatotopic mapping or that areas with greater sensitivity have larger cortical representation oe
- **Answer: Processes bodily sensory information such as touch, pressure, pain and temperature; organised somatotopically, with more cortex for more sensitive body parts.**

Question 4

- **M1** location: primary visual cortex in the occipital lobe, around the calcarine sulcus cao
- **A1** role: initial cortical processing of visual information from the retina, including basic features such as orientation and contrast oe
- **A1** may mention contralateral representation of visual fields oe
- **Answer: Primary visual cortex is in the occipital lobe around the calcarine sulcus; it performs initial cortical processing of visual input, analysing basic features and receiving contralateral visual field information.**

Question 5

- **M1** location: primary auditory cortex in the superior temporal gyrus of the temporal lobe cao
- **A1** function: basic processing of auditory information such as pitch and volume oe
- **A1** may mention that auditory input is received from both ears, with some contralateral bias oe
- **Answer: Primary auditory cortex is in the superior temporal gyrus of the temporal lobe; it processes basic auditory features such as pitch and volume and receives input from both ears.**

Question 6

- **M1** states Broca's area is involved in speech production and the planning of articulate speech cao
- **A1** describes Broca's aphasia: non-fluent, effortful speech with relatively preserved comprehension oe
- **A1** may mention location in left frontal lobe, typically in the inferior frontal gyrus oe
- **Answer: Broca's area, in the left inferior frontal gyrus, is involved in speech production; Broca's aphasia produces non-fluent, effortful speech while comprehension is relatively preserved.**

Question 7

- **M1** states Wernicke's area is involved in language comprehension, understanding spoken and written language cao
- **A1** describes Wernicke's aphasia: fluent but often meaningless speech, with impaired comprehension oe
- **A1** may mention location in the left temporal lobe, typically the superior temporal gyrus posterior region oe
- **Answer: Wernicke's area, in the posterior left temporal lobe, is involved in language comprehension; Wernicke's aphasia produces fluent but often nonsensical speech with poor comprehension.**

Question 8

- **M1** difference 1: Broca's aphasia is non-fluent, Wernicke's aphasia is fluent oe
- **A1** explains why: Broca's affects speech production mechanisms in the left frontal area, making speech effortful; Wernicke's affects posterior temporal areas involved in language formulation oe
- **M1** difference 2: comprehension is relatively preserved in Broca's aphasia but impaired in Wernicke's aphasia oe
- **A1** explains why: Broca's area damage leaves comprehension networks less affected, while Wernicke's area damage disrupts comprehension processing oe
- **Answer: Broca's aphasia is non-fluent and effortful with relatively preserved comprehension, linked to left frontal damage; Wernicke's aphasia is fluent but often meaningless with poor comprehension, linked to posterior left temporal damage.**

Question 9

- **M1** identifies split-brain patients (callosotomy) who had their corpus callosum severed to reduce epileptic seizures oe
- **M1** describes presenting stimuli briefly to left or right visual field so information initially reaches the opposite hemisphere oe
- **A1** states that verbal naming of objects presented to the right visual field (left hemisphere) was usually successful, while naming objects presented to the left visual field (right hemisphere) was impaired oe
- **A1** may mention recognition by touch or drawing with the left hand for right-hemisphere input, showing different abilities between hemispheres oe
- **Answer: Sperry tested callosotomy patients by presenting images or words briefly to the left or right visual field so only one hemisphere initially received the input; the left hemisphere could name right-field stimuli but the right hemisphere could not name left-field stimuli, though it could often recognise or draw items via the left hand.**

Question 10

- **B1** finding 1: left hemisphere (right visual field) can name and verbally identify objects cao
- **B1** finding 2: right hemisphere (left visual field) has difficulty naming verbally but can recognise or select the object by touch or draw it with the left hand cao
- **B1** finding 3: the two hemispheres can process information independently after the corpus callosum is cut, producing dissociations in ability cao
- **Answer: Left hemisphere can name and verbally identify stimuli from the right visual field; right hemisphere cannot name left-field stimuli but can recognise or draw them non-verbally; the hemispheres can act independently after callosotomy.**

Question 11

- **M1** predicts that the patient will name 'PEN' only, because the right visual field projects to the left hemisphere which controls speech oe
- **A1** predicts that the patient will be able to pick up the key with the left hand by touch, because the left hand is controlled by the right hemisphere which received the 'KEY' input oe
- **M1** explains this shows language functions are lateralised to the left hemisphere and non-verbal recognition or tactile-guided action can be supported by the right hemisphere oe
- **A1** links to split-brain: without the corpus callosum the right hemisphere's information cannot be named verbally, illustrating functional separation of hemispheres oe
- **Answer: The patient will likely name 'PEN' (right visual field to left hemisphere) but will pick up the key with the left hand when asked by touch; this demonstrates left-hemisphere language dominance and right-hemisphere non-verbal/tactile abilities, made evident by the severed callosal connection.**

Question 12

- **M1** strength: split-brain research provides clear, causal evidence of hemispheric specialisation because the corpus callosum severing isolates processing, allowing direct comparison of hemisphere abilities oe
- **A1** justification: the dissociation between naming and non-verbal recognition is strong support for localisation of language to the left hemisphere oe
- **M1** limitation: split-brain patients are an unusual, clinical population which may limit generalisability to the intact brain oe
- **A1** justification: effects observed in these patients may result from compensatory reorganisation or surgical and pathological history, so findings may not reflect normal brain organisation fully oe
- **Answer: Strength: split-brain studies give strong causal dissociations showing hemispheric specialisation, for example language naming vs non-verbal recognition. Limitation: split-brain patients are atypical clinical cases, so results may not generalise to the intact population and may be influenced by surgery or reorganisation.**

Question 13

- **Level 4** (10-12): Detailed and accurate knowledge of localisation of function is shown. Arguments for and against localisation are evaluated thoroughly and interactively, including clear consideration of split-brain support and case-study challenges. Discussion is balanced and reaches a reasoned conclusion about the extent of localisation. Specialist terminology is used effectively throughout.
- **Level 3** (7-9): Good knowledge of localisation with several accurate points. Evaluation includes both supporting and challenging evidence with some development. Split-brain and case-study evidence are used, though links may be less developed. Conclusion is present but may be less assured. Terminology is used appropriately.
- **Level 2** (4-6): Basic knowledge of localisation is present. Evaluation is limited or one-sided. Some evidence is used but may be described rather than evaluated. Application of split-brain or case studies is attempted but lacks depth. Answer may be partially organised.
- **Level 1** (1-3): Little relevant knowledge. Evaluation is minimal or absent. Answer may be a list of unconnected points with inaccuracies. Little or no use of relevant evidence.
- **Level 0** (0): No creditworthy content.
- **Indicative content:**
  - AO1 content: Localisation of function claims specific cortical areas are specialised for particular functions, for example motor cortex for voluntary movement, somatosensory cortex for bodily sensation, primary visual cortex in occipital lobe for early visual processing, primary auditory cortex in temporal lobe for basic auditory processing, Broca's area for speech production and Wernicke's area for language comprehension.
  - AO1 content: Hemispheric lateralisation is part of localisation claims, with language typically lateralised to the left hemisphere in right-handed individuals.
  - AO3 support: Sperry's split-brain research shows clear dissociations, such as the left hemisphere being able to name right-field stimuli while the right hemisphere can recognise but not name left-field stimuli, providing causal evidence for specialised functions in different hemispheres.
  - AO3 support: Clinical lesion studies and neurosurgical cases, including classic Broca and Wernicke patient reports, link damage to specific cortical regions with predictable deficits, supporting localisation.
  - AO3 challenge: Case studies exist that challenge strict localisation, for example patients with extensive damage to presumed critical areas who retain some functions, suggesting distributed processing or redundancy; some language recovery and plasticity observations imply functions are not completely fixed to one small region.
  - AO3 challenge: Complexity of tasks such as language and perception often involves networks of regions and interconnections rather than a single cortical spot, so modern views often favour local specialisation within broader distributed networks.
  - AO3 methodological considerations: Split-brain and lesion studies provide strong causal inferences but may have low generalisability; case studies are rich and detailed but are not controlled and may reflect individual variation or compensatory reorganisation.
  - AO3 synthesis and judgement: Conclude that while substantial evidence supports local specialisation for many basic functions and for lateralised language, higher cognitive functions are likely supported by interacting networks; localisation is a useful and broadly accurate model for many cortical functions, but it should be viewed alongside network and connectivity explanations rather than as an absolute, strictly modular account.