6.8 Ways of Studying the Brain: Scanning Techniques and EEG: 30-minute Pack

AQA 7182 · about 30 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer all questions. Full-sentence answers required for extended questions and any question worth 3 marks or more. Allow about 30 minutes for the whole pack.

1 Outline what an event-related potential (ERP) is in brain research and briefly explain how ERPs are obtained from EEG data.

(Total for Question 1 is 3 marks)

2 Outline one strength of using post-mortem brain studies in investigating neurological disorders, as used in brain research.

(Total for Question 2 is 2 marks)

3 Outline how functional magnetic resonance imaging (fMRI) is used to study brain activity, naming what fMRI measures as a proxy for neural activity.

(Total for Question 3 is 3 marks)

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4 State one limitation of fMRI in studying brain function, referring to either temporal resolution or practical constraints in a research setting.

(Total for Question 4 is 3 marks)

5 Complete the strengths and weaknesses comparison task: using fMRI and EEG as methods of studying the brain, give two strengths of fMRI and two weaknesses of EEG. Refer to resolution, invasiveness, or practicality as appropriate.

(Total for Question 5 is 6 marks)

6 Compare fMRI and EEG as methods for studying brain activity. In your answer, describe key features of each technique and evaluate their relative strengths and limitations for cognitive neuroscience research.

(Total for Question 6 is 8 marks)

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Mark scheme · 6.8 Ways of Studying the Brain: Scanning Techniques and EEG: 30-minute Pack

Question 1

defines an ERP as a time-locked electrical response linked to a specific stimulus or event recorded from the scalp oe	**M1**
explains that ERPs are obtained by averaging EEG segments time-locked to repeated presentations of the same stimulus to isolate the stimulus-related signal from background noise oe	**A1**
may mention that particular ERP components are associated with cognitive processes such as attention or error detection oe	**A1**

Answer: An ERP is a stimulus-locked electrical response recorded from the scalp. ERPs are obtained by averaging EEG epochs time-locked to repeated stimuli, which isolates the event-related signal from background EEG noise and reveals components linked to cognitive processes.

Question 2

states a plausible strength, e.g. allows direct examination of brain structures and identification of physical damage or pathology oe	**B1**
explains why this is useful, e.g. can reveal anatomical or neurochemical abnormalities not detectable with non-invasive scans oe	**B1**

Answer: Strength: allows direct examination of brain structures to identify lesions or neurochemical abnormalities, which can reveal physical causes of disorder that non-invasive methods might miss.

Question 3

states that fMRI measures changes in blood oxygenation and flow as an indirect marker of neural activity (the BOLD response) oe	**M1**
explains that participants complete tasks while the scanner records where blood oxygenation increases, indicating active brain regions oe	**A1**
mentions that the technique produces a series of 3D images showing localisation of activity over the brain oe	**A1**

Answer: fMRI measures changes in blood oxygenation and flow, the BOLD response, as a proxy for neural activity. Participants perform tasks in the scanner while 3D images show which brain regions show increased blood oxygenation and are therefore active.

Question 4

identifies a limitation, e.g. poor temporal resolution compared with electrophysiological methods oe	**M1**
explains why this matters, e.g. the BOLD response is delayed and slow, so fMRI cannot track rapid neural processing in milliseconds oe	**A1**
or mentions practical limits such as high cost and the need for participants to remain still in a scanner oe	**A1**

Answer: Limitation: fMRI has poor temporal resolution because the BOLD response is delayed and slow, so it cannot resolve neural events on the millisecond timescale. It is also expensive and requires participants to remain still inside the scanner.

Question 5

gives one correct strength of fMRI such as high spatial resolution or non-invasive functional localisation oe	**M1**
gives a second correct strength of fMRI such as ability to produce 3D brain maps useful for research and clinical planning, or sensitivity to subcortical structures oe	**A1**
gives one correct weakness of EEG such as poor spatial resolution or inability to localise deep sources precisely oe	**M1**
explains that the skull and scalp smear signals, reducing localisation accuracy oe	**A1**
gives a second correct weakness of EEG such as susceptibility to artefacts from muscle or eye movements, or limited use for deep-brain activity oe	**M1**
briefly explains practical consequence, e.g. need for careful preprocessing and restricted experimental tasks to reduce artefacts oe	**A1**

Answer: Two strengths of fMRI: 1) high spatial resolution allowing precise 3D localisation of active cortical and some subcortical regions; 2) non-invasive functional mapping that is useful for research and clinical planning. Two weaknesses of EEG: 1) poor spatial resolution so it cannot precisely localise deep or closely spaced sources because signals are smeared by the skull and scalp; 2) EEG is susceptible to artefacts from muscle and eye movements, requiring careful preprocessing and limiting some experimental setups.

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Question 6

Level 2 Good knowledge and understanding of fMRI and EEG is shown, with clear description of how each technique measures brain activity. The evaluation is well developed and considers several relevant strengths and limitations, including spatial and temporal resolution, invasiveness and practical constraints, and applies these points to suitability for different research questions. Examples or applications are used and explained. Specialist terms are used accurately. **5-8**

Level 1 Basic knowledge of fMRI and EEG with limited description. Evaluation is present but superficial, mentioning one or two strengths or weaknesses without development. Limited application to research questions and few or no examples. Answer may be partly descriptive or list-like. **1-4**

Level 0 No creditworthy content. **0**

Indicative content:

- AO1: fMRI measures changes in blood oxygenation and flow (BOLD response) as an indirect measure of neural activity and produces high-resolution 3D images of active brain regions.
- AO1: EEG records electrical activity via electrodes on the scalp, measuring voltage changes over time produced by synchronous neuronal firing, producing waveforms with excellent temporal resolution.
- AO3: fMRI strength - high spatial resolution allows precise localisation of cortical and some subcortical activity, useful for mapping brain areas involved in cognitive tasks and for clinical planning.
- AO3: fMRI limitation - poor temporal resolution because the haemodynamic response is delayed and sluggish, so it cannot resolve rapid neural events; it is also expensive and requires participants to remain still, which restricts some designs.
- AO3: EEG strength - excellent temporal resolution (millisecond-level) makes it ideal for studying the time-course of sensory and cognitive processing and for event-related potentials when time-locked responses are needed.
- AO3: EEG limitation - poor spatial resolution and difficulty localising deep sources; susceptible to artefacts from muscle movements and eye blinks, requiring careful preprocessing.
- AO3: Suitability - fMRI is well suited to questions about localisation and which brain structures are involved; EEG is better for questions about timing of processing or rapid neural dynamics and for paradigms like ERP that isolate cognitive components.
- AO3: Combined approaches - using EEG and fMRI together or using ERPs derived from EEG can provide complementary information, offsetting weaknesses of each method; practical considerations and research aims determine the appropriate choice.

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