NeuroTrace Study Guide

Domain: Domain I – Basic Concepts & Principles
Section: Neuroanatomy for EEG Localization
Style: Spatial, applied, ABRET-focused

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1. Core Principles (Must Know)

EEG Reflects Superficial Cortical Activity

- **EEG reflects superficial cortical activity:** Surface recording
- EEG records from cortical surface
- Deep structures are poorly represented
- Scalp EEG is surface-limited
- Must understand this limitation

Localization Is Approximate, Not Exact

- **Localization is approximate, not exact:** Regional, not pinpoint
- EEG localizes to regions, not exact points
- Multiple electrodes may be involved
- Spread of activity is common
- Cannot pinpoint exact location

Anatomy Must Be Interpreted Alongside EEG Patterns

- **Anatomy must be interpreted alongside EEG patterns:** Context matters
- EEG findings need anatomical context
- Clinical correlation is essential
- Patterns guide interpretation
- Cannot interpret in isolation

Key Principle

- **EEG localization is regional, not anatomical pinpointing**
- Regional localization is the goal
- Exact anatomical pinpointing is not possible
- Must understand limitations
- Apply cautiously

Practical Application

- Use regional terms (frontal, temporal, etc.)
- Avoid overprecise localization
- Understand EEG limitations
- Apply anatomy contextually

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2. Major Cortical Lobes & Functions
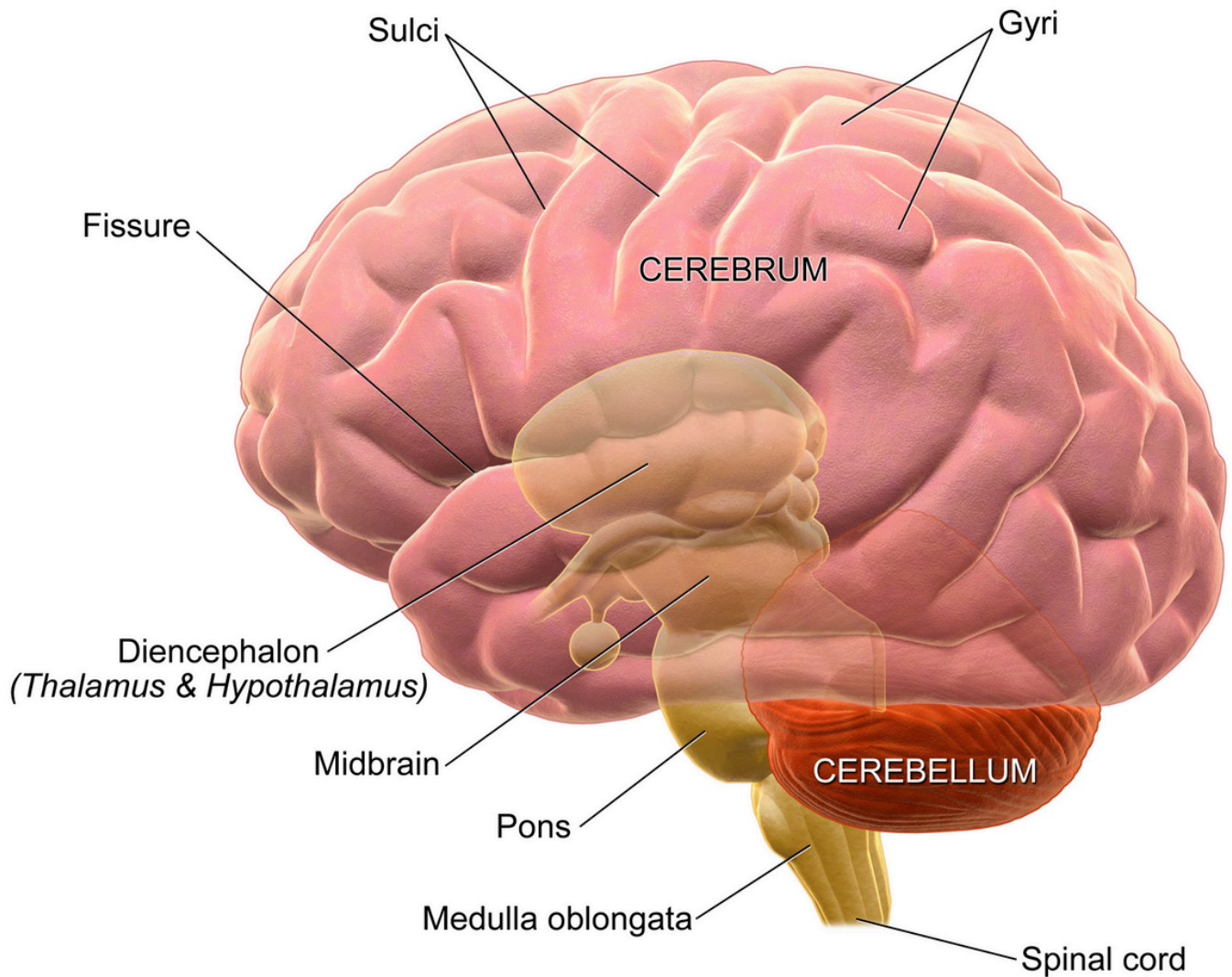
An Introduction to Brain Structures

Figure 1: Lateral view of the brain showing the four major lobes (Frontal, Parietal, Temporal, Occipital) and key functional areas. The precentral gyrus (motor cortex) is highlighted in red, and the postcentral gyrus (sensory cortex) is highlighted in blue. The central sulcus separates the frontal and parietal lobes.

Frontal Lobe

Executive Function

- **Executive function:** Higher cognitive processes
- Planning and decision-making
- Problem-solving
- Attention and working memory
- Complex behaviors

Motor Planning

- **Motor planning:** Movement organization
- Primary motor cortex (precentral gyrus)
- Premotor cortex
- Supplementary motor area
- Motor execution

EEG Relevance

- **Fp, F electrodes:** Frontal region
- Fp1, Fp2: Prefrontal
- F3, F4: Frontal
- F7, F8: Anterior frontal/temporal
- Frontal slowing or spikes

Temporal Lobe

Memory

- **Memory:** Memory formation and retrieval
- Hippocampus (deep, not well seen on EEG)
- Temporal cortex
- Memory consolidation
- Memory retrieval

Language

- **Language:** Language processing
- Left temporal: Language dominant (usually)
- Wernicke's area
- Language comprehension
- Language production

Epilepsy Focus Common

- **Epilepsy focus common:** Temporal lobe epilepsy
- Most common focal epilepsy
- Temporal spikes common
- T3, T4, T5, T6 electrodes
- Critical for localization

Parietal Lobe

Sensory Integration

- **Sensory integration:** Multimodal processing
- Primary sensory cortex (postcentral gyrus)
- Sensory association areas
- Integration of sensory information
- Body schema

Spatial Awareness

- **Spatial awareness:** Spatial processing
- Right parietal: Spatial attention
- Neglect syndromes
- Spatial orientation
- Spatial memory

EEG Relevance

- **P electrodes:** Parietal region
- P3, P4: Parietal
- Pz: Midline parietal
- Parietal slowing or spikes

Occipital Lobe

Visual Processing

- **Visual processing:** Visual information
- Primary visual cortex (calcarine sulcus)
- Visual association areas
- Visual recognition
- Visual memory

Alpha Rhythm Generation

- **Alpha rhythm generation:** Posterior dominant rhythm
- Occipital alpha rhythm
- O1, O2 electrodes
- Reactivity with eye opening/closure
- Normal background activity

EEG Relevance

- **O electrodes:** Occipital region
- O1, O2: Occipital
- Oz: Midline occipital
- Alpha rhythm location

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3. Central Region (Rolandic Area)

Primary Motor and Sensory Cortex

- **Primary motor and sensory cortex:** Central sulcus region
- Precentral gyrus: Motor
- Postcentral gyrus: Sensory
- Central sulcus separates motor and sensory
- Critical functional region

Represented by C Electrodes

- **Represented by C electrodes:** Central region
- C3, C4: Central
- Cz: Midline central
- Central region localization
- Motor/sensory cortex

Mu Rhythm Commonly Observed

- **Mu rhythm commonly observed:** Central rhythm
- 8–13 Hz rhythm
- Central (C3, C4, Cz)
- Arch-shaped morphology
- Suppresses with movement

Best Practice

- Understand central region function
- Recognize mu rhythm
- Localize central findings
- Apply motor/sensory context

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4. EEG Electrodes → Cortical Regions

EEG Electrode	Cortical Region
Fp	Prefrontal
F	Frontal
C	Central (motor/sensory)
T	Temporal
P	Parietal
O	Occipital

ABRET Emphasis
- **Temporal regions are critical for epilepsy localization**
- Temporal lobe epilepsy is common
- T electrodes are essential
- Temporal spikes are frequent
- Must know temporal anatomy

Electrode Naming Logic
- **Electrode naming logic:** Systematic naming
- Letter = region (F, T, C, P, O)
- Number = side (odd = left, even = right)
- "z" = midline
- Systematic localization

Best Practice
- Memorize electrode-to-region mapping
- Understand naming logic
- Apply to localization
- Know temporal importance

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5. Limitations of EEG Localization

Poor Sensitivity To

Deep Structures
- **Deep structures:** Not well represented
- Thalamus, basal ganglia, brainstem
- Deep structures produce minimal scalp EEG
- Cannot localize deep pathology
- Must understand limitation

Small Lesions

- **Small lesions:** May not be visible
- Small cortical lesions may not show
- Depends on size and location
- May require imaging
- EEG is not sensitive to all lesions

Skull and Scalp Distort Signals

- **Skull and scalp distort signals:** Signal attenuation
- Skull attenuates signals
- Scalp spreads signals
- Distortion of localization
- Approximate localization only

ABRET Trap

- **Normal EEG does not exclude deep pathology**
- Deep lesions may not show on EEG
- Normal EEG ≠ no pathology
- Must correlate clinically
- Cannot exclude deep pathology

Best Practice

- Understand EEG limitations
- Know what EEG cannot detect
- Apply limitations to interpretation
- Correlate with clinical findings

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6. Common ABRET Exam Traps

Trap 1: Assuming EEG Can Localize Subcortical Lesions

- **Reality:** EEG localizes cortical surface activity
- **Trap:** May think EEG can localize deep structures
- **Solution:** Understand EEG limitations
- **ABRET focus:** EEG localization limitations

Trap 2: Overinterpreting Single Electrode Abnormalities

- **Reality:** Single electrode findings may be artifact
- **Trap:** May overinterpret single electrode
- **Solution:** Require multiple electrodes or montage confirmation
- **ABRET focus:** Multi-electrode confirmation

Trap 3: Confusing Electrode Name with Exact Anatomy

- **Reality:** Electrodes represent regions, not exact points
- **Trap:** May think electrode = exact anatomical location
- **Solution:** Understand regional localization
- **ABRET focus:** Regional vs exact localization

Trap 4: Ignoring Montage Effects

- **Reality:** Montage affects localization appearance

- **Trap:** May not consider montage
- **Solution:** Always consider montage
- **ABRET focus:** Montage effects on localization

Trap 5: Forgetting Functional Correlations

- **Reality:** Anatomy has functional implications
- **Trap:** May not consider function
- **Solution:** Link anatomy to function
- **ABRET focus:** Functional-anatomical correlation

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7. Clinical Correlation

EEG Findings Guide

Imaging Decisions

- **Imaging decisions:** When to image
- Focal findings may warrant imaging
- Localization guides imaging
- Structural vs functional
- Clinical correlation essential

Clinical Correlation

- **Clinical correlation:** Match findings to symptoms
- EEG findings must match clinical
- Localization must make sense
- Functional-anatomical correlation
- Clinical context is essential

Localization Improves Diagnostic Confidence but Is Not Definitive

- **Localization improves diagnostic confidence but is not definitive**
- Good localization = higher confidence
- But not definitive
- Must correlate clinically
- Cannot diagnose from EEG alone

Best Practice

- Use localization to guide decisions
- Correlate with clinical findings
- Understand limitations
- Apply cautiously

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8. Case-Based Example

Scenario

Clinical Setting: Routine EEG for seizure evaluation
EEG Finding: Spikes at T5
Question: What does this localize to?

Interpretation

- **Left posterior temporal region**
- T5 = left temporal (odd number = left)
- Posterior temporal location
- Regional localization
- Functional implications

Teaching Point

- **EEG localization is regional and functional**
- T5 = left posterior temporal region
- Not exact anatomical point
- Regional localization
- Functional correlation important

ABRET Application

- Given electrode → identify region
- Given region → understand function
- Given finding → localize regionally
- Must know electrode-to-region mapping

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9. Exam Readiness Checklist

Use this checklist to verify your understanding:

- ☐ Can identify cortical lobes (frontal, temporal, parietal, occipital)
- ☐ Can map electrodes to anatomy (Fp→prefrontal, F→frontal, T→temporal, etc.)
- ☐ Understand EEG limitations (deep structures, small lesions, signal distortion)
- ☐ Can apply localization cautiously (regional, not exact)
- ☐ Know that EEG reflects superficial cortical activity
- ☐ Understand that localization is approximate, not exact
- ☐ Know that anatomy must be interpreted alongside EEG patterns
- ☐ Recognize that EEG localization is regional, not anatomical pinpointing
- ☐ Can identify common ABRET exam traps
- ☐ Know temporal regions are critical for epilepsy
- ☐ Understand central region (Rolandic area)
- ☐ Can apply functional-anatomical correlation

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10. Internal Cross-Links

Workflow

- **EEG 10-20 System:** Electrode placement and naming
- **Montages & Referencing:** How montages affect localization

Patterns

- **Focal vs Generalized:** Pattern distribution and localization
- **Epileptiform Discharges:** Localization of epileptiform activity

Cases

- **Localization cases:** Cases involving anatomical localization

- **Focal slowing cases:** Cases with focal findings

Quizzes

- **Neuroanatomy MCQs:** Questions on cortical anatomy and localization
- **Localization questions:** Questions on electrode-to-region mapping
- **Functional correlation questions:** Questions linking anatomy to function

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Study Tips

1. **Memorize electrode-to-region mapping:** Fp→prefrontal, F→frontal, T→temporal, C→central, P→parietal, O→occipital
2. **Learn major lobe functions:** Frontal (executive, motor), Temporal (memory, language, epilepsy), Parietal (sensory, spatial), Occipital (visual, alpha)
3. **Understand central region:** Rolandic area, motor/sensory, mu rhythm
4. **Know the principle:** EEG localization is regional, not exact
5. **Remember the limitations:** Deep structures, small lesions, signal distortion
6. **Know the traps:** Subcortical localization, single electrode, exact anatomy
7. **ABRET focus:** Expect questions on electrode-to-region mapping, lobe functions, and localization limitations

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End of Study Guide

For additional practice, complete quiz questions tagged: neuroanatomy, localization, cortex, lobes