

# NeuroTrace Study Guide

**Domain:** Domain II – EEG Procedures & Instrumentation

**Section:** Amplifiers & Sensitivity

**Style:** Applied, point-form, ABRET-focused

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## 1. Core Concepts (Must Know)

### Signal Characteristics

- EEG signals are **very small (microvolts)**
- Typical EEG amplitude: 10-100  $\mu\text{V}$
- Too small to display directly without amplification
- Require amplification for visualization and measurement

### Amplifier Function

- **Amplifiers increase signal amplitude** for display
- Make small signals visible on screen or paper
- Maintain signal fidelity (preserve waveform shape)
- Do not change the actual brain activity

### Sensitivity Definition

- **Sensitivity determines vertical scaling** of EEG traces
- Controls how large or small waveforms appear
- Expressed in  $\mu\text{V/mm}$  (microvolts per millimeter)
- Lower number = higher sensitivity = larger display

### Key Principle

- **Sensitivity affects appearance, not brain activity**
- Changing sensitivity changes display size, not signal
- Must distinguish display changes from true amplitude changes
- Always verify sensitivity before interpreting amplitude

### Practical Application

- Set appropriate sensitivity for patient age and state
  - Document sensitivity settings in technical report
  - Verify sensitivity before amplitude interpretation
  - Understand that sensitivity is a display setting, not a measurement
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## 2. EEG Amplifiers

### Function

- **Increase signal strength** (amplify microvolt signals)
- **Maintain signal fidelity** (preserve waveform characteristics)
- **Reject common-mode noise** (reduce interference)
- Allow measurement and display of small signals

### Important

- **EEG uses differential amplification**

- Compares signal between two electrodes
- Rejects signals common to both electrodes (noise)
- Amplifies difference between electrodes (cerebral activity)

### **Amplifier Characteristics**

- High input impedance (minimizes signal loading)
- High common-mode rejection ratio (CMRR)
- Low noise characteristics
- Wide frequency response (covers EEG frequency range)

### **Clinical Relevance**

- Good amplifiers essential for quality EEG
  - Poor amplifiers introduce noise and distortion
  - Digital systems have built-in amplifiers
  - Amplifier quality affects diagnostic yield
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## **3. Understanding Sensitivity ( $\mu\text{V/mm}$ )**

### **Definition**

- **Sensitivity = microvolts per millimeter**
- Defines how many microvolts equal one millimeter of vertical display
- Lower number = higher sensitivity = larger waves
- Higher number = lower sensitivity = smaller waves

### **Relationship**

- **Higher sensitivity = smaller  $\mu\text{V/mm}$  value**
  - Example: 5  $\mu\text{V/mm}$  = higher sensitivity
  - Waves appear larger on display
  - More detail visible
- **Lower sensitivity = larger  $\mu\text{V/mm}$  value**
  - Example: 20  $\mu\text{V/mm}$  = lower sensitivity
  - Waves appear smaller on display
  - Less detail visible

### **Sensitivity Table**

Sensitivity	Effect on Display	Use Case
<b>5 <math>\mu\text{V/mm}</math></b>	Larger waves	Low-amplitude activity, pediatric EEG
<b>7 <math>\mu\text{V/mm}</math></b>	Standard	Adult routine EEG (typical default)
<b>10 <math>\mu\text{V/mm}</math></b>	Smaller waves	High-amplitude activity, artifact reduction
<b>15-20 <math>\mu\text{V/mm}</math></b>	Very small waves	Very high amplitude, screening view

### **Typical Settings**

- **Adults:** 7-10  $\mu\text{V/mm}$  (standard)
- **Pediatrics:** 5-7  $\mu\text{V/mm}$  (lower due to smaller amplitudes)

- **Neonates:** 5  $\mu$ V/mm or lower (very small amplitudes)
  - **High-amplitude patterns:** 10-15  $\mu$ V/mm (to fit on screen)
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## 4. Effects of Changing Sensitivity

### Increasing Sensitivity (Lower $\mu$ V/mm Value)

#### Effects

- **Waves appear larger** on display
- **Small activity more visible** (better detail)
- **Can exaggerate artifacts** (artifacts also appear larger)
- **May cause clipping** if amplitude too high

#### When to Use

- Low-amplitude EEG (low voltage)
- Pediatric EEG (smaller amplitudes)
- Detecting subtle abnormalities
- Evaluating low-amplitude patterns

#### ABRET Application

- Given low-voltage EEG → may need higher sensitivity
- Given subtle activity → increase sensitivity to see detail
- Understand that sensitivity change doesn't change signal

### Decreasing Sensitivity (Higher $\mu$ V/mm Value)

#### Effects

- **Waves appear smaller** on display
- **Can obscure low-amplitude activity** (less detail)
- **Reduces artifact appearance** (artifacts also smaller)
- **Allows viewing high-amplitude patterns** (fits on screen)

#### When to Use

- High-amplitude patterns (spikes, seizures)
- Reducing artifact visibility
- Screening view of entire recording
- When activity is too large for display

#### ABRET Application

- Given high-amplitude activity → may need lower sensitivity
- Given artifact → decrease sensitivity to reduce artifact appearance
- Understand that sensitivity change doesn't change signal

#### ABRET Trap

- **Mistaking sensitivity change for true amplitude change**
  - EEG appears "better" but it's just sensitivity adjustment
  - EEG appears "worse" but it's just sensitivity adjustment
  - Always verify sensitivity before interpreting amplitude changes
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## 5. Sensitivity vs Pathology

Appearance	Possible Cause	Action
<b>Large waves</b>	High sensitivity (low $\mu$ V/mm)	Check sensitivity setting
<b>Small waves</b>	Low sensitivity (high $\mu$ V/mm)	Check sensitivity setting
<b>Apparent low voltage EEG</b>	Inappropriate sensitivity (too low)	Increase sensitivity and reassess
<b>Sudden amplitude change</b>	Sensitivity adjustment during recording	Verify sensitivity consistency
<b>True low voltage</b>	Pathological (with correct sensitivity)	Document as clinical finding
<b>True high amplitude</b>	Pathological (with correct sensitivity)	Document as clinical finding

### Key Distinction

- **Display change:** Due to sensitivity setting
- **True change:** Due to cerebral activity
- **Must verify:** Sensitivity before interpreting amplitude
- **Document:** Sensitivity setting in technical report

### Clinical Application

- Low-voltage EEG diagnosis requires proper sensitivity
- High-amplitude patterns require appropriate sensitivity
- Sensitivity must be consistent for comparisons
- Always note sensitivity when reporting amplitude

## 6. Common ABRET Exam Traps

### Trap 1: Confusing Sensitivity with Gain

- **Reality:** These terms are related but not identical
- **Sensitivity:** Display scaling ( $\mu$ V/mm)
- **Gain:** Amplifier amplification factor
- In practice, often used interchangeably, but technically different
- ABRET may test understanding of distinction

### Trap 2: Interpreting Display Changes as Clinical Change

- **Reality:** Sensitivity change alters appearance, not signal
- EEG appears "improved" but it's just sensitivity increase
- EEG appears "worsened" but it's just sensitivity decrease
- Always verify sensitivity before clinical interpretation

### Trap 3: Ignoring Sensitivity During Comparisons

- **Reality:** Cannot compare amplitudes across different sensitivities
- Must use same sensitivity for valid comparison
- Different sensitivities make comparison invalid
- Always note sensitivity when comparing recordings

### Trap 4: Forgetting to Normalize Sensitivity Across Montages

- **Reality:** Sensitivity should be consistent across montages
- Different sensitivities in different montages cause confusion
- Standardize sensitivity for all montages

- Document sensitivity in technical report

### Trap 5: Assuming Sensitivity Doesn't Matter in Digital EEG

- **Reality:** Digital EEG still requires appropriate sensitivity
  - Sensitivity affects display and interpretation
  - Digital systems still need sensitivity settings
  - Good technique essential regardless of system type
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## 7. Clinical Correlation

### Low-Voltage EEG Diagnosis

- **Requires proper sensitivity** (typically 5-7  $\mu$ V/mm)
- Cannot diagnose low voltage with inappropriate sensitivity
- Must verify sensitivity before making diagnosis
- Low-voltage EEG is a clinical finding, not a display artifact

### Pediatric EEG

- **Requires careful sensitivity selection** (typically 5  $\mu$ V/mm)
- Pediatric amplitudes are smaller than adults
- Need higher sensitivity to see activity clearly
- Age-appropriate sensitivity essential for interpretation

### Sensitivity Adjustments During Recording

- **Often used during artifact evaluation**
- Increase sensitivity to see subtle activity
- Decrease sensitivity to reduce artifact appearance
- Document any sensitivity changes in technical report

### Best Practice

- Set appropriate sensitivity at start of recording
  - Document sensitivity in technical report
  - Verify sensitivity before amplitude interpretation
  - Use consistent sensitivity for comparisons
  - Note sensitivity changes during recording
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## 8. Case-Based Example

### Scenario

**Clinical Setting:** Routine EEG recording

**EEG Finding:** EEG suddenly appears low voltage

**Previous Portion:** Normal amplitude activity

**Clinical Concern:** Possible encephalopathy

### Hidden Issue

- **Sensitivity was decreased** during recording
- Sensitivity changed from 7  $\mu$ V/mm to 15  $\mu$ V/mm
- Activity still present but appears smaller
- Not a true clinical change, just display change

## Correct Action

1. **Restore prior sensitivity** (return to 7  $\mu\text{V/mm}$ )
2. **Reassess amplitude** (should appear normal again)
3. **Verify consistency** (check sensitivity throughout recording)
4. **Document** sensitivity settings and any changes
5. **Interpret** amplitude only with correct sensitivity

## Teaching Point

- **Always verify sensitivity before interpreting amplitude**
- Sudden amplitude changes may be sensitivity adjustments
- Low-voltage appearance may be inappropriate sensitivity
- Good technique prevents misinterpretation

## ABRET Application

- Given amplitude change → check sensitivity first
- Given low-voltage appearance → verify sensitivity setting
- Understand that sensitivity affects display, not signal
- Know when sensitivity adjustment is appropriate

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## 9. Exam Readiness Checklist

Use this checklist to verify your understanding:

- Can explain amplifier function (increase signal strength for display)
- Can define sensitivity ( $\mu\text{V/mm}$  - microvolts per millimeter)
- Can predict display changes with sensitivity adjustments
- Can avoid amplitude misinterpretation (verify sensitivity first)
- Understand that higher sensitivity = lower  $\mu\text{V/mm}$  value
- Know that sensitivity affects appearance, not brain activity
- Recognize that changing sensitivity doesn't change signal
- Understand that low-voltage EEG requires proper sensitivity
- Know that pediatric EEG requires careful sensitivity selection
- Can identify ABRET exam traps related to sensitivity

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## 10. Internal Cross-Links

### Workflow

- **Instrumentation Overview:** Sensitivity is part of instrumentation settings
- **Filters & Time Constants:** Sensitivity works with filters for optimal display
- **Artifacts & Troubleshooting:** Sensitivity adjustments used in artifact evaluation

### Patterns

- **Low-Voltage EEG:** Requires proper sensitivity for diagnosis
- **High-Amplitude Activity:** May require lower sensitivity to fit on display
- **Amplitude Abnormalities:** Must verify sensitivity before interpretation

### Cases

- **Sensitivity-related interpretation errors:** Cases teaching sensitivity importance

- **Low-voltage EEG cases:** Cases requiring proper sensitivity
- **Artifact exaggeration:** Cases involving sensitivity and artifacts

## Quizzes

- **Amplifier & sensitivity MCQs:** Questions on function, settings, effects
  - **Amplitude interpretation:** Questions on distinguishing display vs true changes
  - **Technical settings:** Questions on appropriate sensitivity selection
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## Study Tips

1. **Memorize the relationship:** Higher sensitivity = lower  $\mu\text{V}/\text{mm}$  = larger waves
  2. **Understand the principle:** Sensitivity affects display, not signal
  3. **Learn typical settings:** 7  $\mu\text{V}/\text{mm}$  adults, 5  $\mu\text{V}/\text{mm}$  pediatrics
  4. **Practice prediction:** Given sensitivity change, predict display appearance
  5. **Remember the trap:** Don't mistake sensitivity change for clinical change
  6. **Always verify:** Check sensitivity before amplitude interpretation
  7. **ABRET focus:** Expect questions on sensitivity effects and interpretation
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## End of Study Guide

For additional practice, complete quiz questions tagged: *amplifier, sensitivity, gain, amplitude, display*