

# NeuroTrace Study Guide

**Domain:** Domain III – EEG Patterns & Clinical Correlation

**Section:** EEG Artifacts: Recognition & Differentiation

**Style:** Pattern-based, applied, exam-oriented

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## 1. Core Principles (Must Know)

### Artifact Origin

- **Artifacts originate outside the brain**
- Non-cerebral signals that contaminate EEG
- Can be physiologic (body-generated) or non-physiologic (technical)
- Must be distinguished from true cerebral activity

### Artifact Types

- **Physiologic artifacts:** Generated by body (eye movement, muscle, ECG)
- **Non-physiologic artifacts:** Technical (60 Hz, electrode pop, movement)
- Both can mimic pathology
- Recognition prevents misdiagnosis

### Artifact Recognition Relies On

- **Morphology** (shape and appearance)
- **Distribution** (where it appears)
- **Reactivity** (how it responds to changes)
- **Montage behavior** (how it changes with montage)

### Key Principle

- **Cerebral activity obeys neurophysiologic rules; artifacts do not**
- True cerebral activity has consistent characteristics
- Artifacts often violate neurophysiologic rules
- Use this principle to distinguish artifact from pathology

### Practical Application

- Always assess for artifacts before interpreting pathology
  - Compare findings across montages
  - Observe reactivity to patient behavior
  - Understand artifact characteristics
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## 2. Common Physiologic Artifacts

### Eye Movement (EOG)

#### Characteristics

- **Slow rolling eye movements**
- **Frontal predominance** (maximum at Fp1, Fp2)
- **Phase reversal near FP electrodes**
- Bilateral, often synchronous
- Correlates with eye position

### Recognition

- Maximum at frontal pole electrodes
- Phase reversal between Fp1/Fp2 and adjacent electrodes
- Slow, rolling morphology
- Changes with eye position
- Suppressed with eyes closed

### Clinical Correlation

- Normal during wakefulness
- May mimic frontal slowing
- Can obscure frontal abnormalities
- Documented as normal variant

### ABRET Application

- Must distinguish from frontal slowing
  - Eye movement is artifact, not pathology
  - Observe EOG channels if available
  - Note reactivity to eye position
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## Muscle (EMG)

### Characteristics

- **Fast, irregular activity** (20-100+ Hz)
- **Increased with movement** (jaw clenching, talking, head movement)
- **Suppressed during sleep** (muscle tone decreases)
- High frequency, low amplitude (when filtered)
- Often asymmetric

### Recognition

- Fast, spiky appearance
- Irregular, non-rhythmic
- Increases with movement
- Maximum near muscle groups (temporal, frontal)
- Suppressed during sleep

### Clinical Correlation

- Common during wakefulness
- May mimic fast activity (beta)
- Can obscure underlying activity
- Often seen in anxious or agitated patients

### ABRET Application

- Must distinguish from fast cerebral activity
- Muscle is artifact, not pathology
- Observe reactivity to movement
- Note suppression during sleep

### Aliasing Risk

- High-frequency muscle may alias if sampling inadequate
  - Aliased muscle can appear as slow activity
  - Always verify sampling rate for fast activity
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## ECG (Pulse Artifact)

### Characteristics

- **Rhythmic waveform time-locked to heart rate**
- Regular, repeating pattern
- **Often seen near temporal electrodes** (carotid pulse)
- QRS complex visible
- Rate matches heart rate (60-100 bpm typical)

### Recognition

- Regular, rhythmic pattern
- Time-locked to heart rate
- Maximum at temporal electrodes (T3, T4, T5, T6)
- QRS morphology visible
- Rate matches pulse

### Clinical Correlation

- Common in all patients
- More prominent in certain positions
- May mimic periodic patterns
- Usually not clinically significant

### ABRET Application

- Must distinguish from periodic patterns
  - ECG is artifact, not pathology
  - Observe correlation with pulse
  - Note temporal distribution
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## Sweat Artifact

### Characteristics

- **Very slow baseline drift**
- Irregular, wandering baseline
- **Increased with temperature or anxiety**
- Affects multiple channels
- Can obscure all activity

### Recognition

- Very slow baseline movement
- Irregular, non-rhythmic
- Widespread distribution
- Correlates with sweating
- May be temperature-related

### Clinical Correlation

- Common in warm environments
  - More common in anxious patients
  - Can make interpretation difficult
  - May require environmental adjustment
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## 3. Common Non-Physiologic Artifacts

### 60 Hz Interference

#### Characteristics

- **Regular sinusoidal pattern** (60 Hz in US, 50 Hz elsewhere)
- **Linked to poor impedance or grounding**
- Affects all channels or specific channels
- Continuous, regular pattern
- Not time-locked to patient

#### Recognition

- Regular 60 Hz oscillations
- Continuous, not intermittent
- Maximum in high-impedance channels
- Not affected by patient behavior
- Technical in origin

#### Clinical Correlation

- **Technical artifact, not pathology**
- Indicates impedance or grounding problem
- Can obscure cerebral activity
- Requires technical correction

#### Corrective Action

- Check electrode impedance
- Verify ground connection
- Improve electrode contact
- Check for electrical interference sources

#### ABRET Application

- Must recognize as technical artifact
  - Not a cerebral pattern
  - Requires technical correction
  - Understand impedance relationship
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### Electrode Pop

#### Characteristics

- **Sudden high-amplitude transient**
- Brief, sharp deflection
- **Poor electrode contact** (drying paste, loose electrode)
- Often repetitive
- Affects single channel or few channels

#### Recognition

- Sudden, brief deflection
- High amplitude
- Sharp, spiky appearance
- Often repetitive
- Channel-specific

**Clinical Correlation**

- **Technical artifact, not pathology**
- Indicates electrode problem
- May mimic spikes
- Requires electrode correction

**Corrective Action**

- Re-prep skin at electrode site
- Reapply electrode with fresh paste
- Check electrode connection
- Verify impedance

**ABRET Application**

- Must distinguish from true spikes
  - Electrode pop is artifact
  - Note channel-specific nature
  - Understand corrective actions
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**Movement Artifact**

**Characteristics**

- **Irregular baseline shifts**
- **Associated with patient movement**
- Widespread or localized
- Correlates with movement
- Non-rhythmic

**Recognition**

- Irregular baseline movement
- Correlates with patient movement
- Widespread distribution
- Non-stereotyped
- Movement-related

**Clinical Correlation**

- Common in all patients
- More common in children, agitated patients
- Can obscure activity
- May require patient cooperation

**Corrective Action**

- Encourage patient to remain still
  - Reposition patient if needed
  - Use movement sensors if available
  - Document movement in technical report
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**4. Artifact vs Epileptiform Activity**

| Feature    | Artifact                       | Epileptiform |
|------------|--------------------------------|--------------|
| Reactivity | Changes with movement/behavior | Persists     |

|                             |                              |                                   |
|-----------------------------|------------------------------|-----------------------------------|
| <b>Distribution</b>         | Often widespread             | Focal                             |
| <b>Morphology</b>           | Irregular, non-stereotyped   | Stereotyped, consistent           |
| <b>Montage behavior</b>     | Inconsistent across montages | Consistent across montages        |
| <b>Clinical correlation</b> | No correlation with symptoms | Correlates with clinical findings |
| <b>Frequency</b>            | Variable                     | Consistent                        |
| <b>Amplitude</b>            | Variable                     | Consistent                        |
| <b>Field</b>                | May be widespread            | Focal field                       |

## Key Distinctions

### True Epileptiform Activity

- **Persists across montages** (consistent appearance)
- **Stereotyped morphology** (consistent shape)
- **Focal distribution** (localized field)
- **Correlates with clinical findings** (seizure semiology)
- **Follows neurophysiologic rules** (appropriate field, polarity)

### Artifacts

- **May change with montage** (inconsistent appearance)
- **Irregular morphology** (variable shape)
- **May be widespread** (not localized)
- **No clinical correlation** (not related to symptoms)
- **Violates neurophysiologic rules** (inappropriate field, reactivity)

### ABRET Application

- Given pattern → identify artifact vs epileptiform
- Use montage comparison to distinguish
- Observe reactivity to patient behavior
- Correlate with clinical findings

## 5. Montage & Sensitivity Clues

### Artifact Often

- **Changes with montage** (different appearance in different montages)
- **Exaggerated by high sensitivity** (appears larger with higher sensitivity)
- **Inconsistent localization** (different location in different montages)
- **Widespread distribution** (affects multiple channels)
- **Reactive to technical changes** (changes with settings)

### True Cerebral Activity

- **Persists across montages** (consistent appearance)
- **Maintains morphology** (same shape in different montages)
- **Consistent localization** (same location across montages)
- **Focal distribution** (localized field)
- **Not reactive to technical changes** (unchanged by settings)

## Practical Application

- Always compare findings across montages
- Verify sensitivity settings
- Observe how pattern changes with montage
- Use montage comparison to confirm true activity

## ABRET Emphasis

- Montage comparison is essential
  - Artifacts change with montage
  - True activity persists across montages
  - Sensitivity affects artifact appearance
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## 6. Common ABRET Exam Traps

### Trap 1: Mislabeling Muscle Artifact as Fast Activity

- **Reality:** Muscle is artifact, not cerebral fast activity
- Muscle increases with movement, cerebral activity doesn't
- Muscle suppresses during sleep, cerebral activity persists
- Must observe reactivity to distinguish

### Trap 2: Confusing Eye Movement with Frontal Slowing

- **Reality:** Eye movement is artifact, not frontal pathology
- Eye movement changes with eye position, slowing doesn't
- Eye movement has phase reversal at FP, slowing doesn't
- Must observe EOG channels and reactivity

### Trap 3: Assuming Rhythmicity Implies Cerebral Origin

- **Reality:** Artifacts can be rhythmic (ECG, 60 Hz)
- Rhythmicity alone doesn't indicate cerebral origin
- Must consider source and distribution
- ECG and 60 Hz are rhythmic but artifacts

### Trap 4: Ignoring Clinical Context

- **Reality:** Clinical context helps distinguish artifact from pathology
- Artifacts don't correlate with clinical findings
- True pathology correlates with symptoms
- Always consider clinical presentation

### Trap 5: Not Comparing Montages

- **Reality:** Must compare findings across montages
  - Artifacts often change with montage
  - True activity persists across montages
  - Single montage interpretation is incomplete
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## 7. Clinical Correlation

### Artifact Misinterpretation Can Lead To

- **False epilepsy diagnosis** (artifacts mistaken for spikes)

- **Unnecessary treatment** (medications for artifact)
- **Incorrect localization** (artifact mistaken for focal activity)
- **Missed pathology** (artifacts obscuring true abnormalities)

### Pediatric EEGs

- **Especially artifact-prone** (movement, muscle, eye movement)
- Children move more, creating more artifacts
- Normal variants can mimic artifacts
- Requires careful artifact recognition

### Best Practice

- Always assess for artifacts first
- Compare findings across montages
- Observe reactivity to patient behavior
- Correlate with clinical findings
- Document artifacts in technical report

### Clinical Impact

- Accurate artifact recognition prevents misdiagnosis
- Good technique reduces artifacts
- Proper documentation helps interpretation
- Artifact recognition is essential skill

## 8. Case-Based Example

### Scenario

**Clinical Setting:** Routine EEG for seizure evaluation

**EEG Finding:** Rhythmic frontal delta activity

**Clinical Concern:** Possible frontal lobe dysfunction

**Pattern:** 2-3 Hz rhythmic slowing, maximum frontal

### Hidden Issue

- **Eye movement artifact** (not cerebral slowing)
- Patient has nystagmus or eye movements
- Eye movement creates rhythmic frontal activity
- Mistaken for frontal slowing

### Correct Action

1. **Observe EOG channels** (if available) - should show eye movement
2. **Check reactivity** - activity changes with eye position
3. **Compare montages** - activity may change with montage
4. **Correlate with clinical** - no clinical findings support frontal dysfunction
5. **Reassess** - recognize as artifact, not pathology

### Teaching Point

- **Always assess artifact before diagnosing pathology**
- Eye movement can mimic frontal slowing
- EOG channels help identify eye movement
- Reactivity and montage comparison help distinguish

## ABRET Application

- Given rhythmic frontal activity → consider eye movement
  - Observe EOG channels and reactivity
  - Compare across montages
  - Correlate with clinical findings
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## 9. Exam Readiness Checklist

Use this checklist to verify your understanding:

- ☐ Can identify common artifacts (eye movement, muscle, ECG, 60 Hz, electrode pop)
  - ☐ Can differentiate artifact vs pathology (morphology, distribution, reactivity)
  - ☐ Can use montage behavior effectively (artifacts change, true activity persists)
  - ☐ Can apply corrective actions (impedance, electrode contact, patient positioning)
  - ☐ Understand that artifacts originate outside the brain
  - ☐ Know that artifacts can be physiologic or non-physiologic
  - ☐ Recognize that artifacts often change with montage or sensitivity
  - ☐ Understand that true cerebral activity persists across montages
  - ☐ Know that artifact misinterpretation can lead to misdiagnosis
  - ☐ Can identify ABRET exam traps related to artifacts
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## 10. Internal Cross-Links

### Workflow

- **Electrodes & Impedance:** Poor impedance causes artifacts (60 Hz, electrode pop)
- **Amplifiers & Sensitivity:** Sensitivity affects artifact appearance
- **Montages & Referencing:** Montage comparison helps identify artifacts
- **Artifacts & Troubleshooting:** General troubleshooting for artifacts

### Patterns

- **Epileptiform Discharges:** Must distinguish from artifacts (electrode pop, muscle)
- **Normal Patterns:** Artifacts can obscure normal patterns
- **Focal Abnormalities:** Artifacts can mimic focal findings

### Cases

- **Artifact recognition simulations:** Cases teaching artifact identification
- **Apparent epileptiform activity:** Cases where artifact mimics pathology
- **Pediatric EEG noise:** Cases with movement and muscle artifacts
- **Technical setup errors:** Cases involving technical artifacts

### Quizzes

- **EEG artifact MCQs:** Questions on artifact identification and differentiation
  - **Artifact vs pathology:** Questions requiring artifact recognition
  - **Corrective actions:** Questions on troubleshooting artifacts
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## Study Tips

1. **Memorize artifact characteristics:** Morphology, distribution, reactivity
  2. **Learn montage behavior:** Artifacts change, true activity persists
  3. **Practice recognition:** Given pattern, identify artifact vs pathology
  4. **Understand corrective actions:** Impedance, electrode contact, patient positioning
  5. **Remember the principle:** Cerebral activity obeys rules, artifacts don't
  6. **Know the traps:** Muscle as fast activity, eye movement as slowing
  7. **ABRET focus:** Expect questions on artifact identification and differentiation
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## **End of Study Guide**

*For additional practice, complete quiz questions tagged: artifact, emg, eog, ecg, 60hz, electrode-pop*