

NeuroTrace Study Guide

Domain: Domain I – Basic Concepts & Principles

Section: Normal EEG Rhythms

Style: Recognition-based, exam-oriented

1. Core Principles (Must Know)

EEG Rhythms Are Classified by Frequency

- **EEG rhythms are classified by frequency**
- Frequency measured in Hz (cycles per second)
- Four main frequency bands: alpha, beta, theta, delta
- Frequency determines rhythm classification

Normal Rhythms Vary By

Age

- **Age:** Different patterns at different ages
- Infants: Delta/theta predominant
- Children: Gradual emergence of alpha
- Adults: Stable alpha background
- Must use age-appropriate norms

State (Wake, Sleep)

- **State:** Different patterns in different states
- Wake: Alpha, beta
- Drowsiness: Theta, vertex waves
- Sleep: Delta, spindles, K-complexes
- Must know patient state

Region

- **Region:** Different patterns in different regions
- Frontal: Beta, theta
- Central: Mu rhythm
- Parietal: Variable
- Occipital: Alpha (PDR)

Background Assessment Is Foundational to EEG Interpretation

- **Background assessment is foundational to EEG interpretation**
- Must assess background first
- Normal background is baseline
- Abnormalities are deviations from normal
- Background guides interpretation

Key Principle

- **Normal background must be identified before pathology can be recognized**
- Cannot identify abnormal without knowing normal
- Background assessment is first step
- Normal vs abnormal comparison is essential

Practical Application

- Always assess background first
 - Use age-appropriate norms
 - Consider patient state
 - Recognize normal before calling abnormal
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2. Alpha Rhythm

Frequency: 8–13 Hz (Adults)

- **Frequency: 8–13 Hz (adults)**
- Most common in 9–11 Hz range
- May be slower in children
- May be faster in some individuals
- Frequency decreases with age in elderly

Location: Posterior Dominant

- **Location: Posterior dominant**
- Maximal over occipital regions (O1, O2, Oz)
- May extend to parietal regions
- Usually symmetric
- May be asymmetric (normal variant)

Reactivity

Attenuates with Eye Opening

- **Attenuates with eye opening:** Key characteristic
- Present with eyes closed
- Attenuates (reduces) with eyes open
- Returns when eyes close
- Reactivity confirms physiologic origin

Other Reactivity

- **Mental tasks:** May attenuate with mental tasks
- **Alertness:** May vary with alertness
- **Drowsiness:** May slow or disappear
- **Sleep:** Disappears in sleep

ABRET Emphasis

- **Alpha rhythm defines normal adult background organization**
- Presence of alpha = organized background
- Absence of alpha = may indicate dysfunction
- Alpha is hallmark of normal adult EEG
- Must recognize alpha rhythm

Best Practice

- Recognize alpha rhythm (8–13 Hz, posterior)
 - Test reactivity (eye opening)
 - Use alpha to assess background organization
 - Know that absence may indicate dysfunction
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3. Beta Rhythm

Frequency: >13 Hz

- **Frequency: >13 Hz**
- Usually 14–30 Hz
- Low amplitude
- May be continuous or intermittent
- Common in frontal regions

Location: Frontal Predominance

- **Location: Frontal predominance**
- Maximal over frontal regions (Fp1, Fp2, F3, F4)
- May be present centrally
- Usually symmetric
- Low amplitude

Common Causes

Alertness

- **Alertness:** Increased alertness increases beta
- More prominent when alert
- May decrease with drowsiness
- Normal variant

Medications (e.g., Benzodiazepines)

- **Medications (e.g., benzodiazepines):** Increase beta
- Benzodiazepines: Prominent beta
- Other sedatives: May increase beta
- Medication effect, not pathology

ABRET Trap

- **Excess beta may be medication-related, not pathologic**
- Must consider medications
- Excess beta is often medication effect
- Not necessarily abnormal
- Clinical correlation needed

Best Practice

- Recognize beta rhythm (>13 Hz, frontal)
 - Consider medications
 - Know that excess beta may be medication-related
 - Don't overcall beta as abnormal
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4. Theta Rhythm

Frequency: 4–7 Hz

- **Frequency: 4–7 Hz**
- Slower than alpha
- May be normal or abnormal
- Context determines significance

- Must consider age and state

Normal In

Children

- **Children:** Theta is normal in children
- More prominent in younger children
- Decreases with age
- Age-appropriate
- Must use age norms

Drowsiness

- **Drowsiness:** Theta is normal in drowsiness
- Frontal theta in drowsiness
- Normal drowsy pattern
- Not pathologic
- State-dependent

Abnormal If Excessive in Awake Adults

- **Abnormal if excessive in awake adults**
- Excessive theta in awake adults = slowing
- May indicate dysfunction
- Must distinguish from normal
- Context is critical

Best Practice

- Recognize theta rhythm (4–7 Hz)
- Consider age and state
- Know when theta is normal vs abnormal
- Don't overcall theta in children or drowsiness

5. Delta Rhythm

Frequency: <4 Hz

- **Frequency: <4 Hz**
- Slowest frequency band
- May be normal or abnormal
- Context determines significance
- Must consider age and state

Normal In

Infants

- **Infants:** Delta is normal in infants
- Predominant in newborns
- Decreases with age
- Age-appropriate
- Must use age norms

Deep Sleep

- **Deep Sleep:** Delta is normal in deep sleep

- Stage 3/4 sleep: Delta activity
- Normal sleep pattern
- Not pathologic
- State-dependent

Abnormal If Persistent in Awake Adults

- **Abnormal if persistent in awake adults**
- Persistent delta in awake adults = slowing
- May indicate dysfunction
- Must distinguish from normal
- Context is critical

Best Practice

- Recognize delta rhythm (<4 Hz)
 - Consider age and state
 - Know when delta is normal vs abnormal
 - Don't overcall delta in infants or sleep
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6. Age-Related Norms

Infants

Predominant Delta/Theta

- **Predominant delta/theta:** Normal in infants
- Newborns: Delta/theta predominant
- No alpha rhythm
- Age-appropriate
- Must use age norms

Development

- **Development:** Patterns change with development
- Alpha emerges gradually
- Frequency increases with age
- Organization improves
- Must track development

Children

Gradual Emergence of Alpha

- **Gradual emergence of alpha:** Normal development
- Alpha appears around 3–4 months
- Frequency increases with age
- Becomes dominant by 8–10 years
- Must use age norms

Age-Specific Patterns

- **Age-specific patterns:** Different at different ages
- 3 months: 3–4 Hz dominant
- 1 year: 5–6 Hz dominant
- 3 years: 7–8 Hz dominant
- 8 years: 8–9 Hz dominant

Adults

Stable Alpha Background

- **Stable alpha background:** Normal adult pattern
- 8–13 Hz alpha rhythm
- Posterior dominant
- Reactive to eye opening
- Stable pattern

ABRET Emphasis

- **Age-appropriate norms are critical**
- Must use age-appropriate norms
- Cannot use adult norms for children
- Cannot use child norms for adults
- Age context is essential

Best Practice

- Know age-appropriate norms
 - Use correct norms for patient age
 - Don't overcall slowing in children
 - Don't undercall slowing in adults
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7. Common ABRET Exam Traps

Trap 1: Calling Normal Theta Abnormal in Children

- **Reality:** Theta is normal in children
- **Trap:** May call normal theta as abnormal
- **Solution:** Use age-appropriate norms
- **ABRET focus:** Age-dependent interpretation

Trap 2: Mislabeling Beta as Epileptiform

- **Reality:** Beta is normal rhythm
- **Trap:** May call beta as spike or sharp wave
- **Solution:** Recognize beta morphology and frequency
- **ABRET focus:** Rhythm recognition

Trap 3: Ignoring Eye-Opening Reactivity

- **Reality:** Reactivity confirms physiologic origin
- **Trap:** May not test reactivity
- **Solution:** Always test eye-opening reactivity
- **ABRET focus:** Reactivity testing

Trap 4: Forgetting Age Context

- **Reality:** Age determines normal vs abnormal
- **Trap:** May use wrong age norms
- **Solution:** Always consider patient age
- **ABRET focus:** Age-appropriate interpretation

Trap 5: Not Considering State

- **Reality:** State affects normal patterns

- **Trap:** May not consider wake vs sleep
 - **Solution:** Always note patient state
 - **ABRET focus:** State-dependent interpretation
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8. Case-Based Example

Scenario

Clinical Setting: Routine EEG for headache

EEG Finding: 9 Hz posterior rhythm that attenuates with eye opening

Question: Is this normal or abnormal?

Interpretation

- **Normal adult alpha rhythm**
- 9 Hz is within alpha range (8–13 Hz)
- Posterior location is correct
- Reactivity confirms physiologic origin
- Normal finding

Teaching Point

- **Reactivity confirms physiologic origin**
- Eye-opening reactivity is key
- Confirms that rhythm is physiologic
- Distinguishes from artifact
- Essential for identification

ABRET Application

- Given posterior rhythm → check frequency and reactivity
 - Given 8–13 Hz with reactivity → normal alpha
 - Given absence of reactivity → may be artifact
 - Must test reactivity to confirm
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9. Exam Readiness Checklist

Use this checklist to verify your understanding:

- ☐ Can identify normal rhythms (alpha, beta, theta, delta)
 - ☐ Can apply frequency ranges (alpha 8–13 Hz, beta > 13 Hz, theta 4–7 Hz, delta < 4 Hz)
 - ☐ Can consider age and state (age-appropriate norms, state-dependent patterns)
 - ☐ Can assess reactivity (eye-opening, mental tasks)
 - ☐ Understand that normal rhythms vary with age and state
 - ☐ Know that background assessment is foundational
 - ☐ Recognize that normal must be identified before abnormal
 - ☐ Can avoid overcalling normal activity
 - ☐ Know age-appropriate norms for each age group
 - ☐ Can distinguish normal vs abnormal based on context
 - ☐ Understand that reactivity confirms physiologic origin
 - ☐ Can identify common ABRET exam traps
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10. Internal Cross-Links

Patterns

- **Background Activity:** Understanding normal background
- **Diffuse Slowing:** Contrast with normal rhythms
- **Sleep & Graphoelements:** State-dependent normal patterns

Foundations

- **Neurophysiology & Seizure Mechanisms:** How rhythms are generated
- **10-20 System:** Where rhythms are recorded

Cases

- **Normal EEG interpretation cases:** Cases with normal rhythms
- **Background assessment cases:** Cases requiring background evaluation

Quizzes

- **Normal rhythm MCQs:** Questions on rhythm recognition
- **Age norms questions:** Questions on age-appropriate patterns
- **Reactivity questions:** Questions on reactivity testing

Study Tips

1. **Memorize frequency ranges:** Alpha 8–13 Hz, Beta >13 Hz, Theta 4–7 Hz, Delta <4 Hz
2. **Learn age norms:** Infants (delta/theta), Children (gradual alpha), Adults (stable alpha)
3. **Know state effects:** Wake (alpha/beta), Drowsiness (theta), Sleep (delta/spindles)
4. **Understand reactivity:** Eye-opening attenuates alpha, confirms physiologic origin
5. **Remember the principle:** Normal background must be identified before pathology
6. **Know the traps:** Theta in children, beta as epileptiform, ignoring reactivity
7. **ABRET focus:** Expect questions on rhythm recognition, age norms, and reactivity

End of Study Guide

For additional practice, complete quiz questions tagged: alpha, beta, theta, delta, background