NeuroTrace Study Guide

Domain: Domain III – EEG Patterns & Clinical Correlation
Section: Normal EEG Variants
Style: Comparison-focused, exam-oriented, pattern-based

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1. Core Principles (Must Know)

Normal Variants Are Non-Pathologic

- **Normal variants are non-pathologic**
- Benign patterns that occur in healthy individuals
- Do not indicate disease or dysfunction
- Must not be labeled as epileptiform

Occur in Specific Contexts

Age Groups

- **Pediatric EEGs:** More variants than adults
- **Adolescents:** Common during development
- **Adults:** Less common but still occur
- **Elderly:** Some variants may persist

States (Drowsiness, Sleep)

- **Drowsiness:** Many variants appear during drowsiness
- **Light sleep:** Small sharp spikes common
- **Deep sleep:** Some variants may persist
- **Wakefulness:** Less common but possible

Must Not Be Labeled Epileptiform

- **Never call variants epileptiform**
- Variants are normal, not abnormal
- Mislabeling can lead to false diagnosis
- Can cause unnecessary treatment

Key Principle

- **Morphology alone does not define epileptiform activity**
- Sharp morphology ≠ epileptiform
- Must consider context, distribution, aftergoing slow wave
- Clinical correlation is essential

Practical Application

- Always consider age and state
- Compare morphology to known variants
- Look for aftergoing slow wave (epileptiform)
- When in doubt, describe morphology, don't label

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2. Common Normal EEG Variants

Small Sharp Spikes (Benign Epileptiform Transients of Sleep - BETS)

Characteristics

- **Occur during drowsiness/light sleep**
- Most common in light sleep stages
- Rare in wakefulness or deep sleep
- State-dependent occurrence

Morphology

- **Low amplitude:** Usually <50 μV
- **Short duration:** <50 ms (spike-like)
- **Sharp morphology:** May look like spike
- **No aftergoing slow wave:** Key distinguishing feature

Distribution

- **Temporal regions:** Most common location
- **Unilateral or bilateral:** May occur on either side
- **Asymmetric:** Often more prominent on one side
- **Limited field:** Does not spread widely

Clinical Significance

- **Benign:** No clinical significance
- **No seizure risk:** Does not indicate epilepsy
- **Common:** Seen in 20-30% of normal adults
- **Age-related:** More common in middle-aged adults

Wicket Spikes

Characteristics

- **Arciform morphology:** Arch-shaped, notched appearance
- **Temporal regions:** Most common location
- **Occur in trains:** Often appear in brief trains
- **No disruption of background:** Background remains normal

Morphology

- **Arciform (arch-shaped):** Distinctive morphology
- **Notched appearance:** May have notches
- **Low to medium amplitude:** Usually 50-100 μV
- **No aftergoing slow wave:** Key distinguishing feature

Distribution

- **Temporal regions:** T3/T4, T5/T6
- **Unilateral or bilateral:** May occur on either side
- **Symmetric or asymmetric:** Variable
- **Limited field:** Does not spread

Clinical Significance

- **Benign:** No clinical significance
- **No seizure risk:** Does not indicate epilepsy
- **Common:** Seen in 1-2% of normal adults
- **May be mistaken for spikes:** Important to recognize

Mu Rhythm

Characteristics

- **Central (C3/C4):** Over central regions
- **Arch-shaped:** Arciform morphology
- **Suppresses with movement:** Key distinguishing feature
- **8-13 Hz:** Alpha frequency range

Morphology

- **Arch-shaped:** Arciform appearance
- **8-13 Hz:** Alpha frequency
- **Asymmetric:** Often more prominent on one side
- **No aftergoing slow wave:** Key distinguishing feature

Distribution

- **Central regions:** C3, C4, Cz
- **Unilateral or bilateral:** May occur on either side
- **Limited field:** Does not spread widely
- **Reactive:** Suppresses with movement

Clinical Significance

- **Benign:** No clinical significance
- **Normal variant:** Common in healthy individuals
- **Movement-related:** Suppresses with contralateral movement
- **May be mistaken for spikes:** Important to recognize

Lambda Waves

Characteristics

- **Occipital:** Over occipital regions
- **Seen during visual scanning:** Key distinguishing feature
- **Disappear with eye closure:** Key distinguishing feature
- **Positive sharp transients:** Positive polarity

Morphology

- **Positive sharp transients:** Positive polarity
- **Occipital distribution:** O1, O2, Oz
- **Low to medium amplitude:** Usually 20-50 μV
- **No aftergoing slow wave:** Key distinguishing feature

Distribution

- **Occipital regions:** O1, O2, Oz
- **Bilateral:** Usually bilateral
- **Symmetric:** Usually symmetric
- **Limited field:** Does not spread

Clinical Significance

- **Benign:** No clinical significance
- **Normal variant:** Common in healthy individuals
- **Visual-related:** Occurs during visual scanning
- **May be mistaken for spikes:** Important to recognize

Other Common Variants

14 and 6 Hz Positive Spikes

- **Occipital/temporal:** Over occipital and temporal regions

- **14 and 6 Hz:** Characteristic frequency
- **Positive polarity:** Positive spikes
- **Sleep-related:** More common in sleep

Rhythmic Mid-Temporal Theta (RMTD)

- **Temporal:** Over temporal regions
- **Theta frequency:** 4-7 Hz
- **Rhythmic:** Rhythmic appearance
- **Drowsiness:** More common in drowsiness

Subclinical Rhythmic Electroencephalographic Discharge of Adults (SREDA)

- **Temporal/parietal:** Over temporal and parietal regions
- **Rhythmic theta:** Rhythmic theta activity
- **Adults:** More common in adults
- **Benign:** No clinical significance

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3. Normal Variants vs Epileptiform Discharges

Feature	Normal Variant	Epileptiform
Aftergoing slow wave	Absent	Present
Field	Limited	Physiologic (may spread)
Reactivity	State dependent	Persistent
Clinical risk	None	Increased seizure risk
Morphology	May be sharp	Sharp/spike-like
Distribution	Limited	May be widespread
Context	Age/state specific	Not context-specific
Clinical correlation	No seizures	May correlate with seizures

Key Distinctions

Aftergoing Slow Wave

- **Normal variant:** No aftergoing slow wave
- **Epileptiform:** Aftergoing slow wave present
- **Critical feature:** Most important distinguishing feature
- **ABRET focus:** Frequently tested

Field

- **Normal variant:** Limited field (does not spread)
- **Epileptiform:** Physiologic field (may spread)
- **Distribution:** Variants are more localized
- **Spread:** Epileptiform may spread to adjacent regions

Reactivity

- **Normal variant:** State dependent (drowsiness, sleep)
- **Epileptiform:** Persistent (not state dependent)
- **Context:** Variants require specific context

- **Persistence:** Epileptiform persists across states

Clinical Risk

- **Normal variant:** No increased seizure risk
- **Epileptiform:** Increased seizure risk
- **Diagnosis:** Variants do not diagnose epilepsy
- **Treatment:** Variants do not require treatment

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4. Age & State Considerations

Pediatric EEGs Show More Variants

- **More variants in children:** Common in pediatric EEGs
- **Developmental:** Some variants are developmental
- **Age-specific:** Must use age-appropriate norms
- **Don't overcall:** Important not to overcall in children

Drowsiness Increases Benign Sharp Activity

- **Drowsiness:** Many variants appear during drowsiness
- **Light sleep:** Small sharp spikes common
- **State-dependent:** Variants are state-dependent
- **Context matters:** Must consider state

Sleep Stage Context Is Essential

- **Light sleep:** Many variants appear in light sleep
- **Deep sleep:** Some variants may persist
- **REM sleep:** Variants less common
- **Stage-specific:** Must know sleep stage

ABRET Emphasis

- **Age-appropriate interpretation is critical**
- Must use age-appropriate norms
- Don't overcall variants in children
- State context is essential

Best Practice

- Always note patient age
- Always note patient state (wake, drowsy, sleep)
- Compare to age-appropriate norms
- Consider state-dependent occurrence

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5. Common ABRET Exam Traps

Trap 1: Calling Benign Variants Epileptiform

- **Reality:** Variants are normal, not epileptiform
- **Trap:** May call variants as spikes or sharp waves
- **Solution:** Look for aftergoing slow wave
- **ABRET focus:** Frequently tested differentiation

Trap 2: Ignoring State of Occurrence

- **Reality:** Variants are state-dependent
- **Trap:** May call variant as epileptiform without considering state
- **Solution:** Always note state (drowsiness, sleep)
- **ABRET focus:** State context is critical

Trap 3: Overemphasizing Sharpness

- **Reality:** Sharpness alone doesn't make it epileptiform
- **Trap:** May call sharp variant as spike
- **Solution:** Must consider all features (aftergoing slow wave, field, context)
- **ABRET focus:** Morphology alone is not enough

Trap 4: Forgetting Clinical Context

- **Reality:** Clinical context guides interpretation
- **Trap:** May call variant as epileptiform without clinical correlation
- **Solution:** Always correlate with clinical presentation
- **ABRET focus:** Clinical correlation is essential

Trap 5: Not Recognizing Common Variants

- **Reality:** Common variants are frequently seen
- **Trap:** May not recognize common variants (BETS, wicket spikes)
- **Solution:** Learn common variants and their characteristics
- **ABRET focus:** Recognition of common variants

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6. Clinical Correlation

Normal Variants Do Not Diagnose Epilepsy

- **No diagnosis:** Variants do not diagnose epilepsy
- **No treatment:** Variants do not require treatment
- **No risk:** Variants do not increase seizure risk
- **Benign:** Variants are benign findings

EEG Interpretation Must Integrate

History

- **Seizure history:** Does patient have seizures?
- **Medications:** Are there medications that affect EEG?
- **Comorbidities:** Are there other conditions?
- **Clinical context:** What is the clinical question?

Exam

- **Neurological exam:** Are there neurological findings?
- **Mental status:** What is the mental status?
- **Physical exam:** Are there physical findings?
- **Clinical presentation:** What is the clinical presentation?

Imaging (If Available)

- **MRI/CT:** Are there structural abnormalities?
- **Correlation:** Do EEG findings correlate with imaging?
- **Localization:** Does imaging help with localization?
- **Clinical context:** How does imaging fit with clinical picture?

Best Practice

- Always integrate history, exam, and imaging
- Don't interpret EEG in isolation
- Variants require no action if clinical context is normal
- When in doubt, describe morphology, don't label

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7. Case-Based Example

Scenario

Clinical Setting: Routine EEG for headache evaluation
EEG Finding: Temporal sharp transients seen only during drowsiness
Clinical History: No seizures, normal neurological exam
Pattern: Sharp transients, temporal distribution, no aftergoing slow wave, state-dependent

Interpretation

- **Small sharp spikes (benign variant)**
- Temporal distribution
- No aftergoing slow wave
- State-dependent (drowsiness)
- No clinical significance

Teaching Point

- **Lack of aftergoing slow wave favors benignity**
- State-dependent occurrence favors variant
- No clinical correlation (no seizures) favors variant
- Must not be labeled as epileptiform

ABRET Application

- Given sharp transients → look for aftergoing slow wave
- Given state-dependent occurrence → consider variant
- Given no clinical correlation → favor variant
- Must differentiate variant from epileptiform

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8. Exam Readiness Checklist

Use this checklist to verify your understanding:

- [ ] Can identify common variants (BETS, wicket spikes, mu, lambda)
- [ ] Can differentiate variants from epileptiform discharges
- [ ] Can apply age/state context correctly
- [ ] Can avoid overcalling pathology
- [ ] Understand that morphology alone doesn't define epileptiform
- [ ] Know that aftergoing slow wave is key distinguishing feature
- [ ] Recognize that variants are state-dependent
- [ ] Know that variants do not diagnose epilepsy
- [ ] Understand that clinical correlation is essential
- [ ] Can identify common ABRET exam traps

- [ ] Know that variants require no treatment
- [ ] Understand that age-appropriate interpretation is critical

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9. Internal Cross-Links

Patterns

- **Epileptiform Discharges:** Contrast with normal variants
- **Sleep & Graphoelements:** Variants occur in sleep
- **Focal vs Generalized:** Understanding distribution

Workflow

- **Montages & Referencing:** Montage affects variant appearance
- **Filters & Time Constants:** Filters may affect variant recognition

Cases

- **Benign EEG pattern cases:** Cases with normal variants
- **Pediatric EEG cases:** Cases in children with variants
- **Sleep-related cases:** Cases with sleep-related variants

Quizzes

- **Normal variant MCQs:** Questions on variant recognition
- **Differentiation questions:** Questions on variant vs epileptiform
- **Context questions:** Questions on age/state context

Study Tips

1. **Memorize common variants:** BETS, wicket spikes, mu, lambda
2. **Learn distinguishing features:** Aftergoing slow wave, field, reactivity
3. **Practice differentiation:** Variant vs epileptiform
4. **Understand context:** Age and state are critical
5. **Know the principle:** Morphology alone doesn't define epileptiform
6. **Remember the traps:** Calling variants epileptiform, ignoring state
7. **ABRET focus:** Expect questions on differentiation and recognition

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End of Study Guide

For additional practice, complete quiz questions tagged: normal-variant, wicket, mu, lambda, benign-sharp