NeuroTrace Study Guide

Domain: Domain III – EEG Patterns & Clinical Correlation
Section: Diffuse Slowing
Style: Background-analysis, applied, exam-oriented

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1. Core Principles (Must Know)

Background Rhythm Reflects Global Cortical Function

- **Background rhythm reflects global cortical function**
- Normal background indicates normal cortical function
- Abnormal background indicates cortical dysfunction
- Background is the foundation of EEG interpretation

Diffuse Slowing Indicates Generalized Cerebral Dysfunction

- **Diffuse slowing indicates generalized cerebral dysfunction**
- Bilateral, widespread slowing
- Suggests global brain dysfunction
- Different from focal slowing (localized)

Severity Correlates with Degree of Slowing

- **Severity correlates with degree of slowing**
- Mild: Slowed PDR, excess theta
- Moderate: Dominant theta/delta
- Severe: High-amplitude delta, loss of organization
- Severity guides clinical correlation

Key Principle

- **Background organization is more important than amplitude alone**
- Organization (rhythmicity, reactivity) matters more than amplitude
- Well-organized slow background is less severe than disorganized
- Must assess both frequency and organization

Practical Application

- Always assess background first
- Classify as normal, mild, moderate, or severe slowing
- Exclude technical causes before interpretation
- Correlate with clinical presentation

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2. Normal Background Review

Adults

Posterior Dominant Rhythm (PDR)

- **8–13 Hz** (alpha range)
- Present in wakefulness with eyes closed
- Reactive to eye opening (attenuates)
- Symmetric, well-organized
- Maximal over occipital regions

Normal Variants

- **Beta:** 14–30 Hz, frontal-central, low amplitude
- **Theta:** 4–7 Hz, frontal, drowsiness
- **Delta:** <4 Hz, sleep stages, minimal in wake

Children

Age-Dependent Norms

- **Newborns:** Discontinuous, mixed frequencies
- **3 months:** Continuous, 3–4 Hz dominant
- **6 months:** 4–5 Hz dominant
- **1 year:** 5–6 Hz dominant
- **3 years:** 7–8 Hz dominant
- **8 years:** 8–9 Hz dominant
- **Adolescence:** Adult-like (8–13 Hz)

Key Points

- Background frequency increases with age
- Organization improves with maturation
- Must use age-appropriate norms
- Don't overcall slowing in children

Background Must Be Assessed In

Wakefulness

- **Eyes closed:** PDR should be present
- **Eyes open:** PDR should attenuate (reactivity)
- **Mental tasks:** PDR may attenuate
- **Alertness:** Background should be organized

Drowsiness

- **PDR slows:** May drop to 7–8 Hz
- **Frontal theta:** Normal drowsy pattern
- **Vertex waves:** Normal drowsy pattern
- **Reactivity:** May be reduced

Sleep (If Present)

- **Stage 1:** Theta, vertex waves
- **Stage 2:** Sleep spindles, K-complexes
- **Stage 3/4:** Delta activity (normal)
- **REM:** Low amplitude, mixed frequencies

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3. Diffuse Slowing Patterns

Mild Diffuse Slowing

Characteristics

- **Slowed PDR:** PDR <8 Hz in adults
- **Excess theta:** More theta than expected for age/state
- **Preserved organization:** Background still organized
- **Reactivity present:** May still react to eye opening

Clinical Significance

- **Mild encephalopathy:** Early metabolic/toxic changes
- **Medication effects:** Some medications cause mild slowing
- **Fatigue:** May be seen with sleep deprivation
- **Often reversible:** May improve with treatment

Moderate Diffuse Slowing

Characteristics

- **Dominant theta/delta:** Theta or delta is dominant frequency
- **Reduced organization:** Background less organized
- **Reduced reactivity:** May not react to eye opening
- **PDR absent or very slow:** <7 Hz or absent

Clinical Significance

- **Moderate encephalopathy:** More significant dysfunction
- **Metabolic disorders:** Hepatic, renal, metabolic causes
- **Toxic states:** Medications, toxins, drugs
- **May be reversible:** Depends on cause

Severe Diffuse Slowing

Characteristics

- **High-amplitude delta:** Dominant delta activity
- **Loss of organization:** Disorganized, chaotic background
- **No reactivity:** No response to stimulation
- **PDR absent:** No organized background rhythm

Clinical Significance

- **Severe encephalopathy:** Profound dysfunction
- **Hypoxic injury:** Post-anoxic encephalopathy
- **Severe metabolic:** End-stage metabolic disorders
- **Poor prognosis:** Often indicates severe injury

ABRET Emphasis

- **Severity of slowing reflects encephalopathy depth**
- Mild slowing = mild dysfunction
- Moderate slowing = moderate dysfunction
- Severe slowing = severe dysfunction
- Must grade severity accurately

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4. Diffuse vs Focal Slowing

Feature	Diffuse	Focal
Distribution	Bilateral	Regional
Symmetry	Usually symmetric	Asymmetric
Etiology	Metabolic/toxic	Structural
Localization	No	Yes

Clinical Implication	Systemic cause	Focal lesion
Imaging	May not need	Often warranted
Treatment	Systemic	Focal (may be surgical)

Key Distinctions

Diffuse Slowing

- **Bilateral distribution:** Both hemispheres involved
- **Usually symmetric:** Both sides equally affected
- **Systemic causes:** Metabolic, toxic, infectious
- **No localization:** Cannot localize to specific region

Focal Slowing

- **Regional distribution:** Limited to one area
- **Asymmetric:** One side more affected
- **Structural causes:** Lesion, scar, stroke
- **Localization possible:** Can identify specific region

Clinical Application

- Distribution guides etiology
- Diffuse = systemic evaluation (labs, metabolic)
- Focal = structural evaluation (imaging)
- Must distinguish before interpretation

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5. Technical Pitfalls

High LFF Masking Delta

- **Problem:** High LFF (e.g., 5 Hz) attenuates delta activity
- **Result:** May mask true diffuse slowing
- **Solution:** Use low LFF (0.5–1 Hz) to see slow activity
- **ABRET trap:** Calling normal background when LFF too high

Low HFF Exaggerating Slowing

- **Problem:** Low HFF (e.g., 15 Hz) may exaggerate slow activity
- **Result:** May make normal background appear slow
- **Solution:** Use appropriate HFF (35–70 Hz) for routine
- **ABRET trap:** Overcalling slowing with low HFF

Inappropriate Sensitivity

- **Problem:** Too high or too low sensitivity affects appearance
- **Result:** May make background appear abnormal
- **Solution:** Use standard sensitivity (7.5–10 μV/mm)
- **ABRET trap:** Misinterpreting amplitude changes as slowing

Aliasing Mimicking Slowing

- **Problem:** Inadequate sampling rate causes aliasing
- **Result:** High-frequency activity appears as slow activity
- **Solution:** Use adequate sampling rate (≥200 Hz)

- **ABRET trap:** Calling slowing when it's actually aliasing

ABRET Trap

- **Always verify settings before calling diffuse slowing**
- Check LFF, HFF, sensitivity, sampling rate
- Technical errors can mimic or mask slowing
- Must exclude technical causes first

Best Practice

- Verify all technical settings
- Compare across montages
- Check for artifacts
- Confirm with clinical correlation

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6. Common Etiologies

Metabolic Encephalopathy

- **Hepatic:** Liver failure, hepatic encephalopathy
- **Renal:** Uremia, renal failure
- **Electrolyte:** Hyponatremia, hypercalcemia
- **Glucose:** Hypoglycemia, hyperglycemia
- **Thyroid:** Hypothyroidism, hyperthyroidism

Toxic States

- **Medications:** Antiepileptics, sedatives, psychotropics
- **Drugs:** Alcohol, opioids, benzodiazepines
- **Toxins:** Carbon monoxide, lead, mercury
- **Withdrawal:** Alcohol, benzodiazepine withdrawal

Hypoxic-Ischemic Injury

- **Cardiac arrest:** Post-anoxic encephalopathy
- **Respiratory failure:** Hypoxia, hypercapnia
- **Stroke:** Global ischemia
- **Near-drowning:** Hypoxic injury

Diffuse Infections

- **Encephalitis:** Viral, bacterial, autoimmune
- **Meningitis:** Bacterial, viral, fungal
- **Sepsis:** Systemic infection
- **HIV:** HIV encephalopathy

Other Causes

- **Trauma:** Diffuse axonal injury
- **Degenerative:** Alzheimer's, Creutzfeldt-Jakob
- **Inflammatory:** Autoimmune encephalitis
- **Neoplastic:** Diffuse gliomatosis

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7. Common ABRET Exam Traps

Trap 1: Calling Diffuse Slowing with Raised LFF

- **Reality:** High LFF masks slow activity
- **Trap:** May call normal background when LFF too high
- **Solution:** Always check LFF before interpreting
- **ABRET focus:** Technical settings affect interpretation

Trap 2: Overlocalizing Symmetric Slowing

- **Reality:** Symmetric slowing is diffuse, not focal
- **Trap:** May try to localize symmetric patterns
- **Solution:** Symmetric = diffuse, not focal
- **ABRET focus:** Distribution classification

Trap 3: Ignoring Age-Related Norms

- **Reality:** Background frequency varies with age
- **Trap:** May overcall slowing in children
- **Solution:** Use age-appropriate norms
- **ABRET focus:** Pediatric vs adult norms

Trap 4: Confusing Sleep-Related Slowing with Pathology

- **Reality:** Delta in sleep is normal
- **Trap:** May call normal sleep delta as slowing
- **Solution:** Must know patient state (wake vs sleep)
- **ABRET focus:** State-dependent interpretation

Trap 5: Not Excluding Technical Causes

- **Reality:** Technical errors can mimic slowing
- **Trap:** May call technical artifact as slowing
- **Solution:** Always verify settings first
- **ABRET focus:** Technical troubleshooting

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8. Case-Based Example

Scenario

Clinical Setting: ICU EEG for altered mental status
EEG Finding: Generalized theta with poorly formed PDR
Clinical History: Hepatic encephalopathy
Pattern: Diffuse theta (4–7 Hz), bilateral, symmetric, poorly organized

Interpretation

- **Mild to moderate diffuse slowing**
- Bilateral, symmetric theta
- Poorly organized background
- Consistent with metabolic encephalopathy

Teaching Point

- **Diffuse slowing reflects global dysfunction, not focal lesions**
- Bilateral, symmetric = diffuse, not focal
- Metabolic causes common (hepatic, renal, toxic)

- Must correlate with clinical presentation

ABRET Application

- Given diffuse slowing → classify severity (mild/moderate/severe)
- Understand that diffuse = systemic, not structural
- Know that technical settings must be verified
- Correlate with clinical findings

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9. Exam Readiness Checklist

Use this checklist to verify your understanding:

- ☐ Can assess background organization (normal vs abnormal)
- ☐ Can identify diffuse slowing severity (mild/moderate/severe)
- ☐ Can exclude technical causes (LFF, HFF, sensitivity, sampling)
- ☐ Can apply clinical correlation (metabolic, toxic, hypoxic)
- ☐ Understand that diffuse slowing = bilateral, symmetric
- ☐ Know that severity reflects encephalopathy depth
- ☐ Recognize that technical settings affect interpretation
- ☐ Can differentiate diffuse vs focal slowing
- ☐ Know age-appropriate norms for background
- ☐ Understand that background organization matters more than amplitude
- ☐ Can identify common ABRET exam traps
- ☐ Know that diffuse slowing suggests systemic causes

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10. Internal Cross-Links

Technical Settings

- **Filters & Time Constants:** LFF affects slow activity visibility
- **Timebase & Sampling Rate:** Sampling rate prevents aliasing
- **Amplifiers & Sensitivity:** Sensitivity affects amplitude interpretation

Patterns

- **Focal vs Generalized:** Understanding distribution classification
- **Focal Slowing:** Contrast with diffuse slowing
- **Normal Background:** Understanding normal vs abnormal

Workflow

- **Background Assessment:** How to assess background properly
- **Technical Troubleshooting:** Excluding technical causes

Cases

- **Encephalopathy EEG cases:** Cases with diffuse slowing
- **ICU EEG:** Cases in critical care settings
- **Metabolic encephalopathy:** Cases with metabolic causes

Quizzes

- **Diffuse slowing MCQs:** Questions on recognition and interpretation

- **Background assessment:** Questions on background evaluation
- **Technical exclusion:** Questions on excluding technical causes

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Study Tips

1. **Memorize normal background:** Adults 8–13 Hz, age-dependent in children
2. **Learn severity grades:** Mild (slowed PDR), Moderate (theta/delta), Severe (high-amplitude delta)
3. **Practice technical exclusion:** Always check settings before interpreting
4. **Understand distribution:** Diffuse = bilateral, symmetric; Focal = regional, asymmetric
5. **Know common causes:** Metabolic, toxic, hypoxic, infectious
6. **Remember the principle:** Organization matters more than amplitude
7. **ABRET focus:** Expect questions on recognition, severity, and technical pitfalls

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End of Study Guide

For additional practice, complete quiz questions tagged: diffuse-slowing, encephalopathy, background, pdr