NeuroTrace Study Guide

Domain: Domain II – EEG Instrumentation & Procedures
Section: Filters & Time Constants
Format: Point-form, exam-oriented
Tone: Clinical, applied, ABRET-focused

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1. Core Concepts (Must Know)

- EEG filters **attenuate** frequency components; they do not remove signals
- LFF and HFF are the primary EEG filters
- Time constant is mathematically related to LFF
- Digital EEG follows the same physiologic filter principles as analog EEG
- Filter settings affect waveform **appearance**, not the underlying signal
- Understanding filter effects is critical for accurate interpretation

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2. Low-Frequency Filter (LFF)

Purpose

- Controls display of slow activity (delta, slow theta)
- Prevents baseline drift and very slow artifacts

Raising LFF

- **Attenuates slow waves**
- **Masks diffuse slowing** (HIGH-YIELD ABRET TRAP)
- Can falsely normalize EEG appearance
- Reduces delta and very slow theta activity
- May hide encephalopathic patterns

Common Settings

- **Adults:** ~0.1–0.3 Hz
- **Pediatrics:** often lower (0.05–0.1 Hz) to preserve slow activity
- **ICU/Coma:** may need lower settings to detect slow patterns

ABRET Trap

- **Masked encephalopathy due to high LFF**
- EEG appears "normal" but pathology is hidden
- Always verify LFF setting when assessing diffuse slowing

Clinical Impact

- High LFF in encephalopathy → false-negative interpretation
- Pediatric EEGs especially vulnerable to LFF effects
- Always check filter settings before reporting "normal" background

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3. High-Frequency Filter (HFF)

Purpose

- Controls display of fast activity and spike sharpness

- Reduces high-frequency noise and muscle artifact

Lowering HFF

- **Rounds spikes** (reduces sharpness)
- **Reduces epileptiform morphology**
- Attenuates beta and gamma activity
- May hide fast epileptiform discharges

Raising HFF

- Preserves spike sharpness
- May increase muscle artifact visibility
- Better for detecting fast epileptiform activity

Common Settings

- **Typical:** 35–70 Hz
- **Spike detection:** may use higher (70 Hz)
- **Artifact reduction:** may use lower (35 Hz)

ABRET Trap

- **False-negative epileptiform interpretation** due to low HFF
- Rounded spikes may be missed or misinterpreted
- Always verify HFF when assessing for epileptiform activity

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4. Time Constant (Conceptual)

Relationship to LFF

- **Shorter time constant = higher LFF**
- **Longer time constant = better slow-wave preservation**
- Time constant and LFF describe the same phenomenon from different perspectives

Key Concept

- LFF and time constant are inversely related
- Both control slow-wave attenuation
- Understanding one helps understand the other

Practical Application

- Analog systems: time constant setting
- Digital systems: LFF setting (Hz)
- Both achieve the same result

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5. Filter Effects vs True Pathology (Table)

EEG Appearance	Technical Cause	Clinical Implication
Loss of delta activity	LFF too high	May mask encephalopathy
Rounded spikes	HFF too low	May miss epileptiform activity
Excess fast activity	HFF too high OR muscle artifact	Need to differentiate

Apparent normalization	Improper filtering (LFF too high)	False-negative interpretation
Reduced spike amplitude	HFF too low	Epileptiform may be missed
Baseline appears "clean"	LFF too high	Slow pathology hidden

Critical Distinction

- **Technical distortion:** Caused by filter settings
- **True pathology:** Actual cerebral abnormality
- **ABRET expects:** Ability to differentiate these

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6. Common ABRET Exam Traps

Trap 1: Confusing Sensitivity with Filter Effects

- **Sensitivity** controls amplitude (μV/mm)
- **Filters** control frequency content
- These are independent settings
- Don't confuse amplitude changes with frequency filtering

Trap 2: Assuming Digital EEG Compensates

- Digital EEG still requires correct filter settings
- "Automatic" settings may not be optimal
- Always verify filter values, even in digital systems

Trap 3: Misattributing Filter Distortion to Clinical Improvement

- Patient appears "better" but it's just filter change
- Always check settings before attributing changes to clinical status
- Filter changes ≠ clinical improvement

Trap 4: Thinking Photic Stimulation Affects Slow-Wave Interpretation

- Photic affects fast activity (beta/gamma)
- Does NOT affect slow-wave (delta/theta) interpretation
- LFF affects slow waves independently

Trap 5: Not Verifying Settings

- Always check LFF/HFF before interpretation
- Settings may have been changed during recording
- Document filter settings in technical report

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7. Clinical Correlation

Diffuse Slowing Assessment

- **Requires correct LFF** (typically 0.1–0.3 Hz for adults)
- High LFF will mask diffuse slowing
- Always verify LFF when assessing encephalopathy

Pediatric EEGs

- **Especially vulnerable** to filter effects
- Need lower LFF to preserve slow activity

- Pediatric norms include more slow activity

Filter Misuse Consequences

- **Missed pathology:** High LFF hides encephalopathy
- **False positives:** Low HFF rounds normal variants
- **Incorrect interpretation:** Technical artifact mistaken for pathology

Best Practice

- Verify filter settings at start of recording
- Document settings in technical report
- Re-check settings if EEG appears unexpectedly "normal"

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8. Case-Based Example

Scenario

Clinical Setting: Adult patient with altered mental status
EEG Finding: Background appears normal, well-organized
Hidden Issue: LFF set to 1.0 Hz (too high)

What Happened

- Diffuse slowing was present but attenuated by high LFF
- EEG appeared "normal" due to filter artifact
- True pathology (encephalopathy) was masked

Correct Action

1. **Lower LFF** to 0.1–0.3 Hz
2. **Reassess** background activity
3. **Verify** diffuse slowing is now visible
4. **Document** filter change and findings

Teaching Point

- **Always verify settings** before interpretation
- Filter changes can dramatically alter EEG appearance
- "Normal" appearance may be technical artifact

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9. Exam Readiness Checklist

Use this checklist to verify your understanding:

- [ ] Can explain the difference between LFF and HFF
- [ ] Can predict waveform distortion from filter changes
- [ ] Can identify filter-related artifacts
- [ ] Can differentiate technical distortion from true pathology
- [ ] Understand that raising LFF masks diffuse slowing
- [ ] Know that lowering HFF rounds spikes
- [ ] Recognize that filter settings must be verified
- [ ] Understand time constant relationship to LFF
- [ ] Can identify ABRET exam traps related to filters

- [ ] Know common filter settings for adults vs pediatrics

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10. Internal Cross-Links

Workflow

- **Instrumentation & Display Settings** (parent section)
- Related sections: Montages, Artifacts, Waveform Identification

Patterns

- **Diffuse Slowing:** Requires correct LFF to visualize
- **Epileptiform Activity:** Requires correct HFF to detect sharp morphology
- **Normal Variants:** May be distorted by improper filtering

Cases

- Filter-related interpretation errors
- Cases involving masked encephalopathy
- Technical artifact vs true pathology

Quizzes

- Applied filter physics MCQs
- Predict waveform appearance from filter changes
- Identify filter-related artifacts
- ABRET-style filter trap questions

Study Tips

1. **Memorize the traps:** High LFF masks slowing; Low HFF rounds spikes
2. **Practice prediction:** Given filter change, predict EEG appearance
3. **Verify settings:** Always check LFF/HFF before interpretation
4. **Clinical correlation:** Understand why filters matter for patient care
5. **ABRET focus:** Expect questions on filter effects and waveform distortion

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End of Study Guide

For additional practice, complete quiz questions tagged: lff, hff, time-constant, signal-distortion, abret-trap