NeuroTrace Academy Study Guide

Category: Medical Terminology
Topic: Normal EEG Variants
Style: Pattern-based, exam-oriented, discrimination-focused

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1. Core Principles (Must Know)

Normal Variants vs Pathologic Patterns

- **Normal variants are benign and do not indicate pathology**
- **Key distinguishing features prevent misdiagnosis**
- **Reactivity and state-dependence are critical discriminators**
- **Location and morphology help identify variants**

Key Principle

- **Understanding normal variants prevents false-positive interpretations and unnecessary treatment**

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2. Alpha Variants

Fast Alpha Variant

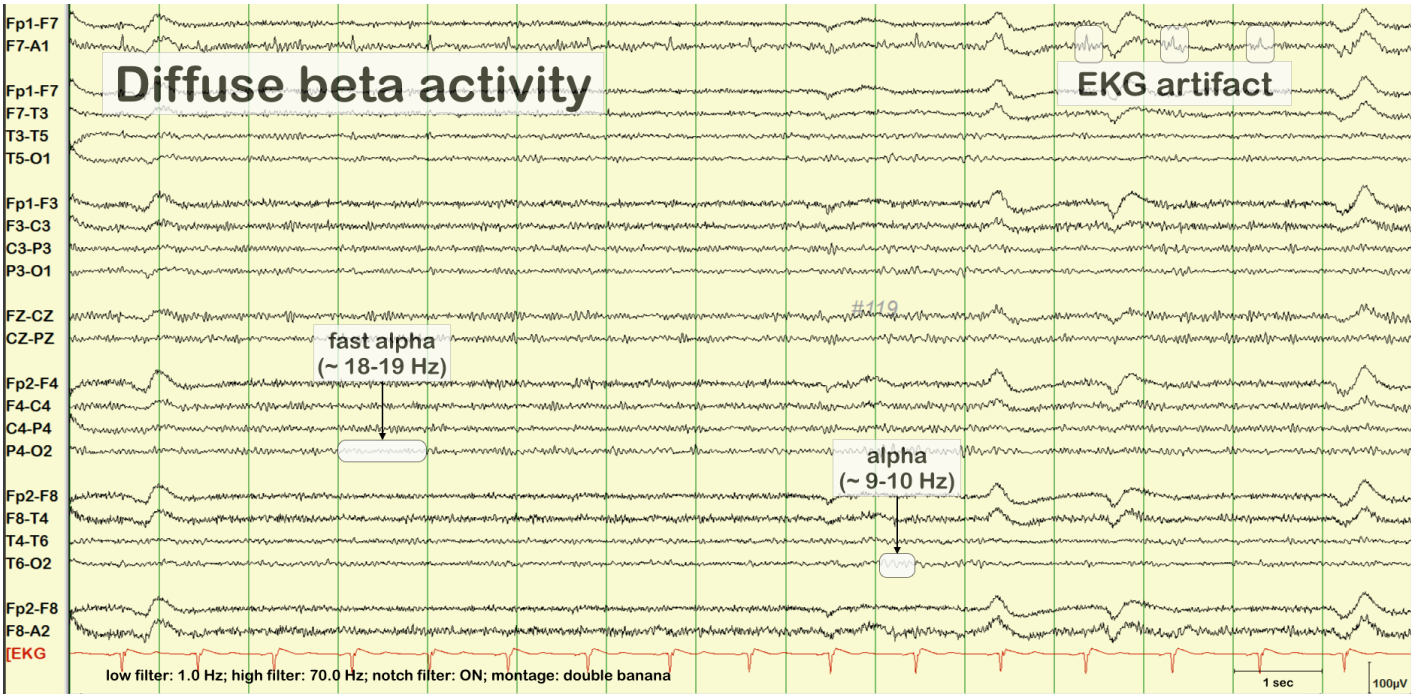

Figure: Fast alpha variant (arrow); sensitivity 7 µV/mm, LFF 1 Hz, HFF 70 Hz

- **Definition:** Harmonic of posterior background rhythm - twice as fast as PDR
- **Frequency:** 16–26 Hz (twice the PDR frequency)
- **Location:** Occipital/posterior regions
- **Morphology:** Notched appearance
- **State:** Wake, eyes-closed

- **Reactivity:** Reactive to eye opening and closure
- **Distinction from Beta:** Similar to beta rhythms except located in occipital rather than frontal, central, and parietal regions
- **Distinction from RMTD:** Both have notched appearance, but fast alpha variant is posterior and reactive; RMTD is mid-temporal and occurs during drowsiness
- 🔑 **Key:** Harmonic (twice as fast) + posterior + reactive = fast alpha variant

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Slow Alpha Variant

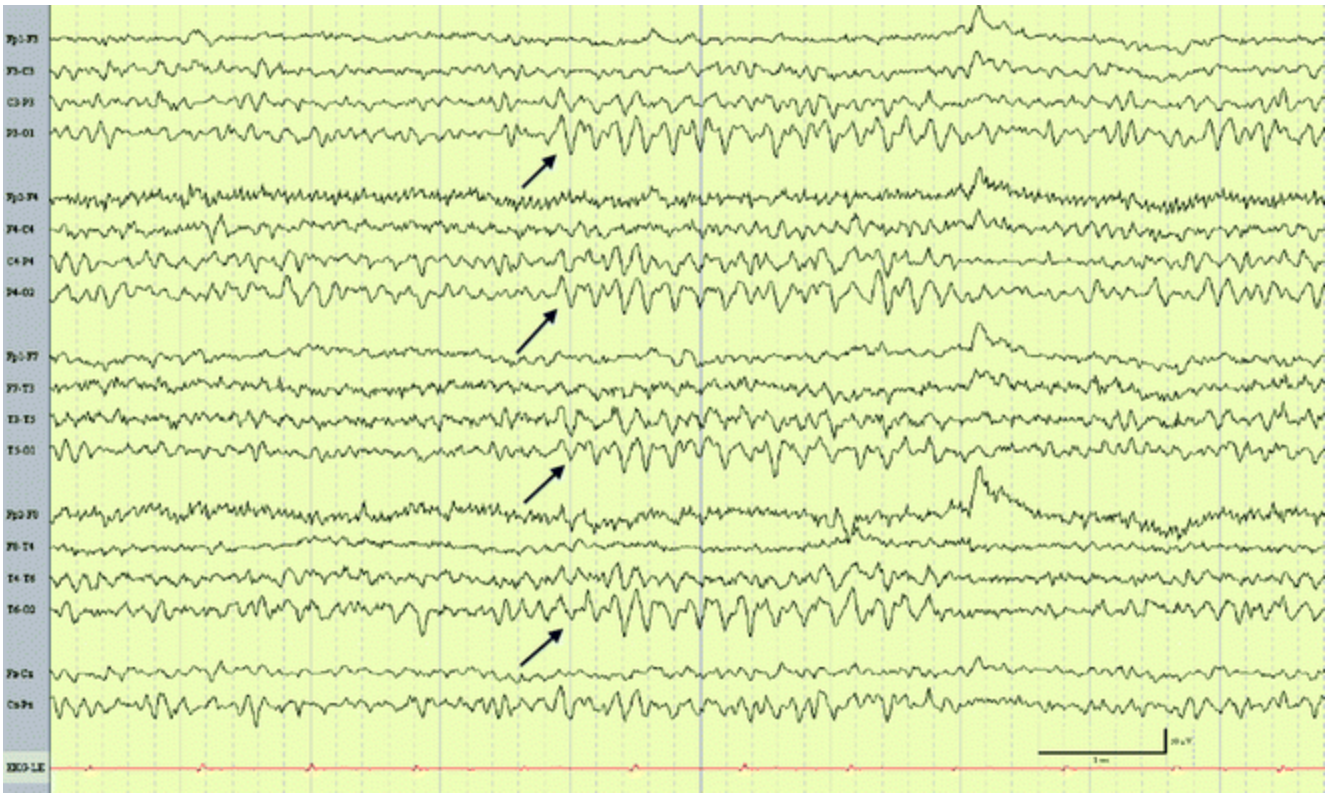

Figure: Slow alpha variant (arrows); sensitivity 7 µV/mm, LFF 1 Hz, HFF 70 Hz

- **Definition:** Harmonic of posterior background rhythm - half as fast as PDR
- **Frequency:** 4–6.5 Hz (half the PDR frequency)
- **Location:** Occipital/posterior regions
- **Morphology:** Notched appearance
- **State:** Wake, eyes-closed
- **Reactivity:** Reactive to eye opening and closure (critical for identification)
- **Distinction from RMTD:** Both have notched appearance and similar frequency, but slow alpha variant is posterior and reactive; RMTD is mid-temporal
- **Distinction from Drowsy Slowing:** Slow alpha variant is reactive; drowsy slowing is state-dependent and not reactive
- 🔑 **Key:** Harmonic (half as fast) + posterior + reactive = slow alpha variant. **More difficult to discern without clear reactivity**

Alpha Squeak

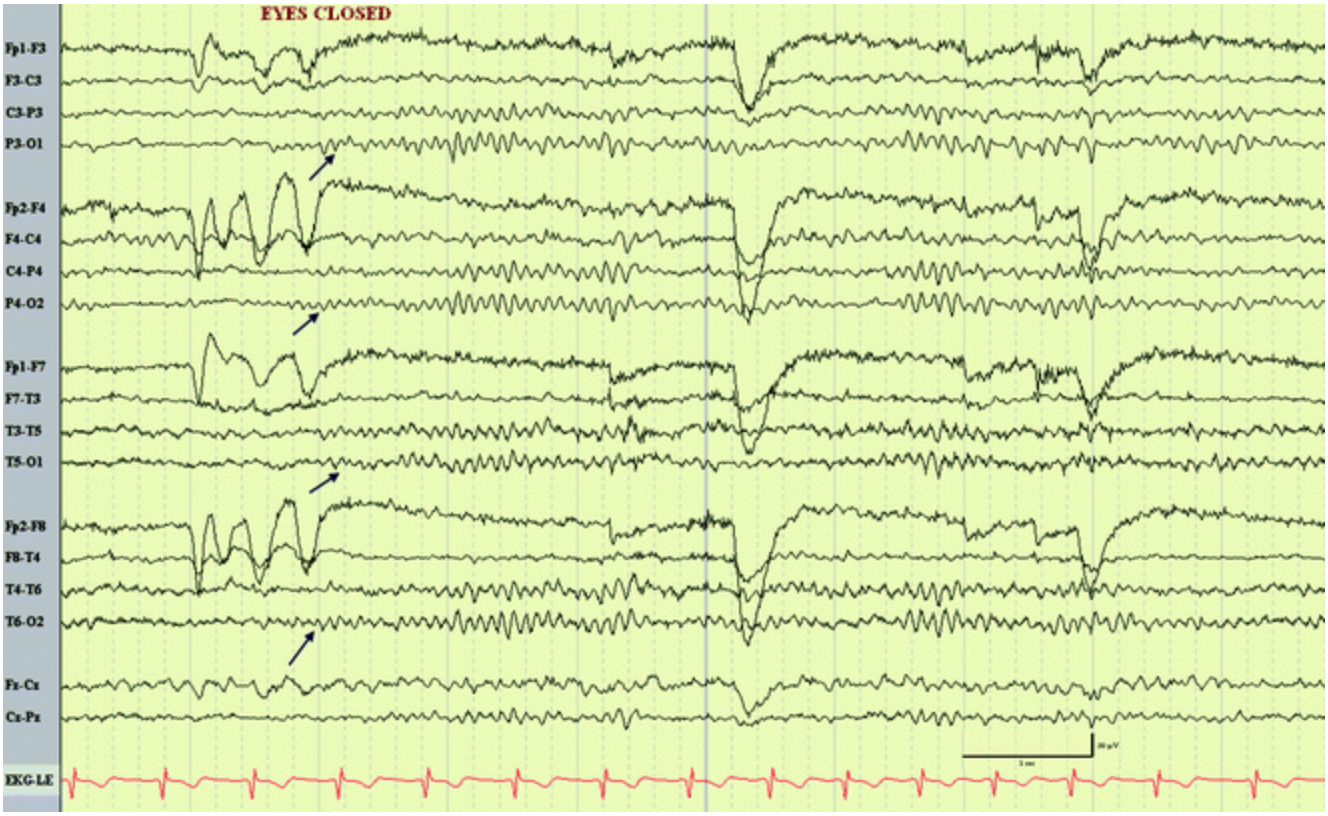

Figure: Alpha squeak (arrows); sensitivity 7 µV/mm, LFF 1 Hz, HFF 70 Hz

- **Definition:** Transient increase in frequency immediately after eye closure
- **Location:** Occipital/posterior regions
- **Timing:** First 0.5–1 s after eye closure
- **State:** Wake, eyes-closed
- **Clinical Significance:** Should be excluded when assessing PDR frequency to avoid overestimation
- 🔑 **Key:** Transient frequency increase + immediately after eye closure = alpha squeak

🔑 **Exam Pearl:** Assessment of PDR frequency should NOT include the first 0.5–1 s after eye closure to avoid overestimation.

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3. Temporal Variants

Rhythmic Mid-Temporal Theta Bursts of Drowsiness (RMTD)

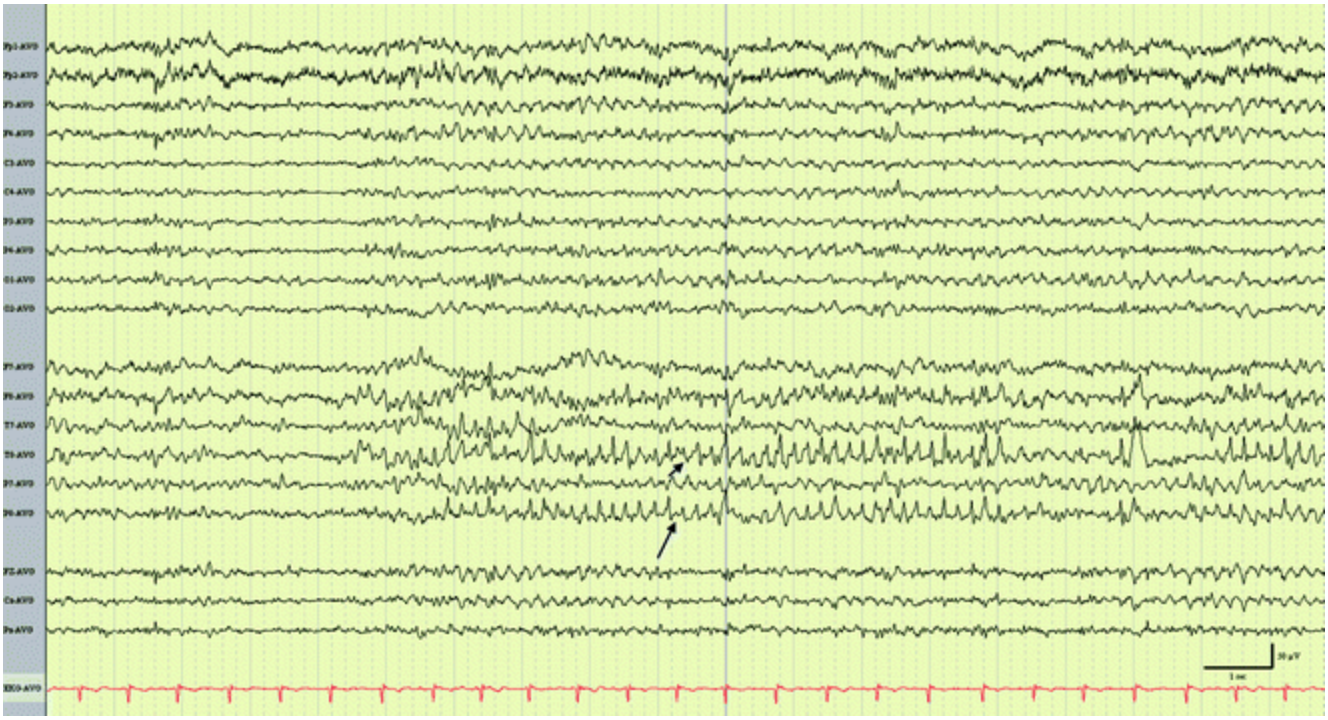

Figure: Rhythmic Mid-Temporal Theta Bursts of Drowsiness (RMTD) (arrows); sensitivity 7 µV/mm, LFF 1 Hz, HFF 70 Hz

- **Also known as:** Rhythmic Mid-Temporal Discharges (RMTD) and psychomotor variant
- **Frequency:** 5–7 Hz
- **Location:** Mid-temporal regions
- **Morphology:** Rhythmic bursts or trains of theta waves usually with a notched appearance
- **State:** Relaxed wakefulness and drowsiness
- **Distribution:** Occurs bilaterally with shifting emphasis from side to side
- **Characteristics:**
  - Monomorphic and monorhythmic
  - Does NOT evolve into other waveforms or frequencies
- **Distinction from Alpha Variants:** Notched appearance can resemble fast/slow alpha variants except RMTD occurs over mid-temporal regions rather than posterior head regions
- **Distinction from Pathologic Temporal Slowing:** RMTD is rhythmic and symmetric; pathologic slowing is irregular and asymmetric
- 🔑 **Key:** Rhythmic + mid-temporal + notched + drowsiness + no evolution = RMTD

Wicket Spikes

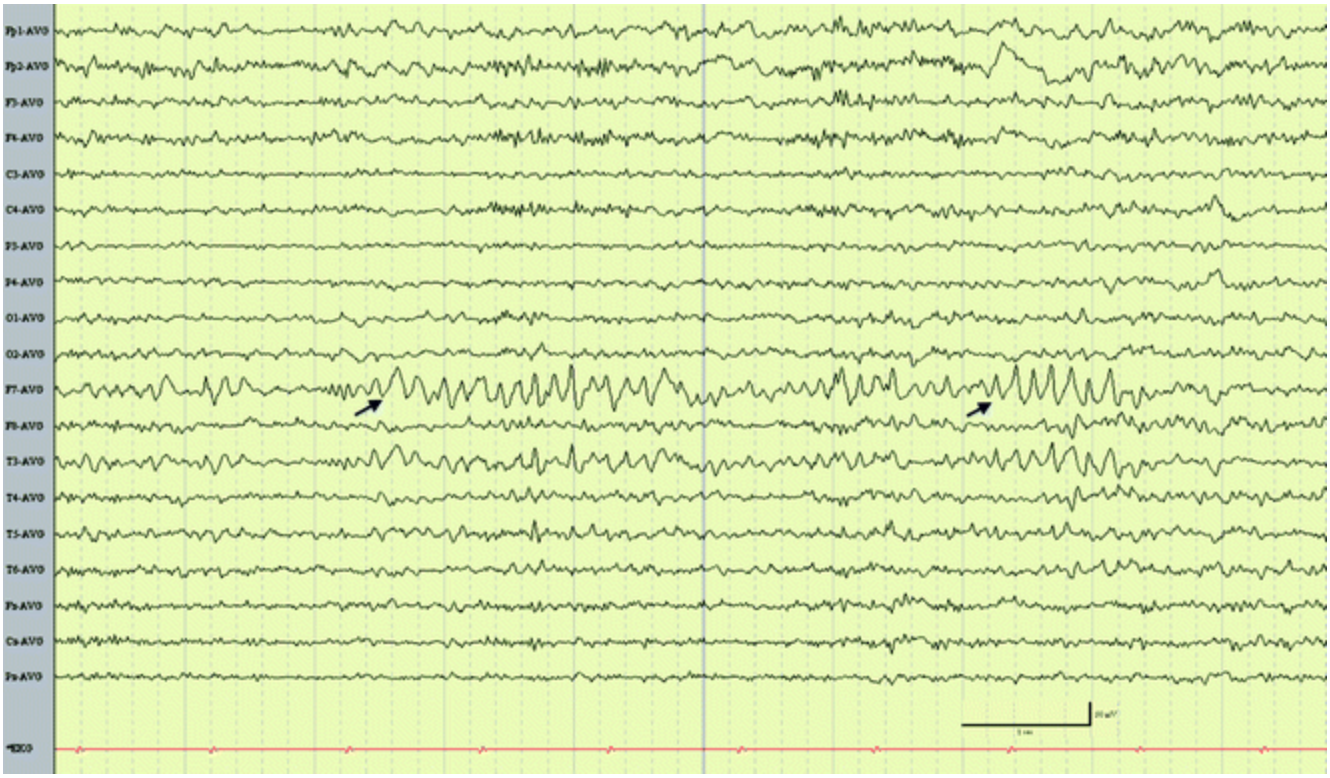

Figure: Left wicket rhythm (arrows); sensitivity 7 µV/mm, LFF 0.5 Hz, HFF 70 Hz

- **Frequency:** 6–11 Hz
- **Location:** Temporal regions
- **Morphology:** Intermittent trains of monophasic arciform waveforms or single spike-like waveforms
- **State:** Wakefulness, drowsiness, and light sleep (disappear in deeper sleep)
- **Distribution:** Occur exclusively on one side (left > right) or bilaterally with shifting predominance
- **Characteristics:**
  - Possibly represent fragments of temporal alpha activity or the third rhythm
  - Lack aftergoing slow waves
  - Do not disrupt background
- **Distinction from Temporal Seizure Discharge:** Wicket spikes lack slow waves and do not disrupt background; seizure discharges have slow waves and disrupt background
- **Distinction from Temporal Spikes:** Wicket spikes occur in trains without slow waves; epileptiform spikes are isolated or in brief bursts with slow waves
- 🔑 **Key:** Trains + arciform + no slow waves + no background disruption = wicket spikes

🔑 **Exam Pearl:** If a single spike is found, it should be compared with a train of wicket spikes on other pages to confirm identification. Should NOT be mistaken for temporal seizure discharge or spikes.

Benign Sporadic Sleep Spikes (BSSS) / Benign Epileptiform Transients of Sleep (BETS)

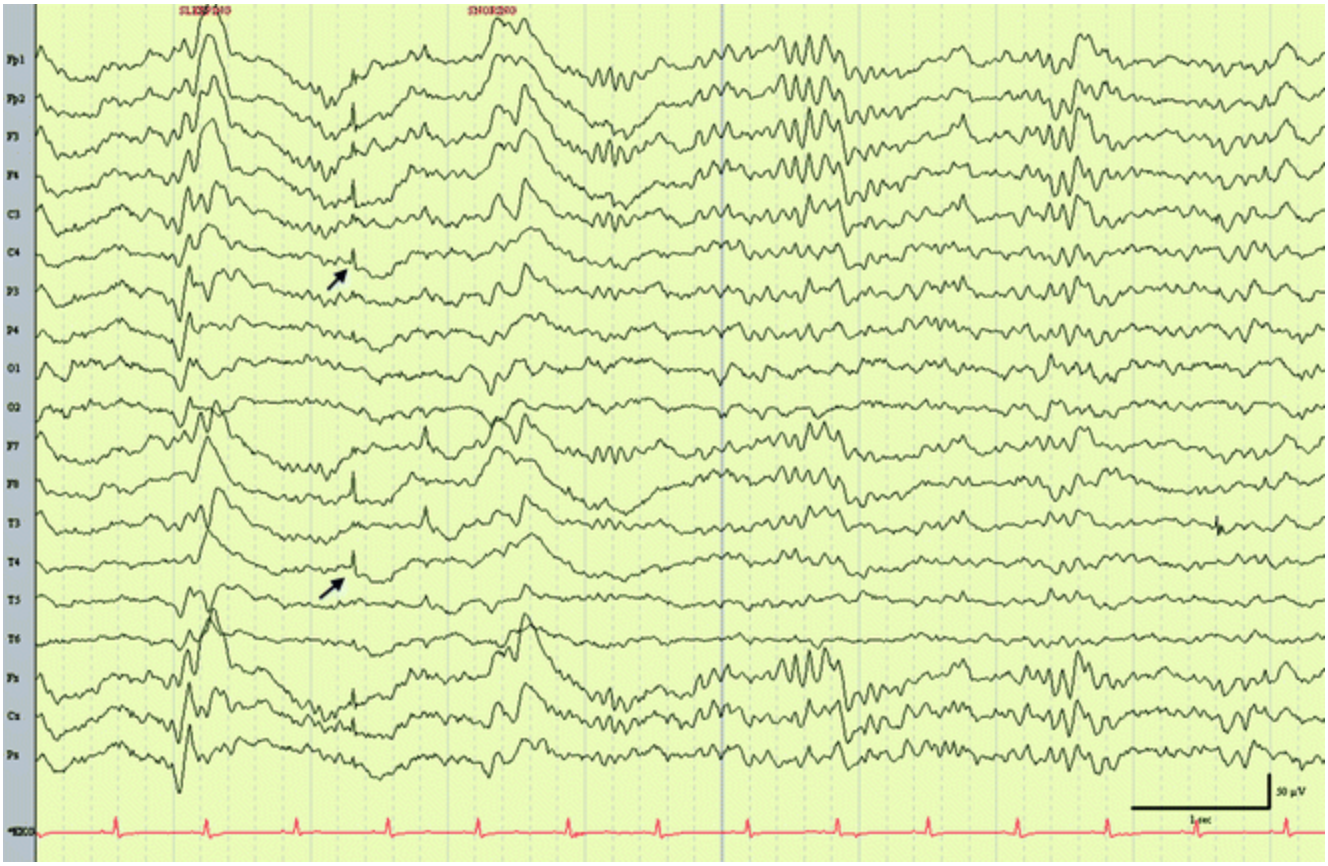

Figure: Benign sporadic sleep spikes (BSSS) (arrows); sensitivity 7 µV/mm, LFF 1 Hz, HFF 70 Hz

- **Also known as:** Small sharp spikes (SSS) or benign epileptiform transients of sleep (BETS)
- **Location:** Temporal regions
- **State:** Drowsiness and light sleep (disappear with deeper sleep)
- **Morphology:**
  - Low-voltage (<50 µV)
  - Short-duration (<50 ms)
  - Monophasic or diphasic
  - Abrupt ascending limb and steep descending limb
- **Characteristics:**
  - Usually do NOT have a slow-wave component
  - Do NOT occur in repetitive trains
  - Commonly occur unilaterally but can independently involve the opposite hemisphere
- **Distinction from Epileptiform Spikes:** BETS lack aftergoing slow waves; epileptiform spikes have slow waves
- **Distinction from Wicket Spikes:** BETS are isolated small spikes; wicket spikes occur in trains
- 🔑 **Key:** Small (<50 µV, <50 ms) + isolated + no slow waves + drowsiness/light sleep = BETS

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4. Central/Midline Variants

Midline Theta Rhythm (Ciganek Rhythm)

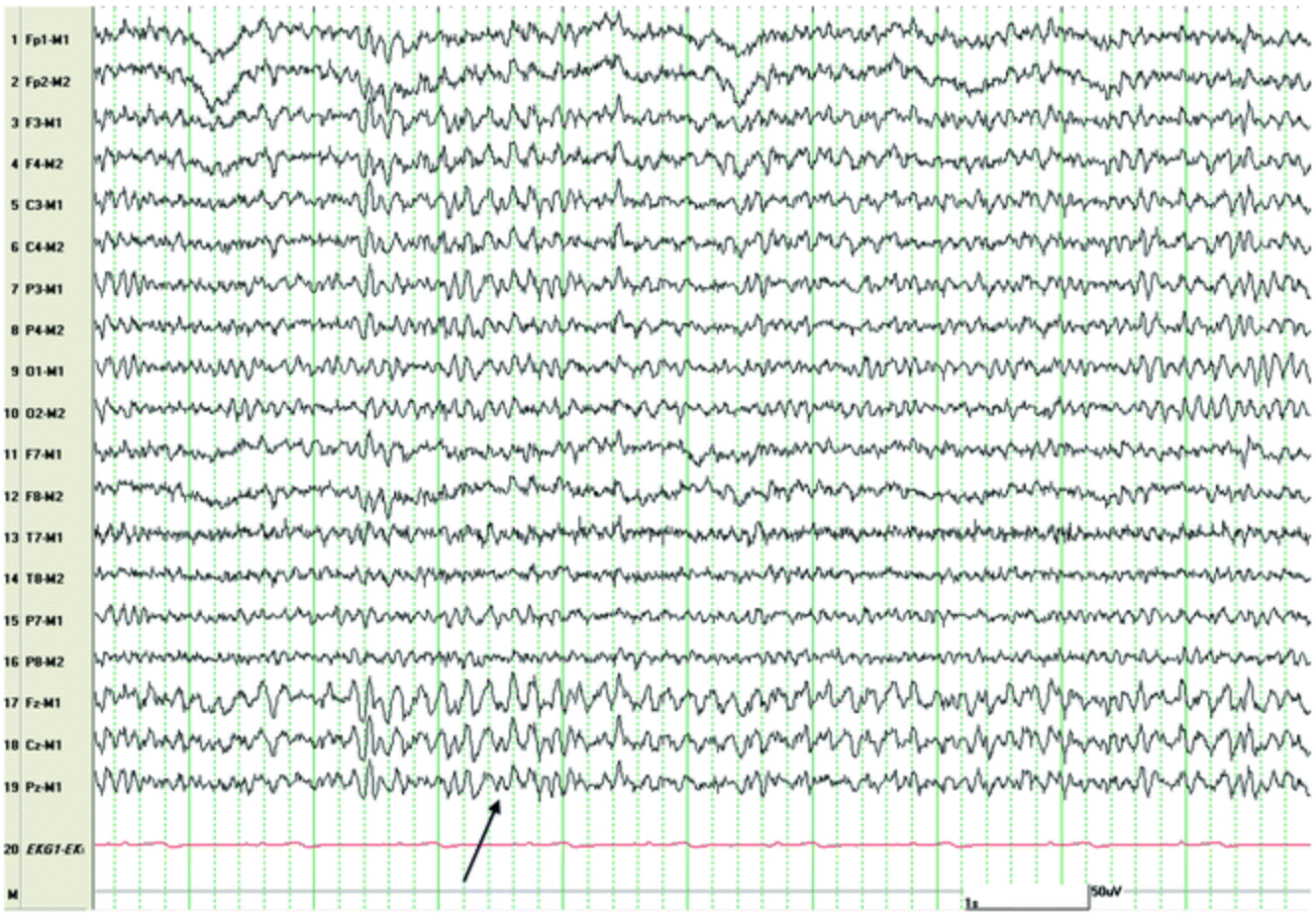

Figure: Midline theta rhythm (arrow); sensitivity 7 µV/mm, LFF 1 Hz, HFF 70 Hz

- **Also known as:** Ciganek rhythm
- **Frequency:** 5–7 Hz
- **Location:** Central vertex lead (Cz) - most prominent
- **Morphology:** Rhythmic train of smooth, sinusoidal, arciform, spiky, or mu-like activity
- **State:** Wakefulness and drowsiness
- **Reactivity:** Variable reactivity to eye opening and alerting
- **Distinction from Mu Rhythm:** Midline theta is 5–7 Hz with variable reactivity; mu rhythm is 8–10 Hz and blocks with movement
- **Distinction from Central Spikes:** Midline theta is rhythmic and sustained; central spikes are isolated and epileptiform
- 🔑 **Key:** 5–7 Hz + vertex (Cz) + variable morphology + variable reactivity = midline theta (Ciganek rhythm)

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5. Generalized Variants

6-Hz Spike-and-Wave Bursts (Phantom Spike-and-Wave)

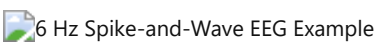
6 Hz Spike-and-Wave EEG Example

Figure: 6-Hz spike-and-wave bursts (arrow); sensitivity 7 µV/mm, LFF 1 Hz, HFF 70 Hz

- **Also known as:** Phantom spike-and-wave
- **Frequency:** 5–7 Hz
- **Location:** Generalized

- **Morphology:** Brief bursts of subtle low-amplitude spikes followed by more prominent slow wave
- **State:** Relaxed wakefulness and drowsiness (disappears with deep sleep)
- **Distribution:** Usually bilateral and synchronous
- **Types:**
  - **FOLD:** Female Occipital Low-amplitude Drowsiness (benign)
  - **WHAM:** Wake High-amplitude Anterior Male (more likely associated with seizures)
- **Critical Distinction:** Disappears with deep sleep (unlike epileptiform spike-and-wave which persists during sleep)
- **Distinction from 3 Hz Spike-and-Wave:** 6 Hz is low amplitude, brief, disappears in deep sleep; 3 Hz is higher amplitude, sustained, persists in sleep, associated with absence seizures
- 🔑 **Key:** Low amplitude + brief + disappears in deep sleep = 6 Hz phantom spike-and-wave

🔑 **Exam Pearl:** FOLD type is benign; WHAM type may be more associated with seizures.

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6. Posterior-Temporal Variants

14- and 6-Hz Positive Bursts (Ctenoids)

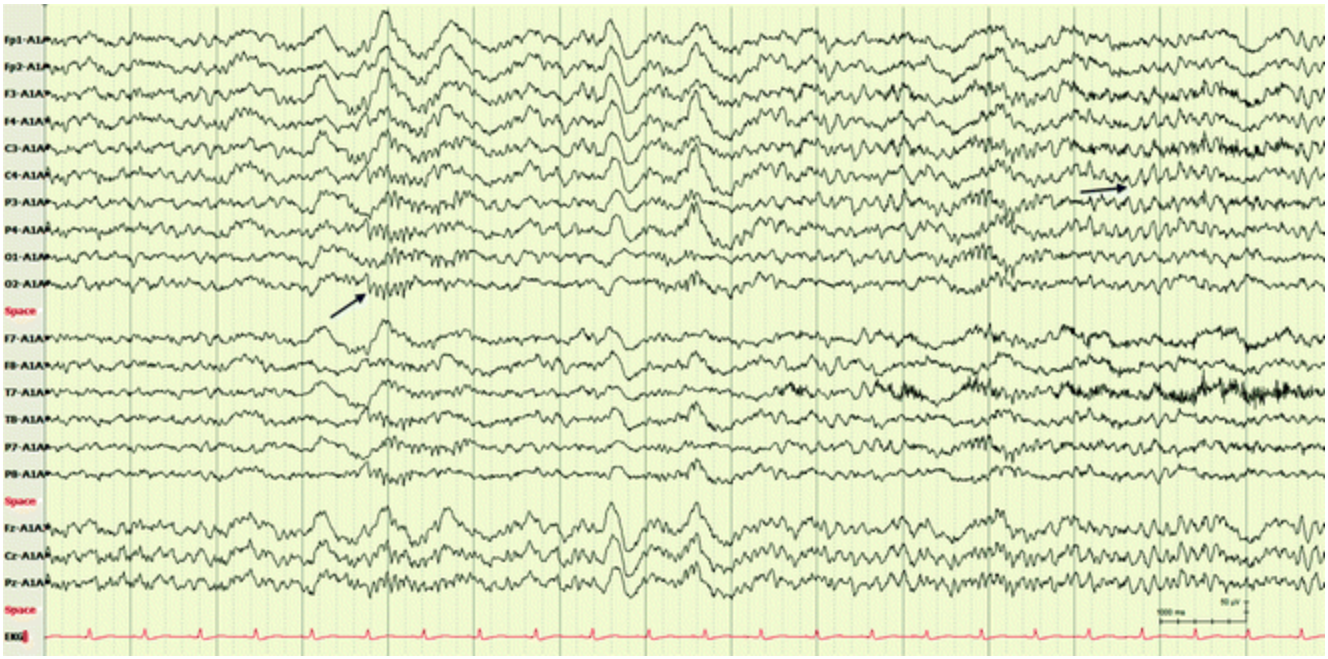

Figure: 14- and 6-Hz positive bursts (arrow); sensitivity 7 µV/mm, LFF 1 Hz, HFF 70 Hz

- **Also known as:** Ctenoids
- **Frequency:** Predominantly 14 Hz; 6 Hz can occur independently or in association with 14 Hz
- **Location:** Posterior temporal region (maximal amplitude)
- **Morphology:** Short trains of arch-shaped waveforms with alternating positive spiky components and negative smooth rounded waveform resembling sleep spindle with sharp positive phase
- **State:** Drowsiness and light sleep
- **Distribution:** Mostly asynchronous, bilateral with shifting predominance
- **Montage:** Better seen in referential montage (ear references)
- **Age:** Peak at age 13–14 years; decrease in incidence with increasing age
- **Clinical Note:** May be enhanced in Reye's syndrome
- **Distinction from Sleep Spindles:** 14&6 Hz positive bursts are posterior-temporal with positive spiky components; sleep spindles are central, 12–14 Hz, and lack positive spiky components

- **Distinction from Temporal Spikes:** 14&6 Hz positive bursts are rhythmic trains with positive spiky components; temporal spikes are isolated and epileptiform
- 🔑 **Key:** 14 Hz + posterior-temporal + positive spiky + arch-shaped + age 13–14 peak = 14&6 Hz positive bursts

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7. Uncommon Variants

Subclinical Rhythmic Electrographic Discharge in Adults (SREDA)

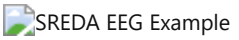
SREDA EEG Example

Figure: Consecutive EEGs showing subclinical rhythmic electrographic discharge in adults (SREDA)

- **Frequency:** Mixed delta and theta initially, evolving to rhythmic 5–7 Hz
- **Location:** Widespread with maximal amplitude over parietal-posterior temporal head regions
- **Morphology:** Abrupt onset of mixed frequencies in delta and theta ranges that evolve into rhythmic pattern consisting of sharp-contoured components 5–7 Hz
- **Duration:** Lasts from 20 s to a few minutes
- **State:** Rest, drowsiness, or during hyperventilation
- **Age:** Seen in people older than 50 years
- **Distribution:** Usually bilateral but may be asymmetric
- **Clinical Significance:** May resemble a subclinical EEG seizure discharge but typically does NOT correlate with clinical seizures (however, this is controversial)
- **Distinction from Seizure Discharge:** SREDA typically has no clinical seizure correlation; seizure discharges show evolution and clinical correlation
- **Distinction from Encephalopathy:** SREDA is abrupt onset, evolves, and resolves; encephalopathy is sustained and correlates with clinical state
- 🔑 **Key:** Age >50 + abrupt onset + evolution + parietal-posterior temporal + no clinical correlation (usually) = SREDA

🔑 **Exam Pearl:** SREDA is uncommon, seen in people >50 years. It shows abrupt onset, evolution from mixed frequencies to rhythmic 5–7 Hz, and typically lacks clinical seizure correlation (though this is controversial).

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8. High-Yield Exam Discrimination Table

Variant	Frequency	Location	State	Key Distinguishing Feature
Fast alpha variant	16–26 Hz	Posterior	Wake, eyes-closed	Harmonic (twice PDR), reactive
Slow alpha variant	4–6.5 Hz	Posterior	Wake, eyes-closed	Harmonic (half PDR), reactive
Alpha squeak	Transient	Posterior	Wake, eyes-closed	First 0.5–1 s after eye closure
RMTD	5–7 Hz	Mid-temporal	Drowsy	Notched, rhythmic, no evolution
Wicket spikes	6–11 Hz	Temporal	Wake/drowsy/light sleep	Trains, arciform, no slow waves
BETS/BSSS	Variable	Temporal	Drowsy/light sleep	<50 μV, <50 ms, isolated
Midline theta	5–7 Hz	Vertex (Cz)	Wake/drowsy	Variable reactivity
6 Hz spike-wave	5–7 Hz	Generalized	Wake/drowsy	Disappears in deep sleep
14&6 Hz positive	14 Hz (6 Hz)	Posterior-temporal	Drowsy/light sleep	Positive spiky, age 13–14 peak

SREDA	5–7 Hz (evolving)	Parietal-posterior temporal	Rest/drowsy/HV	Age >50, abrupt onset, evolution

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9. ABRET Exam Pearls

Critical Distinctions

1. **Alpha Variants:** Harmonics of PDR - fast (twice) or slow (half). Both are posterior and reactive.
2. **RMTD vs Alpha Variants:** Both have notched appearance, but RMTD is mid-temporal (not posterior).
3. **Wicket Spikes:** Trains, arciform, no slow waves. Compare single spikes with trains on other pages.
4. **BETS:** Small (<50 μV, <50 ms), isolated, no slow waves. Disappear in deeper sleep.
5. **6 Hz Spike-and-Wave:** Disappears in deep sleep (unlike epileptiform which persists).
6. **14&6 Hz Positive Bursts:** Peak at age 13–14, posterior-temporal, positive spiky components.
7. **SREDA:** Age >50, abrupt onset, evolution, typically no clinical correlation.

Common Exam Traps

- Confusing alpha variants with beta rhythm (location is key - posterior vs frontal/central)
- Mixing RMTD with pathologic temporal slowing (rhythmic vs irregular)
- Mistaking wicket spikes for temporal seizure discharge (no slow waves, no background disruption)
- Confusing 6 Hz spike-and-wave with epileptiform (disappears in deep sleep vs persists)
- Missing SREDA age requirement (>50 years)

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10. Quick Reference Summary

Must-Know Variants

- **Fast alpha variant:** 16–26 Hz, posterior, harmonic (twice PDR)
- **Slow alpha variant:** 4–6.5 Hz, posterior, harmonic (half PDR)
- **Alpha squeak:** Transient frequency increase, first 0.5–1 s after eye closure
- **RMTD:** 5–7 Hz, mid-temporal, notched, rhythmic, no evolution
- **Wicket spikes:** 6–11 Hz, temporal, trains, arciform, no slow waves
- **BETS/BSSS:** <50 μV, <50 ms, isolated, no slow waves
- **Midline theta:** 5–7 Hz, vertex (Cz), variable reactivity
- **6 Hz spike-wave:** Low amplitude, disappears in deep sleep
- **14&6 Hz positive:** Posterior-temporal, positive spiky, age 13–14 peak
- **SREDA:** Age >50, abrupt onset, evolution, parietal-posterior temporal

Memory Anchors

- Alpha variants = harmonics (fast = twice, slow = half)
- RMTD = mid-temporal (not posterior)
- Wicket = trains + arciform + no slow waves
- BETS = small (<50 μV, <50 ms) + isolated
- 6 Hz = disappears in deep sleep (unlike epileptiform)
- 14&6 Hz = age 13–14 peak
- SREDA = age >50

Next Steps:

- Memorize frequency ranges and locations
- Learn distinguishing features (reactivity, evolution, slow waves)
- Practice discrimination between variants and pathologic patterns
- Understand state-dependence (wake vs drowsy vs sleep)