

Artifacts & Normal Variants Basic EEG Course

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Learning Objectives

- To identify the definition and types of artifacts
- To identify common normal variants

Artifacts



- Unwanted electrical activity arising from different sources, other than cerebral activity
- Physiolocial/ biological artifacts:
 - Artifacts from the eyes and eyelids: Eye movement or blink artifacts
 - Tongue movement artifacts: glossokinetic, chewing, swallowing
 - EMG
 - ECG
- Nonphysiological artifacts: from electical phonemena or devices in the recording environment



Corneoretinal Potential



Blink Artifact



Fa

Eyeball



Retina

Blink Artifact





Left Lateral Eye Movement







Chewing Artifact





Pulse Artifact



ECG Artifact





True Spike-Left Temporal





Artifact



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3 T3-T5	50uV]	
4 T5-01	50uV	man
5 Fp2-F8	50uV	
6 F8-T4	50uV [
7 T4-T6	50uV]	
8 T6-O2	50uV	
9 Fp1-F3	50uV	Man Mar
10 F3-C3	50uV]	
11 C3-P3	50uV [
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15 C4-P4	50uV]	www.www.www.www.www.www.www.www.www.ww
16 P4-02	50uV]	www.www.www.www.www.www.www.www.www.ww
17 Fz-Cz	50uV]	
18 Cz-Pz	50uV]	
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Electrode "pop" Artifact



Patting Artifact





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Normal Variants



- Rhythms or waveforms that have features reminiscent of either interictal or ictal EEG abnormalities
- Found in a substantial proportion of healthy subjects
- NOT representing pathological entities



Normal Variants Patterns

- 1. Rhythmic patterns
- 2. Epileptiform patterns
- 3. Lambda and lambdoids
- 4. Age related variants



Normal Variants Patterns

- 1. Rhythmic patterns
 - Alpha variant
 - Mu rhythm
 - Rhythmic mid-temporal burst of drowsiness (RMTD)
 - Subclinical rhythmic electrographic discharges in adults (SREDA)
 - Midline theta rhythm
 - Frontal arousal rhythm
- 2. Epileptiform patterns
- 3. Lambda and lambdoids
- 4. Age related variants

Alpha Variant



- "Slow/ Subharmonic": half frequency of the patient's PDR
- "Fast/ Supraharmonic": twice of the PDR frequency
- Location: Posterior head regions (O1, O2)
- State: awake
- Blocked by eye opening

Subharmonic Alpha Variant





Supraharmonic Alpha Variant

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F7-T7	I - man many many many many many many many
T7-P7	I WARMANN
P7-01	I MANUMANANANANANANANANANANANANANANANANANA
Fp2-F8	I and a manufacture of the second of the sec
F8-T8	I Vanance was a superior where and a superior and a superior of the superior and a superior and and a
T8-P8	I MANANANANANANANANANANANANANANANANANANAN
P8-02	I representation of the month of the providence of the providence of the second s
Fp1-F3	I and the manufacture of the second and the second se
F3-C3	I mouth the second second way we have been and the second se
СЗ-РЗ	I MANYAMANAMANAMANAMANANANANANANANANANANAN
P3-01	I WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
Fp2-F4	I was a manufare and the second of the second and the second seco
F4-C4	I where we
C4-P4	I ANALAM MANAMANAMANAMANAMANAMANAMANAMANAMANAM
P4-02	I WWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWWW
Fz-Cz	I - Manuman Manu Manuman Manuma Manuman Manusa Manusa Manusa Manusa Manusa Manusa Manusa Manuman Manusa Manuman Manuma Manuma Manu Manu Manu Manu Manu Manu Manu Man
Cz-Pz	I MUMANAMANAMANAMANAMANAMANAMANAMANAMANAMA



Mu Rhythm



- "*µ*" = "motor"
- Associated with sensorimotor cortex
- Morphology: comb, arc
- Frequency: 9-11 Hz
- Location: Central (C3, C4, and Cz)
- State: wakeful
- Blocked by contralatral limb movement

Mu Rhythm



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2 F7-T3	50uV]	man when when a second when a second when the second when the second when the second when the second second when the second
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4 T5-01	50uV	- man and a
5 Fp2-F8	50uV]	when we
6 F8-T4	50uV	www.www.www.www.www.www.www.www.www.ww
7 T4-T6	50uV	man and the second of the seco
8 T6-O2	50uV	
9 Fp1-F3	50uV	many many many many many many many many
10 F3-C3	50uV]	
11 C3-P3	50uV	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
12 P3-01	50uV	man man man man and and and and and and and and and a
13 Fp2-F4	50uV]	mound and any mound of the moun
14 F4-C4	50uV	many when a second when the second second when the second s
15 C4-P4	50uV	
16 P4-O2	50uV	and the second water and the second
17 Fz-Cz	50uV	
18 Cz-Pz	50uV	
19 <i>X1-X2</i>	3500uV]	ECG

Rhythmic Mid-Temporal Burst of Drowsiness (RMTD)

- Psychomotor variants
- Morphology: monomorphic, flat-topped or notched
- Frequency: 5-7 Hz (Theta)
- Location: Mid-temporal (T3, T4)
- State: drowsy, light sleep
- Disappears during deepening sleep
- Do NOT evolve or spread to other sites
- Found in adolescents and young adults

Rhythmic Mid-Temporal Burst of Drowsiness (RMTD)





- Morphology: sharply contoured
- Frequency: 5-7 Hz (Theta)
- Location: Temporo-parietal
- State: drowsy, during hyperventilation
- Mild frequency evolution BUT NO spatial or topographic evolution (e.g. spread to other sites)
- Abrupt offset
- Found in older adults

SREDA

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Ictal Evolution





Midline Theta Rhythm



- Morphology: smooth, arc-shaped (mu-like), previously known as "Ciganek rhythm"
- Frequency: 5-7 Hz (Theta)
- Location: Mid-central (Cz)
- State: wakeful, drowsy
- Reacts to limb movements, alerting, and/or eye opening

Midline Theta Rhythm

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Frontal Arousal Rhythm

- Morphology: notched appearance
- Frequency: 7-10 Hz
- Location: Frontal head regions
- State: sleep to wake transition
- Disappear when fully awake

Frontal Arousal Rhythm

	1
1 Fp1-F7	men man man man man man man man man man ma
2 F7-17	man man and a second way was a second way and a second way and a second way was a second was a se
3 Т7-Р7	warman warma
4 P7-01	man man man man and the second
5 Fp2-F8	man
6 F9-T8	an and a second water and the second water and the second and the
7 19-P8	man man and the second war and the second and the s
8 P8-02	man man man man and a substance of the second secon
9 Fp1-F3	
10 F3-C3	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
11 C3-P3	monorman man man man and and and a second an
12 P3-01	
13 Fp2-F4	
14 F4-C4	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
15 C4-P4	man
16 P4-02	
17 Fz-Cz	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
18 Cz-Pz	mon man man man man man man man man man ma
10 556 4	



Normal Variants Patterns

- 1. Rhythmic patterns
- 2. Epileptiform patterns
 - 14 and 6 Hz positive bursts
 - Small sharp spikes (benign epileptiform transients of sleep: BETS)
 - 6-Hz spike and wave (phantom spike and wave)
 - Wicket spikes
- 3. Lambda and lambdoids
- 4. Age related variants

14 and 6 Hz Positive Bursts



- Morphology: burst of surface positive comb like spikes
- Frequency: 14 or 6 Hz
- Location: anterior/ mid-temporal
- State: drowsiness, light sleep
- Found in young infants (6 Hz), adolescents (14 Hz)
- Best seen with long interelectorde distances (e.g. ear references)

14 and 6 Hz Positive Bursts



Small Sharp Spikes (BETS)



- Morphology: low amplitude, brief duration, mono or biphasic
- Location: posterior temporal
- State: drowsiness, light sleep
- Found in adolescents and adults
- NOT run in trains, disruption of background, or coexisting with rhythmic slowing
- Disappears during deeper sleep stages

Hannie Partie Partie

Small Sharp Spikes (BETS)



6-Hz Spike and Slow Wave (Phantom spike and Wave)



- Location: Anterior (WHAM) or Posterior (FOLD)
- State: Wakeful (WHAM) or Drowsiness (FOLD)
- Found in adolescents and adults



- NOT run in trains, NO disruption of background, or coexisting with rhythmic slowing
- Disappears during deeper sleep stages

Waking, High amplitude, Anterior, Male (WHAM)





Female, Occipital, Low amplitude, Drowsy (FOLD)

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 Fp1 - F3
 F3
 C3
 C3

 Fp2 - F4/main
 Fp2 - F4/main
 Find
 <

Fp1 - F7.

F7 - T7.

Market

F7 - D7.

P7 - O1.

 Fp2 - F8
 F8

TP12 - ECG-----

Wicket Spikes



- Morphology: arciform appearance occurs in brief trains
- Frequency: 6-11 Hz
- Location: temporal
- State: drowsiness, light sleep
- Found in adolescents and adults



No after-going slow wave or disruption of background

Wicket Spikes



Fp1 - F7 - maximum (Maximum (Maximum

 Fpz - Fzminin WWW
 Fpz - Czhiminin WWW

ECGunanty and have been a free and have been a free



Normal Variants Patterns

- 1. Rhythmic patterns
- 2. Epileptiform patterns
- 3. Lambda and lambdoids
 - Lambda
 - Slow lambda of youth (Posterior slow waves of youth)
 - Positive occipital sharp transients of sleep (POSTS)
 - Slow lambdoids of youth (cone-shaped or O-waves)
- 4. Age related variants

Lambda



- Morphology: 'λ' biphasic waveform
- Location: occipital
- State: wakeful
- Appears when the patient scan a complex pattern design
- Block by eye closing
- Found in children > adults

Lambda

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 $\begin{array}{l} \overset{\texttt{W}}{\texttt{Fp1}} = \texttt{F7} \\ \overset{\texttt{W}}{\texttt{W}} \\ \overset{\texttt{W}}}{\texttt{W}} \\ \overset{\texttt{W}}{\texttt{W}} \\ \overset{\texttt{W}}}{ } \\ \overset{\texttt{W}}{\texttt{W}} \\ \overset{\texttt{W}}$

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 $\label{eq:production} Fp2 - F8 \mbox{$M_{\rm max}} \mbox{$M_{\rm max$

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Posterior Slow Waves of Youth



- Morphology: delta waveform superimposed with "alpha" on top
- Location: occipital
- State: wakeful
- Associated with eye closing
- Found in children 8-14 years of age

Posterior Slow Waves of Youth





Positive Occipital Sharp Transients of Sleep (POSTS)

- Morphology: checkmark-like shape √, monophasic
- Location: occipital
- State: drowsy, sleep
- Surface positivity in occipital areas
- Occur in trains 4-5 Hz
- Found in children & adults

POSTS (Bipolar Montage)





POSTS (Average Montage)



Slow Lambdoids of Youth (O-waves)



- Morphology: Cone or O shaped, high voltage, delta activity
- Location: occipital
- State: sleep
- Found in younger children up to 5 years of age

Cone Shaped (O) Waves





Normal Variants Patterns

- 1. Rhythmic patterns
- 2. Epileptiform patterns
- 3. Lambda and lambdoids
- 4. Age related variants
 - Hyperventilation-induced slowing
 - Hypnagogic and hypnopompic hypersynchrony

Hyperventilation Induced Slowing



- Morphology: rhythmic, high voltage, theta to delta activity
- Location: Age dependent- Prominent posteriorly in children, anteriorly in young adults
- State: during hyperventilation
- Return to baseline within 2 minutes
- Focal slowing during hyperventialtion is pathological

Hyperventilation Induced Slowing- 5 yo





Hyperventilation Induced Slowing-Adult





Hypnagogic/ Hypnopompic Hypersynchrony

- Morphology: high voltage, delta activity, spiky components
- Location: fronto-centro-parietal
- State: drowsiness
- Found in 2-4 years of age



Conclusion



- It is essential to avoid misinterpretation of EEG
- Single electrode, nonreasonable field, or positive phase reversal indicate artifactual in nature
- Understanding the criteria to define normal variation and benign variants is crucial



Thank You For Your Attention