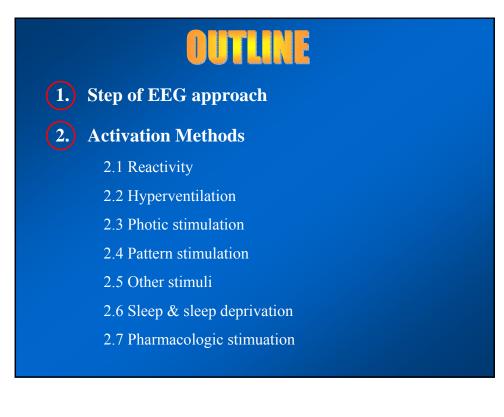
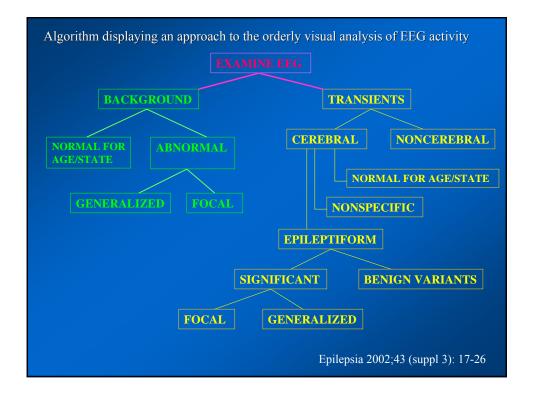
EEG Course

A Systematic Approach to the Electroencephalogram & Activation Methods

Dr. Montri Saengpattrachai June 21st – 22nd, 2010









EEG study in children:

Sedation is not routine



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2. Activation Methods

- 2.1 Reactivity (eye opening & closing)
- 2.2 Hyperventilation
- **2.3 Photic stimulation**
- 2.4 Pattern stimulation
- 2.5 Other stimuli
- 2.6 Sleep & sleep deprivation
- 2.7 Pharmacological activation

2.1 Reactivity

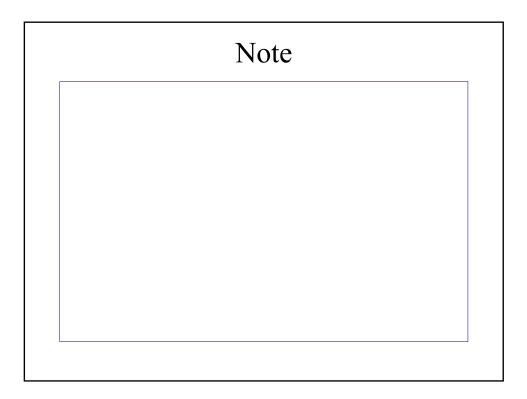
- Children : the occipital alpha rhythm may totally block with the eye open.
- Adults : 24%, no alpha blocking

Bancaud's phenomenon



- unilateral failure to attenuate with eye opening
- indicates abnormality of the same hemisphere that fails to attenuate

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# **2.2 Hyperventilation (HV)**

- Alternation of  $PCO_2$  is the most important factor in producing the EEG response to HV.
- **Procedure**: over-breathe for at least 3 min. (children: cry or sob during the recording)
- The magnitude of HV response depends on
   Effort -Age Posture Blood sugar (< 80 mg/100mL)</li>
- The generation of epileptiform discharges during HV: 80% for idiopathic generalized epilepsies 50% for symptomatic generalized epilepsies
   <10% for localization-related epilepsy</li>

# 2.2 Hyperventilation (HV)

#### **Contraindications**

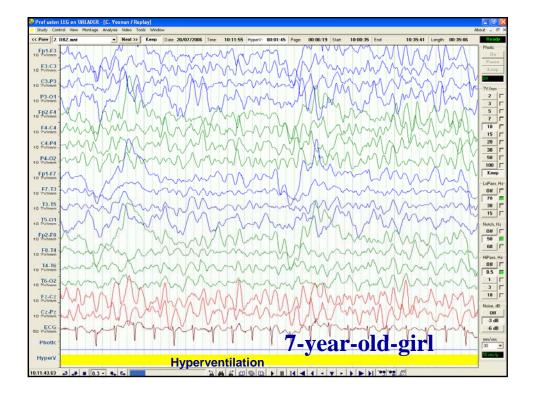
- Severe cardiac disease
- Recent myocardial infarction
- Active or recent asthma
- Recent stroke or TIA
- Intracerebral hemorrhage
- Severe carotid stenosis
- Moya-moya disease
- Hyperviscosity state
- Sickle cell anemia
- Uncontrolled hypertension

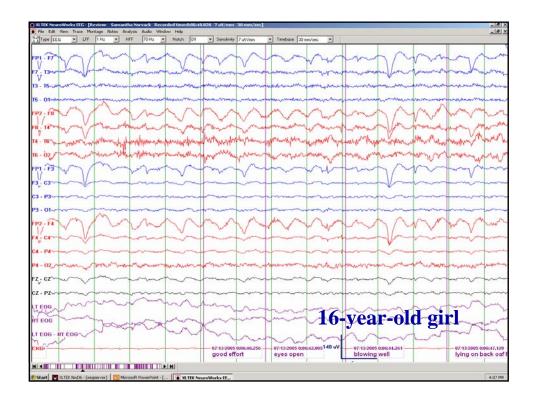
#### Relative contraindications

- Not cooperate patient
- A child whose EEG has already contained frequent generalized spike and wave

# **2.1 Hyperventilation (HV)**

- Normal response:
  - buildup of medium to high amplitude, bisynchronous delta and theta waves.
  - Adults: 10% response; anterior dominant
  - Children: 70% response; ant^r/post^r dominant (85% occurred between 8 and 12 years of age)
  - return to baseline within 60 seconds after stop HV
  - often includes FIRDA, or OIRDA in children





# 2.1 Hyperventilation (HV)

#### Abnormal responses

1. Lateralized or localized slowing

#### 2. Delayed symmetrical or lateralized slowing

• Moyamoya disease: a buildup of slowing several minutes after HV ends (~ 5 min. after HV ends)

#### 3. Asymmetry of background activity

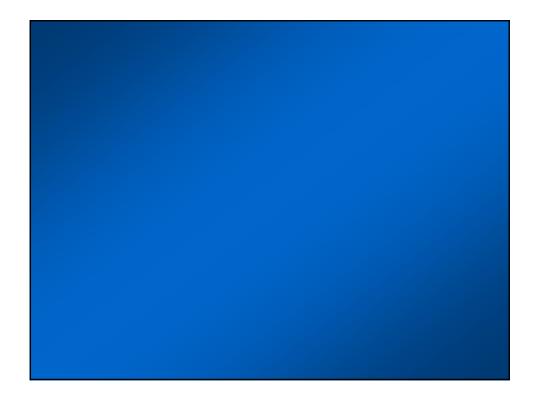
• Usually the abnormality is on the side of higher amplitude response

#### 4. Epileptiform patterns

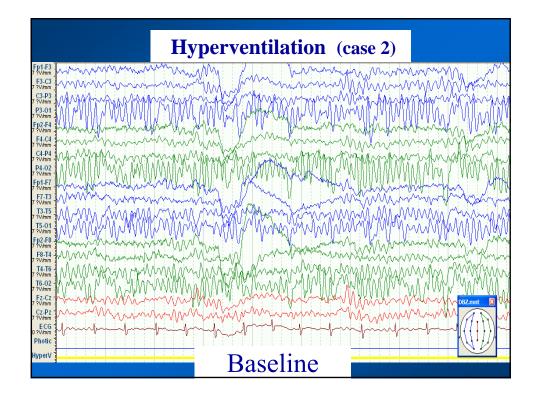
- >80% of untreated children with absence seizures
- typical anterior-dominant 3-Hz spike-and-wave

*Pseudo-absence seizures :* impaired responsiveness during HV + generalized high amplitude 2-to 3- Hz activity

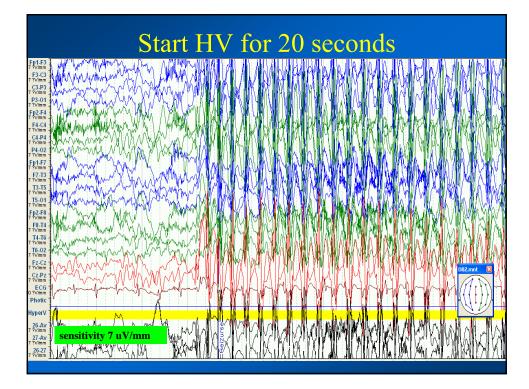
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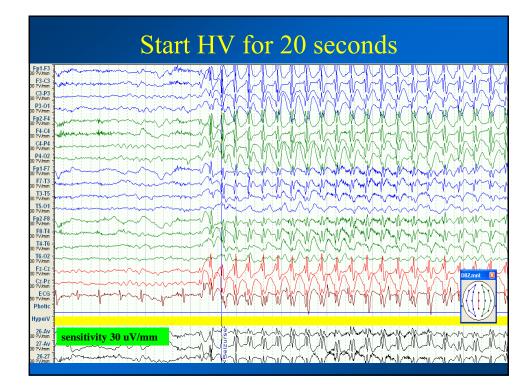


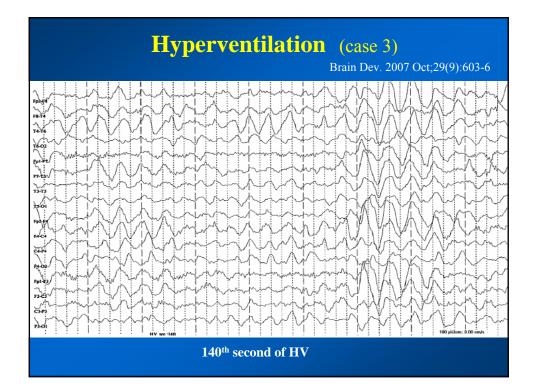
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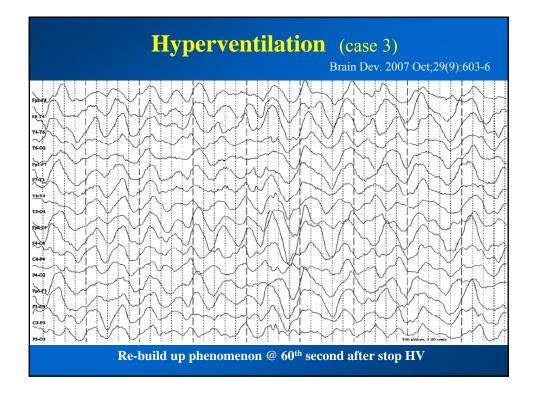


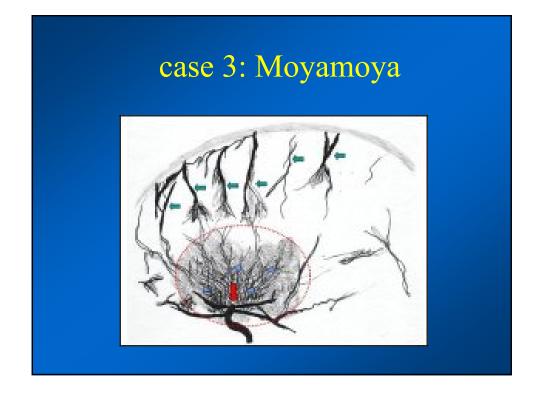


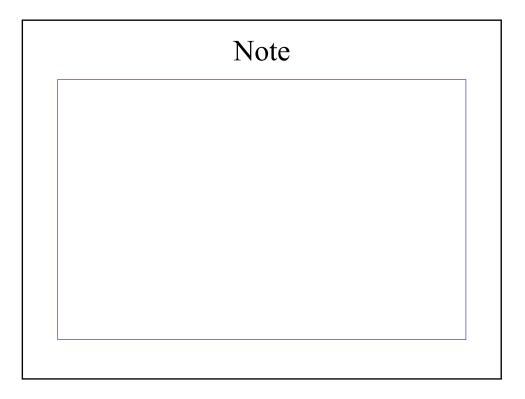














# 2.3 Photic Stimulation (PS)

## Photic stimulator characteristics

- Max. intensity > 100 Nit-s per flash
- Circular field diameter of 13 cm
- Granular diffuser producing light diffusion similar to that of the Grass stimulator
- Central fixation point on diffuser
- Attachment of patterns available
- Single flashes or trains that can be delivered with constant intensity from 1 to 60 Hz



# **2.3 Photic Stimulation (PS)**

## Procedure

- IPS should not be performed during or within 3 min of HV
- Nasion-to-lamp distance of 30 cm
- Longitudinal bipolar or common reference montage
- Flash trains of 10s with at least 7-s intervals
- Eyes open for first 5s of IPS and then closed
- Eyes fixated on center of stimulator
- IPS frequencies: 1,2,3,4,6,8,10,12,14,16,18,20,60,50,40,30,25
- IPS is stopped abruptly if a PPR appears

*IPS = intermittent PS *PPR = photoparoxysmal response

# **2.3 Photic Stimulation (PS)**

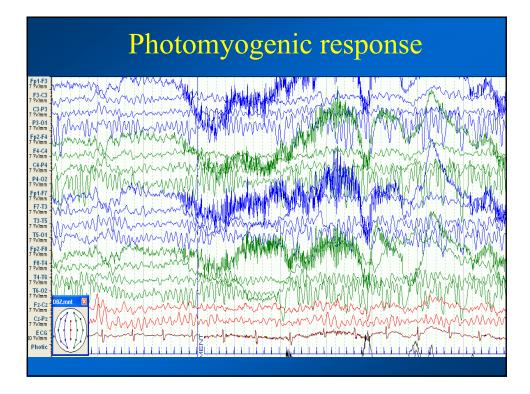
- Normal response:
  - Rhythmic, occipital-dominant waveforms
  - Harmonic (an integer multiple) or subharmonic (an integer dividend) of flash frequency
  - Onset: 70- to 150-millisecond delay
  - At slower flash rates (<5Hz), the photic response consists of a diffuse light evoked potential
  - Photomyogenic responses
  - Unilateral driving may be seen. Interpretation as abnormal usually requires other abnormal features.

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# Photomyogenic (photomyoclonic) response

- First described by Gastuat and Remond
- Prominent in 1% of individuals
- Brief, repetitive muscle spikes in the anterior head region
- Electromyographic potentials <u>time locked</u> to the flash frequency, anterior-dominant.
- Prominent with emotional tension or metabolic/toxic states
- Distinguish from PPR by <u>immediate cessation</u> of the response at the end of stimulation and prominent EMG activity
- Unknown clinical significance



# 2.3 Photic Stimulation (PS)

#### Abnormal responses:

- 1. Photoparoxysmal response (photoepileptiform, photoconvulsive)
- 2. Abnormal response in specific cerebral disorders

# 1. Photoparoxysmal response (PPR)

(Photoepileptiform response, PER)

- Generalized spike-and-slow wave and polyspike-and-slow wave complexes
- ~ 4% of patient with epilepsy have a PPR
- 70% 77% of patient with PPR have epilepsy
- Maximal incidence : 6-15 years of age
- Clinical correlation:
  - 1. GTC
  - 2. Myoclonic (JME ~38%)
  - 3. Absence (~24%)

# PPR

#### • Two types of PPRs:

#### 1. Prolonged or self sustaining

: outlasts at least 100 ms, suggests probable epilepsy (93%)

: generalized spike-and-wave response shows a strong association with epilepsy

#### 2. Self-limited

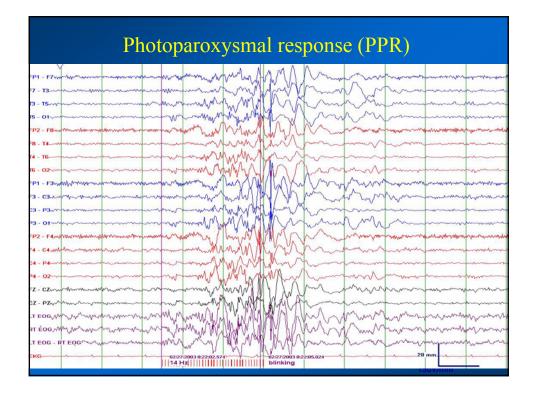
: ceases before or when the flash stops : not diagnostic for epilepsy

#### PER

• The most suggestive features of posterior-dominant PER are:

1. Medium- to high-amplitude spikes or sharp waves persists well beyond (>200 msec.) the termination of the flash stimulus.

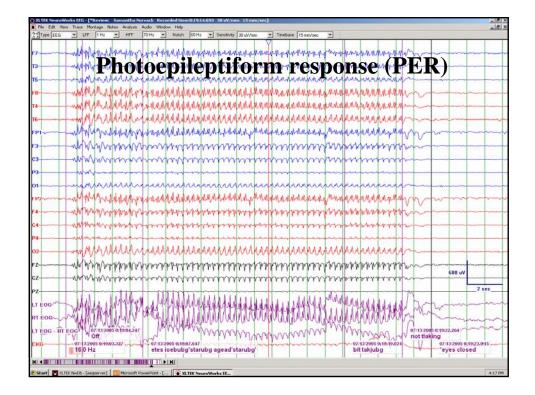
2. Association with clinical convulsive or nonconvulsive seizure activity.



# 2.3 Photic Stimulation (PS)

#### Pitfalls:

- PS is less effective when performed during sleep
- Unilateral monocular stimulation or stimulation during conjugate ocular deviation away from the stimulus is less effective than binocular gaze-directed stimulation
- Repeat the same stimulus train to verify that PPR is related to the flash stimulus
  - Don't repeat immediately (habituation with blocking of the response will occur)
  - Repeat same stimulus train after > 30 seconds later



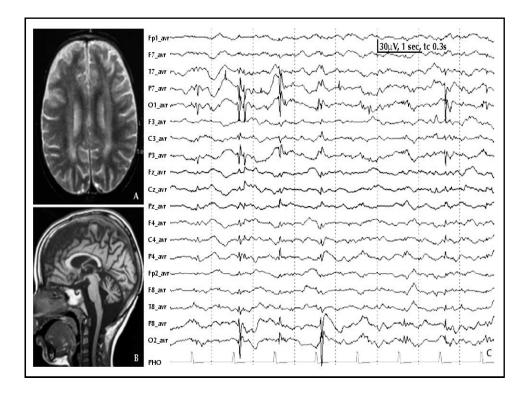
# 2. Abnormal responses in specific cerebral disorders

- ↑ amplitude of photic driving found in
  - cortical epileptogenic lesions
  - skull defects
- $\downarrow$  amplitude of photic driving found in
  - destructive brain lesion
- Photosensitivity
  - partial epilepsy ~ 2.8%
  - generalized epilepsy (idiopathic) ~21%

# 2. Abnormal responses in specific cerebral disorders

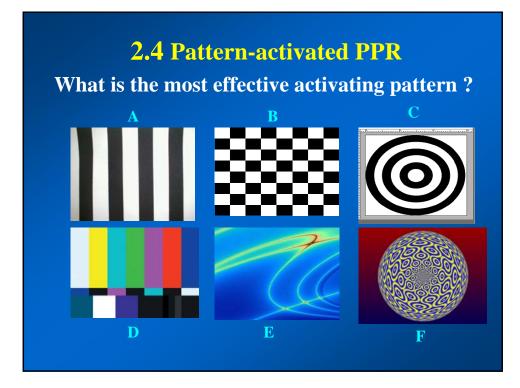
**Q:** What is the pathognomonic EEG findings in patient with late infantile NCL

(Bielschowsky-Jansky form of Batten's disease)



# 2.4 Pattern-activated PPR

- The first report of a patient with pattern sensitivity appeared in 1953 by Bickford et al.
- Virtually all patients with pattern sensitivity also show sensitivity to PS
- However, very few patients with sensitivity to PS also have pattern sensitivity
- Distribution of elicited epileptiform discharges
   : generalized in two thirds of patients,
   : restricted to the posterior head region in one-third.



# 2.5 Other stimuli activation

- may be used in cases where episodic symptoms or signs suggest a convulsive disorder triggered by known stimuli and where a diagnosis is wanting.
- These procedures should be used with caution and with the intention of inducing EEG abnormalities while avoiding precipitation of seizure.
- The benefits of the diagnostic information obtainable by activation of EEG discharges must be weighed against the minor risk of inducing a seizure.

# 2.5 Other stimuli activation

#### 1. Pattern sensitivity

- Virtually all patients with pattern sensitivity also show sensitivity to PS
- However, very few patients with sensitivity to PS also have pattern sensitivity

#### 2. Video game

- Hormes et al., 1995: 40 patients with PPR to stroboscopic PS, 30% of these patients also had sensitivity to video games.

#### 3. Auditory stimuli

- Sudden loud noise (reflex epilepsy)
- Specific musical piece (musicogenic epilepsy)

# 2.5 Other stimuli activation

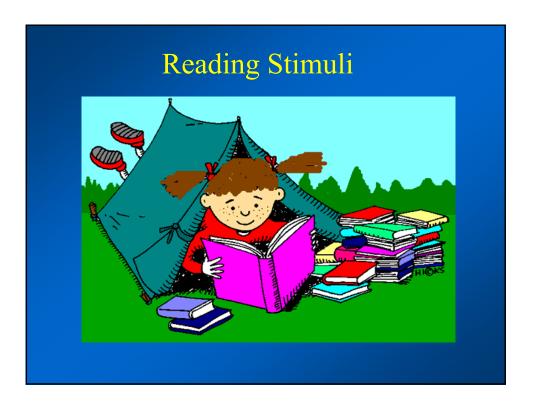
#### 4. Reading

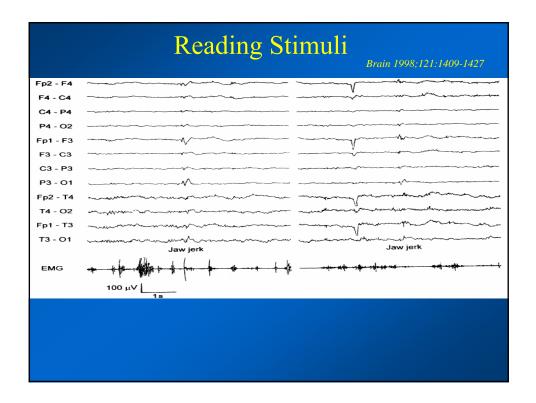
Primary reading epilepsy (intrinsic or perceptive):

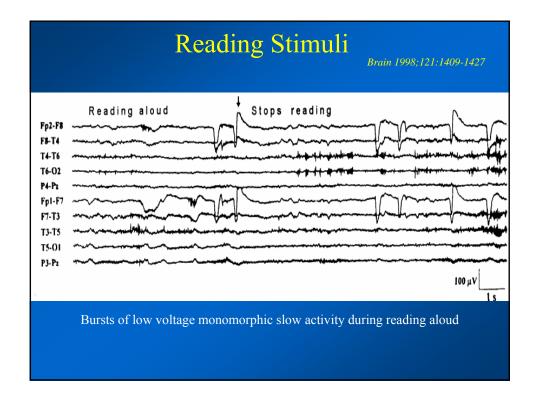
- epileptiform bursts occur after a period of reading
- max. in the parieto-occipital regions
- assoc. with clinical jaw jerking or 'clicking' while reading

Secondary reading epilepsy (extrinsic or sensorial):

- epileptiform discharges appear not only with reading but also under other conditions
- assoc. with pattern sensitivity







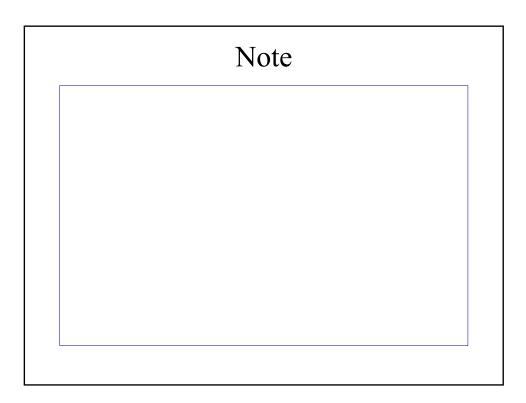
# 2.5 Other stimuli Activation

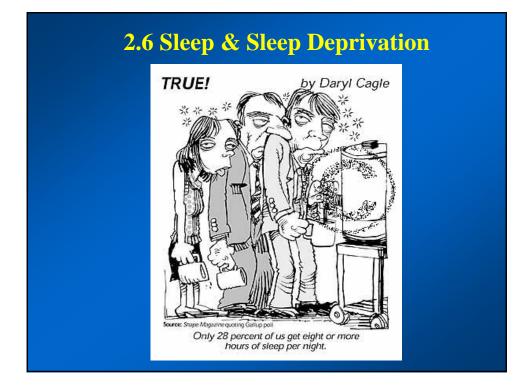
#### 5. Mental concentration

- mental calculation with eye closure
- rarely, mental calculation will precipitate a seizure

#### 6. Tactile stimulation

- touching certain parts of body may induce of abolish epileptiform activity and seizures in some patients
- Somatosensory epilepsy
  - interictal medium to high amplitude spikes over the perisylvian or central parasagittal head regions
  - evoked by tapping on the distal contralateral limbs





# **2.6 Sleep Activation**

#### During sleep

- increase of epileptic discharges rates from 77 to 98% in absences and GTC combined with absences.

#### During sleep deprivation

- permit only about 4 hours of sleep
- increase of epileptiform discharges rates from 50 to 80%.

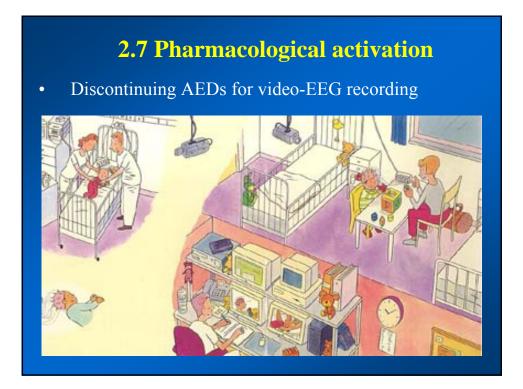
# **2.6 Sleep Activation**

#### **Epileptic syndromes activated by sleep:**

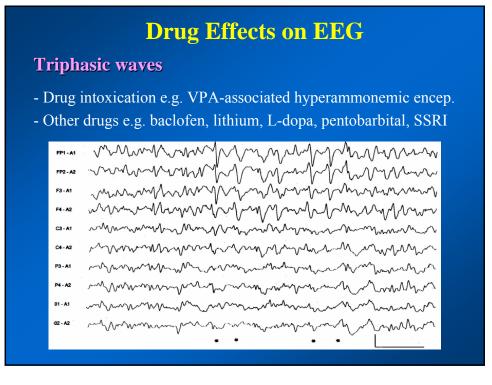
- CSWS
- LGS
- Benign JME
- Benign Rolandic epilepsy (BECTS)
- Frontal lobe epilepsy
- ADNFLE
- Benign occipital epilepsy in infancy
- Nocturnal epileptic myoclonus
- Epilepsy with generalized tonic-clonic seizures on awakening

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# Drug Effects on EEG Clin Neurophysicl 2006;23:206-211 Deckground slower (theta and delta) • "Older" AEDs e.g. PB, PHT, CBZ, VPA • Outpry heiter drugs e.g. clozapine, TCA, lithium • Barbiturates • Benzodiazepines • Occaine • Amphetamine • Methylphenidate • Tricyclic antidepressants • Withdrawal from alcohol and barbiturates



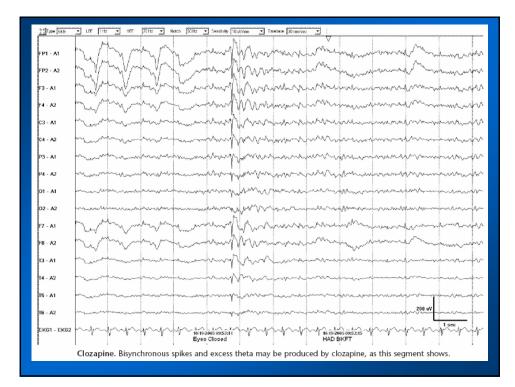
# **Drug Effects on EEG**

# **Epileptiform activity**

- a) Bursts of bisynchronous spikes or polyspikes
  - high doses of clozapine, lithium, phenothiazines, SSRI, TCA
  - acute withdrawal of alcohol or barbiturates
- b) Augmentation of epileptiform discharges
  - reduction of AEDs
  - morphine in neonates

#### **Coma pattern**

- Drug intoxication e.g. pentobarbital, BZD



# **Take home messages**

- Step of EEG approach should be always kept in mind before start to interpret EEG recording.
- Good understanding of EEG waveforms, and specific pattern recognition will increase accuracy of EEG interpretation.
- Skill of EEG interpretation is crucial and need to be increased by regular practice.

