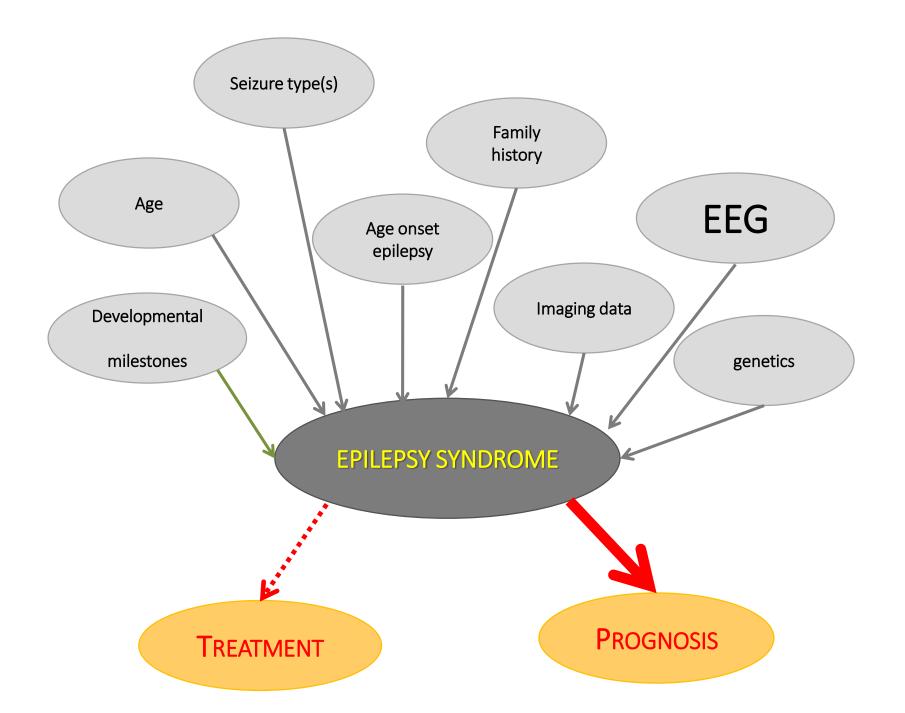
# EEG in children

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## Not all EEGs are equal

- Standard EEG (20 minutes to 1 hour)
- Standard EEG plus sleep stage 1-2
- Sleep deprivation EEG
- Long-term EEG (24 h)
- Presurgical long term monitoring
- video registration
- At least 24 electrodes
- No sedation (if needed melatonine?)
- Interictal versus ictal EEG

### Ictal EEG

## remains golden standard to confirm epilepsy diagnosis

• Rare in short standard EEGs

#### **Interictal EEGs**

- Likelihood to find epileptic abnormalities increases in sleep
- Generalized epilepsies : interictal sometimes normal
- Focal spikes also possible in generalized epilepsies
- Background activity and number of spikes : related to cognitive problems

Event is captured during EEG	Seizure	No seizure
Ictal tracé	Epilepsy diagnosis confirmed	Subclinical seizure
Normal EEG during event	Is it a seizure?	

Event is not captured during EEG	History of a Seizure	No seizure
Interictal epileptic abnormalities	Epilepsy diagnosis Confirmed (???)	Normal ?
Normal EEG	Can be epilepsy	

#### 1. EEG is not necessary for the diagnosis of epilepsy

but it is very helpful

- to classify the epilepsy
- to assess the severity of the epilepsy (risk factor)
- to differentiate epilepsy from non-epileptic paroxysmal events

2. It is not necessary to always repeat EEG during follow up.

But it should be repeated

- 1. When doubt about the diagnosis remains
- 2. When new seizure types occur
- 3. When new neurological problems arise

3. EEG should not be normal before tapering of the anti-epileptic medication is considered

But EEG study after 2 years of seizure freedom is helpful to evaluate the risk of recurrence

### 4. EEG has no *routine* place in the diagnosis of

- Head trauma
- Learning problems
- ADHD

(EEG should not be done before start stimulants)

- Autism

3-5 % of "normal" children have epileptic EEG abnormalities

What is the role of EEG abnormalities in other neurodevelopmental disorders ?

- autism
- ADHD

#### Frequency of Epileptiform Discharges in the Sleep-Deprived Electroencephalogram in Children Evaluated for Attention-Deficit Disorders John J. Millichap, Cynthia V. Stack and J. Gordon Millichap J Child Neurol 2011 26: 6 originally published online 17 August 2010

Frequency of Abnormal Electroencelphalograms (EEGs) in Attention-Deficit Disorder Clinic Patients Who Slept Compared With Those Who Stayed Awake

EEG	Normal	Abnormal	Total
	n (%)	n (%)	n
Sleep	408 (72.0)	159 (28.0) <sup>a</sup>	567
Awake	53 (93.0)	4 (7.0) <sup>a</sup>	57
Total	48 I	163	624

<sup>a</sup> Fisher exact test, P = .0002.

26 %

## EEG : Autism versus ADHD

	PDD					AD/HD		
	Autistic disorder	Asperger disorder	PDD-NOS	PDD with AD/HD <sup>a</sup>	Total	Combined type	Inattention type	Total
Number	15	32	17	51	64	17	5	22
Background abnormalities	5 (33%)	7 (22%)	2 (12%)	12 (24%)	14 (22%)	2 (12%)	0	2 (9%)
Paroxysmal discharges	8 (53%)	19 (59%)	6 (35%)	26 (51%)	33 (52%)	9 (53%)	0	9 (41%)
Diffuse	4 (27%)	11 (34%)	5 (29%)	15 (29%)	20 (31%)	4 (24%)	0	4 (18%)
Foci at Fp-F	3 (20%)	10 (31%)	3 (18%)	15 (29%)	16 (25%)	3 (18%)	-9	3 (14%)
С–Т	3 (20%)	9 (28%)	2 (12%)	12 (24%)	14 (22%)	8 (47%)	0	8 (36%)
P–O	2 (13%)	5 (16%)	3 (18%)	7 (14%)	10 (16%)	5 (29%)	0	5 (23%)
RS	1 (7%)	1 (3%)	1 (6%)	2 (4%)	3 (5%)	0	0	0
Laterality Rt	3 20%	utism :	52%	10 (20%)	13 (20%)	3 (18%)	0	3 (14%)
Lt	1 (7%)	1 (3%)	2 (12%)	4 (8%)	4 (6%)	3 (18%)	0	3 (14%)

Relation between EEG abnormalities and clinical entities.

PDD, pervasive developmental disorder; AD/HD, attention-deficit/hyperactivity disorder; PDD-NOS, pervasive developmental disorder not otherwise specified; Fp–F, fronto polar frontal region; C–T, central temporal region; P–O, parietal-occipital region; RS, rolandic spikes; Rt, right side dominant; Lt, left side dominant, D–I–D–; 4–1–%

<sup>a</sup> Cases of PDD fulfilled the diagnostic criteria for AD/HD.

gnostic criteria for AD/HD. More centro temporal spikes

Kawatani et al, Brain and Development, 2012

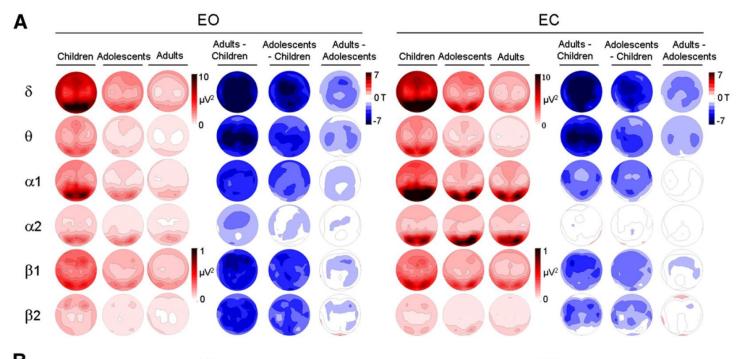
#### 5. EEG studies are not necessary in simple febrile seizures

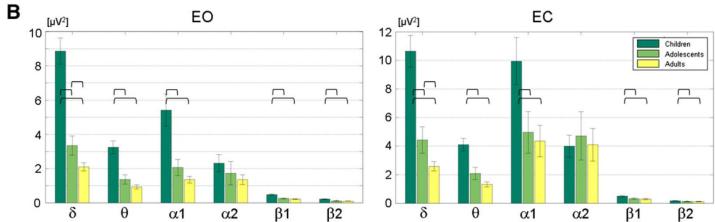
But EEG is helpful in complex febrile seizures (= epilepsy)

## EEG in childhood : developmental issues

- Dominant rhythm moves from central to occipital
- posterior-anterior gradient develops early on
- Dominant rhythm at 6 years should be >= 8 Hz
- Slow activity (theta) physiological , but symmetric
- Stage 1 and 2 sleep : most epileptogenic
- Sleep spindles asymmetric, and longer duration up to 6 months
- Many more artifacts and normal variants
- Epileptic activity comparable to adults

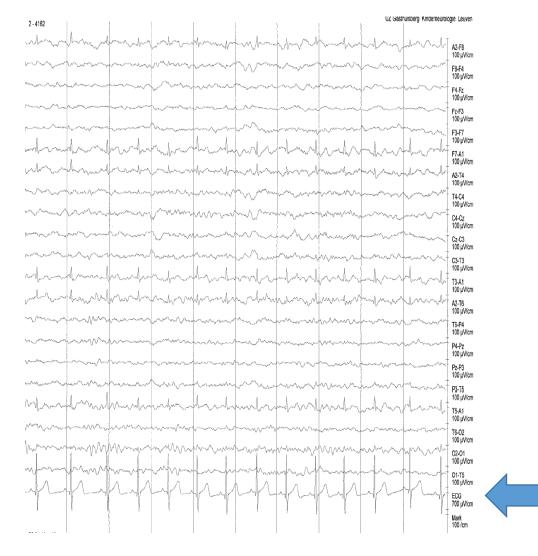
R. Lüchinger et al. / NeuroImage 60 (2012) 1426-1439





## Always include ECG





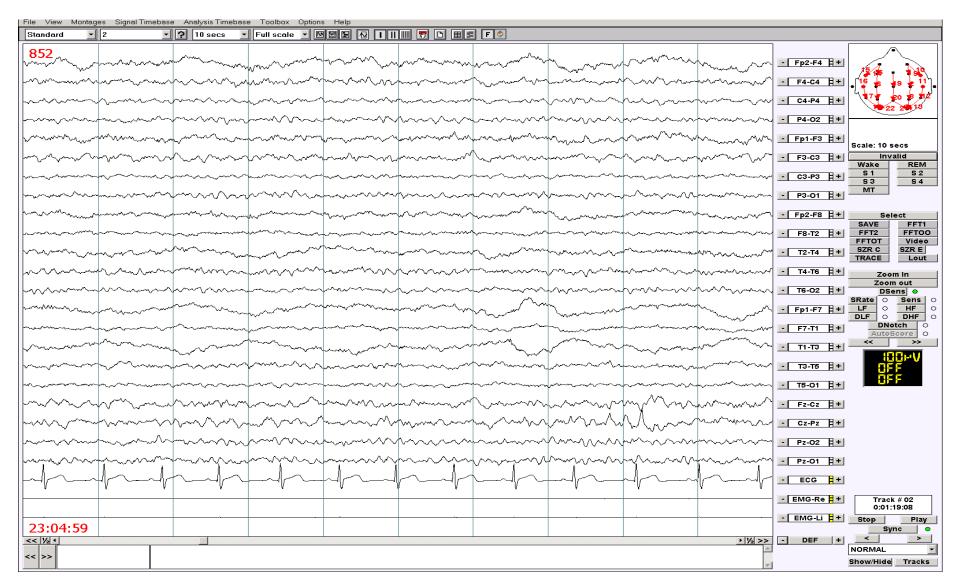
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## Drowsiness: posterior alpha is gone



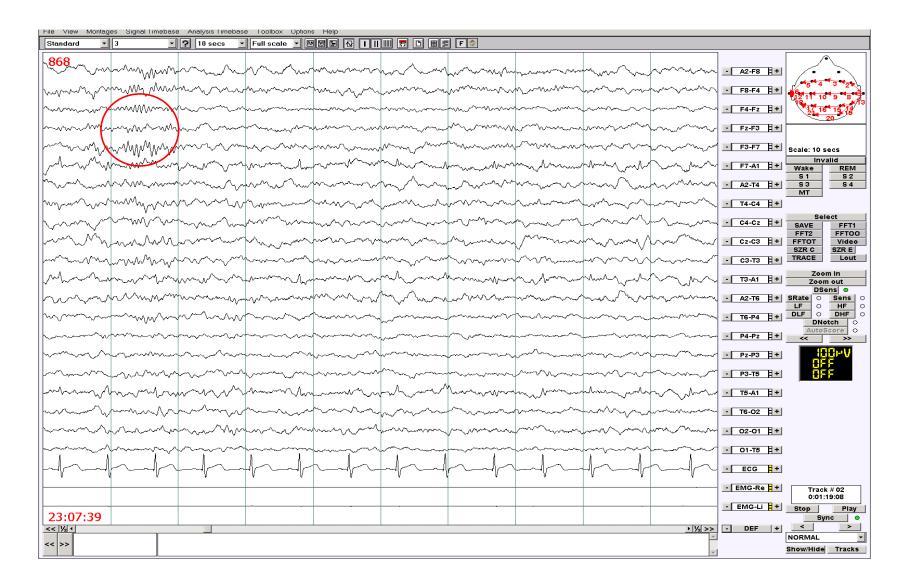
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#### Sleep: Stage 2 non-REM sleep : vertex sharp waves

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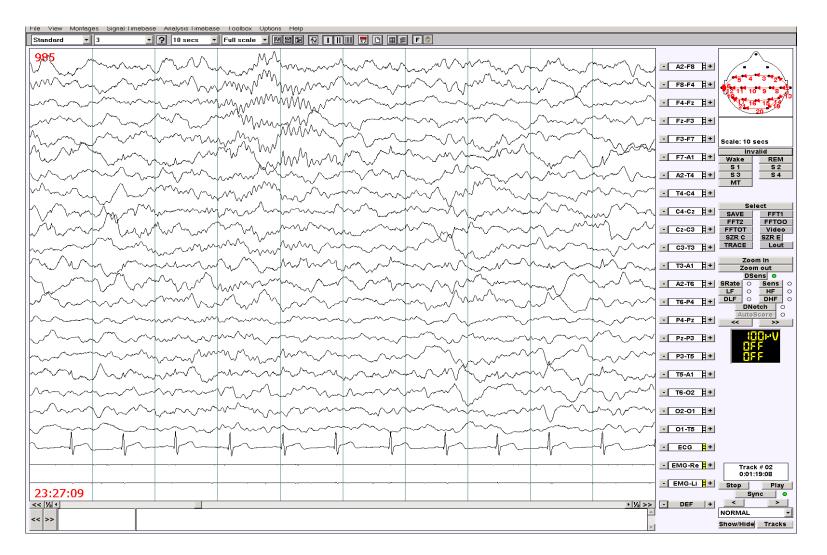
#### Sleep: Stage 2 non-REM sleep spindles



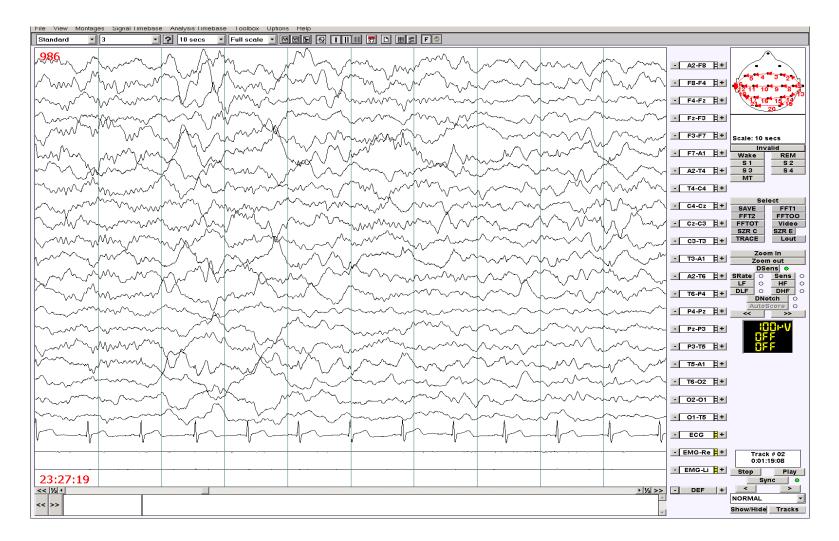
## Sleep: Stage 2 non-REM sleep: K complexes

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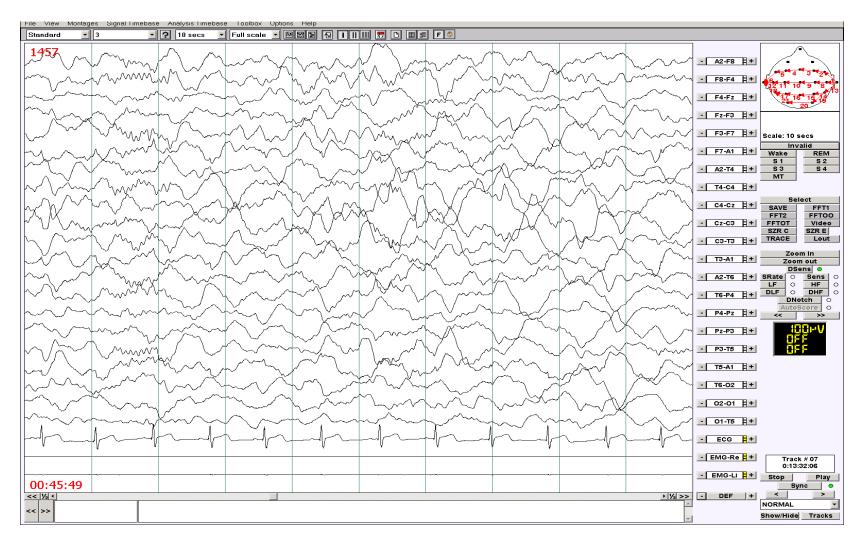
#### Sleep Stage 3 non-REM sleep : delta activity (20-50%)



#### Sleep: Stage 3 non-REM sleep: delta activity (20-50%)



#### Sleep Stage 4 non-REM sleep: domination of delta activity (>80%)

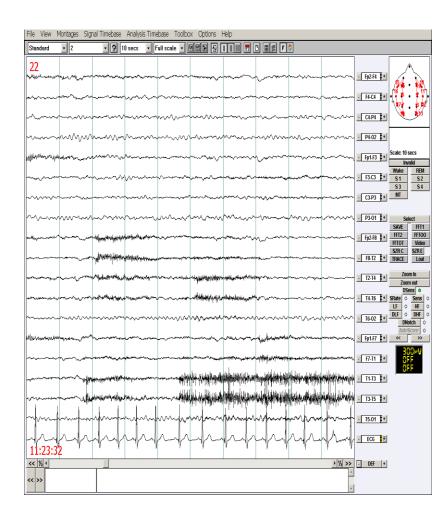


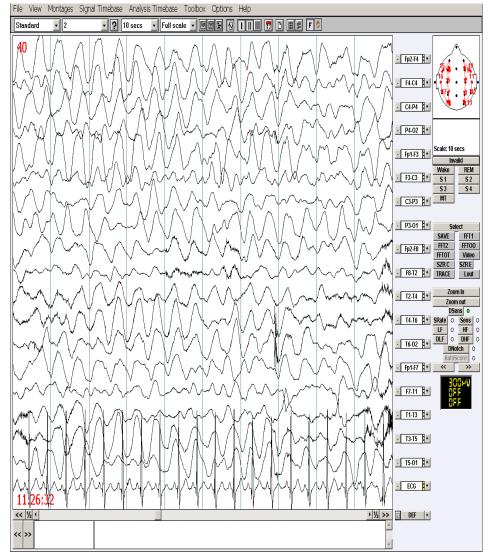
#### REM- (Rapid Eye Movements)

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#### Provocation by Hyperventilation

Left: 5 y old child, normal background activity before HV is started. Right: after 2 minutes of HV bilateral high voltage slowing delta

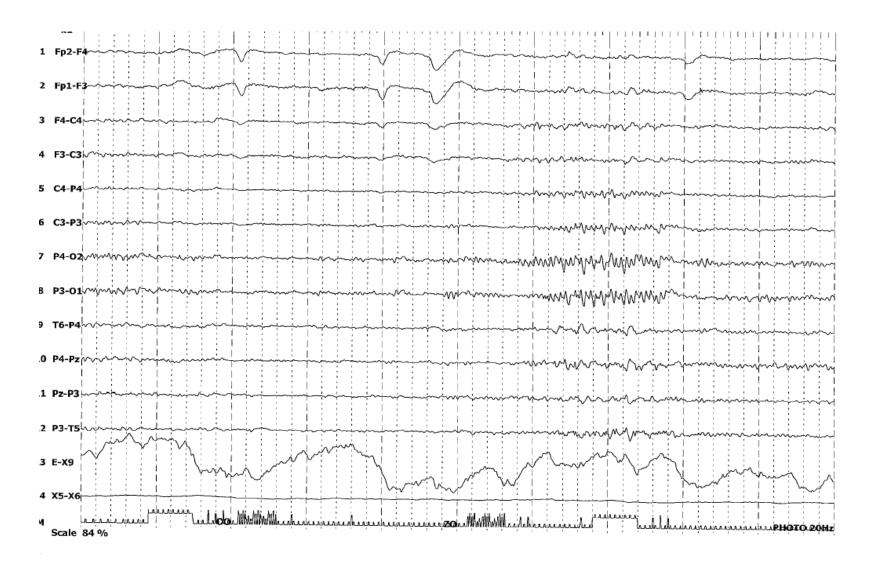




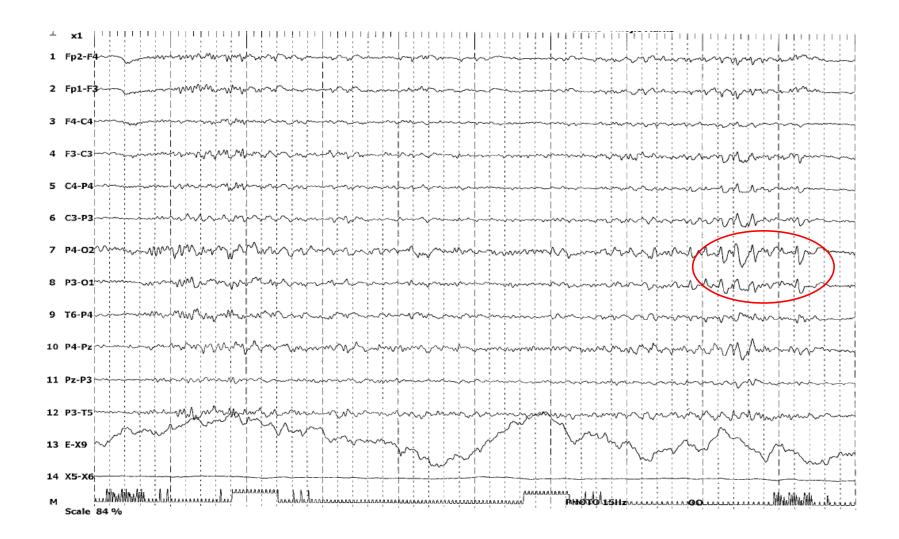
Intermittent photic stimulation : Photoparoxysmal Response Classification of PPR (Waltz et al. 1992)

PPR type	Features
Туре 1	Spikes/sharp waves in occipital areas, same frequency as stimulation frequency
Type 2	Parieto-occipital spikes with posterior localized biphasic slow waves
Туре 3	Parieto-occipital spikes with posterior localized biphasic slow waves which spread to anterior regions
Туре 4	Generalized spike-wave complexes
	PHOTOCONVULSIVE

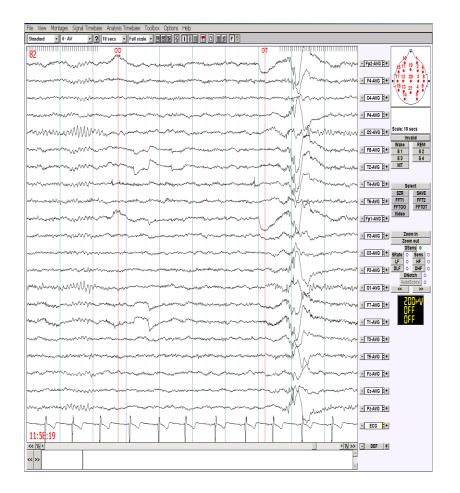
PPR Type 1 : spikes over occipital electrodes ('driving')

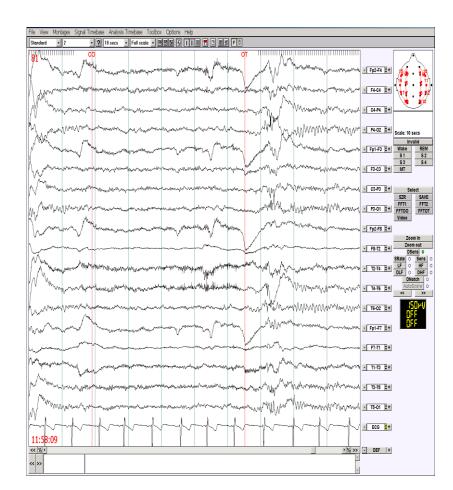


#### PPR Type 2: Parieto-occipital spikes

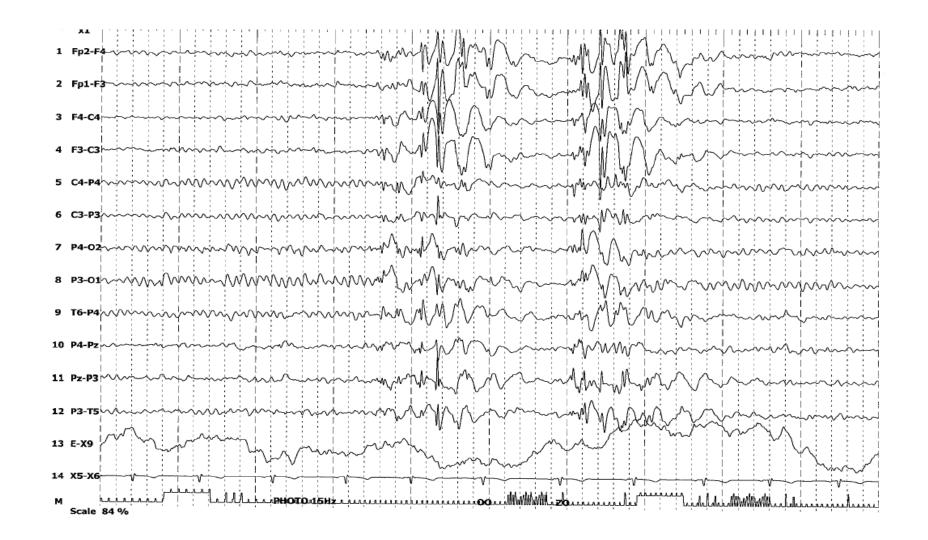


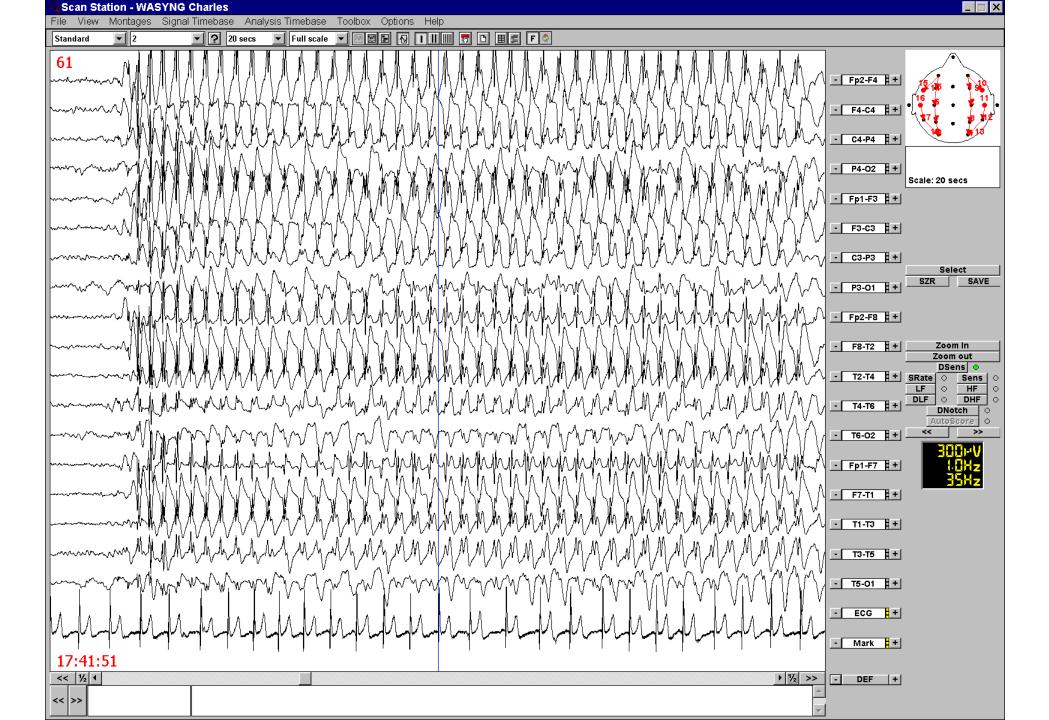
#### PPR Type 3: Parieto-occipital spikes which spread to anterior regions





#### PPR Type 4: Generalized spike-wave complexes

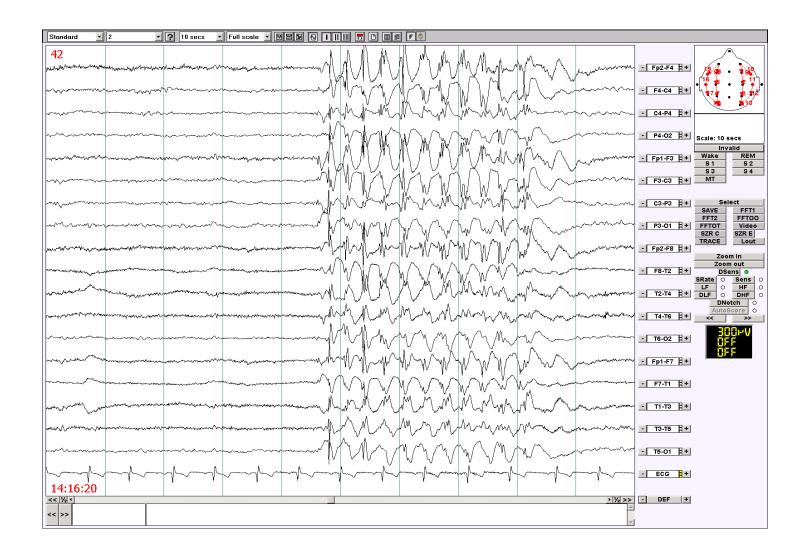




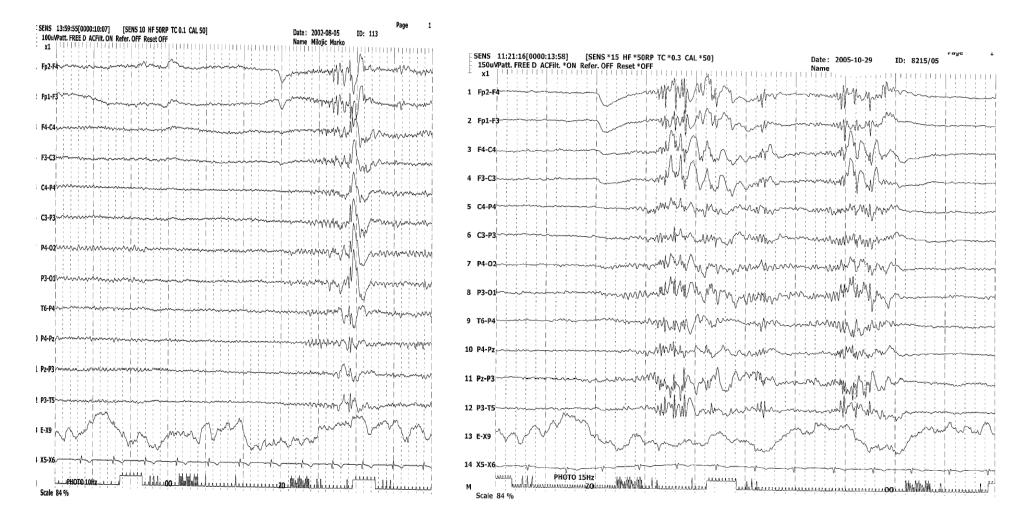
#### Childhood absence epilepsy (CAE) girl 7 y old. Ictal EEG pattern, bifrontal onset

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## Juvenile absence epilepsy (JAE), female, 13 y old. Generalized epileptiform discharge, 3.5 Hz spike and wave

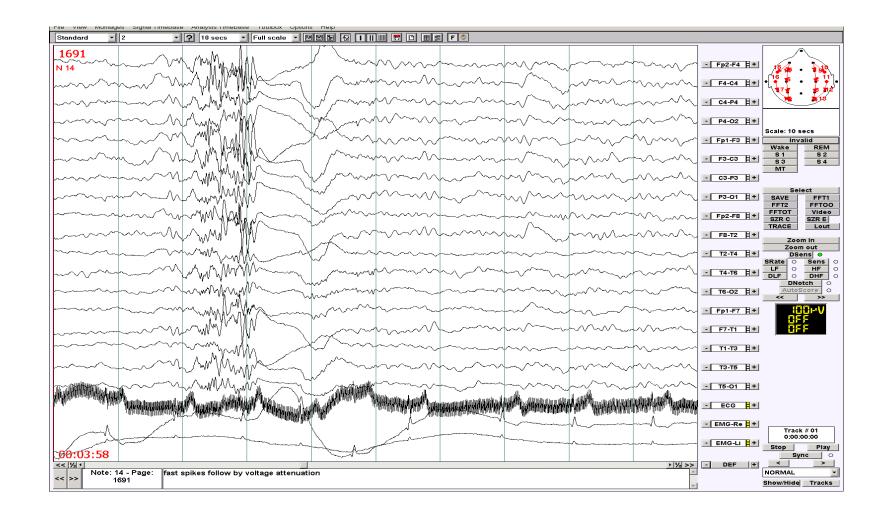


Female 15y old with Juvenile myoclonic epilepsy (JME) Generalized poly-spike waves (during IPS)



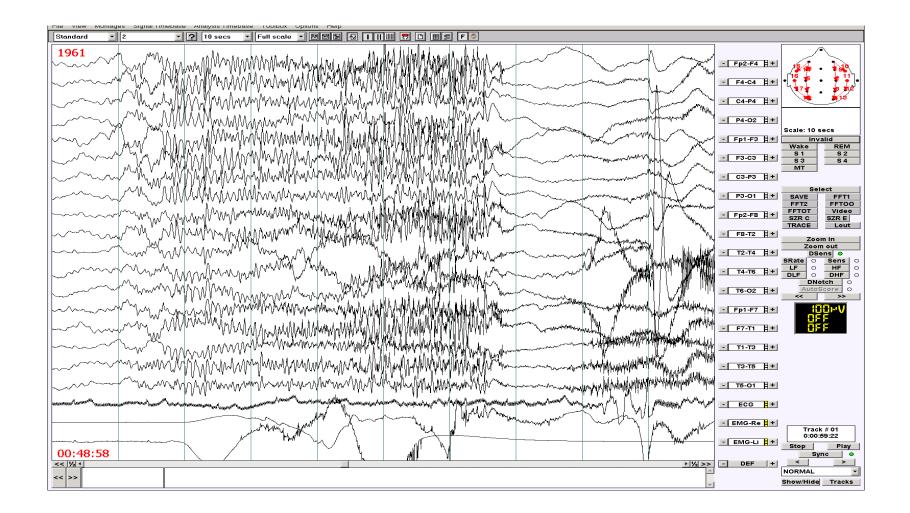
## Boy 10 y old with Lennox Gastaut Syndrome.

Generalized paroxysms of spikes followed by short postparoxysmal attenuation

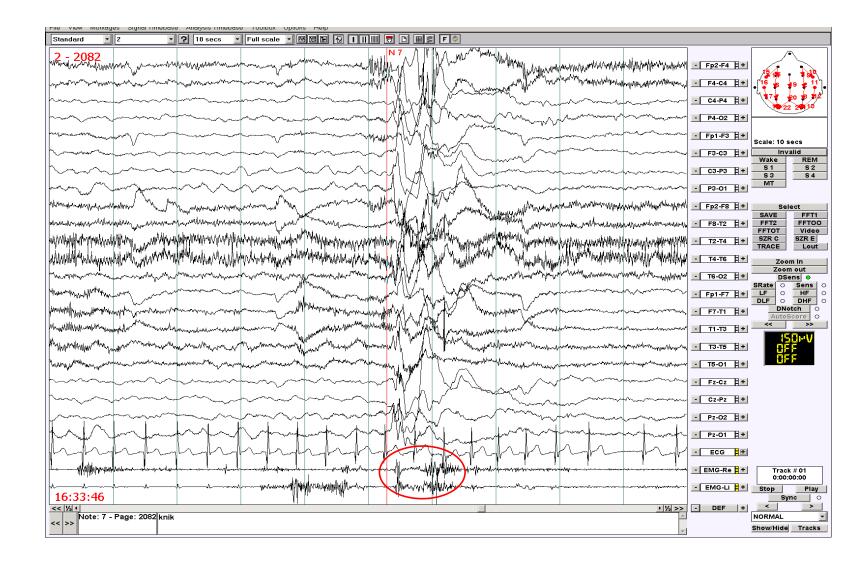


## Male 24y old, frontal lobe epilepsy

Ictal sleep EEG: tonic seizure : fast activity 10-14Hz, and postictal attenuation.

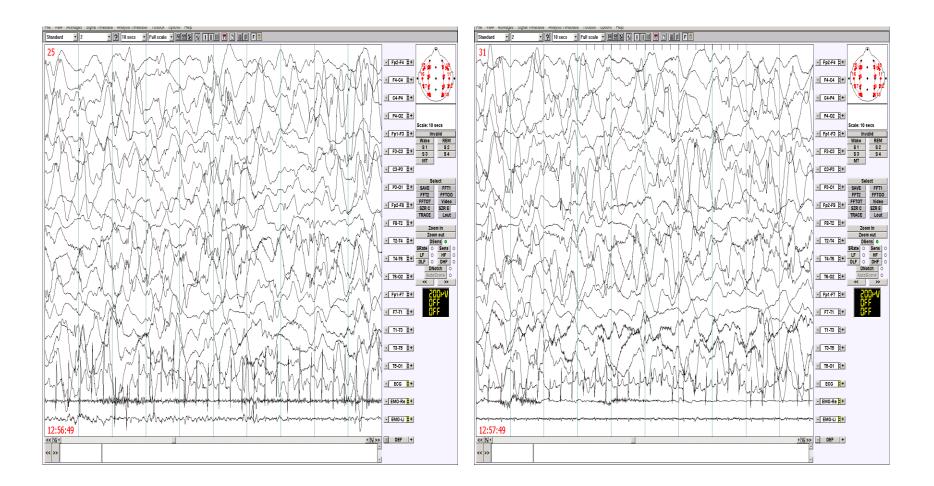


## Boy, 2 ½ y old with Sturge Weber syndrome. Ictal tracé : Myoclonic seizure



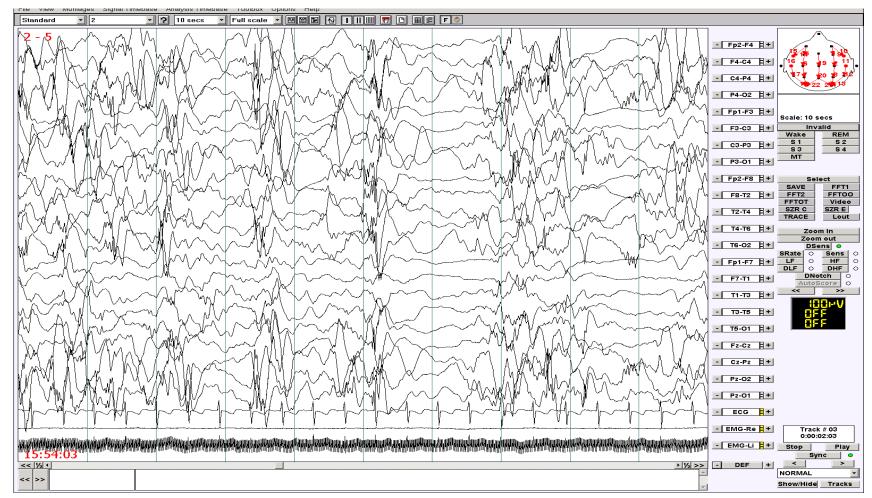
West syndrome in 7 months old baby:

hypsarrhythmia : high voltage irregular slow activity with multifocal spikes and sharp waves

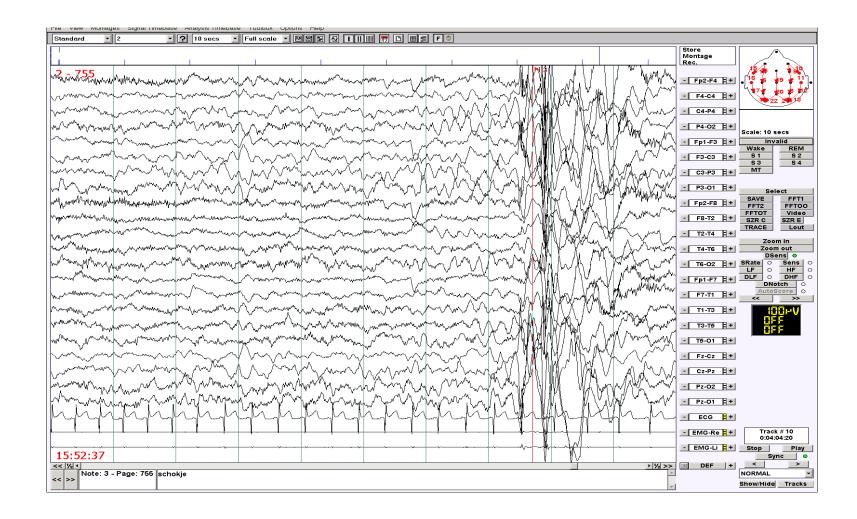


Interictal sleep EEG (2 ½ months old baby with flexion spasms)

disorganized background activity with very frequent generalized epileptiform discharges, and short suppression burst



7 months baby with contolled extension spasms (West syndrome). Generalized epileptic abnormalities



5 days old baby with Early Infantile Epileptic Encephalopathy with suppression burst .

Ohtahara syndrome

