Basic Principles for EEG reading

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Steps for EEG reading

After: Guidenline 7 – J Clin Neurophysiol 2006;23:118-121

- 1) An orderly approach to visual analysis – unbiased description, no jump to conclusions
- 2) Determination of abnormality by synthesis of 1) (no evidence-based grading scale is published)
- 3) Interpretation of 2) on the basis of clinical symptoms and published correlations (Clinical report)

What parameters do I have to consider when starting EEG reading?

- 1) Age of the proband, patient

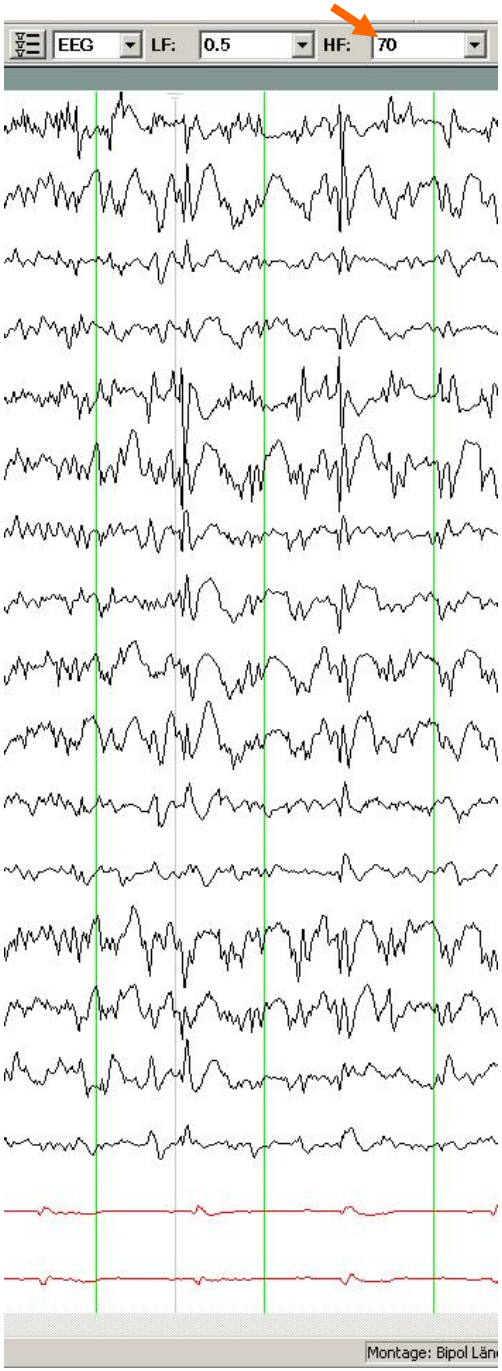
- 2) Technical parameters:
  high pass filters
  low pass filters
  voltage calibration (uV/mm)
  paper speed (mm/sec)

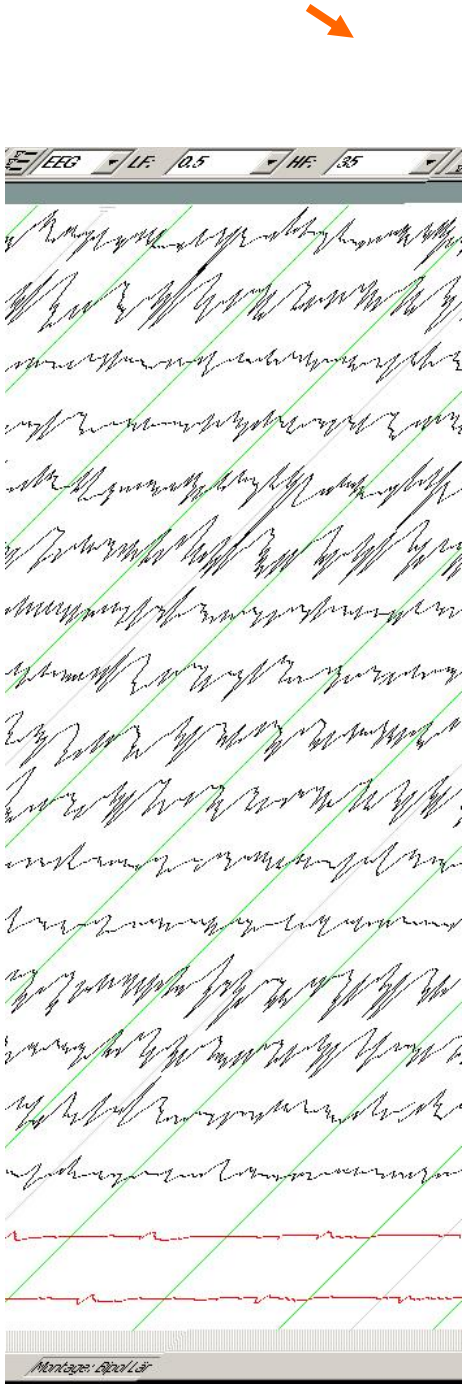
- 3) State of vigilance:
  Chek of reactivity and memory by technician and in questionable cases by MD on duty

- 4) Clinical details
  not essential for steps 1) and 2). Should be known for step 3)

Significance of filters

- Without filters the EEG is unreadable (DC- potentials, artifacts)
- Low frequency = high pass filter (tc 0.1 – 5.0 or cutoff frequency 1.6 Hz – 0.03 Hz)
- High frequency = low pass filter (15 – 70 Hz)
- Filters change EEG-waves
- Spikes are attenuated by high frequency filters, slow waves by low frequency filters
- Filters without significant loss of information in clinical EEG: tc 0.3 and high frequency filter 30


EEG
LF:
0.5
HF:
70
Montage: Bipol Läng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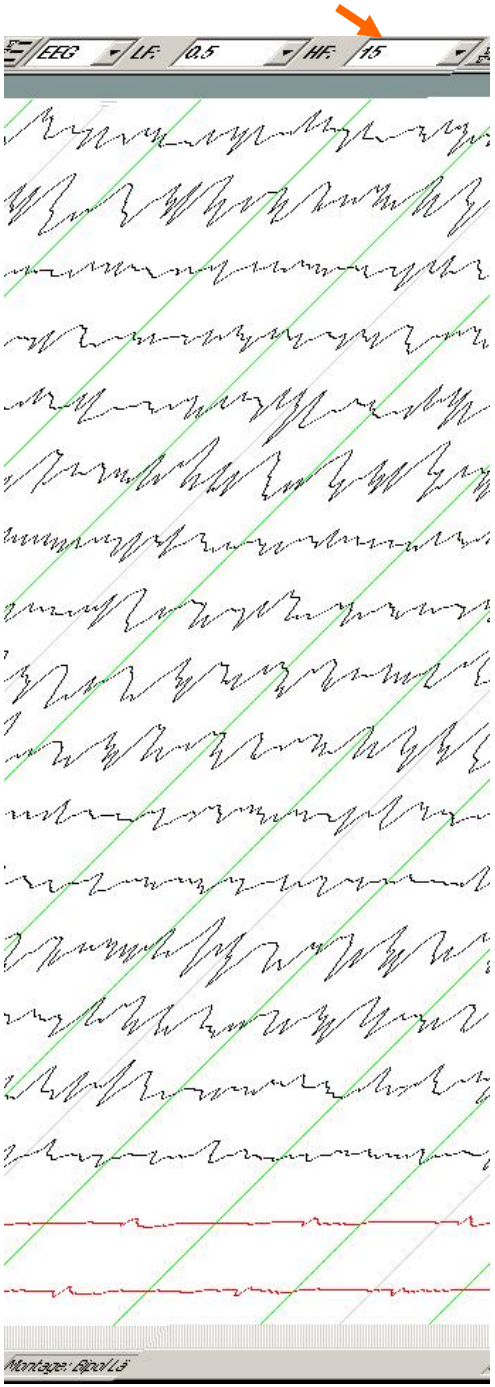
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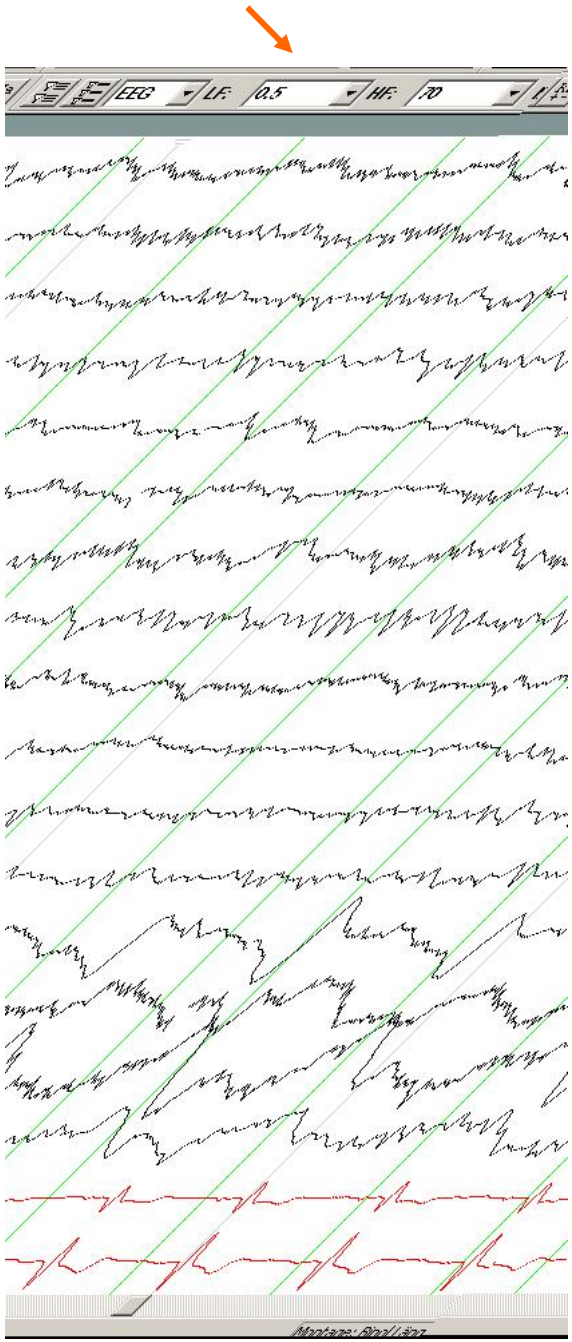
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EEG
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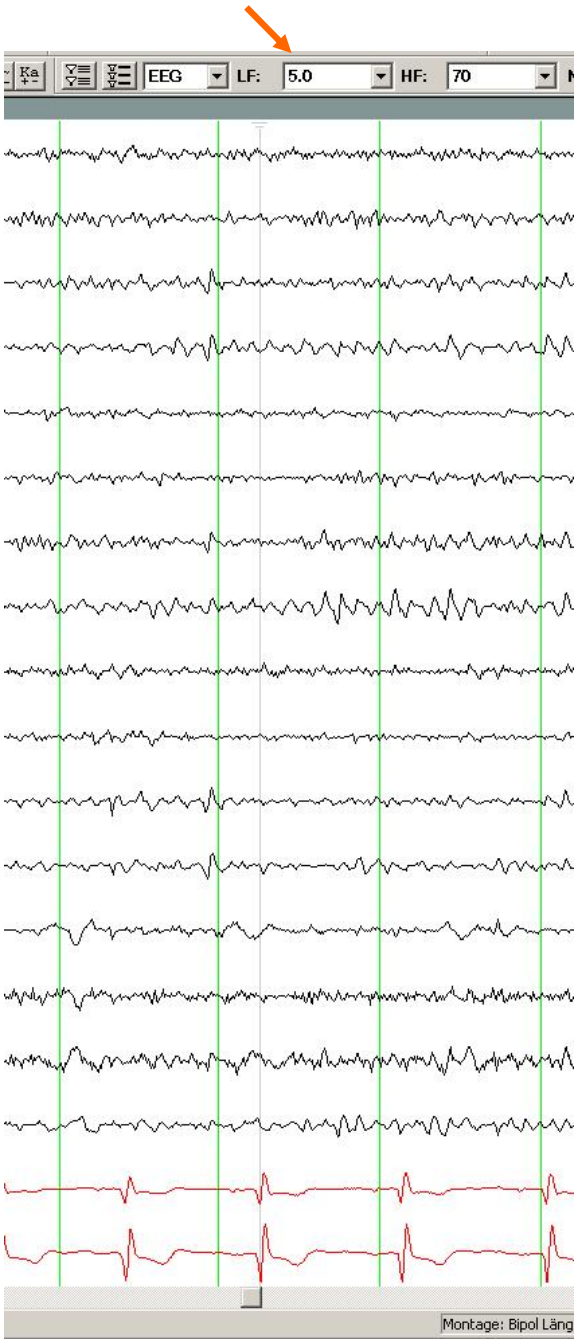
EEG
LF:
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HF:
70
Montage: Bipol Läng

Syndromes of neuro-executive disturbances

Disturbed motor control	Global cerebral dysfunction	Partial cerebral dysfunction
reactivity 0 od. +/0 memory +	reactivity 0 memory 0	reactivity +/0 memory +/0
Pyramidal lesions	Coma (eyes closed) Dysfunction of ARAS at ponto-mesencephalic junction	Dementia
Extrapyramidal syndromes	Coma (eyes closed except with tonic eye movements in hypoxic states) Dysfunction down to midbrain level (intoxikation, hypoxia, metabolic , anaesthesia, ...)	Absence seizures, FCS, NCSE, postictal
Locked- in Syndrome	GTCS, CSE	Recovery from anaesthesia
ALS, final state	Final state of dementia ?+VS (UWS) (eyes periodically opened)	Recovery from GTCS, coma, VS (UWS) ...
Polyneuropathies (u.a. GBS)	VS = UWS (eyes periodically opened)	MCS

0 = no function, +/0 = function disturbed, + = normal function

TABLE 5.1. *Essential characteristics of electroencephalographic analysis*

1. Frequency or wavelength
2. Voltage
3. Waveform
4. Regulation
   a. Frequency
   b. Voltage
5. Manner of occurrence (random, serial, continuous)
6. Locus
7. Reactivity (eye opening, mental calculation, acapnia, sensory stimulation, movement, affective state)
8. Interhemispheric coherence (homologous areas)
   a. Symmetry
      i. Voltage
      ii. Frequency
   b. Synchrony
      i. Wave
      ii. Burst

From: Kellaway,P: Orderly approach to visual analysis.
In: Ebersole,JS, Pedley,TA (eds.): Current Practice of Clinical Electroencephalography.
III.Ed. 2003

?árhythm, basic rhythm, basic activity

- ?5–rhythm:
  8-12 Hz, occipital, occurring with eyes closed and with relaxation, blocking with eye opening and other exogenous stimuli . Indicates wakefulness

- Basic rhythm: represents a slow equivalent to ?-rhythm (? demented state or initial drowsiness)

- No ?- or basic rhythm – disturbance of quantitative consciousness

- Basic activity: describes the prevalent wave form

Z. EEG–EMG 13 (1982) 28–33

Aktivitäten im α-Frequenzbereich und Koma

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Universitätsklinik für Neurologie Innsbruck und Neurologische Abteilung des Aö. Landeskrankenhauses Linz

1) Areactive activities in the alpha range with pontine lesions

2) Reactive alpha rhythm in LiS

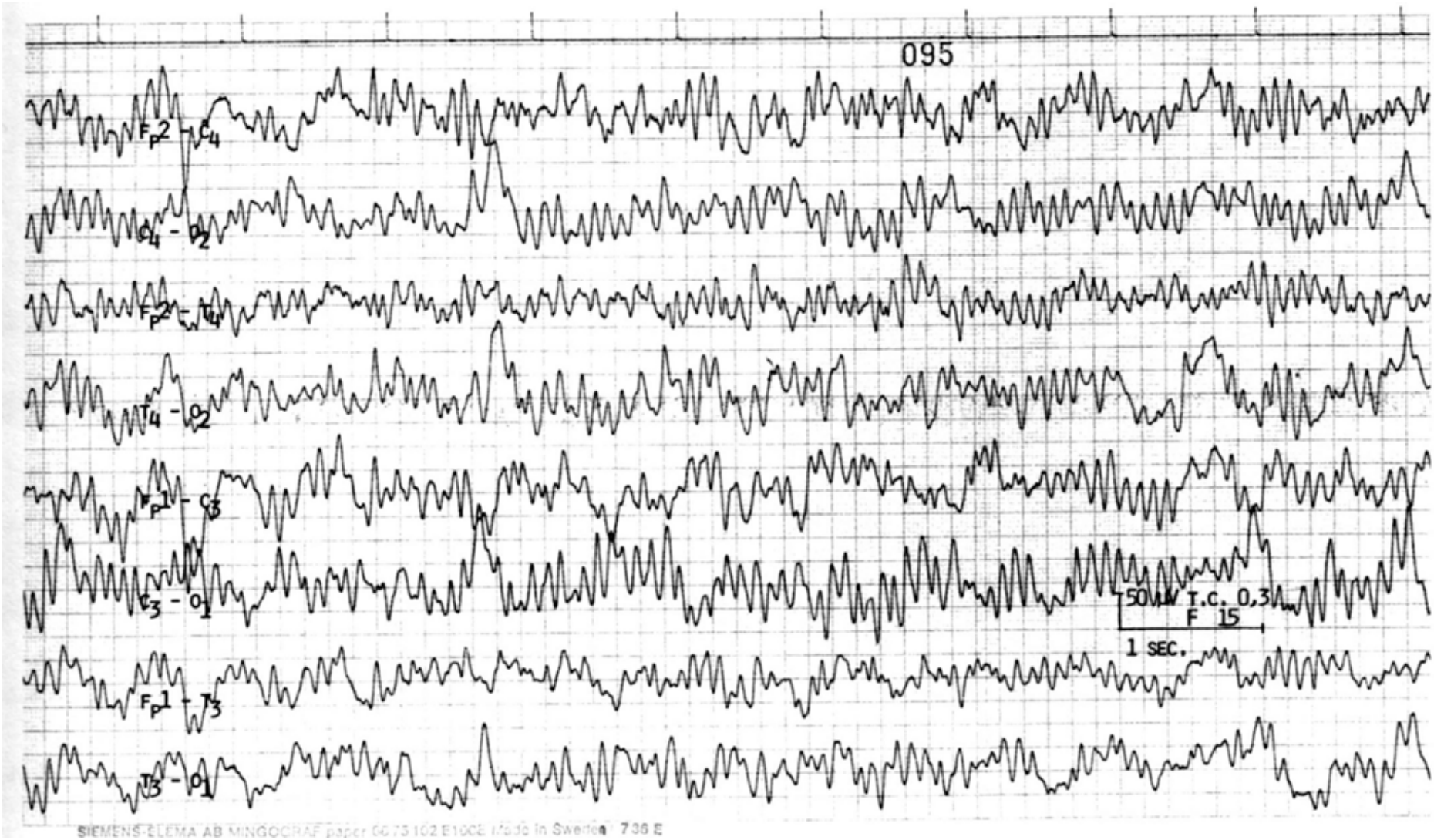
3) Reactive alpha rhythm in total LiS

4) Alpha activities with intoxications

5) Spindle-like alpha activities with comatose states due to herniations

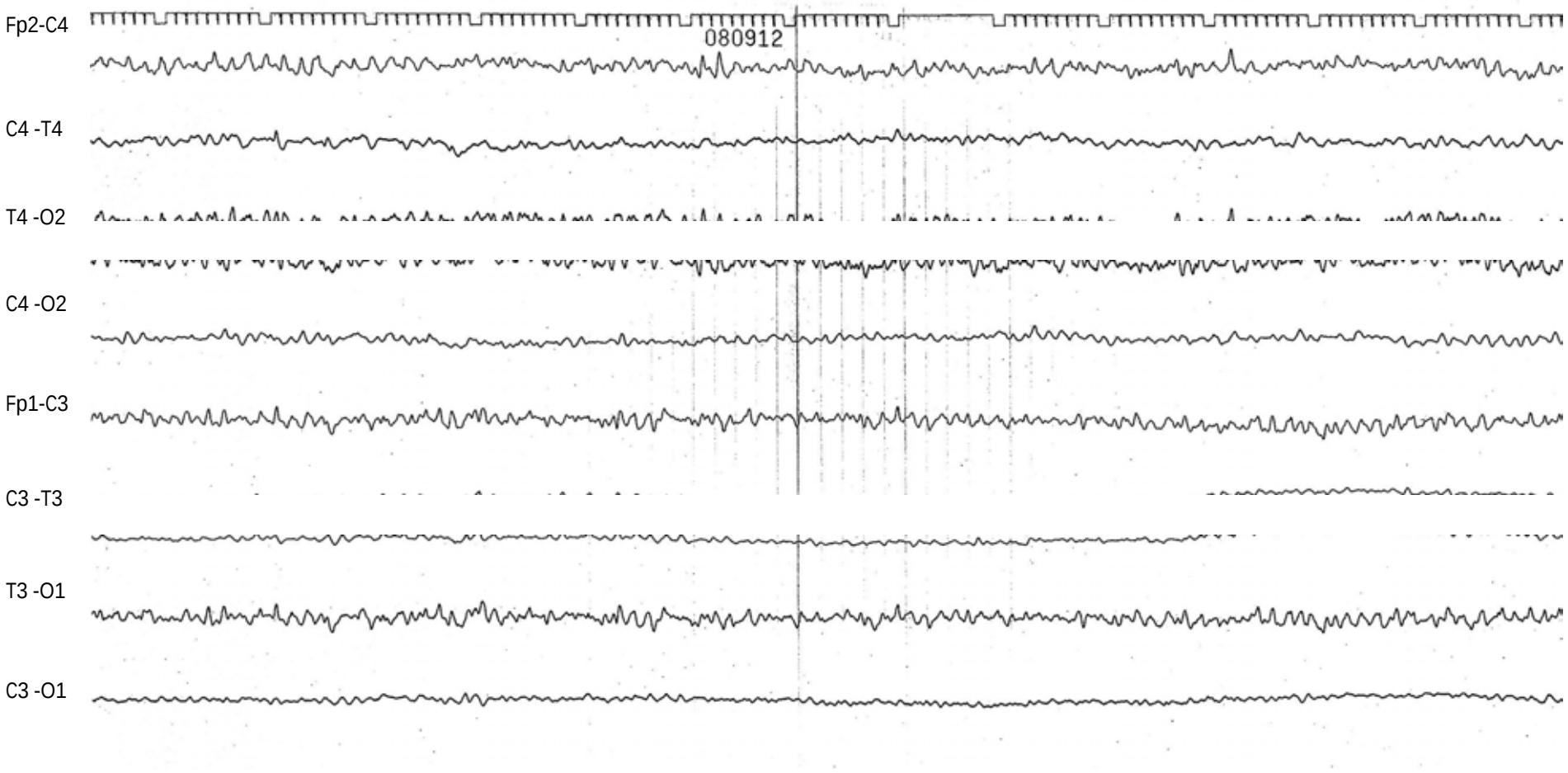
6) Alpha activities as an epileptiform pattern

7) Alpha coma pattern



E.H., female, 24 years. Coma due to Sumnopan R intoxication in a suicidal attempt. Exhibited decerebrate posturing in the early phase of coma. Recovered. Diffuse slowing with superimposed alpha- and beta-frequencies

M.M., female, 81 years. 14.07.1992. Nr. 8-7466. tc 0.1 (!) F 35. Comatose, on respirator after CRA. Mixed ?\ and theta - frequencies and periodic sharp transients over R frontal region



M.M., female, 81 years. 14.07.1992. Nr. 8-7466. tc 0.1 F 70. Identical record as with previous folie, 5 minutes later. ?\coma pattern.

tc 1.0 F 70. 09.11.1997. Migraine. 4/sec rhythm over the posterior (?) regions, blocked by eye opening („Augen auf“). After eye closure („Augen zu“) 9/sec ?-rhythm

Orderly description of EEG activities

- 1) ?4 or basic rhythm
- 2) 4-7/sec (= theta) activities
- 3) 14-25/sec (= ?4) activities
- 4) 1-3/sec (delta) activities
- 5) Reactions to exogenous stimulation (blocking of ?4 rhythm, others)
- 6) Effect of hyperventilation.
  HV is contraindicated in several patients (SAB, vascular lesions ...)
- 7) Changes in vigilance
- 8) Definite abnormalities (diffuse or focal slow waves, spikes, abnormal patterns, ...)

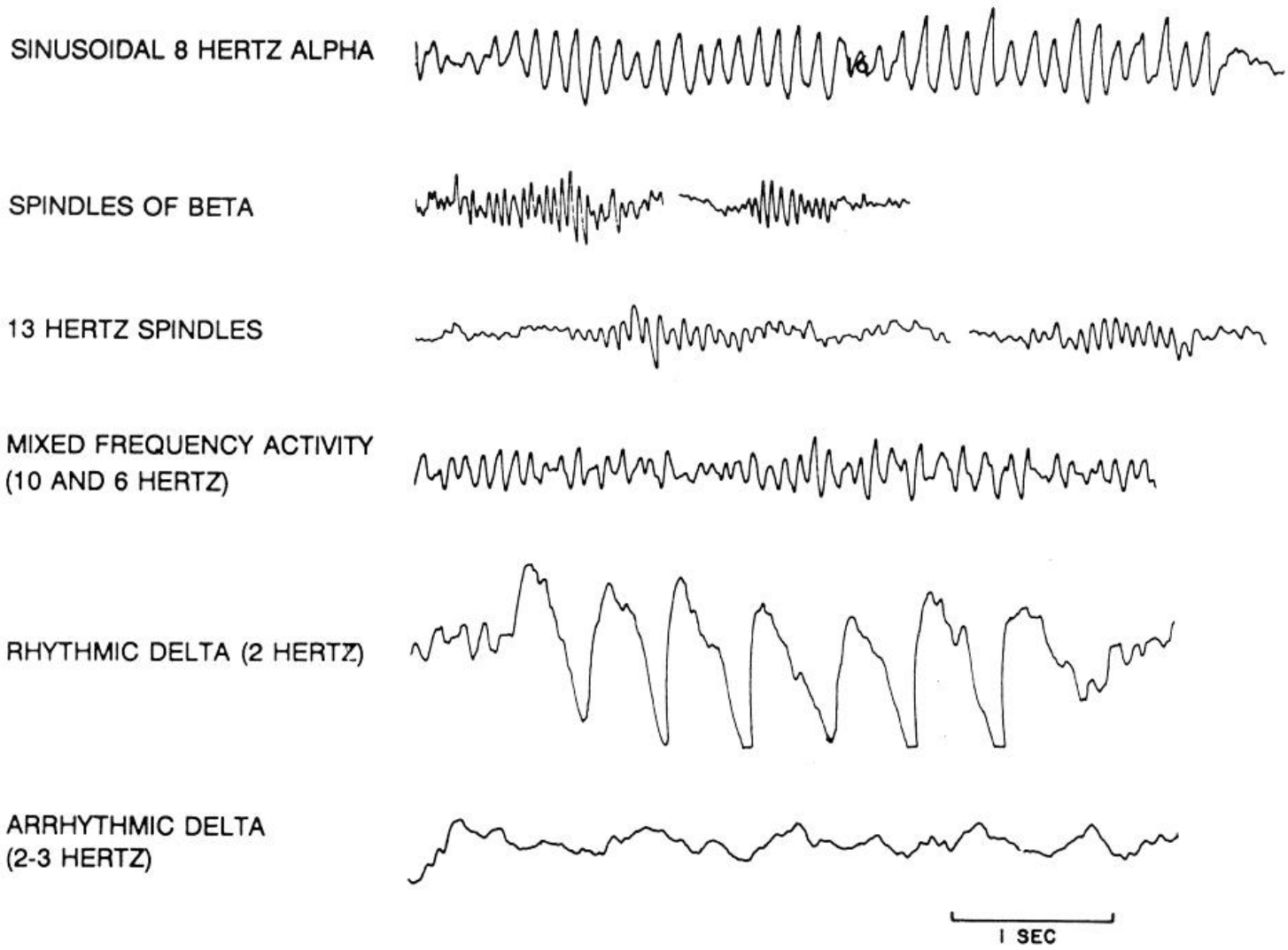


FIG. 1–2. Various wave forms. "Classical" appearance of several types of wave forms which appear in this atlas.

From: Blume,WT, Kaibara,M, Young,GB: Atlas of Adult Electroencephalography

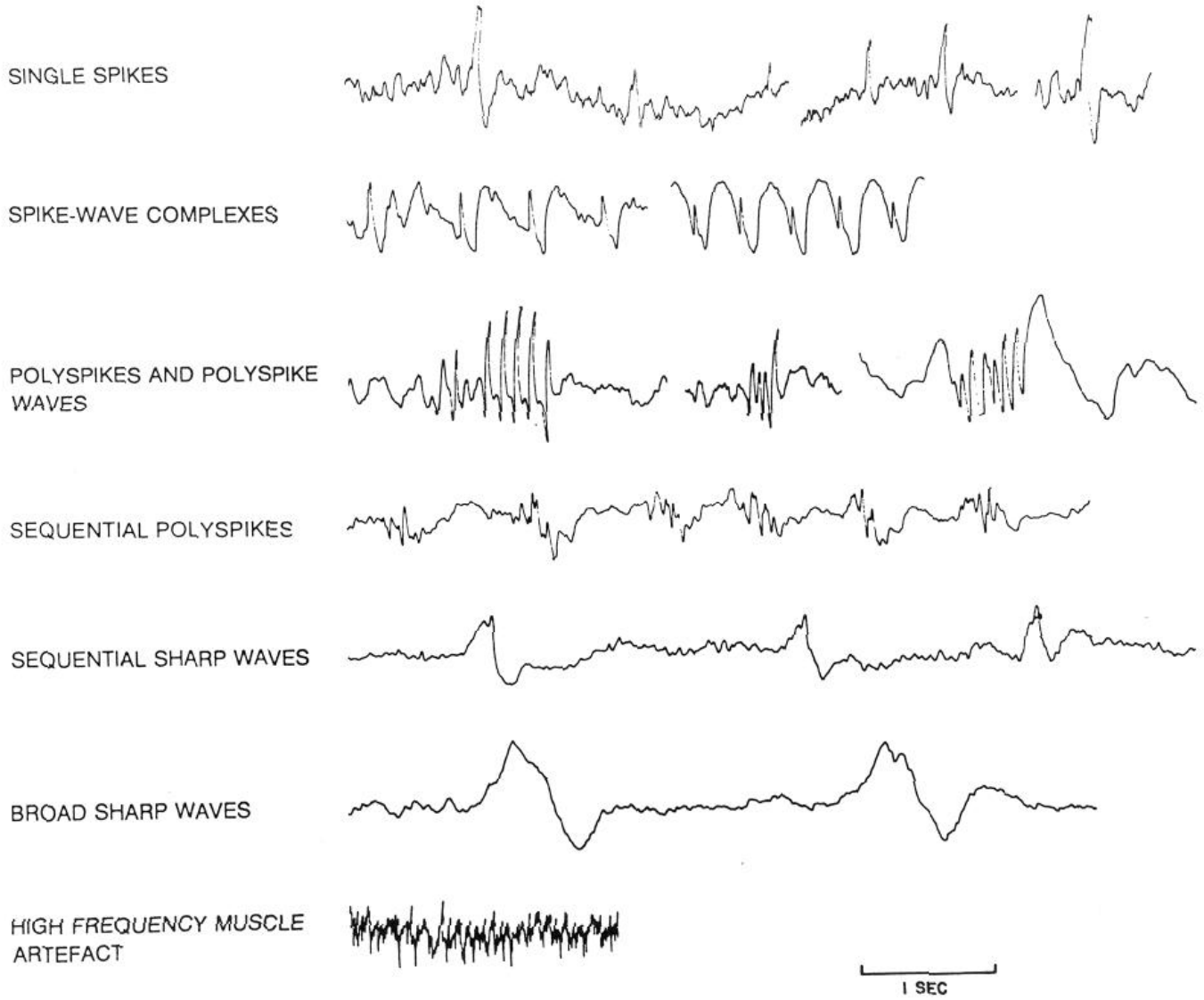


FIG. 1–2. *(continued)*

From: Blume,WT, Kaibara,M, Young,GB: Atlas of Adult Electroencephalography

' Sharp Waves—An Underrecognized EEG Pattern in Patients with Epileptic Seizures

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Gerhard Bauer,* ,

Summary: Broad sharp waves (BSWs) are a rare pattern defined as focal or lateralized high voltage, sharply contoured 0.5 to 1.5sec waves distinguished from background activities by exceeding their voltage for at least two times. The aim of the study was to determine EEG criteria, frequency, and clinical significance of BSWs. During a 2-year period, we prospectively gathered EEG records exhibiting BSWs in a large EEG laboratory of a university hospital. Clinical variables and the relationship to epileptic seizures were analyzed. Forty-eight (0.6% of 7669) patients exhibited BSWs. In 38 (79%) patients, they were localized over the frontal region. In 31 (65%) patients, no spikes or sharp waves have been recorded. Thirty-four (71%) patients underwent previous neurosurgical interventions. All but one patient suffered one or more epileptic seizures corresponding to a positive predictive value of BSWs for seizures of 98%. A symptomatic etiology of the seizures (i.e., head trauma, brain tumor, aneurysm clipping after subarachnoid hemorrhage, and stroke) could be established in all but two patients. In four patients, seizures have been classified as acute symptomatic; in 43 (86%) patients remote symptomatic epilepsy was diagnosed; in 38 (79%) patients of frontal lobe origin. Broad sharp waves should be considered as an epileptiform EEG pattern on its own. Since BSWs are an indicator for acute and/or remote cerebral

Key Words: Epileptiform EEG pattern, Symptomatic epilepsy, Frontal lobe epilepsy, Craniotomy, Broad sharp wave, Zeta wave.

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The terminology of EEG graphoelements found in patients with epileptic seizures remains a matter of debate. The glossary of terms most commonly used by clinical electroencephalographers (Noachtar et al., 1999) differentiates "epileptiform" and "seizure" patterns. Epileptiform discharges are considered interictal. Seizure patterns with clinical symptoms are termed "subclinical." A number of distinctive graphoelements with a high specificity for epileptic seizures are not covered by the glossary, e.g., paroxysmal/

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METHODS

Broad sharp waves have been defined as focal or lateralized paroxysmal high voltage sharply contoured delta waves, distinguished from background activity and with a duration of 1 to 2 seconds. A zeta-like shape of the complex (Magnus, 1970; Magnus and Van der Holst, 1987) represents a morphologic criterion. The amplitudes of BSWs had to exceed the amplitudes of the background activities for at

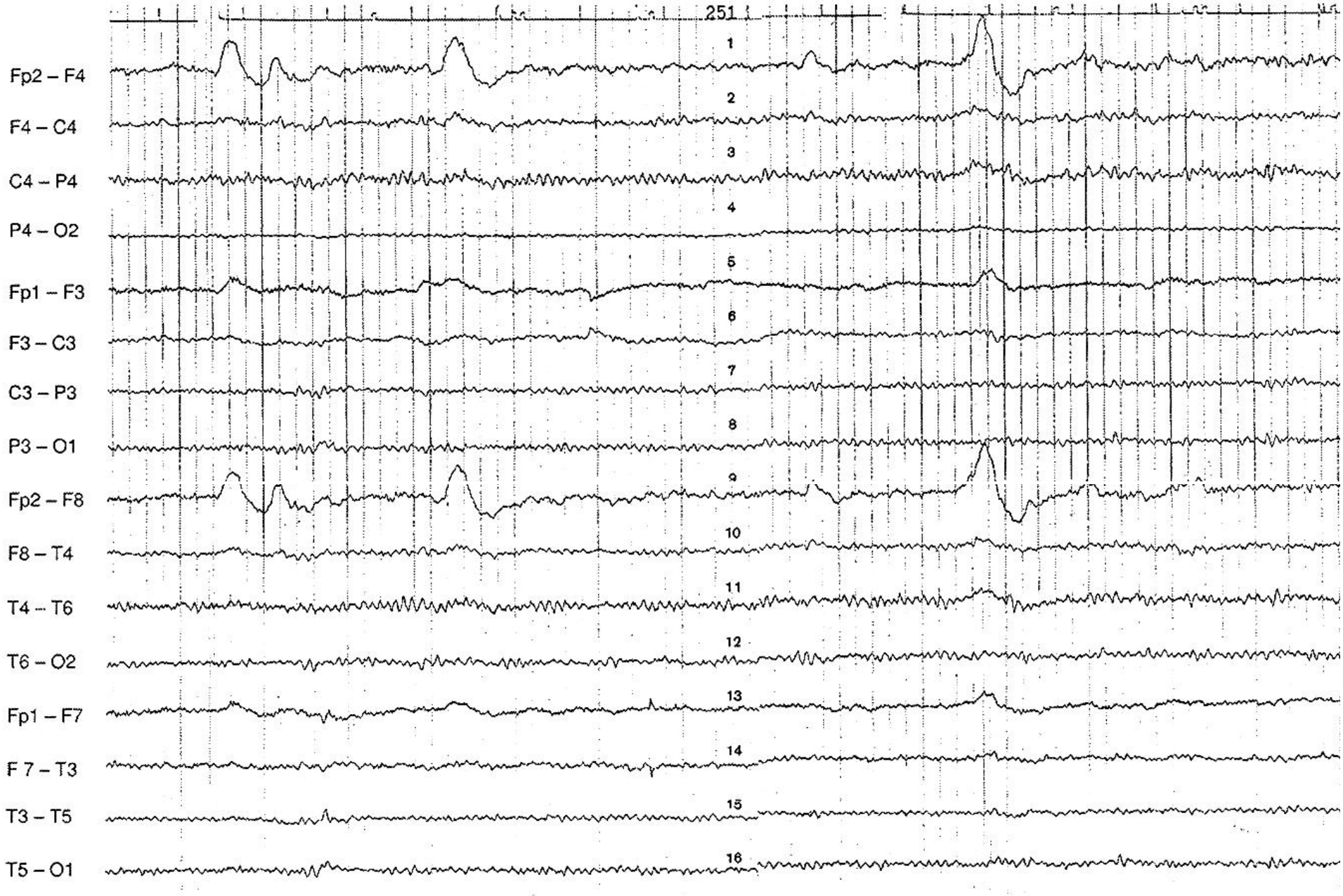


FIGURE 1. Female, 19 years. 7 μV/mm tc 0.3 F 70. Symptomatic epilepsy after surgical removal of a right frontal tuber in tuberous sclerosis complex. Randomly occurring broad sharp waves over right frontal region.

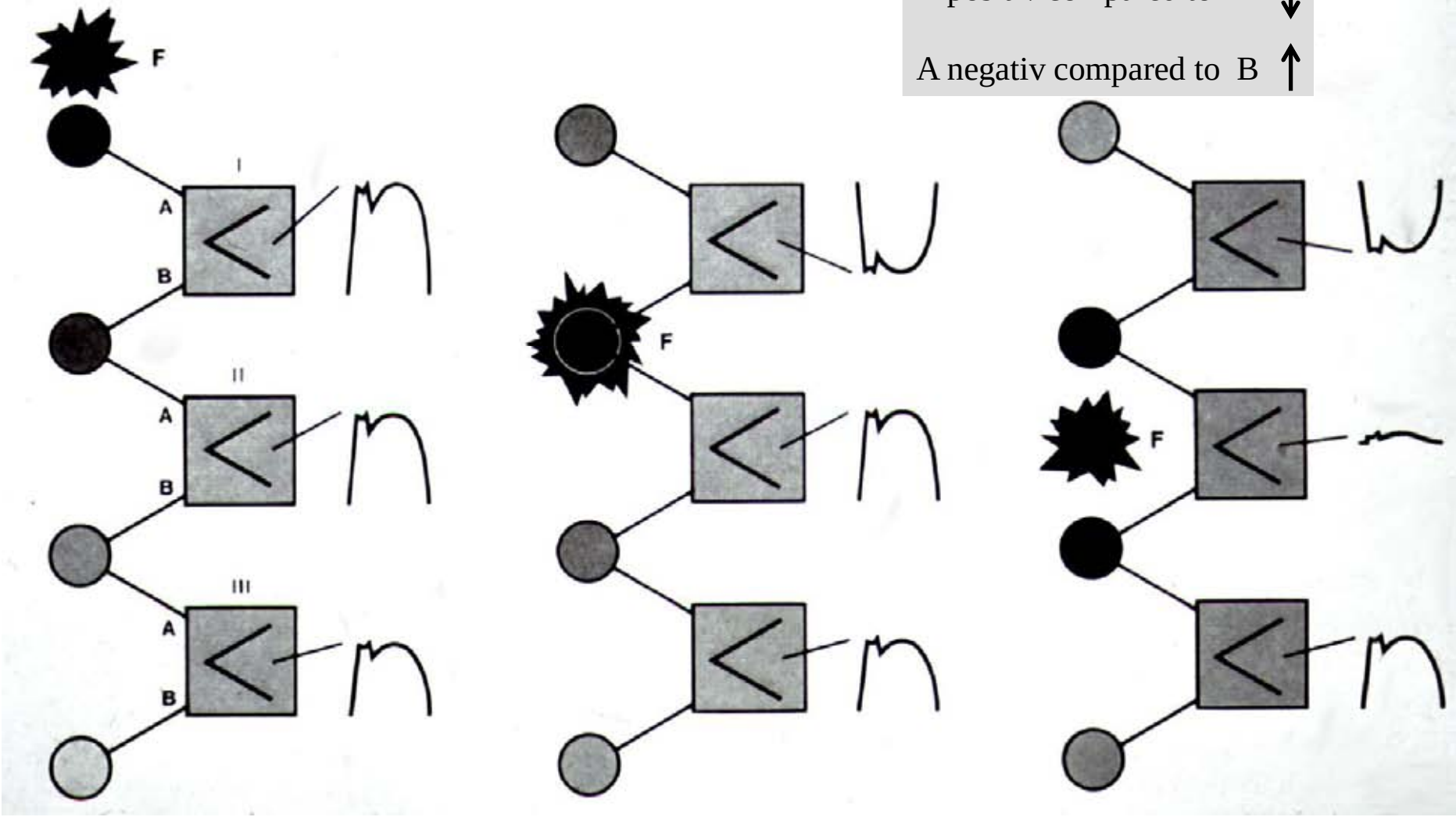
Localization of EEG waves

From: Hess,R.: EEG-Fibel

Convention of polarity

A positiv compared to B ↓

A negativ compared to B ↑



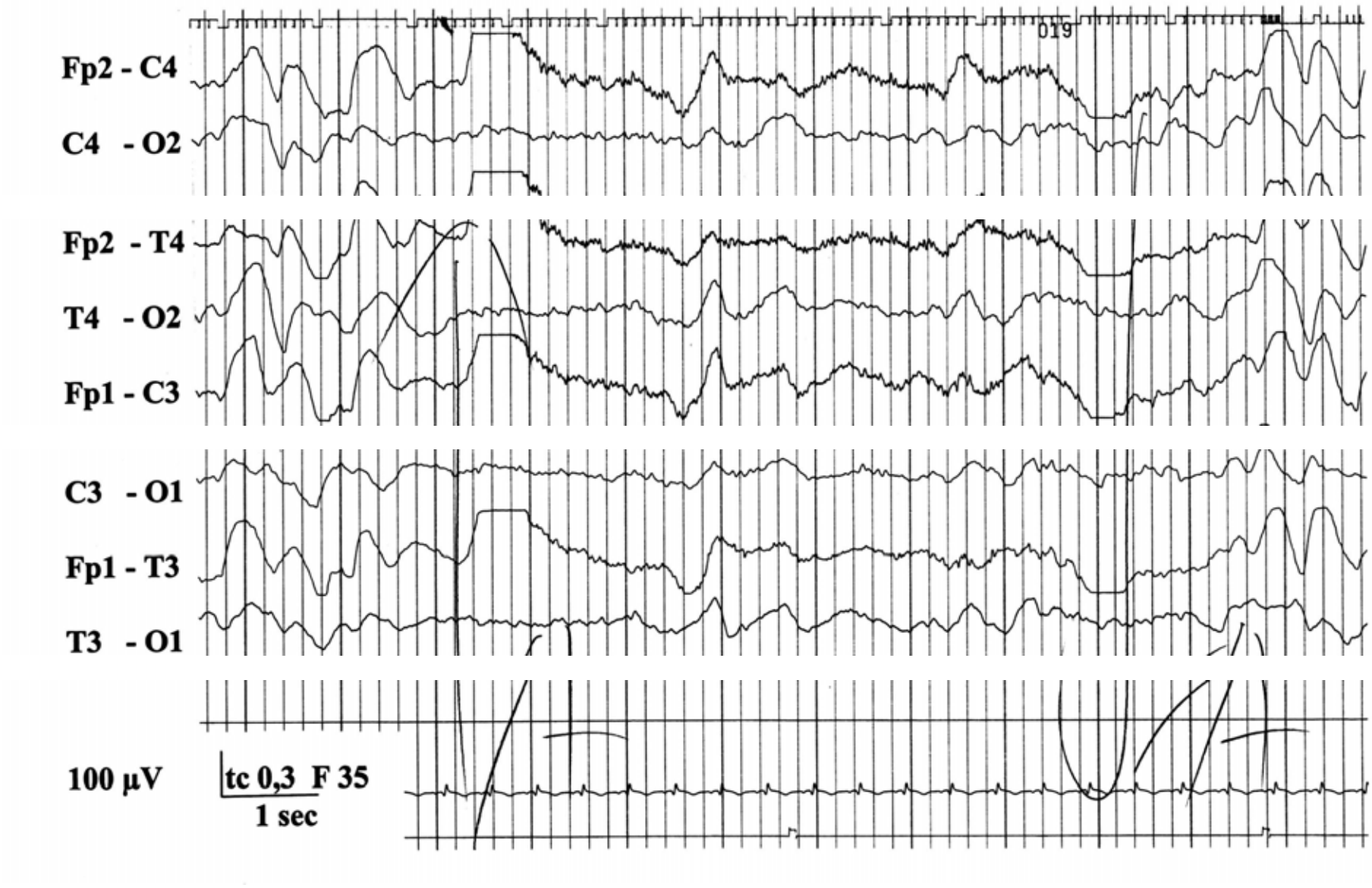
Phase reversal: Localizes waves generated by a circumscript cortical field. Can only be observed with bipolar montages. With referential montages maximal amplitude indicates the generator. Phase reversal represents a normal phenomenon.

Reactivity to exogenous stimulation

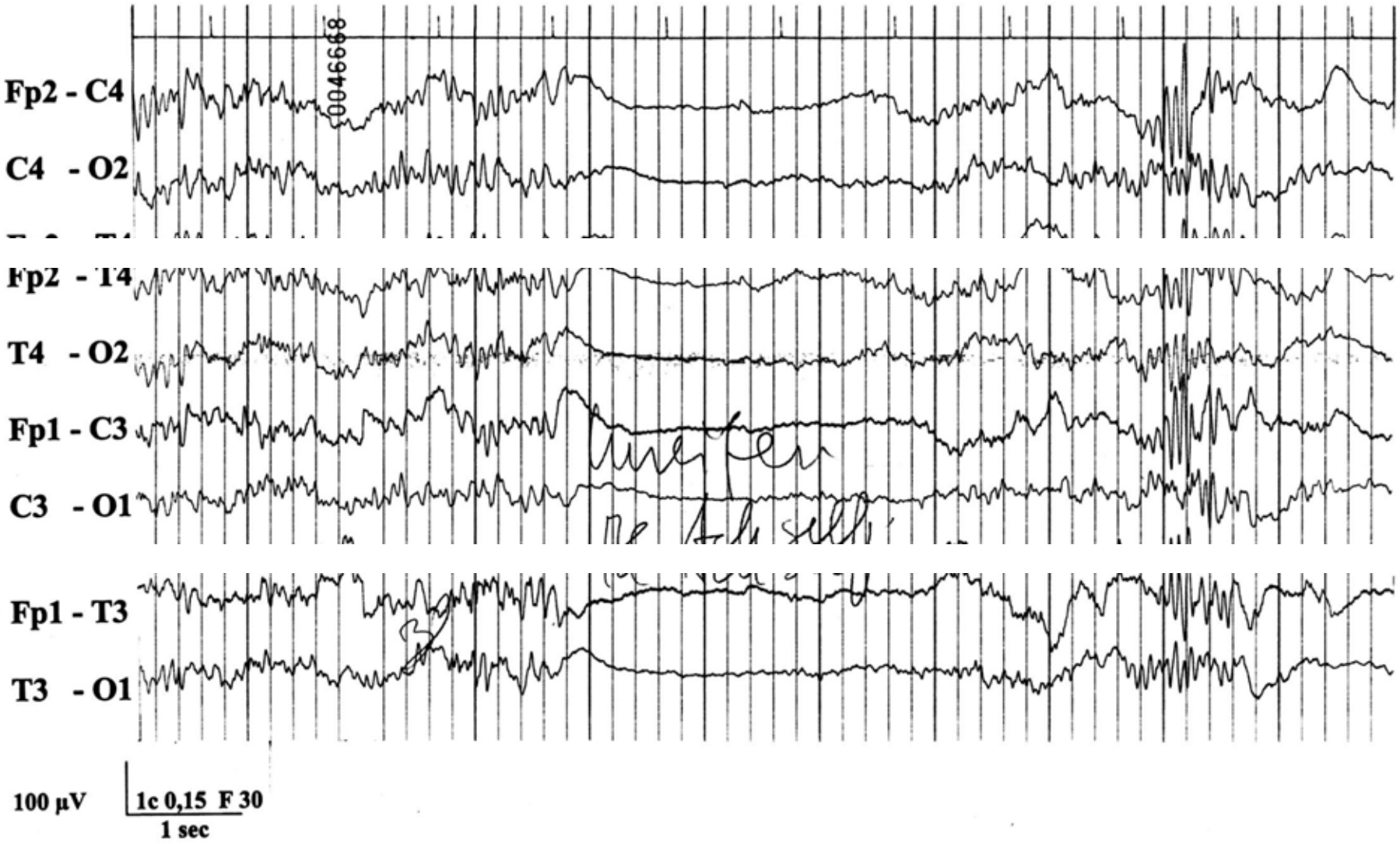
- An EEG record not checking reactivity is incomplete

- Orderly approach to stimulation
  active eye opening
  calling patient´s name
  passive eye opening
  noxious stimuli: right and left, face and thorax

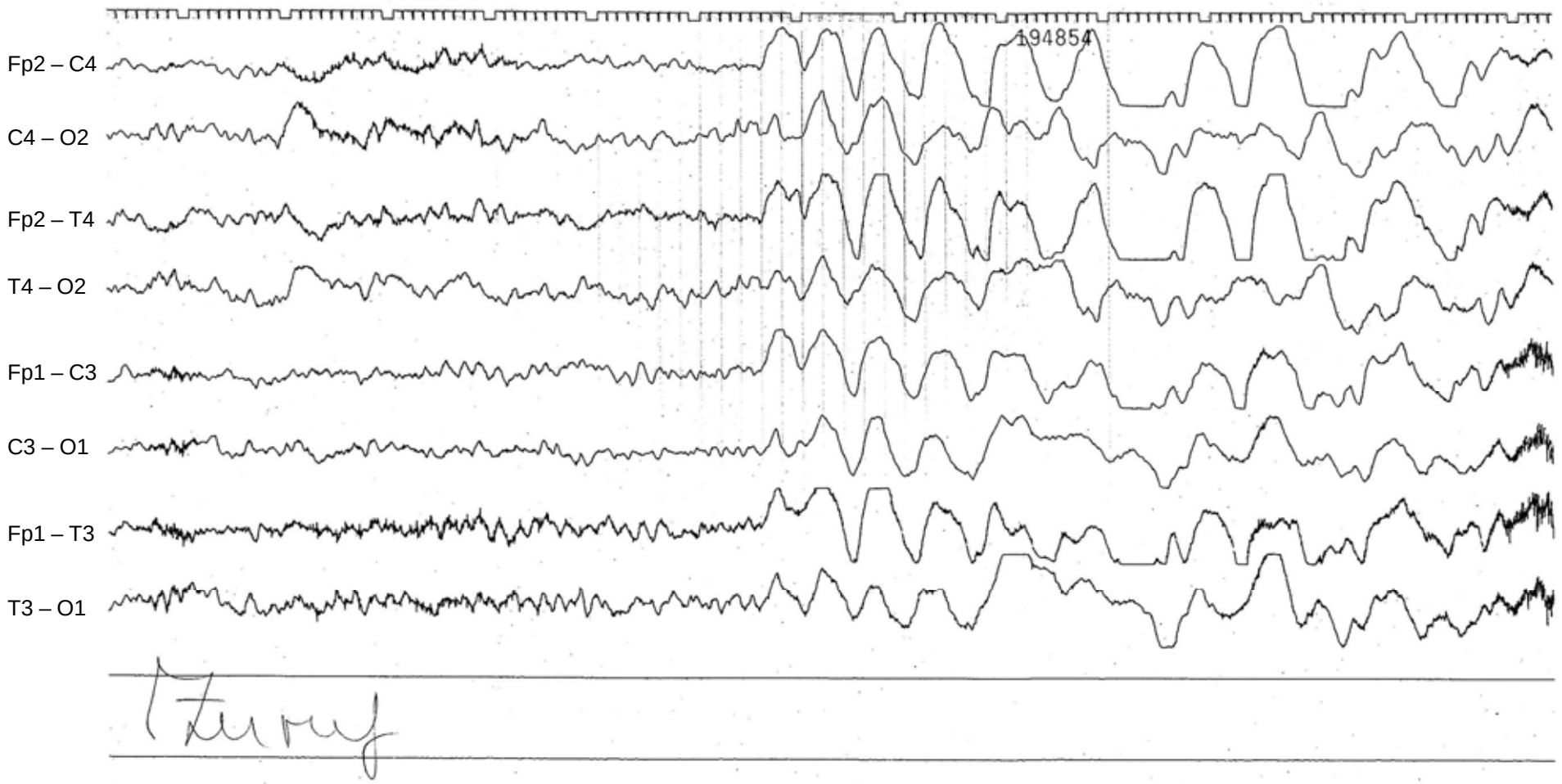
- Description of the type of reaction
  Blocking response, alerting response ...



Sch.H., female, 21 years. Metabolic encephalopathy
Block of slow waves with eye opening on command



Sch.J., 49 years, male. Coma after liver transplantation. Died after a week. With painful stimuli („Kneifen re Achselfalte“) attenuation of cerebral activity.



Sch.B., female, 25 years. 02-03-95. Nr.8-8991. tc 1.0 F 70. Obtunded after moderate head trauma. Diffuse mixed rhythmical ?€à activities and some ?€Ö waves, R > L. Prolonged train of sinusoidal 2/sec rhythmical waves ? secondary to acoustic stimulation (“Zuruf“). Exactness of the technician?

?áBasic principles

- Have a sufficient training in EEG reading
- Consider technical parameters
- Train your technician
- See the patient (if possible)
- Advice the technician to call MD on duty in severe or questionable cases
- There are still unsolved topics like grades of severity, type of reactions to stimuli ...