Use and abuse of clinical EEG

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PARACELSUS
MEDIZINISCHE PRIVATUNIVERSITÄT

Agenda

- Indications à use of EEG
- Referral to EEG laboratory
  - Clinical reasoning and clinical questions
- Recording of the EEG
  - Technical factors
  - Patient related factors
- Analysis of the EEG
  - Systematic description – “EEG reading”
- Summary
- Interpretation

When to ask for an EEG? - Indications

- Seizures , epilepsies, and status epilepticus
- Non epileptic attacks
- Disturbances of consciousness, coma, brain death
- Dementia, delirium
- Encephalopathies
- CNS-infections
- Psychosis of unknown cause
- Cerebrovascular disorders
- Sleep disorders: narcolepsy, OSAS, etc.
- ...

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Seizures, epilepsies, and status epilepticus

- Is it an “epileptic seizure” or “epilepsy”?
  - à high PPV
  - à low NPV
- Which epilepsy syndrome or group of syndromes?
  - à TLE: anterior temporal Spikes, TIRDA
  - à IGE (genetic epilepsies): generalised 3/s SW, generalised PSW
- How is the treatment success?
  - à IGEs (genetic epilepsies)
  - à TLE
- Is the patient seizure free? (3/s-SW in CAE)
- Is it status epilepoticus? (especially in ICUs or intermittent psychic or behavioural changes)
- Is the SE successfully treated?

How to improve the diagnostic yield?

- Repeat the standard EEG
  - After 3 recordings 84% relevant information, after 4 EEGs à 92%[1]
- Sleep-EEG, (sleep deprivation or medically induced sleep)
- EEG-recordings in the first 24-48h after the seizure [2-4]

1: Salinski et al. Epilepsia 1987; 2: Bauer et al. Z EEG-EMG 1975, 3: King et al. Lancet 1998, 4: Trinka and Schoibl 2010

SPECIAL ARTICLE

AMERICAN ACADEMY OF NEUROLOGY

Practice Parameter: Evaluating an apparent unprovoked first seizure in adults (an evidence-based review)

Report of the Quality Standards Subcommittee of the American Academy of Neurology and the American Epilepsy Society

Diagnostics	N=	abnormal	epileptiform
EEG	1766	51%	29%
CT/MRI	928	15%	
Laboratory	464	95% CI 0-26	

Epileptology of the first seizure

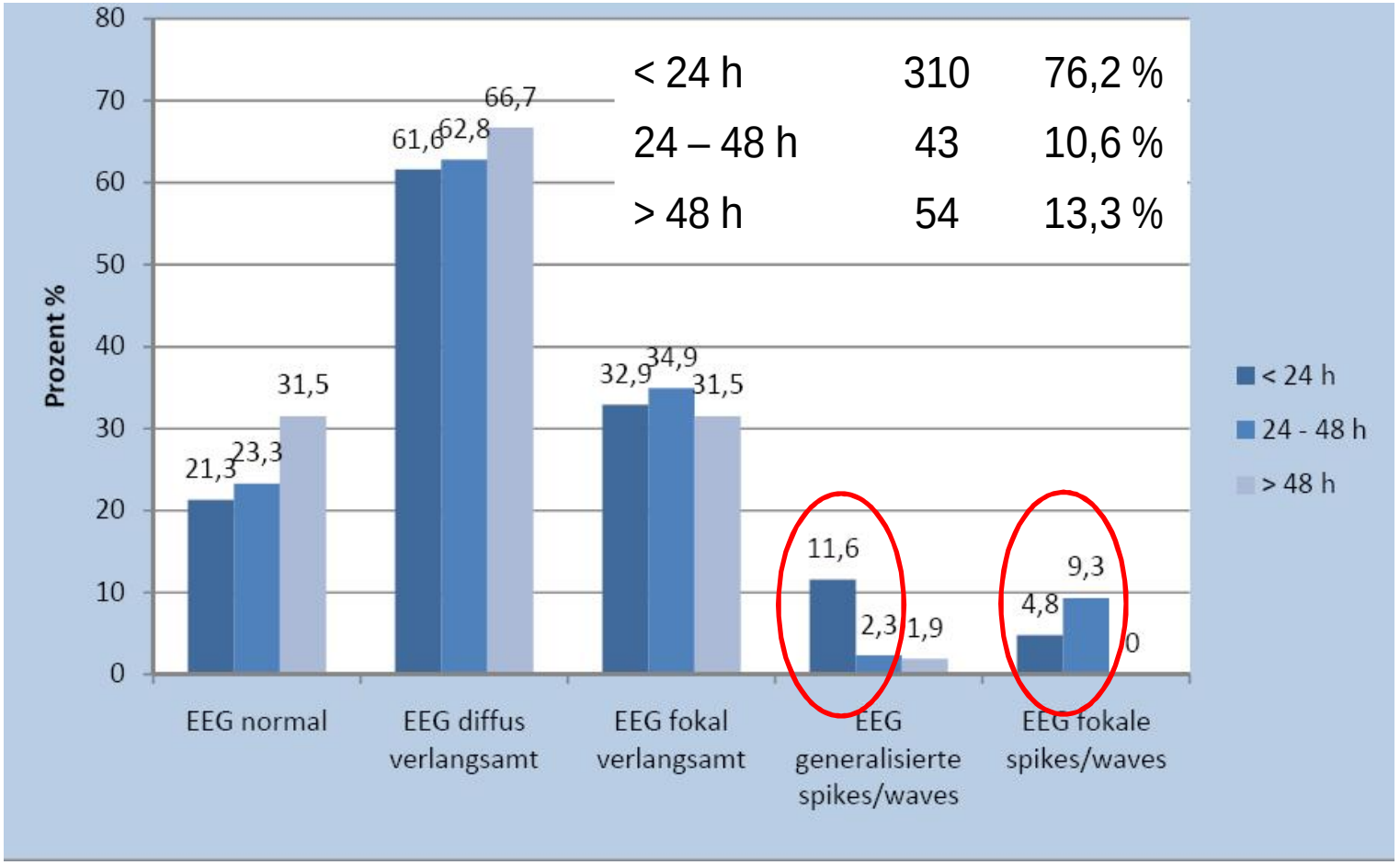
- Prospective study (n=300) [2]
- Focal vs. generalised
  - Neurol. exam 47%
  - EEG <24h, SE-EEG +30%
  - MRI + 4%
  - Total 81%
- EEG early vs. late
  51% vs 34%[2]
- EEG < 24 h after the first seizure is recommended [1,2,3, 4]

- Retrospective study (n=512) [4]
- 1.1.2006-31.12.2007
- 115 (22.5%), median 2 preindexseizures
- Age median 57 (17-96) years

EEG	N=	%
Normal	93	22.9 %
Diffuse slowing	254	62.4 %
Focal slowing	134	32.9 %
Generalised SW	38	9.3 %
Focal SW	19	4.7 %

1: Bauer G. Z EEG-EMG 1975; 2: King et al. Lancet 1998; 3: Krumholz et al. Neurology 2007; 4: Schoibl and Trinka 2010

Epileptology of the first seizure



1: Schoibl and Trinka 2010

Available online at www.sciencedirect.com
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Epilepsy & Behavior 6 (2005) 433–434
Epilepsy & Behavior
www.elsevier.com/locate/yebeh

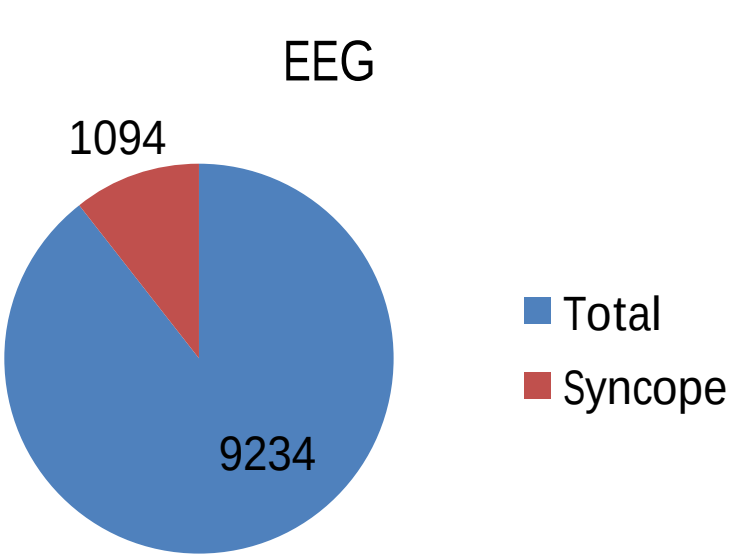
Brief Communication

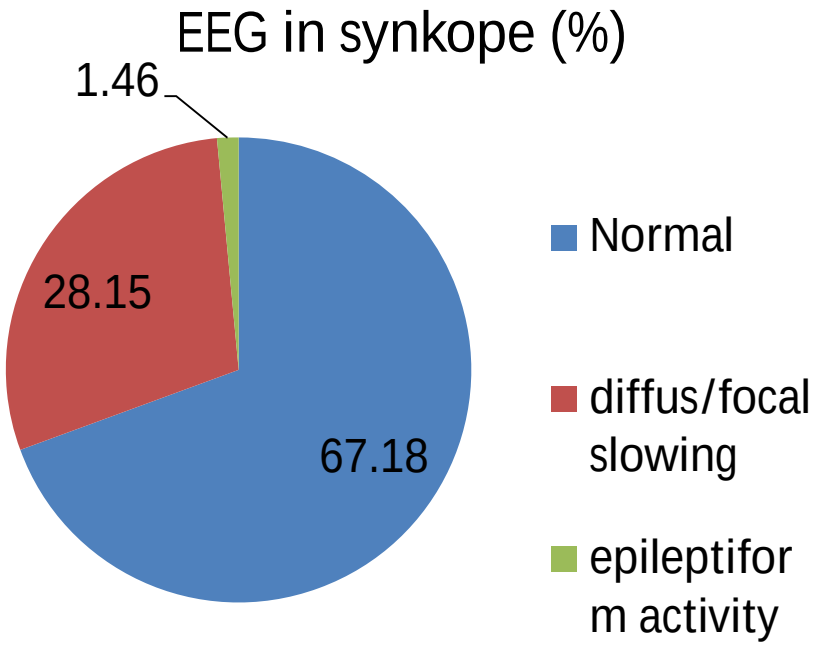
The diagnostic value of EEGs in patients with syncope

Abuhuziefa Abubakr *, Ilse Wambacq

New Jersey Neuroscience Institute, Seton Hall University for Graduate Medical Education, 65 James Street, Edison, NJ 08818, USA

Received 3 November 2004; revised 6 January 2005; accepted 7 January 2005





How to improve the diagnostic yield?

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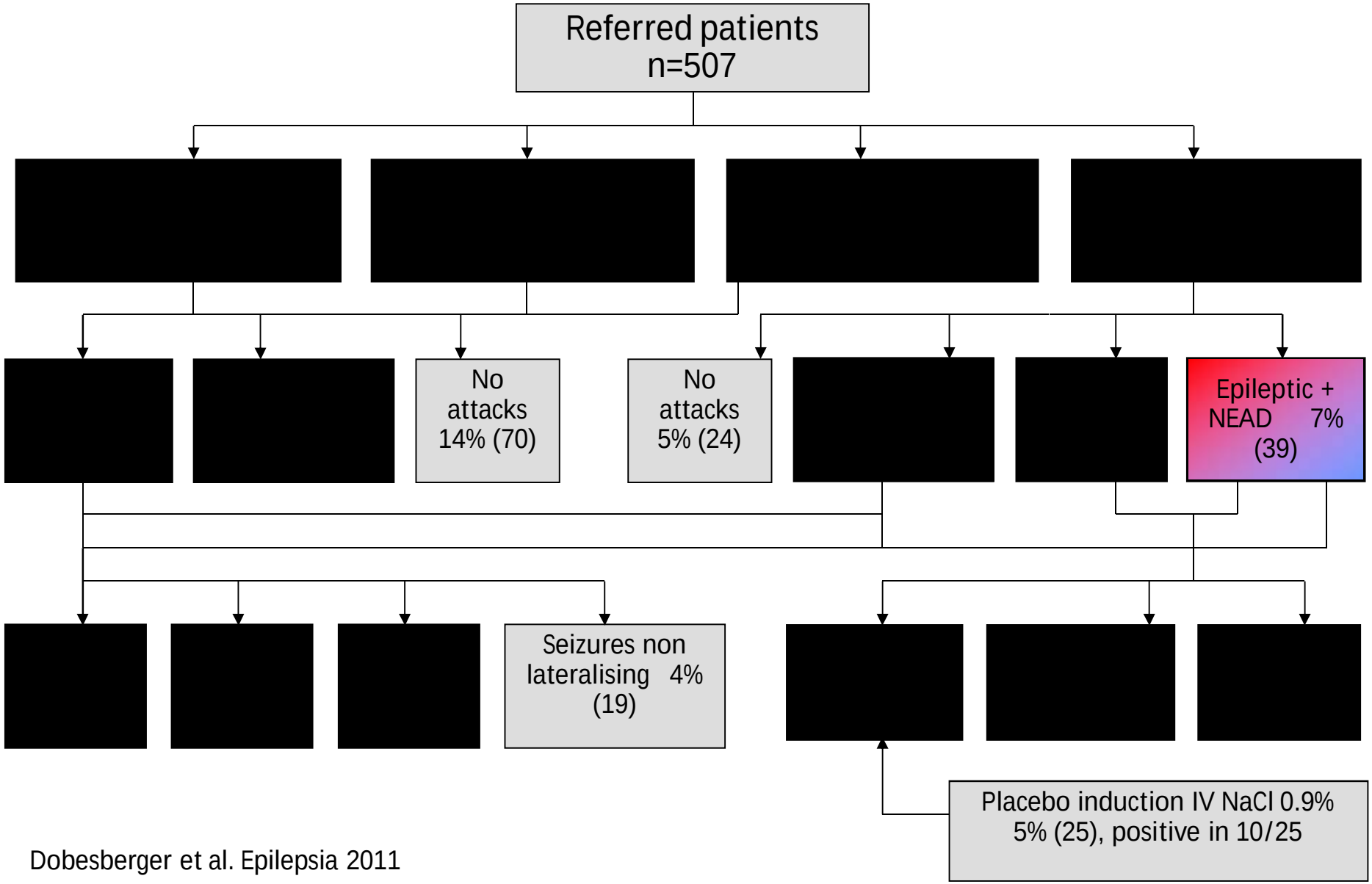
  - After 3 recordings 84% relevant information, after 4 EEGs à 92%[1]
- Sleep-EEG, (sleep deprivation or medically induced sleep)
- EEG-recordings in the first 24-48h after the seizure [2-4]
- Long term Video-EEG recordings[5,6]

1: Salinski et al. Epilepsia 1987; 2: Bauer et al. Z EEG-EMG 1975, 3: King et al. Lancet 1998, 4: Trinka and Schoibl 2010; 5: Benbadis et al. Epilepsia 2004; 6: Dobesberger et al. Epilepsia 2011

Diagnostic yield of Video-EEG



Dobesberger et al. Epilepsia 2011

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Principles of EEG reading

A five step approach:

1. Referral
   - Clinical question
2. Recording of the EEGs
   - Technical factors
   - Patient related factors
3. Analysis of the EEG recording
   - Systematic description – “reading”
4. Summary of the description
5. Interpretation

Referral

- History: .....
- Medication: not reported
- Question:
  k sd s v c v y x
- Rule out.....
- EEG -report: .....
- Summary: ...spikes right temporal...

- Epilepsy or not?

- History: loss of consciousness and jeking left upper extremity
- Medication: none
- Question: epileptiforme activity?, focal activity?
- EEG-report: .....
- Summary: ...spikes right temporal...

Epilepsy!

How to improve the clinical use of EEG

- List of indication
- Communication with referring clinicians!!
- Test criteria:
  - Sensitivity, specificity
  - Positive and negative predictive value
- Answer the questions being asked
  - Interpretation à clinical experience
  - In case of doubt: avoid overinterpretations and ask the referring physician

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Recording of an EEG

Technical aspects

- Set of electrodes (10/20 or 10/10)
- Sensitivity: 7µV/mm
- display: 3cm/s or ~10 s/monitor frame
- High frequency filter (lowpass filter):
  - 70Hz
- Low frequency filter (highpass filter):
  - TC 0.3s à 0.53 Hz (1/(2?Œ))

Recording of an EEG

Patient related factors

- Age
- Level of consciousness
  - Awake vs. somnolent (sleepy)
  - Not relaxed, uncooperative, restless
  - delir, stuporous, comatose
  - Sedating medications, mechanical ventilation
  - Clinical events during the recording à periictal testing

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EEG Analysis

- Frequency (wave length)
- Amplitude (voltage)
- Form (morphology)
- Regulation:
  - Frequency
  - amplitude
- Pattern of occurrence
- Localisation
- Reagibility
- Lateralisation
  - Symmetry
  - Synchrony

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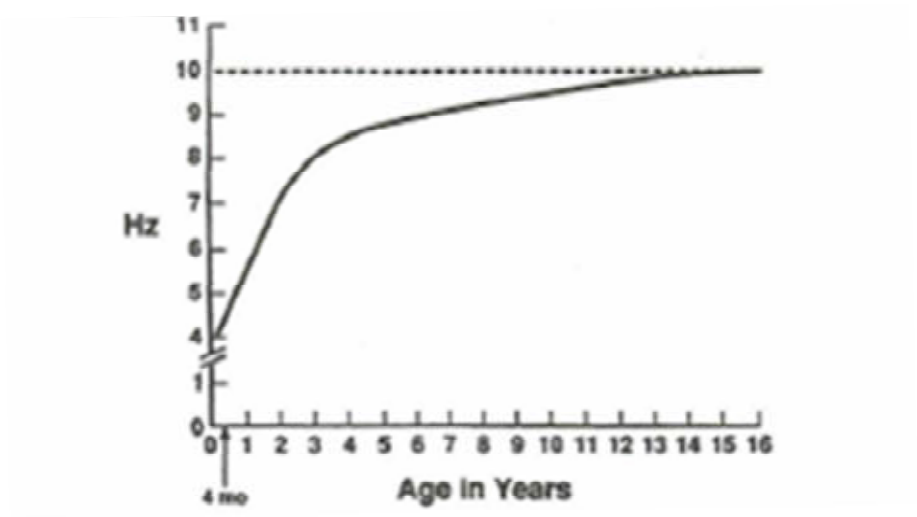
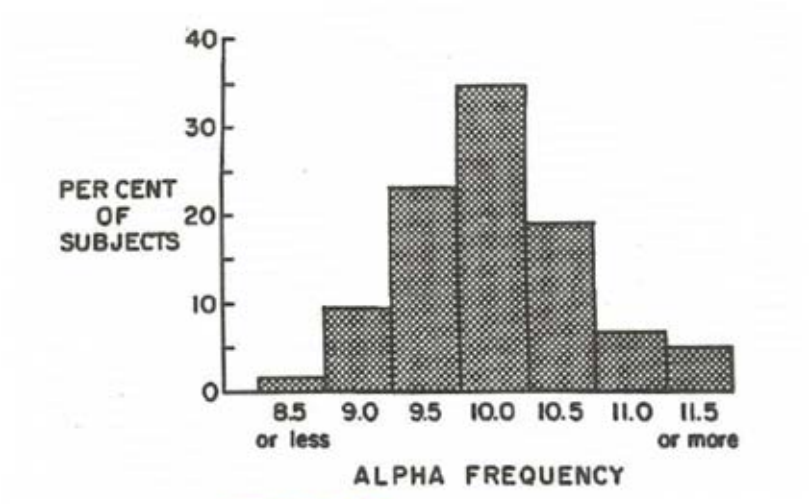
α-Wellen: 8-13 Hz
-Wellen: 14-30 Hz
θ-Wellen: 4-7 Hz
δ-Wellen 0.5-3.5 Hz



EEG Analyse

- Frequency (wave length)

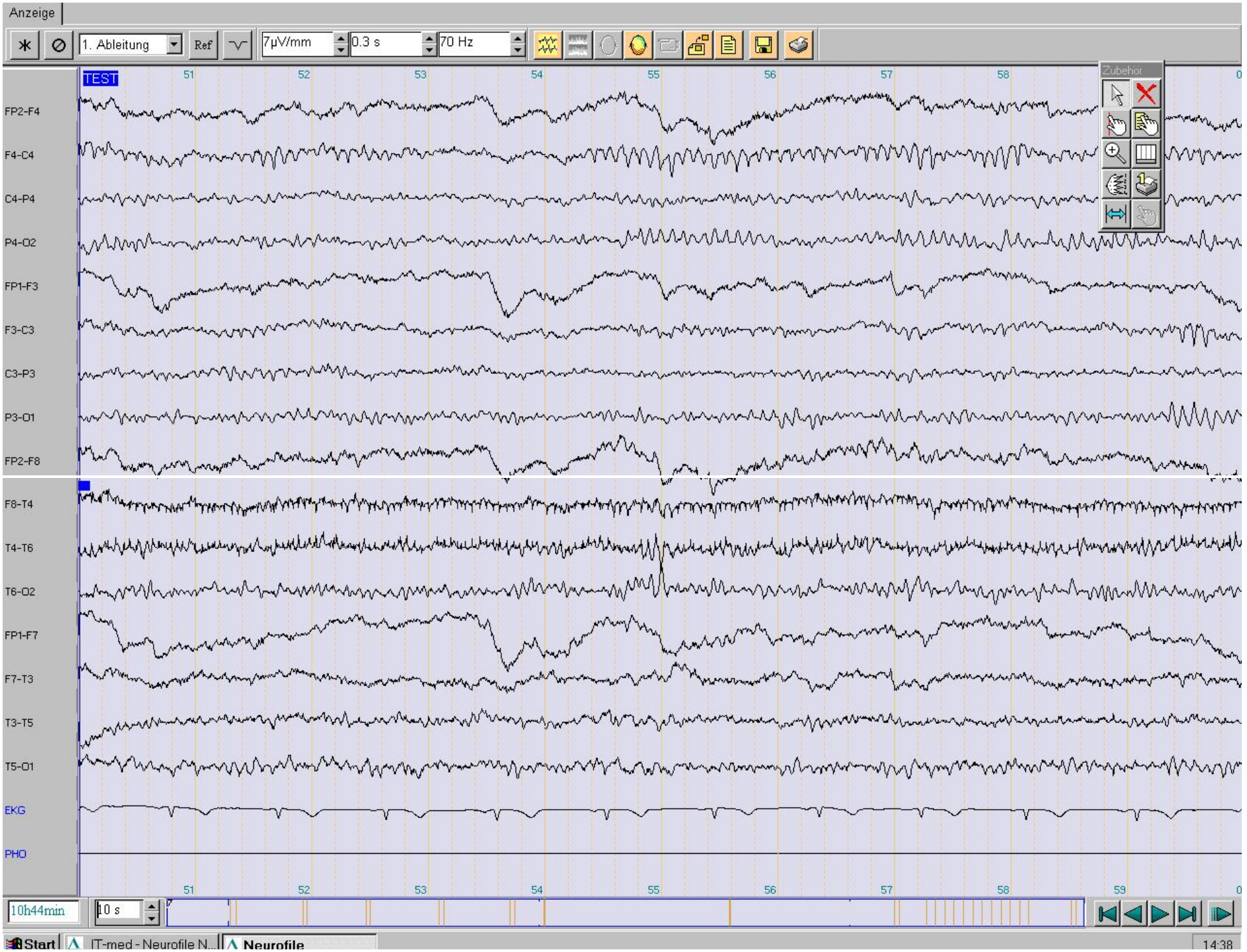


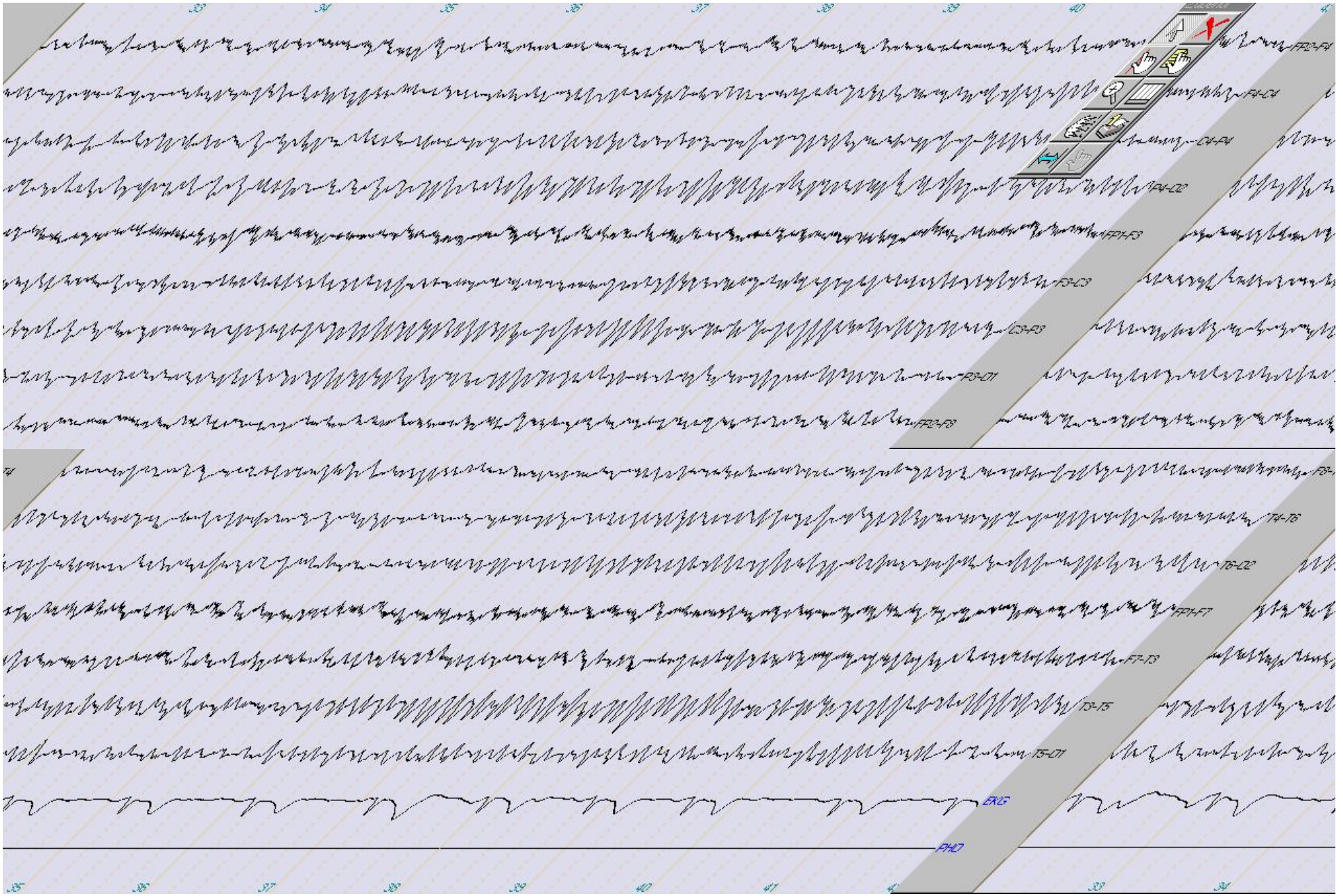
Alpha rhythm in 200 healthy probands 24-35 yrs (Maulsby et al. 1968)

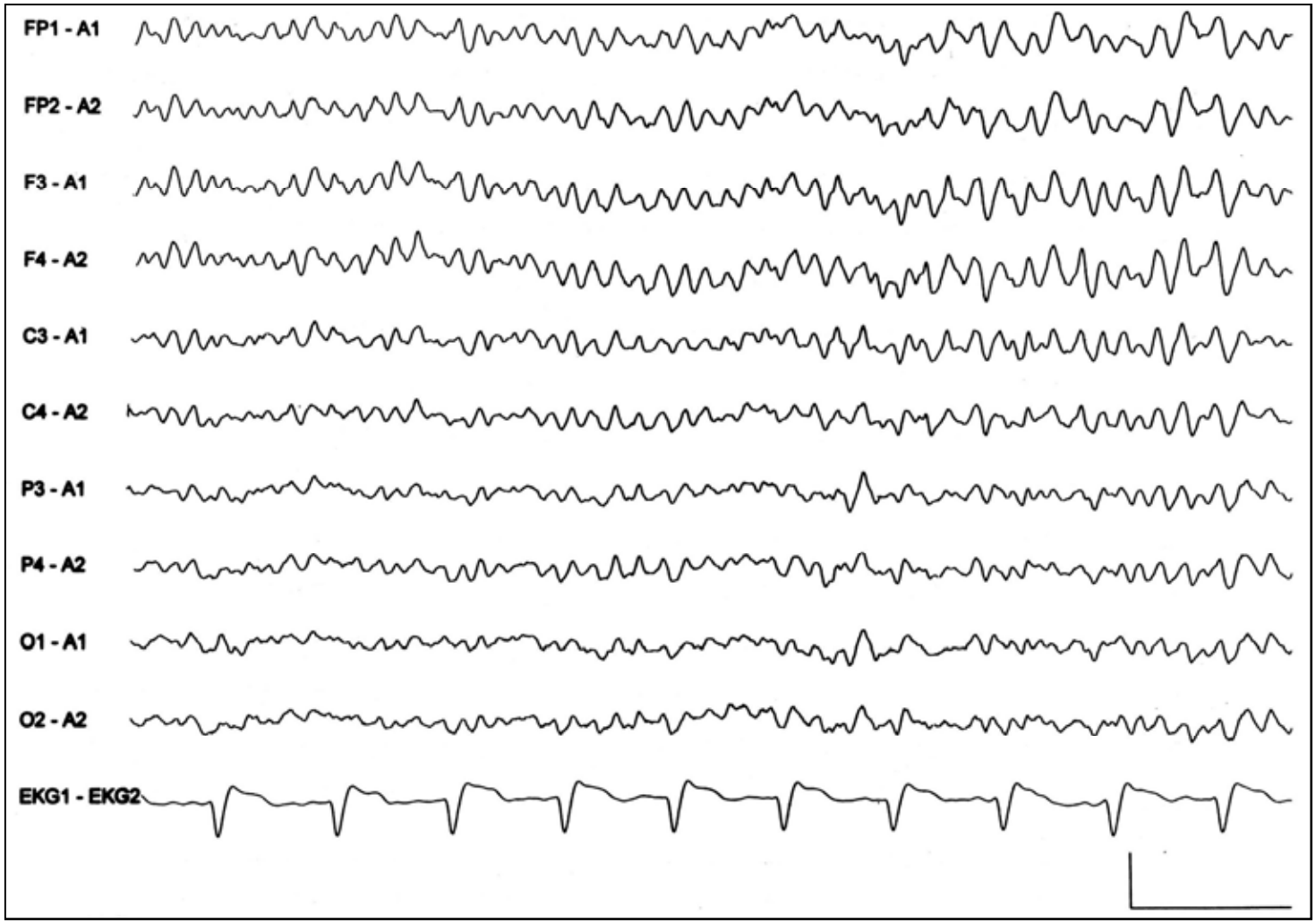
Alpha rhythm:

- 8.5 – 11.5 Herz
- Occipital dominance
- relaxed wakefulness
- eyes closed
- blocking after eye opening (desynchronisation)
- à in the fully conscious patients

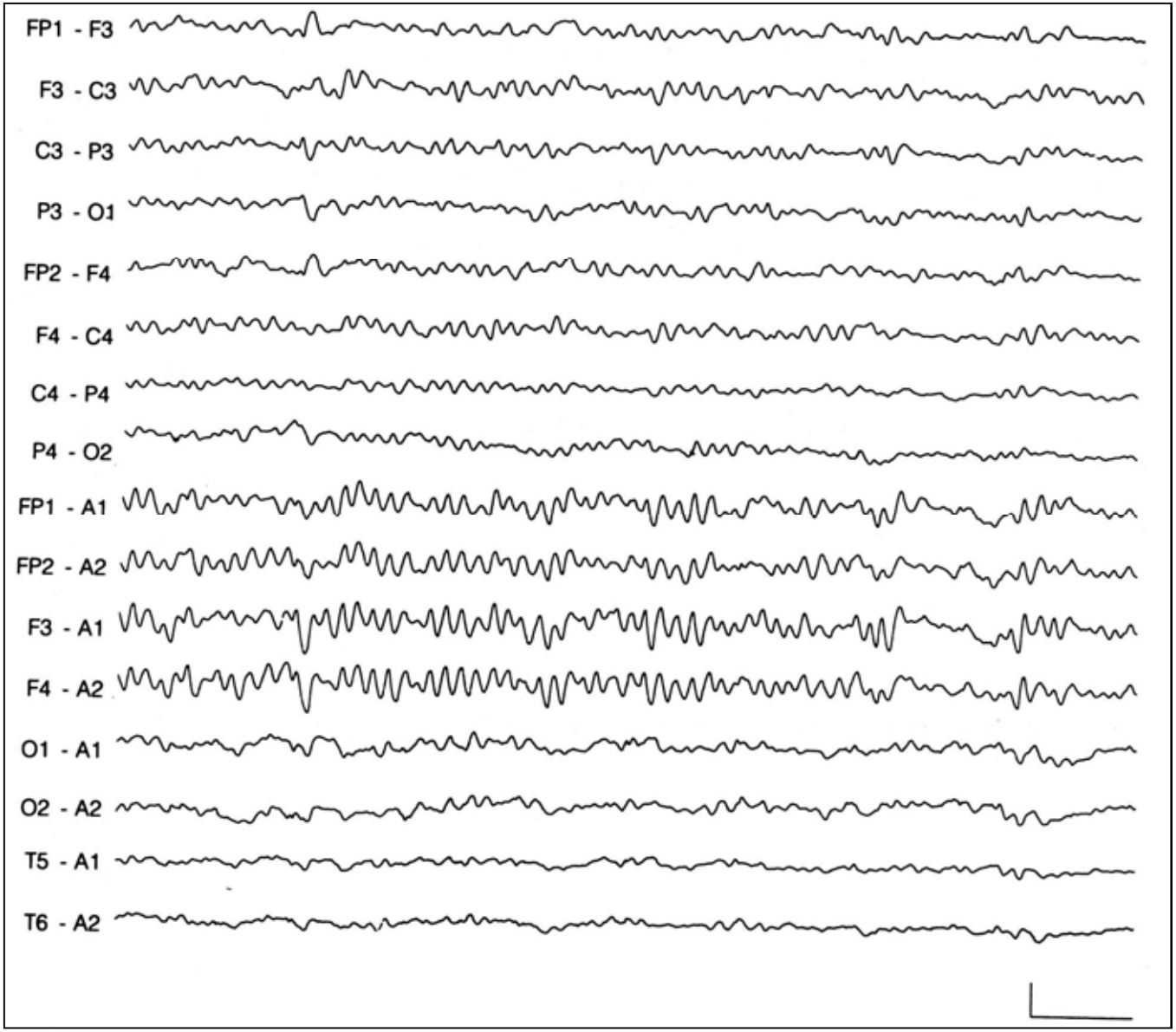
- Regbinfat


Anzeige
1. Ableitung
Ref
7µV/mm
0.3 s
70 Hz
Zubehör
TEST
51
52
53
54
55
56
57
58
FP2-F4
F4-C4
C4-P4
P4-O2
FP1-F3
F3-C3
C3-P3
P3-O1
FP2-F8
F8-T4
T4-T6
T6-O2
FP1-F7
F7-T3
T3-T5
T5-O1
EKG
PHO
59
10h44min
10 s
Start
IT-med - Neurofile N...
Neurofile
14:38

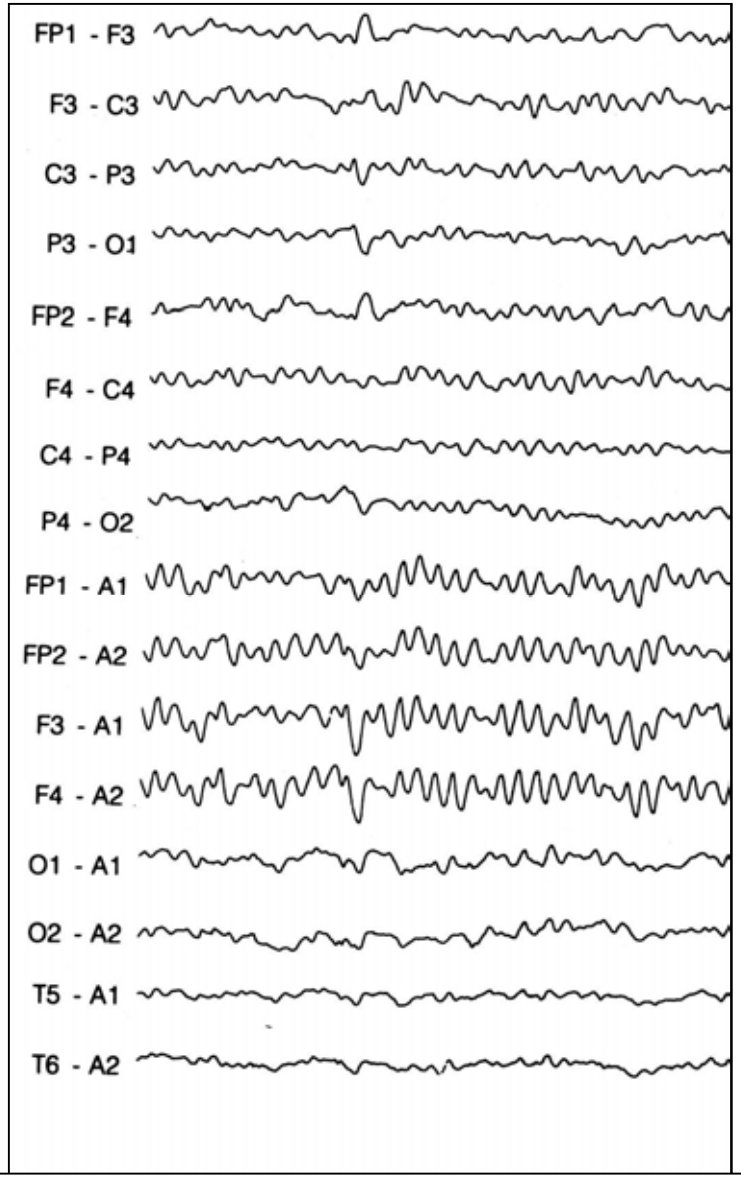

ERG


FP1 - A1
FP2 - A2
F3 - A1
F4 - A2
C3 - A1
C4 - A2
P3 - A1
P4 - A2
O1 - A1
O2 - A2
EKG1 - EKG2

Alpha Coma


FP1 - F3
F3 - C3
C3 - P3
P3 - O1
FP2 - F4
F4 - C4
C4 - P4
P4 - O2
FP1 - A1
FP2 - A2
F3 - A1
F4 - A2
O1 - A1
O2 - A2
T5 - A1
T6 - A2

Alpha Coma



8-13 Hz, 10-50µV, anterior maximum

Rarely 4-7 Hz (“theta-coma“)

Sinusoidal, not modulated

areactive

Variable theta and delta activity

In adults and children

Hypoxic encephalopathy

Intoxications

Westmoreland et al. 1975; Kaplan et al. 1999; Grindal et al. 1977; Obeso et al. 1980

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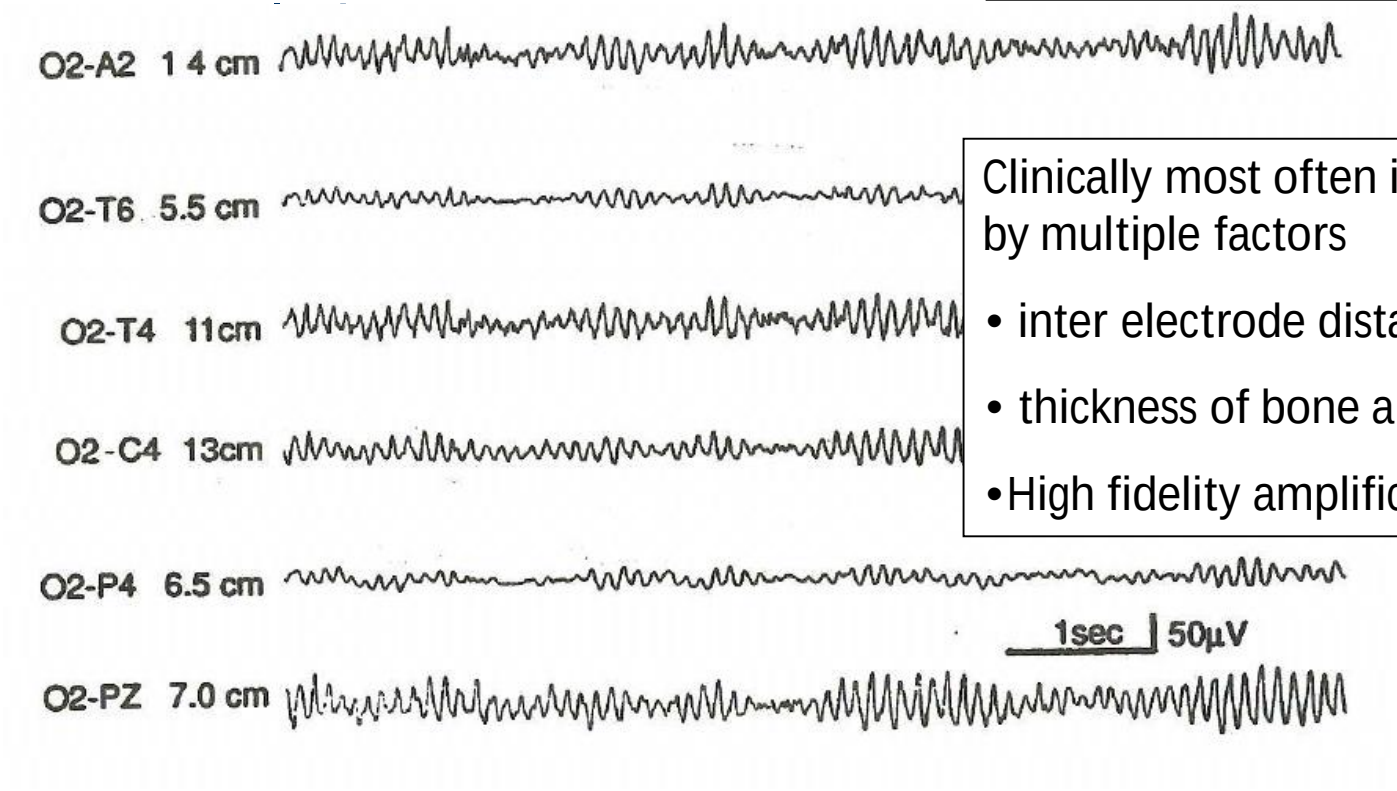
EEG Analysis

- Frequency (wave length)
- Amplitude (voltage)
- Form (morphology)

Low amplitude: <20µV
Low-medium amplitude: 20-50µV
Medium amplitude: 50-70µV
High amplitude: >100µV

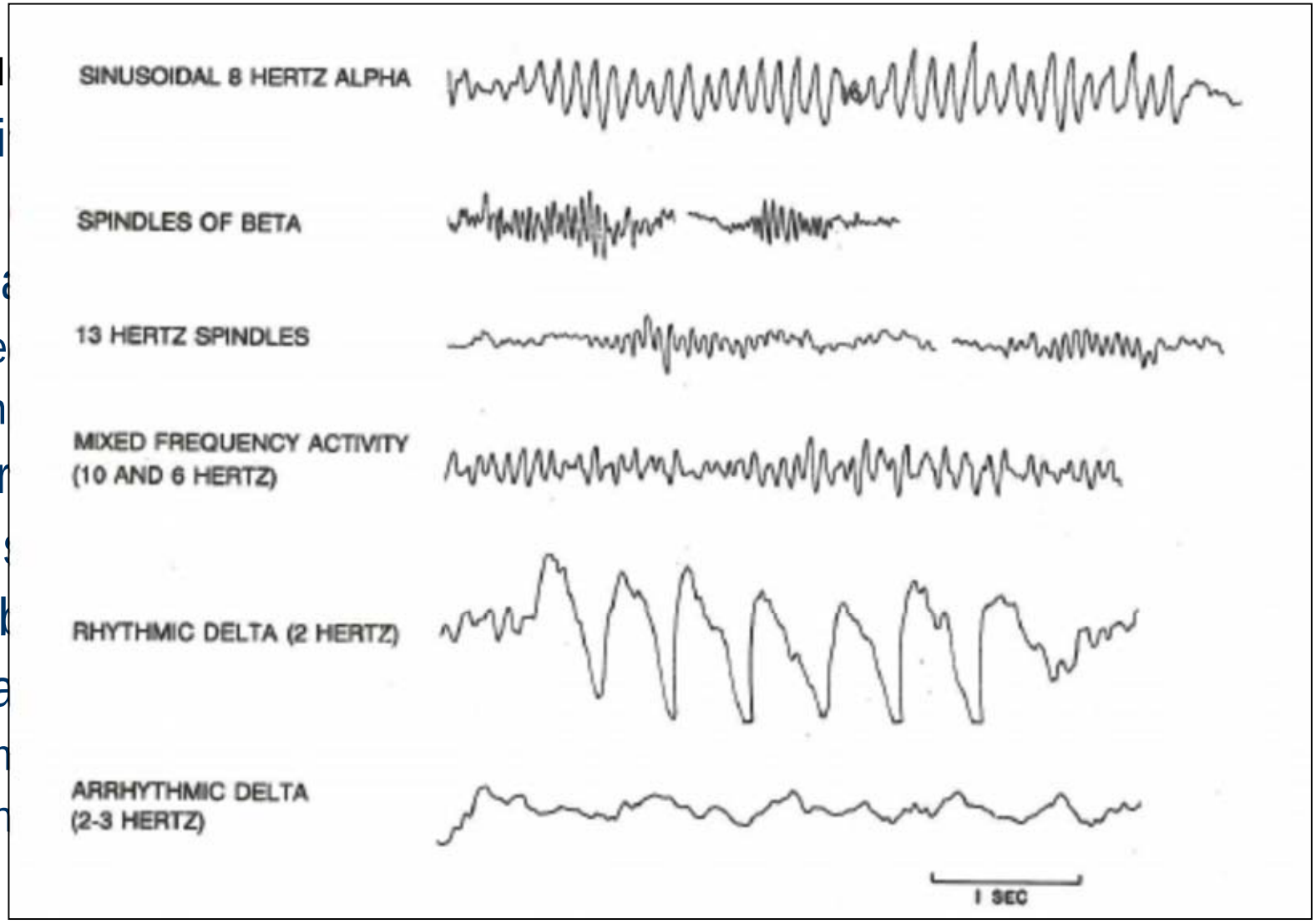


Clinically most often irrelevant à influenced by multiple factors

- inter electrode distance
- thickness of bone and scalp
- High fidelity amplification

EEG Analysis

- Frequ
- Ampli
- Form
- Regula
  - Fre
  - am
- Patter
- Localis
- Reagib
- Latera
  - Syn
  - Syn



EEG Analysis

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- Ampli
- Form
- Regula
  - Fre
  - am
- Patter
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  - Syn

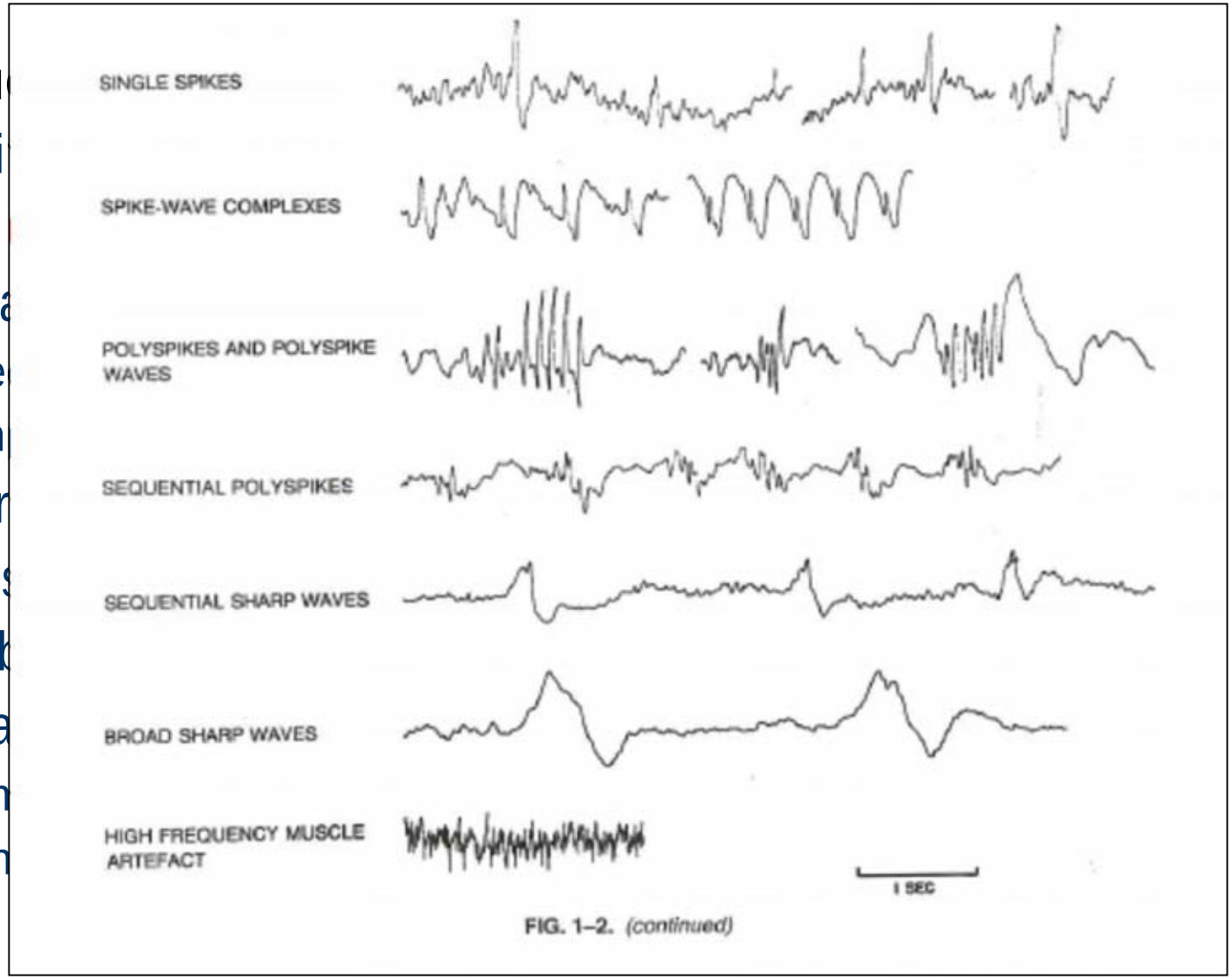

FIG. 1–2. *(continued)*

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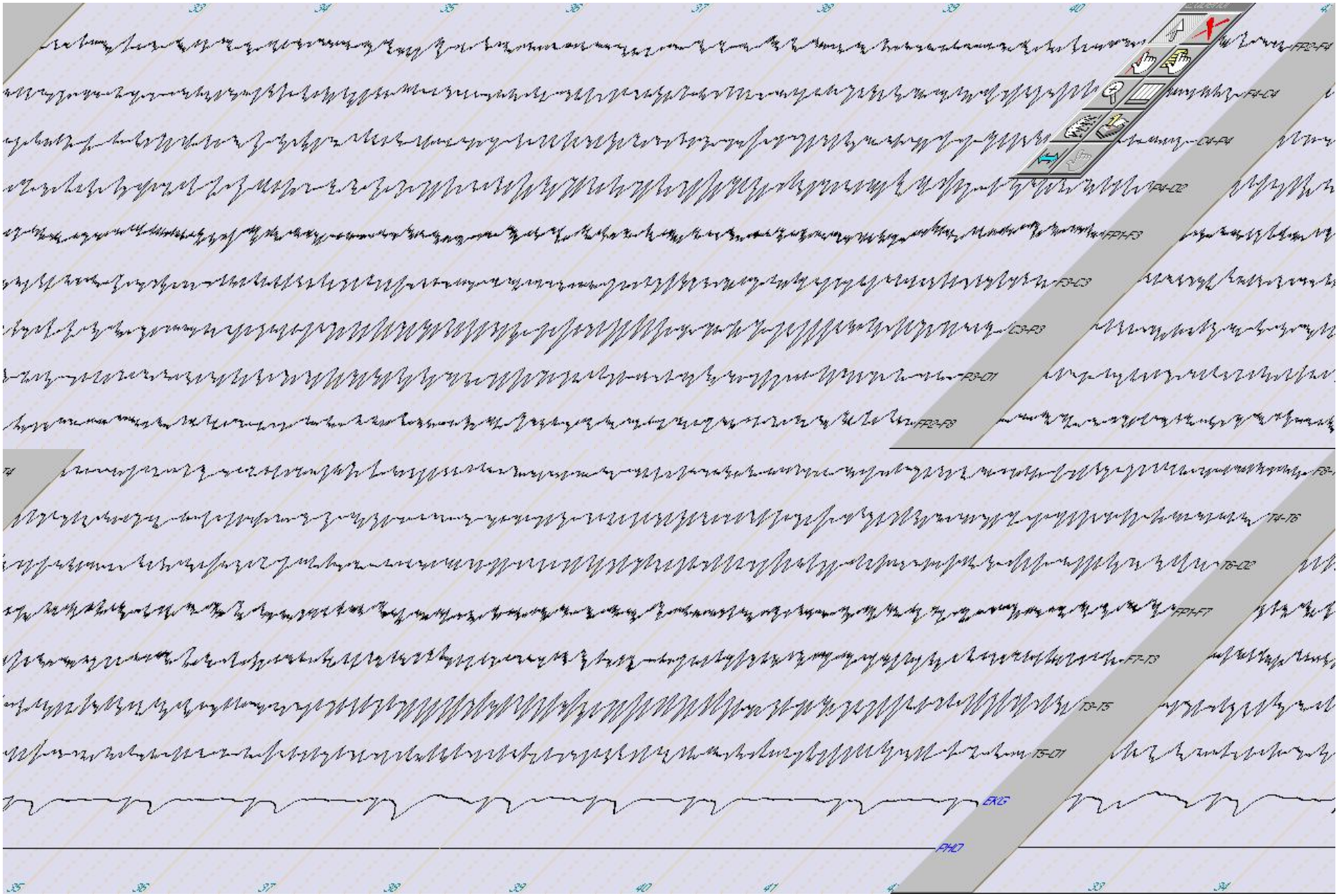
Stable –labile

good, moderate poorly, not-modulated


ERG

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Generalised: over all brain regions

Diffuse: over wide regions of one or both hemispheres

Lateralised: right or left hemisherid dominance

Unilateral: either right or left

Bilateral: over both hemishperes

Focal: over a circumscribed area

Regional: over a limited part of one hemisphere (3 elektrodes)

EEG Analysis

Every EEG must test reactivity

Special importance in quantitative disorders of consciousness

- Form (morphology)

Orderly approach:

- Eyes open active à passive
- Call name / acoustic stimuli
- painful stimuli (R/L)

Blocking (Alpharhythmus)

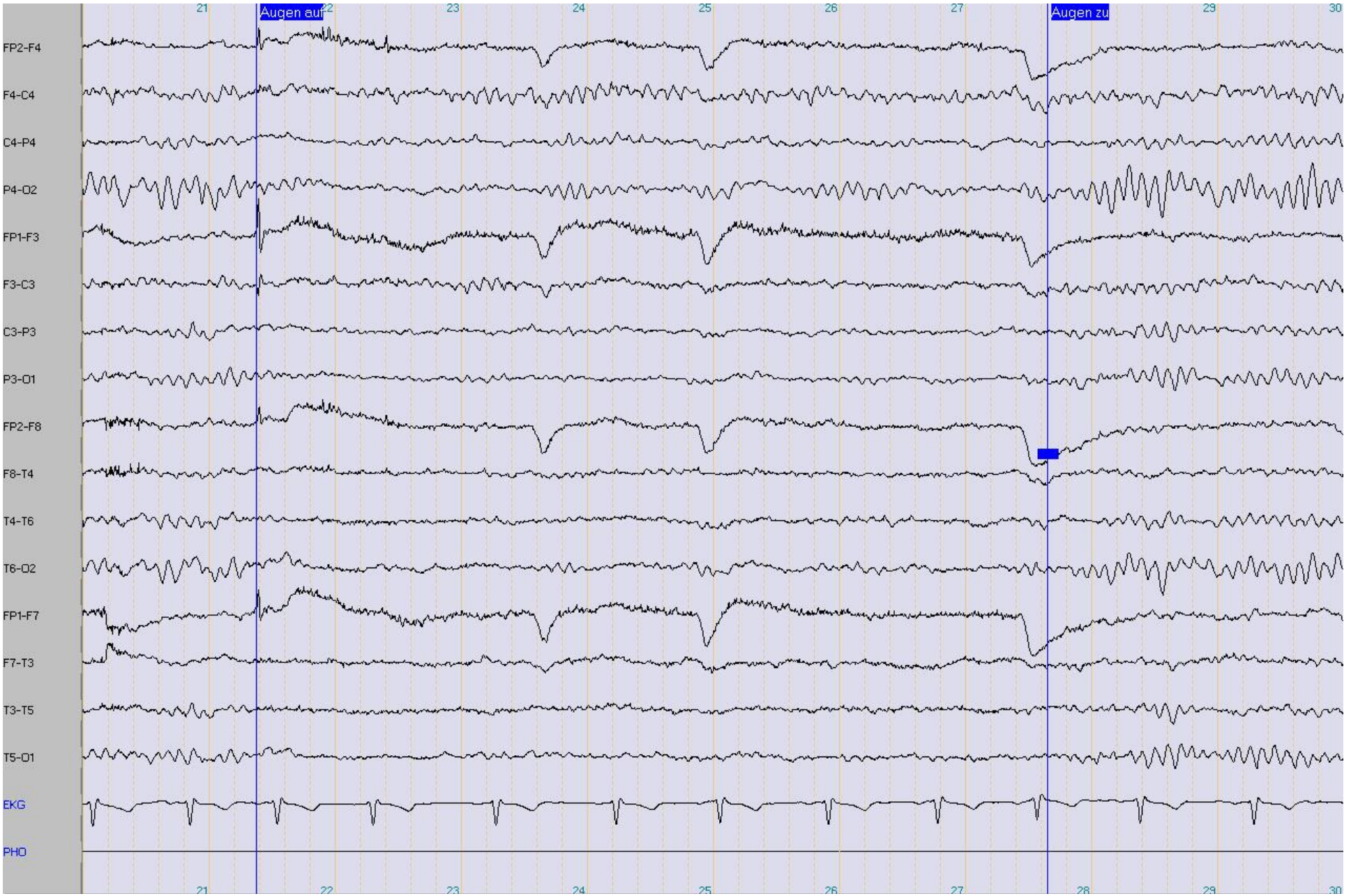
Arousal

Delta-activation

Suppression of slower activity

No reactivity

- Localisation
- Reagibility
- Lateralisation
  - Symmetry
  - Synchrony
- Reagibility


21
Augen auf
22
23
24
25
26
27
Augen zu
29
30
FP2-F4
F4-C4
C4-P4
P4-O2
FP1-F3
F3-C3
C3-P3
P3-O1
FP2-F8
F8-T4
T4-T6
T6-O2
FP1-F7
F7-T3
T3-T5
T5-O1
EKG
PHO
21
22
23
24
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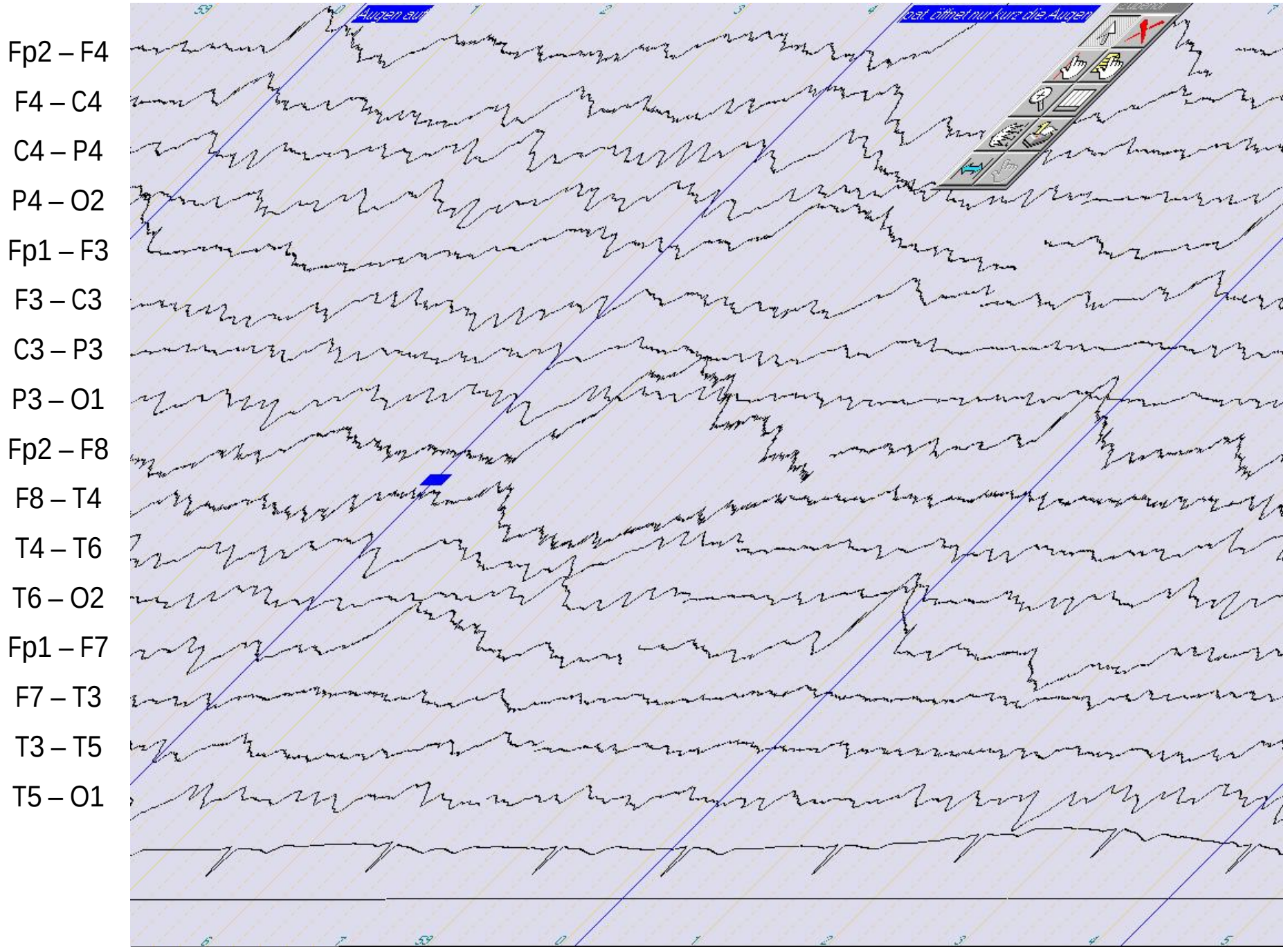
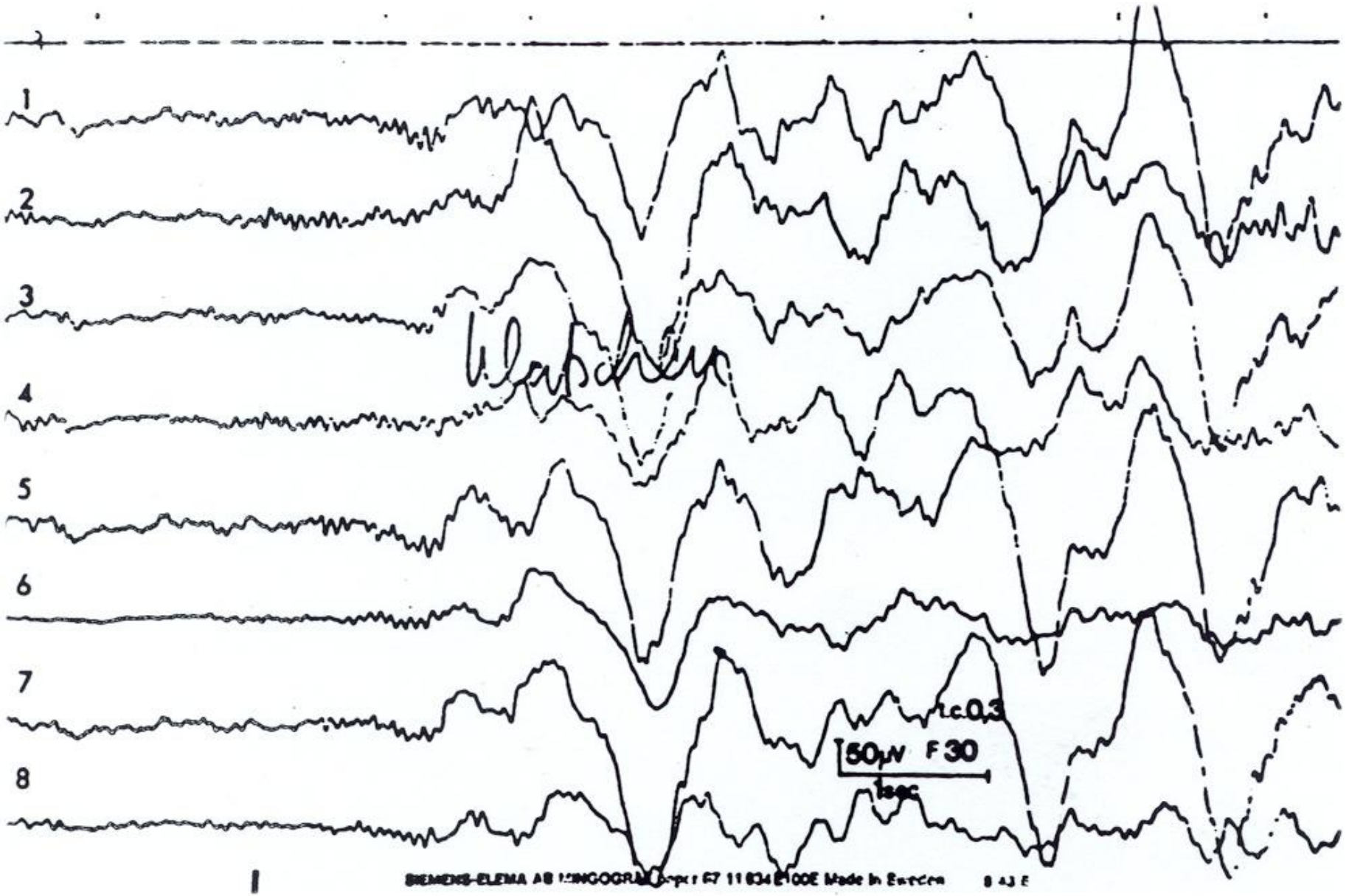
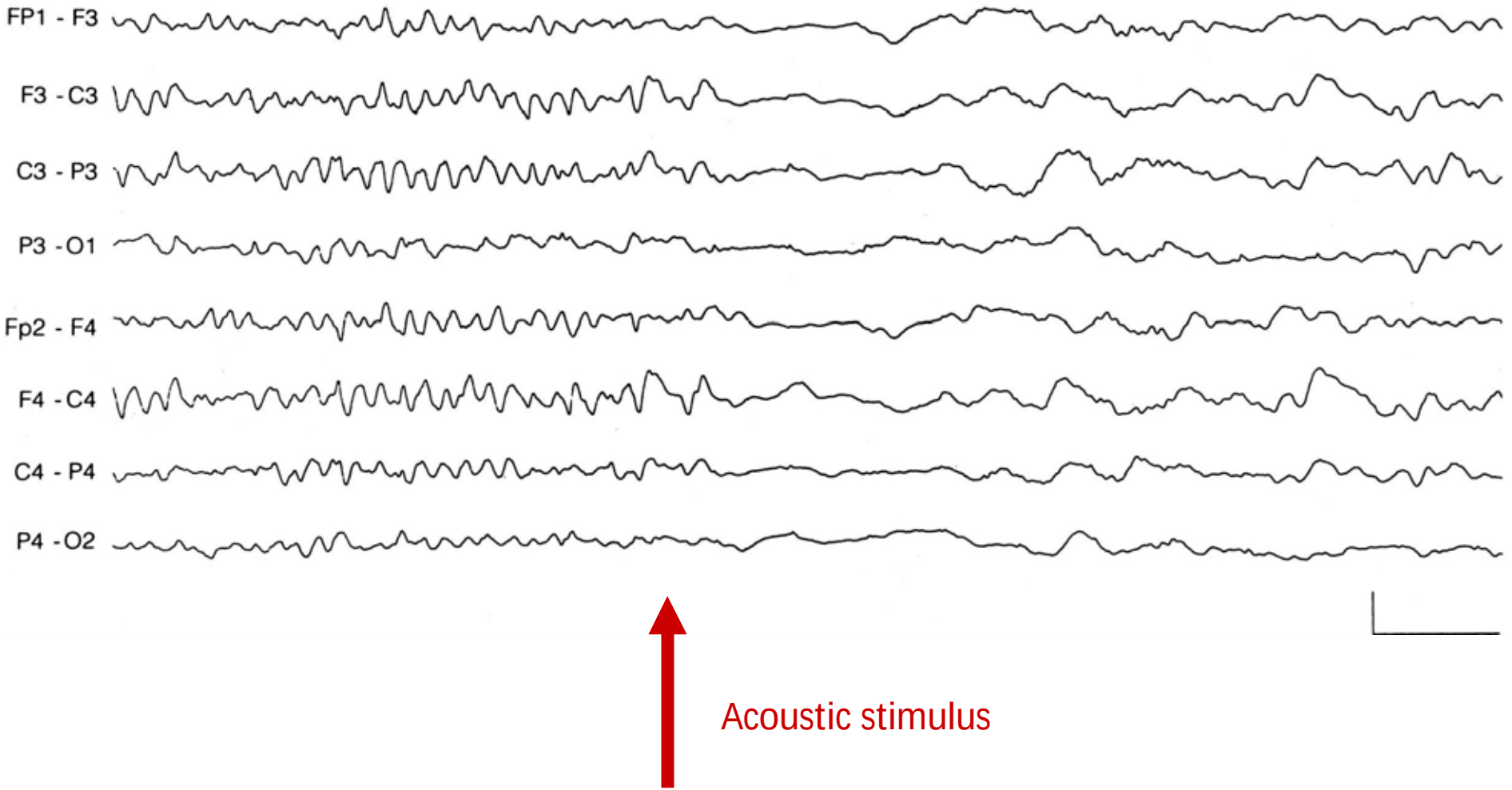
28
29
30


Fp2 – F4
F4 – C4
C4 – P4
P4 – O2
Fp1 – F3
F3 – C3
C3 – P3
P3 – O1
Fp2 – F8
F8 – T4
T4 – T6
T6 – O2
Fp1 – F7
F7 – T3
T3 – T5
T5 – O1
Augen auf
bei öffnen nur kurz die Augen


1
2
3
4
5
6
7
8
Lc 0,3
50µV F 30
1sec
SIEMENS-ELEMA AB

Alternating Patterns



Summary

- Clinical EEG can answer only certain questions à list of indications
- Strength is high temporal resolution and wide applicability
- Referring physicians and electroencephalographers must engage a dialog
- Prop
- Star

Epilepsia, **(*):1–13, 2013
doi: 10.1111/epi.12135

SPECIAL REPORT

Standardized computer-based organized reporting of EEG: SCORE

*†Sándor Beniczky, ‡Harald Aurlien, ‡Jan C. Brøgger, †Anders Fuglsang-Frederiksen, §António Martins-da-Silva, ¶Eugen Trinka, #Gerhard Visser, *'***Guido Rubboli, *Helle Hjalgrim, ††Hermann Stefan, ‡‡Ingmar Rosén, §§Jana Zarubova, ¶Judith Dobesberger, *Jørgen Alving, ¶¶##Kjeld V. Andersen, ¶¶Martin Fabricius, *Mary D. Atkins, ***Miri Neufeld, †††Perrine Plouin, ‡‡‡Petr Marusic, §§§Ronit Pressler, ¶¶¶Ruta Mameniskiene, ††Rüdiger Hopfengärtner, #Walter van Emde Boas, and ###Peter Wolf

1: Benitzcky et al Epilepsia 2013