Conferinta Diaspora
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SENSIBILITATEA EEG IN MONITORIZAREA PROFUNZIMII ANESTEZIEI

Pavel B[1,2], Calin A[1], Braga RI[1], Zahiu D[1], Zagrean L[1] .
[1]Centrul de Excellenta in Neurostiinte, UMF "Carol Davila"
[2]Clinica ATI, Spitalul Universitar de Urgenta Bucuresti

Anestezia

- **Dumnezeu**-este primul anestezist

- Anestezia este o stare de "nonresponsivness" la stimuli
- -Hipnoza
- -Analgezie
- -Stabilitate vegetativa

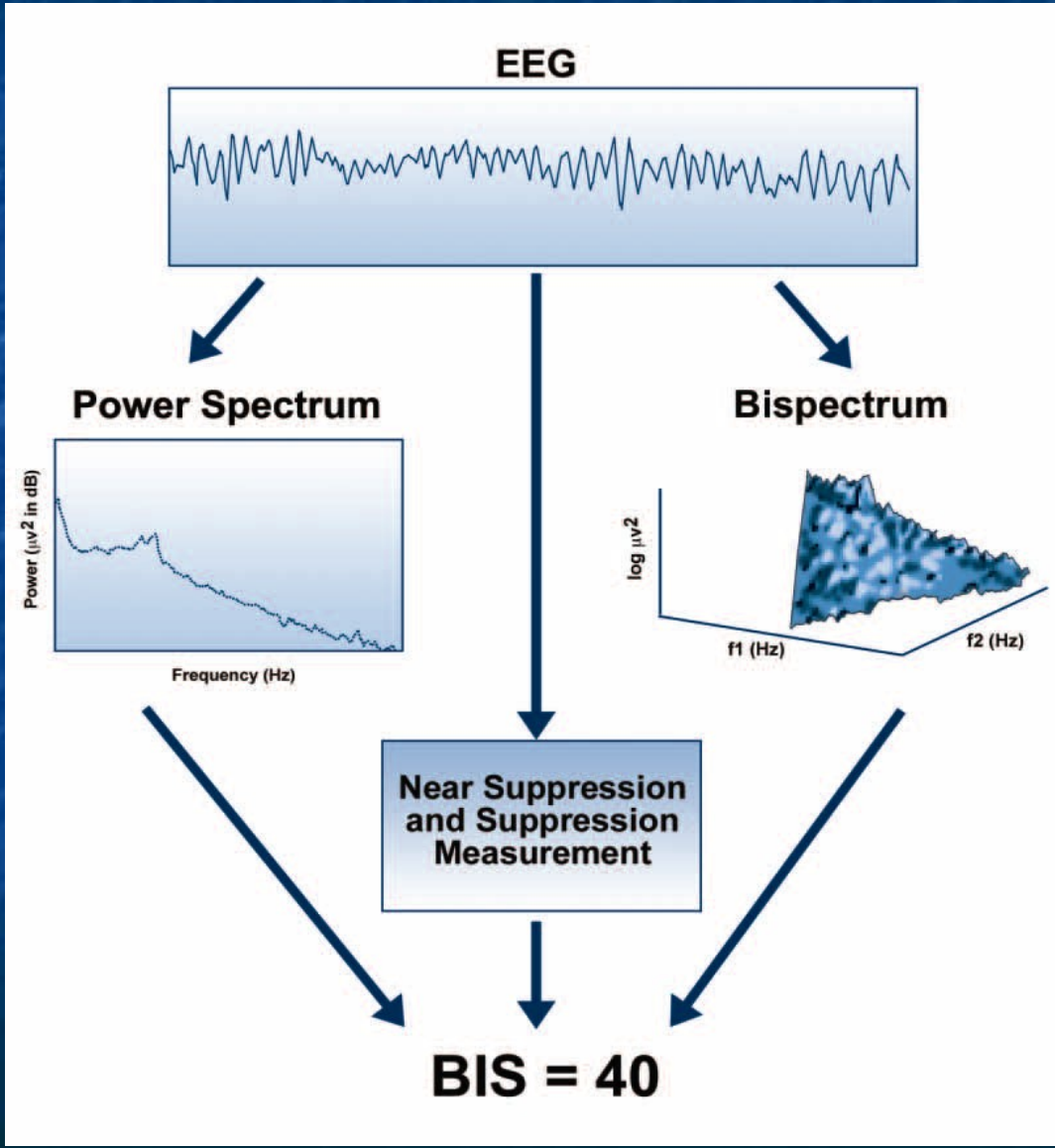
Monitorizarea profunzimii anesteziei

- Indexul bispectral(BIS)

- Entropia spectrala

- Narcotrend

Indexul bispectral



Indexul bispectral

Components of the BIS

Beta Ratio Log(P30–47/P11–20)

SyncFastSlow Log(B0.5–47/B40–47)

QuaziSuppression

Suppression Ratio Measures of suppressed EEG

within the preceding minute

Px–y is the sum of the spectral power within x and y Hz. Bx–y is the sum of the Bispectrum in the area subtended from frequency x to y on both axes. The domain of the bispectrum is triangular due to symmetry conditions and a limit on the highest frequency in the EEG

Entropia spectrala

In the summation step, the spectral entropy corresponding to the frequency range $[f_1,f_2]$ is computed as a sum:

$$S[f_1,f_2] = \sum_{f_i=f_1}^{f_2} P_n(f_i)\log\left(\frac{1}{P_n(f_i)}\right) \qquad (3)$$

Thereafter, the entropy value is normalized to range between 1 (maximum irregularity) and 0 (complete regularity). The value is divided by the factor log $(N[f_1,f_2])$ where $N[f_1,f_2]$ is equal to the total number of frequency components in the range $[f_1,f_2]$:

$$S_N[f_1,f_2] = \frac{S[f_1,f_2]}{\log(N[f_1,f_2])} \qquad (4)$$

$$\frac{1}{\log(N[f_1,f_2])} P_n(f_i)\log\left(\frac{1}{P_n(f_i)}\right).$$

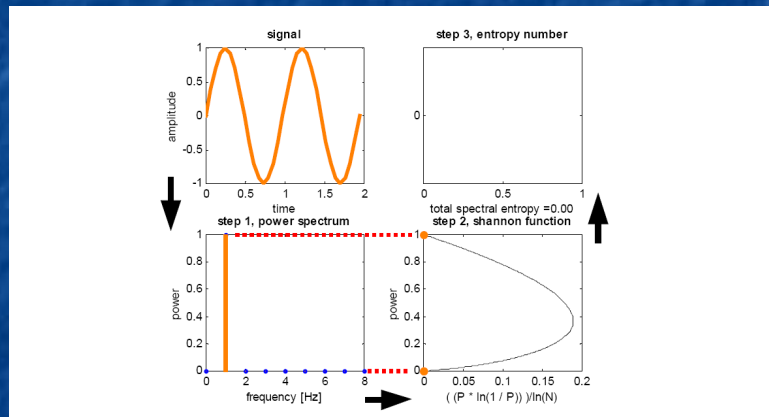
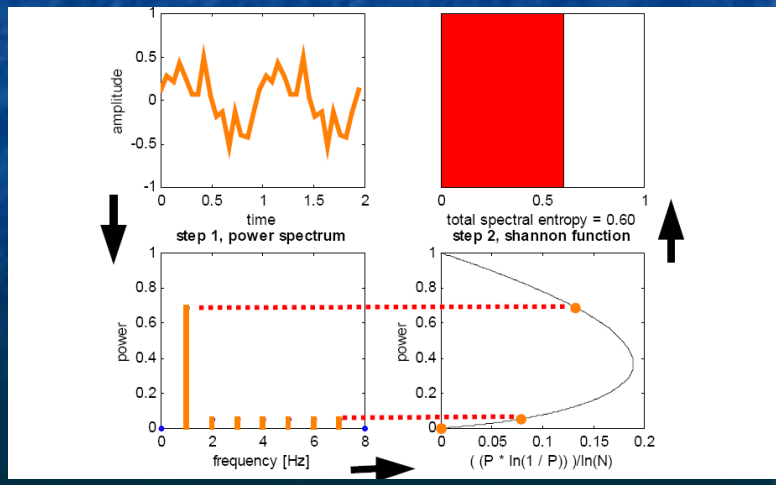


Fig. 1. The perfect sine wave in Fig. 1 includes only one nonzero spectral component, which is



Narcotrend

Table 1. Narcotrend Index, corresponding predominant EEG electroencephalogram features [5], and clinical description [6].

Narcotrend Index	Predominant EEG characteristics	Clinical description
100–95	α-waves	Awake
94–90	↓	Sedation
89–85	β-waves	↓
84–80	↓	
79–75	↓	Light anaesthesia
74–70	Θ-waves	↓
69–65	↓	
64–57	↓	General anaesthesia
56–47	↓	
46–37	↓	
36–27	↓	General anaesthesia with deep hypnosis
26–20	δ-waves	↓
19–13	↓	
12–5	Burst suppression	Very deep general anaesthesia
4–0	Isoelectric EEG	

Obiectivul studiului

- In acest studiu, am dorit sa aflam care este cel mai sensibil indice EEG(MEF, SEF, AE, PE) la modificarile de profunzime anestezica, la sobolan.

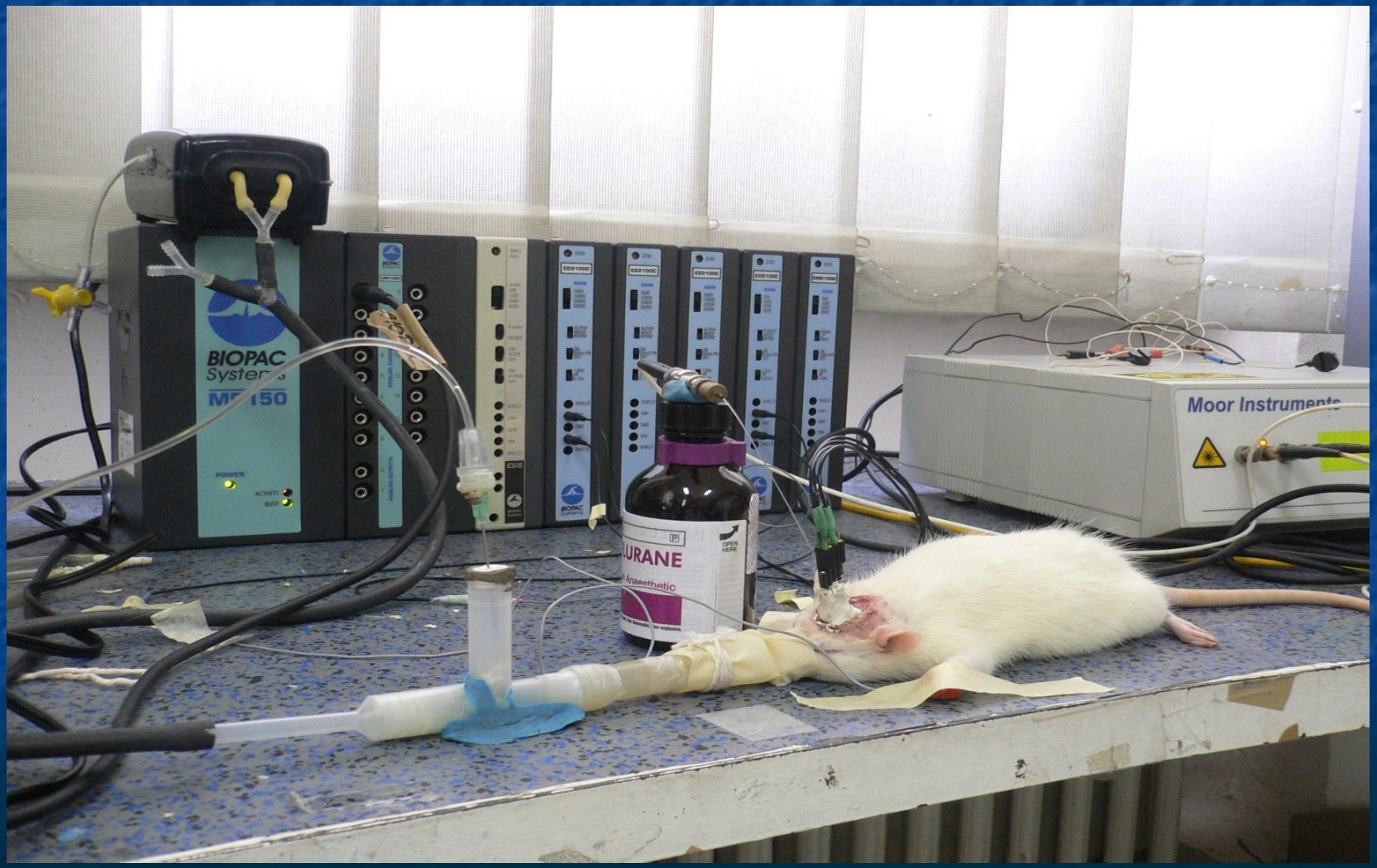
Material si Metoda

- Am folosit doua loturi de sobolani(5 sobolani/lot)
- Primul lot a primit anestezie cu **isofluran**

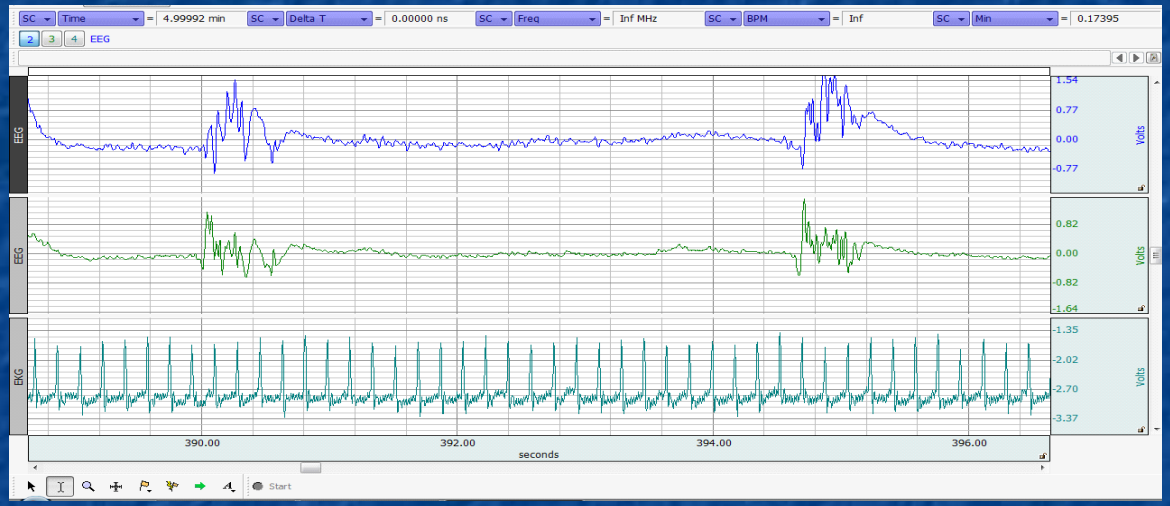
Al doilea a primit anestezie cu **isofluran** la care s-a adaugat si **tramadol** ca analgezic.

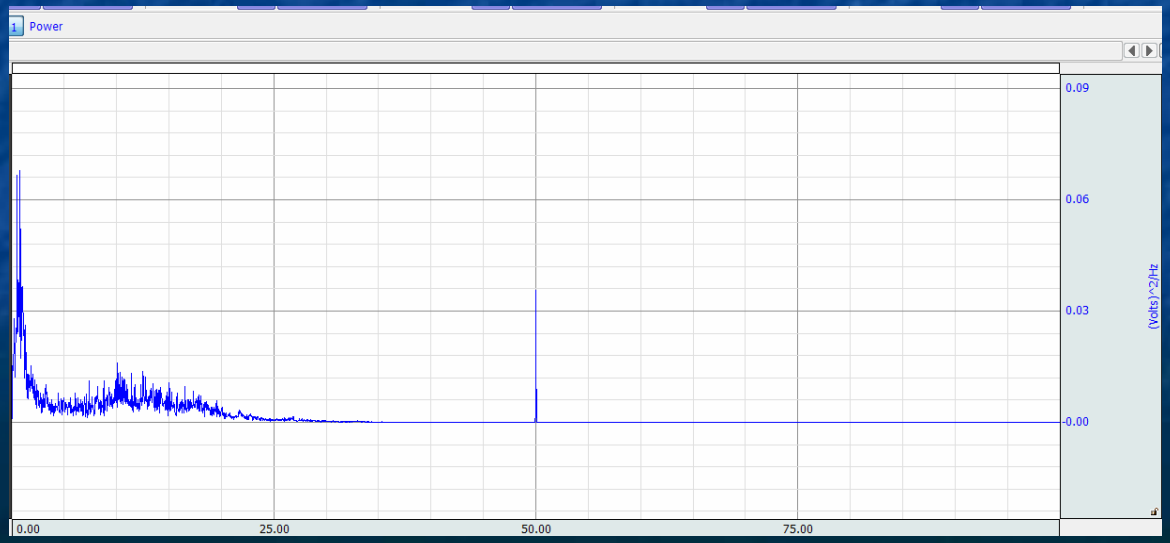
Profunzimea anestezica a fost mentinuta constant, in **burst suppression**, cu o **rata de supresie de 80%.** Sobolanilor din ambele loturi li s-a aplicat un stimul dureros, in timpul anesteziei, timp de un minut. Noi am analizat inregistrarile EEG inainte si in timpul stimularii dureroase, folosind frecventa mediana(MEF), frecventa de margine specrtala 95% (SEF 95%), entropia aproximativa(AE) si entropia permutationala(PE).

Material si Metoda

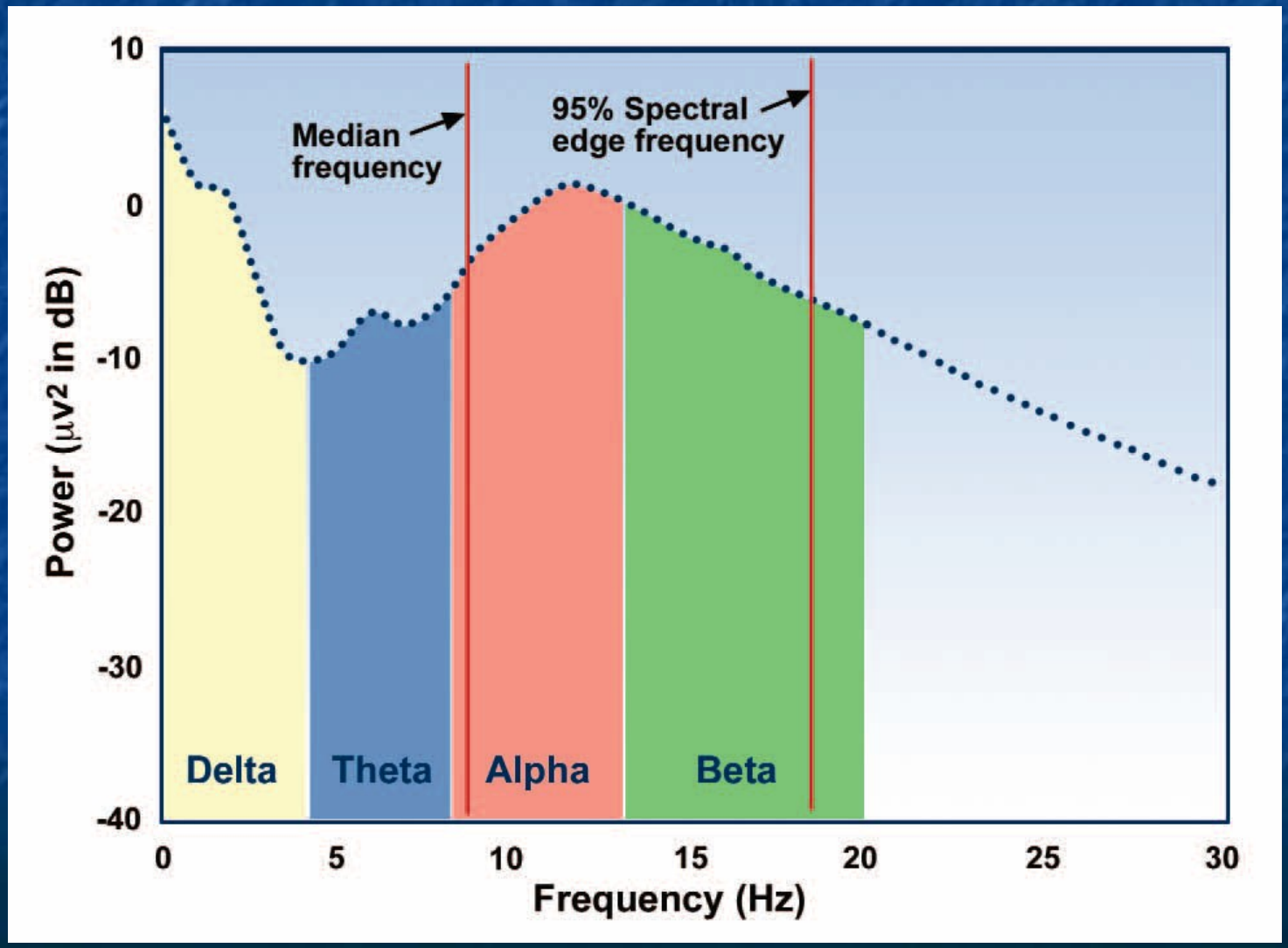


Puterea spectrala





Ce sunt MEF, SEF ?

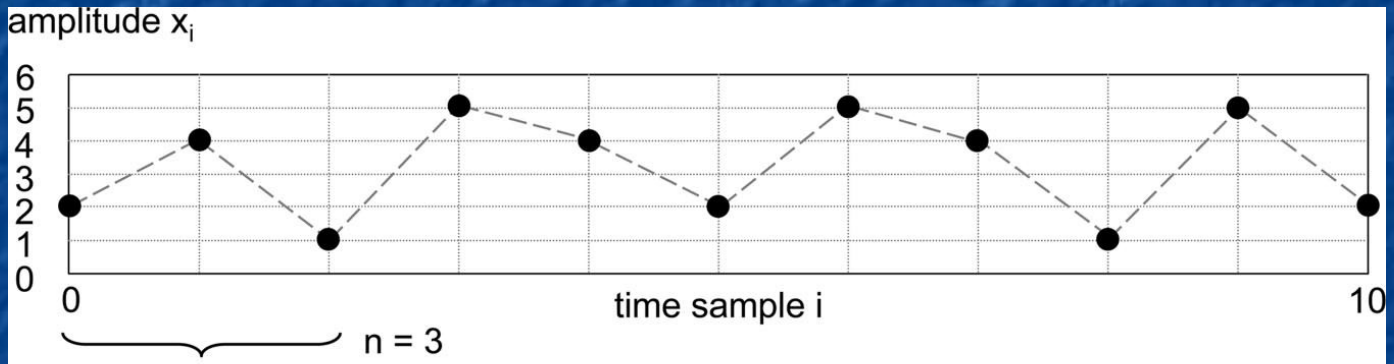


Approximate entropy

- ApEn introdusa de Pincus-1991, pentru a determina modificarile dintrun sistem coplex
- ApEn este o masura a predictabilitatii seriilor de timp.
- ApEn cuantifica cat de constanta este distanta dintre doi vectori ai unei serii

Permutation entropy

- Algoritmul entropiei permutationale a fost publicat dde Bandt-2001
- Jordan-2008, foloseste entropia permutationala pentru analiza EEG.

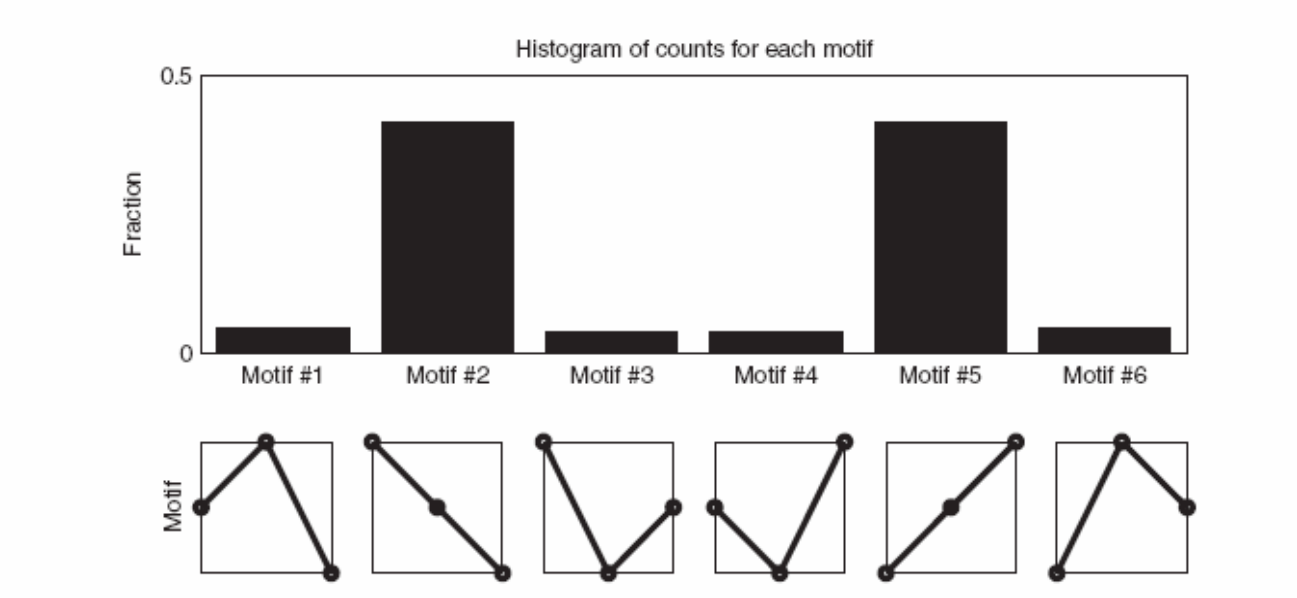


x_i :	2 4 1	4 1 5	1 5 4	5 4 2	4 2 5	2 5 4	5 4 1	4 1 5	1 5 2
π_k :	(1 2 0) π_1	(1 0 2) π_2	(0 2 1) π_3	(2 1 0) π_4	(1 0 2) π_2	(0 2 1) π_3	(2 1 0) π_4	(1 0 2) π_2	(0 2 1) π_3

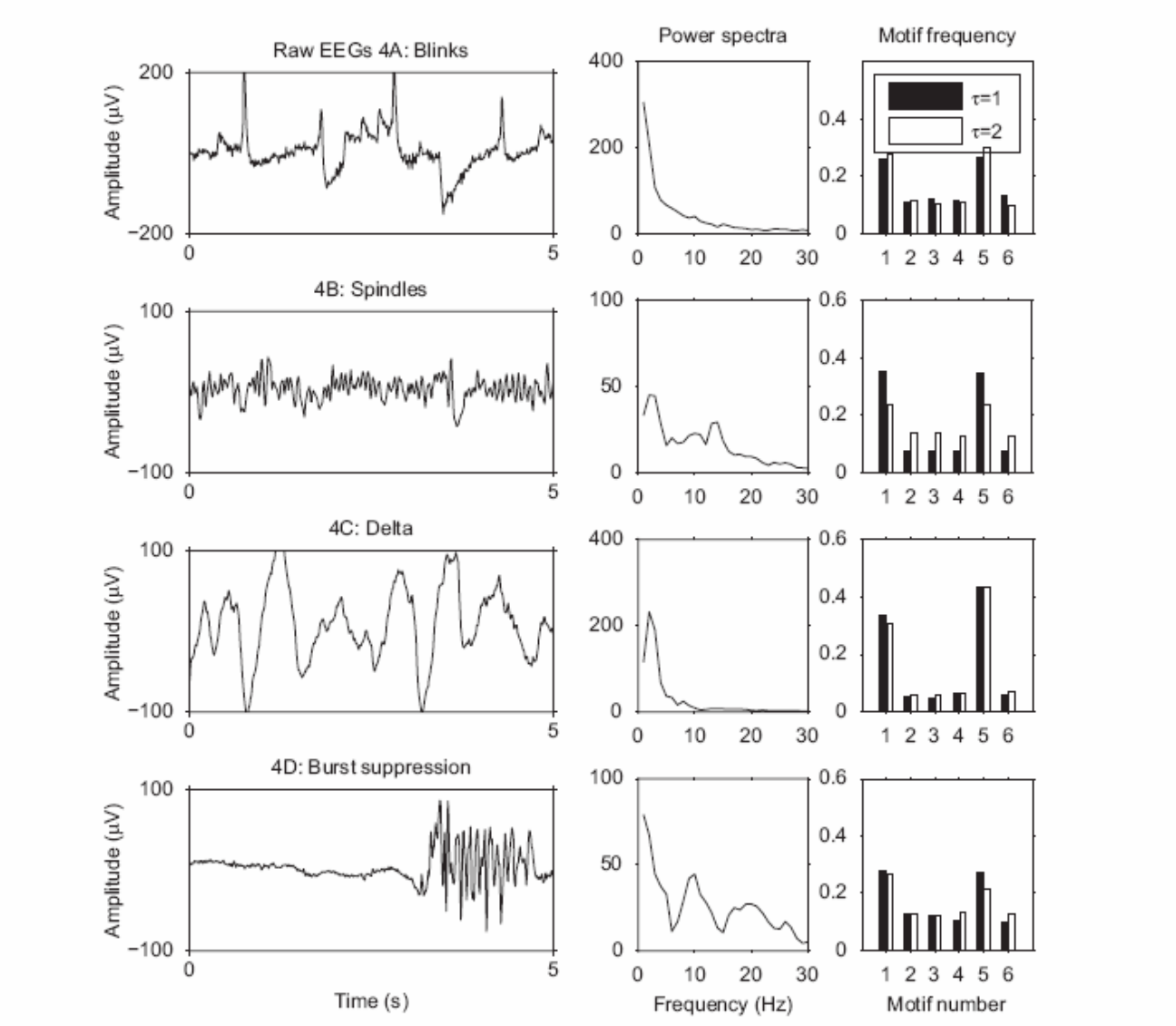
$$p(\pi_k): \left.\begin{array}{l} p(\pi_1) = 1/9 \\ p(\pi_2) = 3/9 \\ p(\pi_3) = 3/9 \\ p(\pi_4) = 2/9 \end{array}\right\} \Rightarrow \text{PeEn} = -\sum_k p(\pi_k)\cdot\log p(\pi_k) = 0.569$$

Permutation entropy

- EEG poate fi descrisa ca o succesiune de pattern-uri(motive).
- Entropia permutationala calculeaza probabilitatea de aparitie a acestora.
- Avantajul entropiei permutationale fata de restul parametrilor EEG este rezistenta la “zgomot”.



Permutation Entropy



Rezultate

- MEF a variat in timpul stimularii dureroase cu un procent cuprins intre **5%** si **90%**!
- SEF a variat in timpul stimularii dureroase cu un procent cuprins intre **15%** si **27%**.
- PE a variat in timpul stimularii dureroase cu un procent cuprins intre **1,7%** si **3%**.
- AE a variat in timpul stimularii dureroase cu un procent cuprins intre **0%** si **2%**.

Perspective

- Studii recente(2010), sustin ca in timpul anesteziei conectivitatea corticala scade, astfel incat un potential evocat de la nivelul ariei Brodman 6 nu ajunge la nivelul polului anterior al lobului frontal!

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Behavioral/Systems/Cognitive

Cortical and Subcortical Connectivity Changes during Decreasing Levels of Consciousness in Humans: A Functional Magnetic Resonance Imaging Study using Propofol

Róisín Ní Mhuircheartaigh, Debbie Rosenorn-Lanng, Richard Wise, Saad Jbabdi, Richard Rogers, and Irene Tracey
Centre for Functional Magnetic Resonance of the Brain (FMRIB), Department of Clinical Neurology and Nuffield Department of Anaesthetics, John Radcliffe Hospital, University of Oxford, Oxford, OX3 9DU, United Kingdom

Breakdown in cortical effective connectivity during midazolam-induced loss of consciousness

Fabio Ferrarelli[a], Marcello Massimini[b], Simone Sarasso[a], Adenauer Casali[b], Brady A. Riedner[a], Giuditta Angelini[c], Giulio Tononi[a,1], and Robert A. Pearce[c,1]

Departments of [a]Psychiatry and [c]Anesthesiology, University of Wisconsin, Madison, WI 53719; and [b]Department of Clinical Sciences, University of Milan, 20157 Milan, Italy

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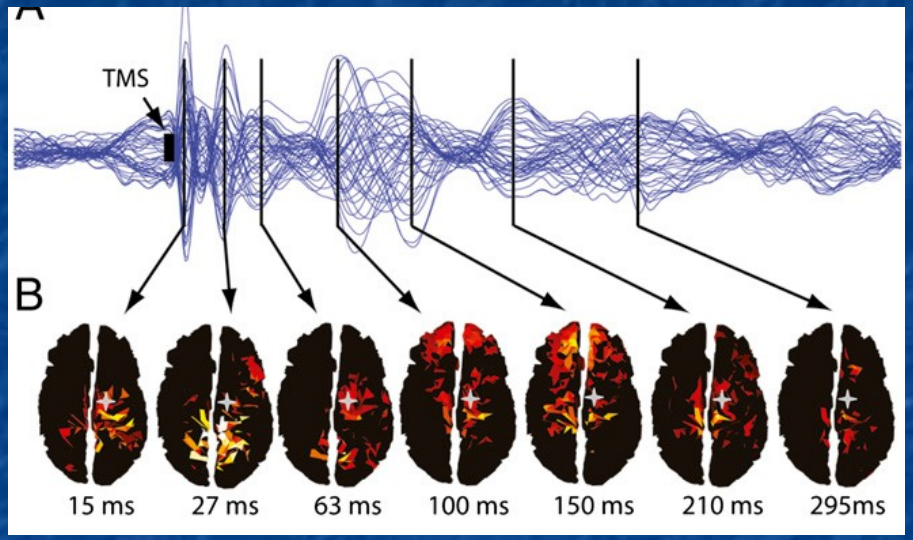
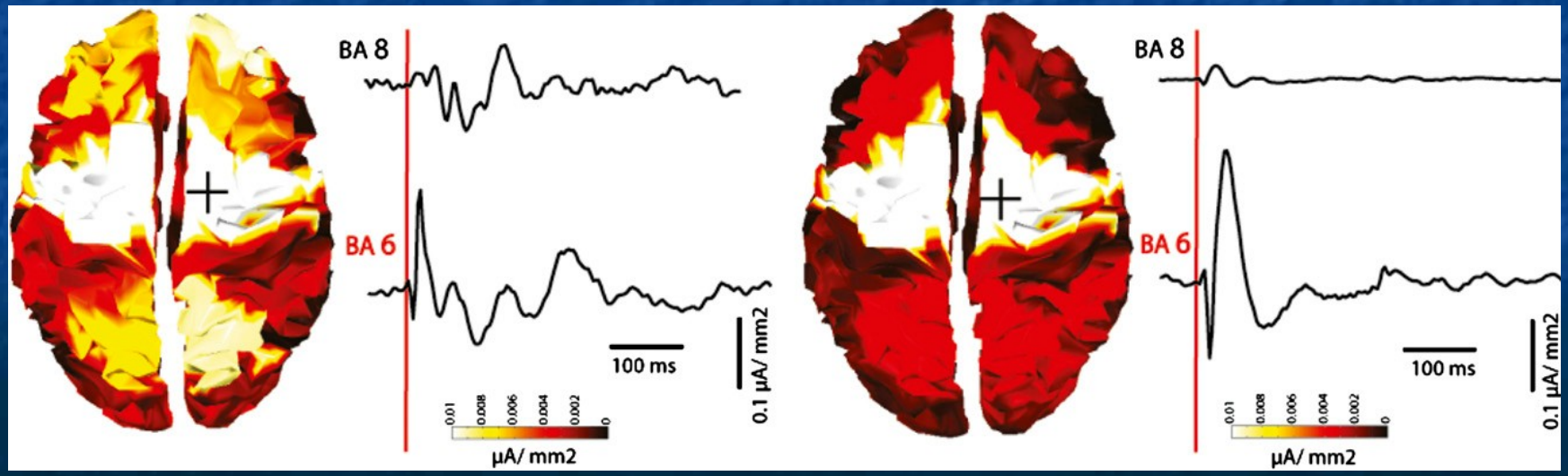
Perspective





Concluzii

- Monitorizarea profunzimii anesteziei este obligatorie!
- Analiza EEG, in timpul anesteziei ofera cea mai buna predictie asupra profunzimii anesteziei.
- In urma analizei datelor, frecventa mediana si frecventa de margine spectrala 95%, s-au dovedit a fi cele mai sensibile la modificarile de profunzime anestezica, dar **entropia permutationala** a avut cea mai constanta variatie in ambele loturi.