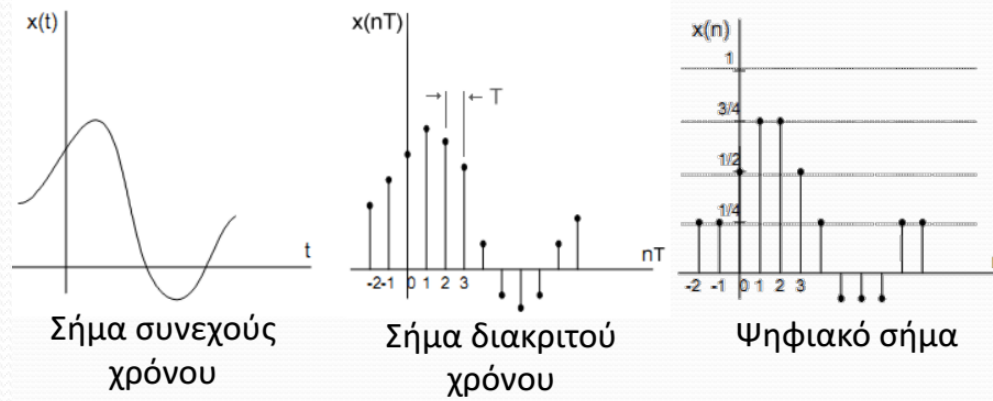


Biomedical Informatics

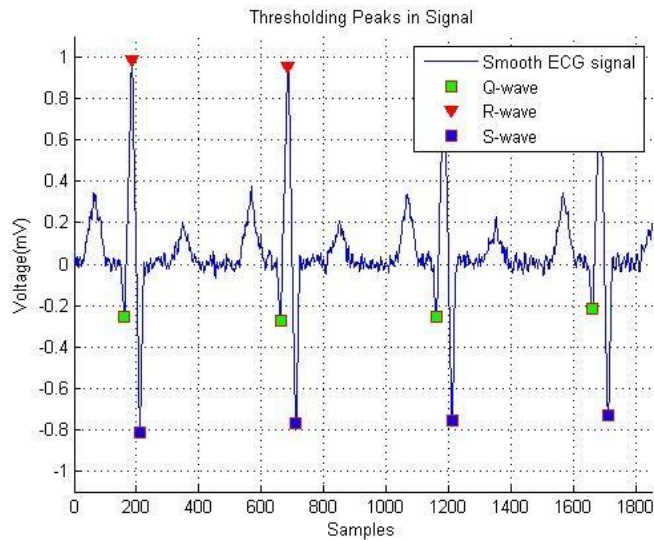
Lefteris Koumakis

Bio Signals

Biomedical signals



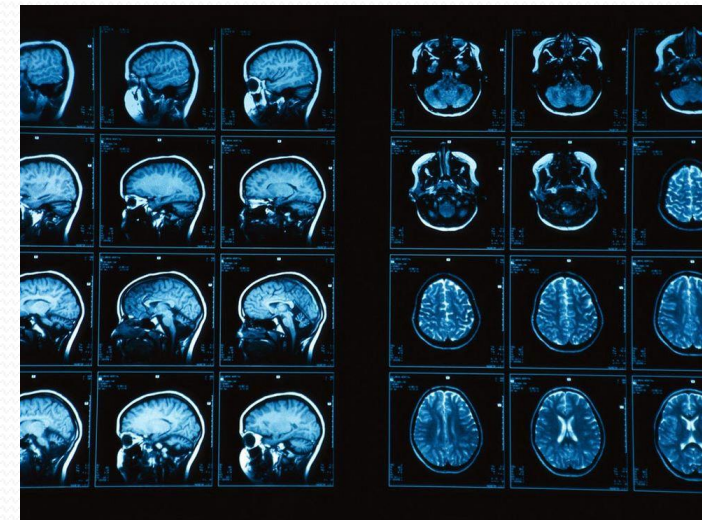
1 D



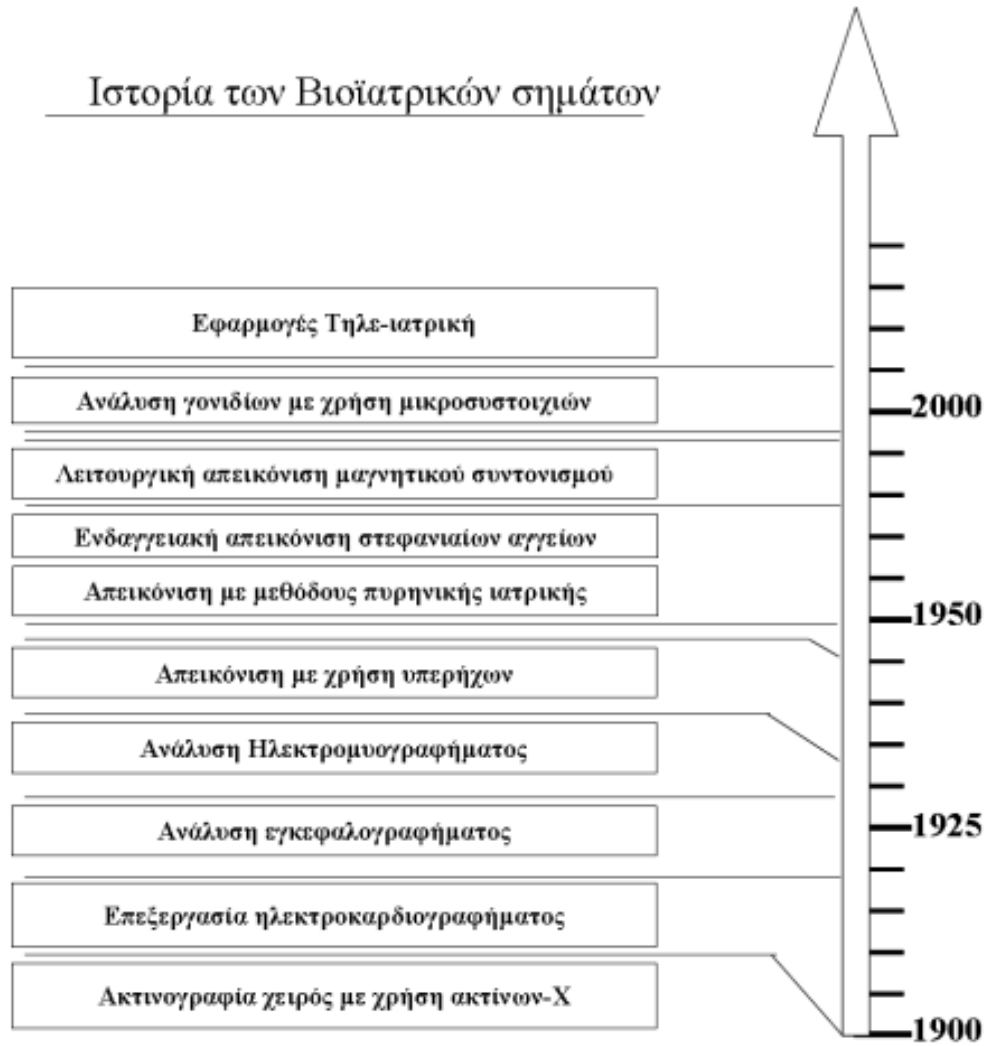
2 D



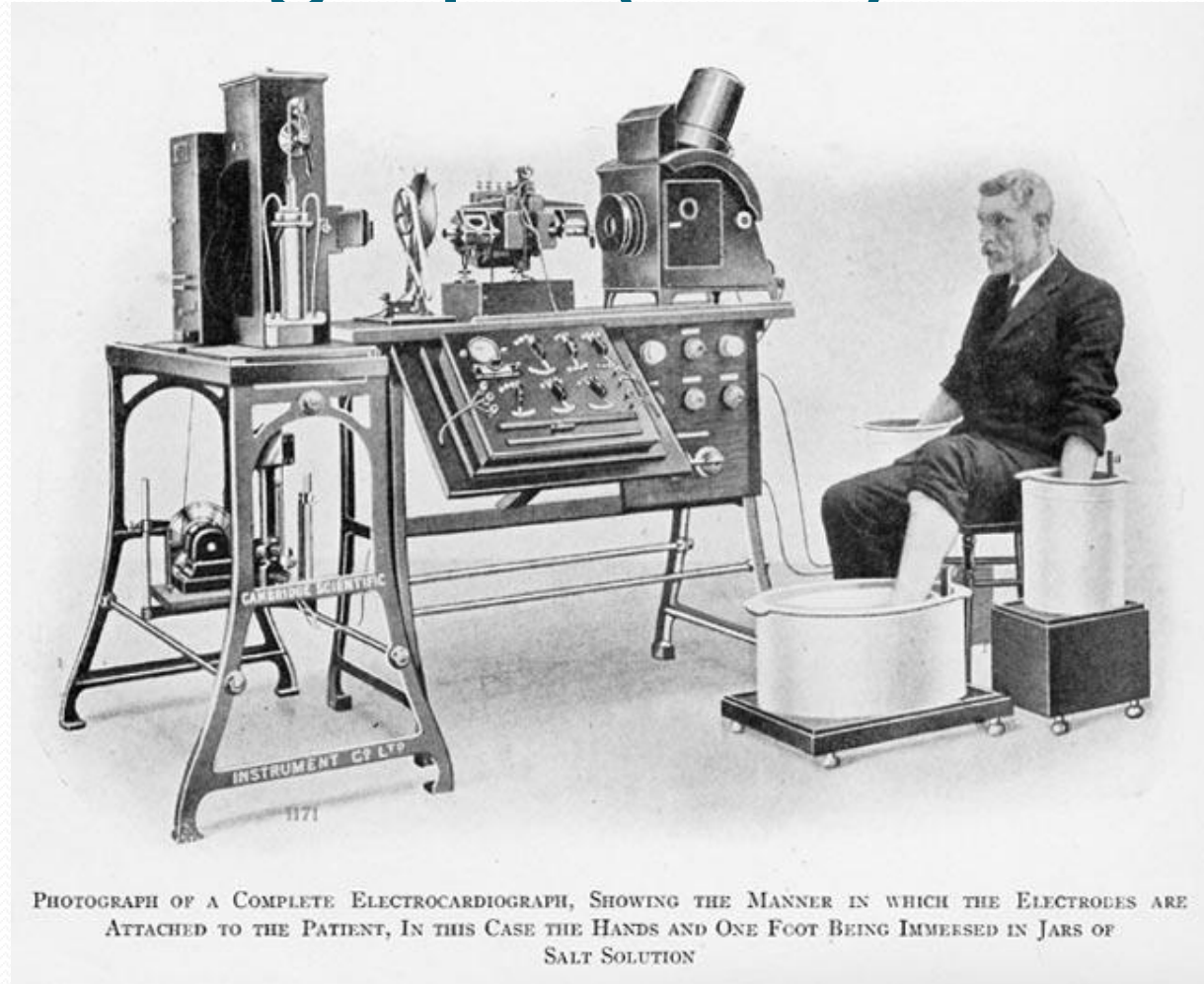
3 D



Ιστορία των Βιοϊατρικών σημάτων



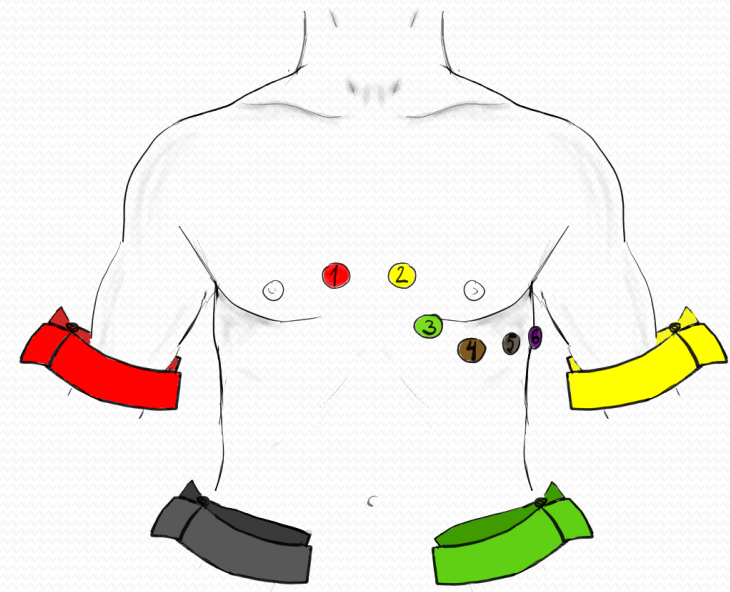
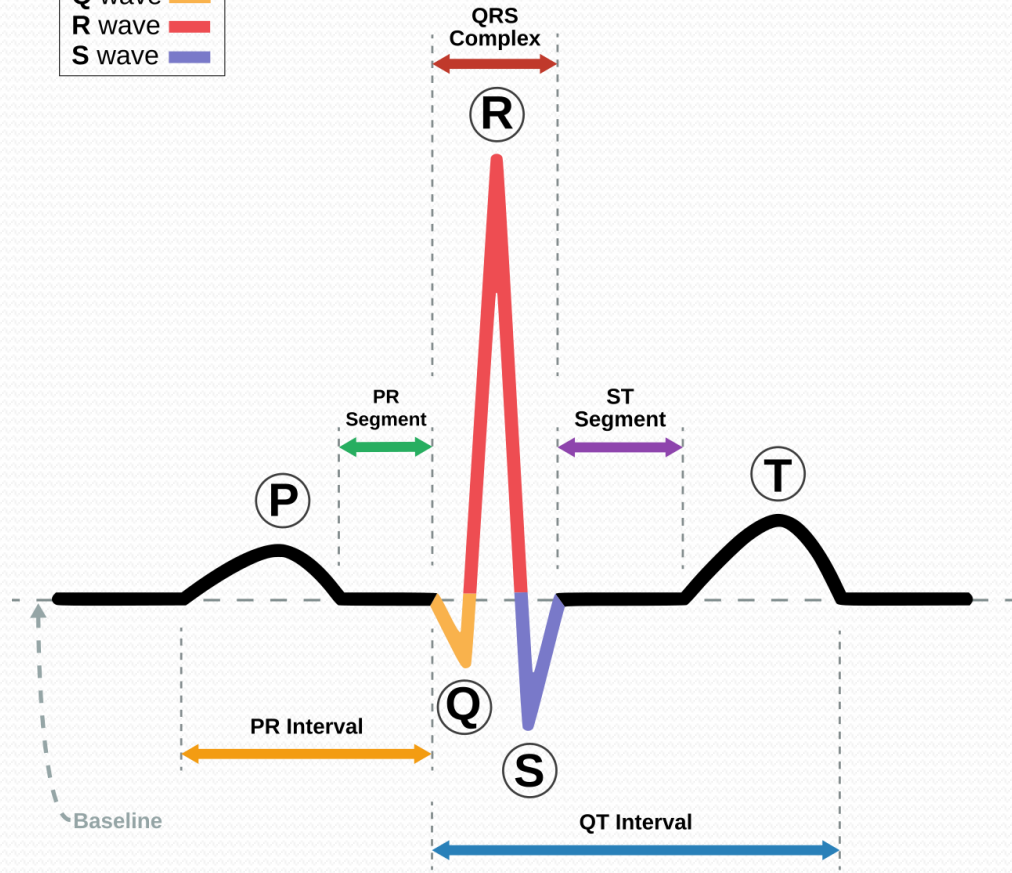
Electrocardiograph (ECG)



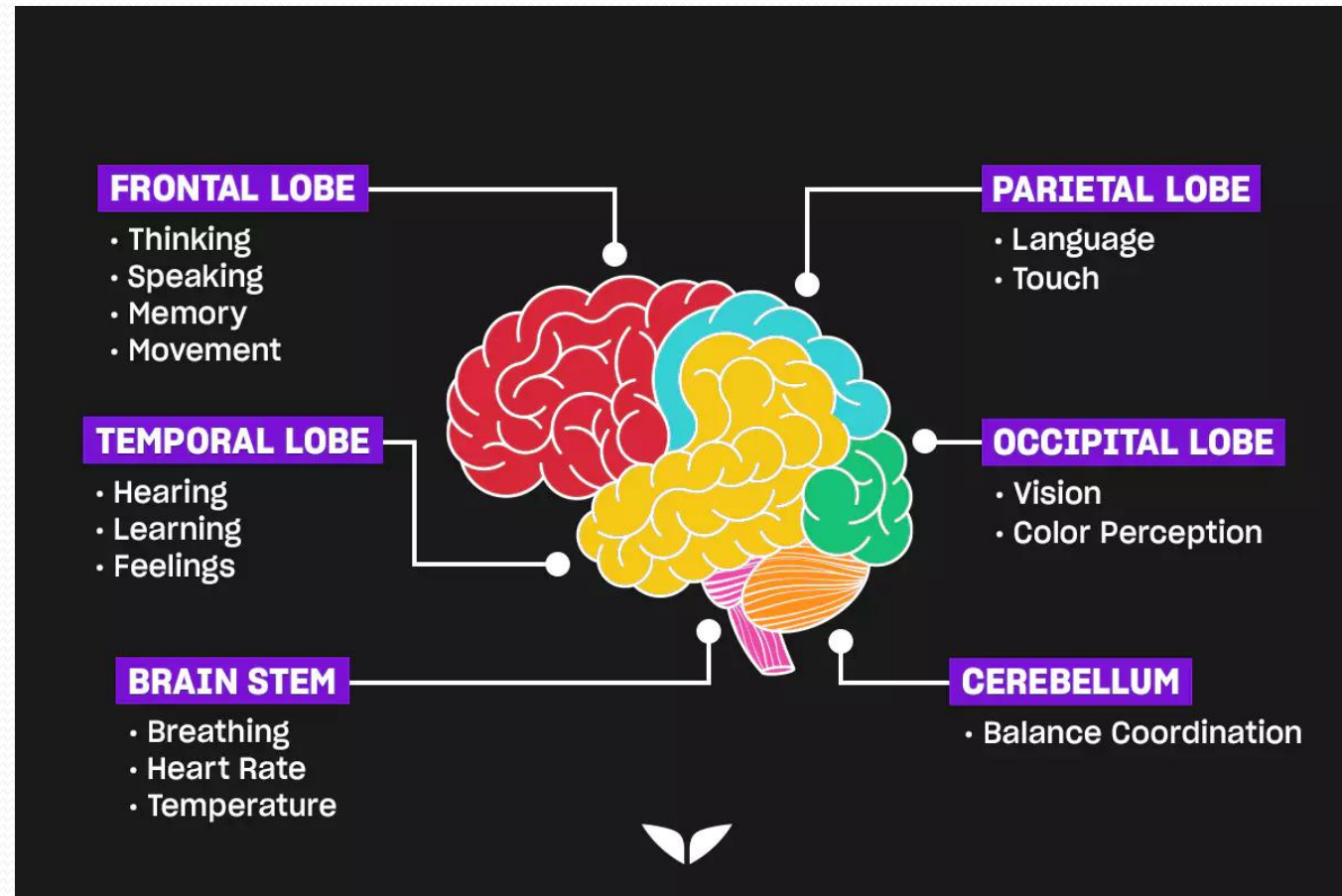
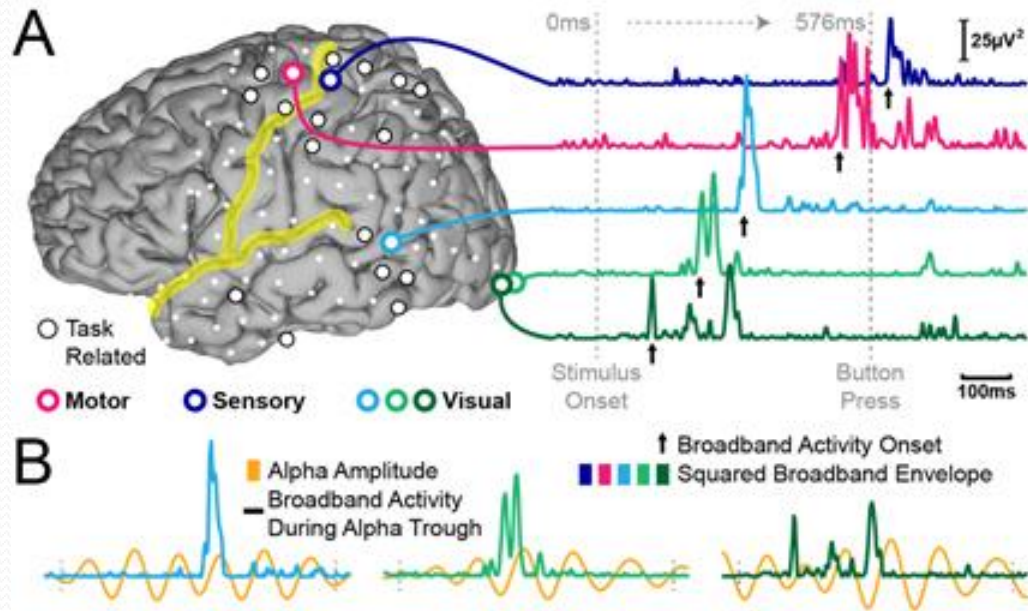
Nobel Prize in
Physiology or
Medicine in 1924

ECG

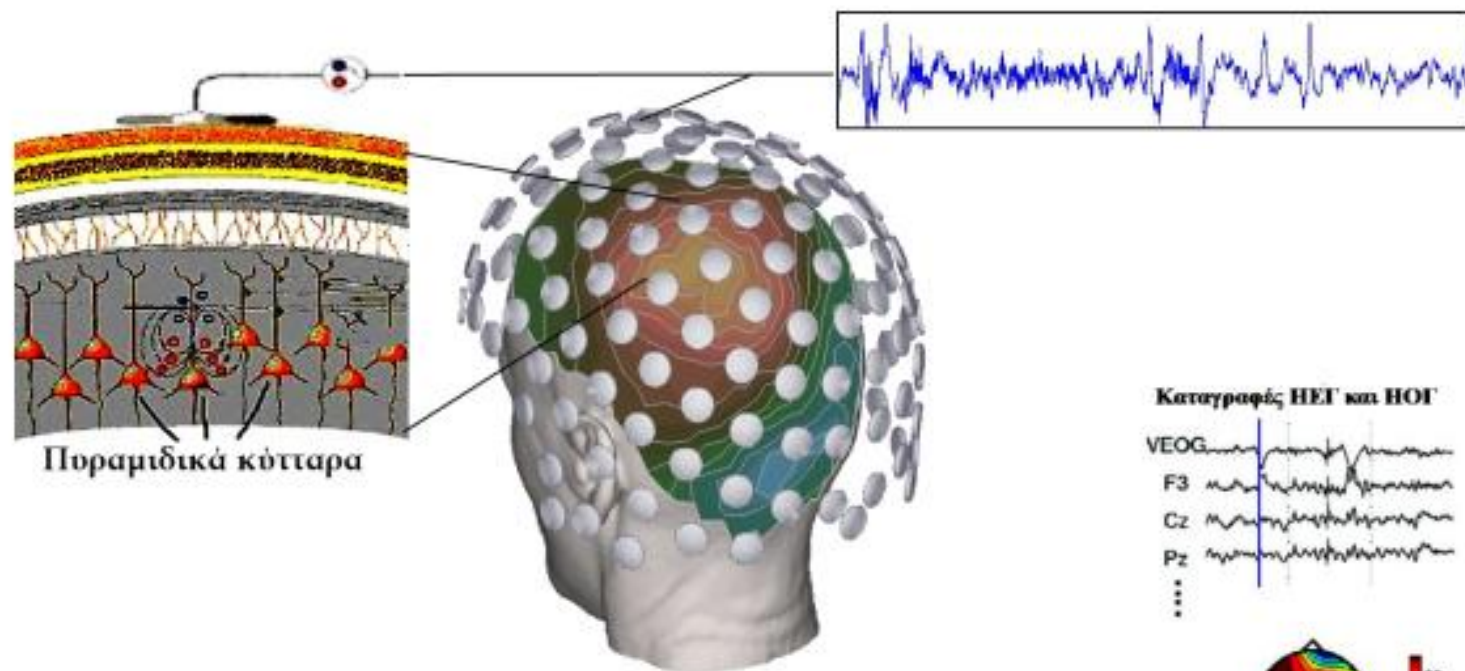
- Q wave
- R wave
- S wave



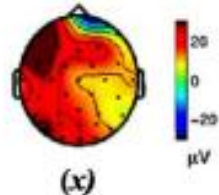
EEG



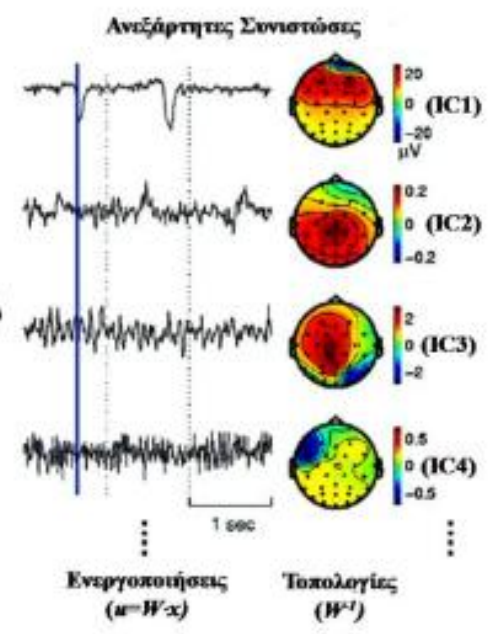
EEG



Καταγραφές ΗΕΓ και ΗΟΓ



Αποσύνθεση
(W)



CGM & activity tracker

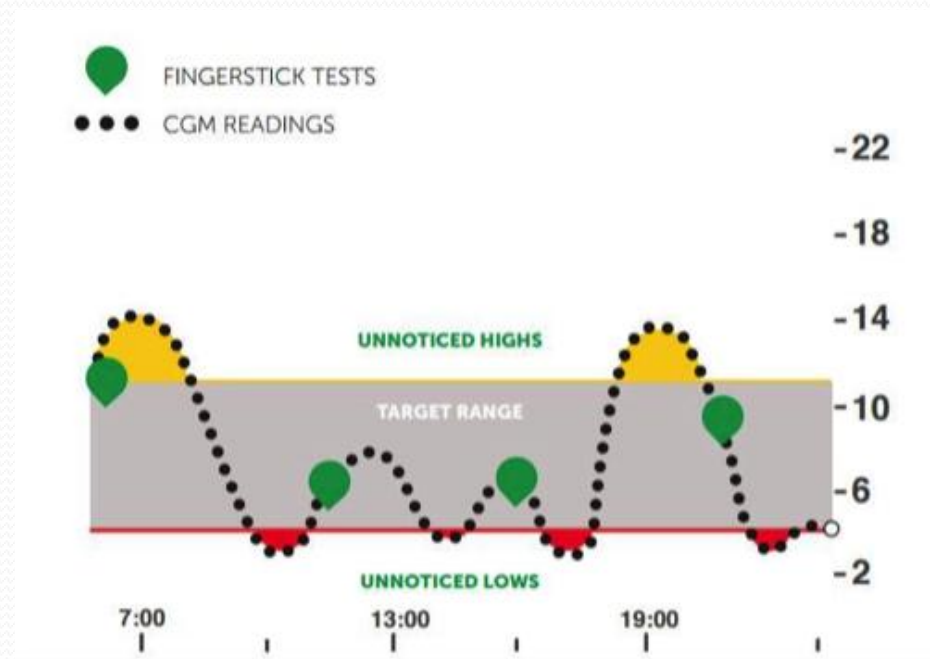
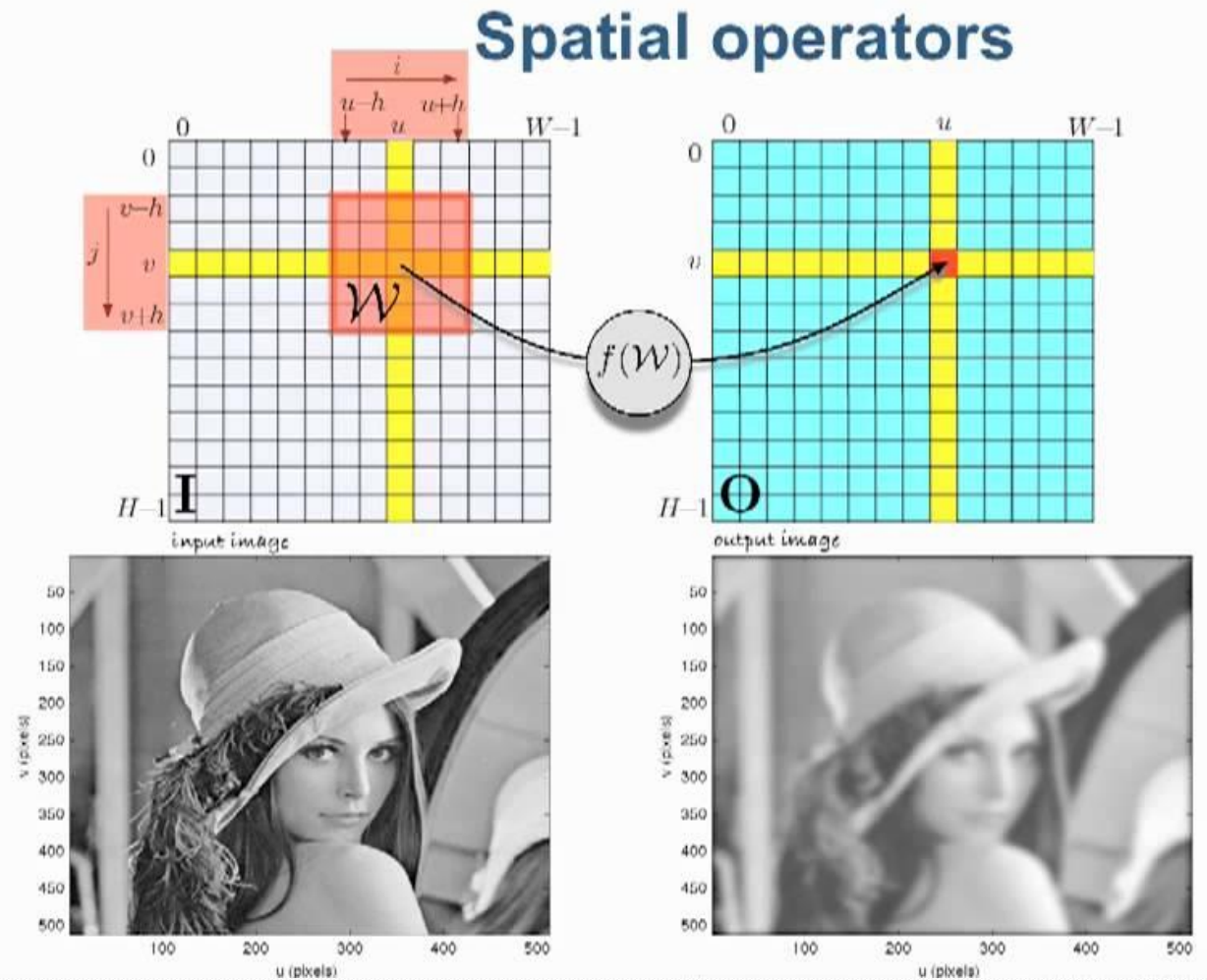
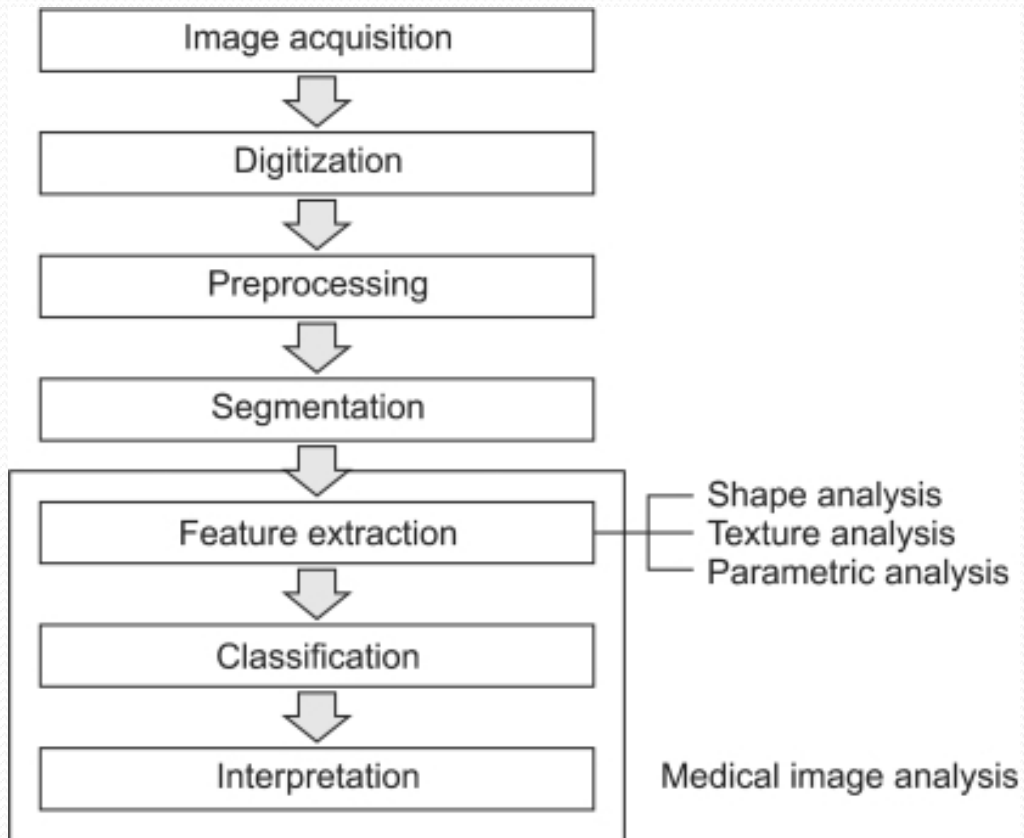


Image processing



X-Ray



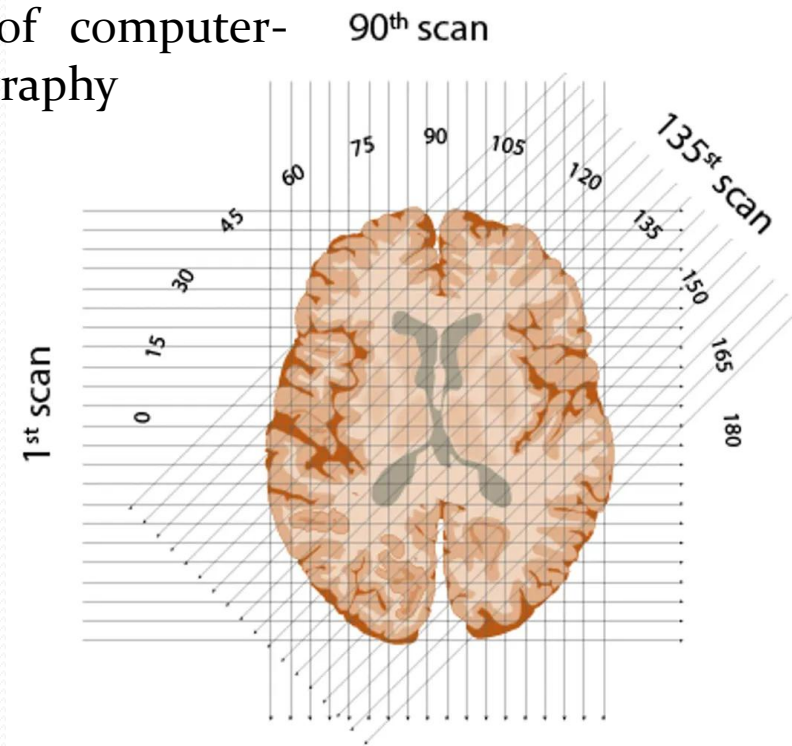
In **1901**, Röntgen became the first recipient of the Nobel Prize in Physics



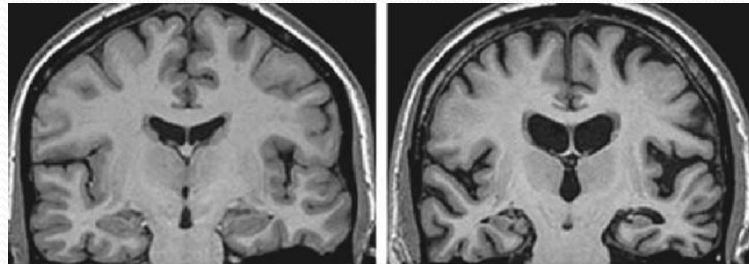
computer-assisted tomography (CT)



1979 Nobel Prize in Physiology or Medicine was awarded jointly to Allan M. Cormack and Godfrey N. Hounsfield for the development of computer-assisted tomography

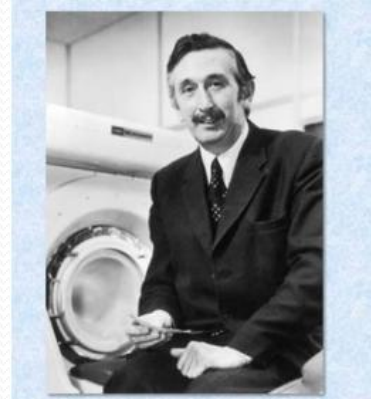
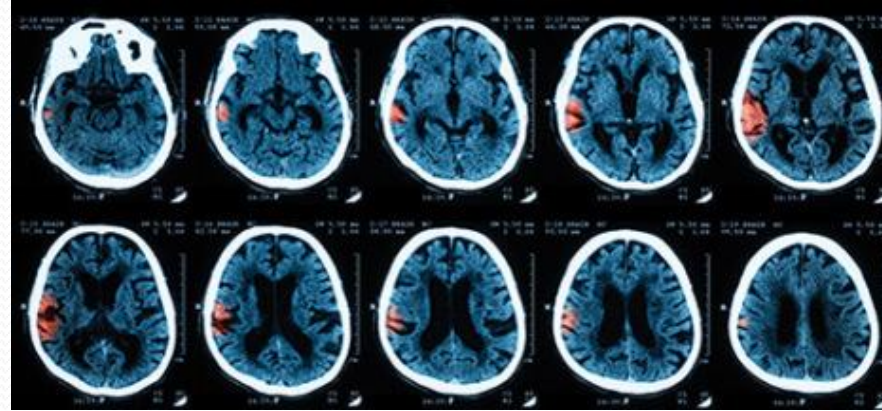


Magnetic Resonance Imaging (MRI)



Healthy

Alzheimer's



Sir Godfrey Hounsfield (Nobel prize 1979)



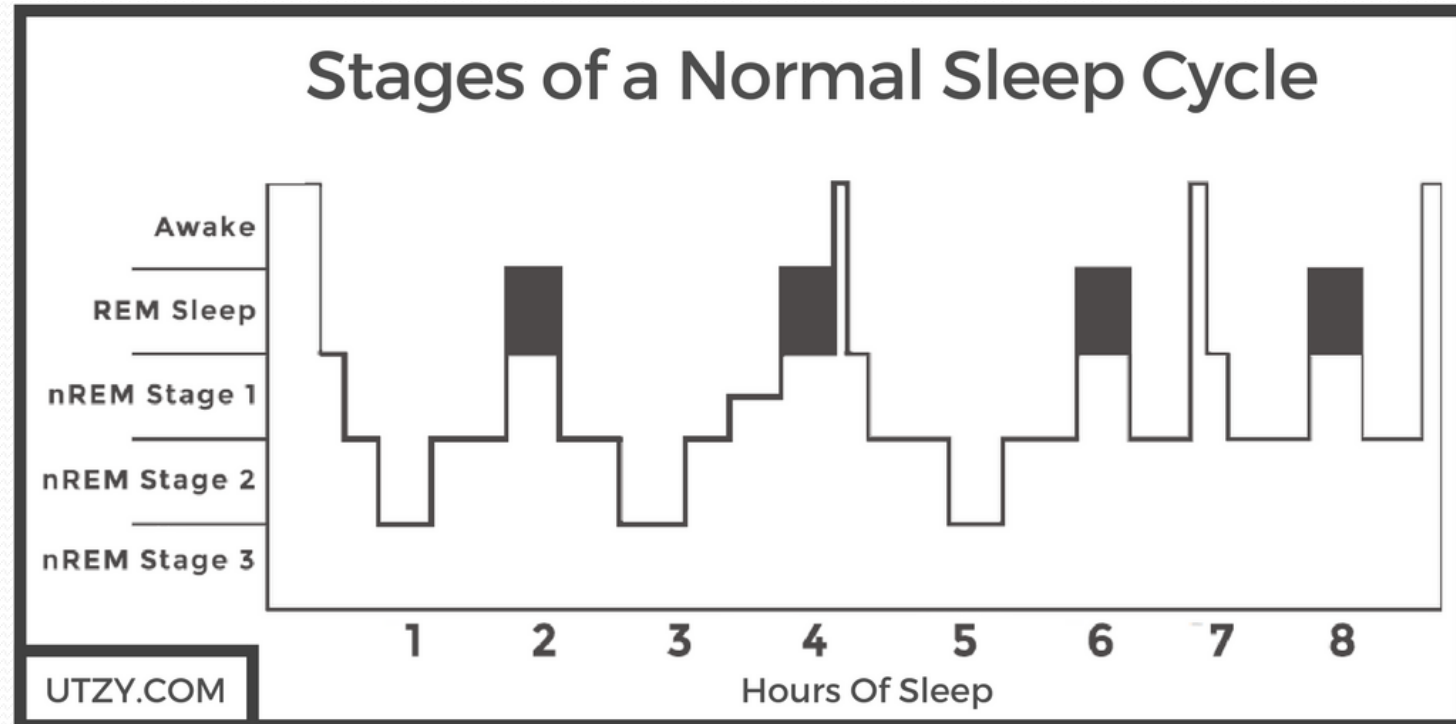
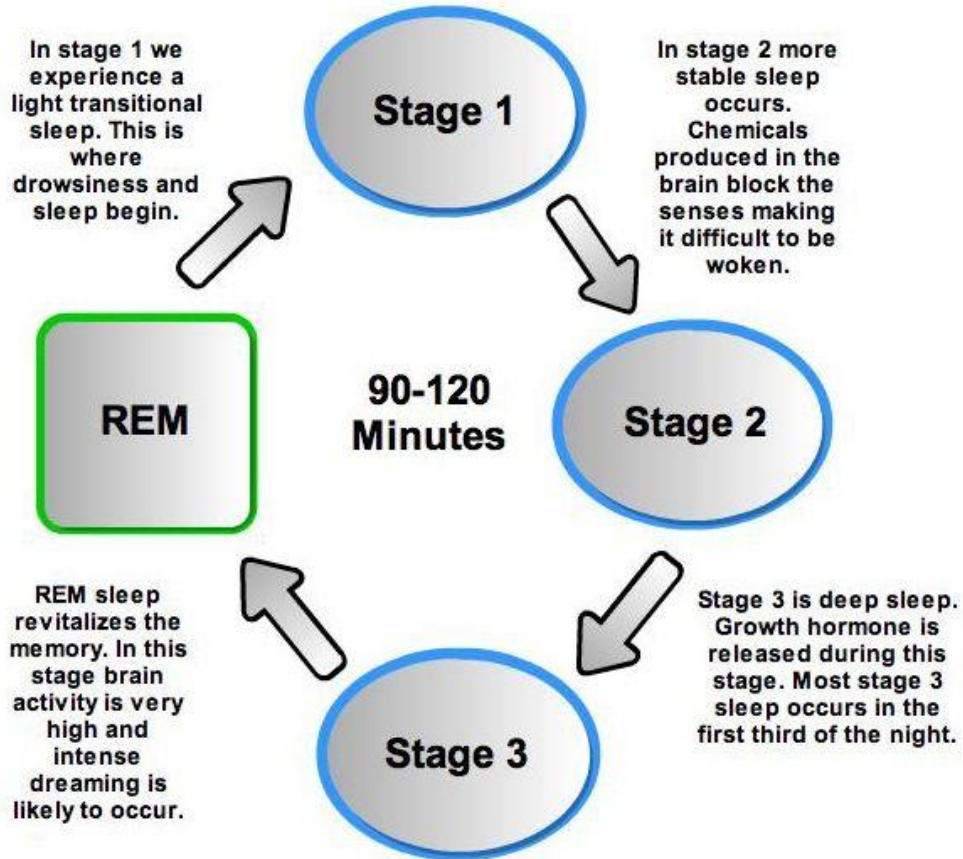
2003 Nobel Prize in Physiology or Medicine was awarded jointly to American chemist Paul C. Lauterbur and British physicist Sir Peter Mansfield for their pioneering discoveries concerning MRI

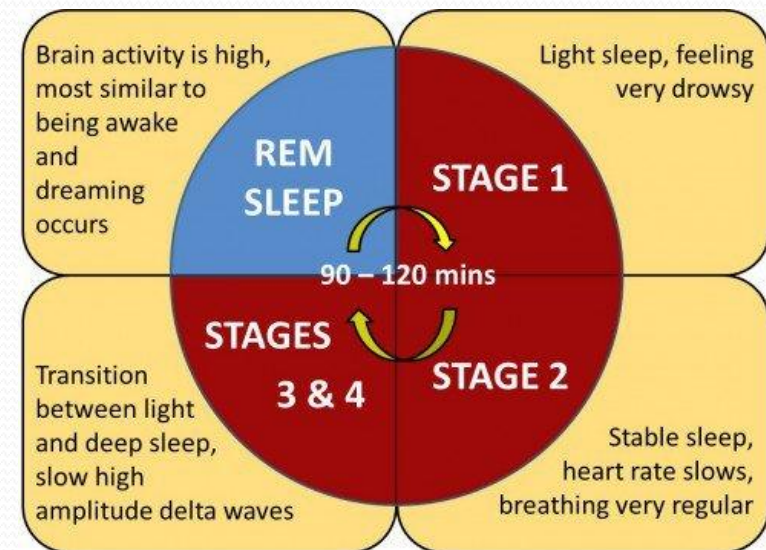
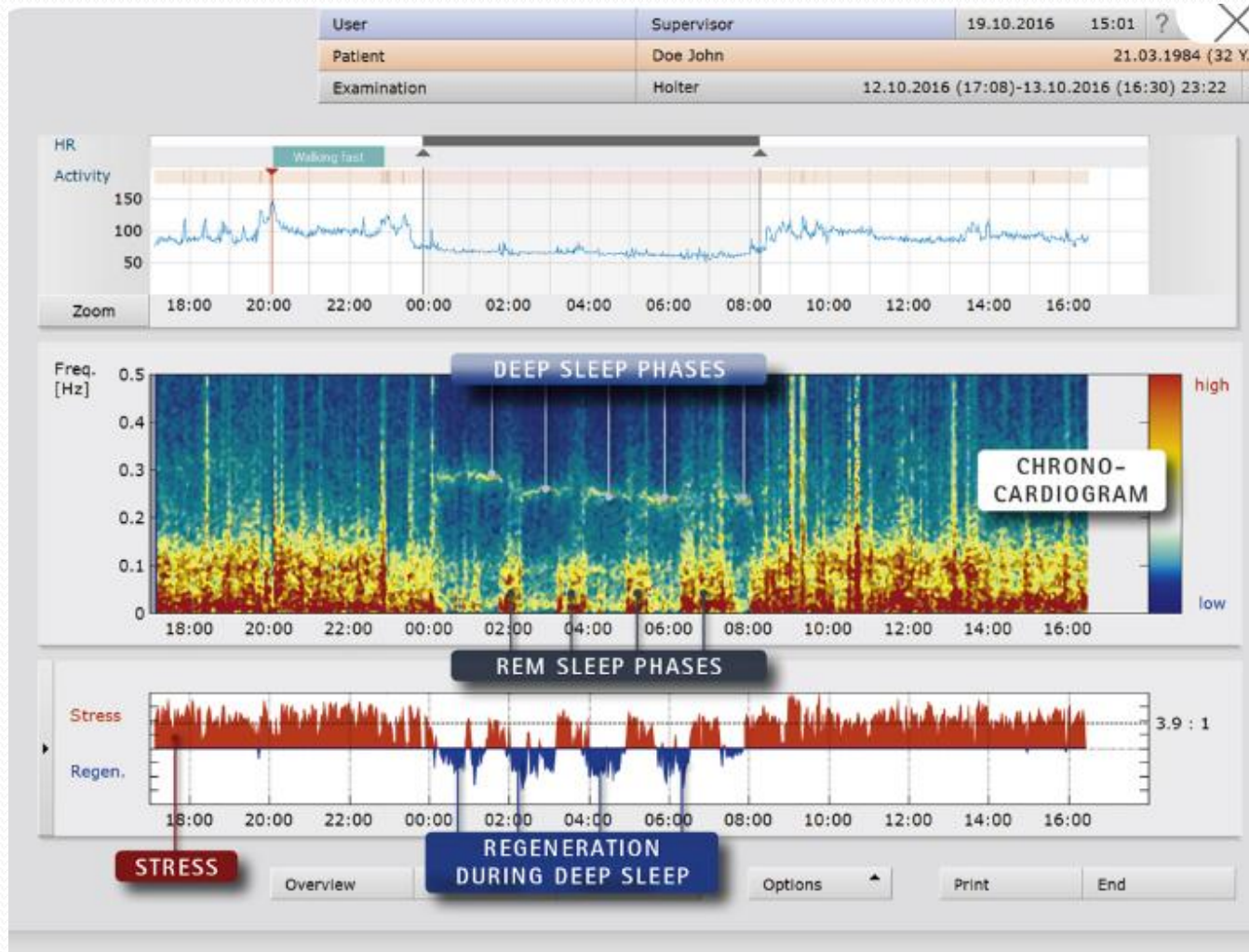


Biomedical Informatics

Sleep

Sleep stages





Accuracy

[1] W. . D. Scherz, D. Fritz, O. R. Velicu, R. Seepold και N. M. Madrid, «Heart rate spectrum analysis for sleep,» αρ. 26, 2017

<https://link.springer.com/article/10.1186/s13639-017-0072-z>

- **41,3%** accuracy (only from RR intervals)
- Polysomnography measures 11 parameters

Sleep stage detection using only heart rate

Mitsukura, Yasue, Koichi Fukunaga, Masato Yasui, and Masaru Mimura.
"Sleep stage detection using only heart rate." *Health informatics journal*
26, no. 1 (2020): 376-387.

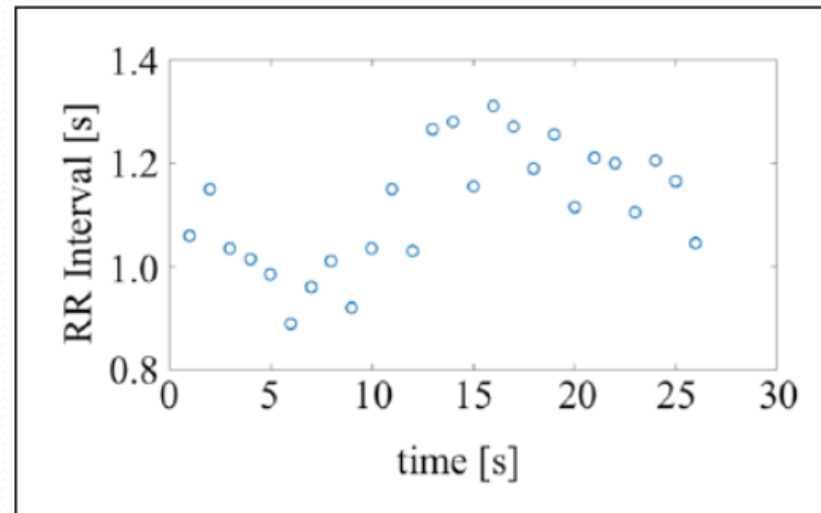
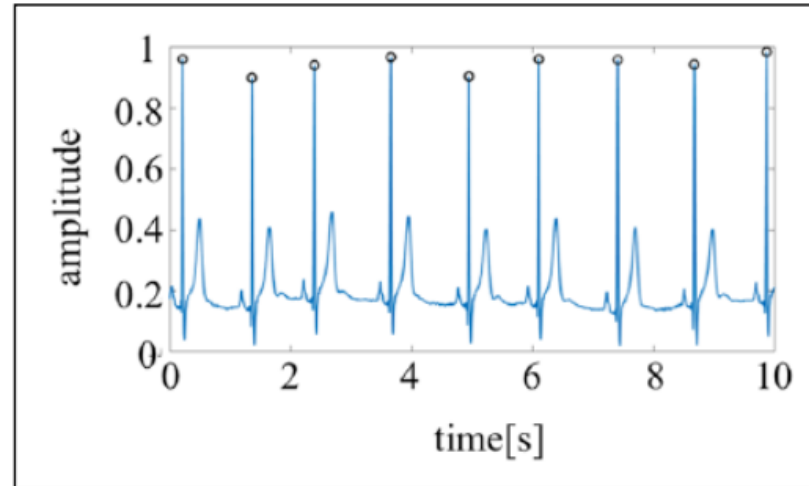
<https://journals.sagepub.com/doi/pdf/10.1177/1460458219827349>

Sleep stage detection using only heart rate

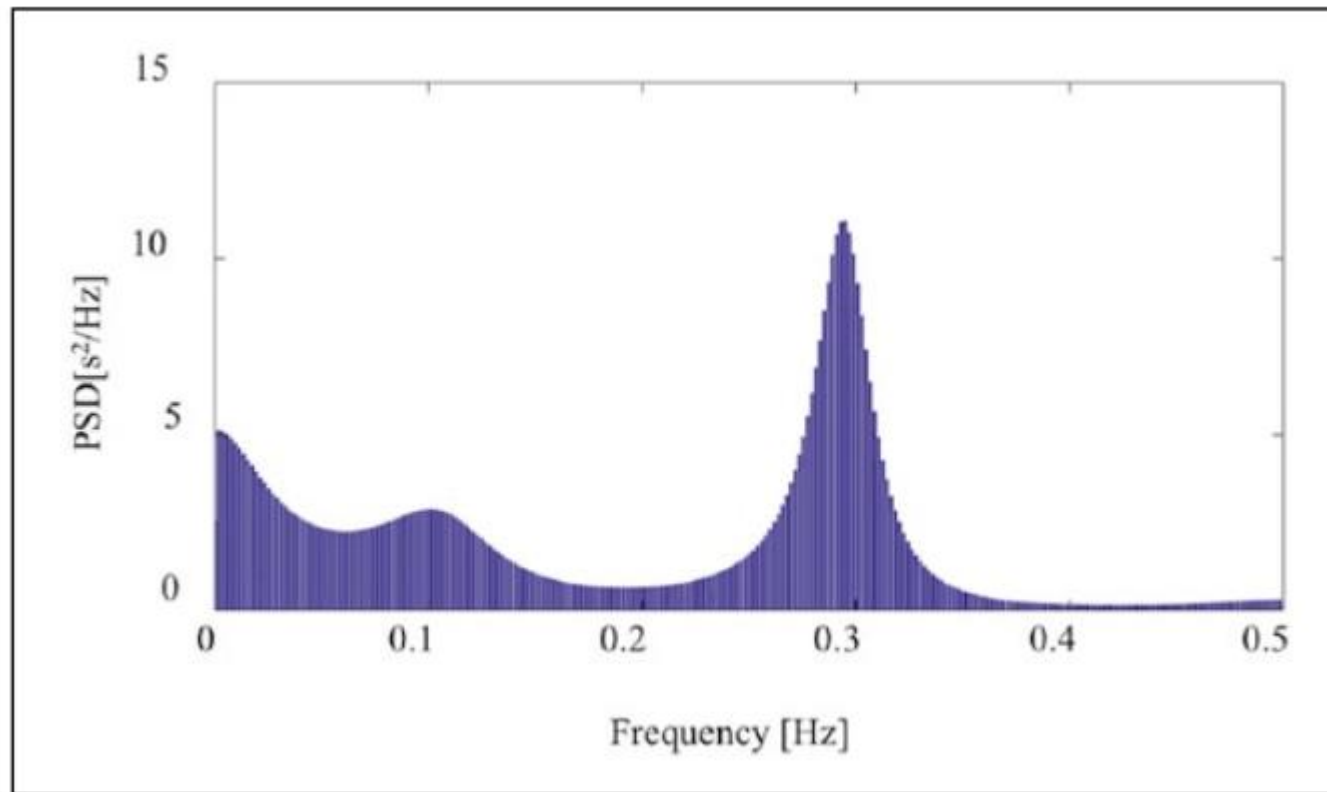
- A new easy model for monitoring the sleep stages is built on only heart rate calculated by the electrocardiogram.
- This enabled us to easily assess the sleep quality based on five stages.
- This experiment included a total of 50 subjects.
- The overall accuracy in determining the five sleep stages was **66.0 percent**.

Parameters (RRI)

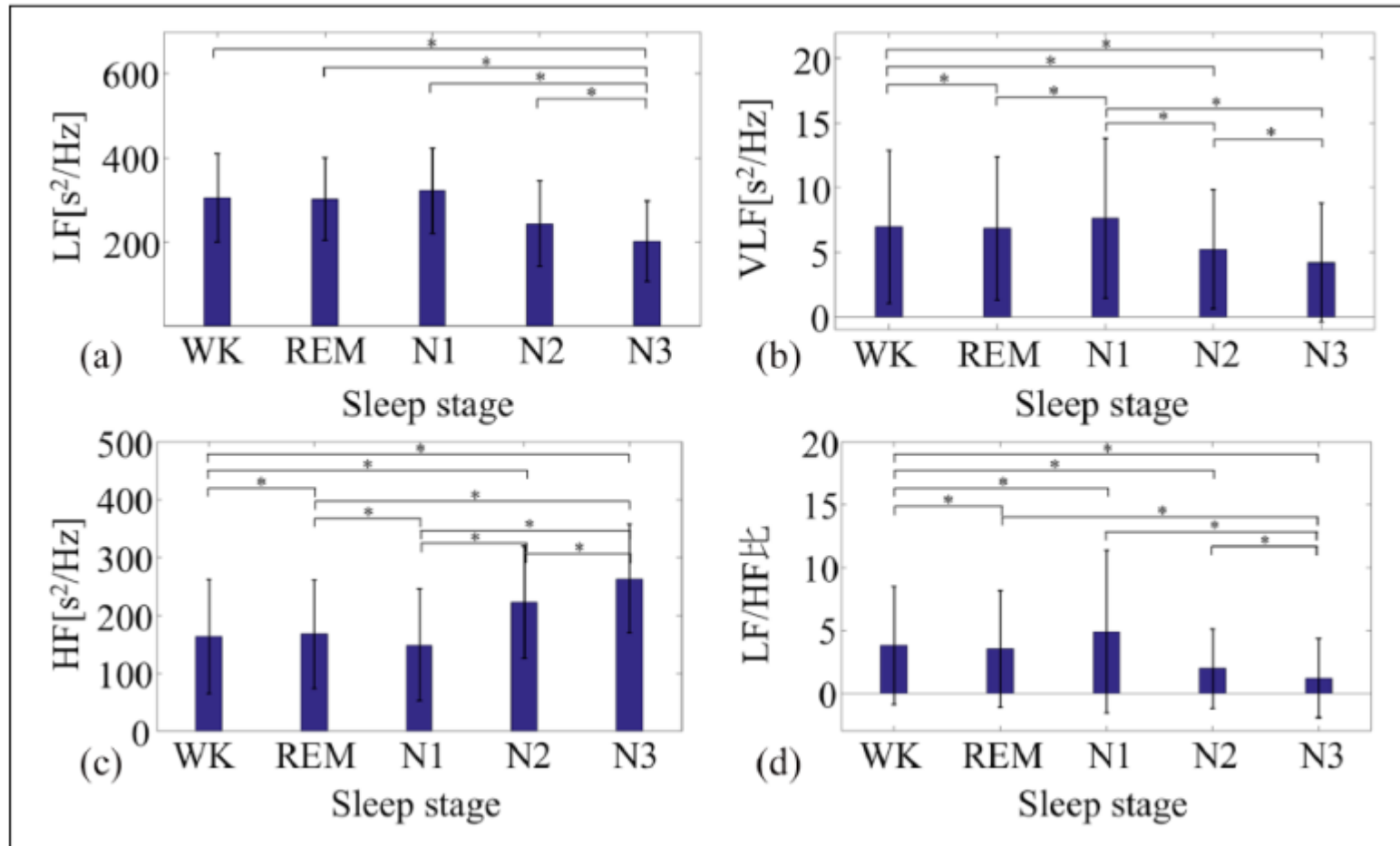
- Preprocessing and calculation of the ECG R-R interval
- Calculation of the R-R interval
- Calculation of VLF, LF, and HF by the power spectral density



power spectral density (PSD)



LF, HF, VLF, and LF:HF features



classification

- Recurrent neural network (RNN)
- Hidden Markov model (HMM)
- Neural network (NN)
- Support vector machine (SVM)
- Random forest (RF)

Leave-one-out cross validation with one subject as the test data and the remaining subjects as the training data was performed to evaluate the classifier

Results

Table 3. Comparison of the proposed method with previous studies.

Sleep stage recognition rate (%)						
Methods	WK	REM	NI	N2	N3	Overall
NN	13.5 ± 12.4	31.7 ± 27.9	3.9 ± 5.9	77.4 ± 23.1	11.6 ± 27.1	50.3 ± 12.0
SVM	0.6 ± 1.6	7.1 ± 22.7	0.0 ± 0.0	98.9 ± 1.9	5.4 ± 22.9	55.1 ± 8.2
RF	8.5 ± 7.4	25.6 ± 21.5	2.7 ± 4.3	88.0 ± 9.6	6.7 ± 22.8	53.8 ± 8.6

NN: neural network; SVM: support vector machine; RF: random forest; WK: arousal; REM: random eye movement.

Table 4. Comparison of the proposed method with previous studies.

Methods	Bio-signal	Subjects	Stage	Recognition rate (%)
Proposed	ECG	50	4	72
			5	66
Isa et al. ³³	ECG	16	4	60
Tanida et al. ³⁰	ECG	22	4	56
Fonseca et al. ³¹	ECG, RIP	48	4	69
Willemen et al. ³²	ECG, RIP, ACT	85	4	69

ECG: electrocardiogram; RIP: respiratory inductance plethysmography; ACT: actigraph.



END