NEUROSPEC
Research Neurosciences

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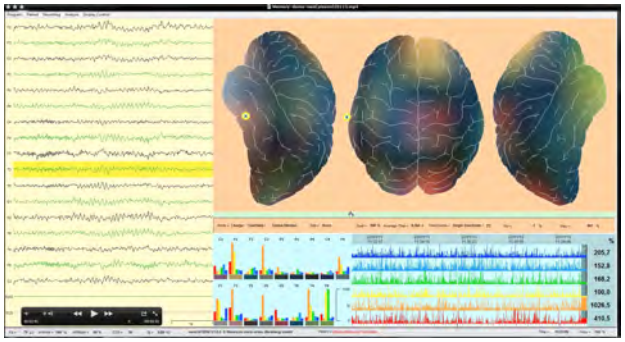
neo-CATEEM®
EEG-based Neuro-Imaging



Cortical distribution of spectral frequencies during performance of a memory test with selective spectral theta wave increases (sweep length 364 ms).

Since Hans Berger`s discovery of human electric brain waves, evaluation and interpretation of what he called an “Elektroenkephalogramm” (EEG) has remained a challenge to neurologists and brain researchers up to date. Already in 1932, Dietsch and Berger suggested quantitative frequency analysis of the signal. But, every day practice had to await help from computers in order to manage the needed mathematical transformation called Fast Fourier Transformation (FFT) resulting in a quick and objective description of the EEG. Computer aided on-line construction of electric brain maps now allows to follow brain activity in real time. The software package CATEEM® - developed with proprietary computer systems about 20 years ago – has now been translated to run under the operating system Windows® as neo-CATEEM®. Nearly 3 maps per second are delivered for example during fast mental activities (s. figure). This opens the door for psychophysiological research for example in combination with eye tracking as well as for neurological diagnosis. Recording from 16 physical EEG channels corresponds to otherwise use of 64 electrode positions for mapping in conventional EEG settings.

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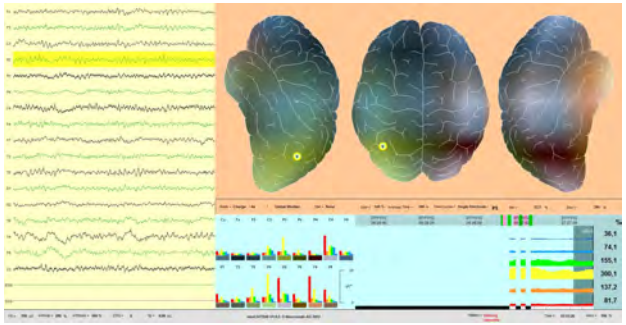
neo-CATEEM® in Neurology

There is a long history of use of EEG in Neurology. But up to now in most cases assessment is only performed by visual inspection of the raw EEG curves. However, quantitative assessment definitely opens a wider horizon of interpretation. Comparison of the individual patient data to a date base containing several hundreds of normally functioning brains allows for discovering even small deviations of electric power within 6 frequency ranges. This also applies for assessment of psychiatric diseases.



Documentation of a patient suffering from cerebral bleeding in the parietal lobe. Raw EEG is depicted on the left side. Mapping shows very high alpha activity in parietal area. Electric power (μV^2) is presented as bar-graph for each electrode position in the lower middle part of the figure. Time course of changes is shown for all frequencies at one pre-selected electrode position (P3) at the right lower part of the figure. Based on spectral frequency deviations from normality a rational therapeutic trial might be tried with drugs whose influence on brain electricity is known to change alpha activity.

Dimpfel W. Spectral Signature of Time Averaged EEG Source Density During Brain Disease in Comparison to a Norm Database of 300 Healthy subjects.

ICNE 2012 2nd International Congress of Neurology & Epidemiology, Nice, France.

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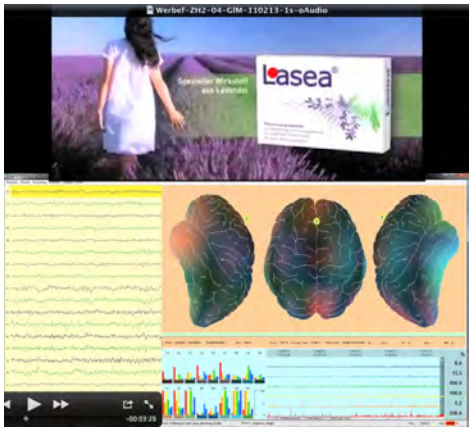
neo-CATEEM® in Market Research

The biggest advantage of conventional EEG recording is the high time resolution, with which data can be gathered from different brain areas. Unfortunately, the raw signal cannot be interpreted in an objective reproducible manner. The most common way to achieve quantitative assessment is spectral frequency analysis by use of Fast Fourier Transformation (FFT). We recently discovered a method of documentation of ultrafast periods of 364 milliseconds. This has opened a new dimension of quantitative EEG analysis. Corresponding numerical values together with a brain map are now called an “Enkephaloglyph”. The map contains frequency ranges coded into spectral colors, which are presented as an additive color mixture. An example of such a short time period of EEG recording is documented during an eye-gaze on a TV commercial. The new approach of high time resolution quantitative EEG will enable us to set up a library of enkephalo-glyphs of brain electric activity related to individual mental reactions (memory!) or emotions.



Dimpfel W. Simultaneous Eye Tracking and Fast Dynamic EEG Current Source Density Imaging for Assessment of Commercials or Websites.

6th European Conference on Eye Movements ECM 2011, Marseille, France.

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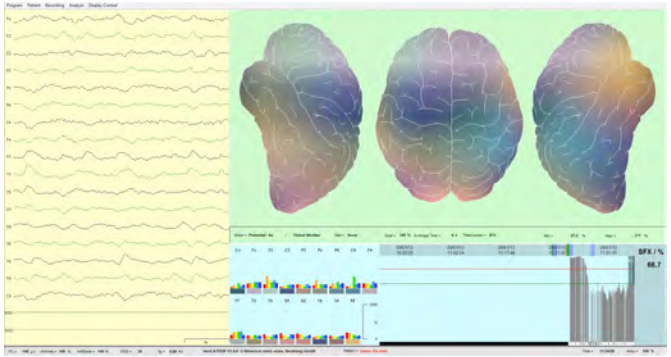
neo-CATEEM® during Sleep

Due to a newly developed world wide patented index of depth of sleep, which was developed at the end of the nineties, new objective assessment of sleep became available (Dimpfel, 1998). It is based on the relationship of theta and beta frequencies of the EEG and depicts depth of sleep between 35 and 100%. Sleep starts at about 80%. This sleep index – also called sleep frequency index (SFX) or "Hypnax" – was validated against the gold standard of Rechtschaffen and Kales. Meanwhile this approach has proven to be more sensitive and better suitable to characterize drug effects in comparison to the historical but still widely used analysis by Rechtschaffen and Kales (Rechtschaffen and Kales, 1968). The time course of sleep - also called an Electrohypnogram - is depicted according to depth of sleep not longer as a stairway but – more physiologically – as a continuous change of deeper and flat sleep.



Time Course of depth of sleep during carotid surgery (grey bars). The lower the % value on the right ordinate the deeper the sleep.

References

Dimpfel W. Enkephaloglyphen. Spektrale Signaturen der elektrischen Hirntätigkeit als Spiegel der Psyche, Bod Verlag, Norderstedt, 2011.

Dimpfel W, Suter A. Sleep improving effects of a single dose administration of a valerian/hops fluid extract. A double blind, randomized, placebo-controlled sleep-EEG-study in a parallel design using the electrohypnogram. Eur J Med Res. 2008; 13: 200-204.

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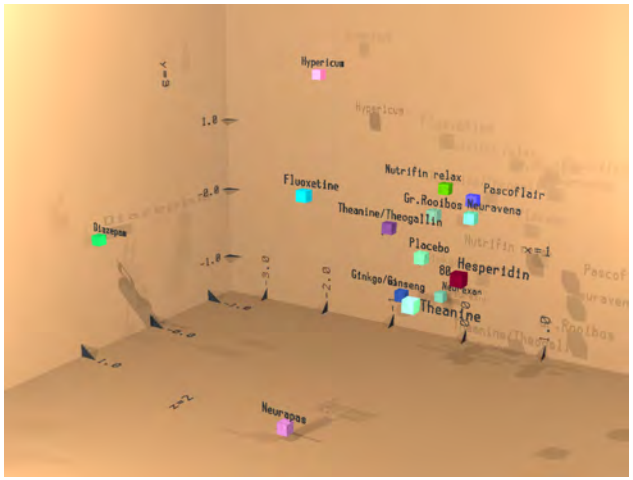
neo-CATEEM® in Pharmacology

Quantitative assessment of drug action has been followed now for about 20 years with CATEEM®. Spectral frequency changes in different brain regions are calculated and fed into a linear discriminant analysis (17 brain regions x 6 frequency ranges = 102 variables). The results are displayed by means of a 6-dimensional plot:



Result of the first three functions is coded into space (x, y and z axis), results from next three functions into color (RGB mode like used in TV). Drug action is now discriminated according to differences in change of spectral frequencies as determined by source density evaluation of the quantitative EEG (Results from this type of assessment correspond to those of Magnet-encephalography). Similar drug action is recognized by close neighborhood and similar color (This kind of evaluation is not part of the commercially available software package). Thus, during clinical studies dose as well as time dependent changes of electric brain activity can be monitored.

Dimpfel W, Koch K, Weiss G. Early Effect of NEURAPAS® balance on Current Source Density (CSD) of Human EEG. BMC Psychiatry 2011; 11:123.

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neo-CATEEM® Software

Special features of neo-CATEEM®:

- Pattern of all frequency changes is documented within one single map.
- Highest time resolution is sweep length of 364 milliseconds to produce one map.
- Online moving average possible up to 3 minutes for neurological diagnosis.
- Automatic comparison of 102 EEG parameters to data-base containing several hundred healthy brains.
- Data are recorded and documented in a voltage mode or surface charge mode (source density, results correspond to magnet-encephalography).
- Power within six specially defined frequency bands reflects changes of particular neurotransmitter action.
- Continuous measurement of depth of sleep by a patented algorithm.

The calculated results offer:

- Topographical online real-time representation.
- Chronology of the frequency changes.
- Electrical power in μV^2 or as global median presented as bargraph for each electrode position.
- Parameter SFx (Sleep Frequency Index) for determination of the depth of sleep (patented algorithms).

Neo-CATEEM® has been adapted to different amplifiers. There are more than 80 publications in international journals based on use of CATEEM®.

Further information or download of the program neo-CATEEM® can be obtained from:

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