

Neuronal Abnormality Topography

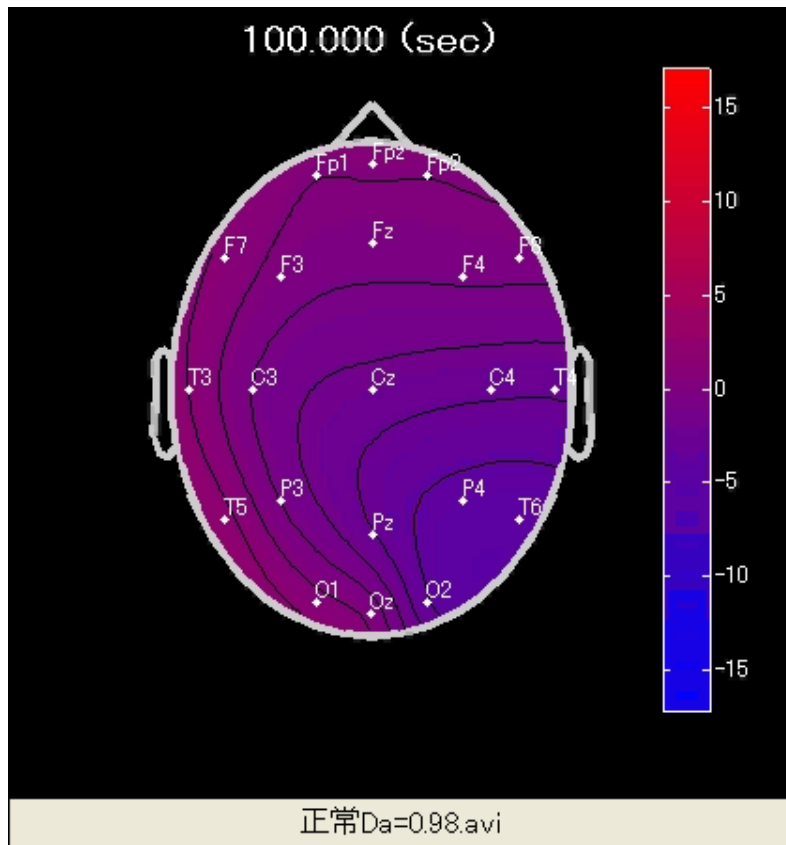
A new imaging tool of brain disorders

Brain Functions Laboratory, Inc.

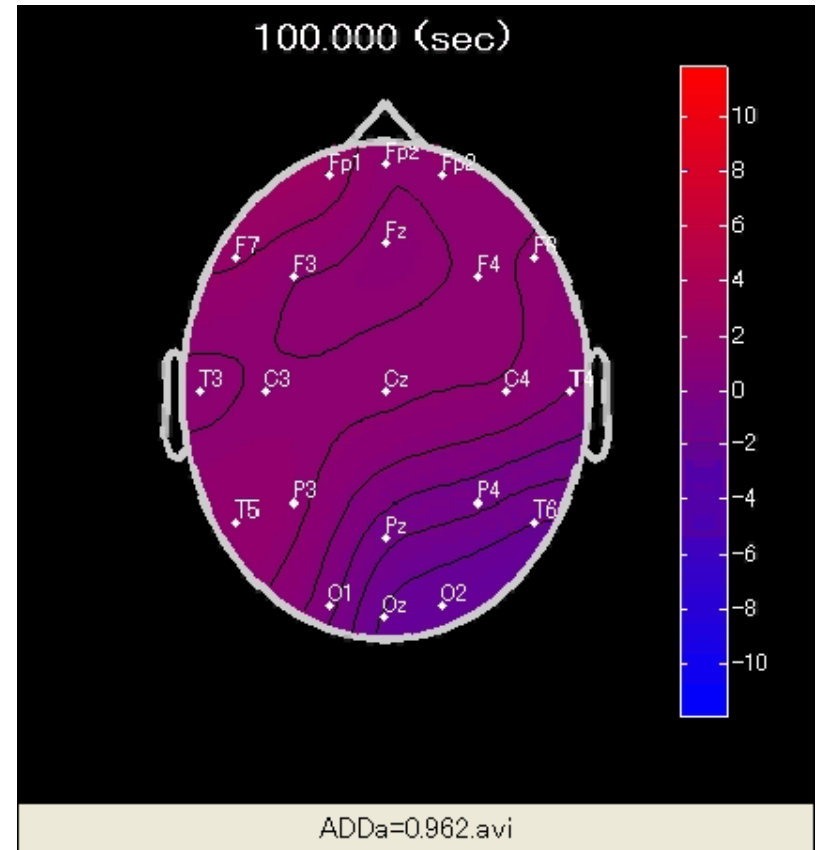
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Dynamic behavior of electroencephalogram (EEG) recorded at 21 sites(Alpha component)



normal



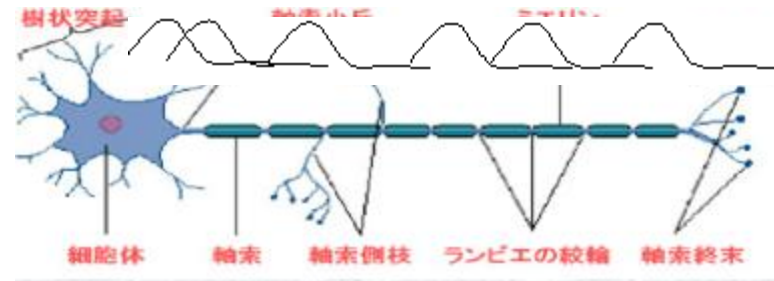
Alzheimer's disease

EEG is originated from neuronal discharges.

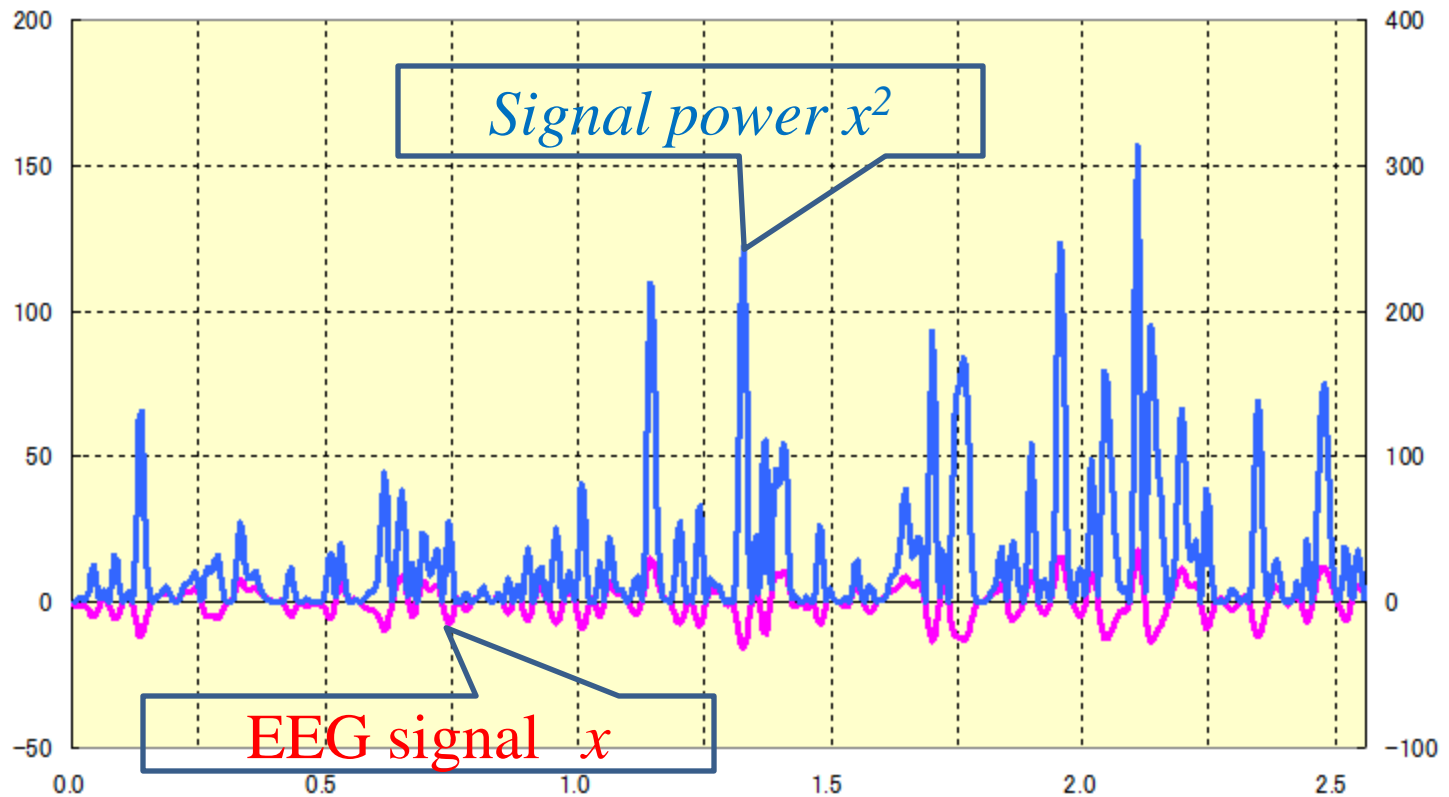
A sequence of action potential impulses forms EEG signals.

Neuronal discharge synchronization and its waveforms determine scalp potential waveforms.

Bio-signals are coded in neuronal discharge timings.



***Synchronous** neuronal discharges characterize power fluctuations or power variance of EEG signal x .*



$$\text{Normalized power variance (NPV)} = \frac{\langle (\text{voltage})^4 \rangle - \langle (\text{voltage})^2 \rangle^2}{\langle (\text{voltage})^2 \rangle^2}$$

$$z \text{ score} = \frac{NPV_{obs} - \langle NPV \rangle_{NL}}{\sigma_{NL}}$$

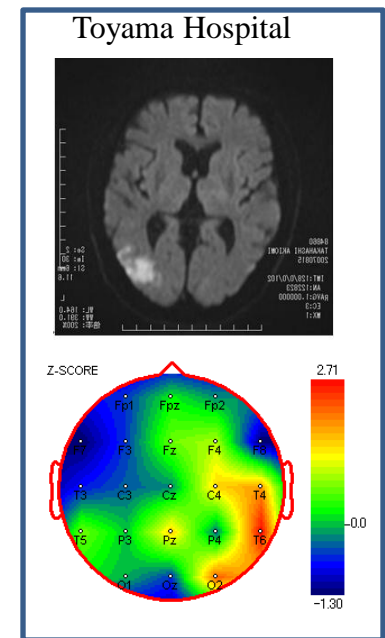
represents a deviation of an observed NPV_{obs} value from the mean $\langle NPV \rangle_{NL}$ of normal controls in units of its standard deviation σ_{NL} .

$z > 1$: abnormal synchronization of neuronal discharges.

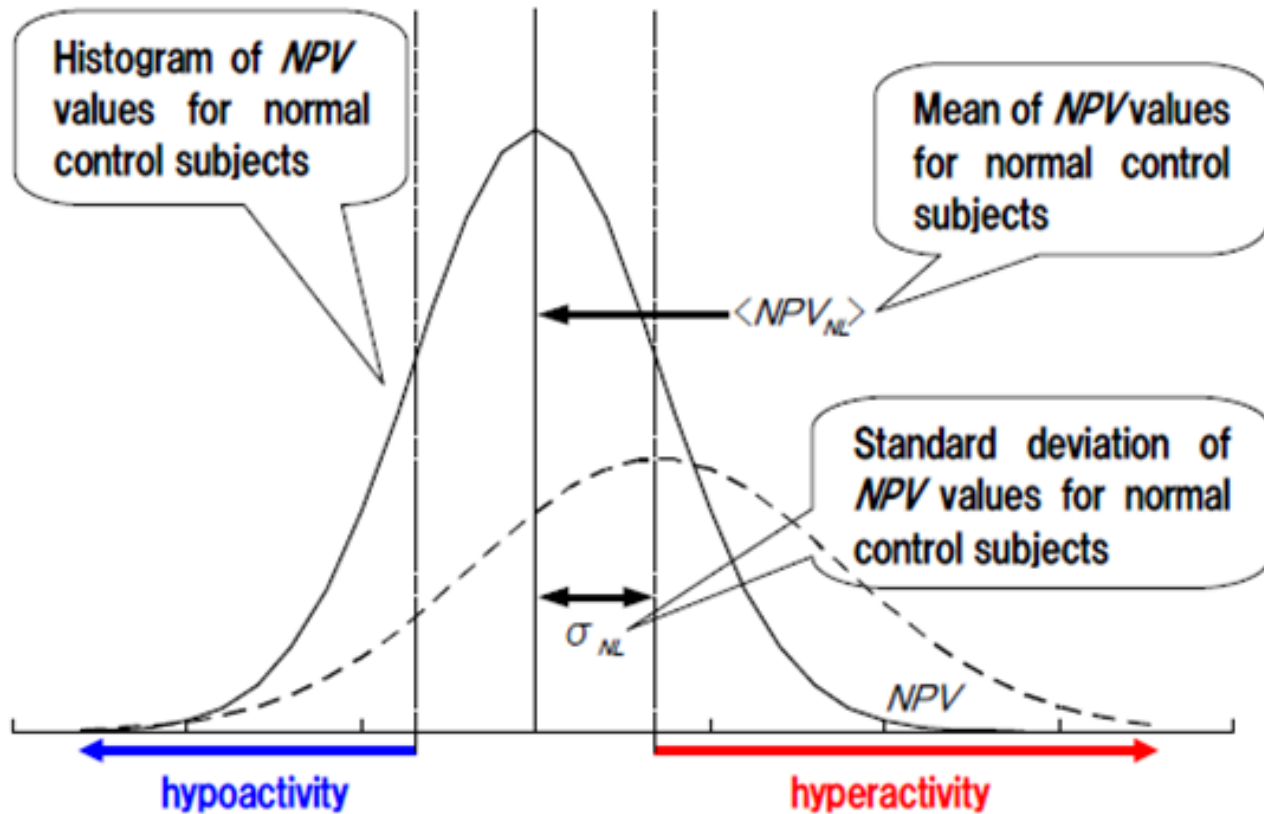
***positive case:** compensation for lost neuronal activities in cerebral infarction.*

***negative case:** epileptic seizure*

$z < -1$: abnormal desynchronization of neuronal discharges

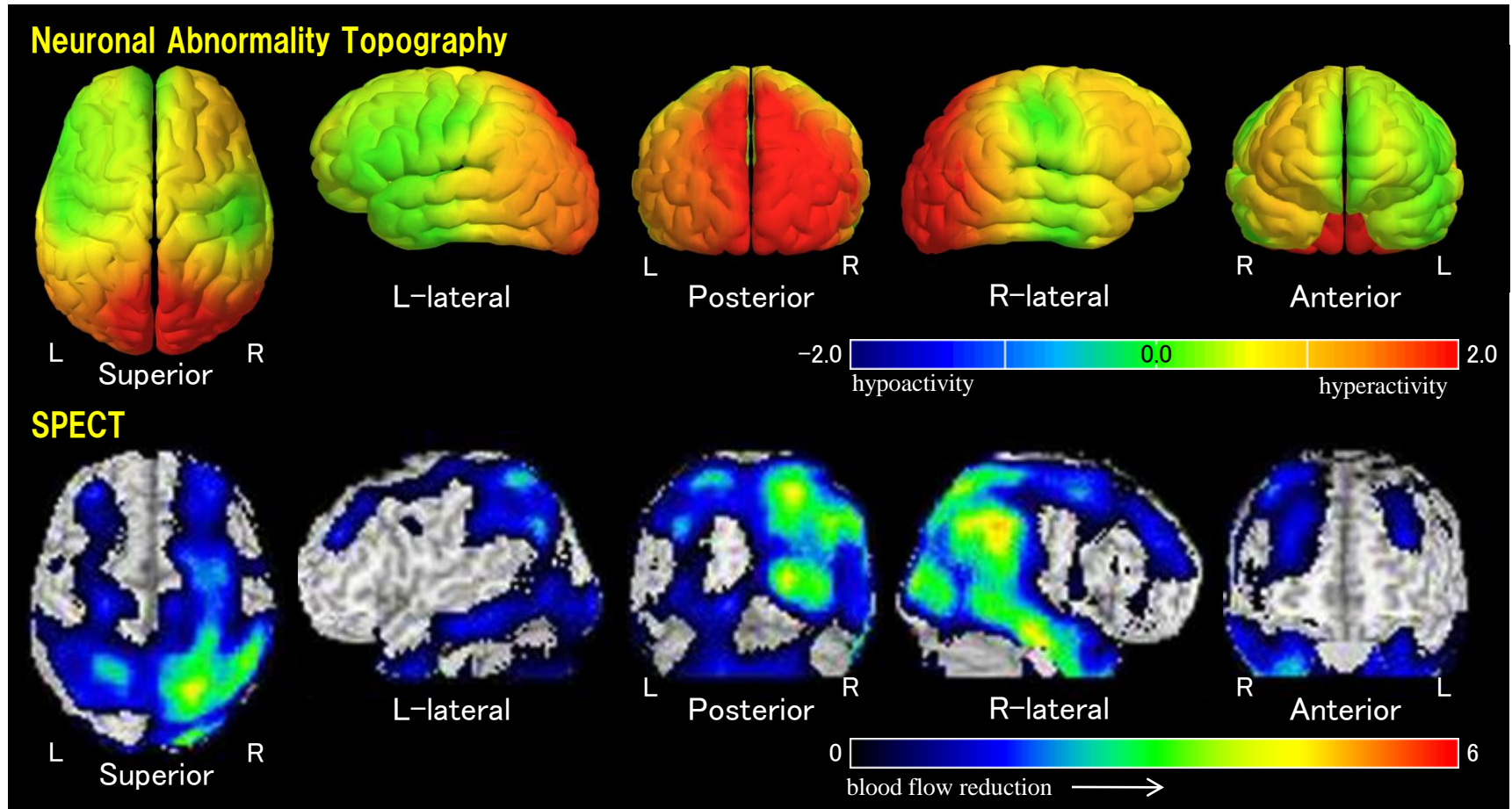


$$NPV_j \equiv \frac{\langle (\text{voltage})_j^4 \rangle - \langle (\text{voltage})_j^2 \rangle^2}{\langle (\text{voltage})_j^2 \rangle^2}.$$



Histogram of NPV values

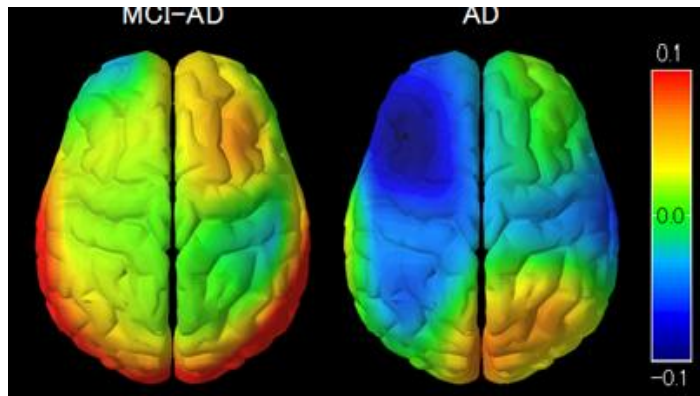
Comparison of neuronal abnormality topogram with regional cerebral blood flow reduction map of SPECT in an AD patient



FINDING: *In AD (Alzheimer's disease) patients, regional cerebral blood flow reduction is associated with **hyperactive** or **hypoactive** neuronal abnormalities.*

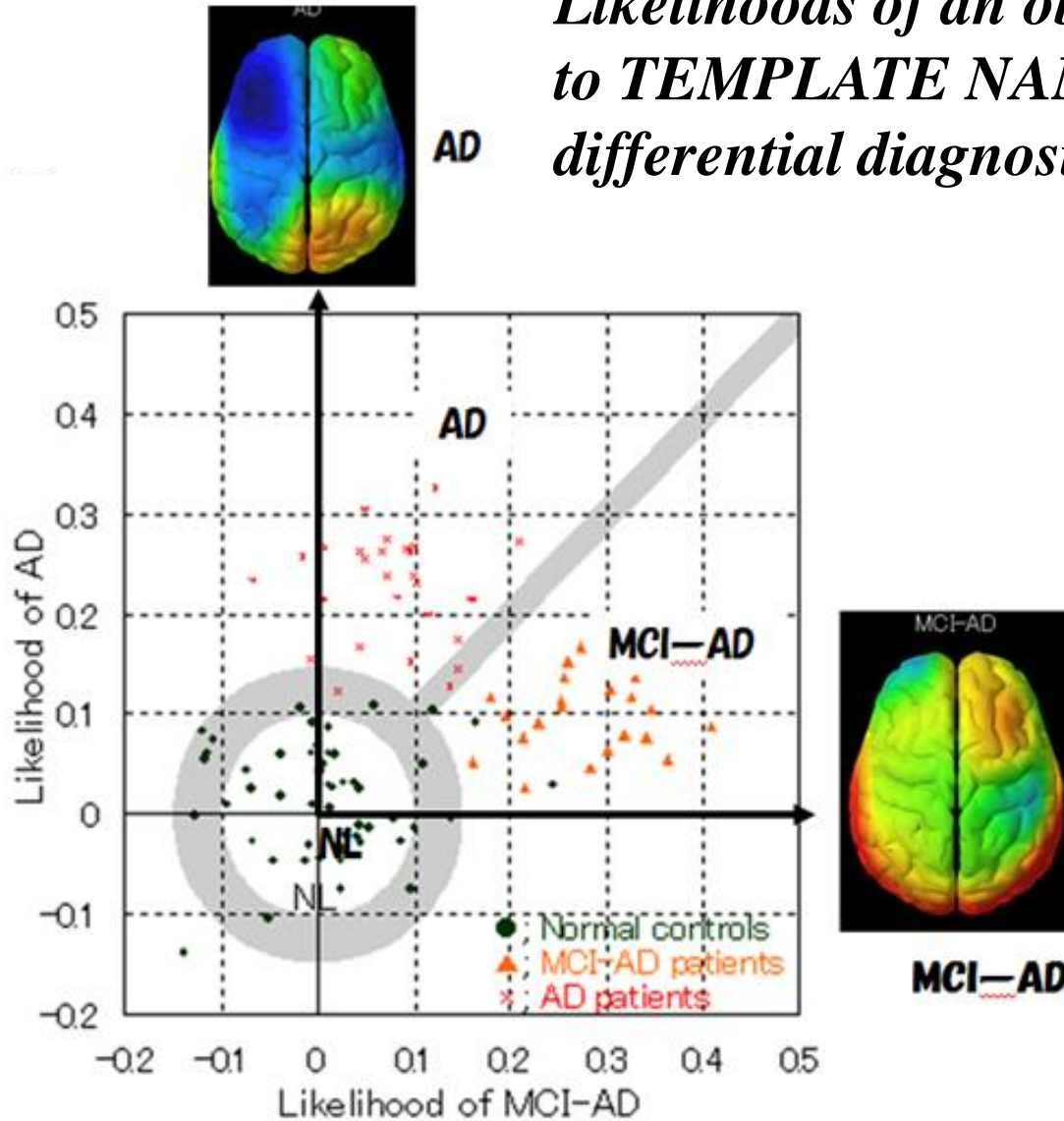
Initial stage of AD: mostly in neuronal hyperactivity.

Advanced stage of AD: mostly in hypoactive neuronal abnormality.



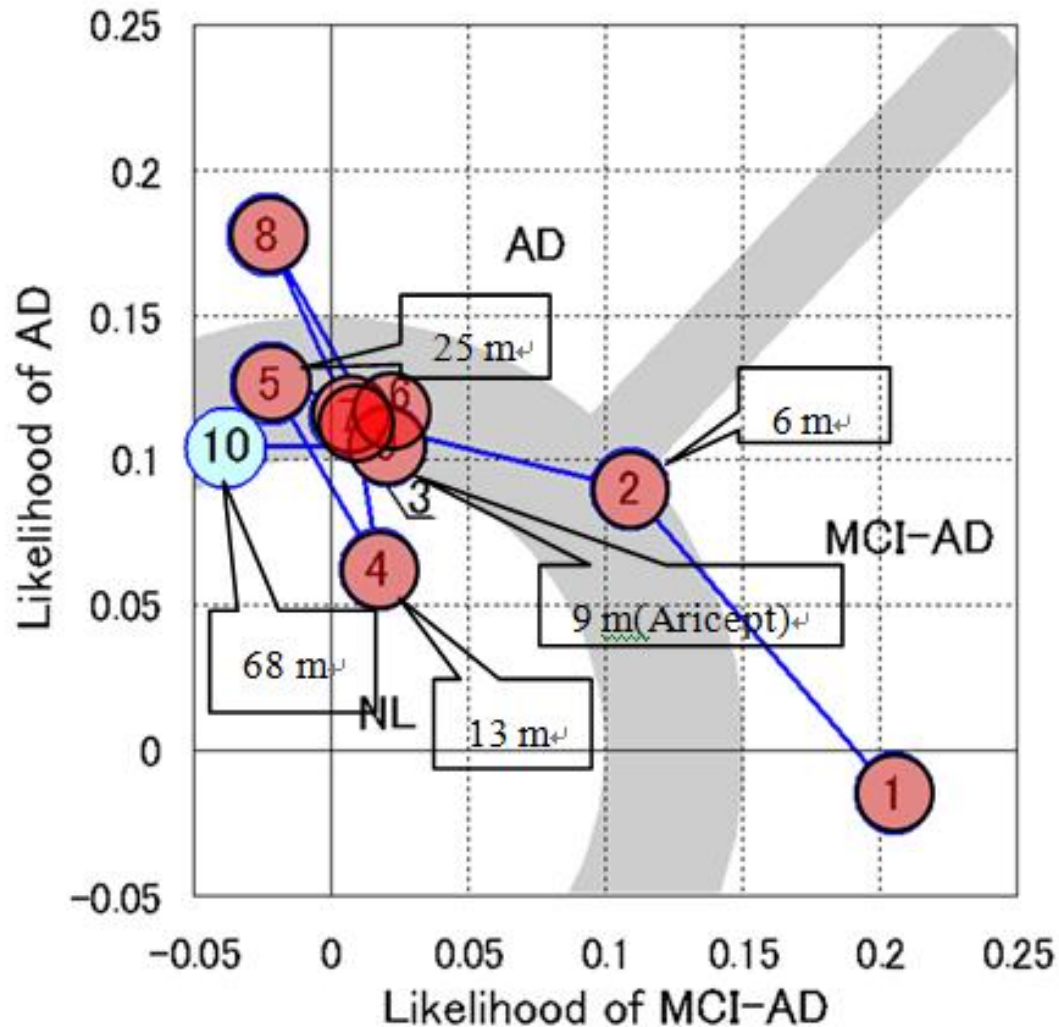
Template NAMs (Neuronal Abnormality Maps) for MCI and AD

Likelihoods of an observed NAM to TEMPLATE NAMs lead to differential diagnosis.

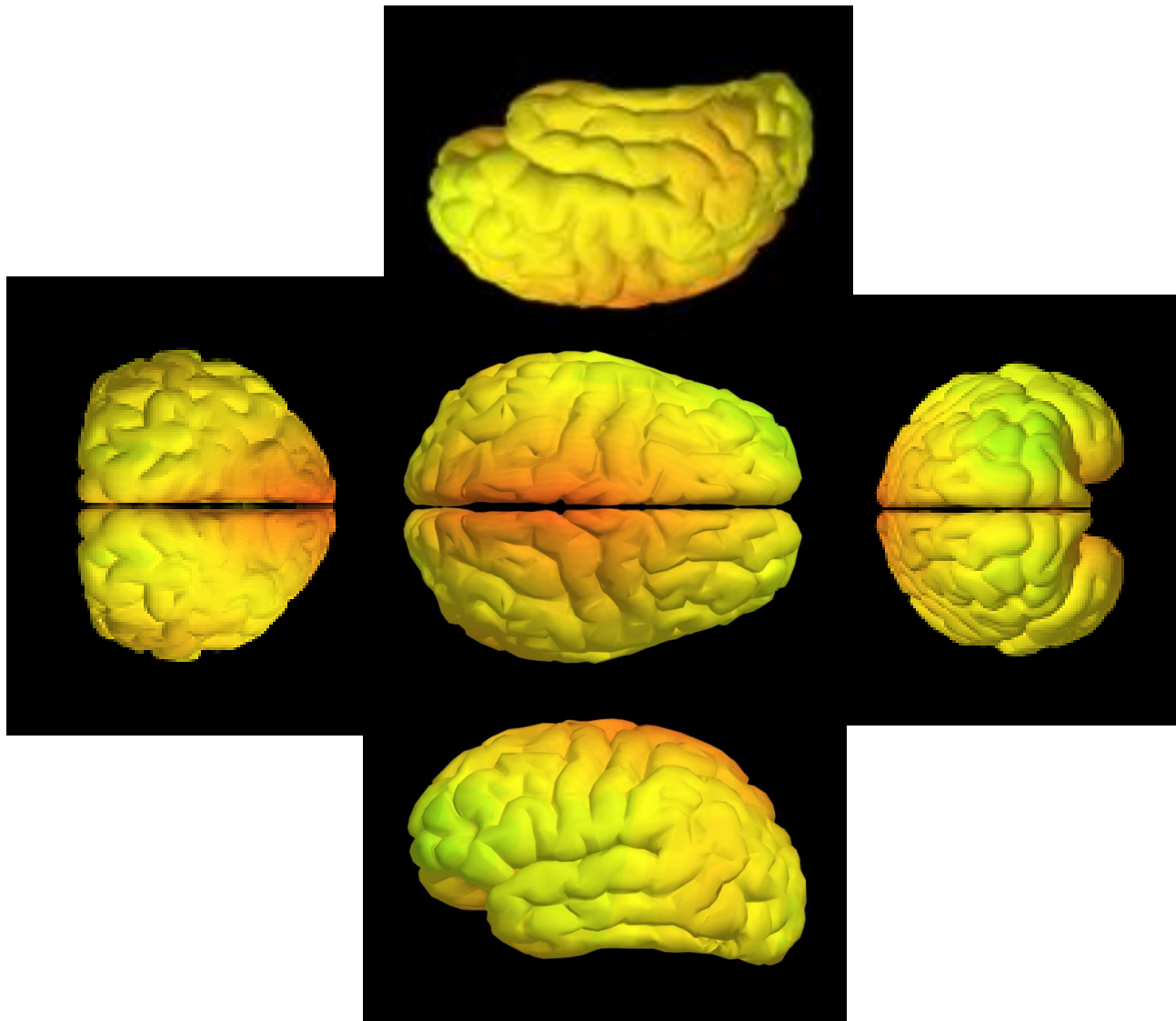


Likelihood Diagram

Longitudinal observation from MCI to AD for 68 months
(Kurashiki-Heisei Hospital)

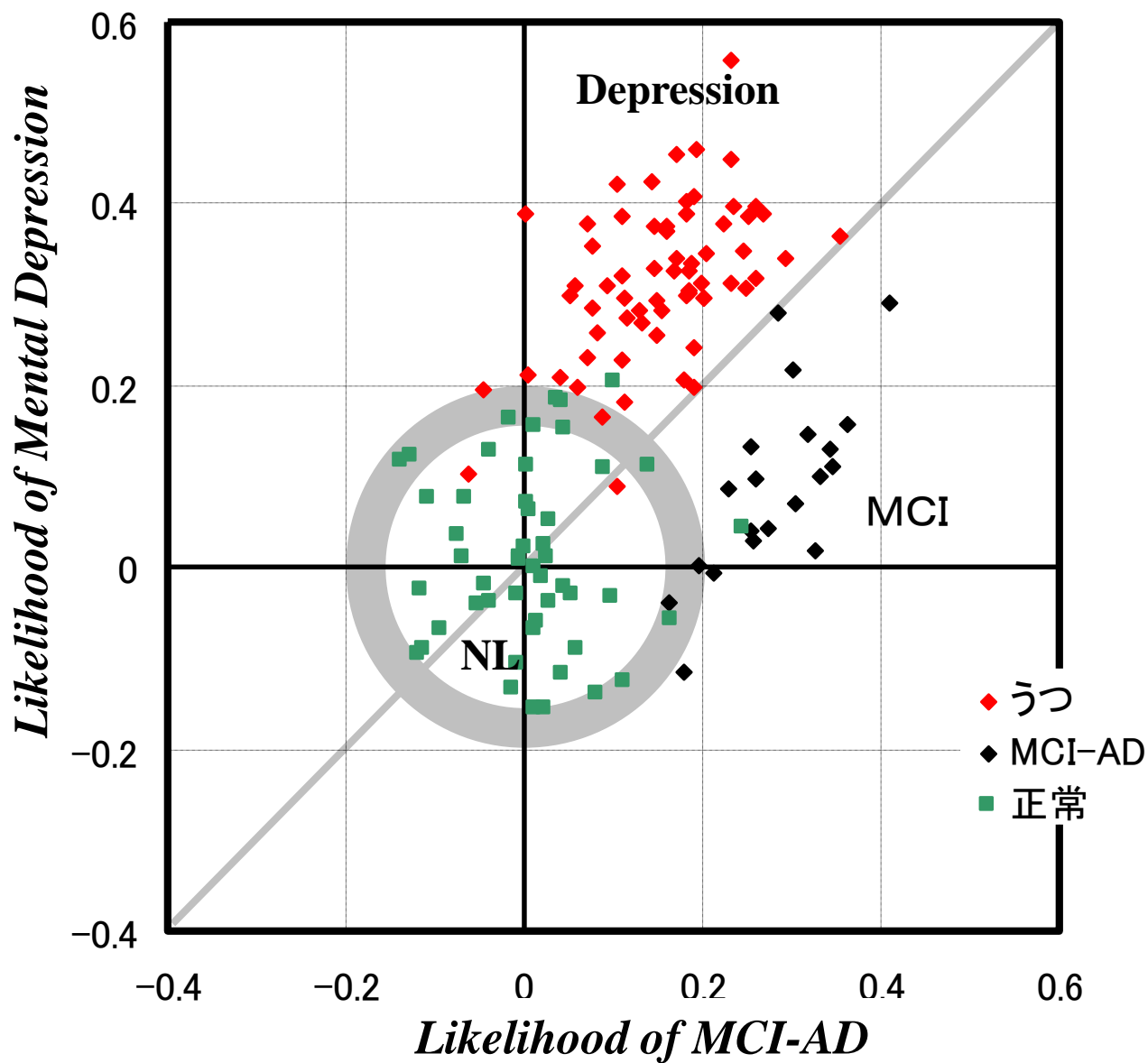


Template NAM for early stage of mental depression
(Kudoh-Chiaki Clinic)



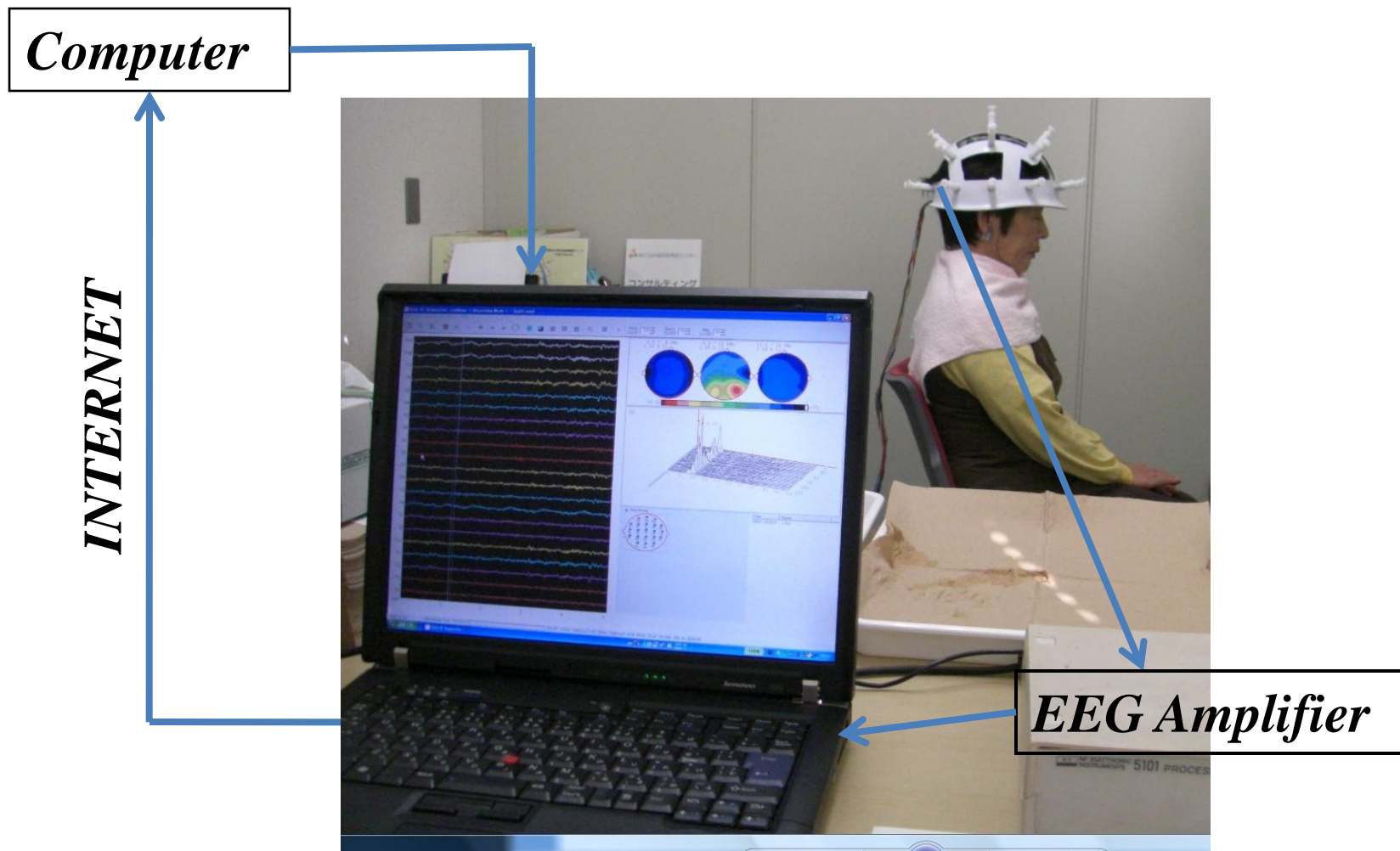
Likelihood Diagram for Mental Depression and MCI-AD

(Kudoh-Chiaki Clinic + National Center of Neurology & Psychiatry)



EEG Analysis for NAT

(15~20 minutes)



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