Neuroscience and Smart Aging

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Background: Animal Researches

Researches on the micro-architecture of the cerebral cortex to understand neuro-vascular coupling

Two Photon Laser Scanning Microscope

Multi-Channel Electrophysiological Set-up
Background: Human Researches

Background: Human Researches
Our Research Facilities

3T-MRI: Philips Intera Achieva 3.0T Quasar Dual

- Precise Anatomy
- Fiber Tracking
- Mapping of Individual Brain Function
Our New Research Facilities

Wearable NIRs

日立基礎研究所試作機 An Experimental Model by Advanced Research Laboratory, Hitachi Ltd.
NIRs Measurement during Driving Motorcycle
Examples of Industry-University Joint Research

-Development of new intervention and prevention methods for senile dementia-
Mental-Exercise Hypothesis

• The rate of age-related decline in measures of cognitive functioning will be less pronounced for people who are more mentally active, or, equivalently, that the cognitive differences among people who vary in level of mental activity will be greater with increased age.
Hypotheses from Brain Science

- Importance of the Prefrontal Cortex

1) Verbal and non-verbal communication
2) Logical thinking
3) Working memory
4) Control, especially inhibition, for behavior
5) Control for emotion
6) Intention
7) Attention
8) Initiation
9) Learning

The prefrontal cortex plays extremely important roles in keeping our daily life healthy and happy.
Changes of Neuropsychological Measures during Aging

Cognitive tasks require semantic knowledge

Cognitive tasks required prefrontal functions

Modified from Salthouse 2006
Randomized controlled trial on cognitive intervention in senile dementia Alzheimer type (SDAT) 
\( n = 32, \text{ mean age } 85.7 \)
Select Effective Tasks for Activating PFC

• Reviewing the previous functional brain imaging studies

• The task(s) must
  – activate bilateral PFC
  – be simple and easy

v.s. rest p < 0.05 (corrected)
Examples of Learning Materials
Case 3 (85 yrs Female: SDAT)
Showing dramatic changes after three month intervention
NIRs measurements

Prior to Intervention

One month after intervention

82 years old female, SDAT, MMSE 15, FAB 7
Each group consisted of 16 SDAT (Senile Dementia Alzheimer Type) patients diagnosed by DSM-IV.
Single blind, randomized controlled trial on cognitive intervention in community dwelling seniors
(n = 98, mean age 75.4, 70 to 86 y.o.)
Examples of Learning Materials

As for daily cognitive intervention, the subjects were asked to solve systematized basic problems in reading and arithmetic everyday for six months (Kawashima et al., 2005).
The participants in the experimental group were asked to come to class in two elementary schools near their place of residence once a week. The daily learning time for the two tasks was approximately 15 min.
RCT-healthy seniors
Changes in Neuropsychological Characteristics
(6M follow up)

Cognitive measure:
Mini-mental state examination (MMSE)
Frontal Assessment Battery at Bedside (FAB)
Digit symbol substitution test of WAIR-R (DST)
Analysis on active cohort study of elders (n = 323)
Psychological measures (6 M follow up)
In the Oogaki, Gifu project, 20 aged subjects who were diagnosed as MCI (mild cognitive impairment) participated. 18 subjects became normal after 6 month intervention program has been taken place.
• In 2007, our cognitive intervention system is used for daily care of dementia patients at more than 700 nursing homes, and for mental exercise of community dwelling seniors at 56 local governments.
Examples of Industry-University Joint Research

-R&D of Games and TV Programs-
Brain activity during playing video games

The most videogames do not activate the prefrontal cortex. In addition, they often deactivate the prefrontal cortex.
R&D of video game that can activate the prefrontal cortex

*Needs*
Company (e.g. Nintendo)
Game soft

*Seeds*
Tohoku University
Measure brain activity

We evaluated and made suggestions how to activate the prefrontal cortex using brain imaging techniques. This evaluation (scientific proof) added values to the game itself and made it mega-hit!
Beneficial Effects on Cognitive Functions by Nintendo DS Brain Training Games

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