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# Neuroscience and Smart Aging

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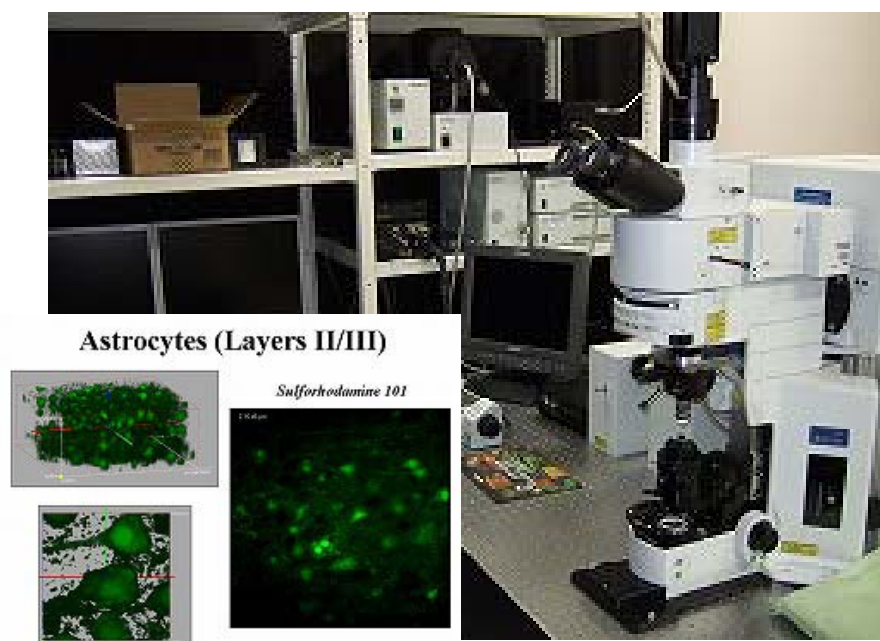
<http://www.fbi.idac.tohoku.ac.jp/fbi/>



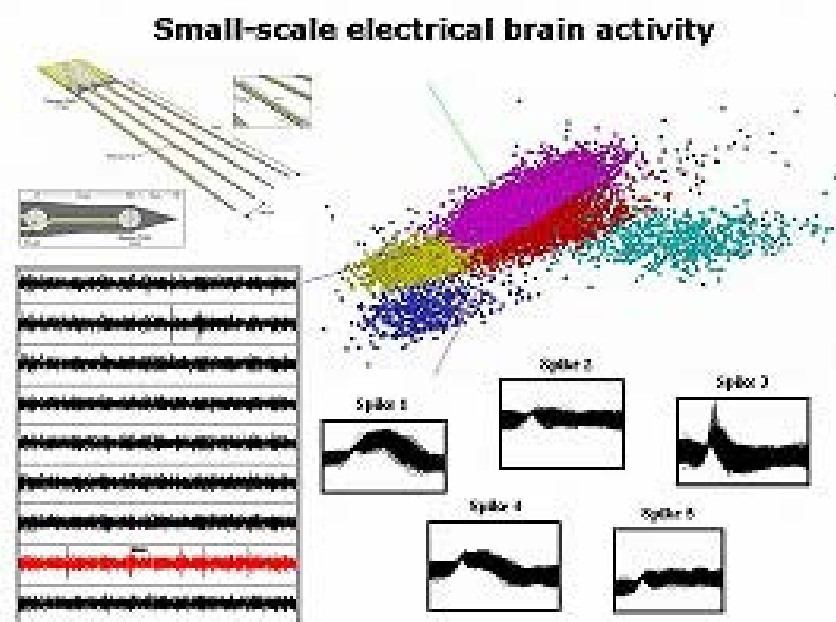
# Background: Animal Researches

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

## Basic Brain Science using Functional Brain Imaging Techniques



Functional MRI



Near Infra-red  
Spectroscopy (NIRs)



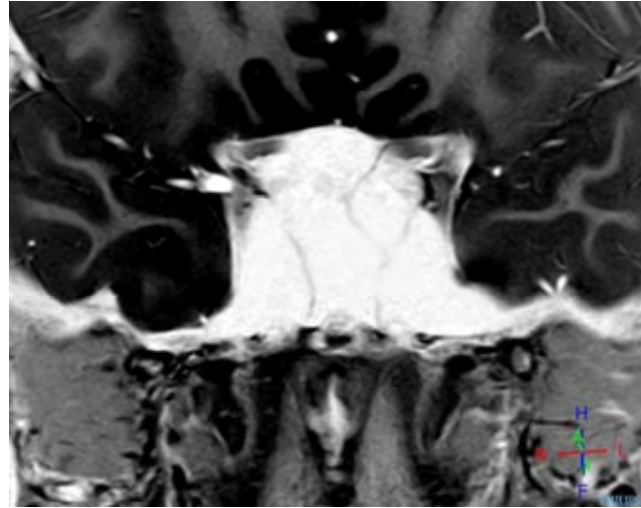
Multi-channel EEG

The final goals of our studies are to reveal functional organization of human brain involved in higher brain function, and to figure out the relationship between brain and mind.



# Our Research Facilities

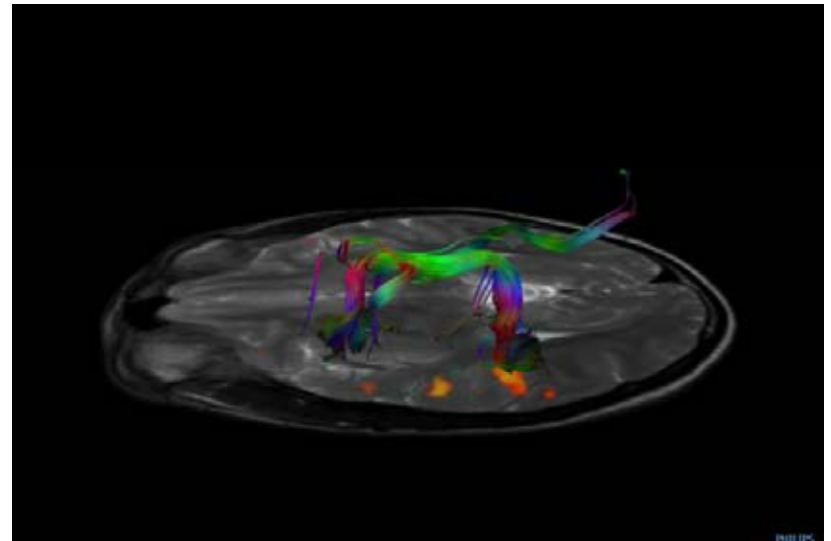
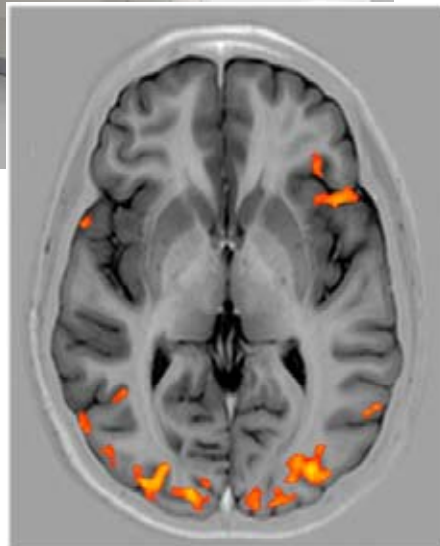
3T-MRI: Philips Intera Achieva 3.0T Quasar Dual



Precise Anatomy

Fiber Tracking

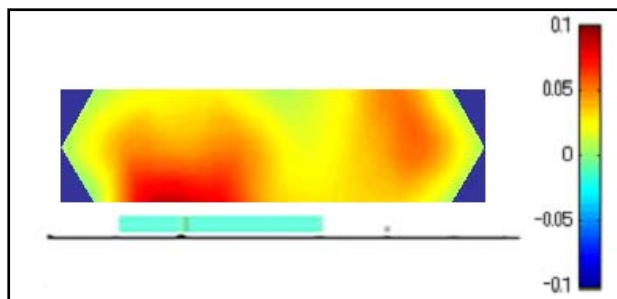
Mapping of  
Individual Brain  
Function





# 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.

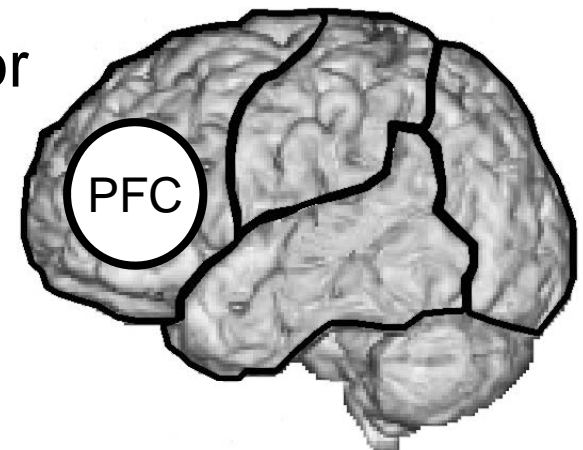




# Hypotheses from Brain Science

- Importance of the Prefrontal Cortex

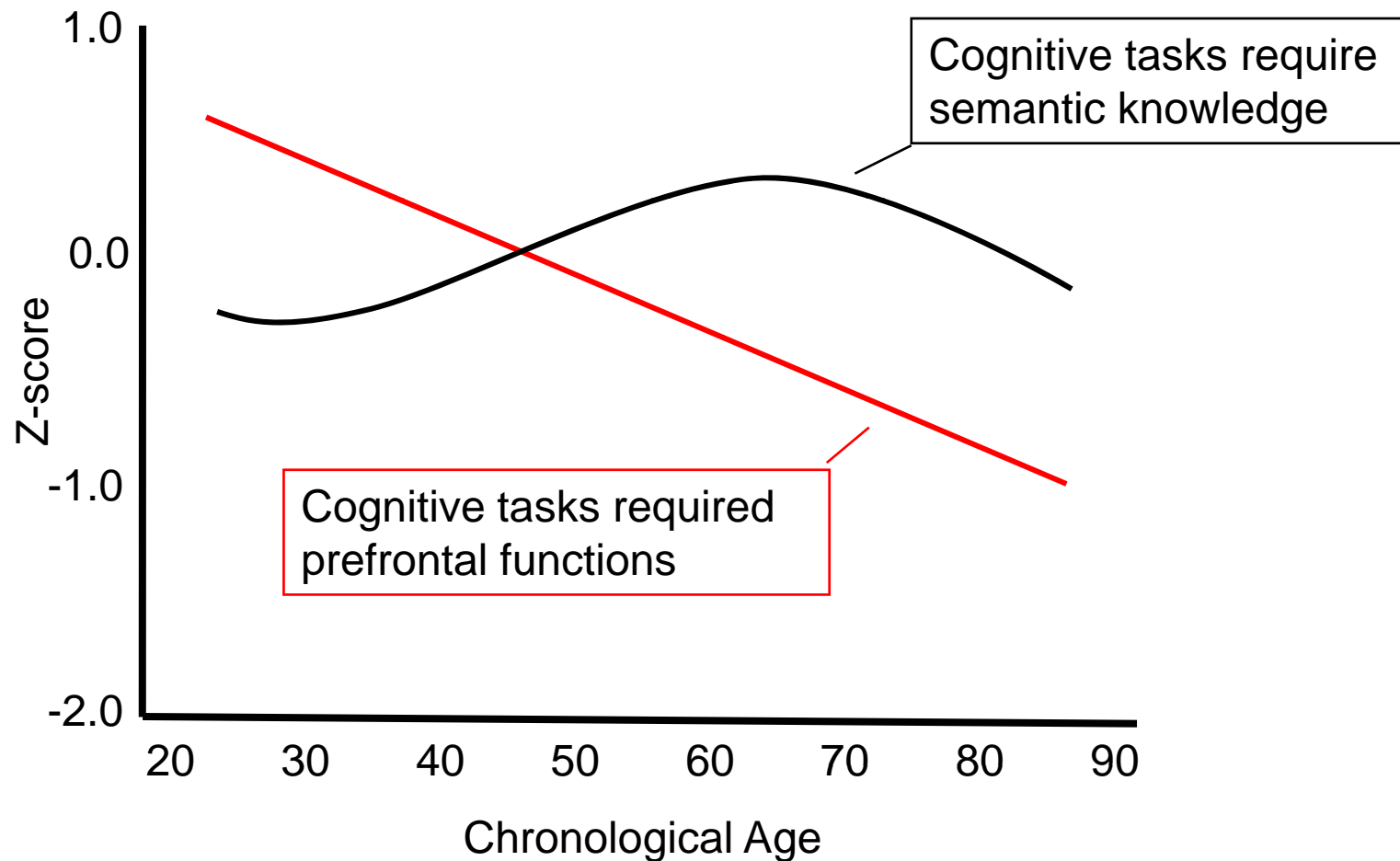
- 1) Verbal and non-verbal communication
- 2) Logical thinking
- 3) Working memory
- 4) Control, especially inhibition, for behavior
- 5) Control for emotion
- 6) Intention
- 7) Attention
- 8) Initiation
- 9) Learning



*The prefrontal cortex plays extremely important roles in keeping our daily life healthy and happy.*



# Changes of Neuropsychological Measures during Aging

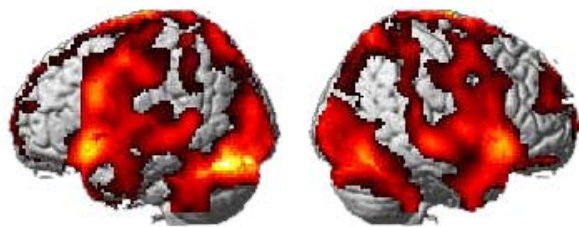


Modified from Salthouse 2006

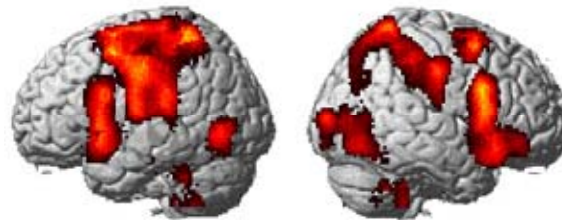
Randomized controlled trial on cognitive intervention  
in senile dementia Alzheimer type (SDAT)  
(n = 32, mean age 85.7)

# Select Effective Tasks for Activating PFC

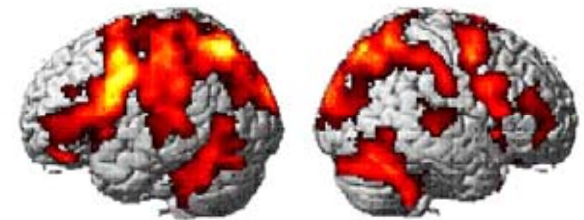
- Reviewing the previous functional brain imaging studies
- The task(s) must
  - activate bilateral PFC
  - be simple and easy



Reading aloud



Hand writing



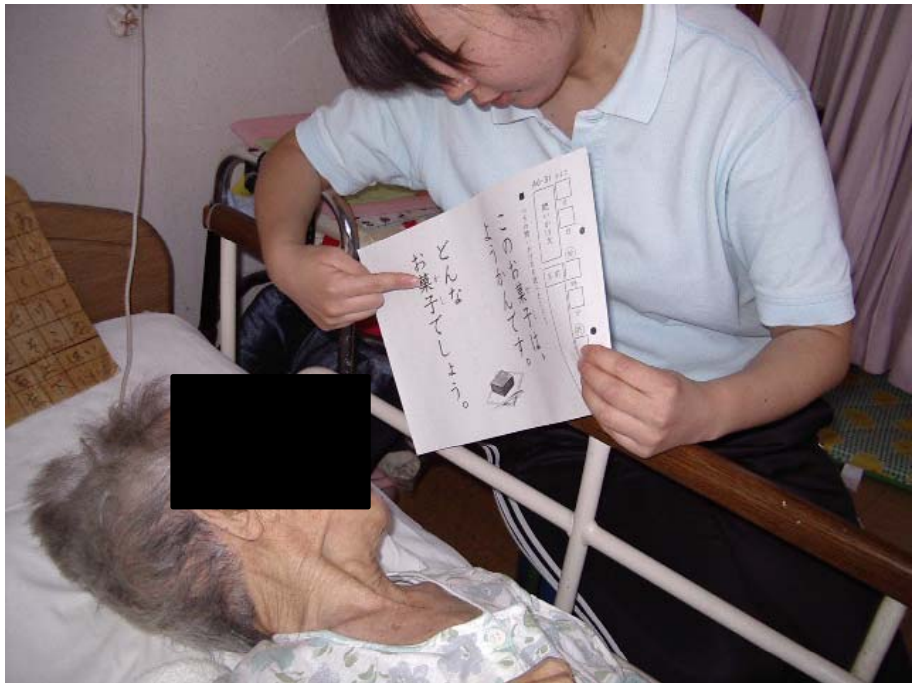
Simple arithmetic

v.s. rest  $p < 0.05$  (corrected)

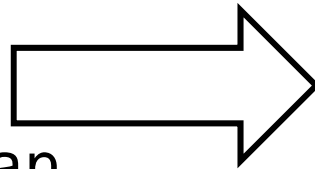
# Examples of Learning Materials



Case 3 (85 yrs Female: SDAT)  
Showing dramatic changes after three month intervention

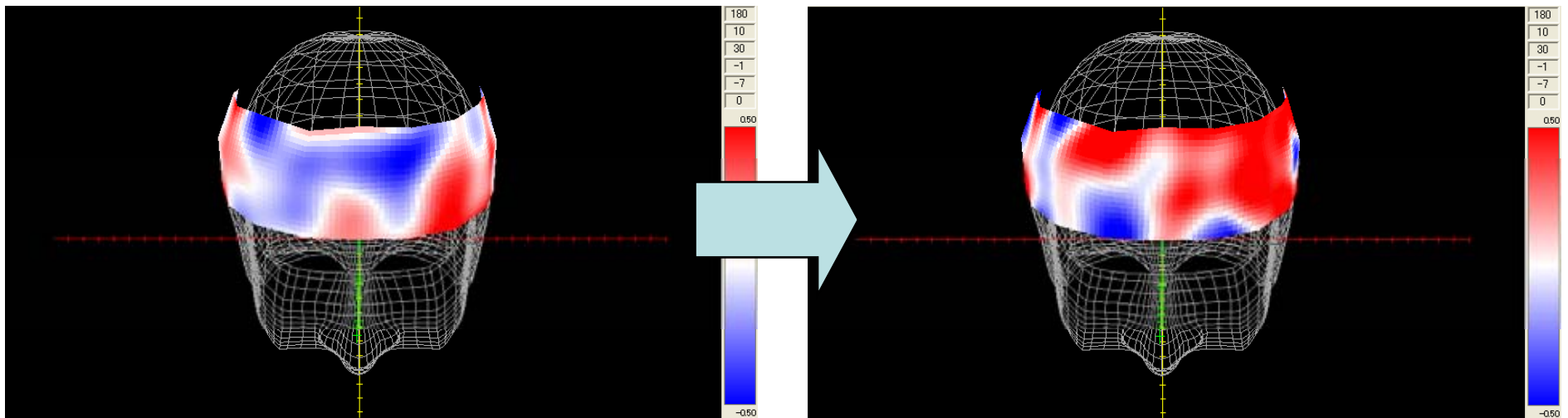


Jan. 2005  
(bedridden more than  
three years)



Mar. 2005  
(learning on the  
wheelchair)

# NIRs measurements



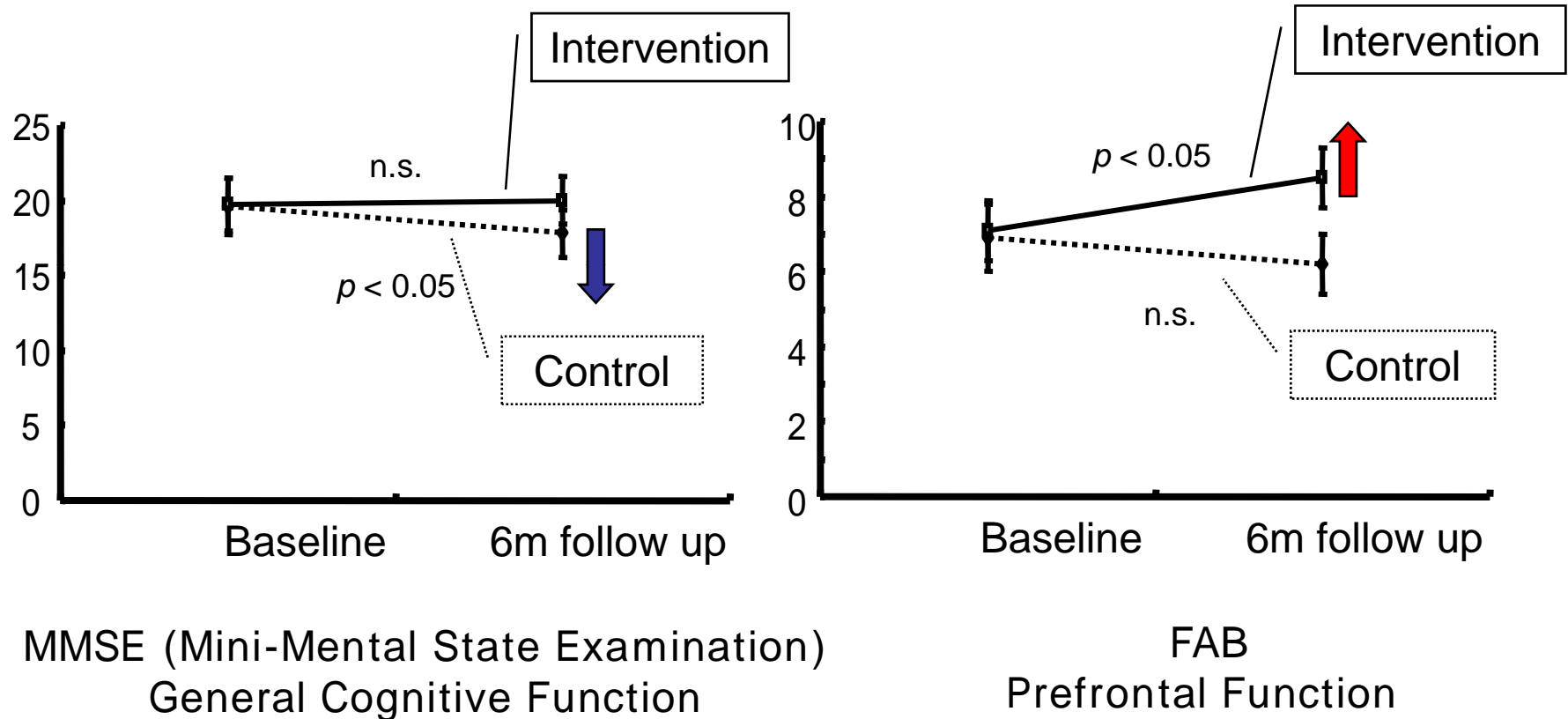
Prior to Intervention

One month after intervention

82 years old female, SDAT, MMSE 15, FAB 7



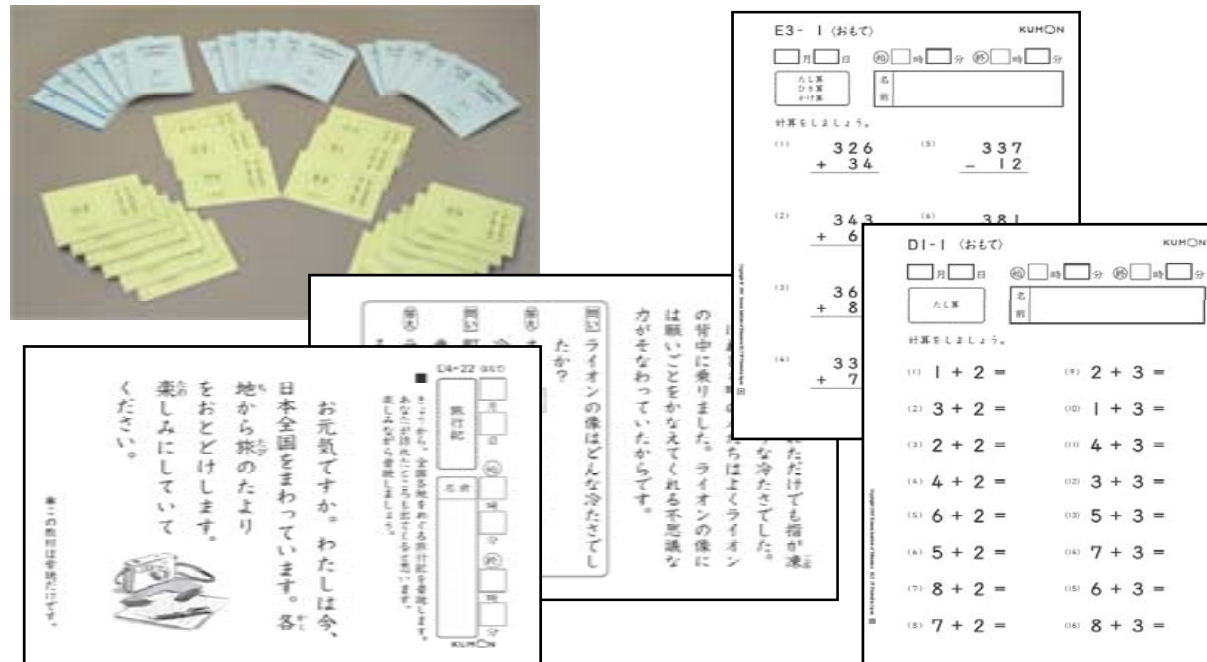
# Changes in Neuropsychological Characteristics



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

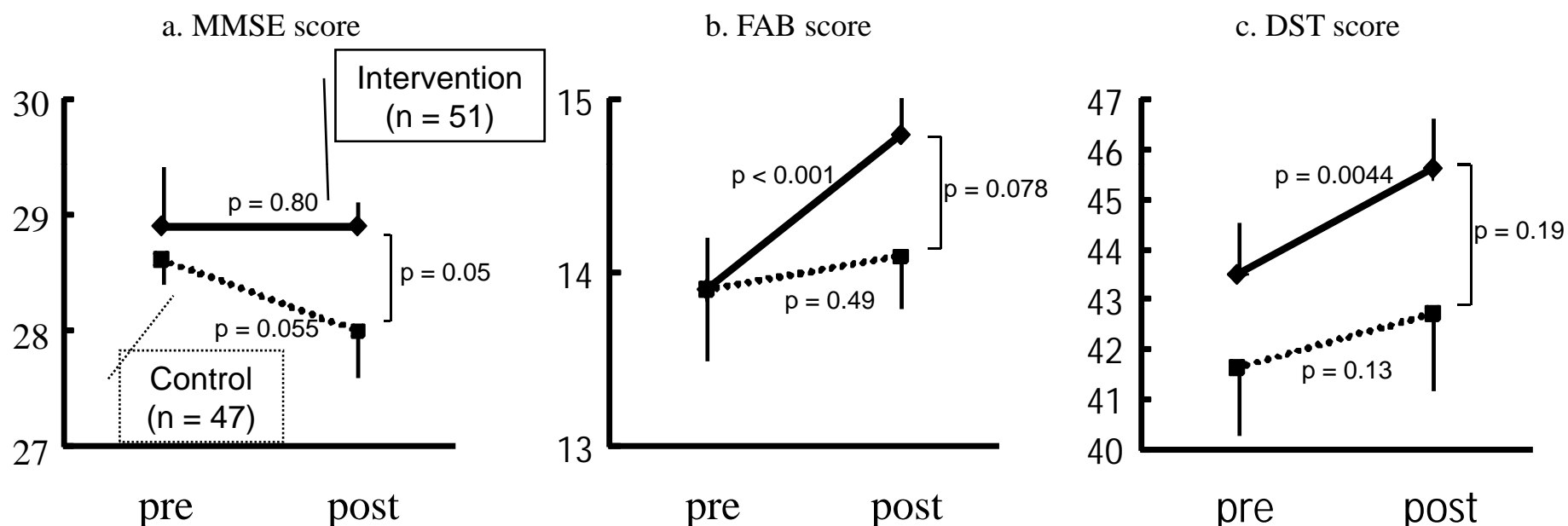


As for daily cognitive intervention, the subjects were asked to solve systematized basic problems in reading and arithmetic everyday for six months (Kawashima et al., 2005).



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.

# Changes in Neuropsychological Characteristics (6M follow up)



Cognitive measure:

Mini-mental state examination (MMSE)

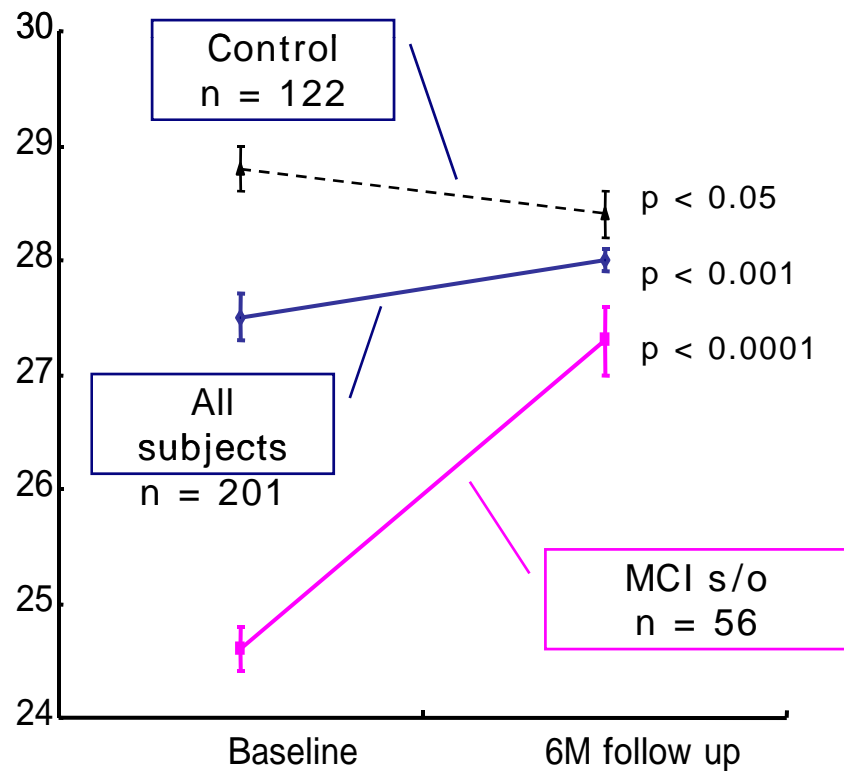
Frontal Assessment Battery at Bedside (FAB)

Digit symbol substitution test of WAIR-R (DST)

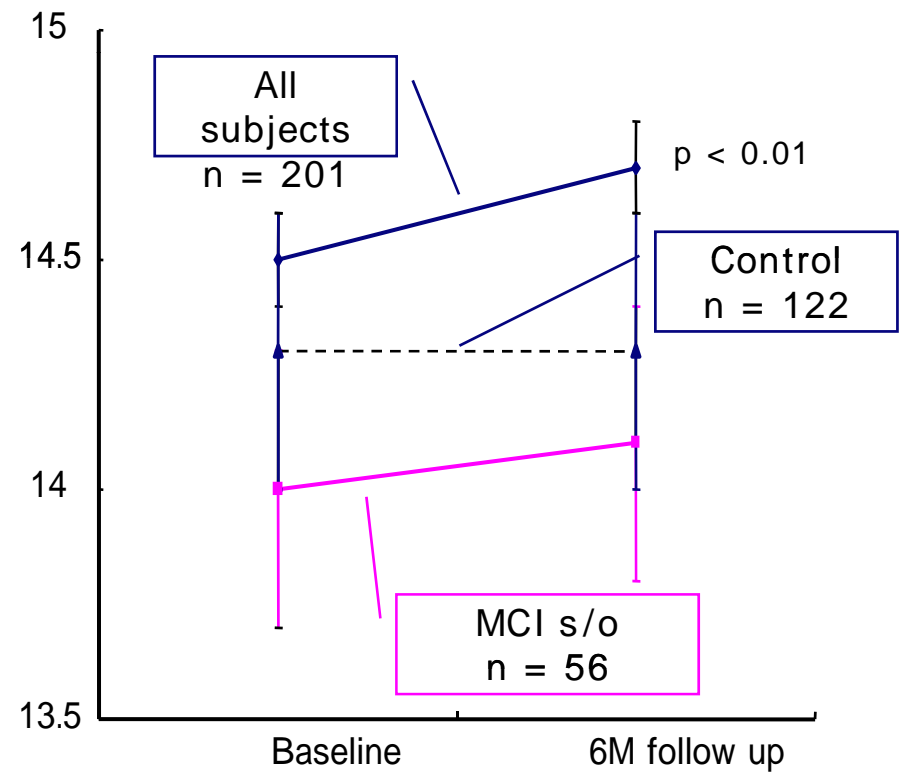
# Analysis on active cohort study of elders (n = 323)

# Psychological measures (6 M follow up)

## Changes of MMSE score

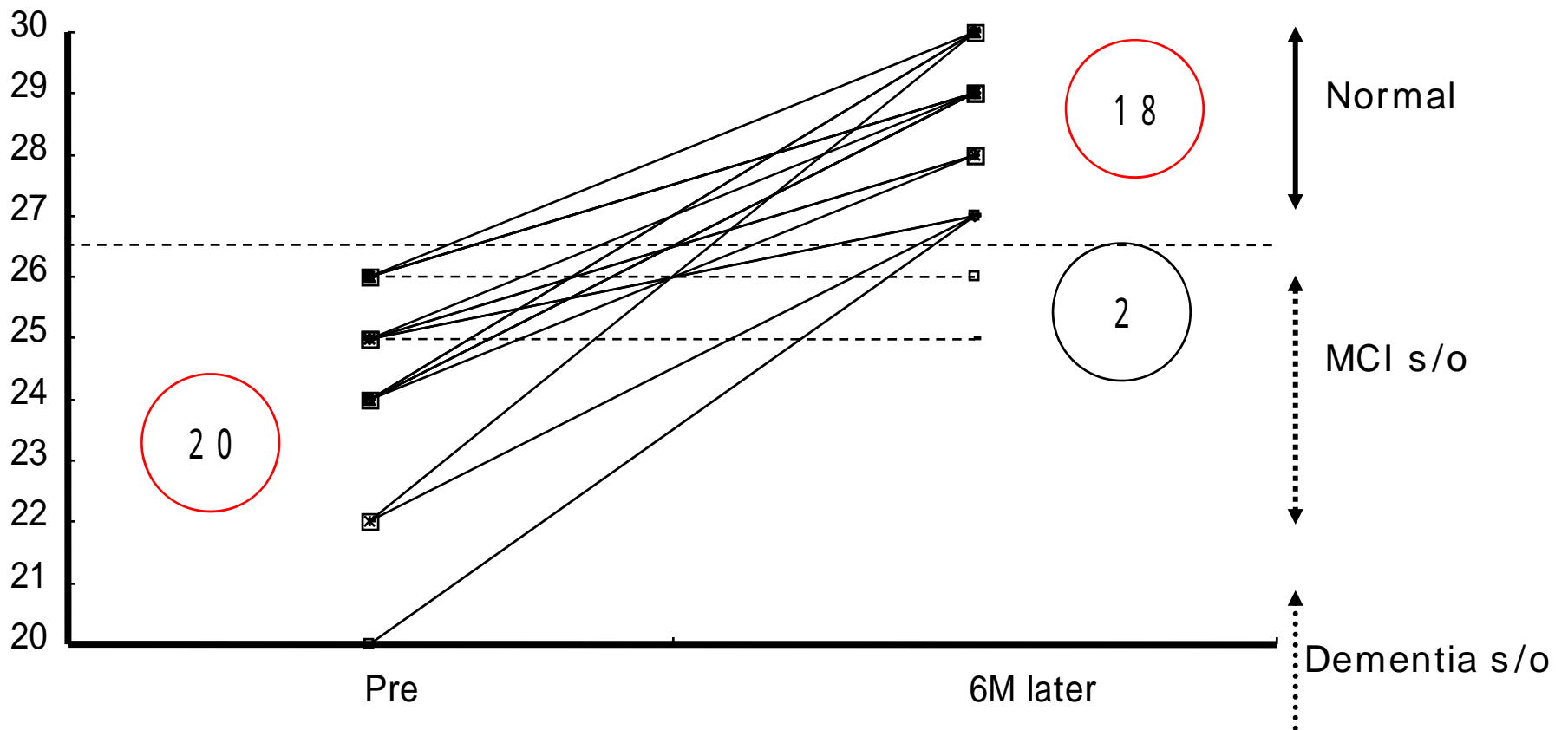


## Changes of FAB score



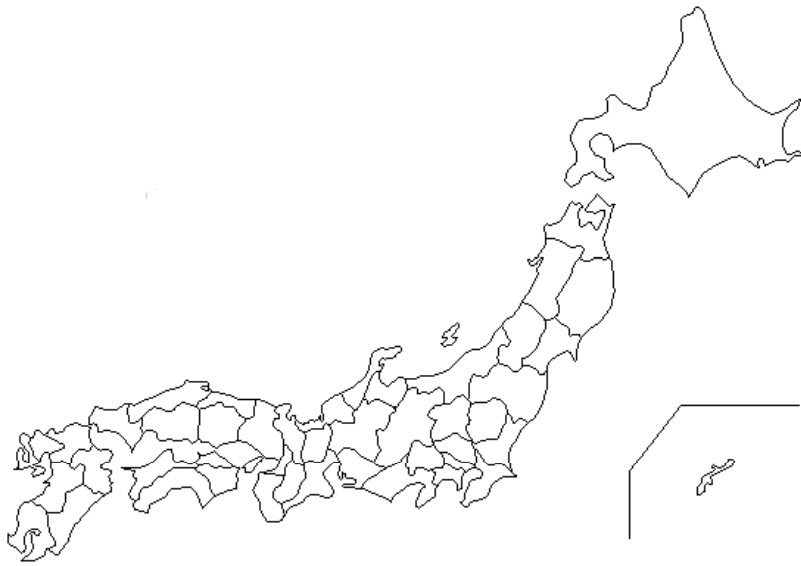


## Changes of MMSE Score during 6M Intervention - Oogaki, Gifu project-



*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.*

# Achievement



- 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.

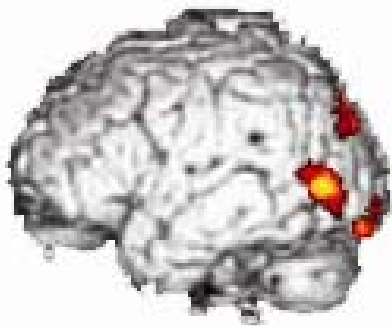


# Examples of Industry-University Joint Research

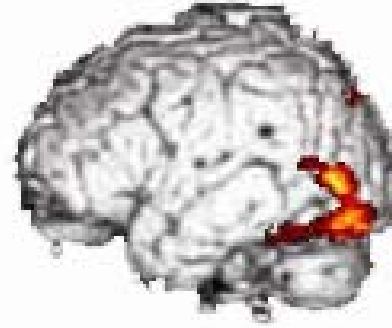
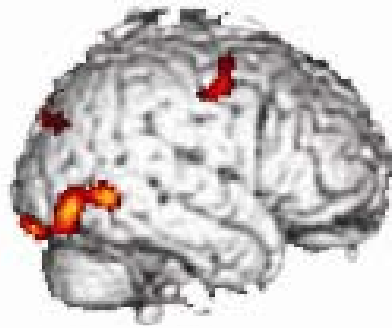
*-R&D of Games and TV Programs-*



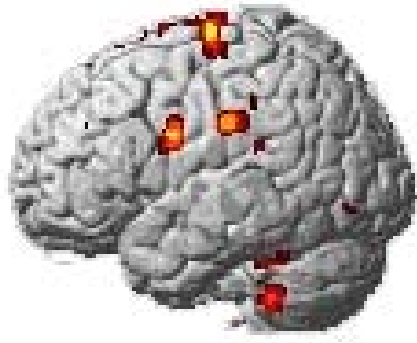
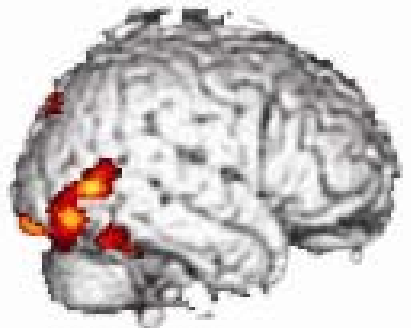
# Brain activity during playing video games



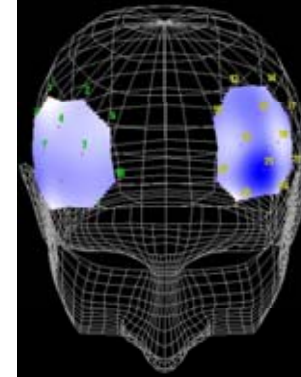
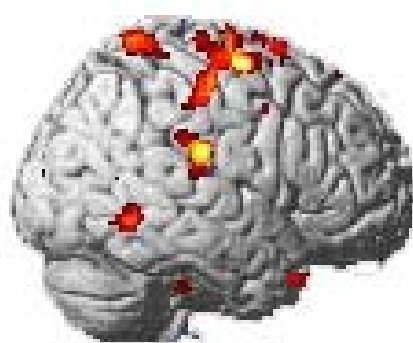
Fighting game (fMRI)



Shooting game (fMRI)



Puzzle game (fMRI)

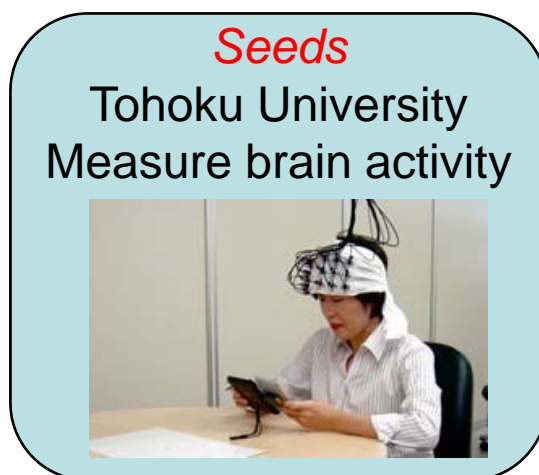
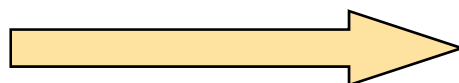
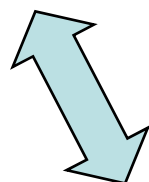
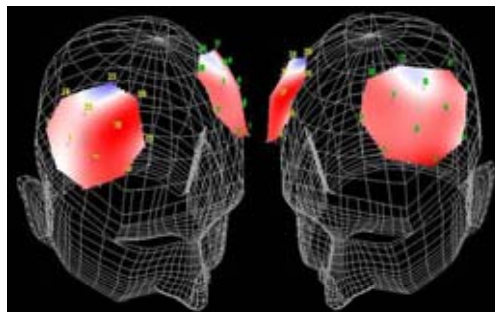


Puzzle game (NIRs)

The most videogames do not activate the prefrontal cortex.  
In addition, they often deactivate the prefrontal cortex.



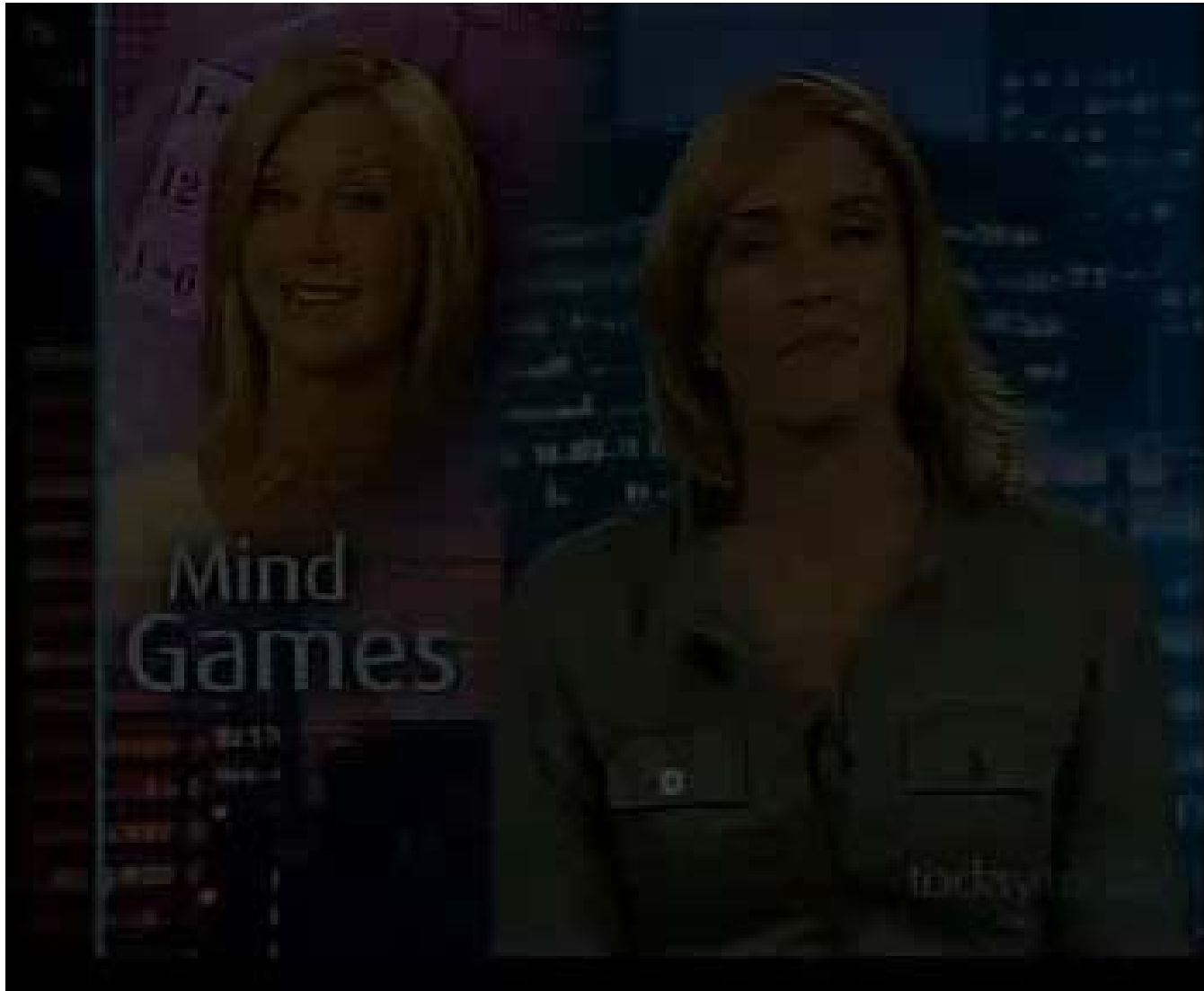
# R&D of video game that can activate the prefrontal cortex



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 <sup>28</sup>



“Today Tonight” 2008.06.24 Australia





ブレインイメージング研究棟 竣工記念

平成20年4月28日