

How can we increase old individual's abilities to contribute to increased productivity in our society?

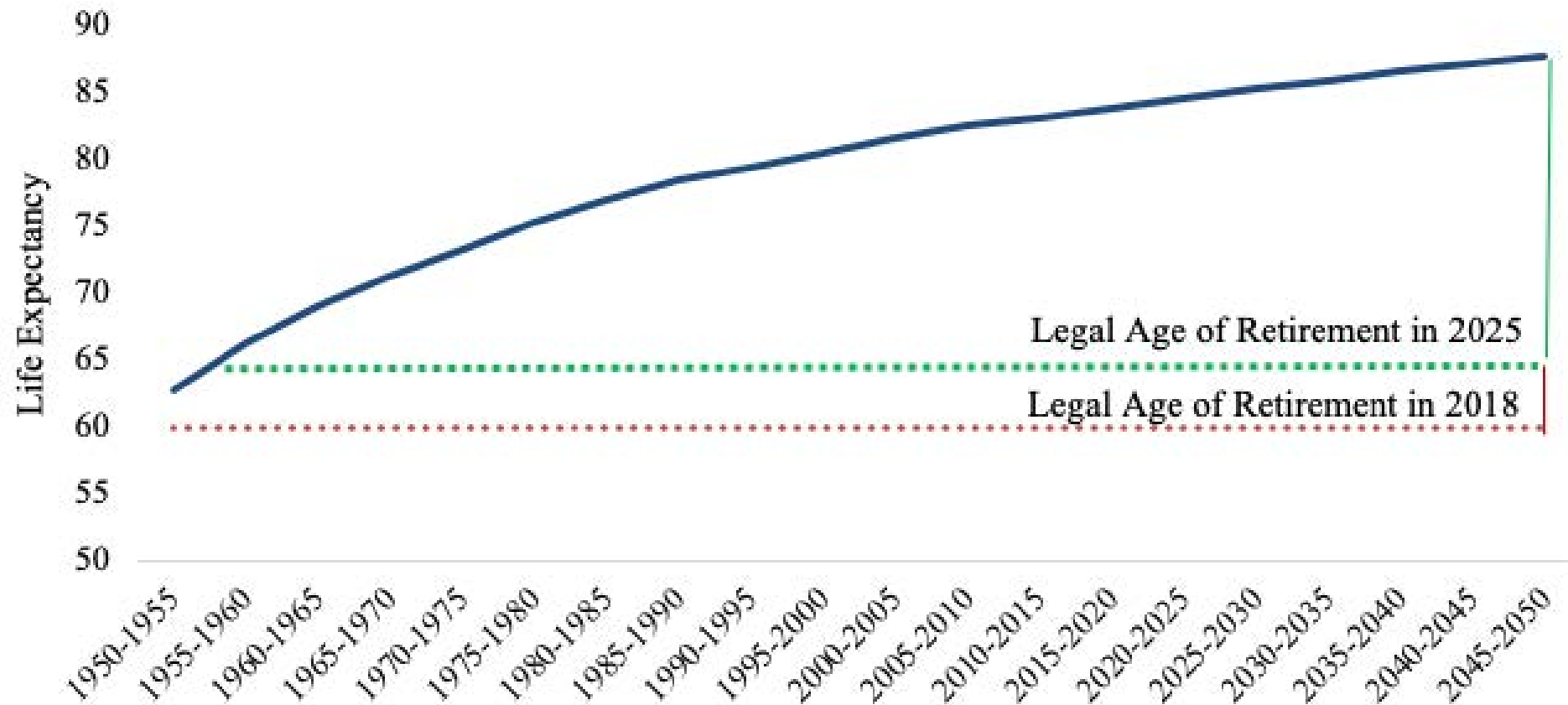
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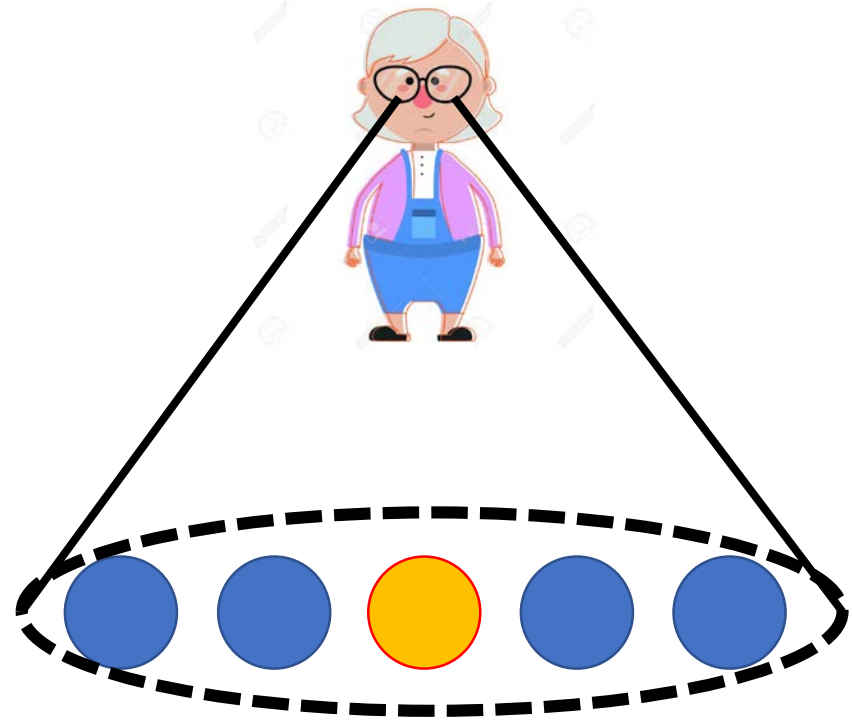
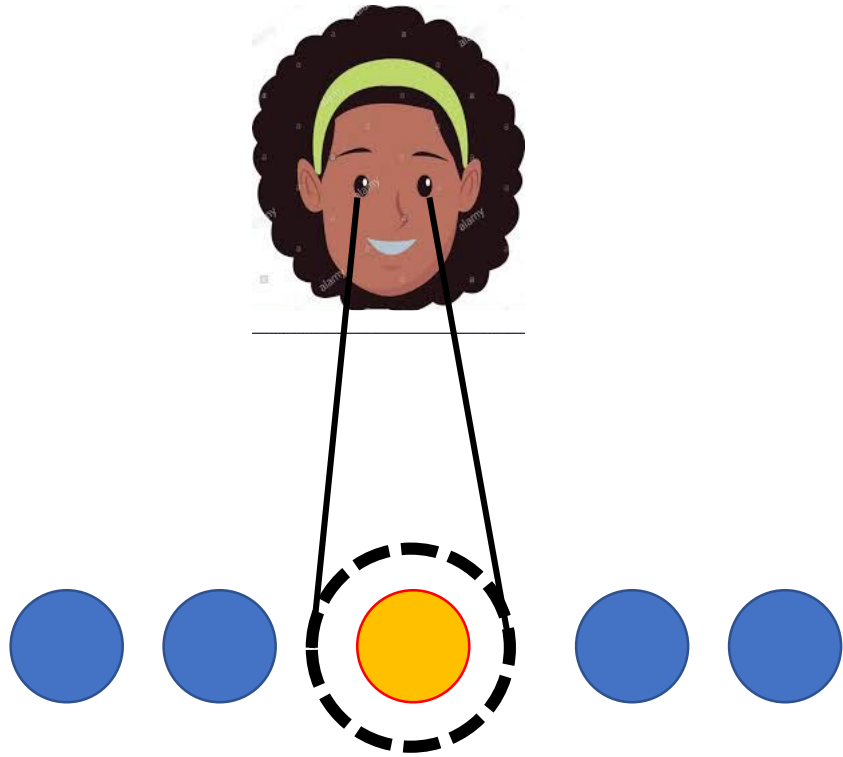
# Today's talk

1. An increasing ratio of older individuals who do not work
2. Difference in the brain processing between older and younger individuals?
3. Making super older individuals
  - Decoded fMRI Neurofeedback
  - Magnetic Resonance Spectroscopy (MRS)
  - Developing online MRS neurofeedback
4. Research environments

# 1. How can we deal with the society that has an increasing ratio of older individuals?



## 2. What functions of older adults decline and what functions do not?



Tsushima, Sasaki & Watanabe *Science*, 2006  
Chang, Sasaki & Watanabe *Current Biology* 2013  
Yotsumoto et al *Nature Communications* 2013

### 3. What is different in brain processing between older and younger individuals?

- No significant difference in encoding ability between younger and older individuals
- Downside: older individuals learn more items than necessary.
- Advantage: Older people have a more global perspective than younger people.
- Older individuals has smaller GABA concentrations in the brain, leading to less inhibitory control than younger individuals.

## 4. How can we make super-old individuals

Increase GABA concentration → Increase learning efficiency

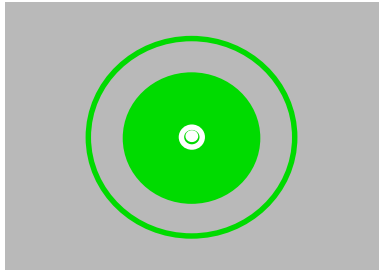
Decrease GABA concentration → Increase a perspective



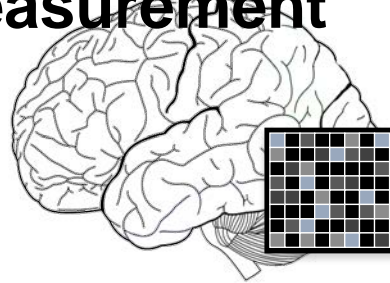
Online MRS neurofeedback

# Decoded **fMRI** neurofeedback

Similarity  
feedback

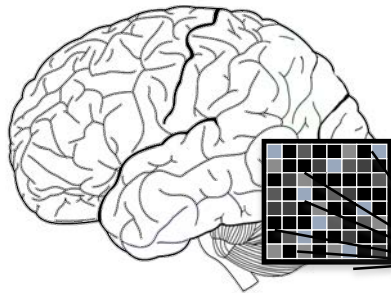


fMRI  
measurement



*Money as reward*

Similarity  
calculation



Similarity  
calculator

Shibata et al, Science, 2011



Shibata



Sasaki



Kawato



Watanabe

# Decoded **fMRI** neurofeedback

1. Association between two items  
(Amano et al, Current Biology, 2016)



CiNet & ATR & Brown

2. Changing face reference (Shibata et al,  
PLOS Biology, 2016)



Brown & ATR

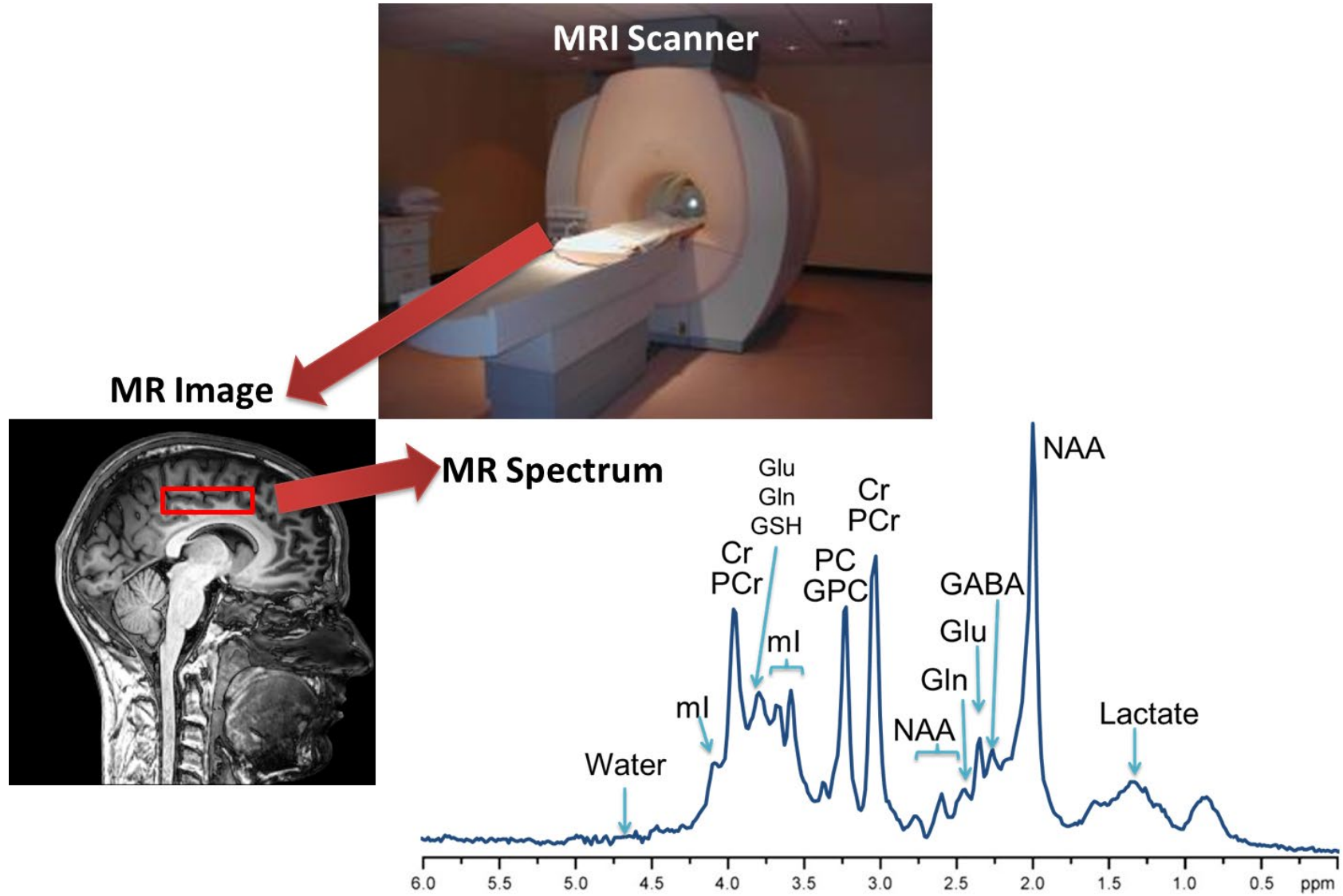
3. Eliminating traumatic memory  
(Koizumi et al, Nature Human Behavior 2016)



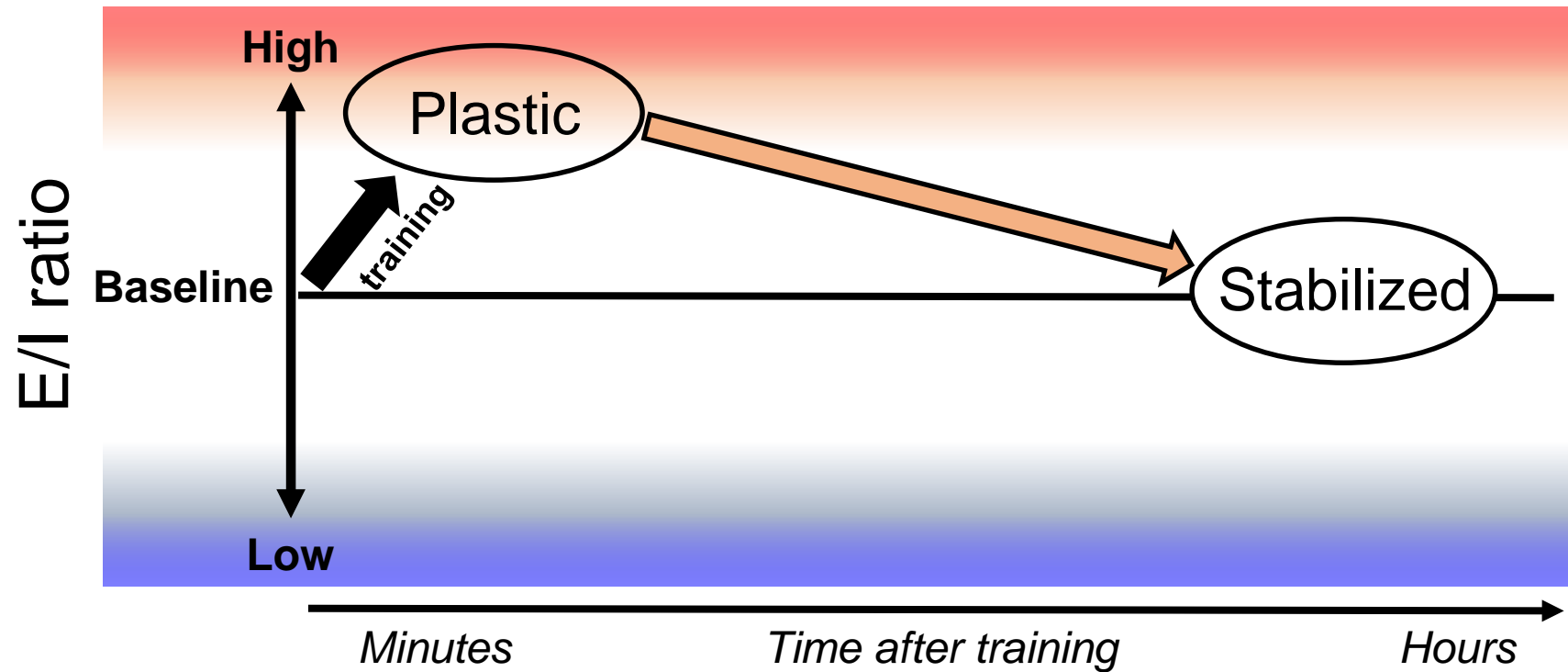
CiNet & UCLA & ATR



# Magnetic Resonance Spectroscopy (MRS)



# Plasticity and stability of learning



Shibata et al, *Nature Neuroscience*, 2017  
Bang et al, *Nature Human Behaviour*, 2018

# Development of online MRS neurofeedback

Control the concentration of GABA in a targeted brain region



Letting older individuals learning or memorize more efficiently while keeping older individual's global perspective abilities



Super-old individuals

# What research environment is necessary?

Improving older adults' brain functions → Making super older adults

- a. Clarify behavioral functions that decline in older people  
← Psychological assessments (Psychology)
- b. Finding brain processing that underlies functional declines  
← Human brain imaging, Animal physiology, Neuroscience)
- c. Improving brain processing that underlies the declines  
← Neurofeedback, Brain Machine Interface (Engineering)
- d. Assess how declined functions are improved (Psychology)

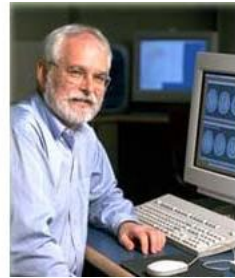
# Interdisciplinary Approaches

## Brain Models

David Mamford  
Fields Prize  
for algebraic  
Geometry

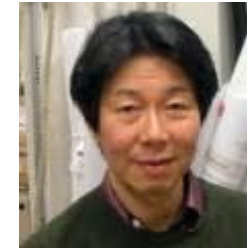


## Brain Machine Interface



John Donoghue

## Brain Imaging Neurofeedback



Takeo Watanabe



Yuka Sasaki

Leon Cooper  
Nobel Prize  
for super  
conductivity



Psychology  
U Tokyo



ATR



CiNet



Sony



# Conclusion

How can we deal with aging society in Japan?

We need to develop training methods by which the amount of GABA in the older individual's brain is controlled to increase learning and memory.