Improving the Mind with a Hop, Skip, and a Jump

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Part 2: What works?

Exercise, Aging Brain, and Cognition

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Outline

- Does mental exercise work?
- Does physical exercise work?

Does mental exercise work?

- Training improves the performance on trained tasks
- The benefits of training can be very narrow – difficult to transfer to other untrained tasks.
- Mental exercise may not spare age-related cognitive declines

➢ Effects of training and transfer of training effects:

Ball et al., 2002 – The ACTIVE Project

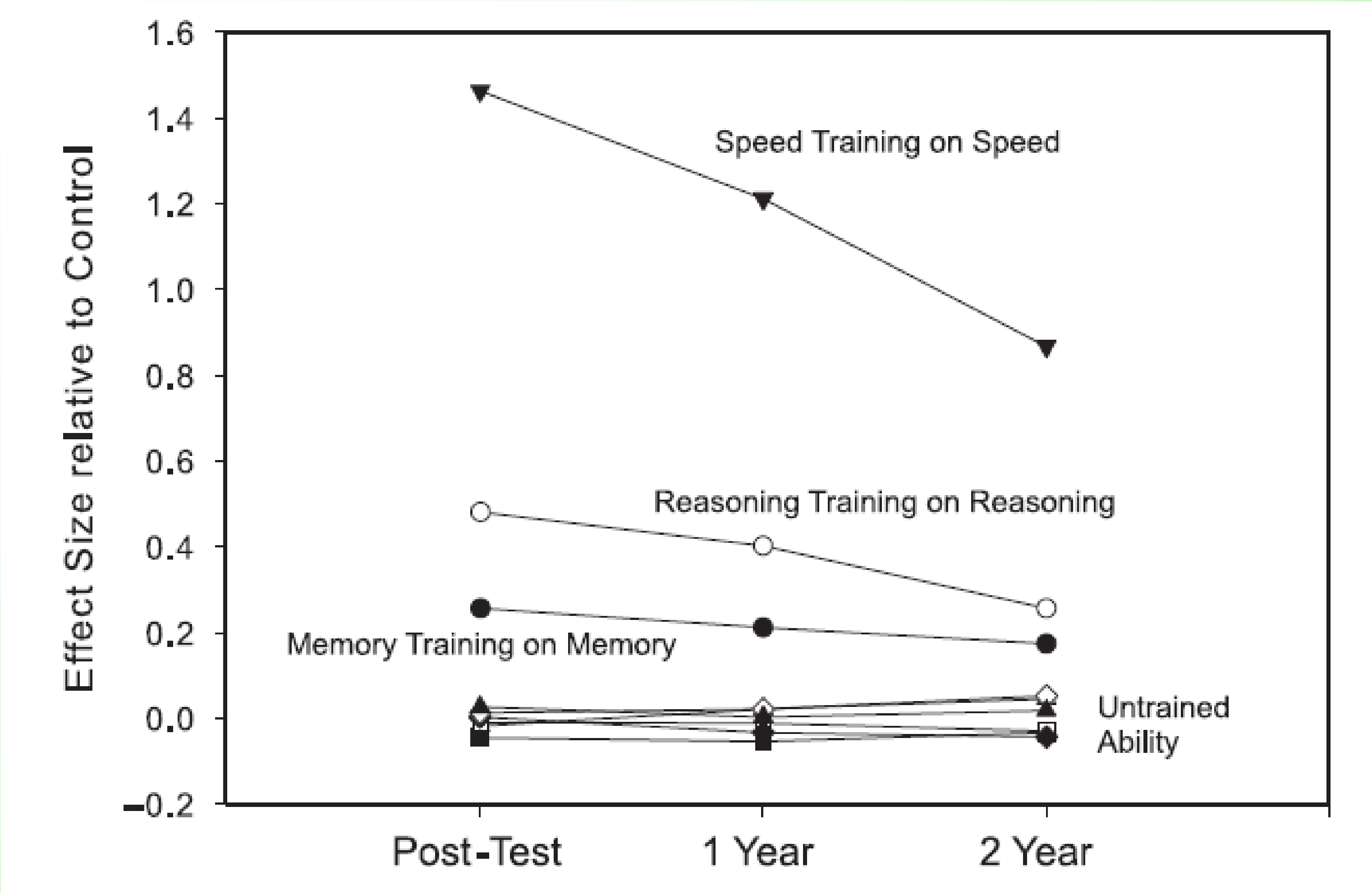
Advanced Cognitive Training for Independent and Vital Elderly

N=2832, Age range: 65-94

10 session of training on:

- **Memory**
- **Reasoning**
- **Speed**

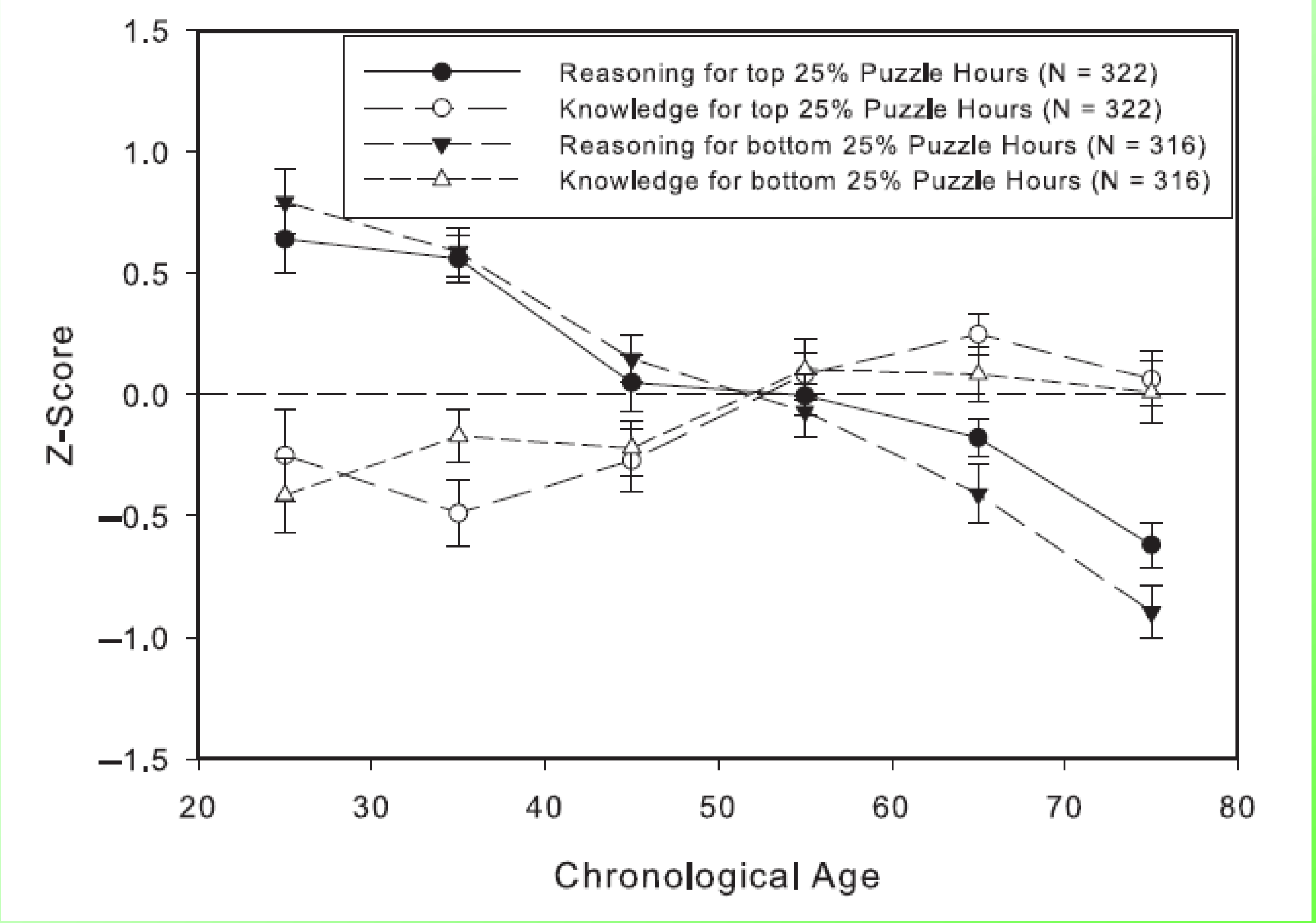
Outcome measures: Cognitive demanding everyday measures



Data from Ball et al., 2002. Adapted in Salthouse, 2006

The effect of crossword puzzles:

Salthouse, 2006



Ackerman, Kanfer, & Calderwood, 2010

Training on:

- **Wii – Nintendo big brain academy task**
- **Knowledge related reading**

20 hours a month for two months

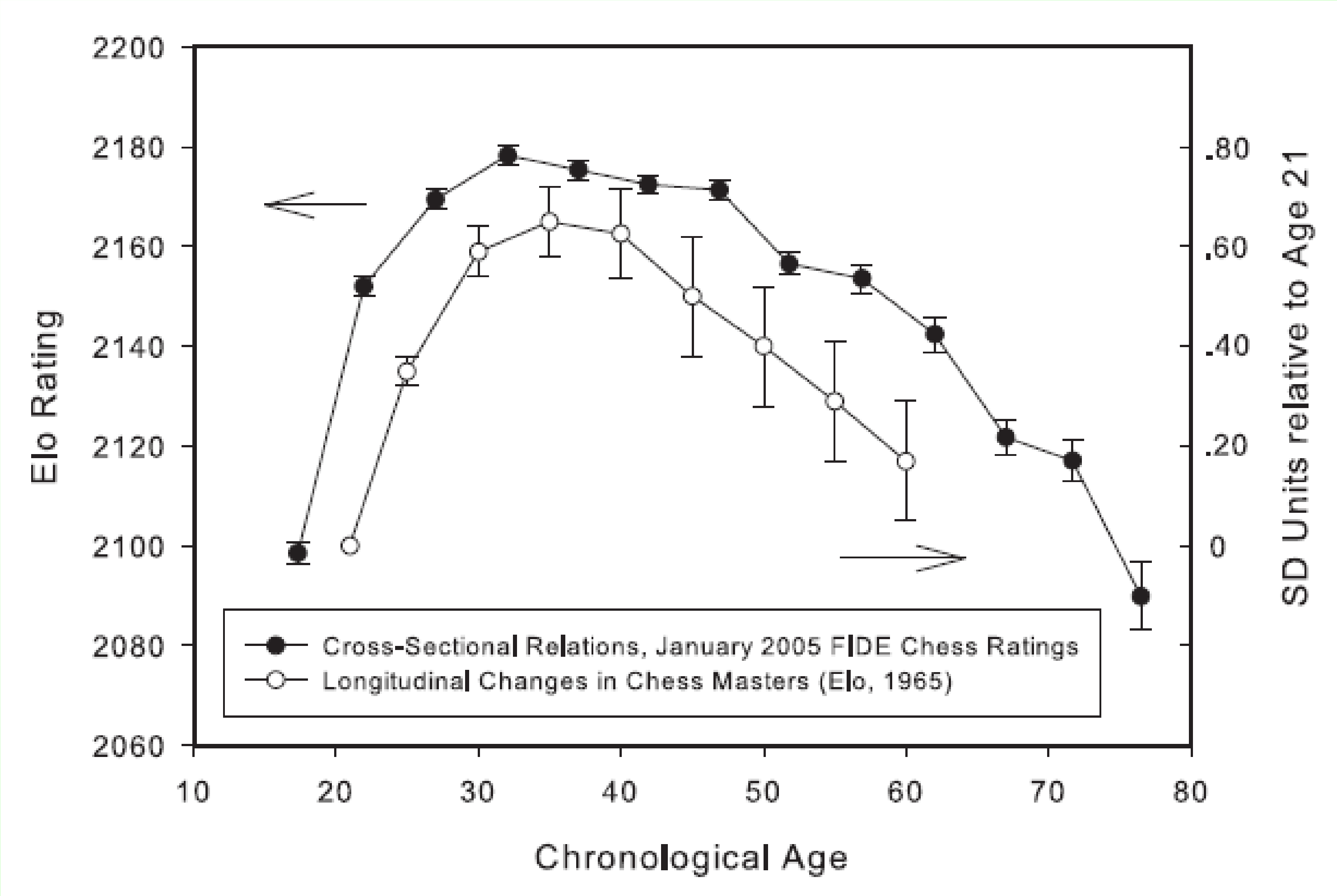
Results:

Significant improvement in each task but no transfer to general abilities.

- **Can mental exercises spare us from age-related declines?**

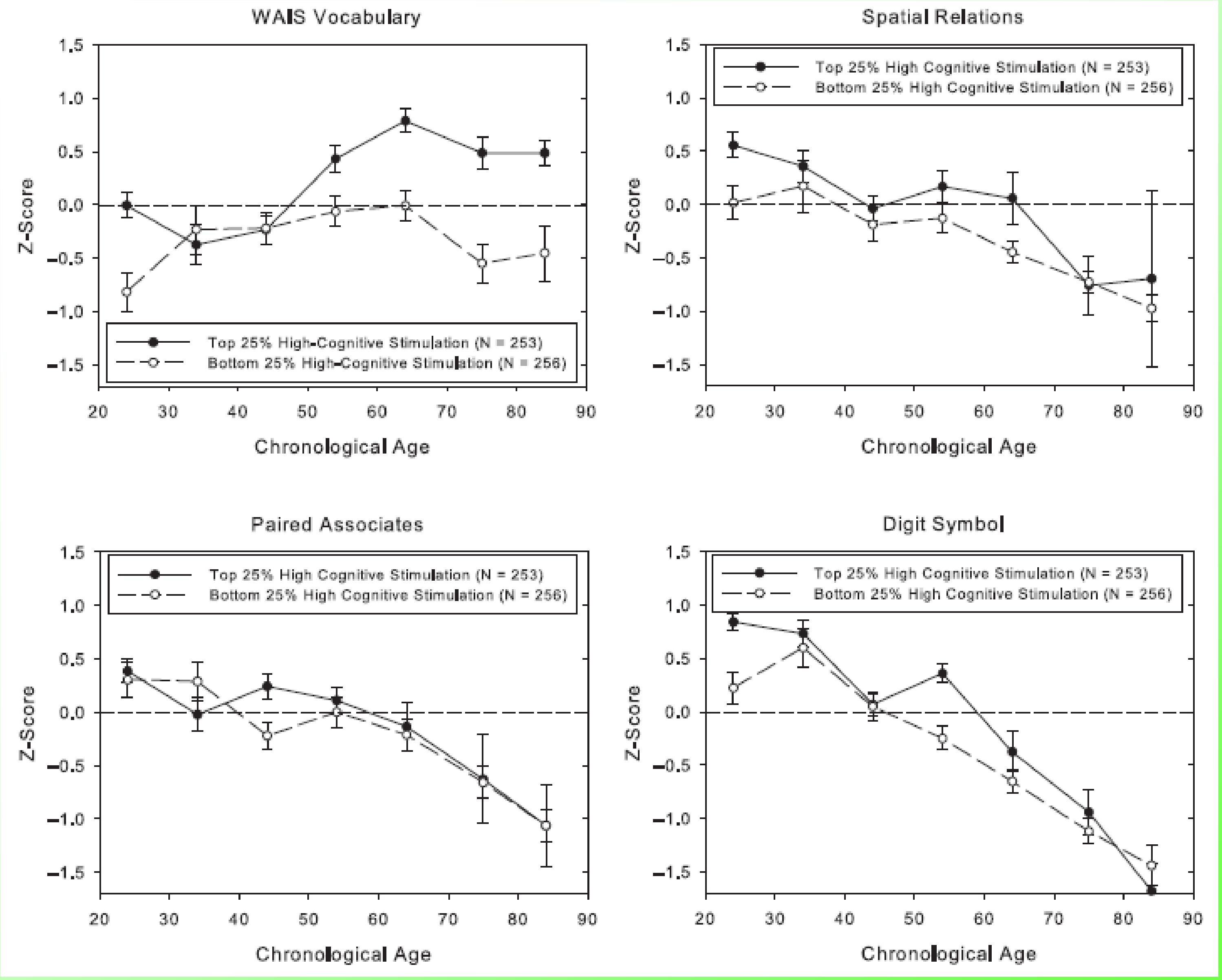
Not really

Age-related changes in chess masters



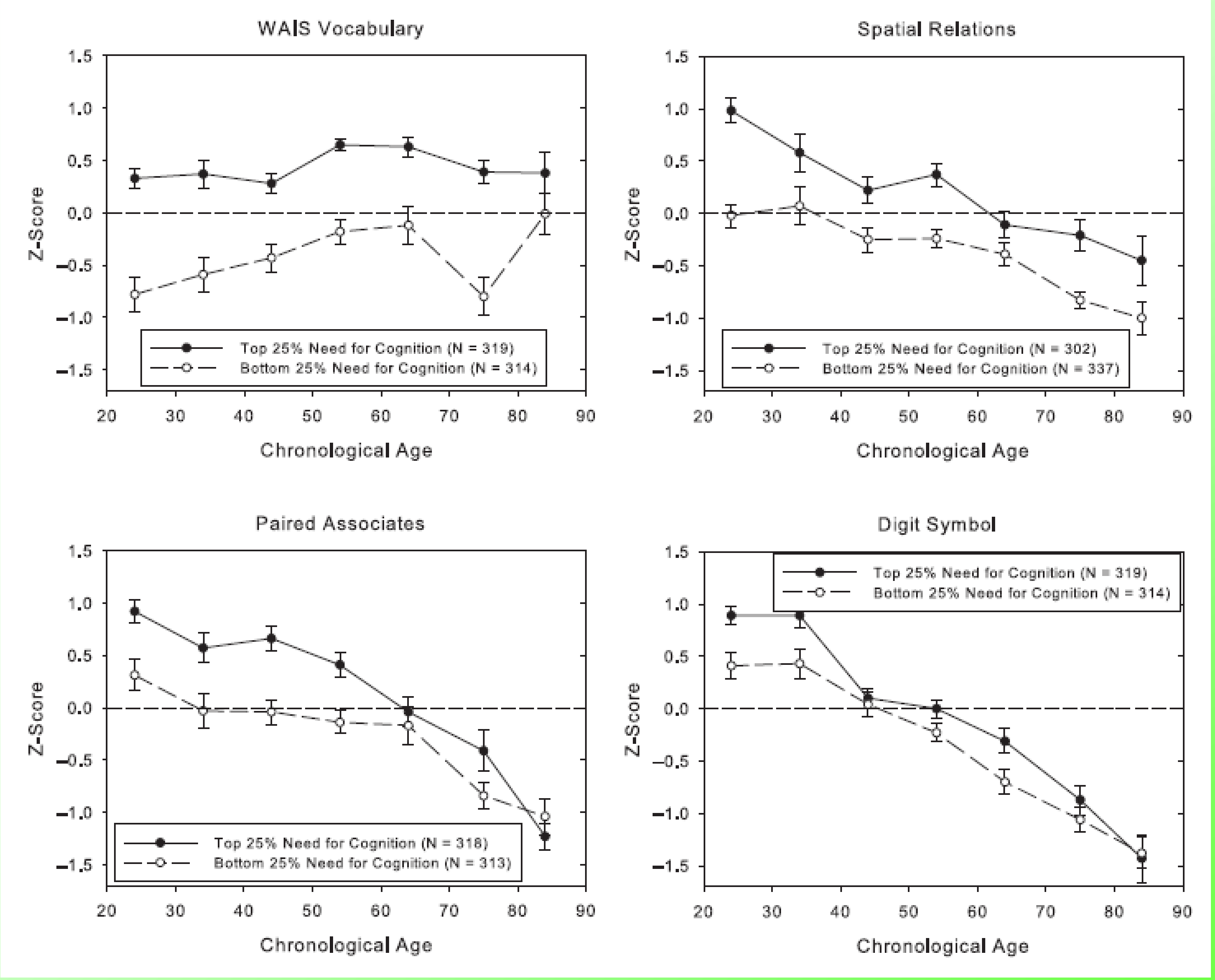
Salthouse, 2006

Amount of cognitively stimulating activities engaged:



Salthouse, 2006

Need for cognition – People seek out cognitive stimulation:



What about physical exercise?

- Fitness effects are seen in a number of cognitive functions (e.g., Colcombe & Kramer, 2003).

- Aerobic exercise has been associated with enhancement in brain structures and functions.
  - Cell proliferation
  - Brain Volume
  - Hippocampal volume
  - Medial temporal lobe
  - Improved functions
    - Task switching Churchill et al., 2002
    - Attention control: Prakash et al., 2011

- Aerobic exercise in other areas:
  - Decrease the proportions of senescent blood T-cells (Spielmann, et al., 2011)
  - Insulin resistance and cognitive functions (Yanagwa, et al., 2010)

Colcombe & Kramer, 2003 - A Meta Analysis

All of the studies included in the analyses had:

- **an aerobic fitness component**
- **a longitudinal design**

The main findings are:

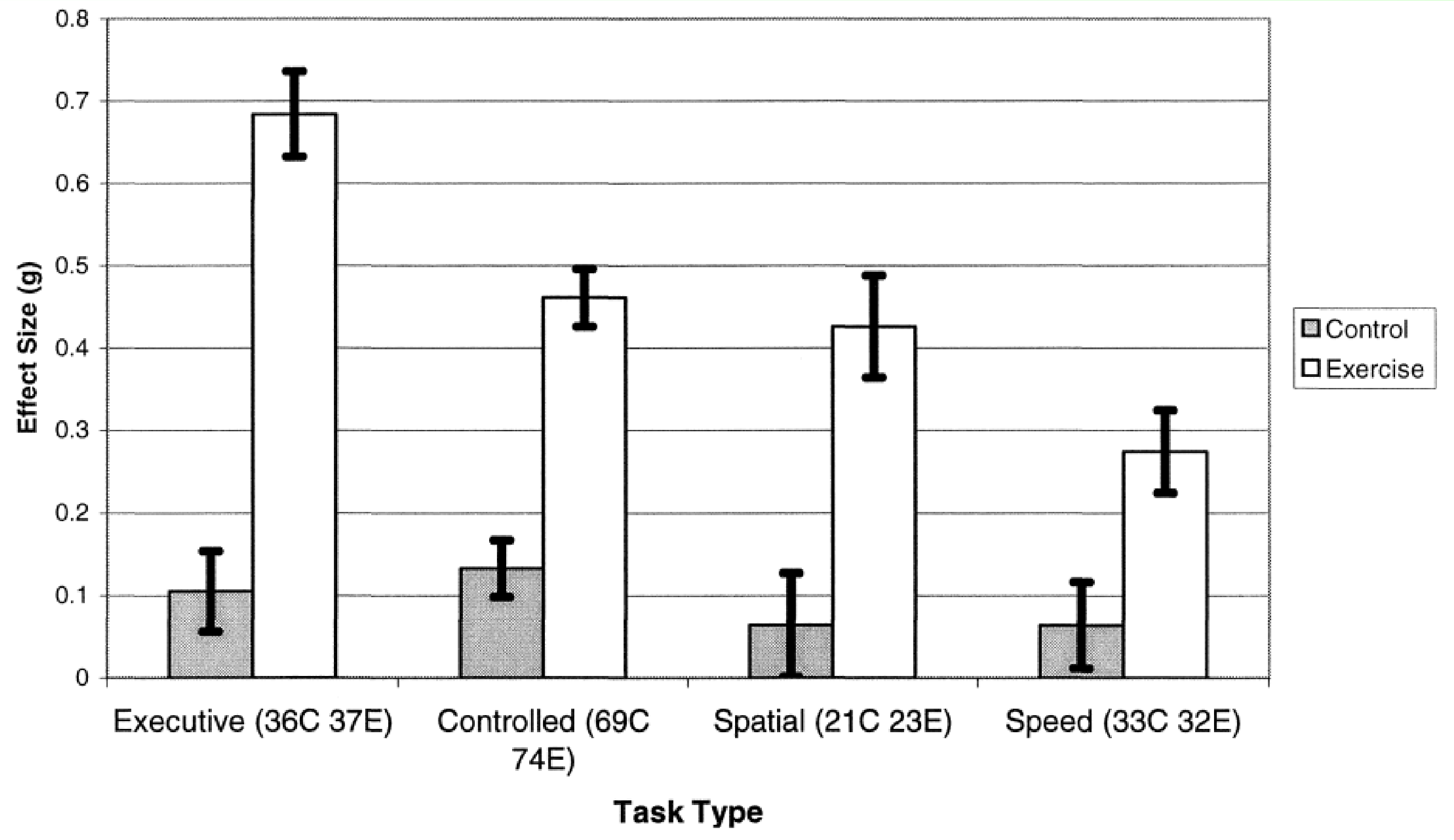
1. **Fitness training increased performance 0.5SD on average.**

2. **Robust but process-specific benefits accrue with fitness training.**

1. Fitness training increased performance 0.5SD on average

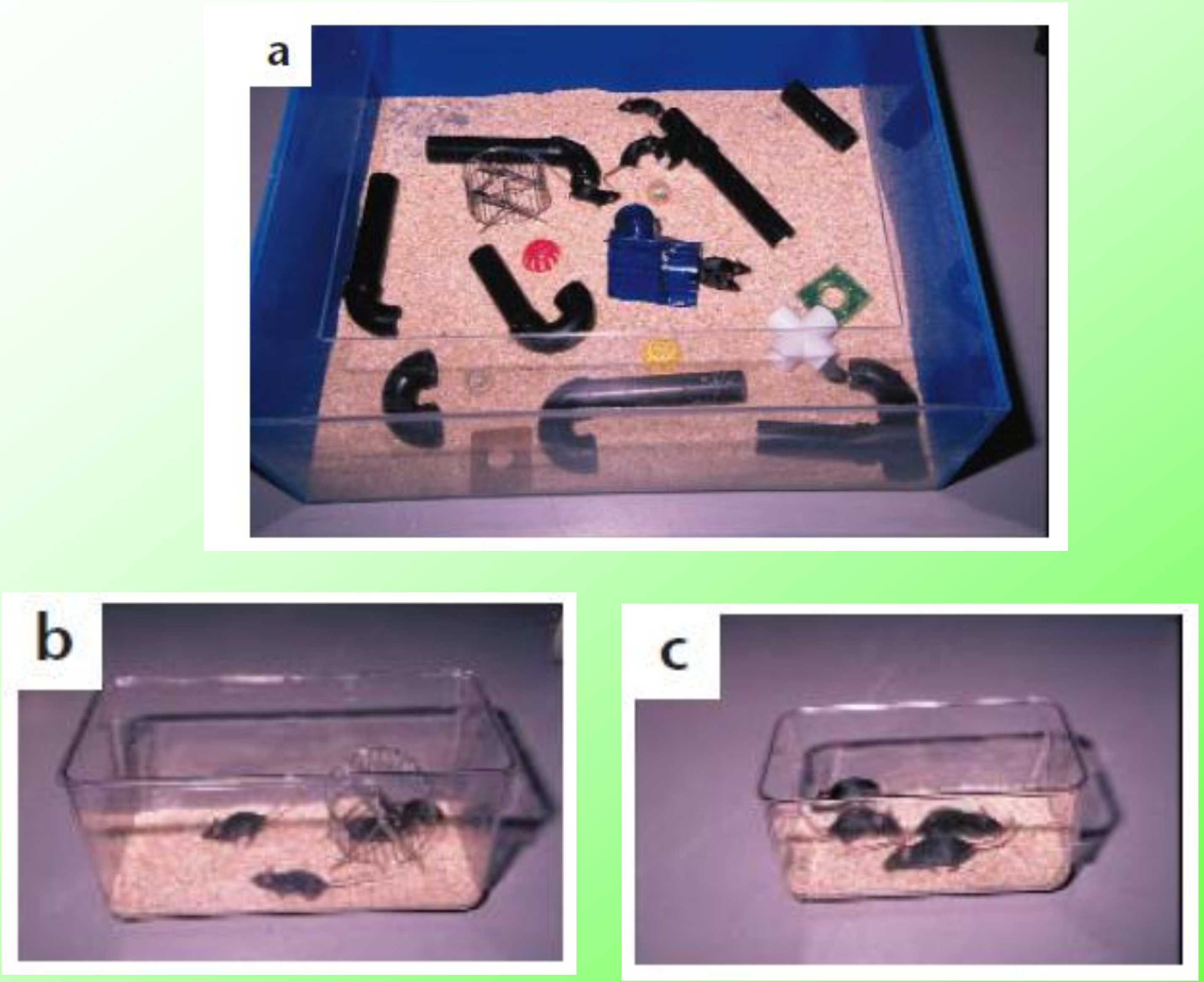
Moderator variable	Effect size	*SE*	*n*	*p*
Overall				
Control	0.164	0.028	96	*
Exercise	0.478[1]	0.029	101	*
Exercisers				
Training characteristics				
Training type				
Combined	0.59[2]	0.049	49	*
Cardiovascular only	0.41	0.037	52	*
Program duration				
Short (1–3 mo)	0.522[2]	0.067	38	*
Medium (4–6 mo)	0.269	0.047	36	*
Long (6+ mo)	0.674[1,2]	0.048	27	*
Session duration				
Short (15–30 min)	0.176	0.089	11	
Moderate (31–45 min)	0.614[1,3]	0.052	24	*
Long (46–60 min)	0.466[1]	0.041	53	*
Participants' characteristics				
Sex				
High female (>50% female)	0.604[2]	0.036	67	*
High male (≥50% male)	0.150	0.055	27	*
Age				
Young-old (55–65)	0.298	0.044	31	*
Mid-old (66–70)	0.693[1,3]	0.056	37	*
Old-old (71–80)	0.549[1]	0.058	33	*

2. Robust but process-specific benefits accrue with fitness training.

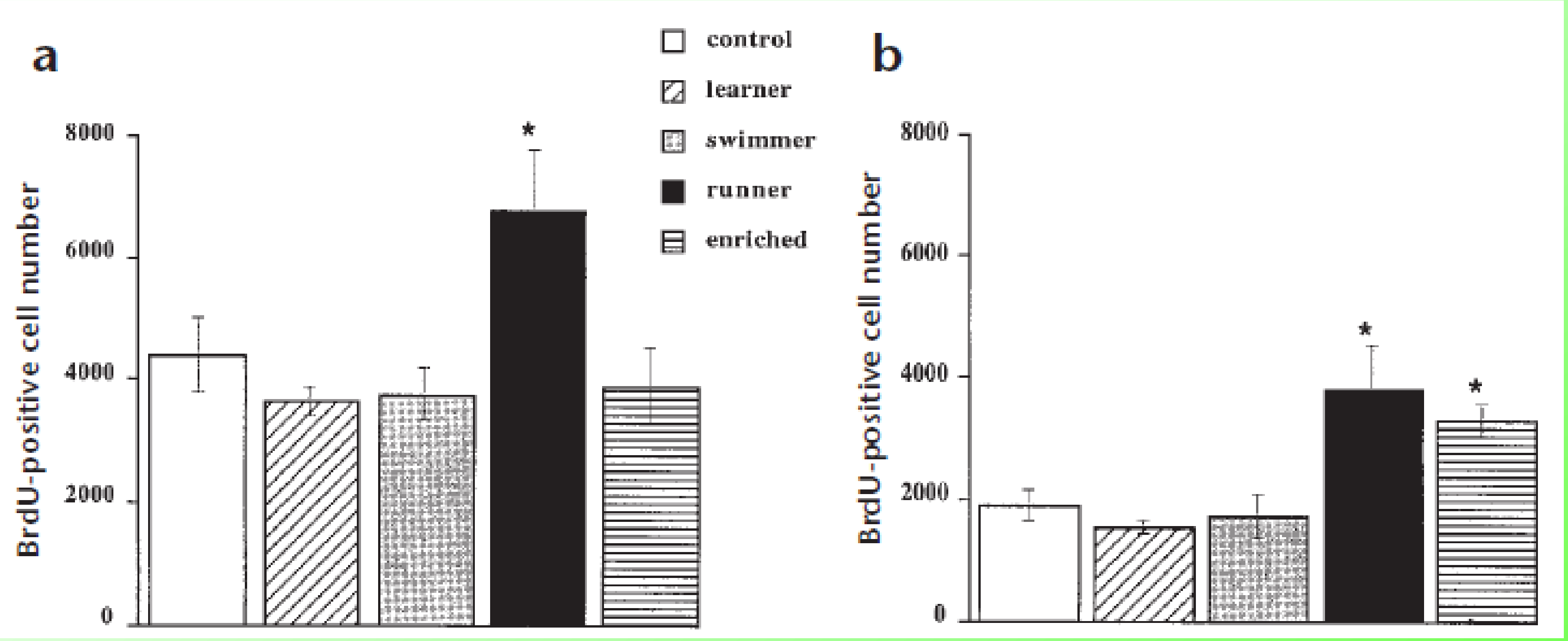


- **Aerobic exercise has been associated with enhancement in brain structures and functions.**
  - **Cell proliferation**
  - **Brain Volume**
  - **Hippocampal volume**
  - **Medial temporal lobe**

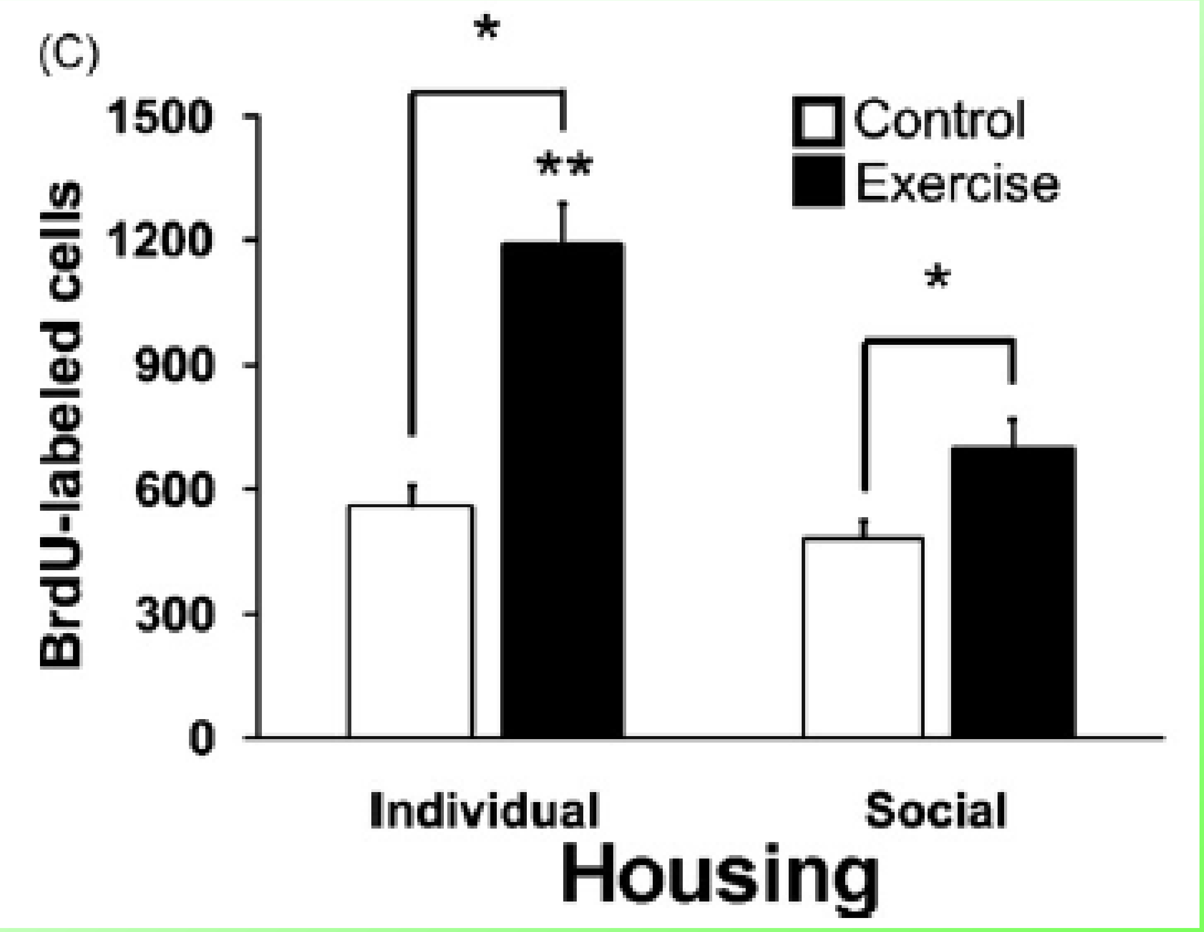
<u>**Cell proliferation**</u> **Van Praag, Kempermann, & Gage, 1999**



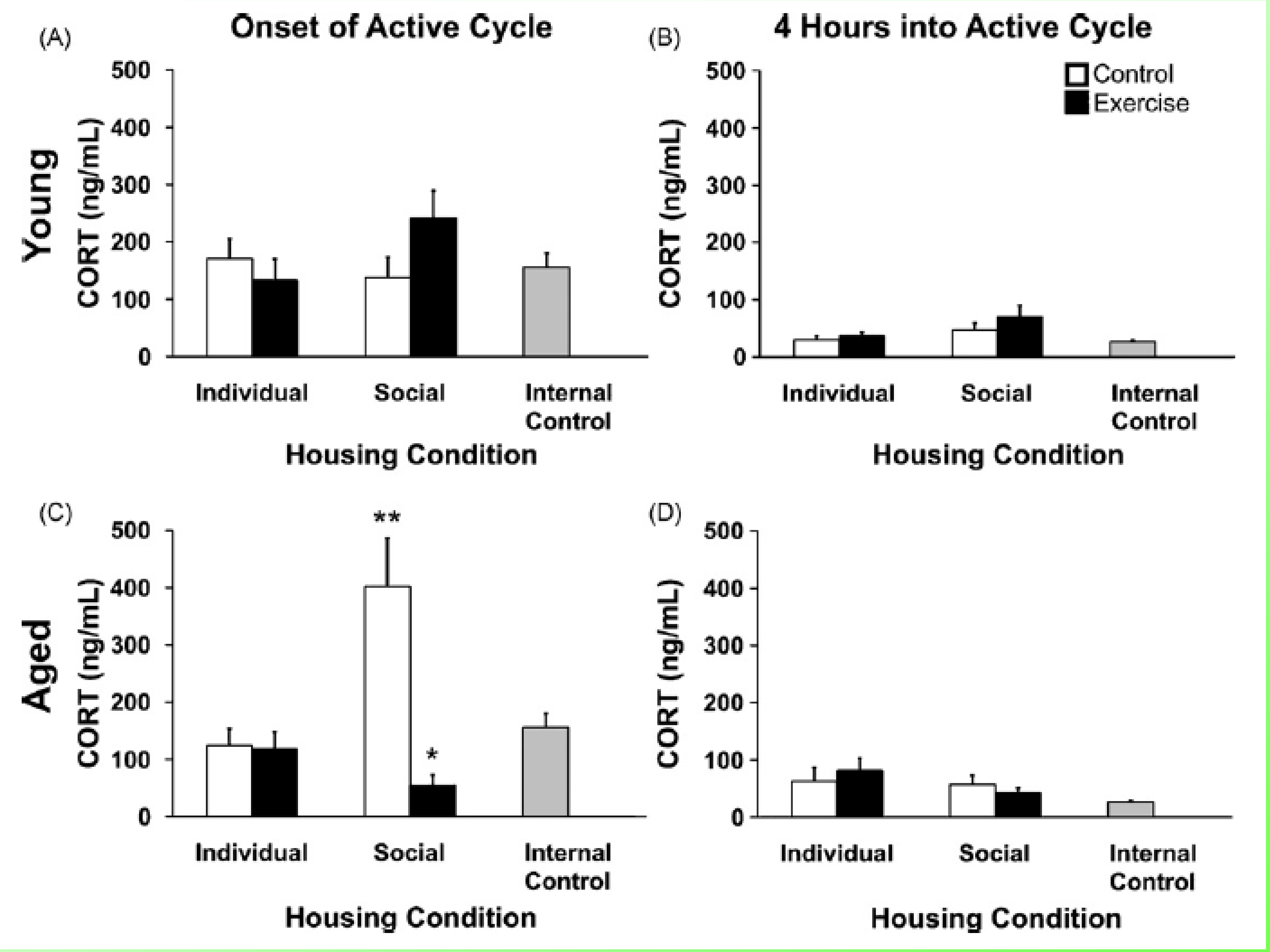
- **Cell proliferation was only associated with voluntary running**
- **Both running and enrichment groups roughly doubled the total number of surviving new cells in the dentate gyrus**



Running enhances cell genesis in aged mice: Kannangara et al., 2011



Running reduces stress in aged mice: Kannangara et al., 2011



Brain Volume: Colcombe et al., 2006

59 healthy older adults, age between 60-79

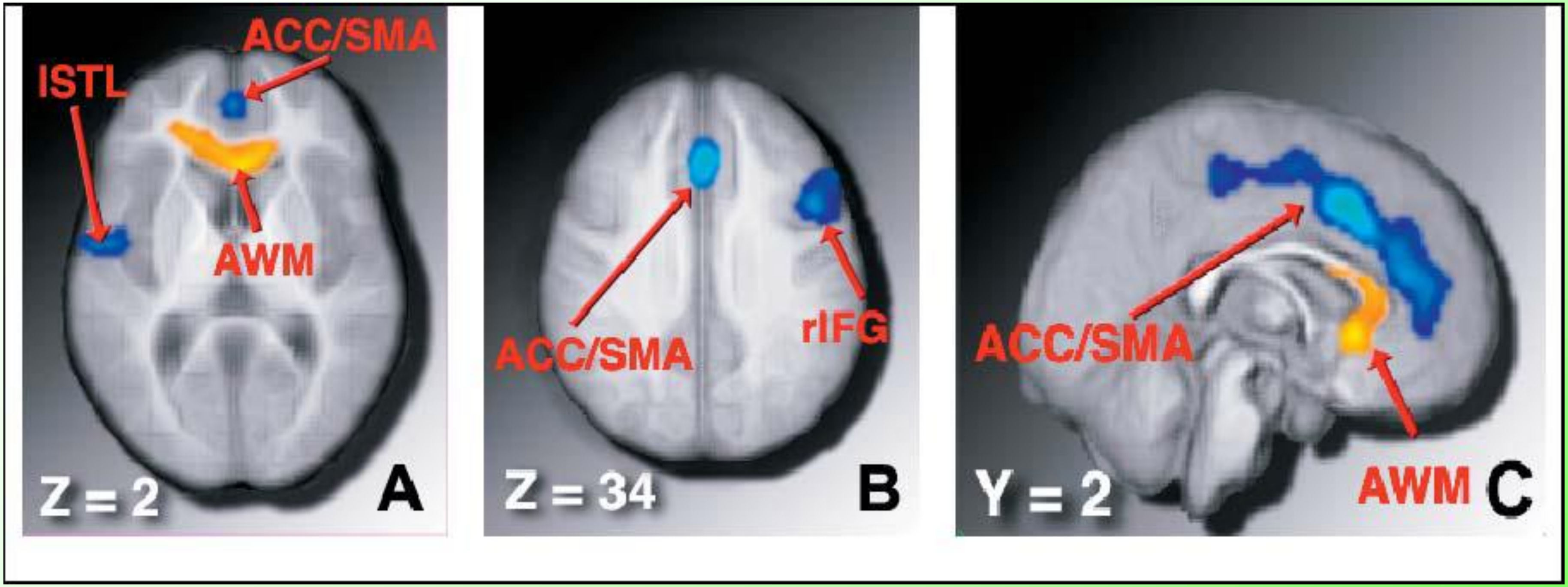
6 months of randomized clinical trial

Aerobic training versus stretching & toning

One hour training three times a week for six months.

40-50% to 60-70% of maximum HR

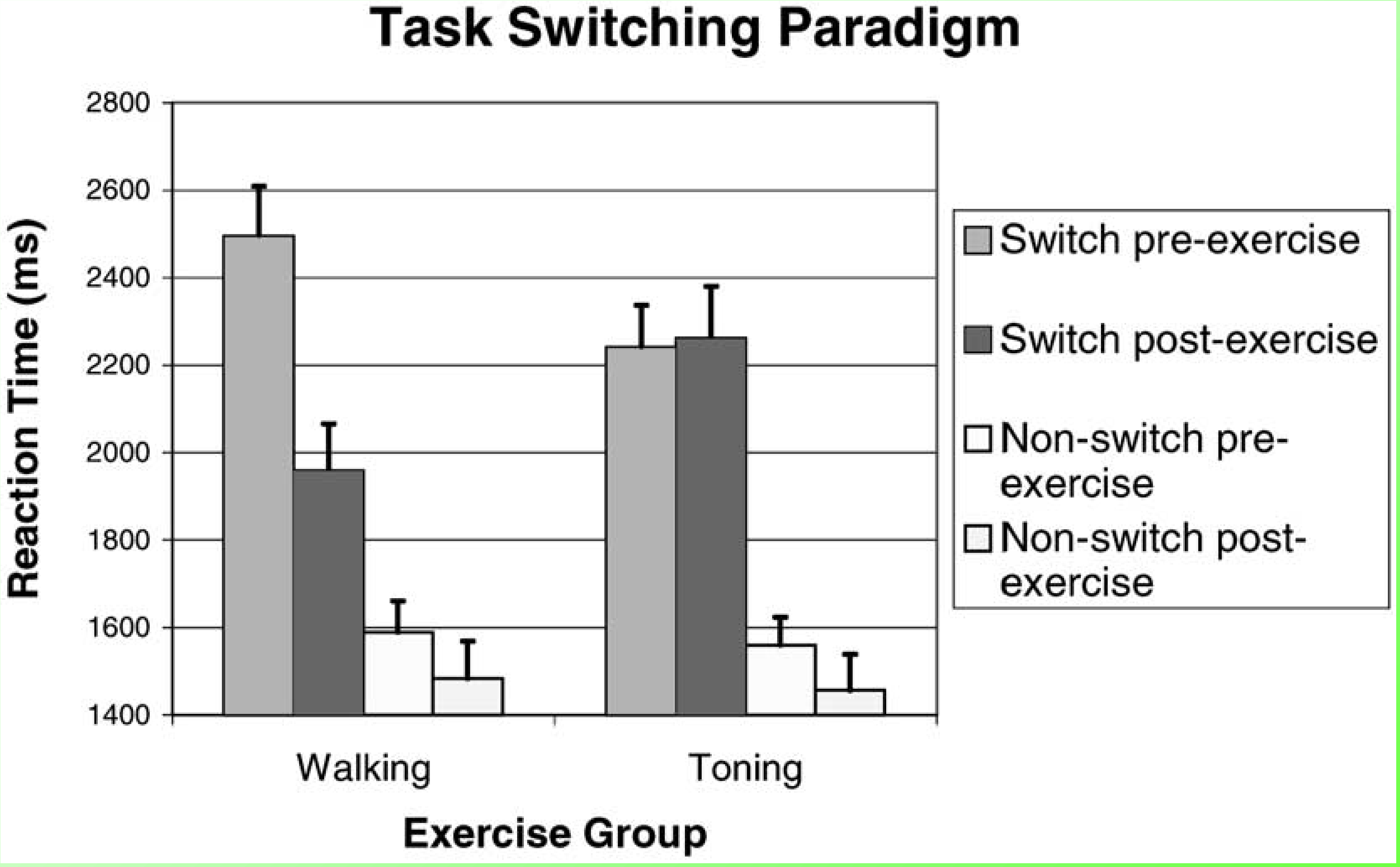
Found increases in volume in the prefrontal and temporal regions.



Blue regions: Gray matter volume was increased for aerobic exercisers, relative to nonaerobic controls.
Yellow regions: White matter volume was increased for aerobic exercisers, relative to controls.

Colcombe et al., 2006

Churchill et al., 2002

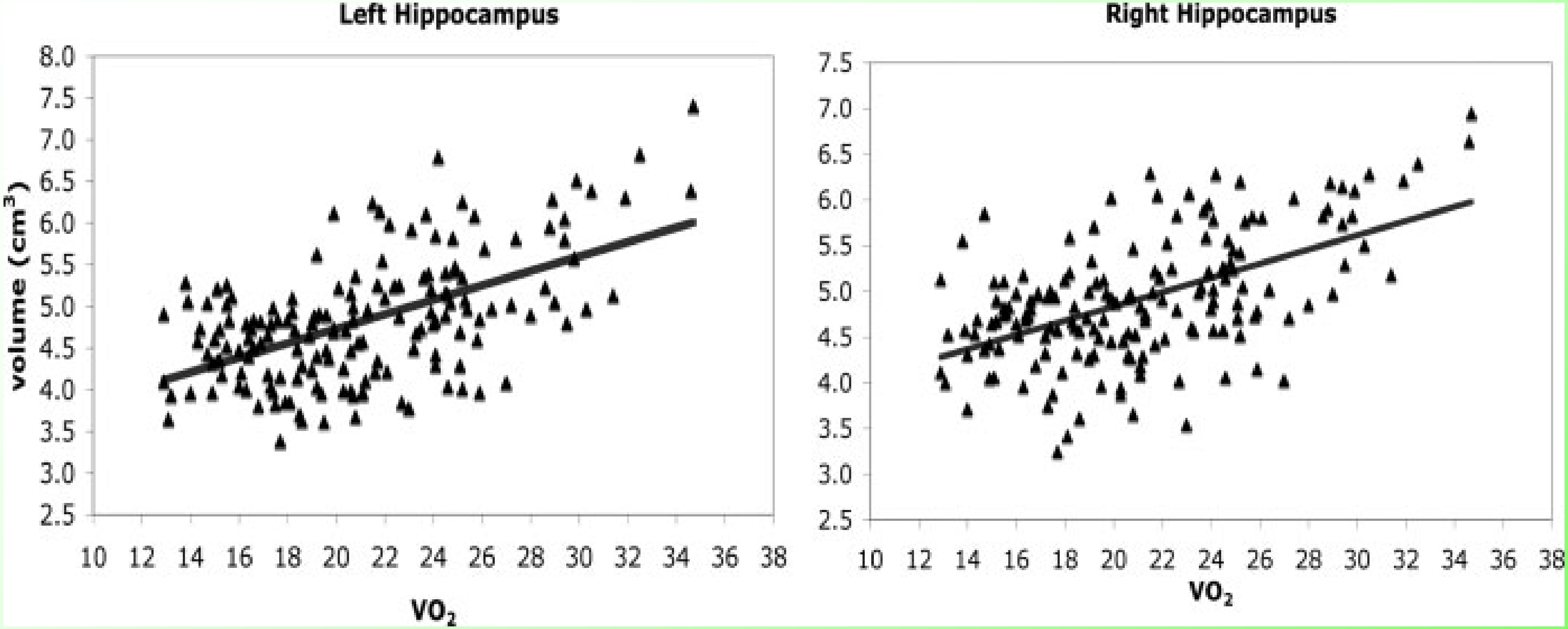


Hippocampal volume:

Erickson et al., 2009

109 Female and 56 Male

Age: 59-81 years old


Left Hippocampus
Right Hippocampus
volume (cm³)
VO₂
VO₂

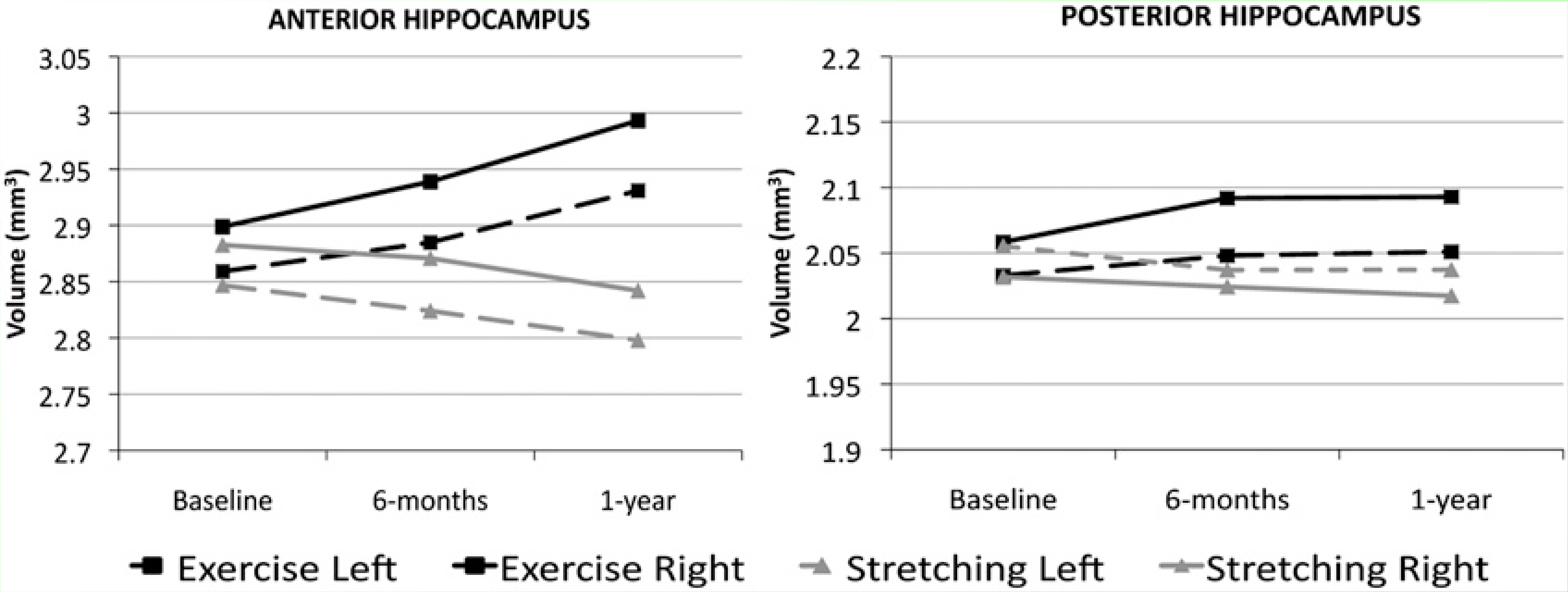
A training study - Erickson, et al., 2011

Increases size of hippocampus
Improves memory

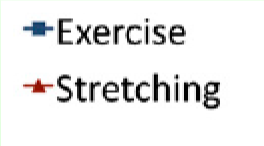
Aerobic training: N=60

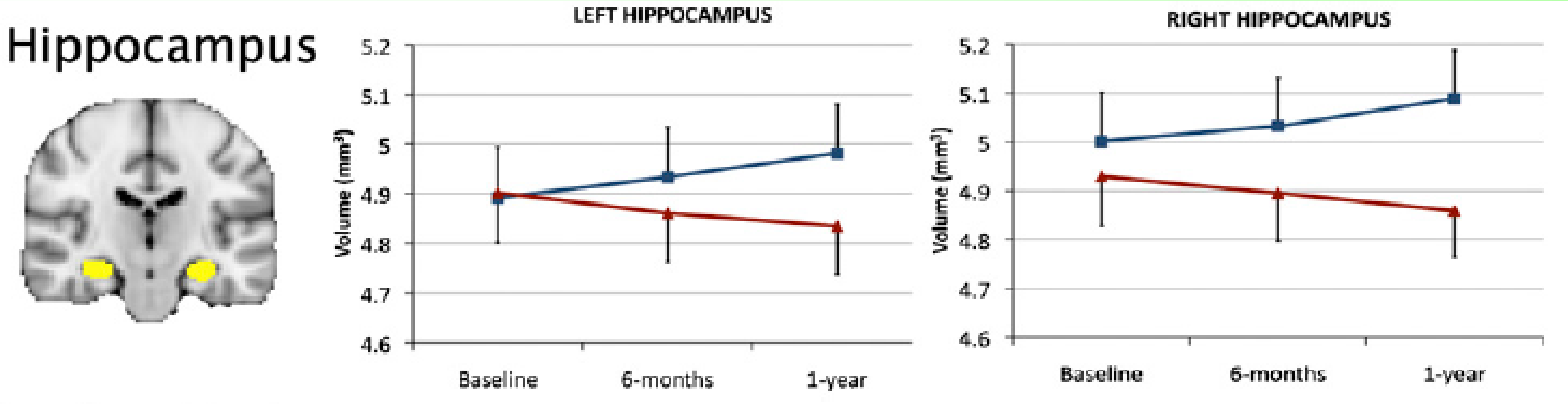
40 minute walking sessions – for a year
60-75% maximum heart rate

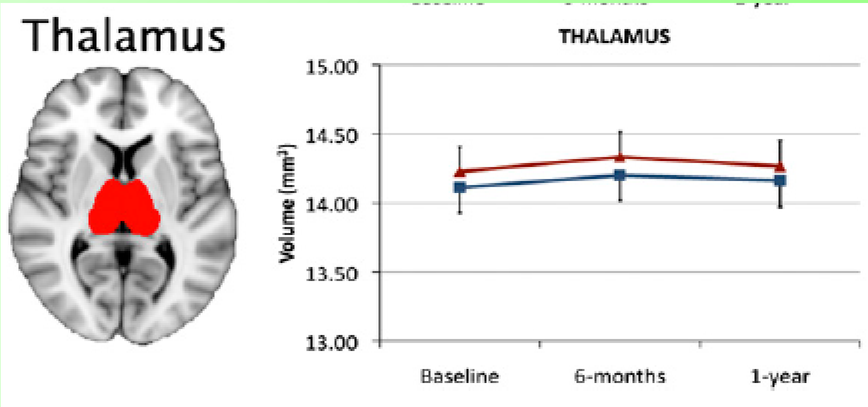
Stretching and tones –
yoga, dumbbells, resistant bands



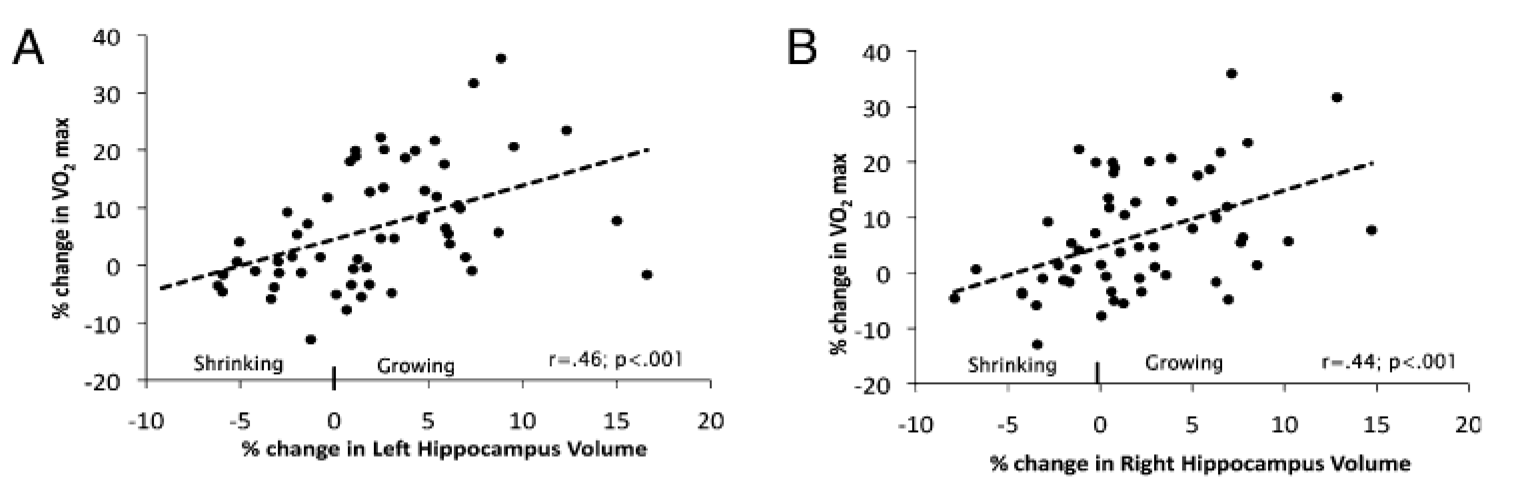
The exercise group showed a selective increase in the anterior hippocampus and no change in the posterior hippocampus.


Exercise
Stretching


Hippocampus
LEFT HIPPOCAMPUS
RIGHT HIPPOCAMPUS
Volume (mm³)
5.2
5.1
5
4.9
4.8
4.7
4.6
Baseline
6-months
1-year

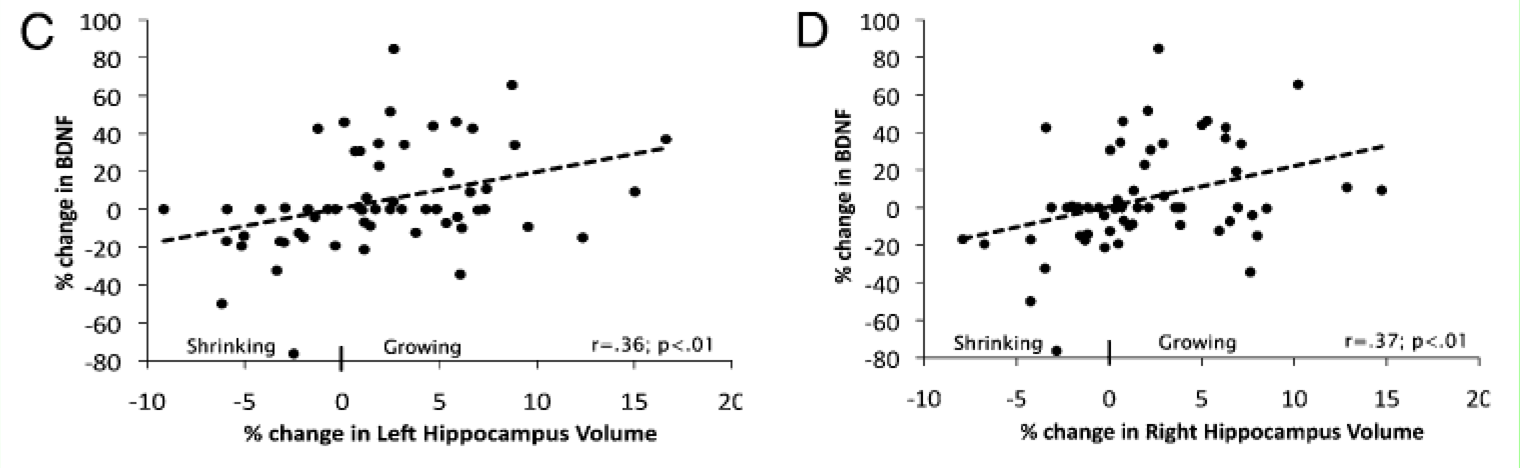

Thalamus
THALAMUS
Volume (mm³)
15.00
14.50
14.00
13.50
13.00
Baseline
6-months
1-year

Aerobic fitness and hippocampal volume

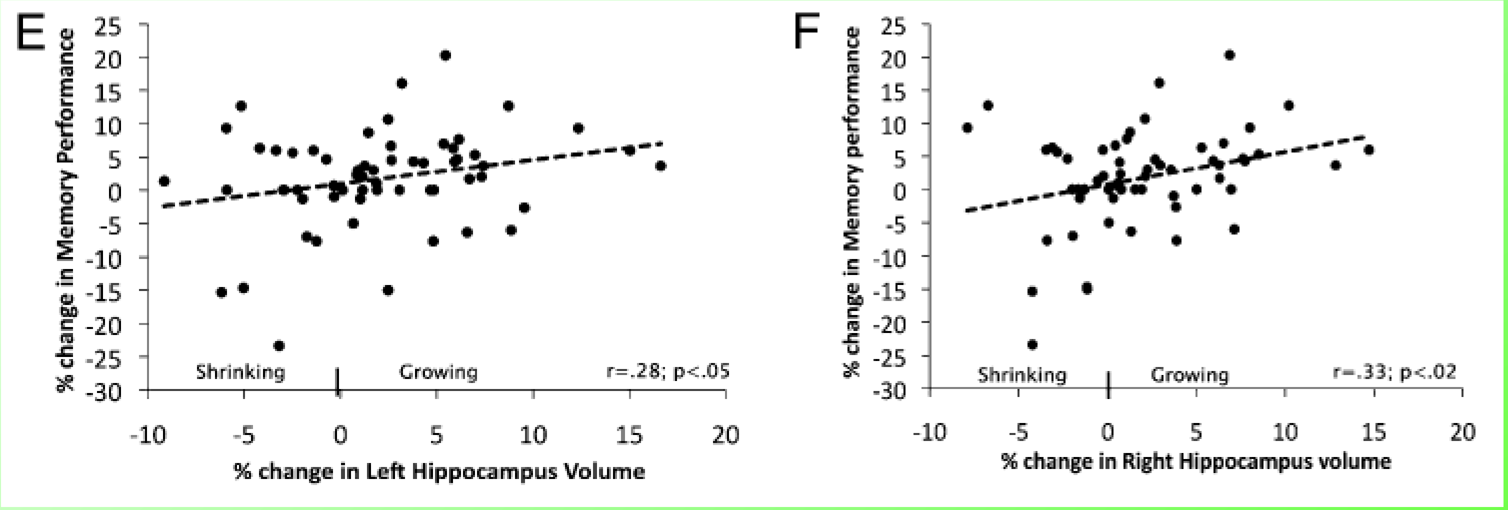


Erickson, et al., 2011

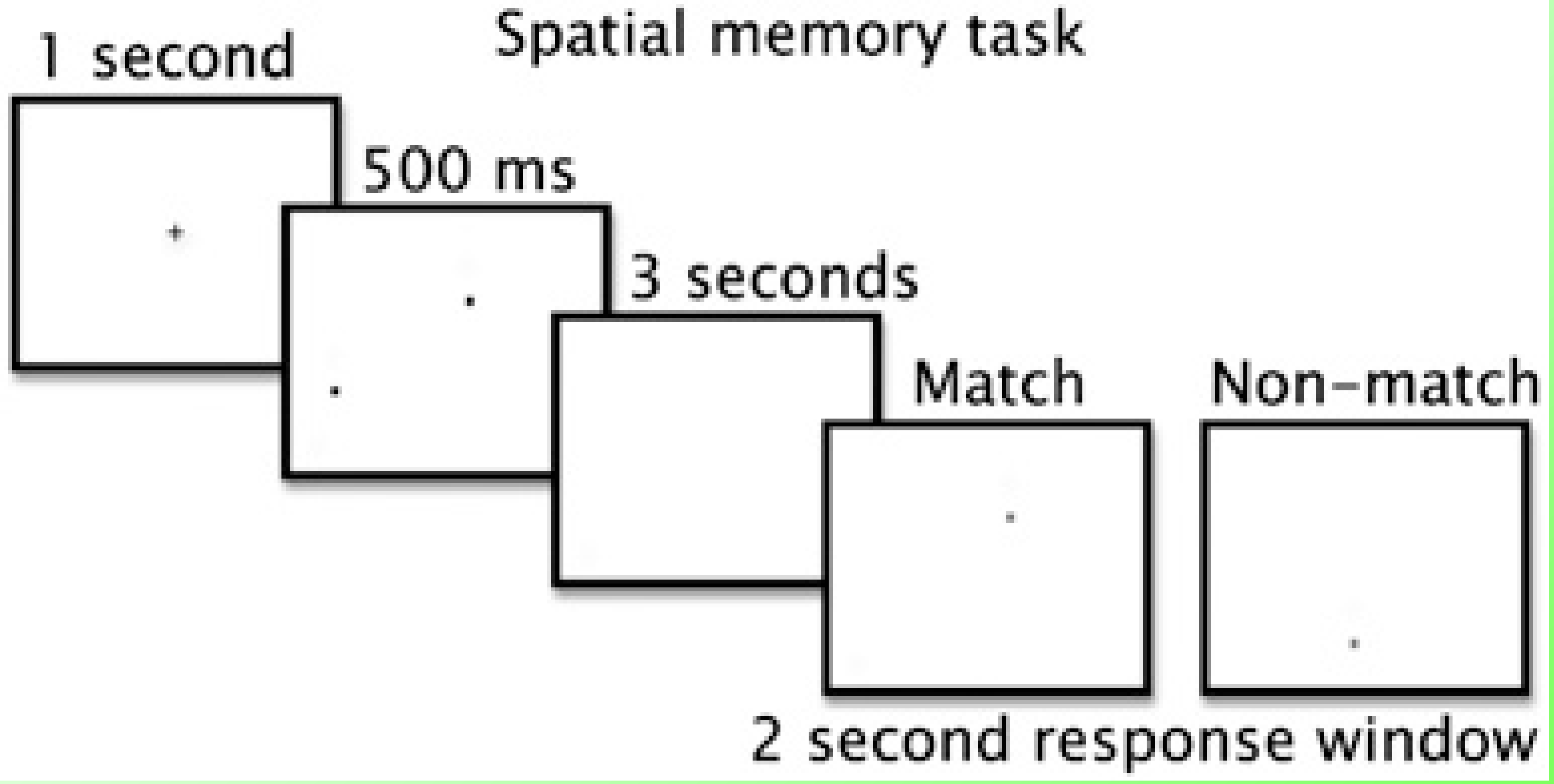
Hippocampal volume and cell proliferation



Hippocampal volume and spatial memory



Erickson, et al., 2011



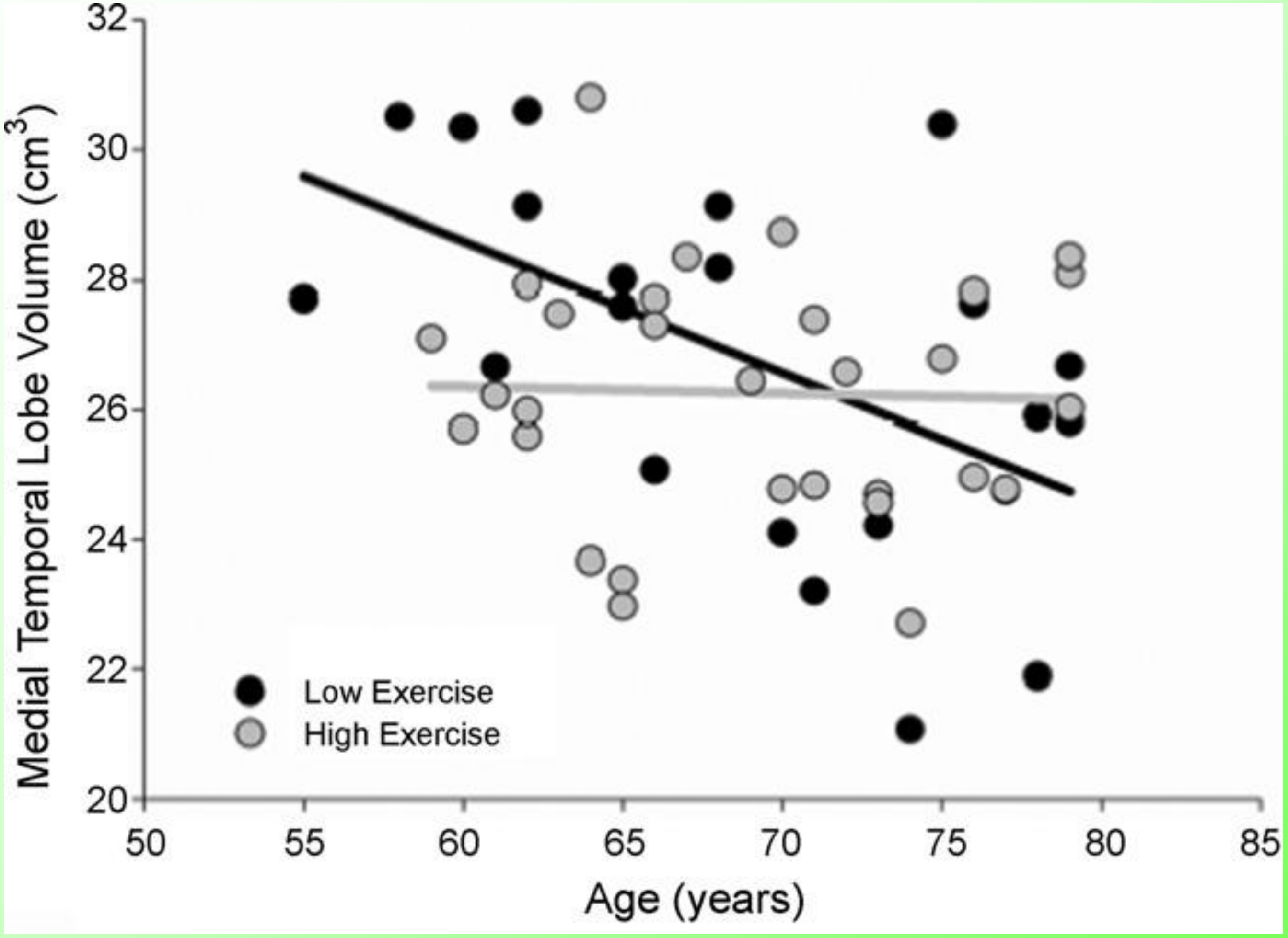
Erickson, *et al.*, 2011

The medial temporal lobe:

Bugg & Head, 2011

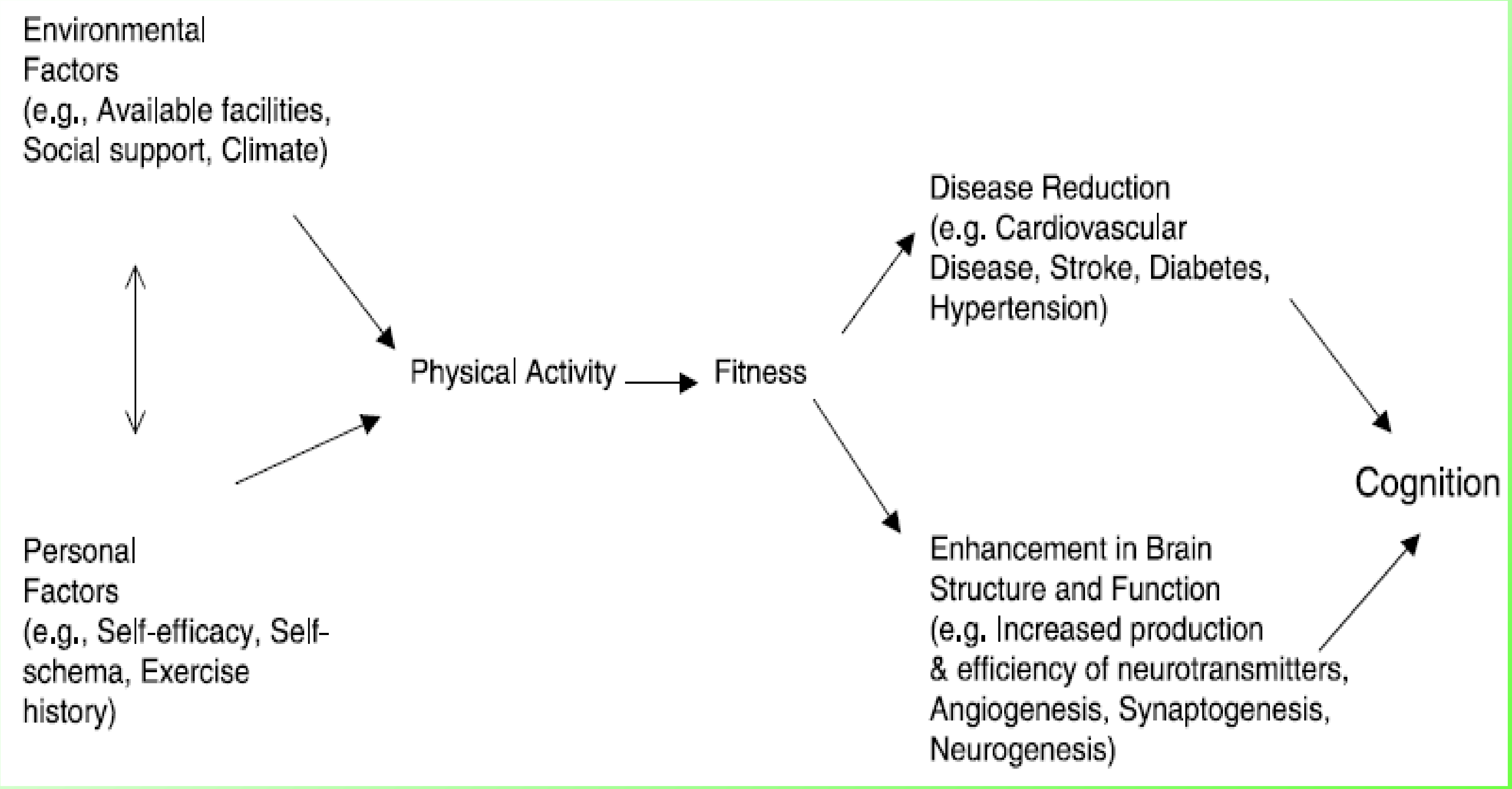
N=52, 55-79 years old

Exercise history in the past 10 years



Bugg & Head, 2011

The Big Picture



McAuley, Kramer, & Colcombe, 2004

Thank You

NO