



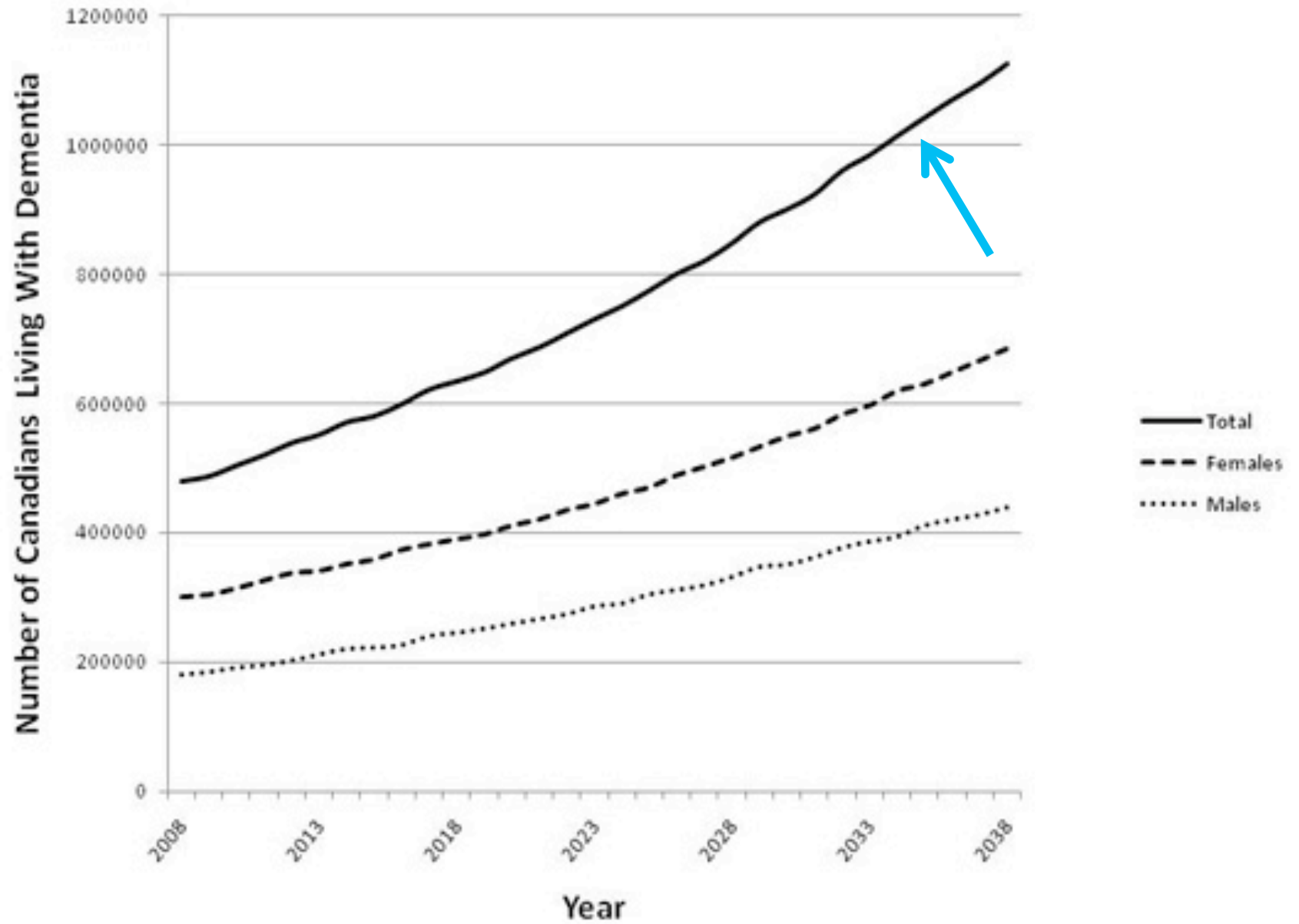
# THE COGNITIVE BENEFITS OF EXERCISE

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# Background

- Cognitive decline among seniors – major health issue
- 35 million worldwide have dementia
- Incidence rate = 4.6 million new cases of dementia/year
  - one new case every 7 seconds

### Prevalence of Dementia in Canada by Sex 2008 to 2038

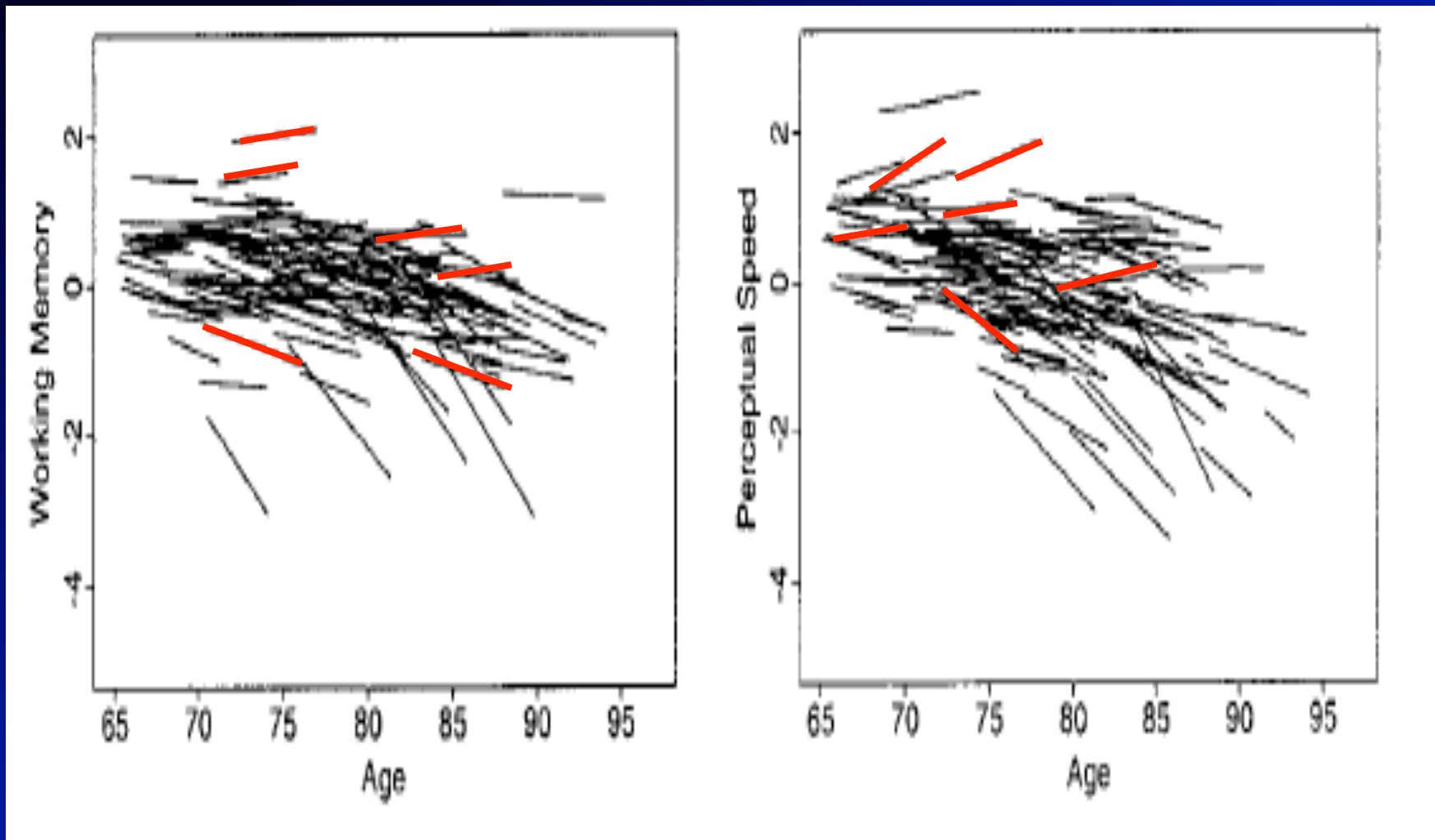


# Significance of Prevention

- If delay onset of AD by 2 years in the USA, 50 years thereafter there would be ~ 2 million fewer cases than currently projected.
- If delayed by 1 year, ~ 800,000 fewer prevalent cases.

Brookmeyer *et al.*, 1998

# Is Cognitive Decline Inevitable?



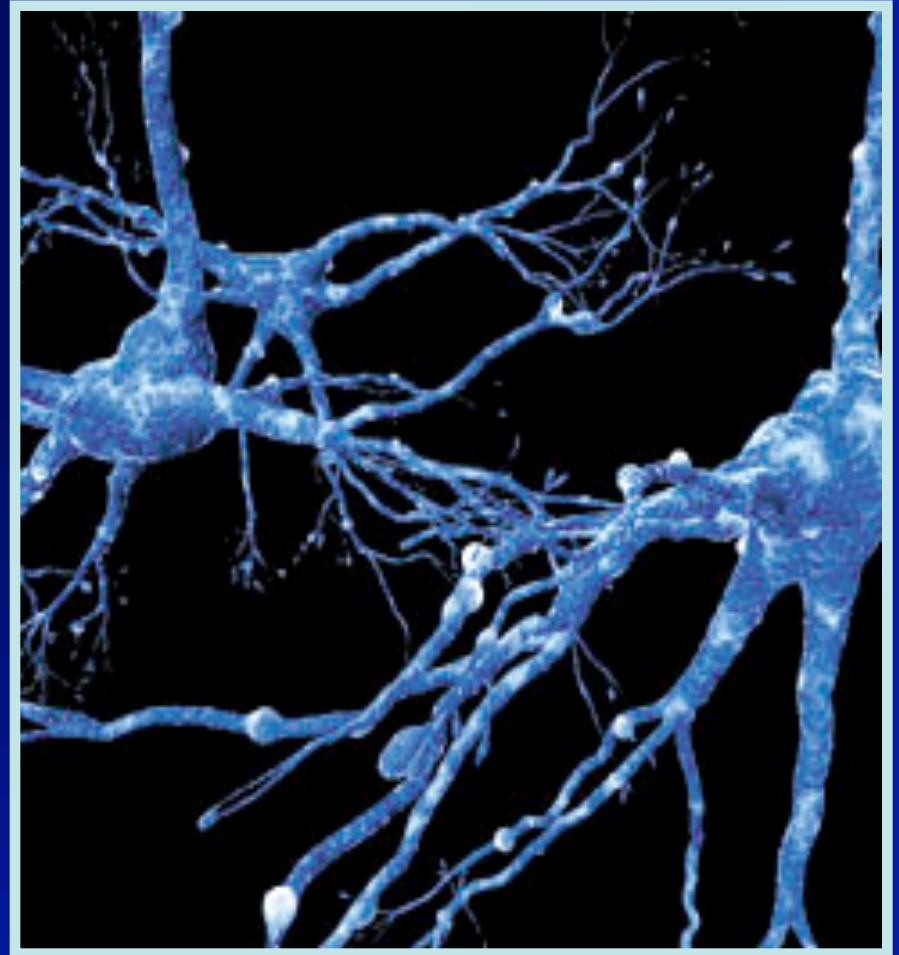
Wilson *et al.*, 2002 (Catholic Clergy)

# Is Cognitive Decline Inevitable?

- Cognitive decline and brain deterioration are common with aging
- Much variability in the rate and degree of decline
- Decline & deterioration are neither ubiquitous nor inevitable with aging

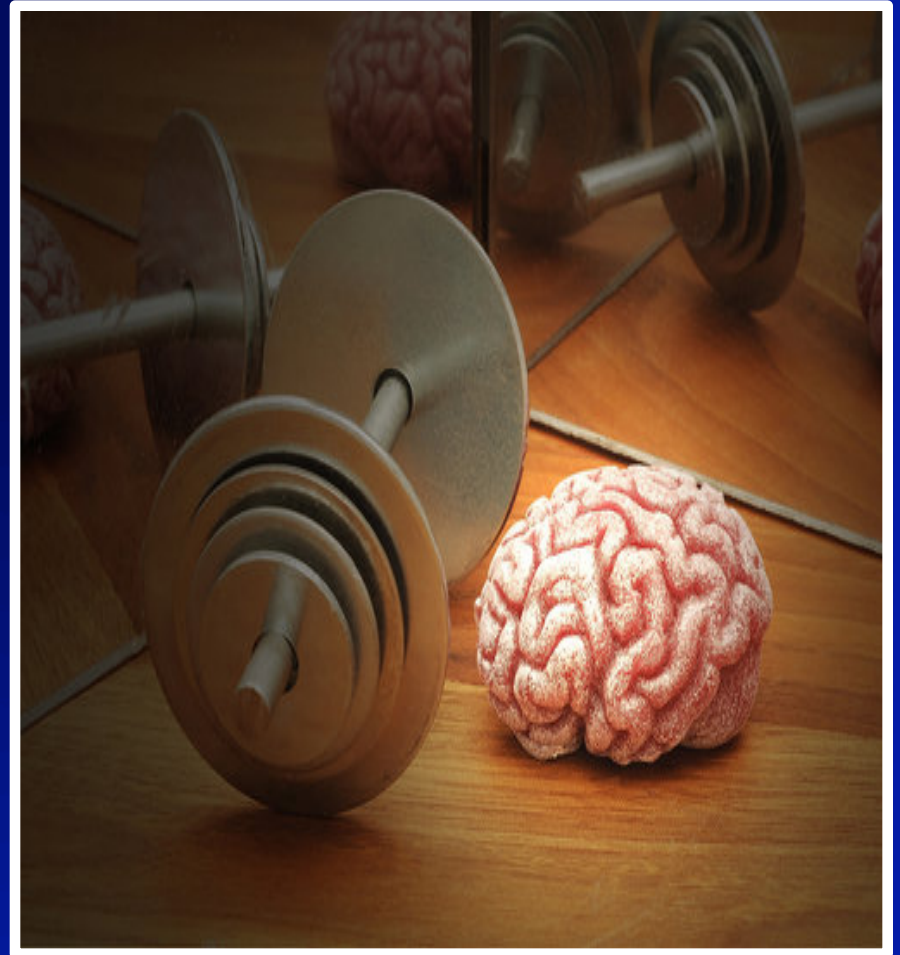
# Decline is not Inevitable with Aging

- Brain is plastic throughout the lifespan
- Brain structure and function adapt to experience
  - Akin to your muscles responding positively to exercise



# Physical Activity and the Brain

- Protects the brain by reducing risk factors for cognitive decline
  - e.g., high blood pressure
- Promotes growth of new cells and blood vessels





# Physical Activity and Cognition: The Evidence

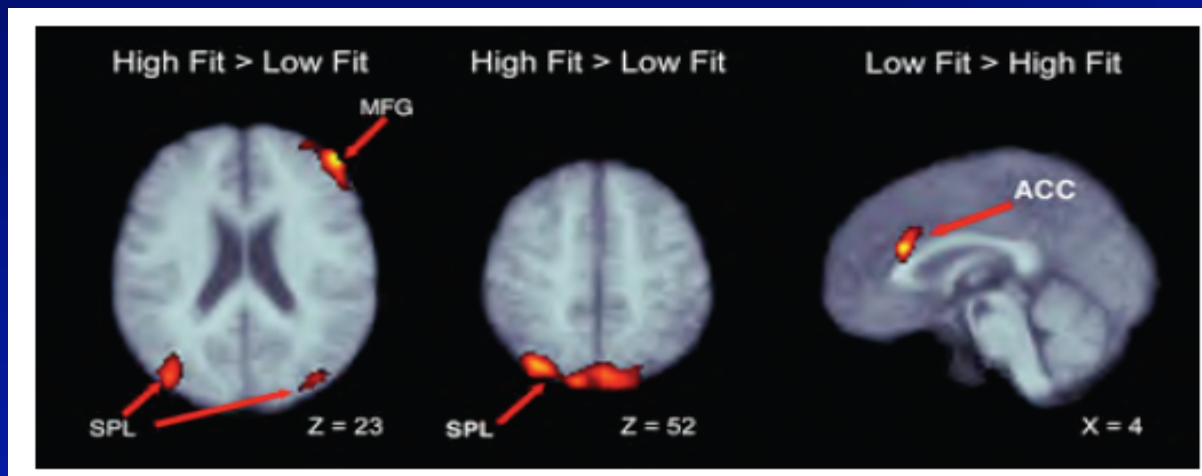
- Animal
  - Positive effects of physical activity on cognitive performance (e.g., learning, memory) and brain structure
- Human
  - Evidence supporting the neuroprotective role of physical activity comes from:
    - Prospective observational studies
    - Randomized controlled trials (RCTs)

# Physical Activity and Cognition: RCTs of Exercise Training

- Exercise Training
  - Aerobic training
  - Resistance training
  - Balance/agility training

# Physical Activity and Cognition: RCT of Aerobic Training

- Colcombe *et al.*, PNAS, 2004
  - 26-week, 3x/week walking program improved cognitive performance and brain function as assessed by fMRI
  - Increases in gray and white matter volumes as assessed by MRI



# Physical Activity and Cognition: RCT of Resistance Training

- Liu-Ambrose *et al.*, Arch Intern Med, 2010 (1)
  - 1x/week and 2x/week resistance training significantly improved cognitive performance
  - 2x/week resistance training also had benefits for brain function as assessed by fMRI (under review)



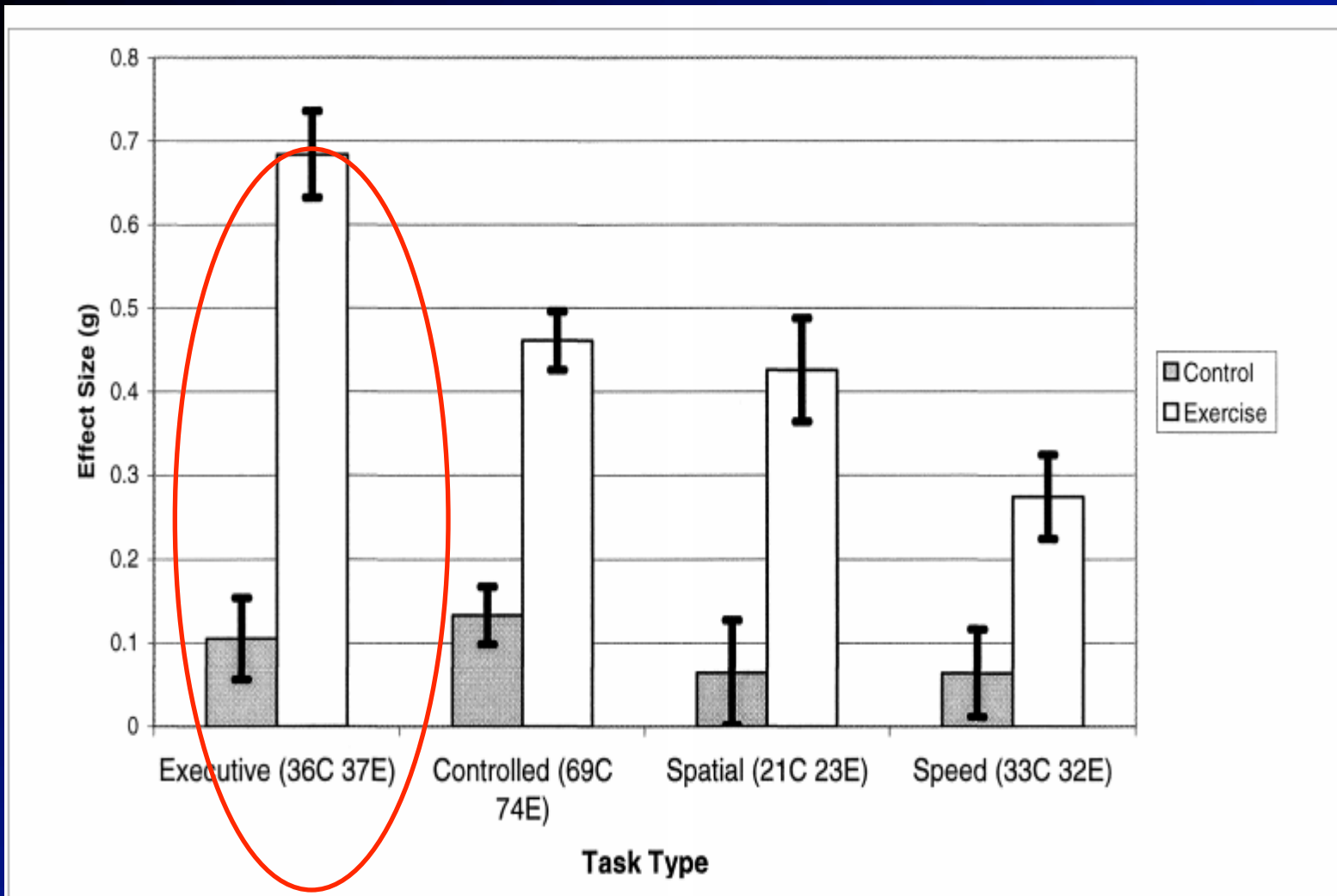
# Physical Activity and Cognition: RCT of Resistance Training

- Liu-Ambrose *et al.*, Arch Intern Med, 2010 (2)
  - Benefit of resistance training on cognitive performance persisted 12 months after formal cessation



# Physical Activity and Cognition: Meta-Analysis of Aerobic Training

- Colcombe and Kramer, Psychol Sci, 2003
  - Exercise training positively influences cognitive performance (4 domains)
  - Most beneficial for executive processes
  - Studies with more women show a larger effect of training on cognition
  - Effect size of training is similar for both normal and cognitively impaired adults (~0.5)



**Fig. 1.** Effect sizes for the different process-task types reflecting the four theoretical hypotheses concerning the process-based specificity of the benefits of fitness training. Parenthetical notations on the x-axis indicate the number of effect sizes contributing to the point estimates for each task type in the exercise (E) and nonexercise (C) groups. Error bars show standard errors.

Can Exercise Training Benefit  
those with Cognitive Impairment?



# Physical Activity and Cognitive Impairment: Meta-Analysis

- Heyn *et al.*, Arch Phys Med Rehabil, 2004
  - Is exercise broadly beneficial?
  - RCTs; MMSE < 26/30
  - Included those with mild cognitive impairment to dementia
  - 30 trials, 2020 participants included

# Physical Activity and Cognitive Impairment: Meta-Analysis

Table 1: Summary ES Values of Exercise Training

Outcome	No. of Effects	ES*	Standard Error	ES 95% CI
Health-related physical fitness <sup>†</sup>	40	.69	.04	.58-.80
Cardiovascular	18	.62	.06	.45-.78
Strength	17	.75	.06	.58-.93
Flexibility	4	.91	.17	.47-1.36
Cognitive	12	.57	.07	.38-.75
Functional	20	.59	.06	.43-.76
Behavior	13	.54	.07	.36-.72
Overall ES <sup>  </sup>	85	.62	.03	.55-.70

# Mild Cognitive Impairment

- Diagnosis based on memory complaints within the context of normal everyday function
- Greater risk of developing dementia
- Heterogeneous group
- Prevalence and progression rates vary depending on the methodology and diagnostic criteria used

# Physical Activity & MCI

Control

Usual Care

Exercise

Walk & Other  
Physical Activity

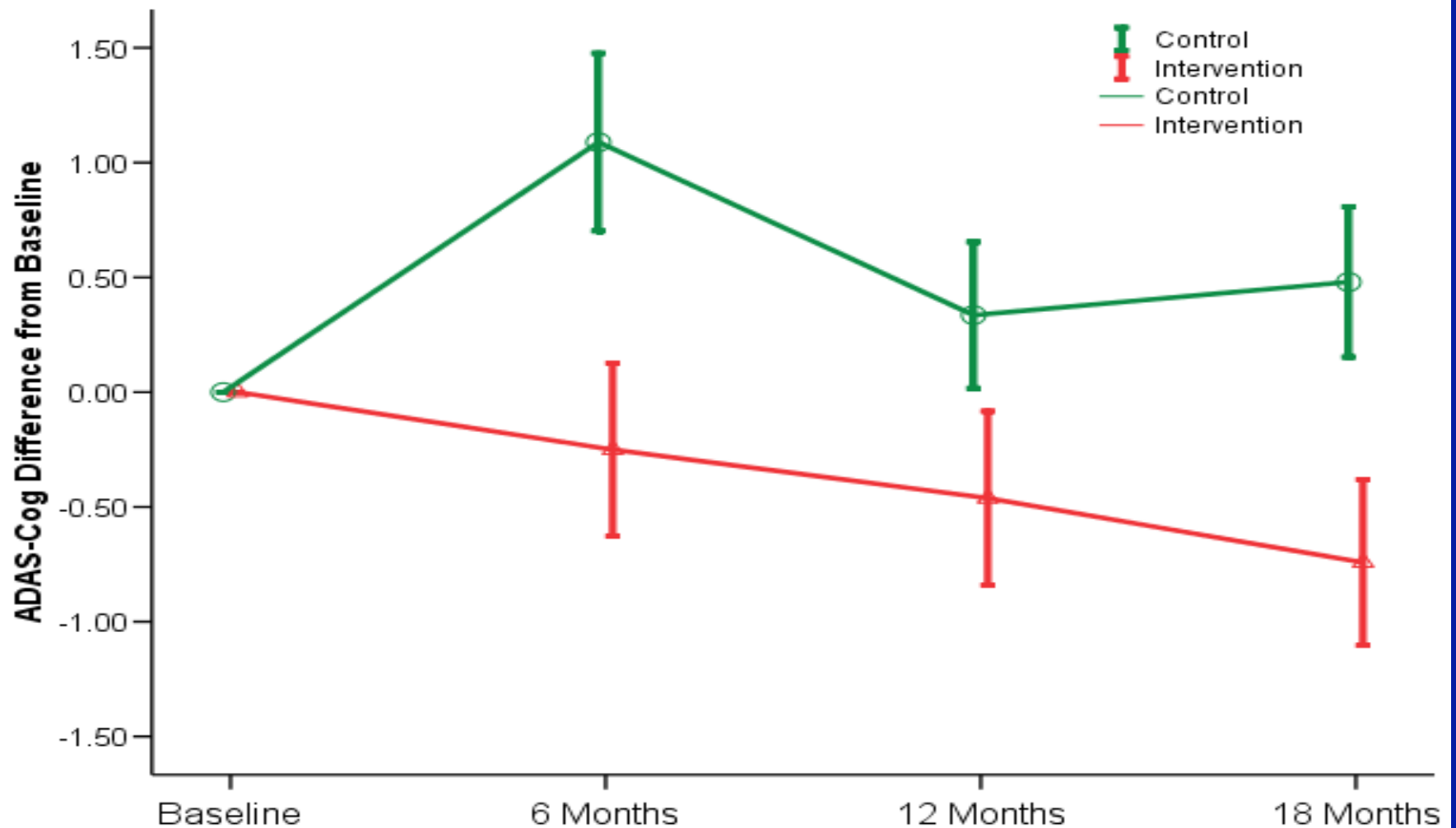
Intervention

Follow-Up

Time (Months) - - - -> 0 6 12 18

Lautenschlager *et al.*, JAMA, 2008

# Physical Activity & MCI



# Aerobic Exercise & MCI

Control

Stretching Exercise (4x/week)

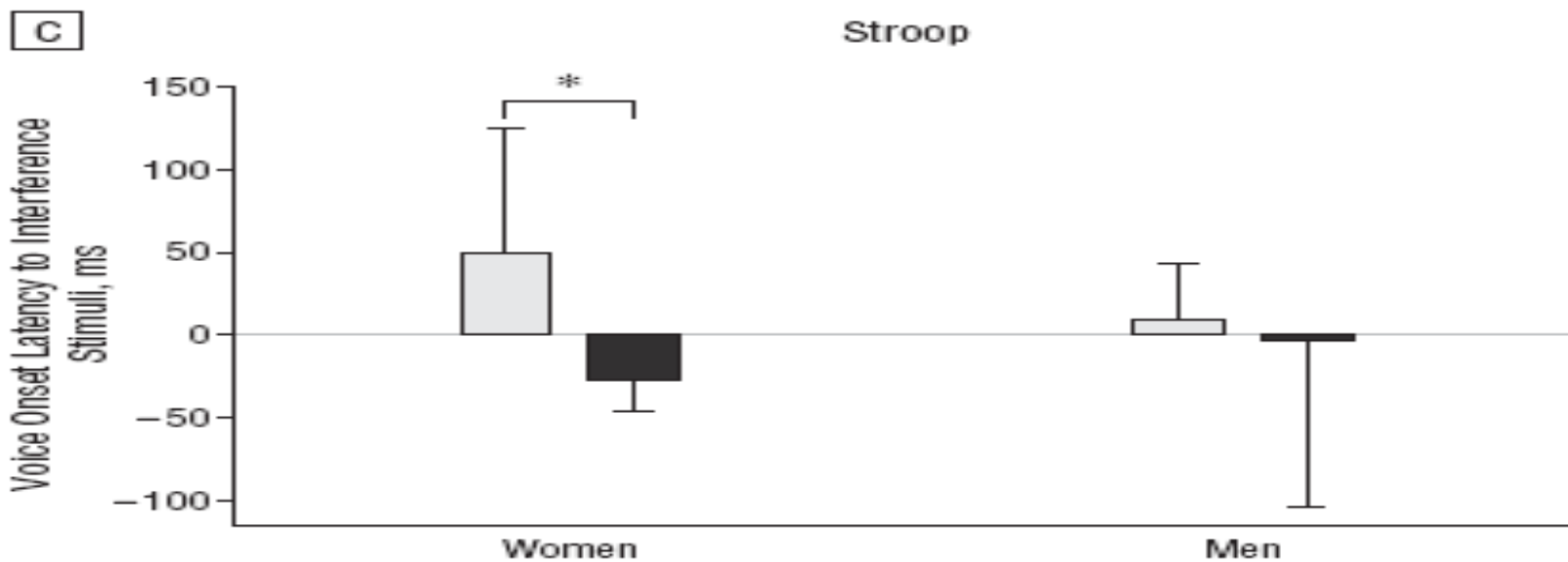
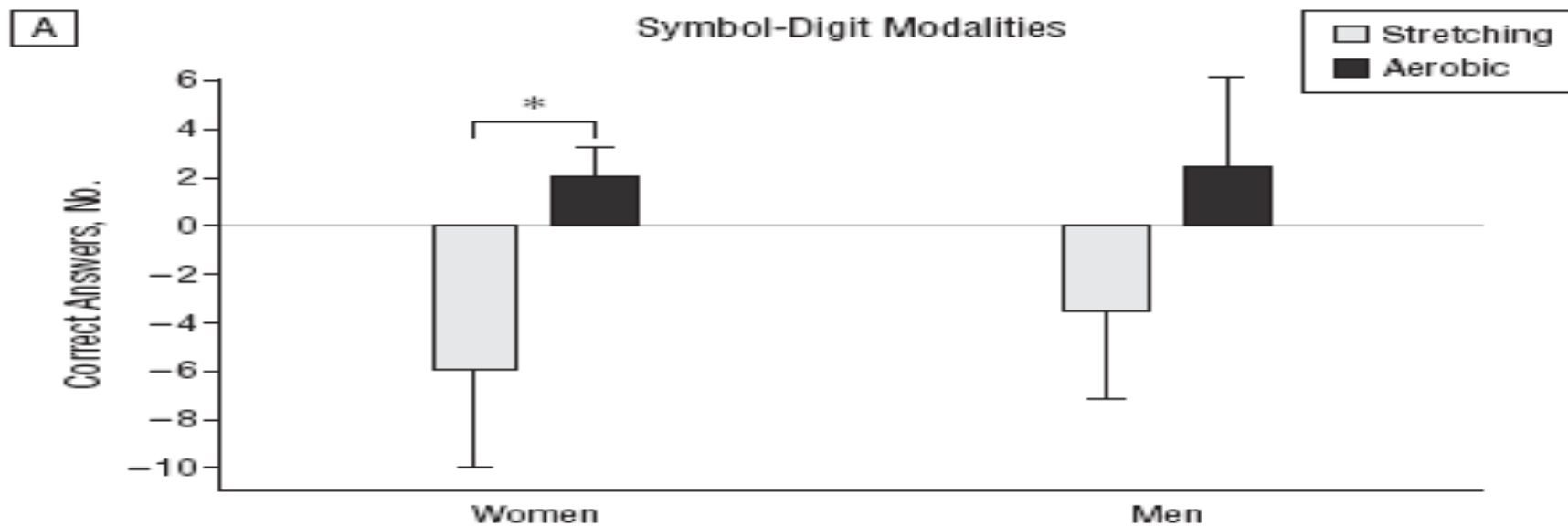
Exercise

Aerobic Training (4x/week)

Time (Months) - - - -> 0 3 6

Baker *et al.*, Arch Neurol, 2010

# Aerobic Exercise & MCI



# Summary

- Exercise has both benefits for both cognitive and brain function
  - Even among those with cognitive impairment
- More work is needed to refine exercise prescription for optimal benefits:
  - Type
  - Frequency
  - Duration
  - Intensity



# Current Research Highlight

- PROMOTE Study
  - Effect of aerobic exercise on cognitive function
    - Individuals with mild vascular cognitive impairment
    - 12 month study
    - More information is available!

# Acknowledgements



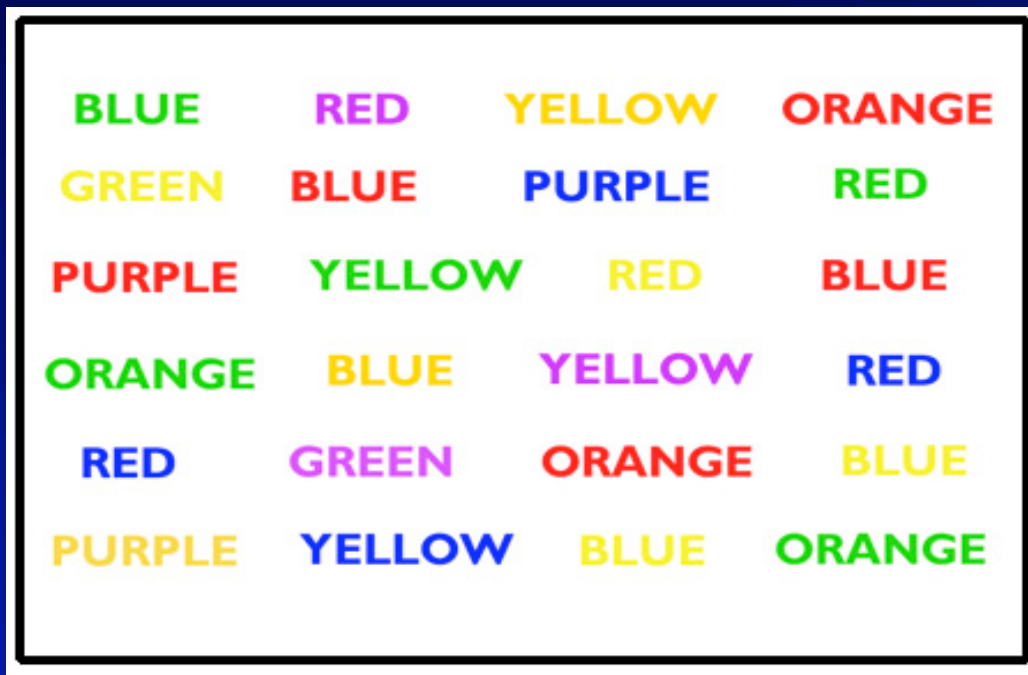
- Participants
- Colleagues
- Michael Smith Foundation for Health Research
- Canadian Institutes of Health Research
- Vancouver Foundation

# Thanks!



# Primary Outcome Measure

- Selective attention and conflict resolution
  - Associated with falls, balance, and mobility
  - Responds to exercise



Rapport *et al.*, 1998

Liu-Ambrose *et al.*, 2006

Liu-Ambrose *et al.*, 2008