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
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

  - 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

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

Time (Months)

0 6 12 18

Intervention Follow-Up

Lautenschlager et al., JAMA, 2008
Physical Activity & MCI

The graph illustrates the change in ADAS-Cog scores over time for two groups: Control and Intervention. The x-axis represents time points: Baseline, 6 Months, 12 Months, and 18 Months. The y-axis shows the difference from Baseline. The green line represents the Control group, and the red line represents the Intervention group. The graph shows a trend where the Intervention group has a higher ADAS-Cog score difference from Baseline compared to the Control group at 6 Months, with a decrease by 12 Months, and a further decrease by 18 Months.
Aerobic Exercise & MCI

Control

Exercise

Stretching Exercise (4x/week)

Aerobic Training (4x/week)

Time (Months)

Baker et al., Arch Neurol, 2010
Aerobic Exercise & MCI

Symbol-Digit Modalities

Correct Answers, No.

Women

Men

Stretching

Aerobic

* p < 0.05

Stroop

Voice Onset Latency to Interference Stimuli, ms

Women

Men

* p < 0.05
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