Moving and Improving: The Potential for Exercise to Enhance Word Retrieval in Aphasia

Presentation by

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Outline

- Cognitive function in aging and aphasia
- Exercise effects on cognition
- Acute effects of physical exercise on novel word learning
- Potential for physical exercise to improve word retrieval treatments in aphasia

Cognition and Aging

- Age-related changes in cognition apparent before age 50
- Biggest effect of aging is on executive functions
- Speed of processing, reasoning, and memory also impacted
- Negative effects on learning

Cognition and Aphasia

- Individuals aphasia often have lasting cognitive impairments
  - attention
  - executive function (working memory, inhibition)
  - visuospatial abilities
- Affect language processing and may limit rehabilitation potential
  - less likely to acquire/maintain benefit from treatment

- Treatment can improve word retrieval in aphasia
  - individual variability
  - magnitude and duration of change

Can we make traditional treatments even more effective?

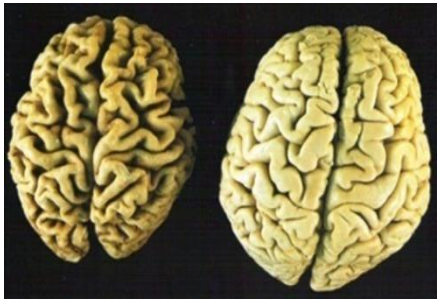
- Neuromodulatory approaches to improving cognitive functions are increasingly popular in aging and disease

  - pharmacology
  - non-invasive brain stimulation (TMS, tDCS)
  - physical exercise (acute and long-term)

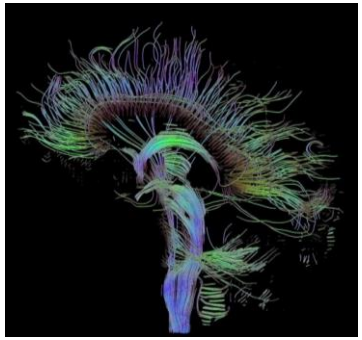
Exercise and the Brain

Aging and disease can decrease brain volume BUT exercise can:

- Increase brain volumes (frontal and temporal)



- Increase connections between brain regions



Exercise and the Brain

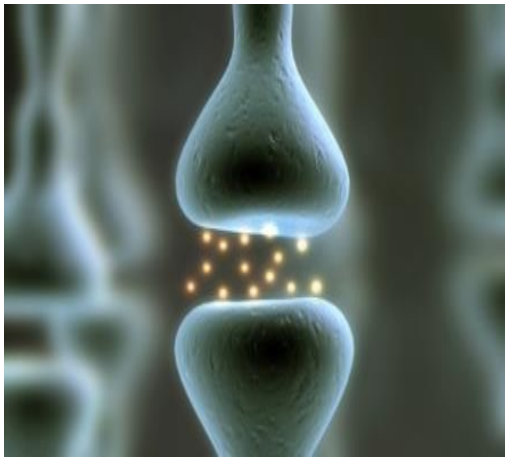
Aging and disease can cause vascular changes in the brain BUT exercise can:

- Increase cerebral blood flow

Exercise and the Brain

Aging and disease can decrease neurochemical and neurotrophic release BUT exercise can:

- Increase the release of dopamine and BDNF, which are involved in learning and memory



Exercise and the Brain

Exercise changes **the brain** changes behavior

- Cognitive function
- Psychological wellbeing
- Physical wellbeing

Exercise and the Brain

In comparison to other neuromodulatory techniques:

- Safe for most people
- Cost-effective
- Accessible
- Acceptable

Exercise and Cognition

- Exercise can improve cognitive function in normal aging
  - long-term programs (chronic exercise)
  - single sessions (acute exercise)
- Improvements in executive function most commonly reported
- Single sessions can have a moderate-large effect on retention in long-term memory (Roig et al., 2013)
- Individuals with the lowest levels of cognitive ability may improve most (Sibley & Beilock, 2007; Schmidt-Kassow et al., 2013)

Exercise and Cognition

- Fewer studies on exercise to improve cognition in stroke
- Some studies have failed to demonstrate exercise-induced changes in cognition (Cummings et al., 2011)
- Some evidence for positive effects:
  - executive function (Kluding, et al., 2011; Rand et al., 2010)
  - memory (Rand et al., 2010; Pyoria et al., 2007)
  - language (Pyoria et al., 2007)

Exercise and Cognition

- Problems with current exercise studies in stroke:
  - small sample sizes
  - lack of experimental control
  - lack of information about presence/severity of aphasia
  - differences in exercise training/assessment, cognitive measures, individual factors

Exercise and Cognition

Overall Conclusion:

- Language, learning and memory are supported by overlapping brain regions whose functions are known to improve with exercise

Can word retrieval treatment accompanied by exercise boost treatment outcomes?

Start from the

Aging and Aphasia

- The brain of someone with aphasia is (in most cases) an aging brain

- Signal to noise ratio in the brain increases with age and is further increased in aphasia
  - right frontal activity increases may interfere with word finding in neurologically healthy adults and people with aphasia

- It may be important to consider the aging component in developing treatments for age-related disease (Crosson et al., 2015)

Novel word learning

Dependent on three processes:

1) availability of a semantic link between the new word and existing words

2) ease of creating and maintaining a phonological form in working memory

3) support of the new phonological form by similar forms stored in long term memory

Service & Craik, 1993

Novel word learning

Memory Mechanisms

- Acquisition (encoding)
- Consolidation
- Supported by the medial temporal lobe, hippocampus and language areas of the brain (Davis & Gaskell, 2009)

What does novel word learning have to do with word re-learning and word retrieval ?

- Overlapping semantic and phonological processes
  - Familiar object– novel word
  - Unfamiliar object– novel word

- Approaches to improve word learning have translated to improved word retrieval in aphasia

Basso et al., 2001; Whiting et al., 2007, 2008

What do we know about exercise and novel word learning?

- Acute exercise has a positive influence on word learning in young adults (timing, intensity)

- Related to different mechanisms
  - Immediate learning= BDNF, salivary cortisol
  - 1 week retention= dopamine
  - 8 week retention= norepinephrine

Salias, 2013; Schmidt-Kassow et al., 2010, 2013; Winter et al., 2007

Aim of preliminary study:

To determine if acute, moderate-intensity aerobic exercise significantly improves novel word learning in neurologically normal older adults

Long-term goal of research:

Development of targeted, exercise-based treatments for word retrieval deficits in aphasia

Method

Design

- Within-subjects crossover design comparing moderate-intensity exercise to gentle stretching

Participants

- 10 monolingual English speakers (3 male, 7 female)
- 55-74 years old (mean= 66.2)

Method

- *Three training sessions* in each condition (AE and ST):

AE condition

- 30-minute of cycling
- Individual target heart rate zone (50-75% of MHR)

ST condition

- 30-minute sessions
- Gentle upper and lower extremity stretches

Method

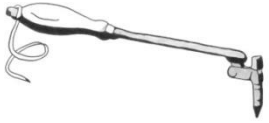
Word learning task

- 60 objects randomly presented
  - familiar objects (n=30)

bisob

  - unfamiliar ancient farm tools (n=30)

gesil



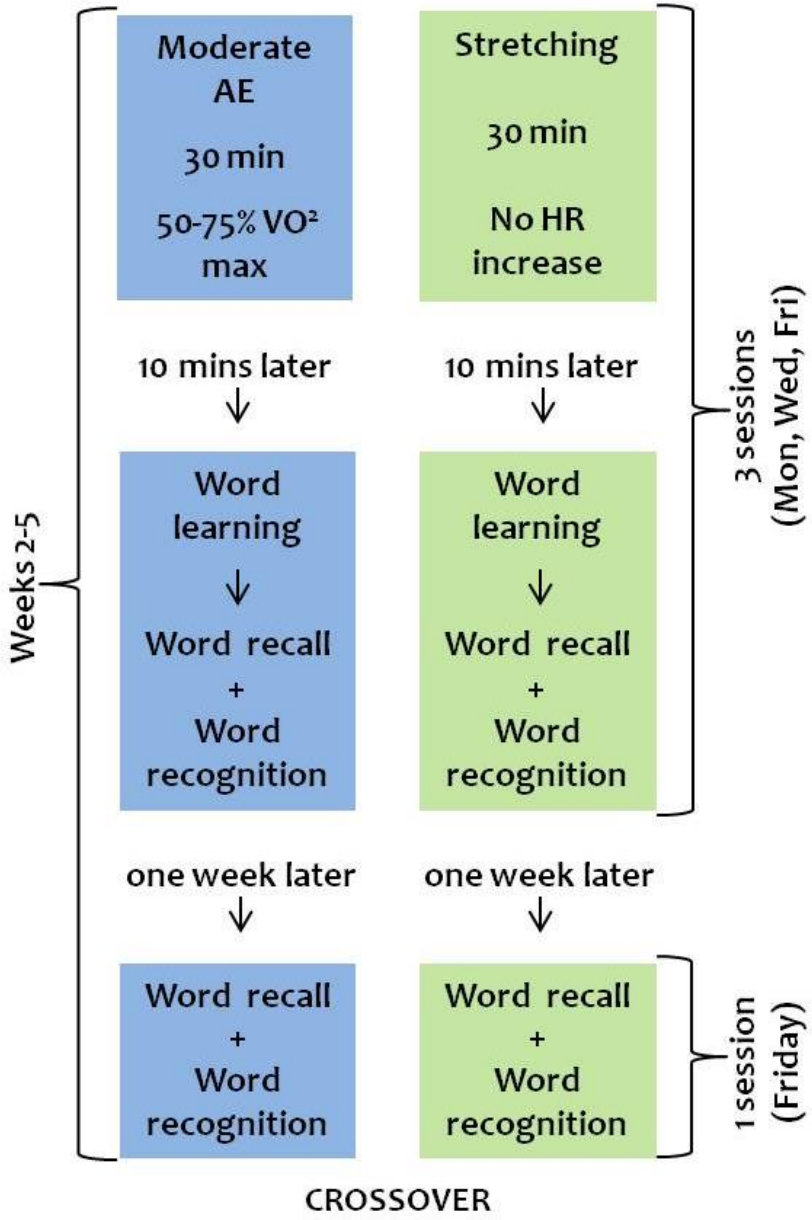
Method

Recall and Recognition Tasks

- Type the nonword name

- Indicate as quickly and accurately as possible which of three objects matches the nonword

- Immediately after learning sessions and one week later

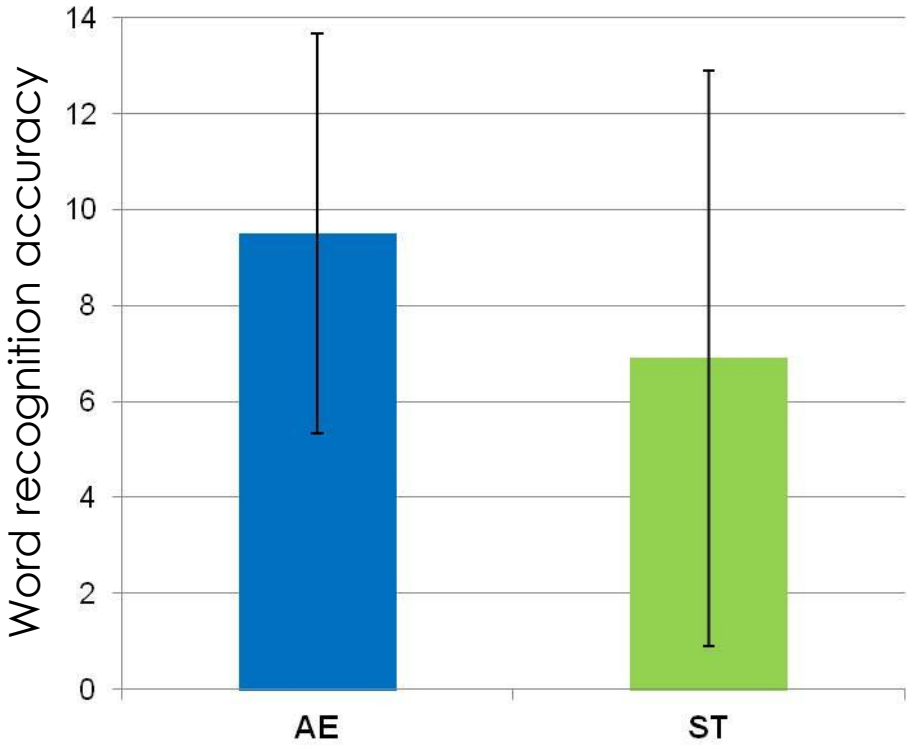

Moderate AE
30 min
50-75% VO² max
Stretching
30 min
No HR increase
10 mins later
10 mins later
Word learning
Word recall + Word recognition
Word learning
Word recall + Word recognition
one week later
one week later
Word recall + Word recognition
Word recall + Word recognition
Weeks 2-5
3 sessions (Mon, Wed, Fri)
1 session (Friday)
CROSSOVER

Results

For recognition of familiar objects:

❖ Significant difference in conditions (p= .030, ηp^2= .57)

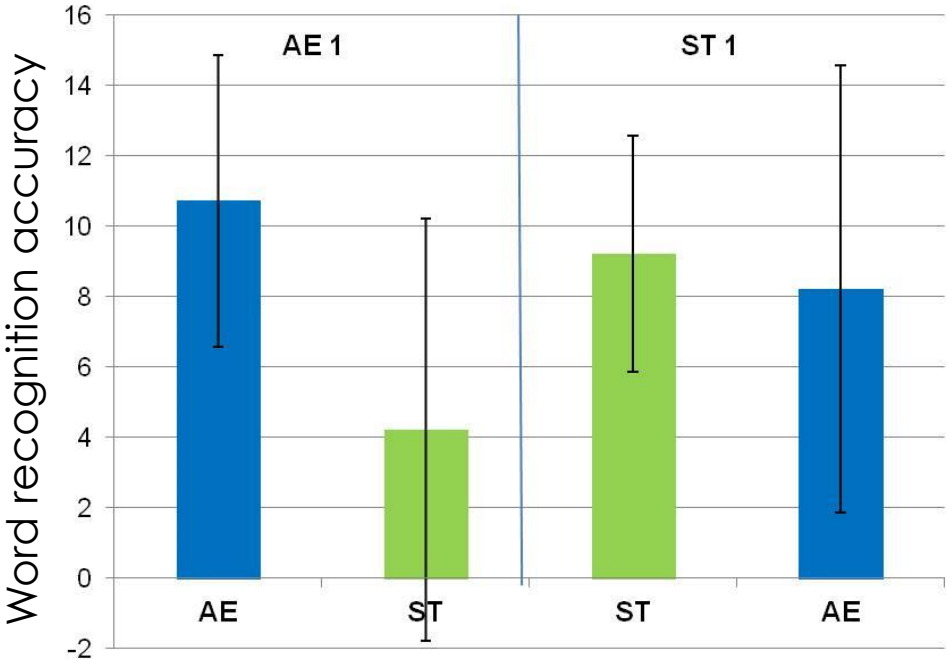
• better in the AE condition



Results

❖ Significant Condition x Condition Order interaction (p= .008, ηp^2= .71)

- better in the AE condition for the AE1 group



Discussion

- Word learning task was difficult, so not able to capture the effect of exercise on word recall
- Moderate-intensity exercise enhanced word recognition for familiar objects
  - semantic information important
  - recognition is relevant to recall
- Better performance in the AE1 condition may be due to long-term retention of words after exercise (consolidation)

Conclusions

- Findings in neurologically normal older adults are similar to findings in young adults
- More data are needed to show exercise effects on word *recall*
- Preliminary evidence supports further research

Future Research

- Individual factors
  - Baseline cognitive function
- Exercise factors
  - Intensity, duration, type of exercise
- Task-related factors
  - Intensity, word properties

Future Research

- **Temporal factors**
  - Exercise before vs. after learning
- **Mechanisms of change**
  - Neurophysiological mechanisms
  - Memory mechanisms

Considerations for Aphasia

- Physical impairment
- Fatigue

Considerations for Aphasia

It will take more than just evidence to implement

- Beliefs about exercise after stroke
  - education
- Self-efficacy regarding exercise
  - change in identity, attitude first

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