Exercise-induced increased network connectivity in the elderly: walking improves brain efficiency

Ashley Morgan¹, Paul Laurienti¹, Mark Espeland¹, Walter Rejeski², Janine Jennings², Jeff Katula², Qawi Telesford, Crystal Wuchelkav, Jonathan Burdette¹
¹Wake Forest University Health Sciences, Winston-Salem, NC, ²Wake Forest University, Winston-Salem, NC

Introduction

- Literature suggests that exercise is beneficial for cognitive function in older adults
- We explore network connectivity changes due to an exercise intervention
- Exercise-induced changes in hippocampal blood flow are evaluated as a potential mechanism underlying the increases in network connectivity

Study Population

- Volunteer subgroup of sedentary older adults from larger study (SHARP-P)
- Aerobic fitness is associated with increased hippocampal tissue and blood volumes
- We explore network connectivity changes due to an exercise intervention
- Exercise-induced changes in hippocampal blood flow are evaluated as a potential mechanism underlying the increases in network connectivity

Scanning procedure

- Post-treatment only, completed within one month after the interventions had been completed (participants in the ET group continued to exercise after completion of the scanning protocol)
- 1.5T GE scanner using an 8-channel head coil (GE Med Systems, Milwaukee, WI)
- Anatomic imaging (3D BRAVO), perfusion imaging (PASL, TR3000, voxel size 3.75mm x 3.75mm x 8mm), and resting fMRI (EPI, TR2000, voxel size 3.75mm x 3.75mm x 5mm)

Network metrics

- Degree (k) measures the connectedness of a node
- Hubs are the most connected nodes in a network. These nodes are critical for network stability and information flow.
- Modularity (Newman 2004) identifies highly interconnected neighborhoods within an entire network. The example in the figure below shows a network with 4 distinct communities.

Conclusions

- Network science can be used to better understand brain function.
- Exercise may lead to higher perfusion in the hippocampus.
- Exercise-induced changes in hippocampal blood flow are evaluated as a potential mechanism underlying the increases in network connectivity.
- Exercise-associated network changes demonstrated here may be the underlying neurophysiological causes of the previously reported blood volume and brain volume changes seen in exercise in older adults.
- Exercise-induced increased network connectivity in the elderly: walking improves brain efficiency.