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Objective: To examine the feasibility of implementing a cardiorespiratory exercise stimulus during functional Magnetic Resonance Imaging (fMRI).
Participants and Methods: 12 young adults (age: 18-22 years) completed progressive maximal exercise testing and a brain MRI scan. During scanning, participants completed three runs of functional MRI (volumes = 619; TR = 800 ms; multiband = 4; voxel size = 3 mm^3). During each 8 minute fMRI run, participants completed an exercise challenge consisting of alternating blocks of exercise and rest. Exercise was implemented with a cardiostepper, an MRI-compatible device (similar to a Stairmaster) capable of generating a cardiorespiratory exercise stimulus. During exercise blocks, participants stepped at a rate of 60 Hz with pedal resistance determined by participants' fitness level. Heart rate and respiration data were collected during MRI. fMRI data were processed and analyzed using FMRIB Software Library (FSL). The ARtifact Detection Toolbox (ART) software was also used to identify volumes with significant artifact, and ICA-AROMA was used to remove motion-related BOLD signal components.
Results: During exercise blocks, heart rate increased (mean = 131 beats per minute) compared to rest (mean = 87 beats per minute; $t(34) = 4.3$; $p < .001$). The mean heart rate during exercise blocks corresponds to an exercise intensity in the light to moderate intensity range for this age group. Motion (median framewise displacement) was significantly higher during exercise (mean = .53 mm) than rest (mean = .36 mm). Across all blocks, ART classified 19.8% of brain volumes as artifact-containing outliers, with 69% of the outliers occurring during exercise blocks. Although greater head motion was observed during exercise, the use of ICA-AROMA reduced the impact of motion considerably, recovering an additional 25% of the task-related signal, relative to noise. Comparison of fMRI activity during exercise versus rest revealed significant associations with primary and supplementary motor cortices, hippocampus, and the insula, among other regions.
Conclusions: The current study demonstrates the feasibility of eliciting light to moderate intensity cardiorespiratory exercise (using a lower body stepping exercise) during functional MRI. Although increased head motion was observed during exercise compared to rest, the degree of head motion was roughly approximate to the values published in previous fMRI studies and post image acquisition processing improved task-related signal. During exercise, increased brain activation was observed in regions associated with the central command network, which regulates autonomic nervous system and musculoskeletal function during exercise.

Categories: Neuroimaging
Keyword 1: neuroimaging: functional
Keyword 2: movement
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48 Sex Differences and Longitudinal Changes in White Matter Microstructure in Healthy Older Adults

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Objective: As the global population of older adults increases, it is crucial to study the healthy aging brain. Despite representing approximately 50% of brain tissue, investigations of changes in white matter (WM) have been limited. Given that women outlive men in most populations worldwide, evaluating factors such as sex and gender in the normal aging trajectory are

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particularly important. However, past research has been limited by varying definitions of these terms and methodological challenges. Further, limited studies have employed longitudinal designs. The objective of the present study was to 1) compare sex similarities and differences in WM microstructure, and 2) investigate longitudinal changes in WM in healthy older adults. The Parkinson's Progression Markers Initiative (PPMI) is an ongoing observational longitudinal study designed to investigate biomarkers related to Parkinson's disease. For up-to-date information, please see: https://www.ppmi-info.org/. The PPMI study presents a convenient opportunity to investigate the expected aging trajectory among healthy older adults by using data from its healthy control cohort.
Participants and Methods: Participants (N=40) included 16 females (mean age = 60.50 + 5.99) and 24 males (mean age = 65.50 + 7.53) from the healthy control cohort of the PPMI. Diffusion tensor imaging (DTI) data from two time points (baseline and approximately one year later) were analyzed using tract-based spatial statistics from the FMRIB Software Library (FSL). Diffusion weighted images were acquired with a Siemens 3T TIM Trio scanner with a 12 channel Matrix head coil. All images were acquired with a spin echo, echo planar imaging sequence with 64 gradient directions and a b-value of 1000s/mm2 with a voxel size of 2 mm3. Two analyses were conducted: 1) between-groups, comparing differences in WM microstructure between males and females at baseline while controlling for age and total brain volume (TBV), and 2) within-subject, examining longitudinal changes in WM from baseline to one year later. DTI metrics included fractional anisotropy (FA) and mean diffusivity (MD).
Results: Males were significantly older than females and had significantly larger TBVs. Results of voxelwise comparisons revealed no statistically significant differences in FA or MD between males and females when controlling for age and TBV. Longitudinally over one year, decreases in MD ($p<.05$, corrected) were found in the right superior and inferior longitudinal fasciculus, the right corticospinal tract, and the right inferior fronto-occipital fasciculus. Stability in FA was observed over one year. There was also an average of a one-point decline on the Montreal Cognitive Assessment during the study period of one year.
Conclusions: No significant sex differences in WM microstructure were found, which agrees with a published review of the literature that men and women show very similar brain structure after accounting for brain size differences. Across the entire sample, longitudinal changes in WM were captured via neuroimaging across a one-year time frame. Follow-up exploration of these data suggests great intraindividual variability in trajectories over time, which may have affected the overall group trajectory. Continued research of factors that contribute to the identifying individual healthy aging trajectories is warranted.

Categories: Neuroimaging
Keyword 1: aging (normal)
Keyword 2: neuroimaging: structural
Keyword 3: brain structure
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49 Locus Coeruleus MR Signal Interacts with CSF p-tau/AB42 to Predict Attention, Executive Function, and Verbal Memory

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Objective: The locus coeruleus (LC) plays a key role in cognitive processes such as attention, executive function, and memory. The LC has been identified as an early site of tau accumulation in Alzheimer's disease (AD). LC neurons are thought to survive, albeit with limited functionality, until later stages of the disease, though how exactly this limited functionality impacts cognition through the course of AD is still poorly understood. We investigated the interactive effects of an imaging biomarker of the LC and AD-related cerebrospinal fluid (CSF) biomarkers on attention, executive function, and memory.
Participants and Methods: We recruited 67 older adults from the San Diego community (mean age=74.52 years; 38 cognitively normal, 23 with mild cognitive impairment, and 6 with probable AD). Participants had LC-sensitive magnetic resonance imaging (MRI) used to obtain a measure of LC signal relative to surrounding tissue, with lower LC signal possibly

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