The Impact of Mindfulness Training on Declarative Memory Performance and Microstructural Integrity of Major White Matter Tracts Associated with the Hippocampus

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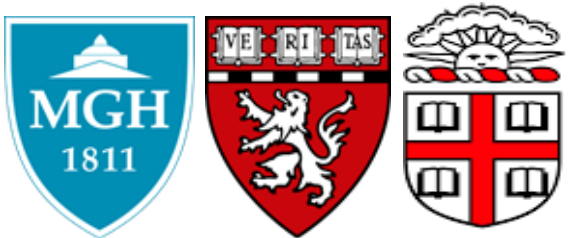

Introduction:

-Age-related white matter (WM) degradation underlies decreases in working memory performance

-The hippocampus is essential to cognitive performance

-Interventions to decelerate cognitive decline are of great interest.

How do MBIs Impact Hippocampal White Matter (WM) Tracts in Healthy Aging?

Investigating WM Integrity:

Diffusion Tensor Imaging (DTI):

- Uses anisotropic diffusion to estimate axonal organization in the brain

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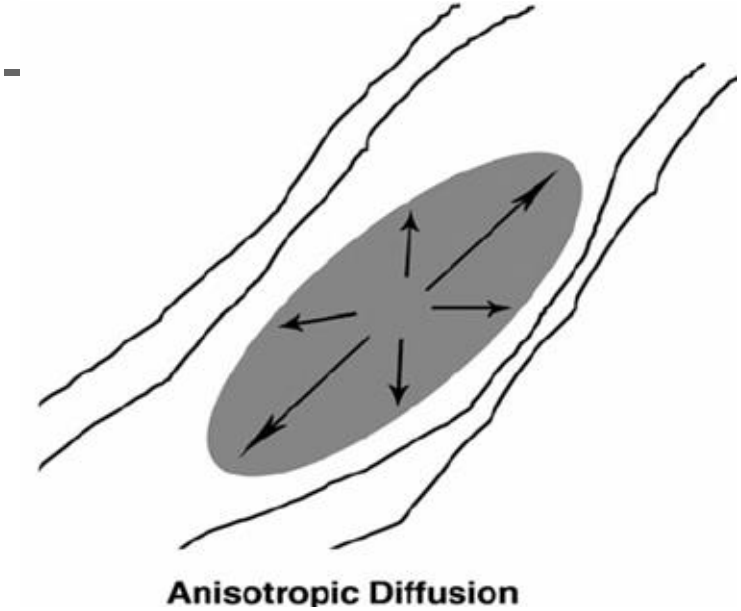
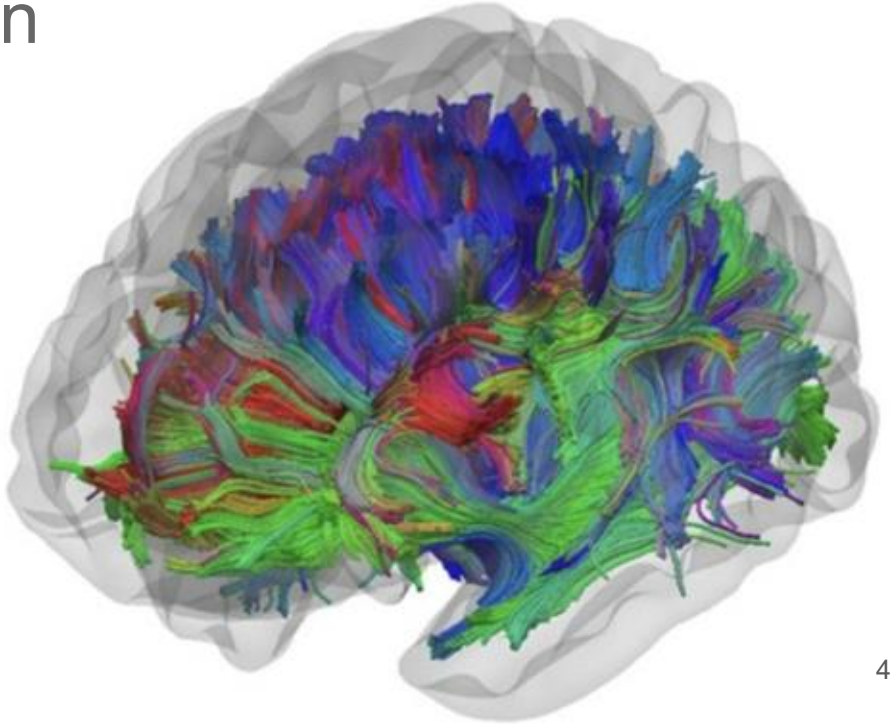
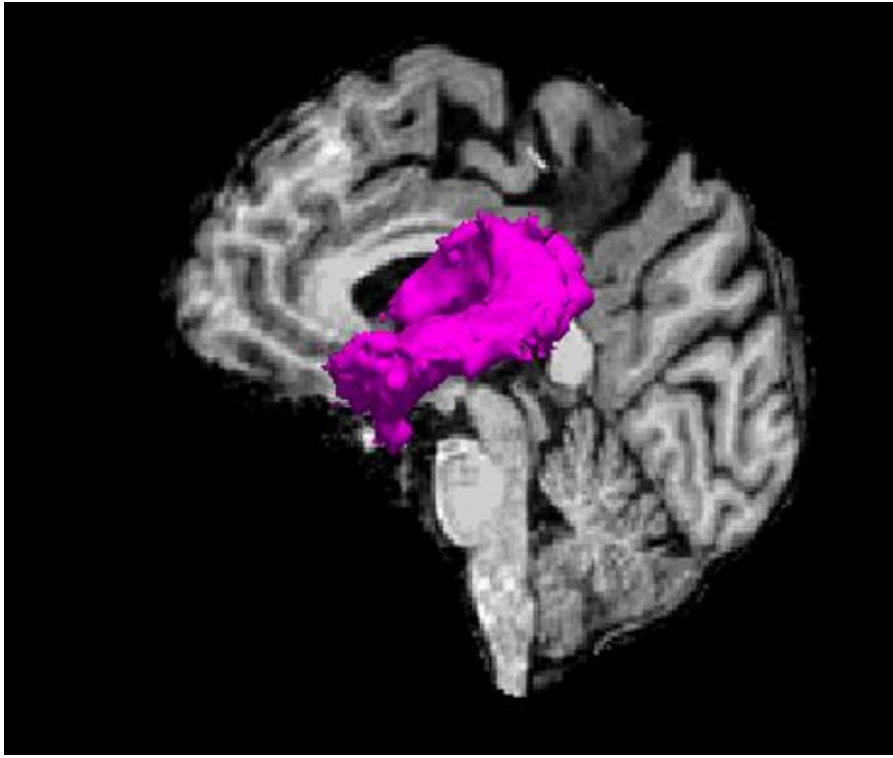


Anisotropic Diffusion



Tracts of Interest:

- Uncinate Fasciculus (UF) - hippocampus/amygdala/ frontal lobes
  - Modifiable through MT (Hölzel,2016)
- Fornix of the hippocampus - Major output of the hippocampus



Hypothesis I: Mindfulness Training will produce significant increases in **Fractional Anisotropy (FA)** within the **Uncinate Fasciculus (UF)** and **Fornix of the Hippocampus.**

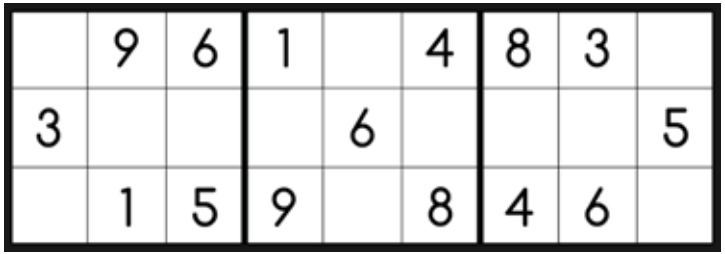
Study Design

- 138 healthy older adults (seeking brain training)
- 65-80 years old, cognitively normal
- No prior meditation or yoga experience
- Tested at baseline, end of program, and at 12 months program end

Study Interventions

Mindfulness Training

- N = 47
- 8 wk intervention including weekly meetings and 40 minutes of daily mindfulness meditation practice
- Instruction derived from MBSR but focused on cognitive enhancement, not stress reduction

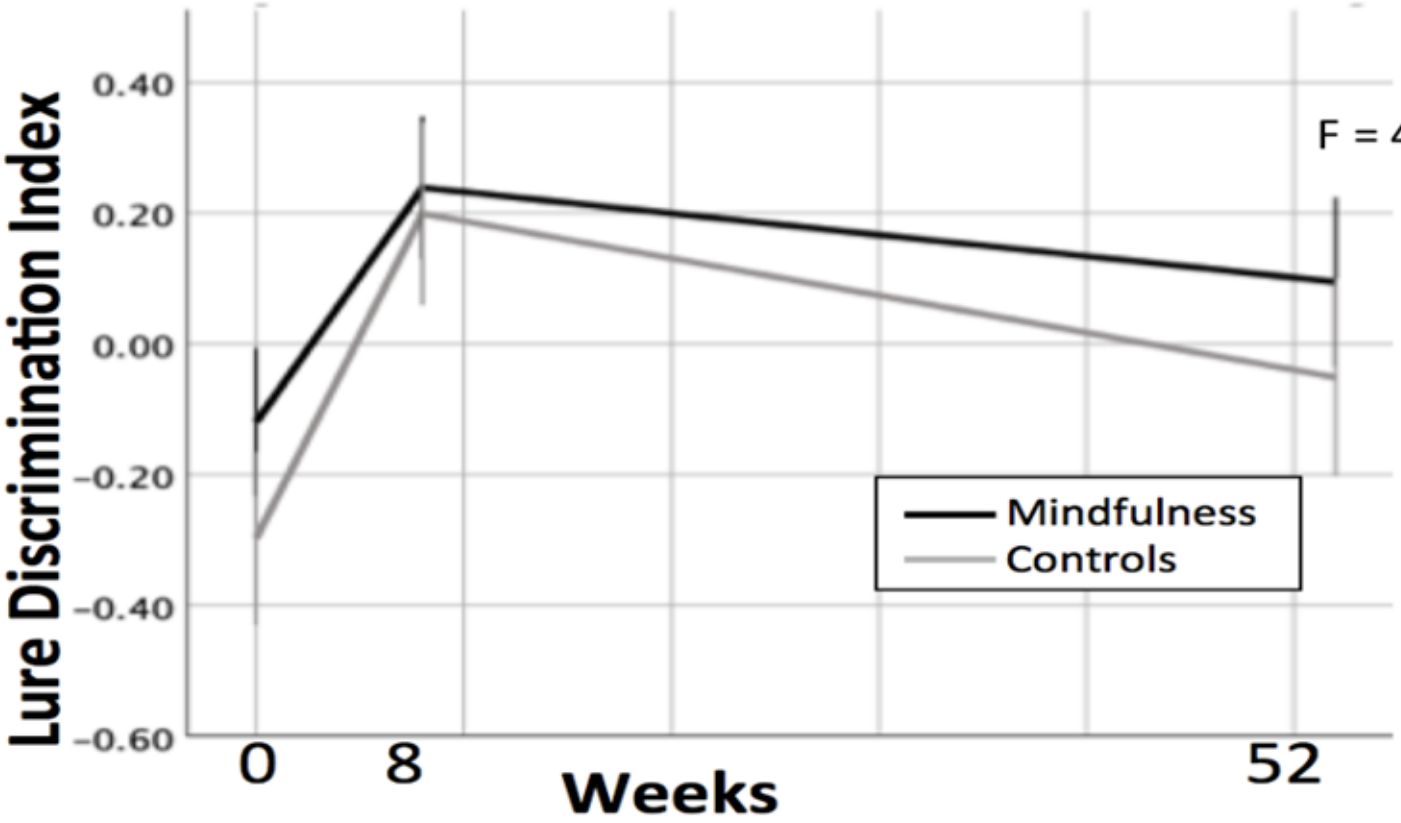


	9	6	1		4	8	3	
3				6				5
	1	5	9		8	4	6	

Cognitive Fitness Training

- N = 49
- 8 wk intervention including weekly meetings and 40 minutes of daily brain games (puzzles, sudoku, crosswords, etc)

Changes in Declarative Memory (MST) Within Study Population

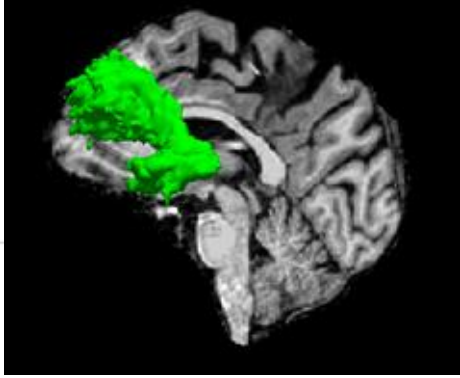


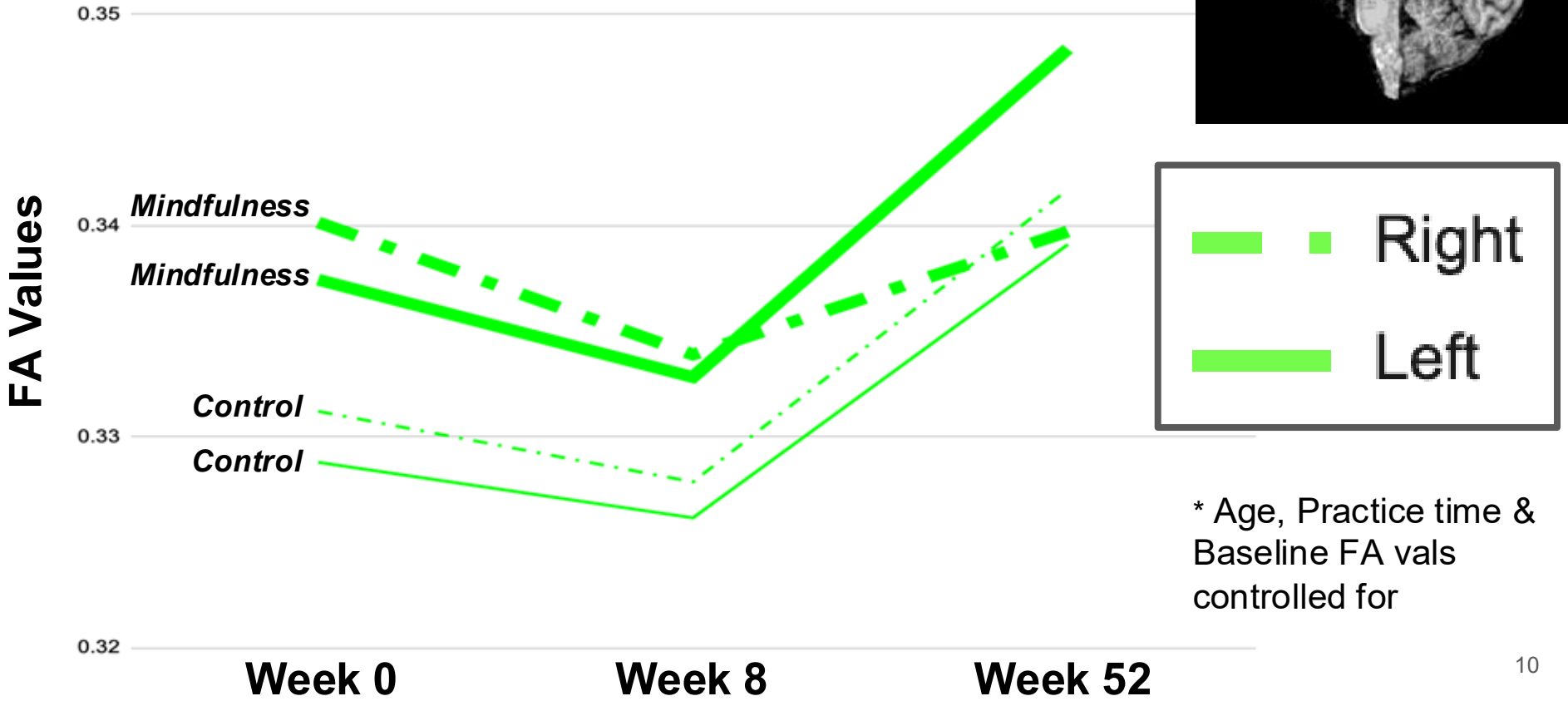
Herrera et al., *In Progress*

Uncinate Fasciculus

Right GxT

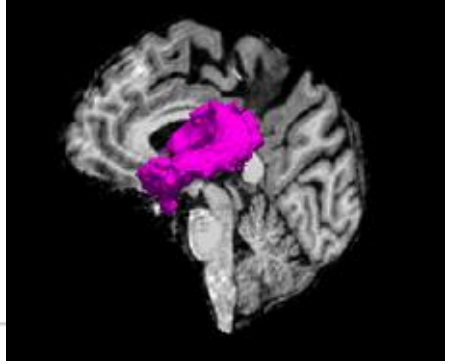
F = 2.77 p = 0.0662



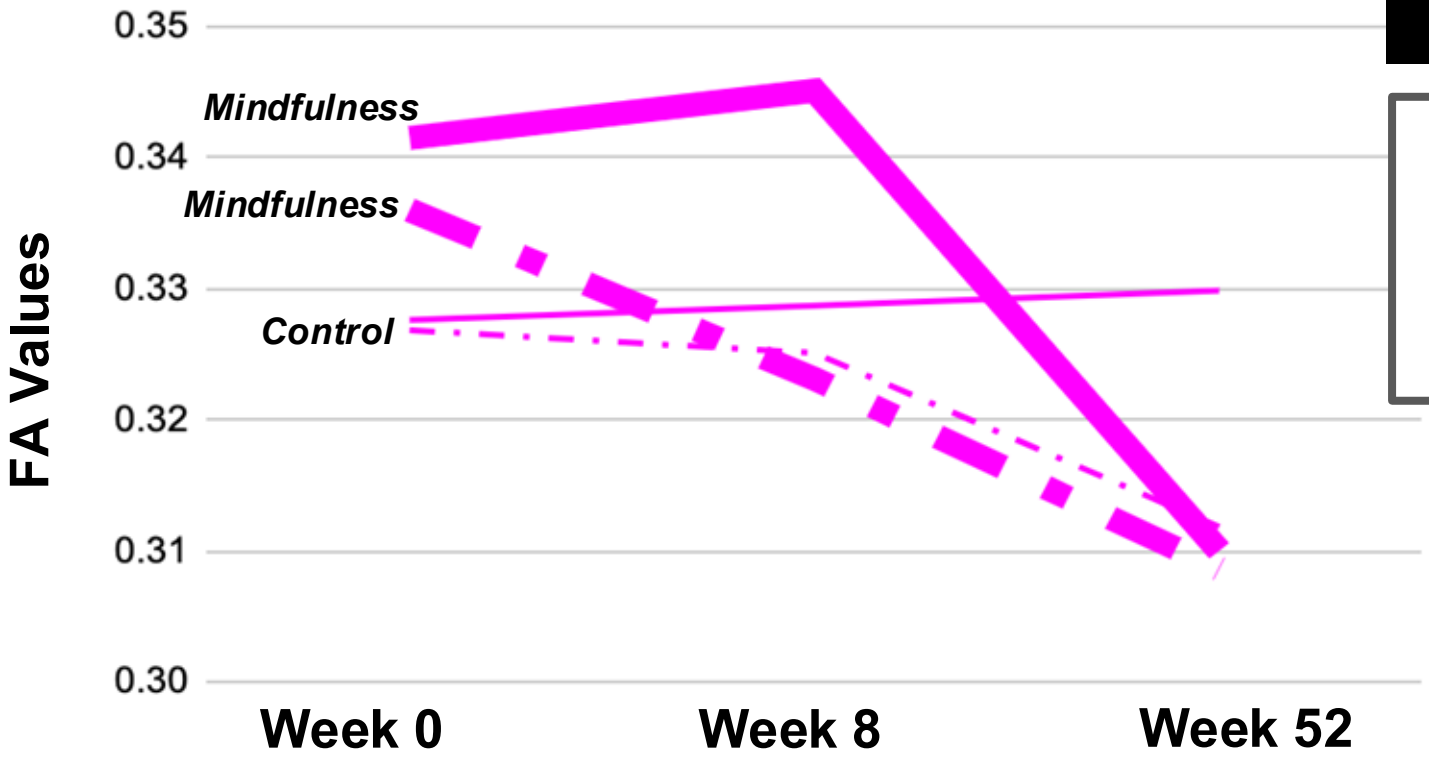


* Age, Practice time & Baseline FA vals controlled for

Fornix of Hippocampus



Within-Mindfulness
L Fornix : p = 0.0150
R Fornix: p = 0.0330



* Age, Practice time & Baseline FA vals controlled for

Hypothesis II: Significant changes in FA values within the UF and the Fornix of Hippocampus will correlate with increases in measures of declarative memory.

No Relationship between FA values within the Uncinate Fasciculus and the Fornix of Hippocampus and measures of declarative memory.

Exploratory Investigation

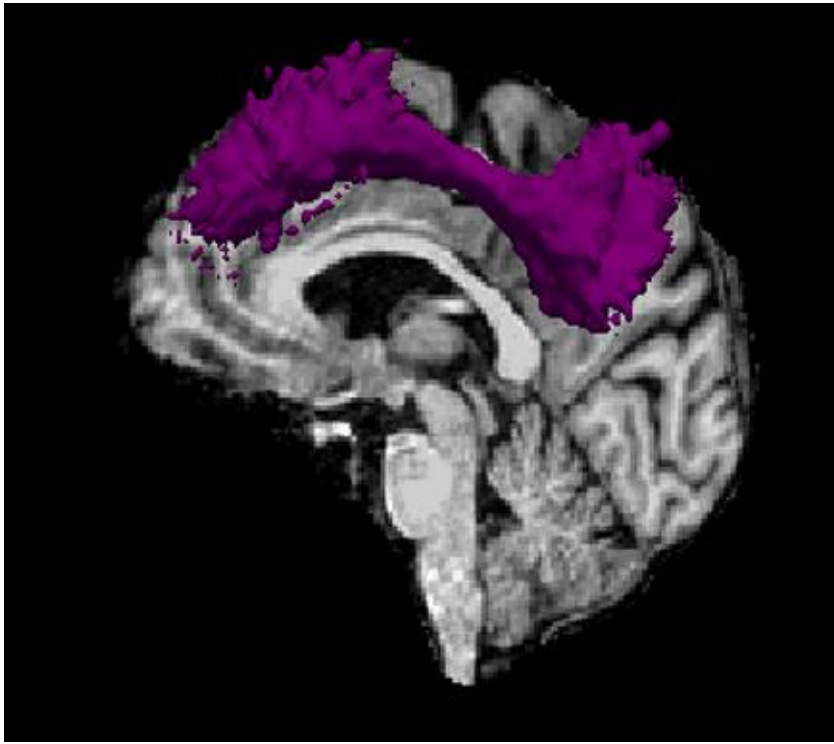
Exploratory Tracts of Interest

Cingulum Bundle - Ventral

- Major Input to Hippocampus
- Supports memory, executive function

Cingulum Bundle - Dorsal

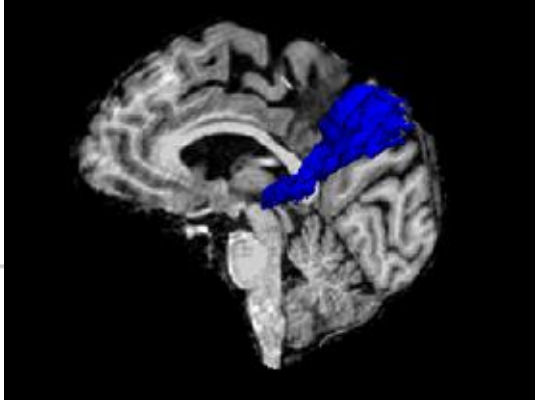
- Major Input to Hippocampus
- Cognitive control

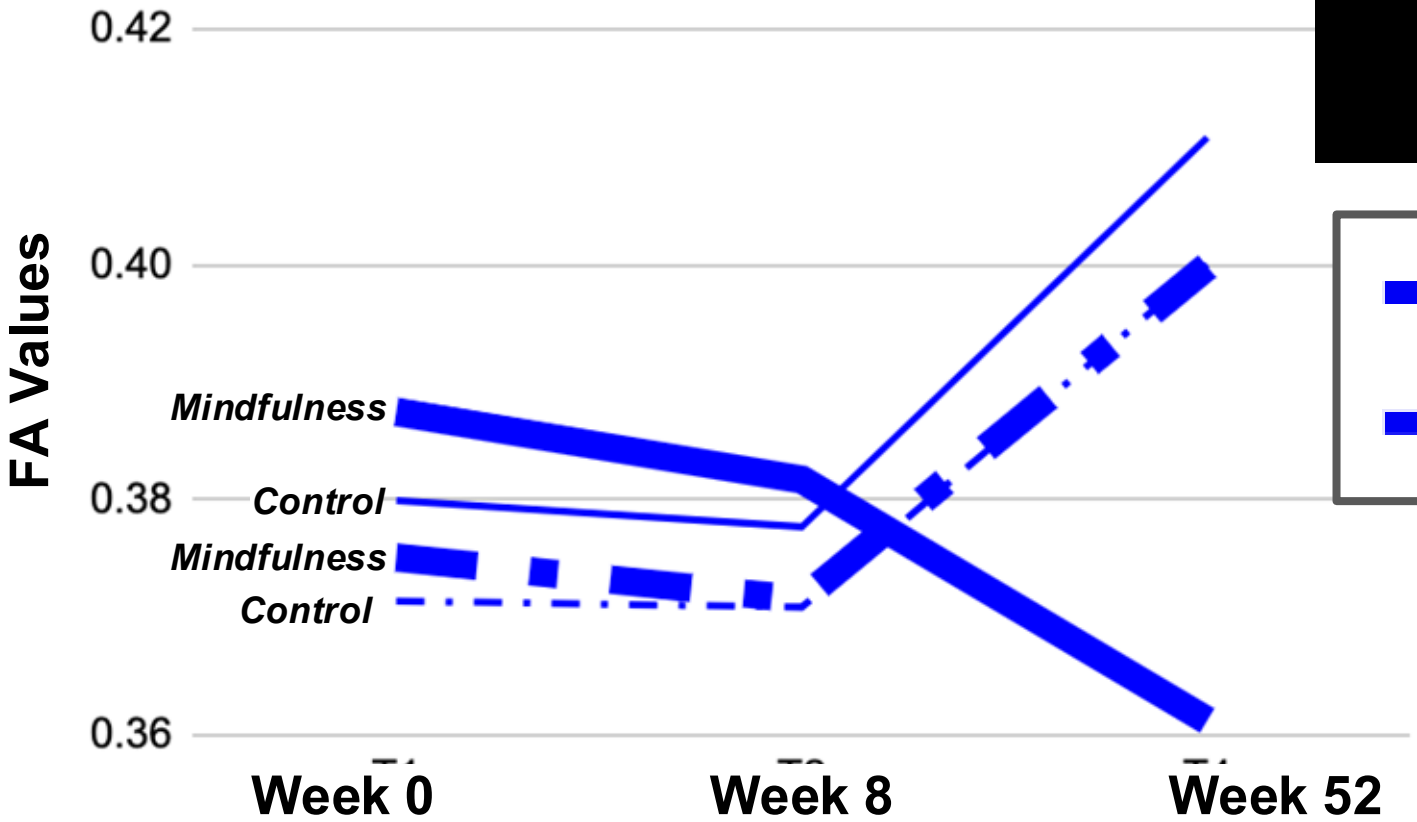


Cingulum Bundle - Ventral

Left GxT

F = 14.902 p = <0.0001



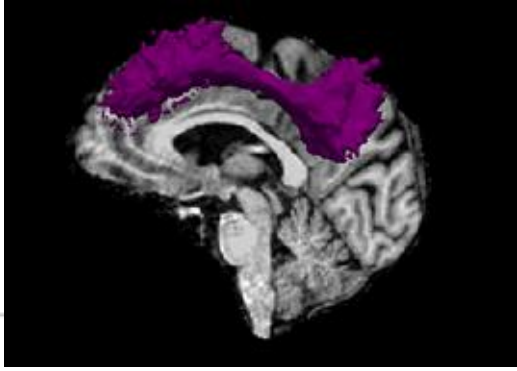


Right

Left

* Age, Practice time & Baseline FA vals controlled for

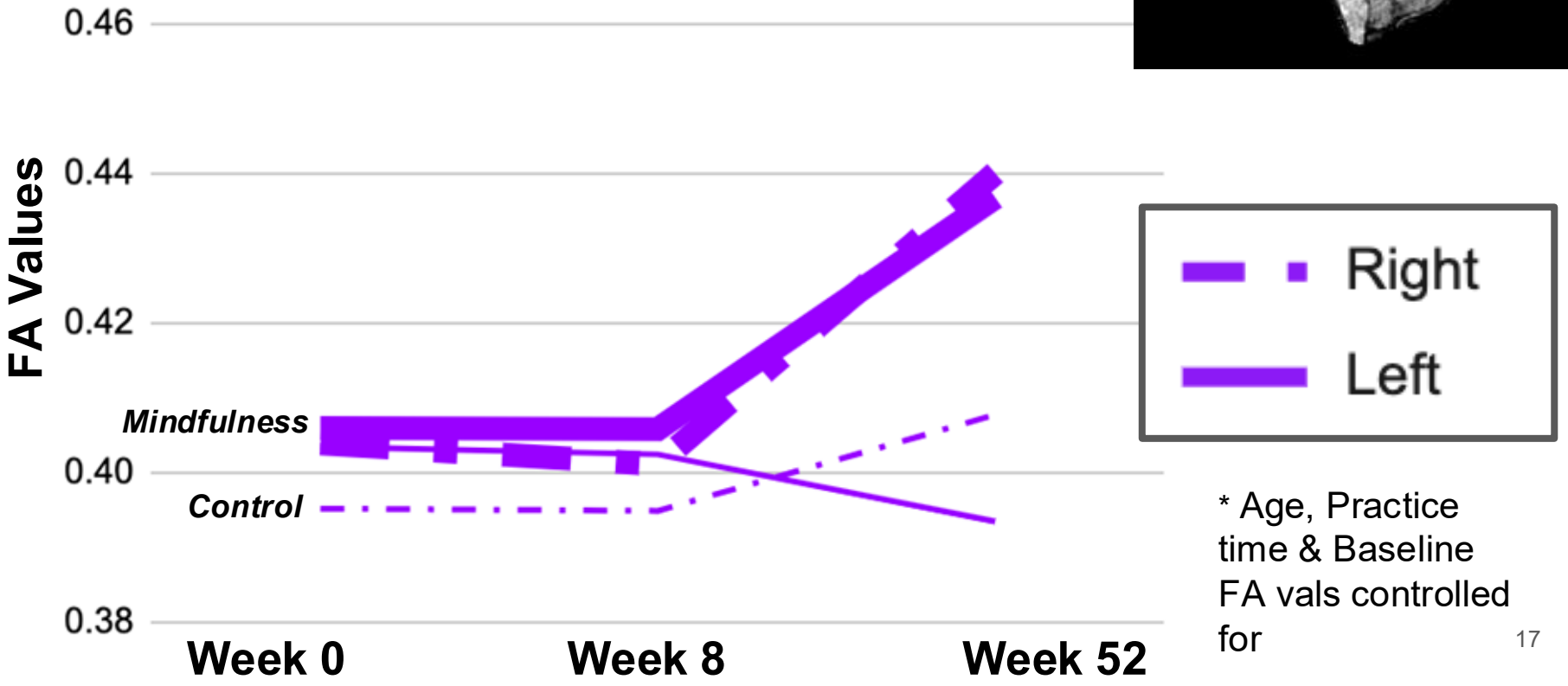
Cingulum Bundle - Dorsal



GxT

Left - F = 10.320 p = 0.0001

Right - F = 10.457 p = 0.001



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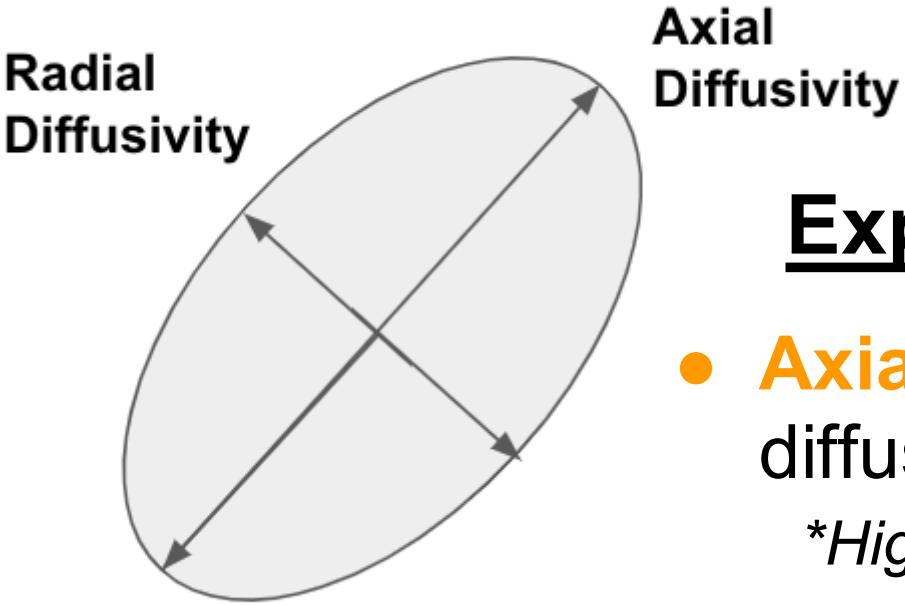


Exploratory Metrics:

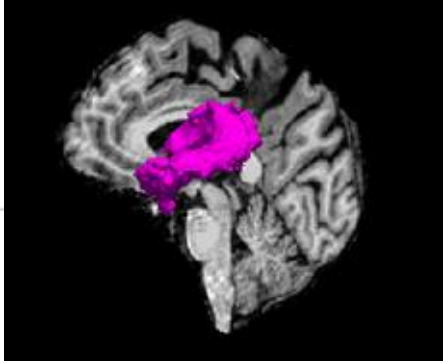
- **Axial Diffusivity (AD)** - diffusion parallel to fiber tracts

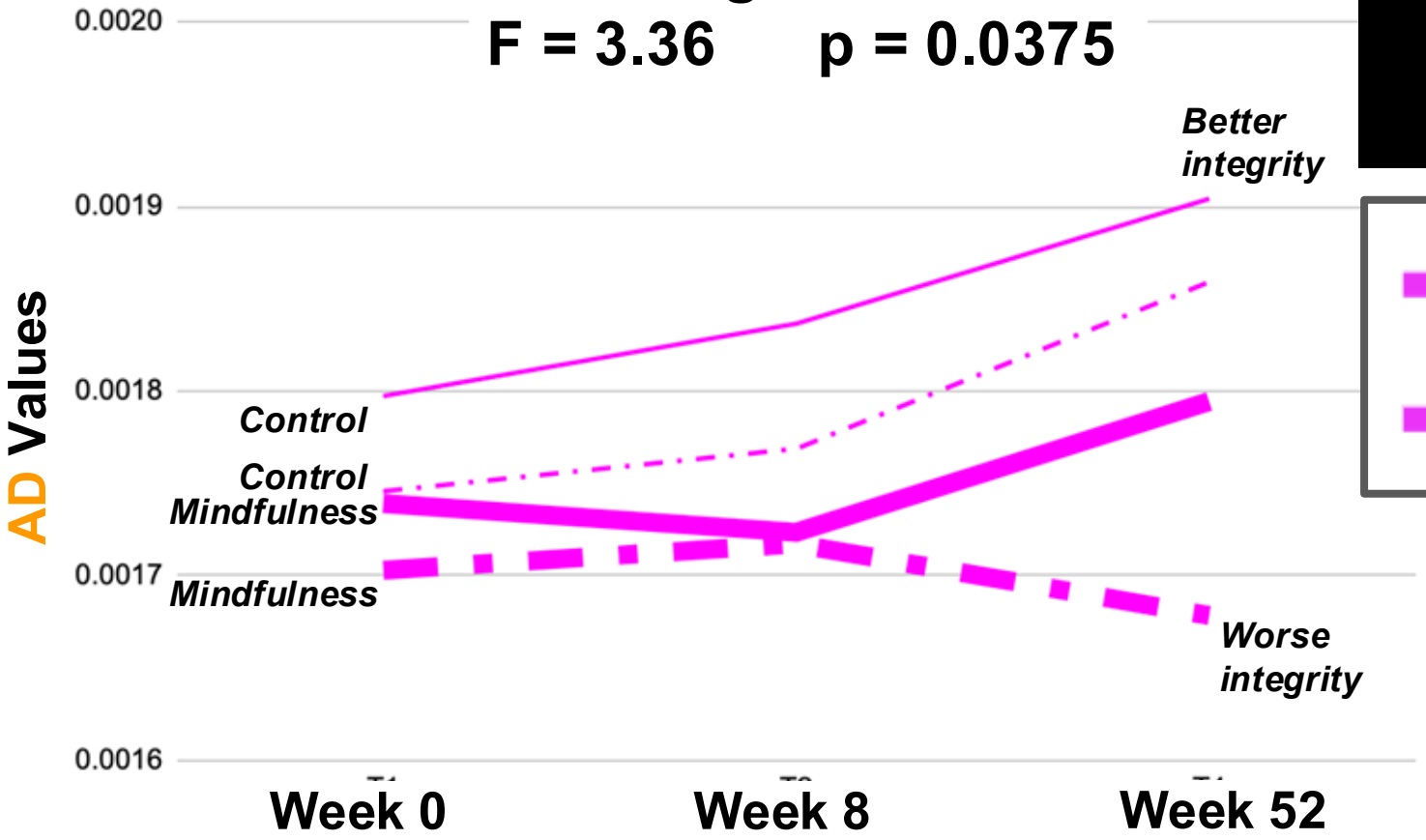
  Higher values = better integrity

- **Radial Diffusivity (RD)** - diffusion perpendicular to axonal fibers

  Lower values = better integrity

Fornix of Hippocampus



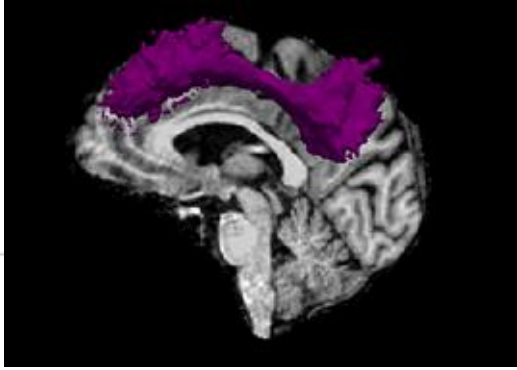


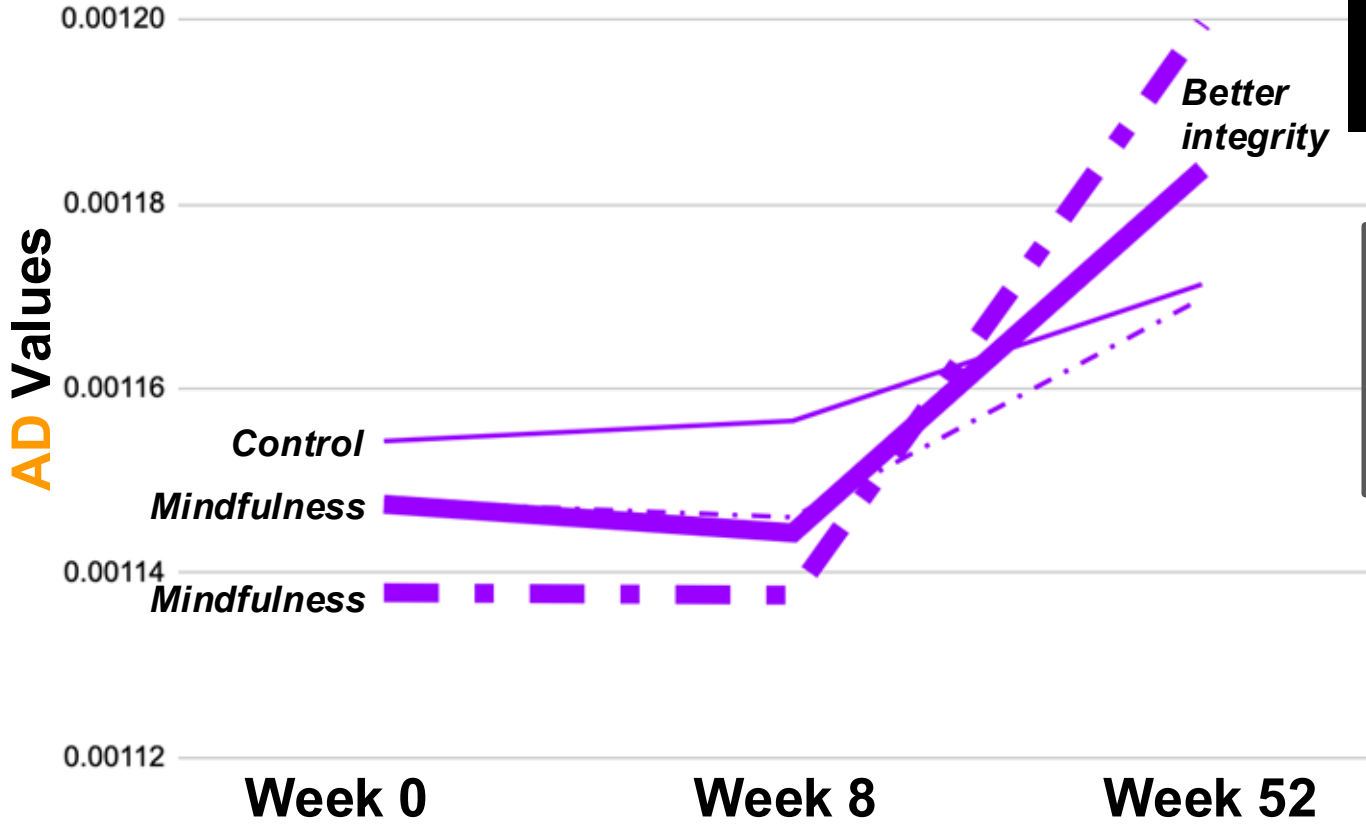
* Age, Practice time & Baseline FA vals controlled for

Cingulum Bundle - Dorsal

Right GxT

F = 4.74 p = 0.0102



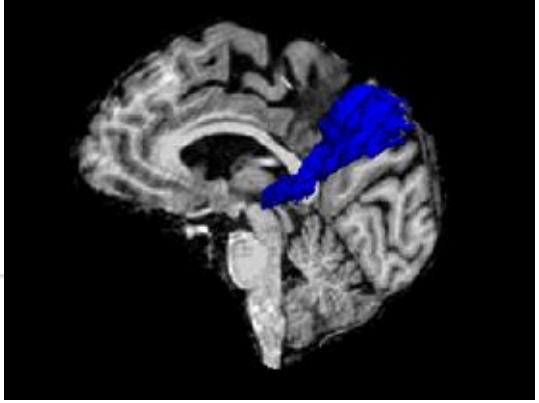


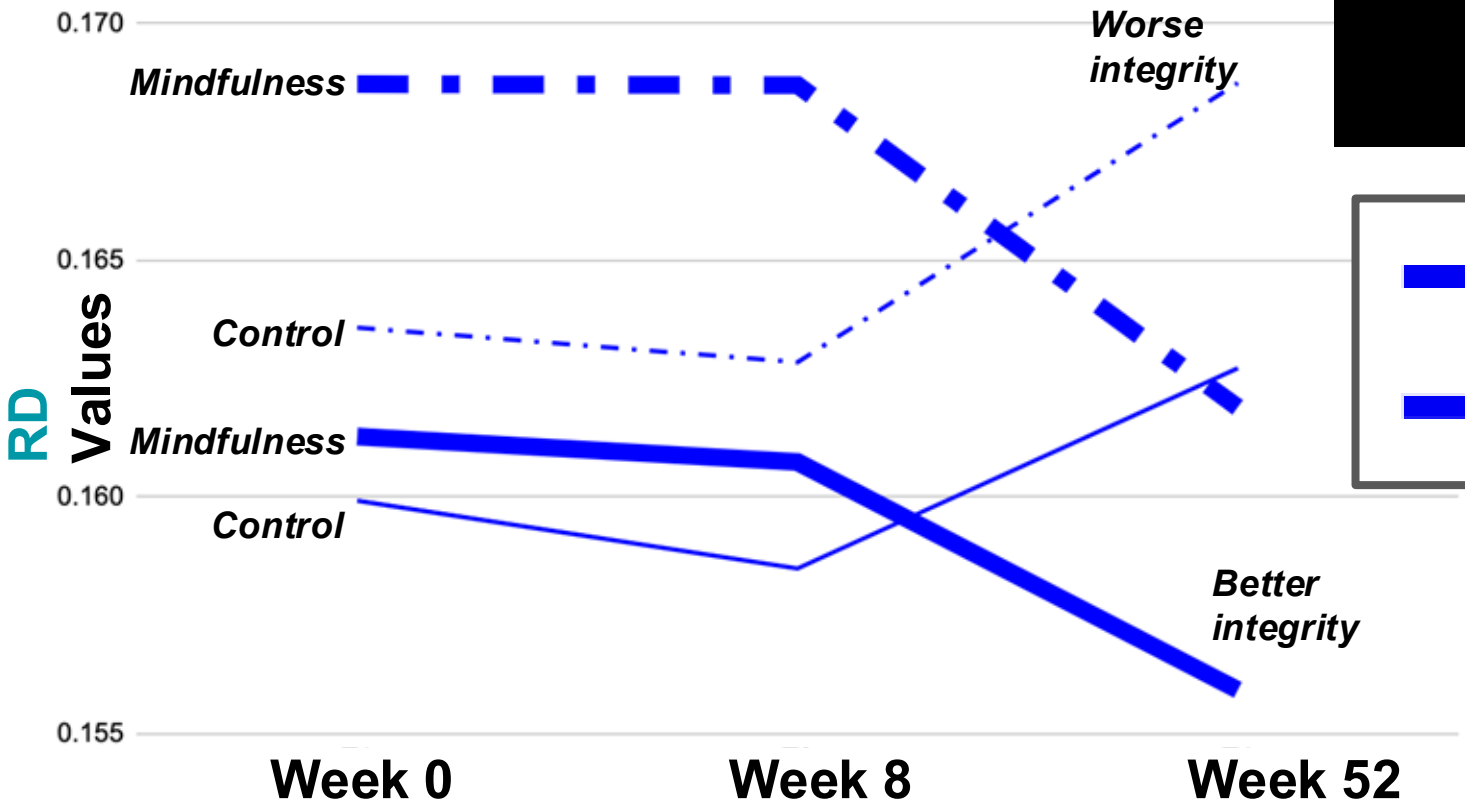
* Age, Practice time & Baseline FA vals controlled for

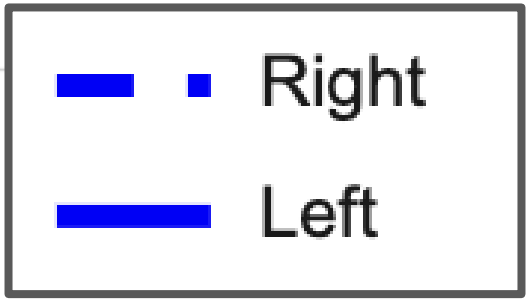
Cingulum Bundle - Ventral

Right GxT

F = 8.96 p = 0.0002







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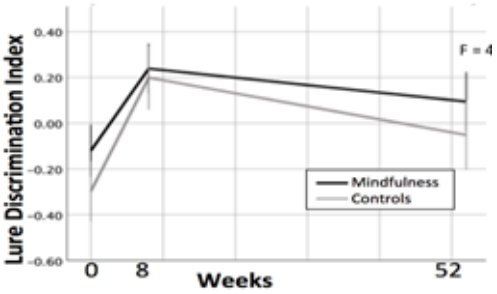
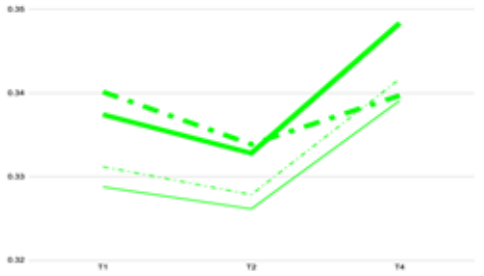
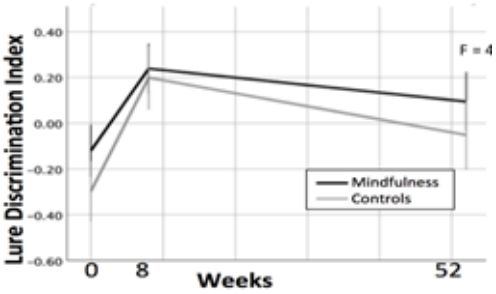


Uncinate Fasciculus

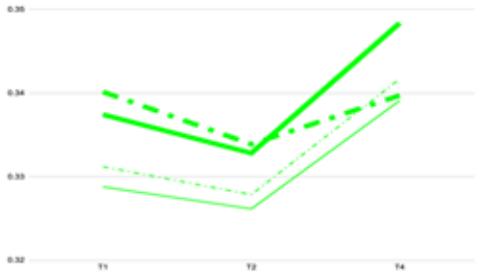


Uncinate Fasciculus	Mindfulness		Control	
	Wk 8-Wk 0	Wk52-Wk8	Wk8-Wk0	Wk52-Wk8
Left AD	**p = -0.018**			
Right AD				

- Both increases & decreases in AD associated with cognitive improvement
- Representative of beneficial results given correlation with cognition and significant increases in cognition from week 0 to week 8

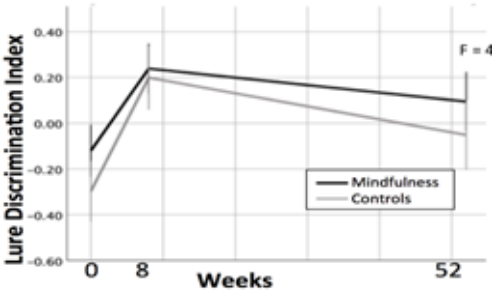


Uncinate Fasciculus

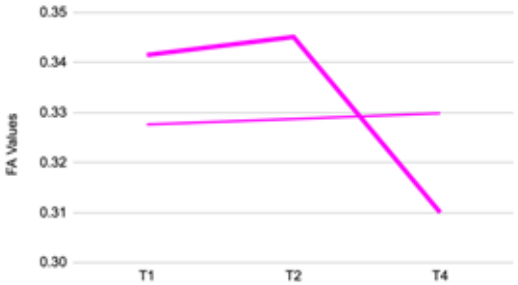


Uncinate Fasciculus	Mindfulness		Control	
	Wk 8-Wk 0	Wk52-Wk8	Wk8-Wk0	Wk52-Wk8
Left RD				
Right RD		**p = -0.05**		

- Could explain why there were no significant decrease in cognition in mindfulness group between Week 8 and Week 52



Fornix of the Hippocampus



Hippocampal Fornix	Mindfulness		Control	
	Wk8-Wk0	Wk52-Wk8	Wk8-Wk0	Wk52-Wk8
Left RD	**p = -0.053**	**p = 0.007**		
Right RD				

- Decreases in RD, indicating increased integrity, related to increases in cognitive performance
- Decreases in RD between Wk 8 and Wk 52 might contribute to slower rate of memory decline in Mindfulness group

Conclusions:

-Hippocampal WM tracts are modified by Mindfulness Training in healthy older adults

-Memory improvements in each group are associated with different diffusion metrics

-Mindfulness-related changes in both the fornix and uncinate fasciculus contribute to enhanced declarative memory

-Other neuroimaging modalities are needed to clarify cellular level changes contributing to FA, i.e. crossing fibers vs. pruning, etc.

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M4: Mindfulness Mechanisms and Methods Meeting

OCTOBER 5-6, 2023

Washington University in St. Louis

www.mindfulnessmechanisms.org

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Thank you :)

Questions or Comments?

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