

Does the fornix support episodic memory and spatial navigation throughout development? A DTI investigation



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INTRODUCTION

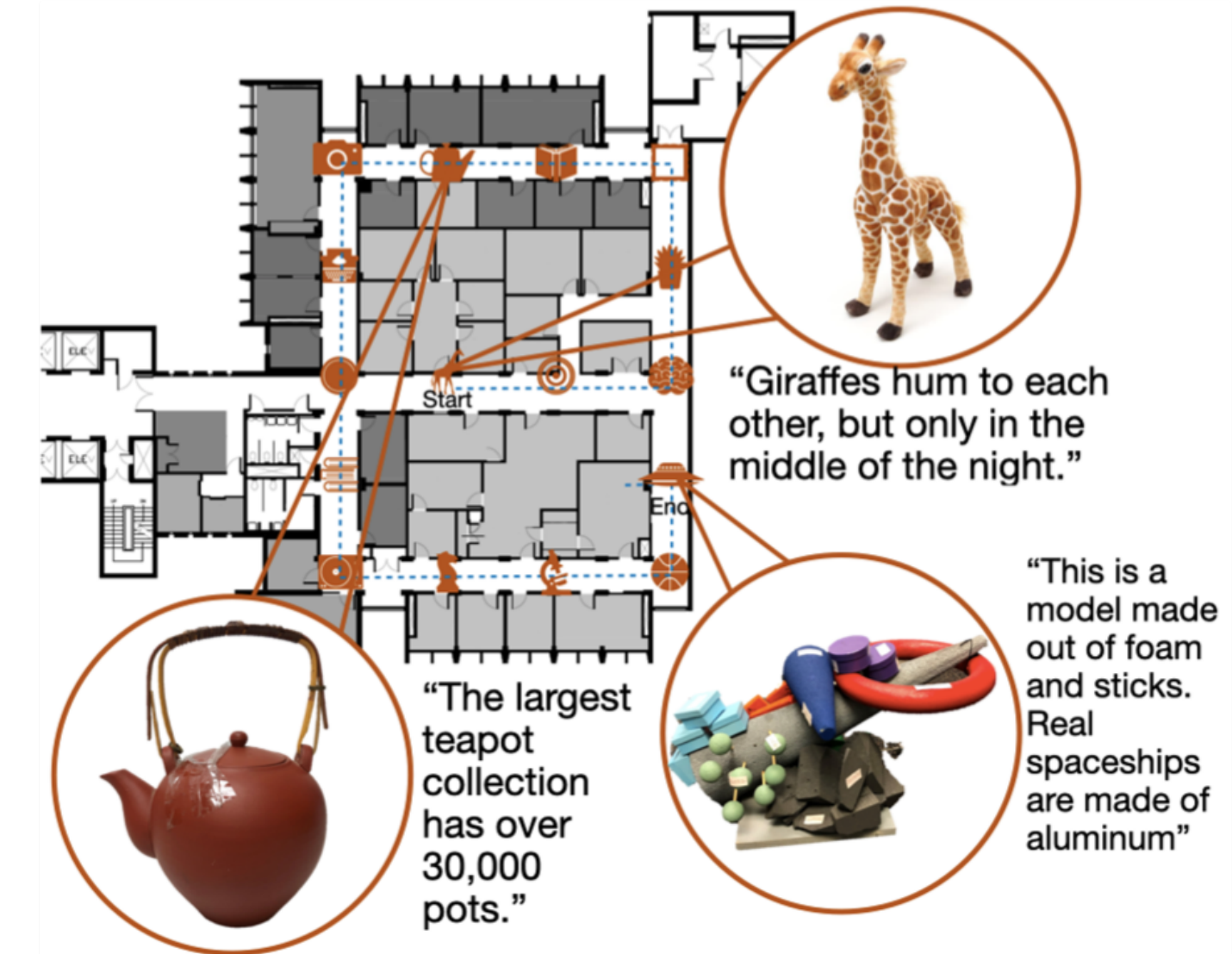
- It is currently unclear whether episodic memory and spatial memory are linked¹, behaviorally and neurally.
- Both episodic memory and spatial navigation depend on medial temporal lobe structures (e.g. hippocampus, parahippocampus)² and the white matter tracts that connect the hippocampus to subcortical regions (e.g. fornix)³.
- Fornix lesions in non-human animal models lead to memory impairments in conditioning⁴, reversal learning⁴, and Morris Water Maze performance⁵.
- Fornix microstructure is related to episodic (including autobiographical) memory measures in adults² and children⁴.
- The literature on human navigation and the fornix is very sparse⁵.

In this study, we had participants undergo a real-world encoding experience that allows us to relate spatial and episodic memory to fornix macro and microstructure from childhood to adulthood.

METHODS

Participants	KBIT2
N = 42 adults (M _{age} = 23.1)	IQ: verbal and nonverbal intelligence (control variable)
N = 46 8-13YO (M _{age} = 10.3)	

Encoding
Participants take a **real-world tour** that combines a spatial experience with 16 unique episodic events.



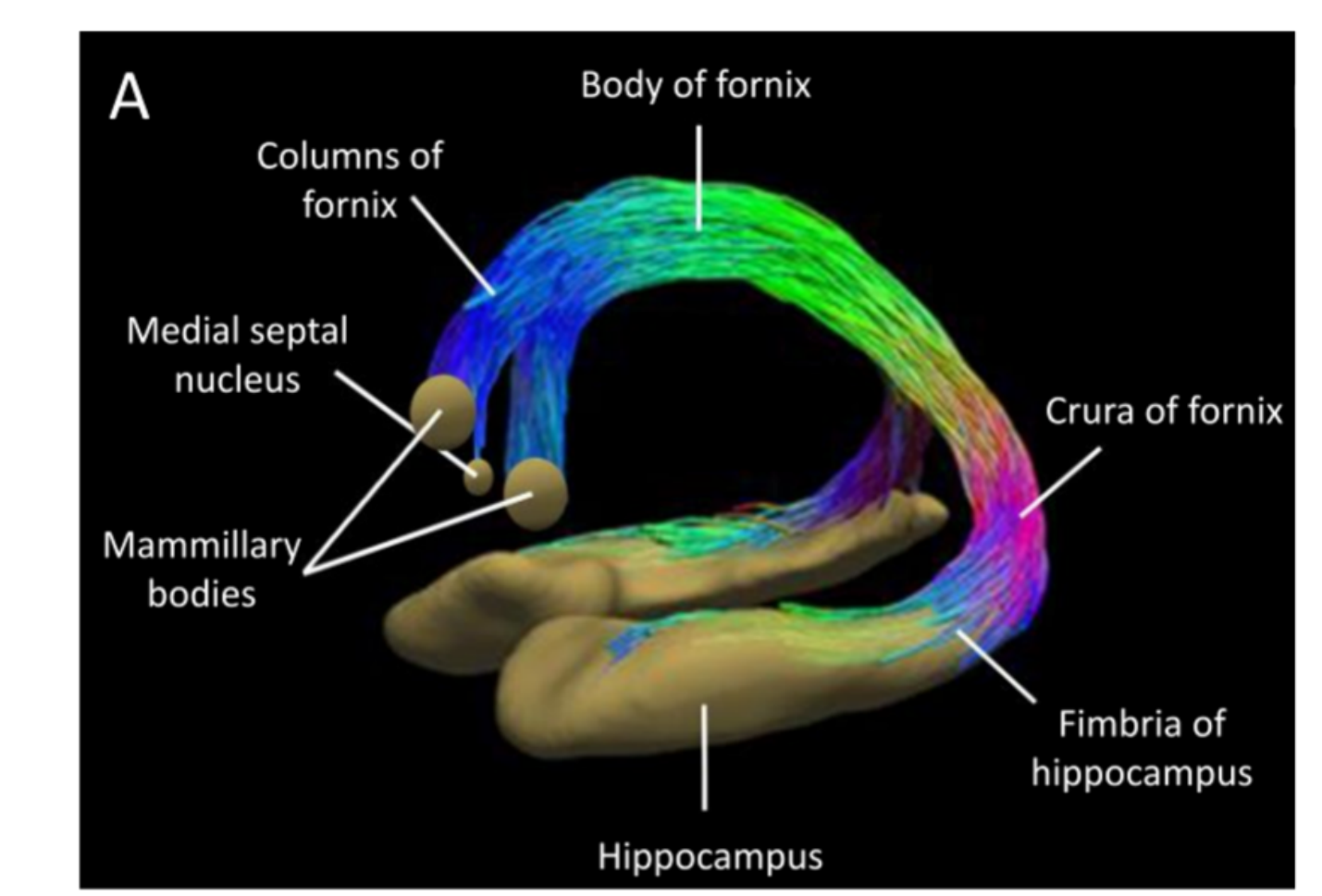
Episodic memory tasks

Free recall	Cued recognition
"On my left I saw a big kangaroo plushie and it had like a joey in its pouch"	"What item did you see one before the teapot?" "What color was the laser on the spaceship?"
Internal details score calculated by using Levine ⁶ coding method	40 AFC questions, scored by accuracy

Spatial navigation tasks

Map building	Route test	Pointing (JRD)
R ² , variance similarity to correct map	Average path distance	Average angular error
Spatial navigation composite score z-standardized each score and then averaged together		

Diffusion Tensor Imaging

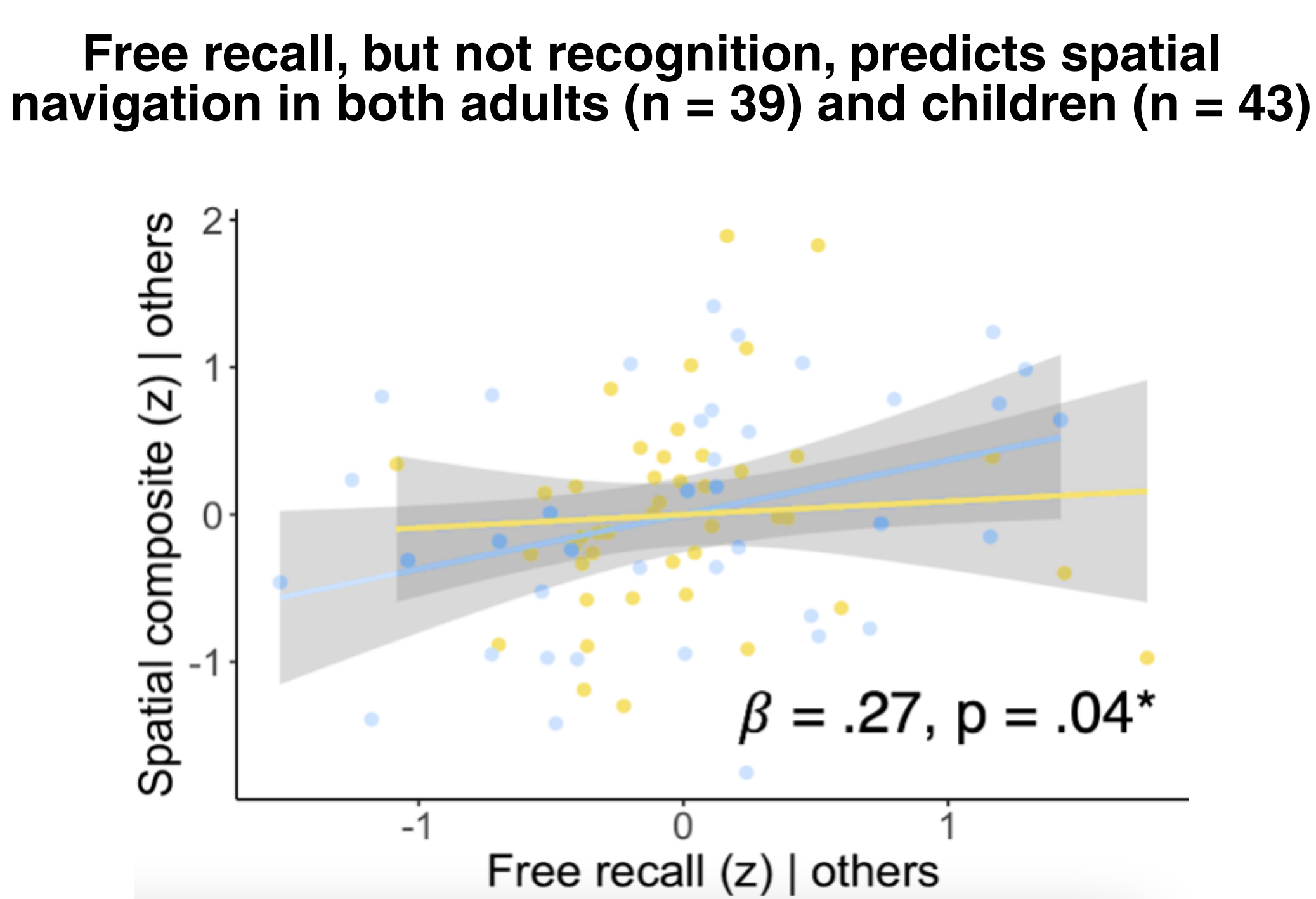
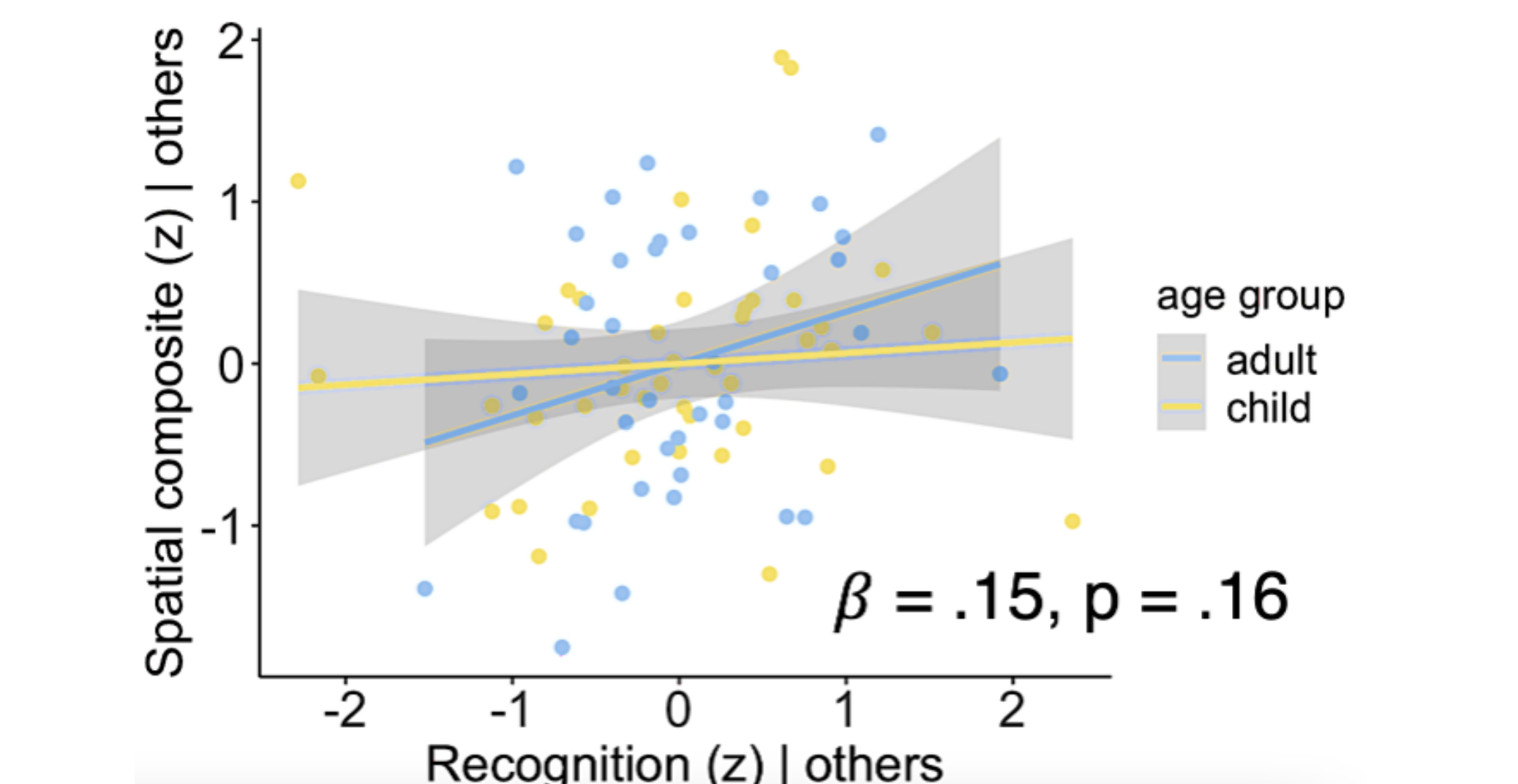
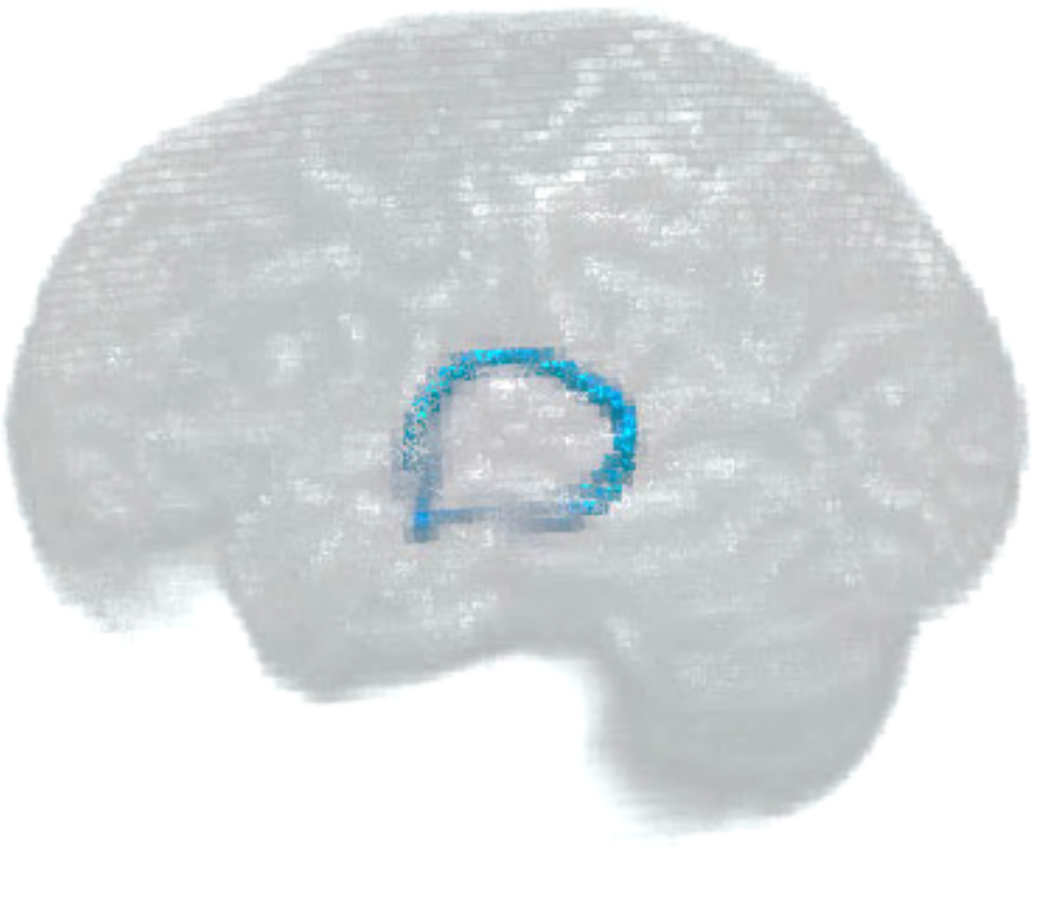


- The **fornix** and a control tract get extracted using **probabilistic tractography** in FSL.
- Free water (FW) correction** is applied (using the software DIPY) due to close proximity to the third ventricle.
- Macrostructure (**tract volume**) and microstructure (**FA, FA_t, MD, MD_t**) metrics are extracted for the whole tract.

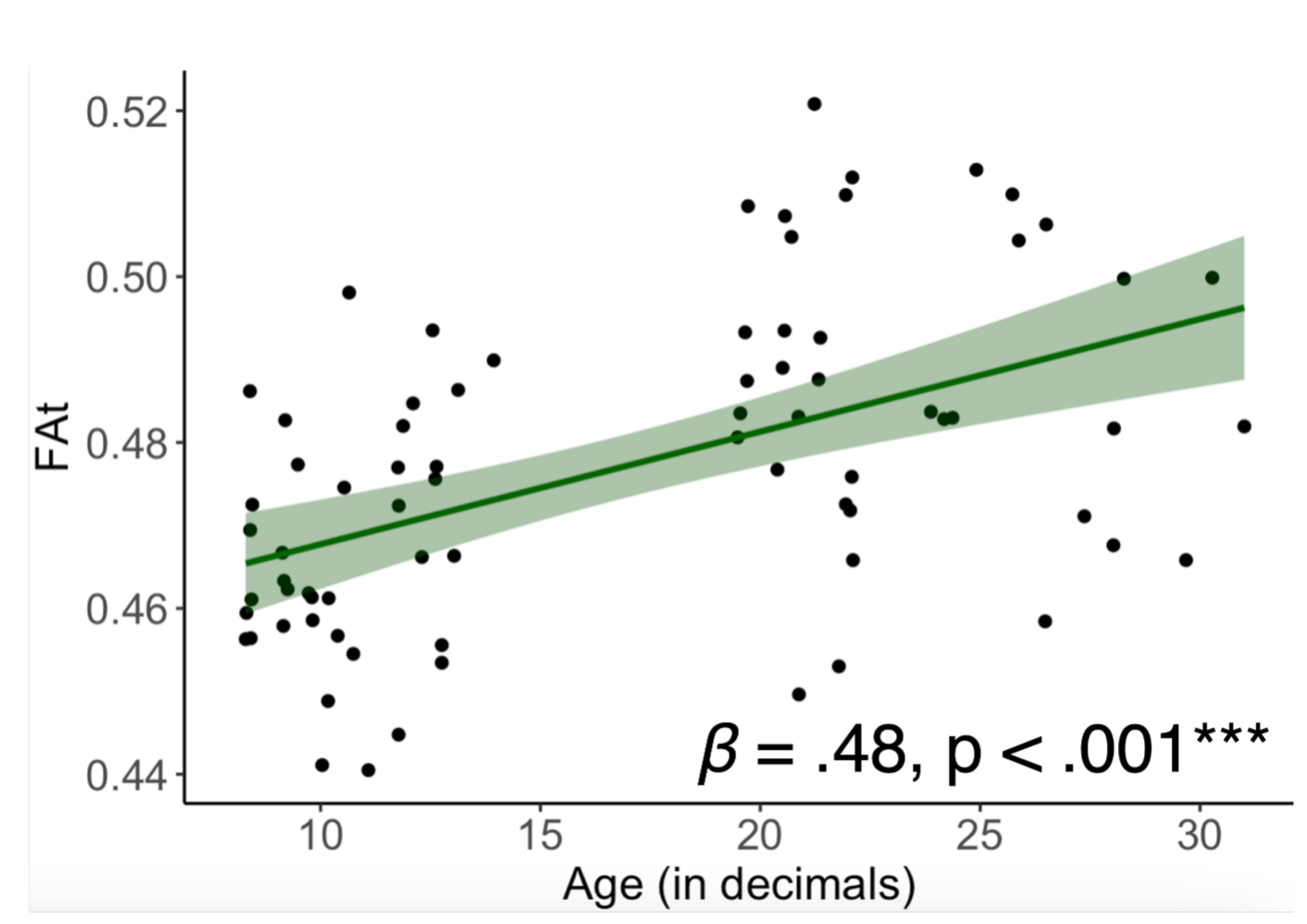
RESULTS



Fornix tractography reconstruction of a representative participant



Free water corrected fractional anisotropy (FA_t) increases with age



Multilevel linear models of fornix volume and microstructure predicting spatial navigation and episodic memory, individually, have not yielded significant results in the current sample

CONCLUSION

- Children and adults with better episodic recall also have more accurate overall spatial memory, with adults performing better.
- Fornix microstructure seems to mature between childhood and adulthood.
- In our study, episodic and spatial memories did not significantly correlate with fornix macro and microstructure across development

Future directions

- Finish data collection and preprocessing of diffusion images for children sample N_{target} = 80 (40 8-10YO and 40 11-13YO).
- Run probabilistic tractography and extract control tract.

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