Quantifying Hippocampal Circuitry in Humans

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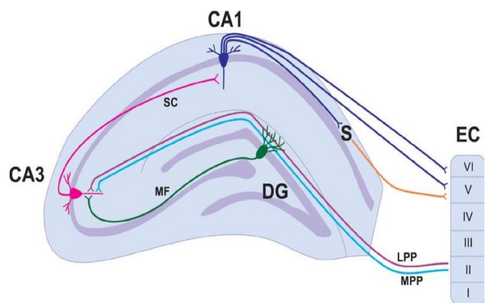
Introduction

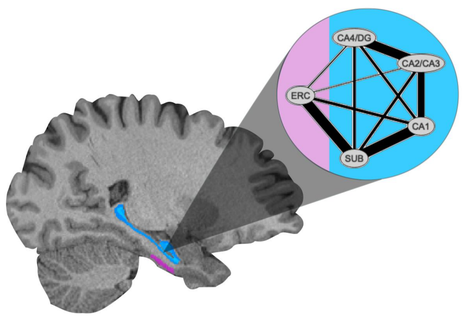
Hippocampus (HPC) is a key structure in learning and memory.[1]

The function of distinct anatomically defined subfields of HPC have been studied extensively.[2] Yet, it remains unclear these subfields are connected through intrinsic **white matter fibers** to allow information flow within HPC.

Recent studies have begun characterizing broader HPC connections with cortical and subcortical regions with diffusion-weighted MRI.[3,4]



Pathway diagram from[9]



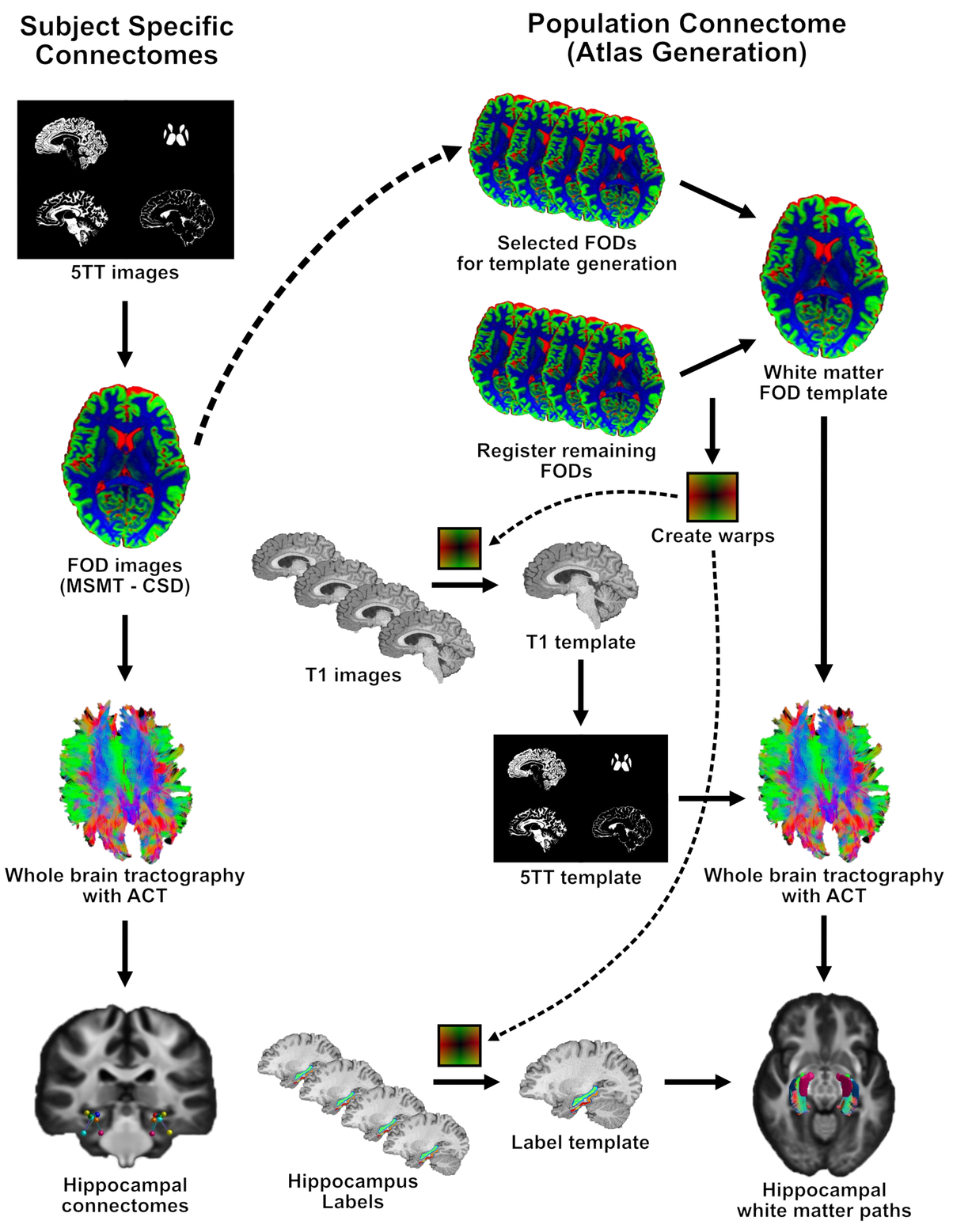
Goal: Quantifying white matter pathways in the human hippocampus and entorhinal cortex

Methods

N = 831 young adults from the Human Connectome Project[5]

Preprocessed T1 (0.7x0.7x0.7mm) and diffusion data (1.25x1.25x1.25mm)

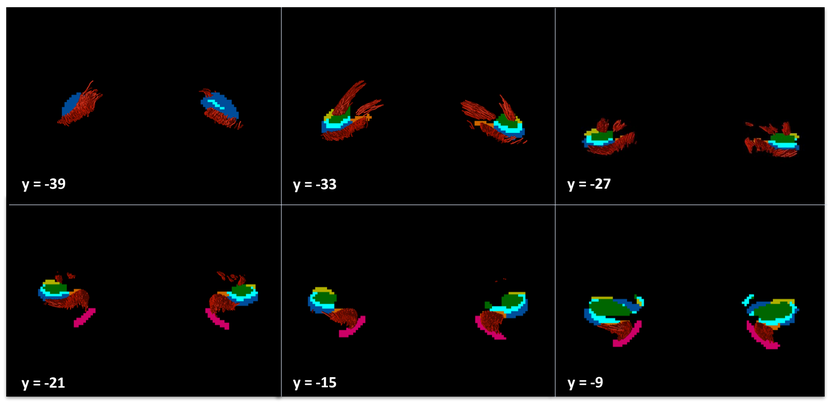
- Hippocampal subfield segmentation using MAGeTBrain[6]
- Medial temporal lobe segmentation using ASHS[7] through ITK-SNAP
- Individual connectome and HPC white matter atlas generation with MRtrix[8]

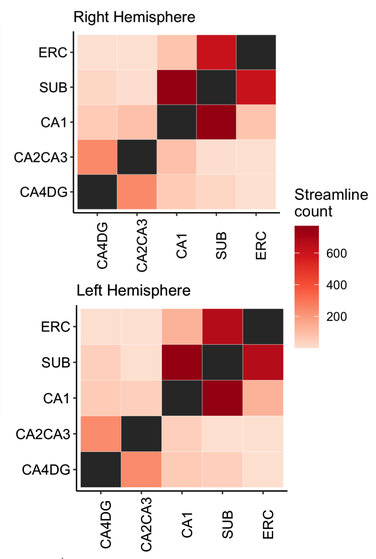


Results

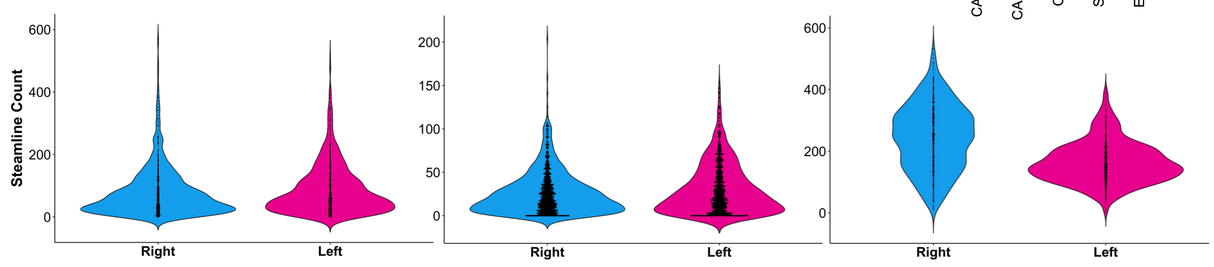
Quantified HPC white matter connections reflect hypothesized pathways (i.e., ERC-CA1, CA4DG–CA2CA3, CA2CA3-CA1, CA1-SUB, SUB-ERC, SUB-CA4DG).

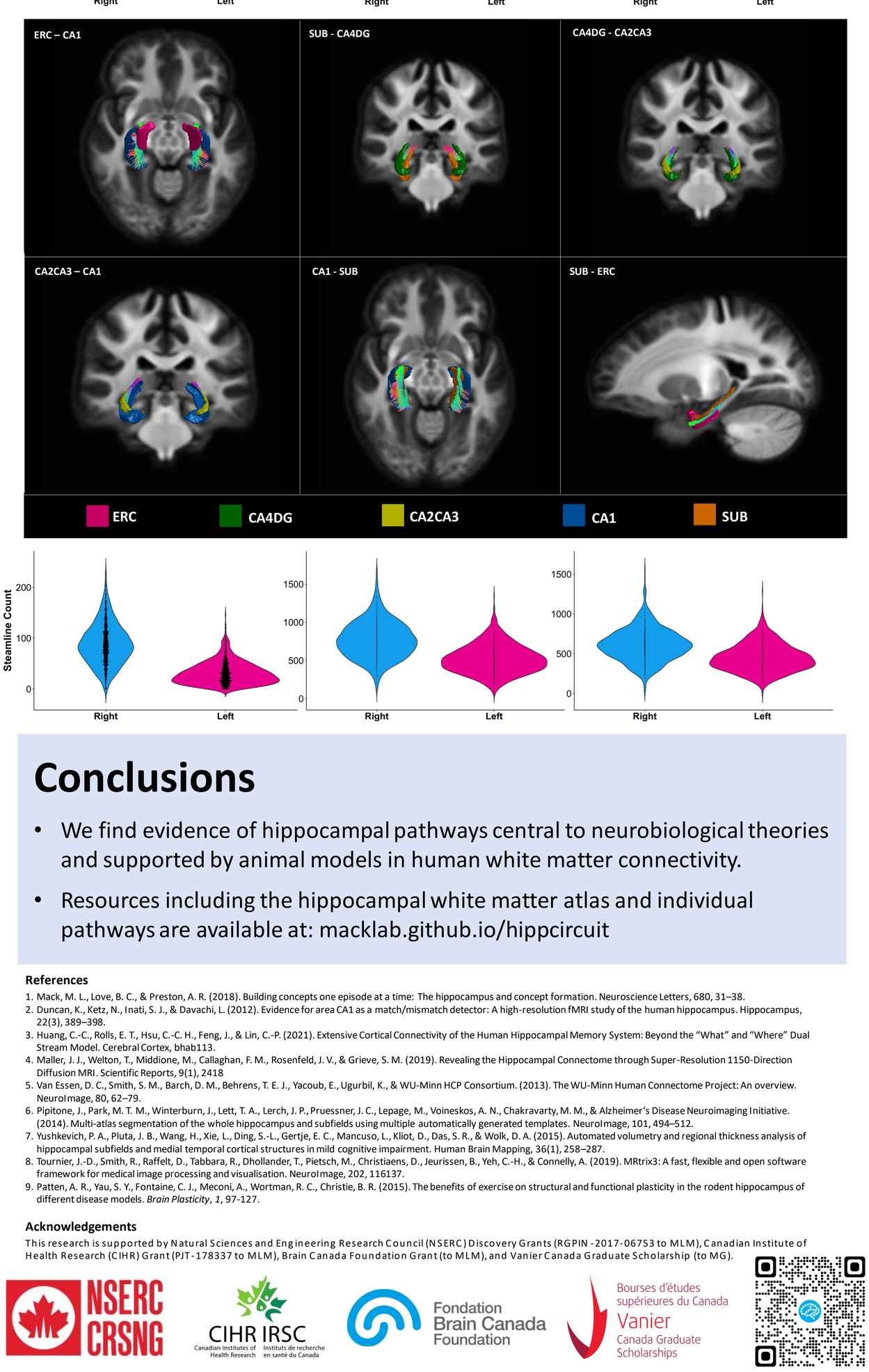
The output connections of the HPC circuitry (i.e., CA1-SUB) present significantly higher streamline count than the input connections (i.e., ERC-CA2/3, ERC-CA4/DG), $t(830) = 92.74$, $p < 0.001$ and $t(830) = 92.55$, $p < 0.001$, respectively.





Significantly higher streamline count among the right HPC white matter pathways than the left HPC ($p < 0.05$).





Conclusions

- We find evidence of hippocampal pathways central to neurobiological theories and supported by animal models in human white matter connectivity.
- Resources including the hippocampal white matter atlas and individual pathways are available at: macklab.github.io/hippcircuit

References

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Acknowledgements

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