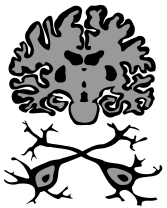
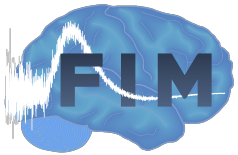
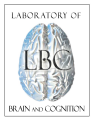
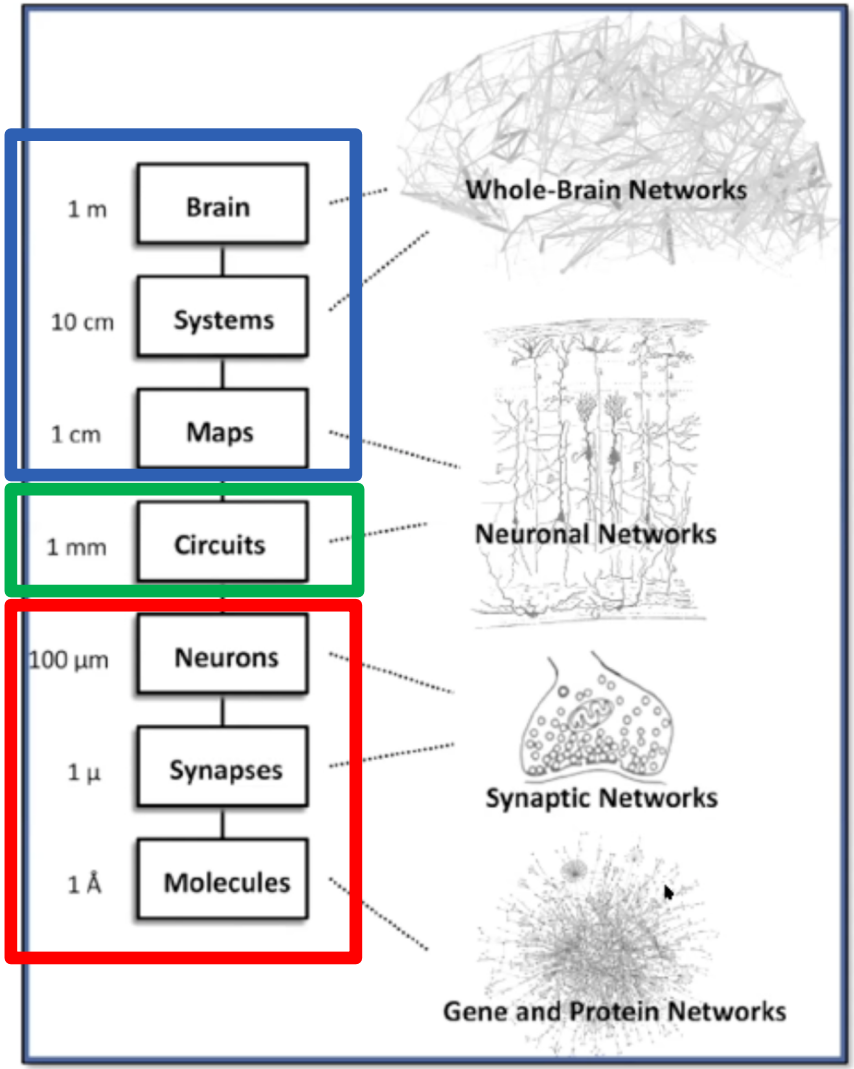
Layer-dependent Functional Connectivity Methods

Richard Klein, Peter Bandettini









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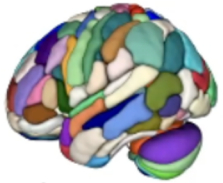
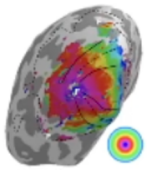
behavior



brain areas

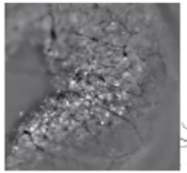


within-areas

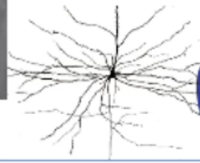
layers & columns

Coverage

100 neurons



neuron



DNA

Resolution

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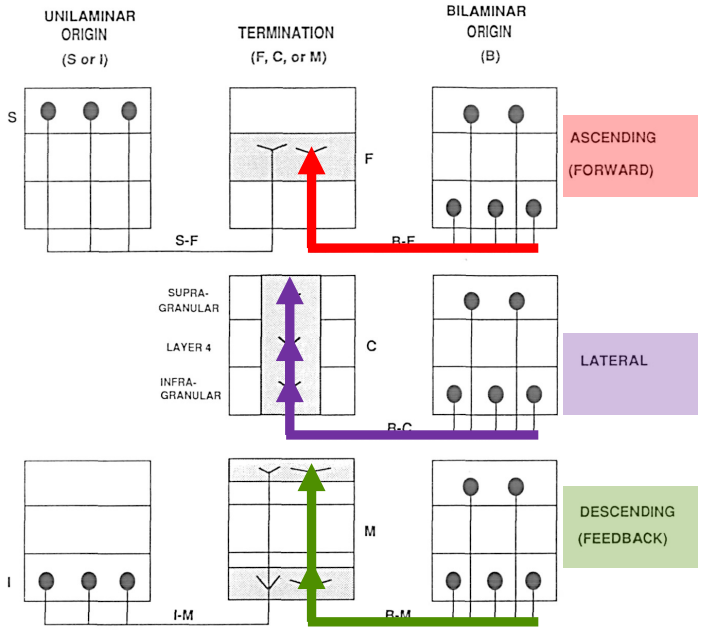
Why layers and columns?

Layer connectivity provides **directionality**

Feedforward connections terminate in middle layers

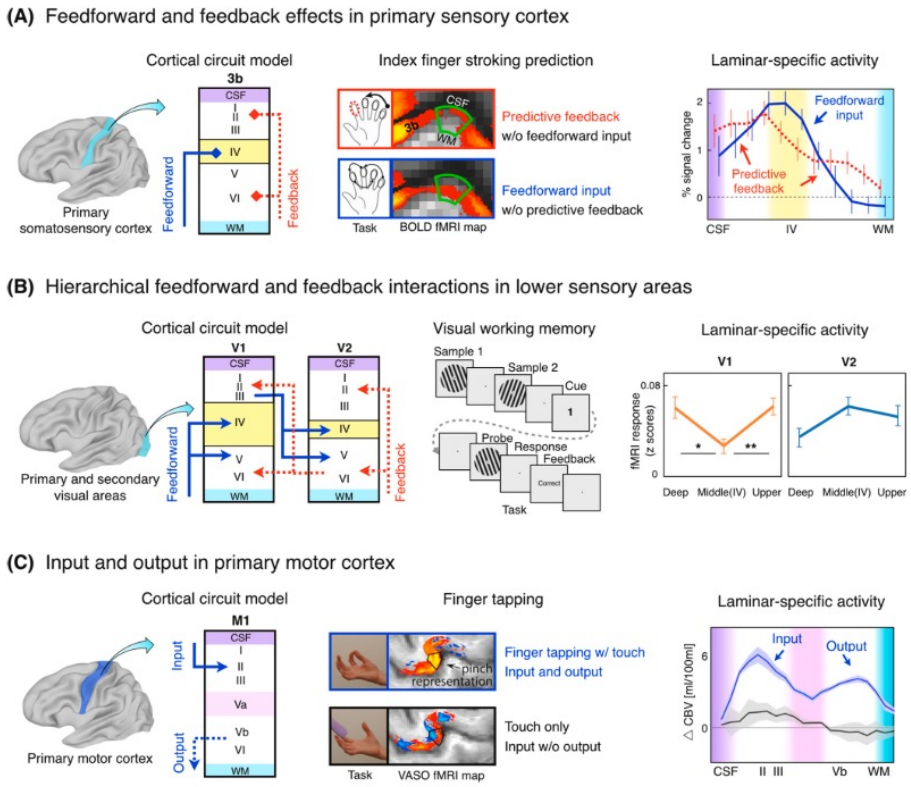
Feedback connections terminate in superficial and deep layers

Lateral connections terminate in superficial, middle, and deep layers



Felleman, D. J., & Van Essen, D. C. (1991). Distributed hierarchical processing in the primate cerebral cortex. *Cerebral Cortex*

Why layers and columns?



Yang, J., Huber, L., Yu, Y., & Bandettini, P. A. (2021). Linking cortical circuit models to human cognition with laminar fMRI. *Neuroscience & Biobehavioral Reviews*

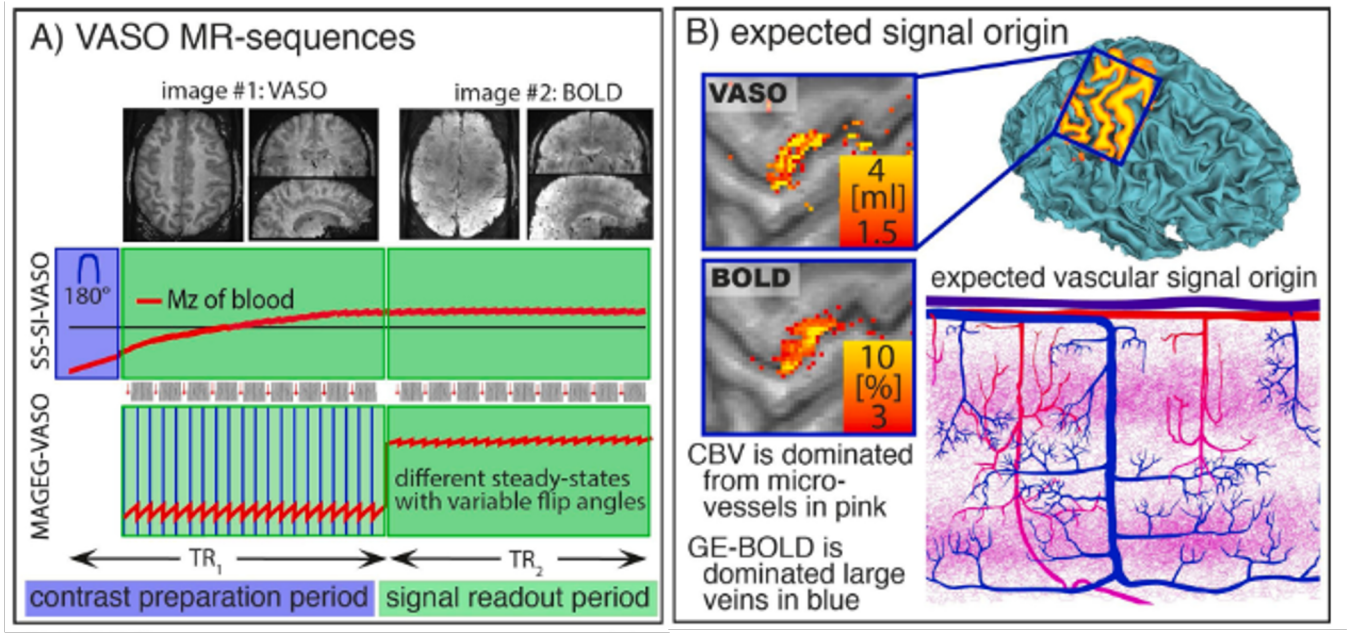
How do we assess functional connectivity?

Vascular-Space-Occupancy (VASO) fMRI

VASO detects changes in cerebral blood volume (CBV)

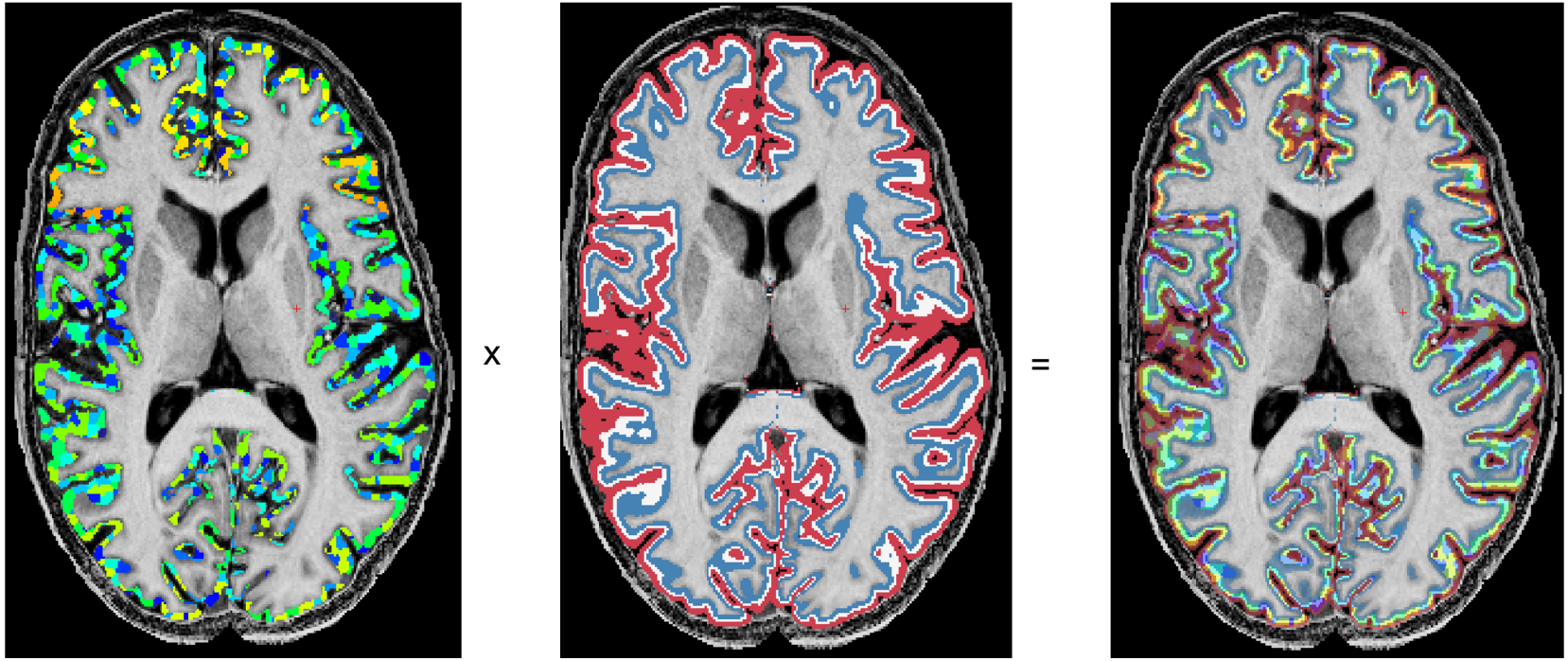
VASO is selective for homogenously distributed micro-vessels along the GM ribbon

Double-stripe effect



How do we assess functional connectivity?

Building Layers and Columns

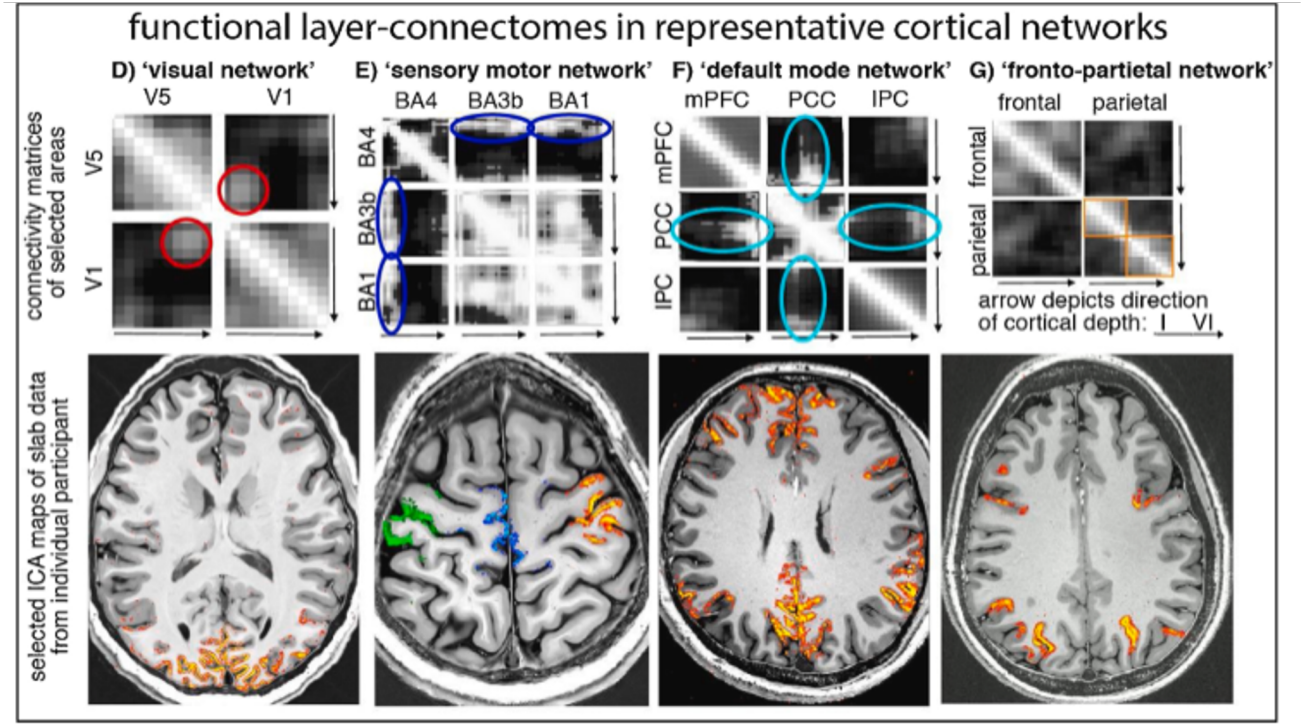


Functional Connectivity Analysis

Movie-watching

ICA to isolate networks of interest

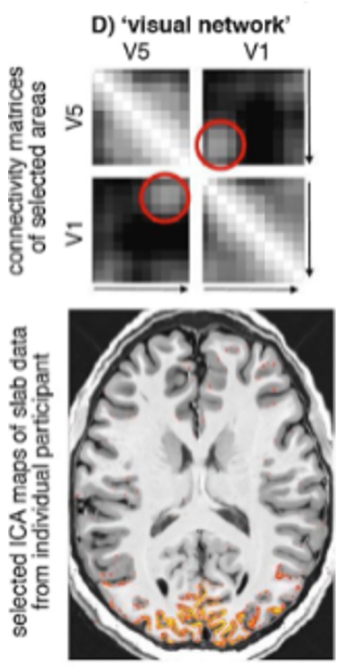
Functional connectivity between layers of ROIs using VASO data



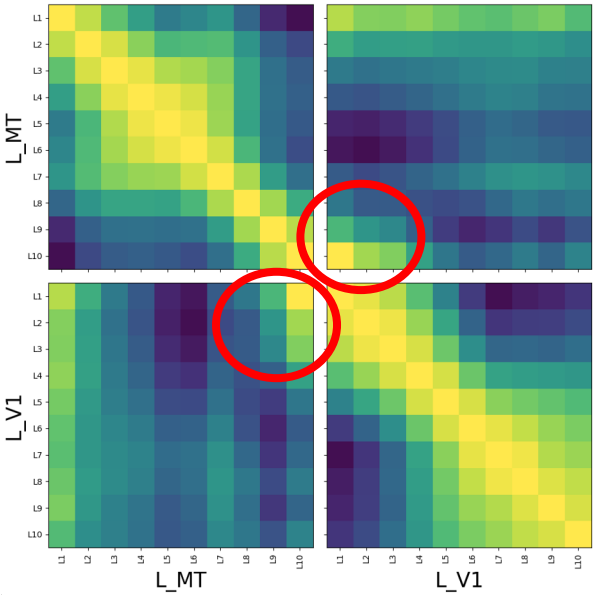
Huber, L., Finn, E. S., Chai, Y., Goebel, R., Stirnberg, R., Stöcker, T., … Poser, B. A. (2020). Layer-dependent functional connectivity methods. *Progress in Neurobiology*, (May).

Visual Network

V1 receives top-down feedback in **superficial** layers from V5/MT, while V5/MT receives bottom-up input in the **middle/deeper** layers



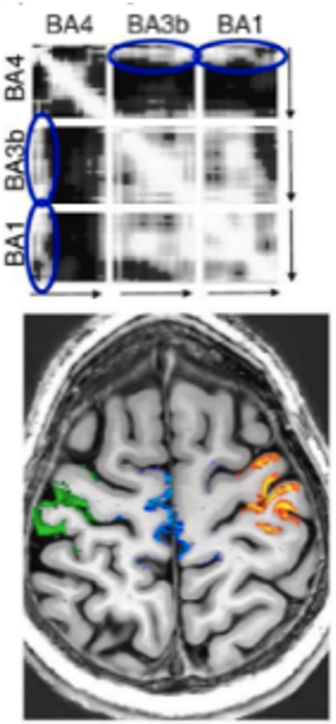
Visual Network (L_V1 L_MT)



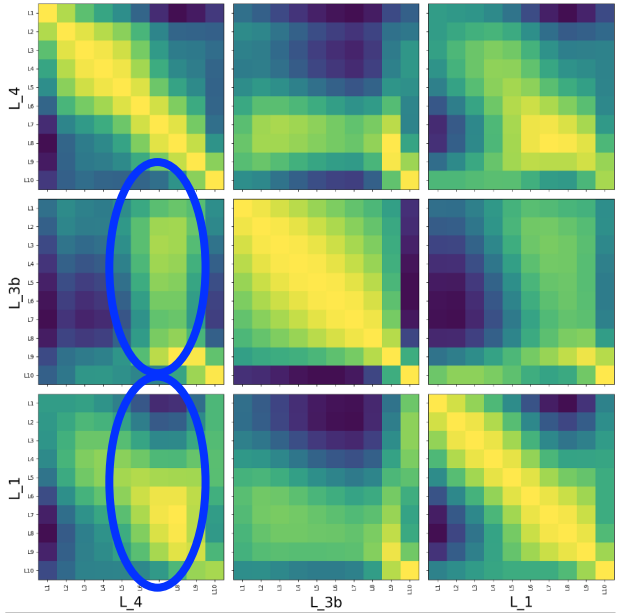
Sensory Motor Network

Primary motor cortex receives input from the sensory areas **solely in superficial layers**

We get correlations with middle/deeper layers of BA4. We would expect more superficial correlations (layer misalignment)



Sensory Motor Network
(L_4, L_3b, L_1)

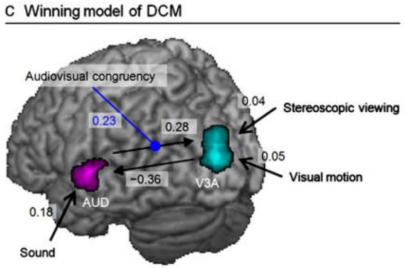


Audio-visual interactions in Area V3A

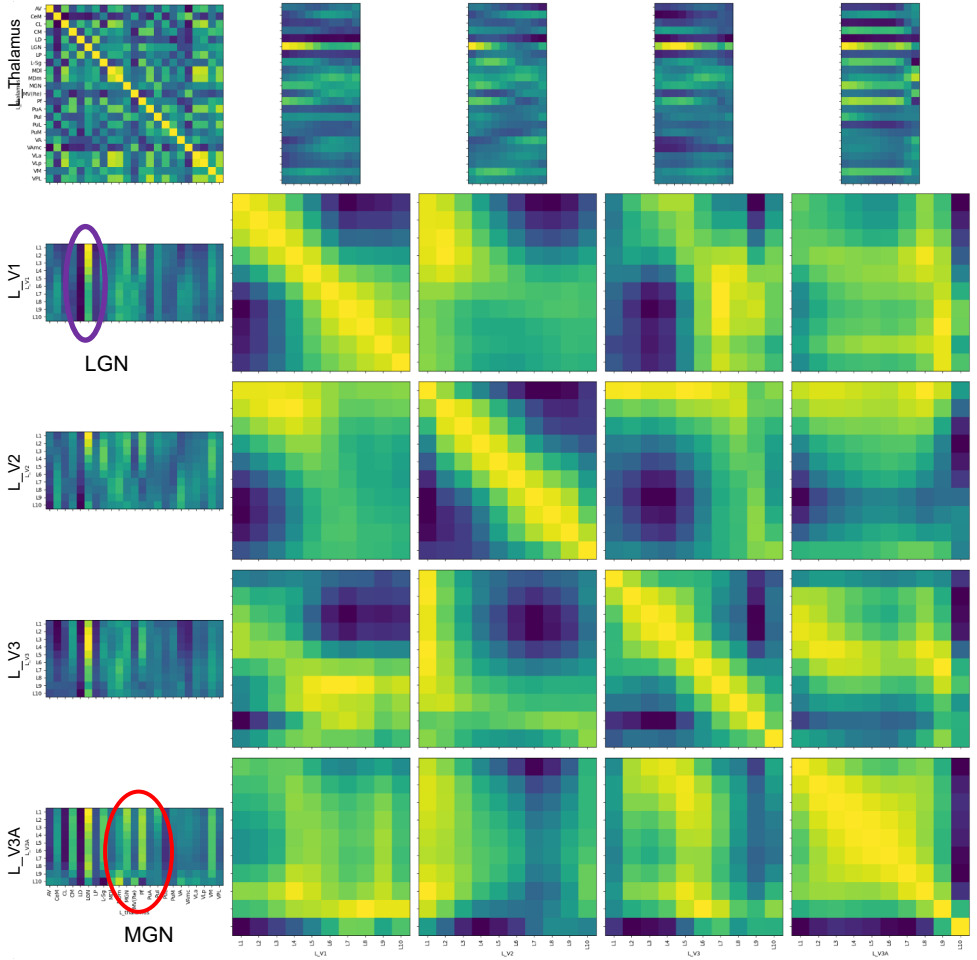
LGN correlates with **superficial layers of the early visual ROIs**, <u>we would expect middle layers</u> (layer misalignment?)

Interestingly, V3A may be getting some auditory input (slight correlation with MGN)

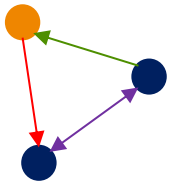
“Changes of visual size and auditory intensity provide us with the main cues about motion direction in depth”

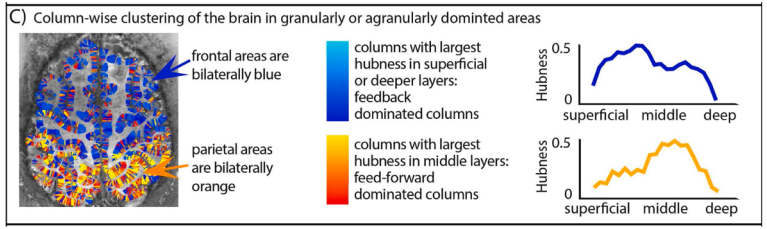


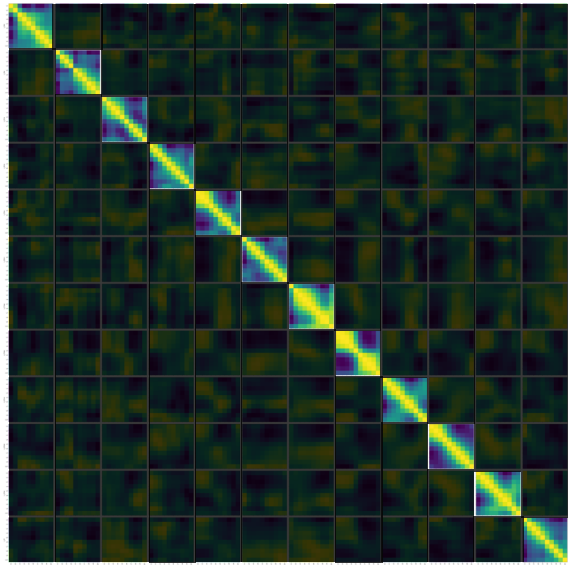
Ogawa, A., & Macaluso, E. (2013). Audio-visual interactions for motion perception in depth modulate activity in visual area V3A. *NeuroImage*



Clustering Nodes



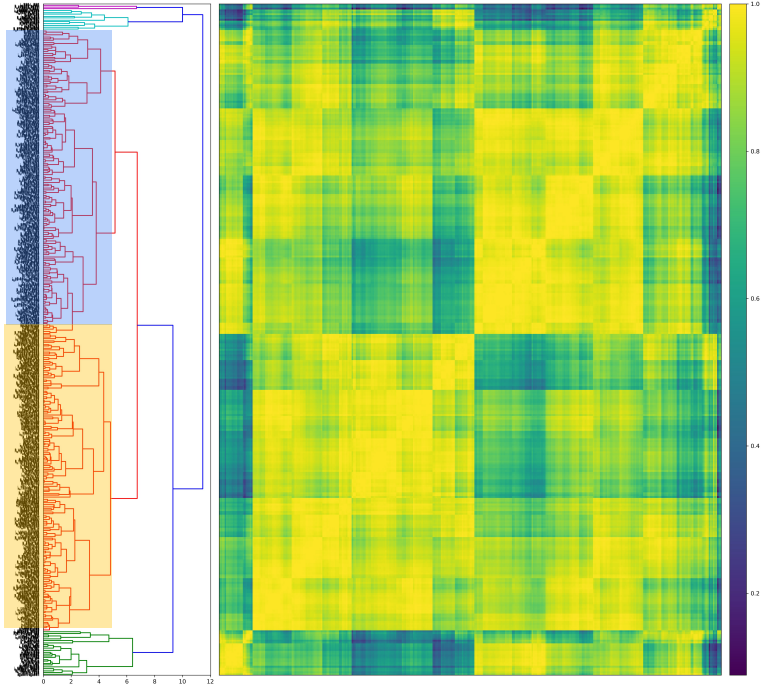




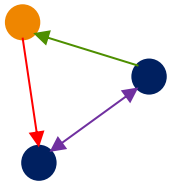
360 nodes

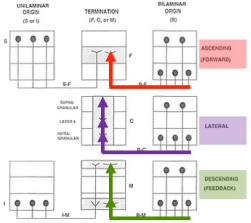
We expect 2 major node clusters:

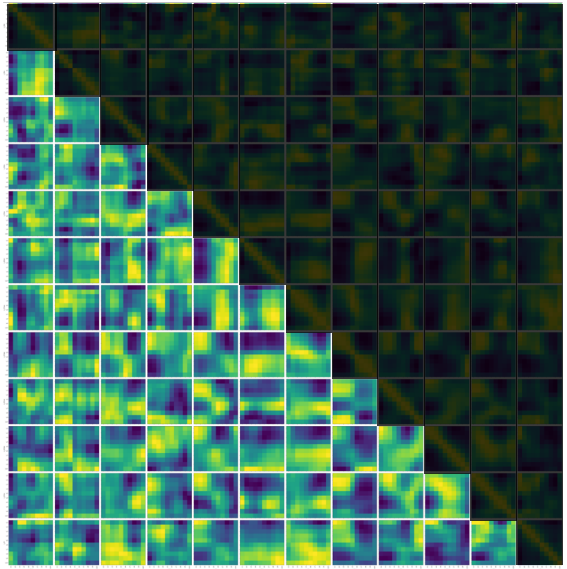
- Feedforward dominant
- Feedback dominant



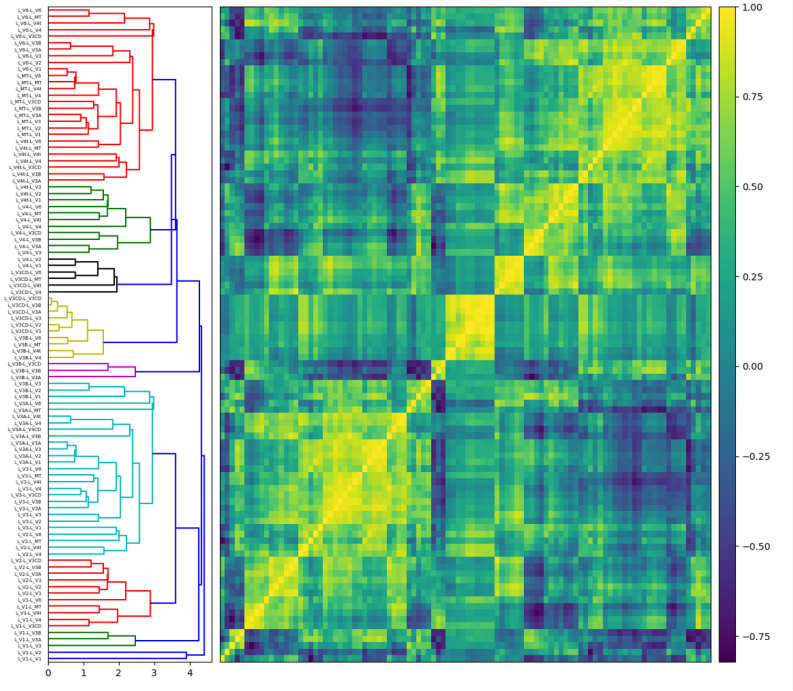
Clustering Edges







66 edges (64620 edges total!)
We would expect at least 3 clusters: feedforward, feedback, and lateral. More if connectivities differ from those proposed by Felleman and Van Essen.



Thank You

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John VanMeter