

finger representation in M1

BOLD is hard because large vessels result in more across 'columns'

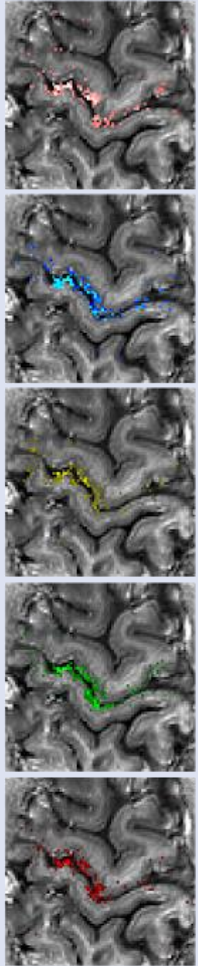
VASO

digit response

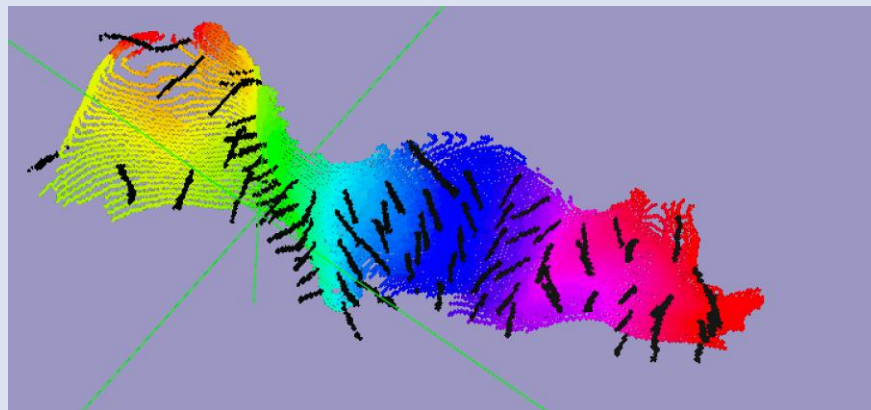
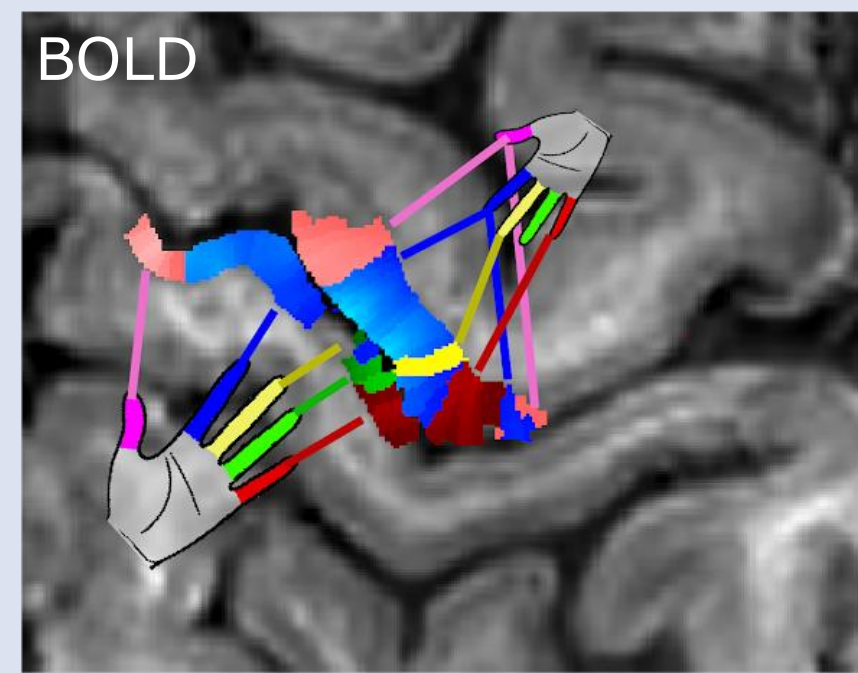
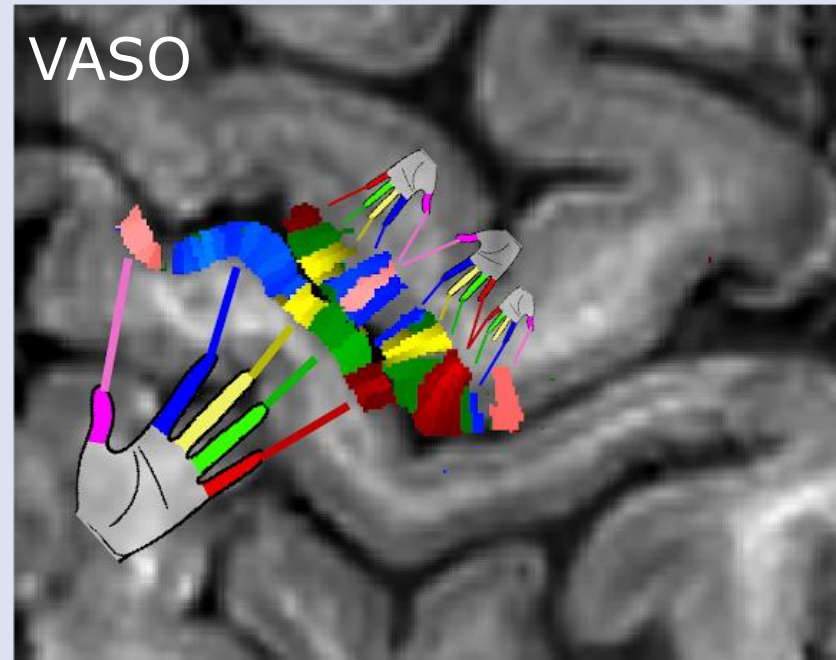
columnar response compared to other digits

columnar digit dominance map

columnar digit dominance map

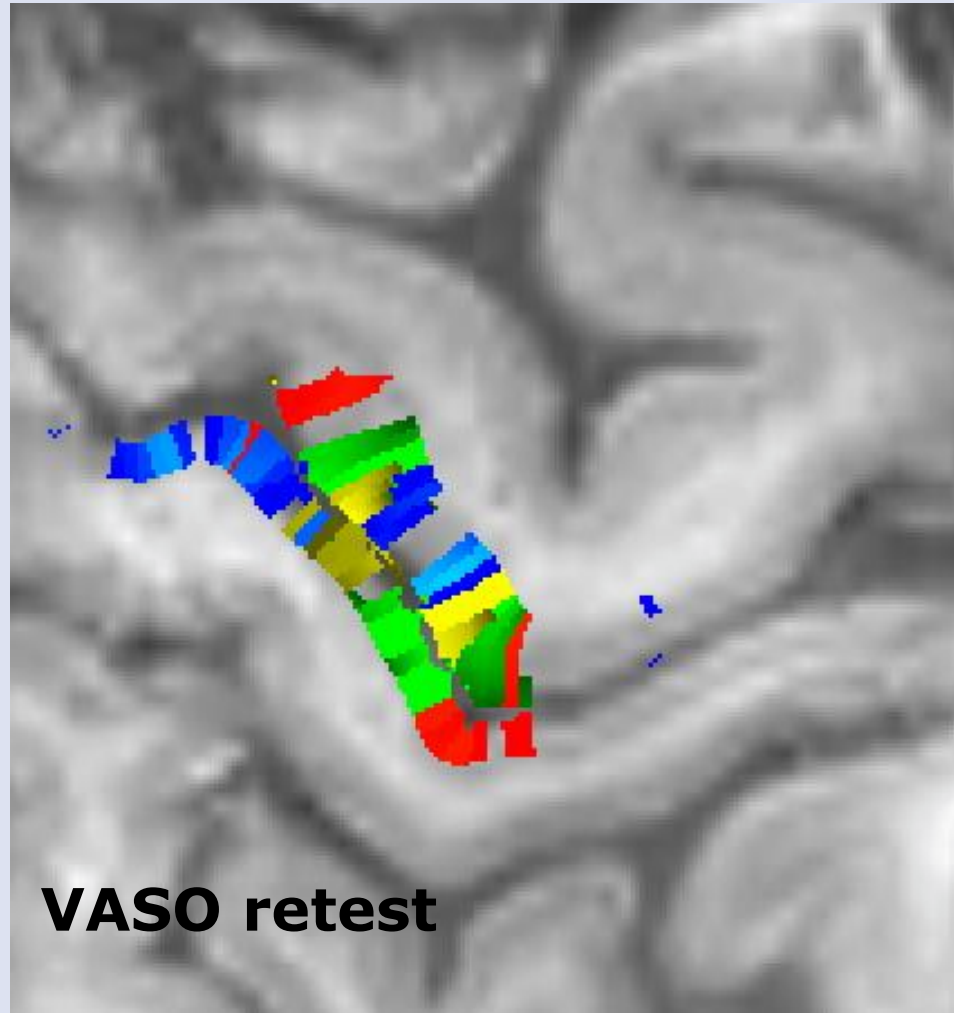
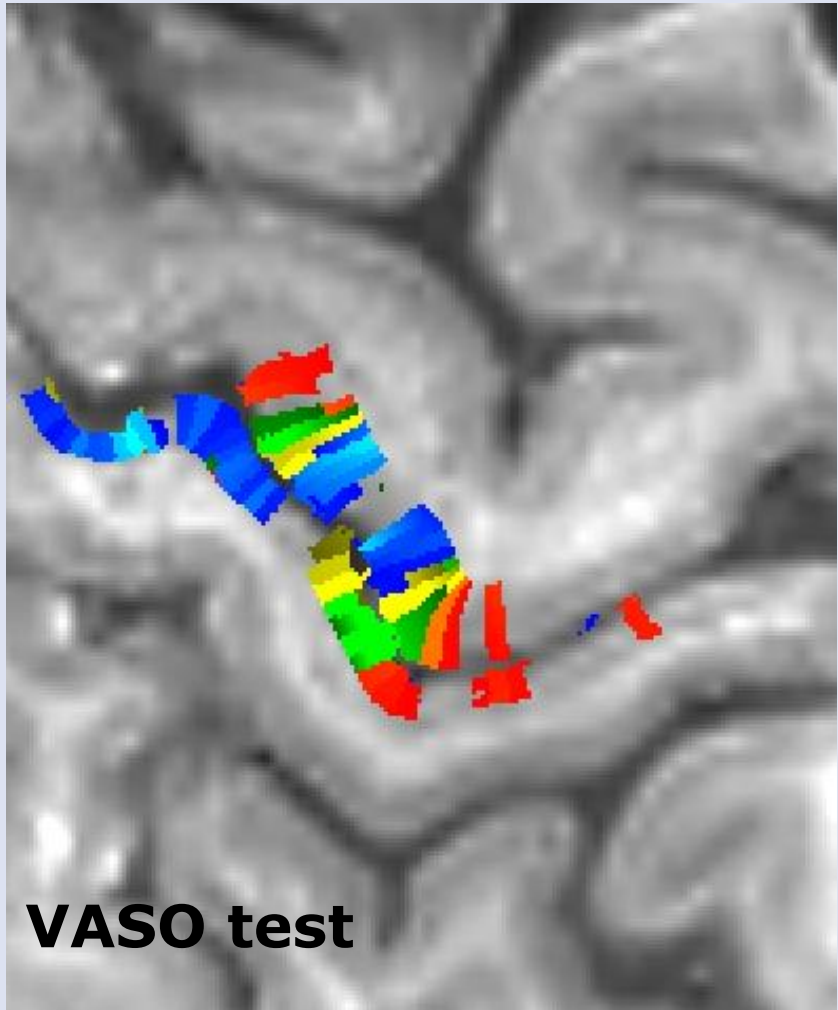


1
 Δ VASO [ml]
-1



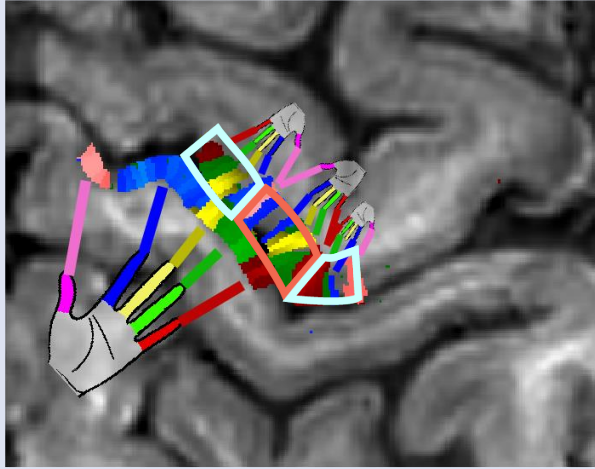
- index finger tapping (0.75 Hz)
- middle finger tapping (0.75 Hz)
- ring finger tapping (0.75 Hz)
- little finger tapping (0.75 Hz)
- thumb tapping (0.75 Hz)

Consistency across days

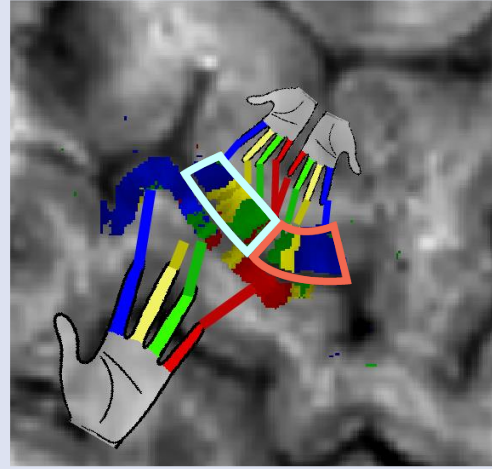


Consistency across people

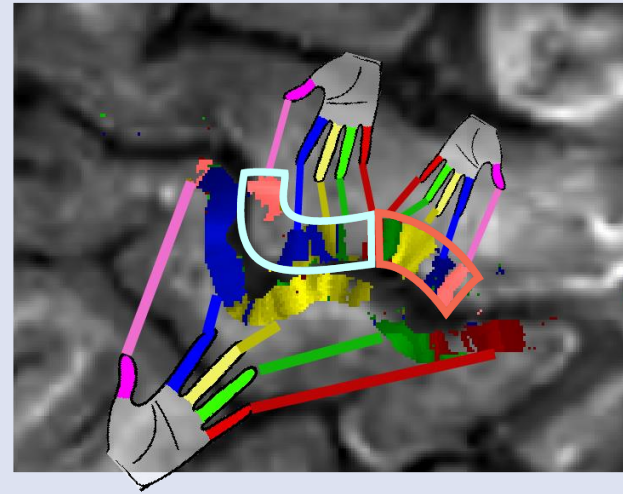
participant 1



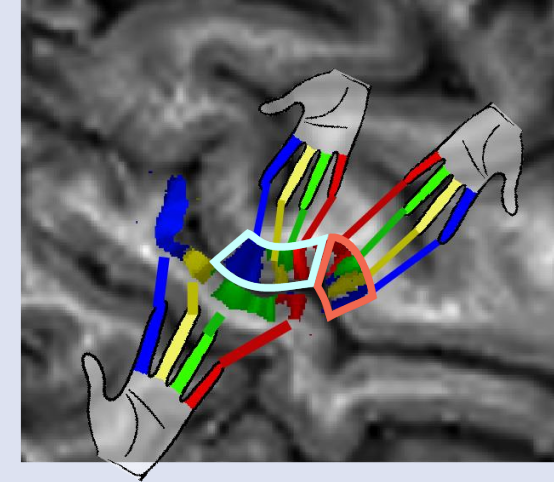
participant 2



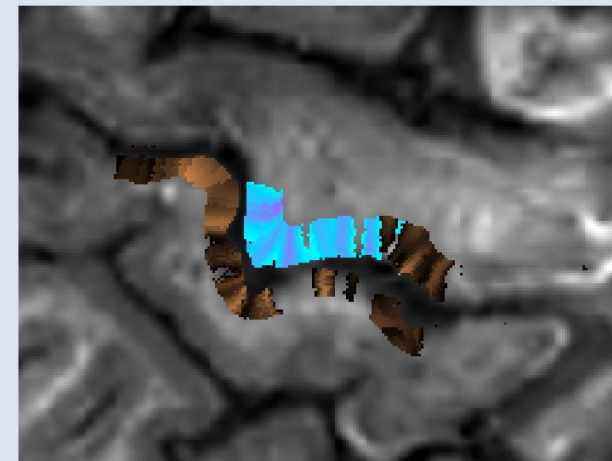
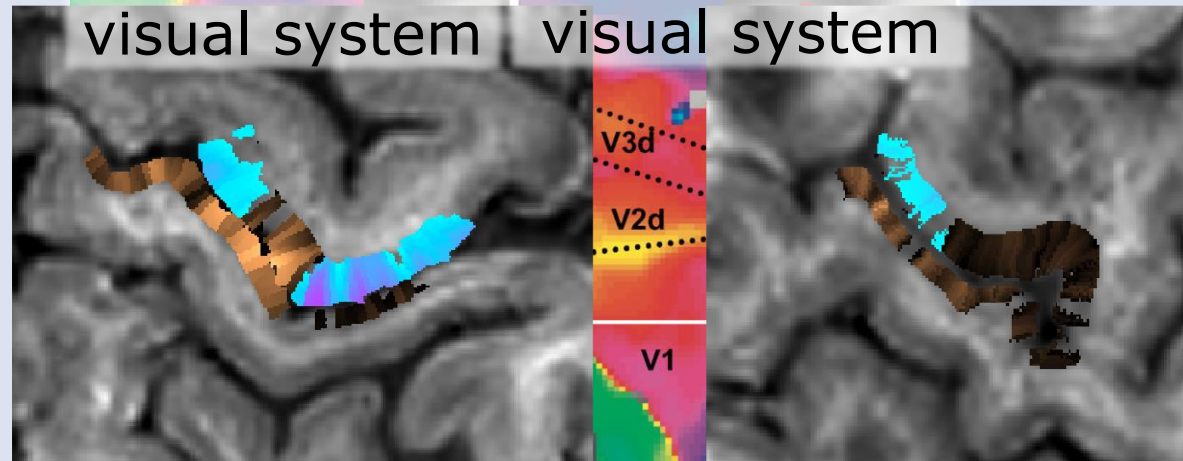
participant 3



participant 4

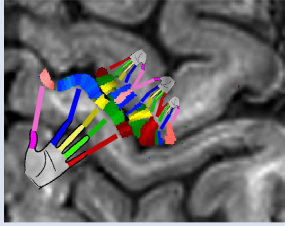


hand representations in polar angles in match "action maps"

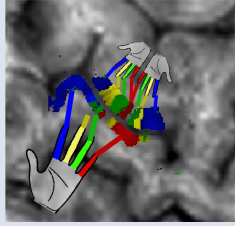


Discussion

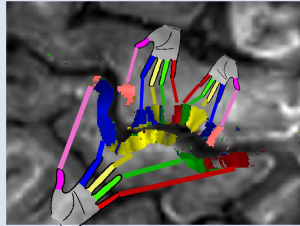
participant 1



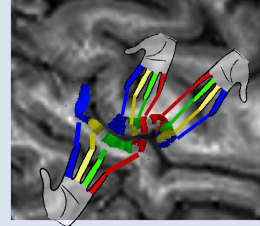
participant 2



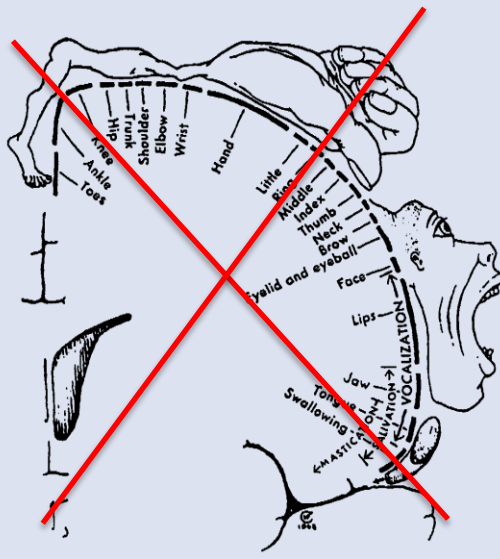
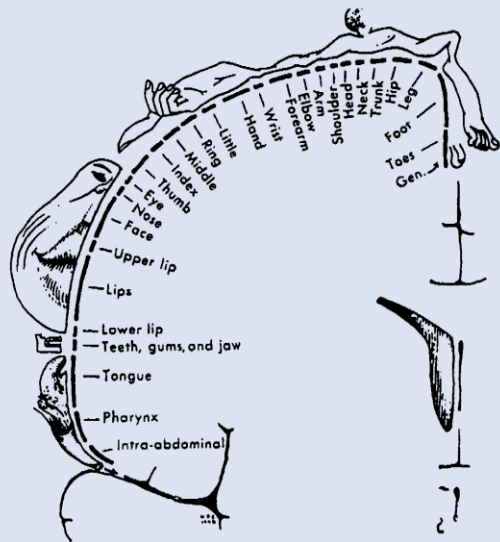
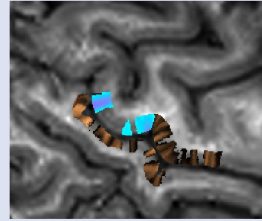
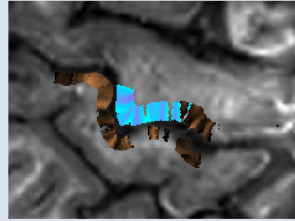
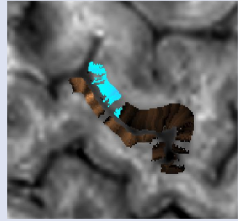
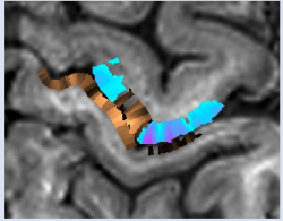
participant 3



participant 4



hand representations match "action maps"



somatosensory area (left) and primary motor area (right).

Penfield, W., and Boldrey, E. (1937)

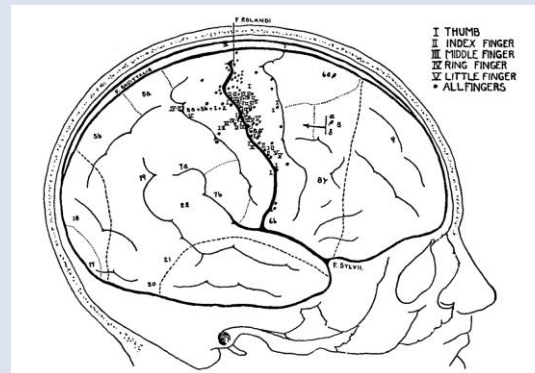
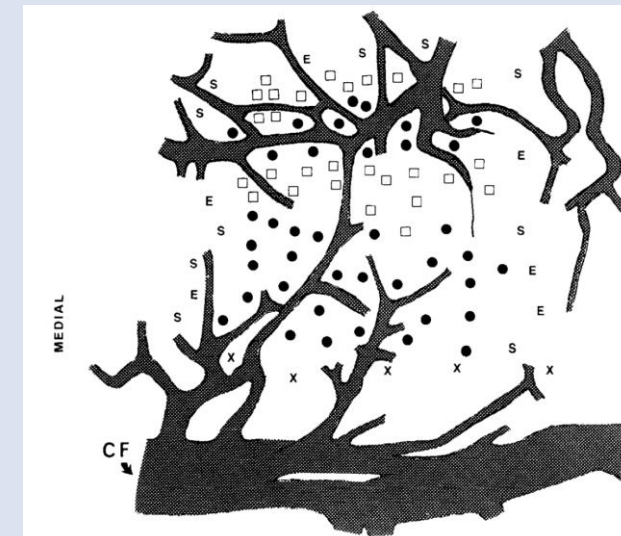


FIG. 12.—Movement of digits.

and little fingers, and the middle, ring and little fingers. We were surprised that the point for so useful and used a digit as the index finger was not encountered more frequently. It responded no more frequently than the little finger.

Flexion and extension responses were often separable in an individual case, and points for one digit were sometimes found separated rather widely as though these members had a comparatively large amount of cortex devoted to them. Patient 118 had some interesting finger

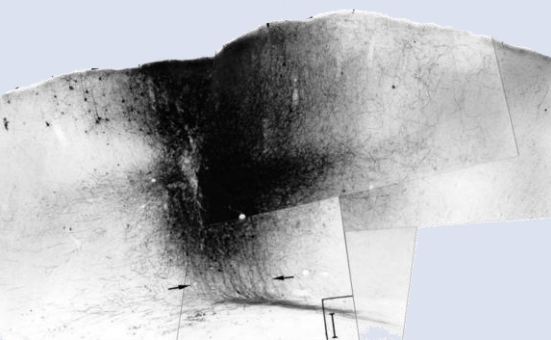
Strick. (1982).



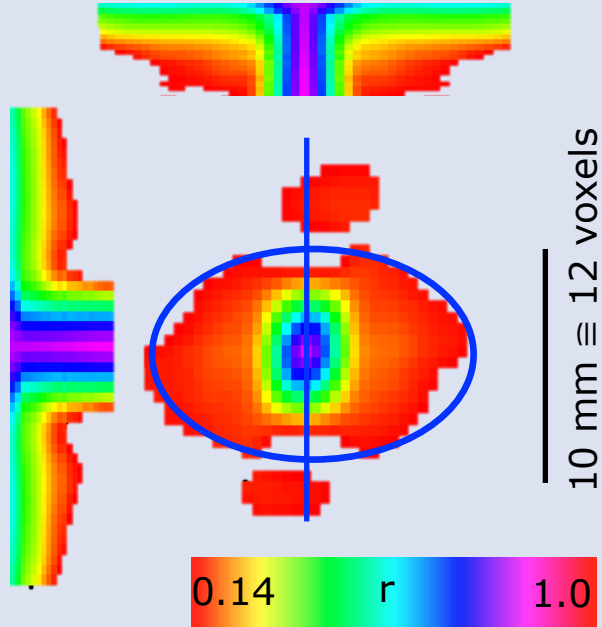
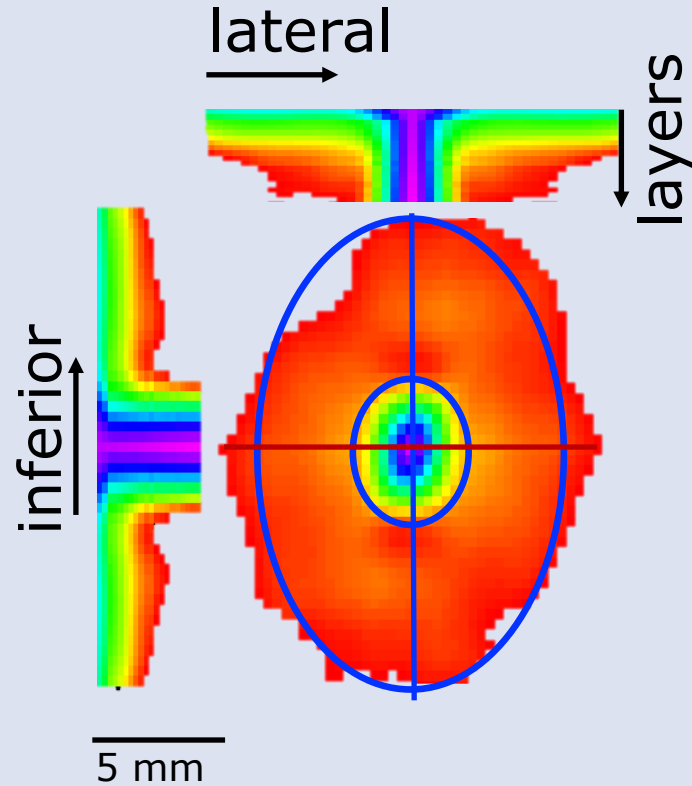
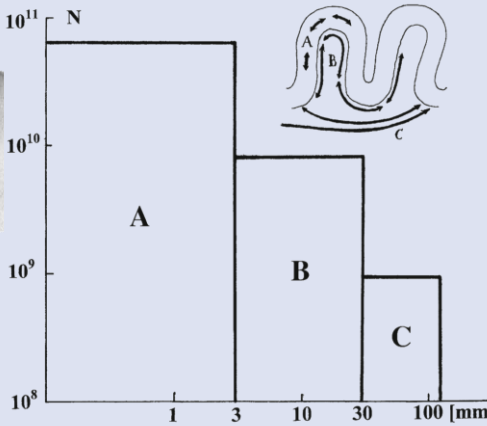
Near-range and far-range connectivity

Layer II/III

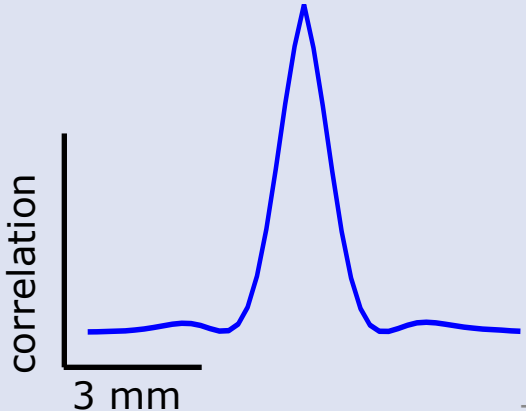
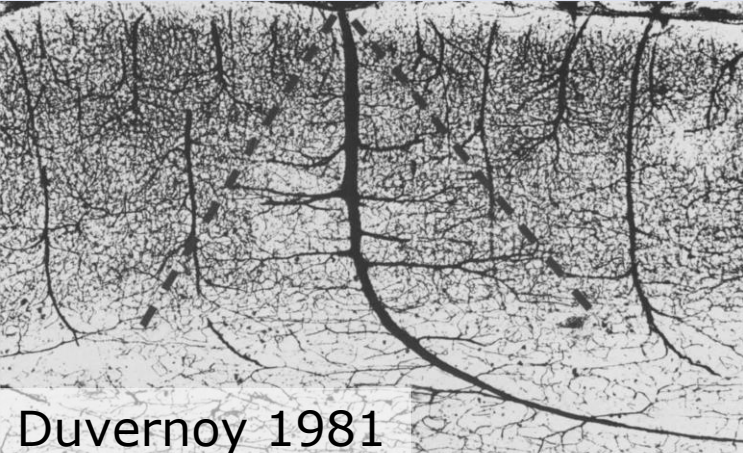
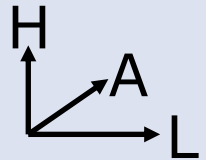
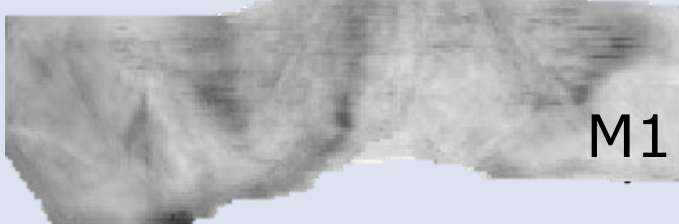
Layer Vb/VI



[Almut Schuetz, Biol. Cyb.]



IMAGiro

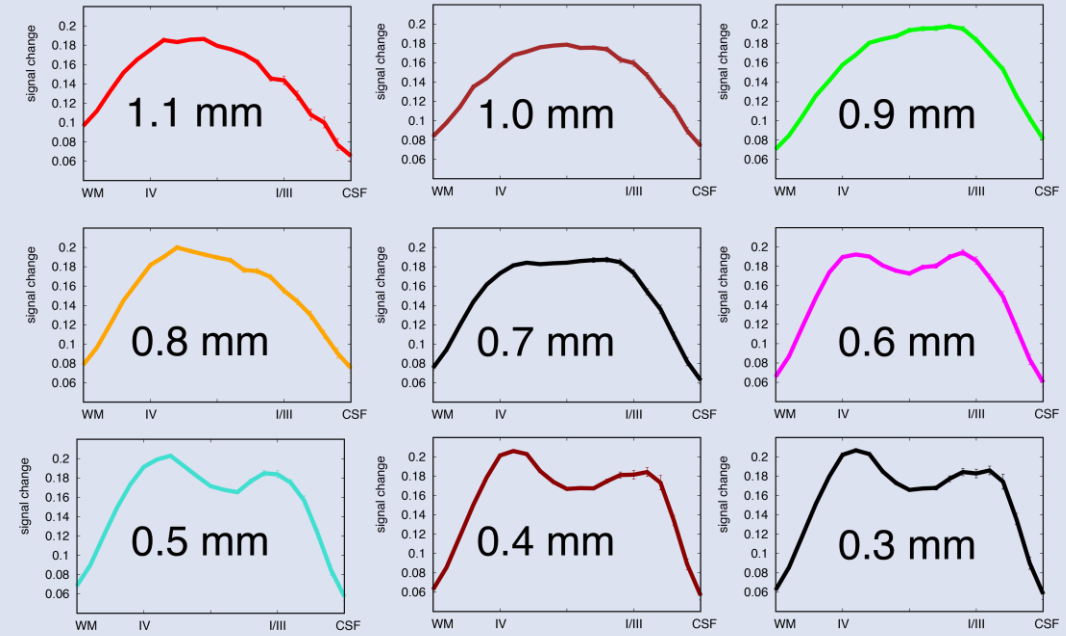
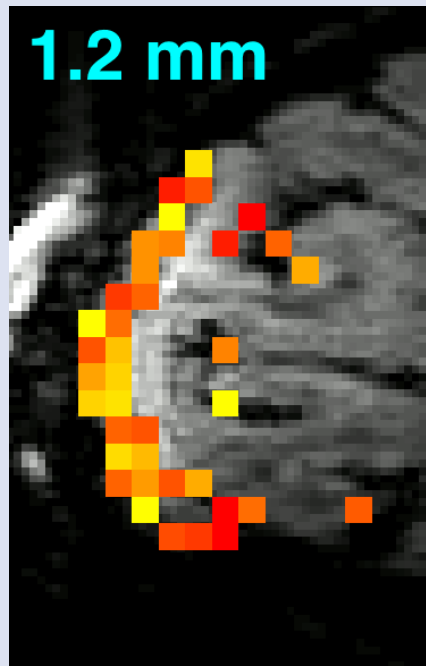


Layer-fMRI in V1



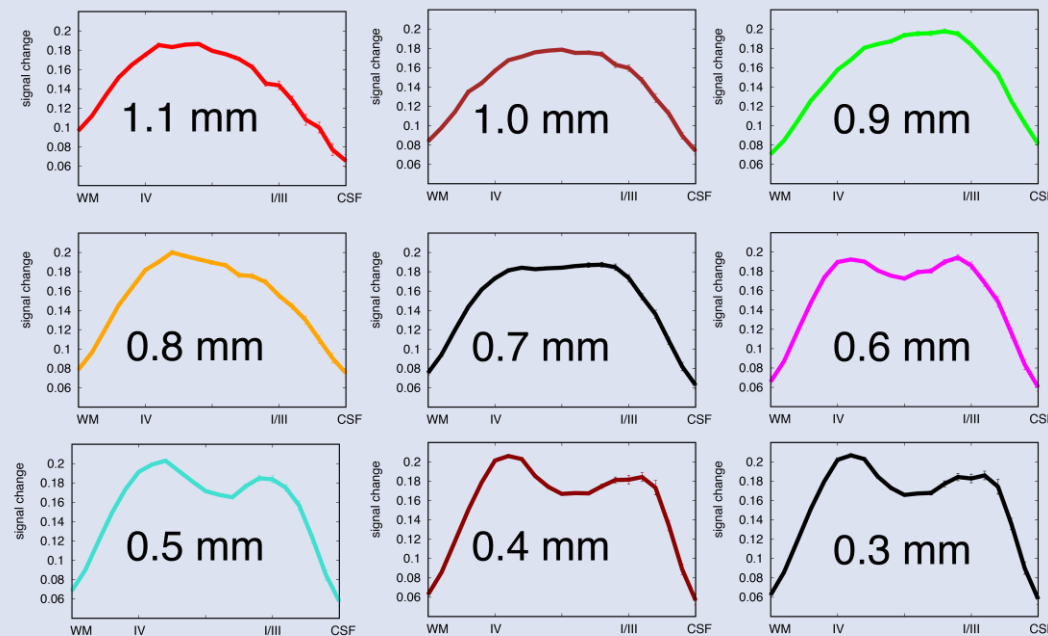
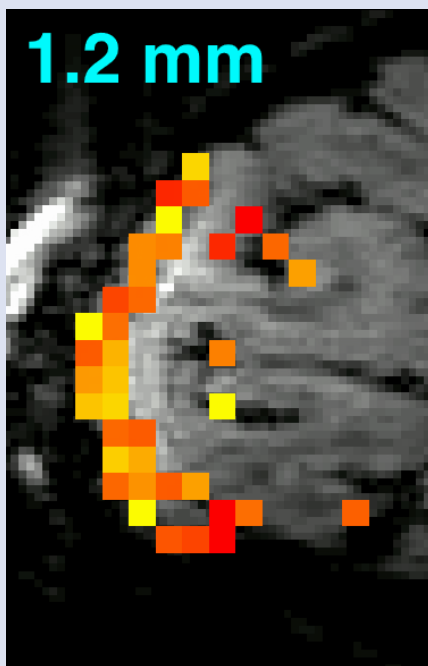
Huber et al. NeuroImage 2014, in collaboration with Jozien Goense

Layer-fMRI in V1

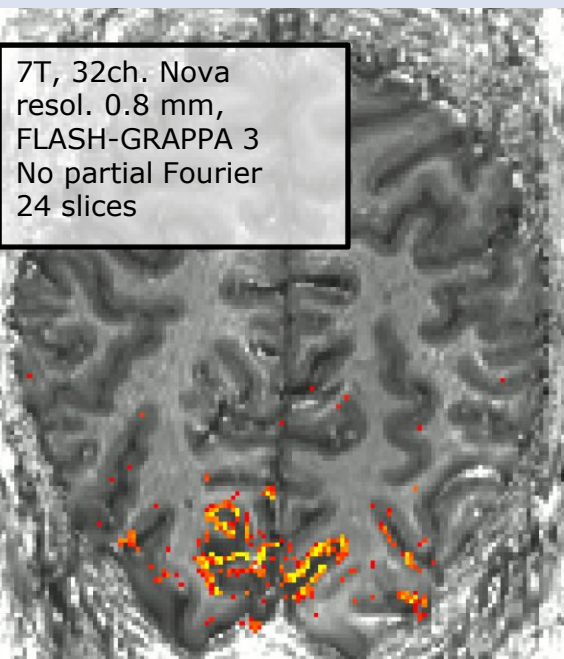
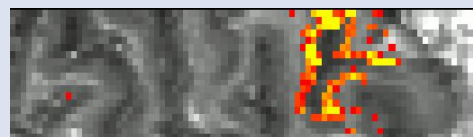
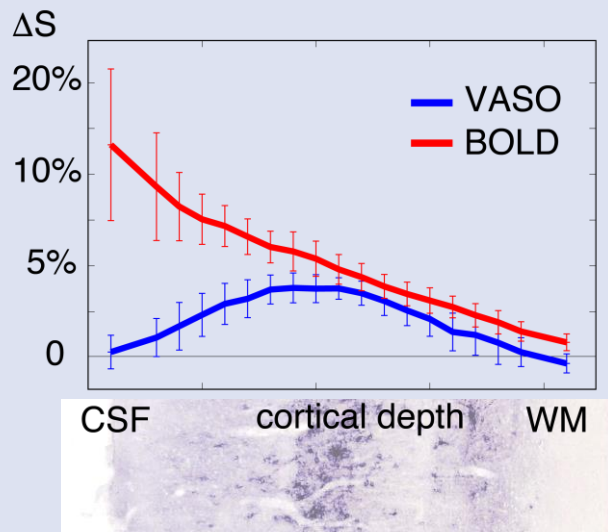
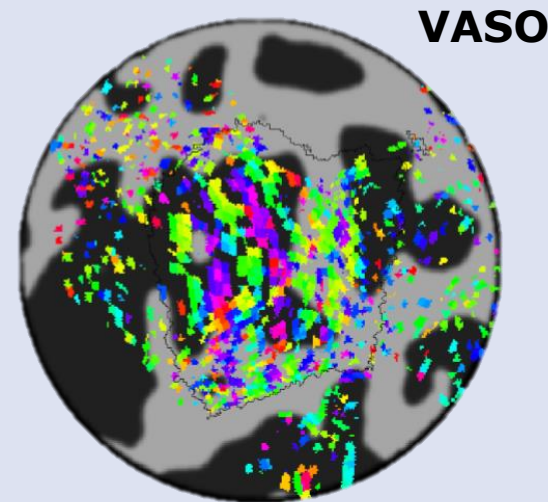
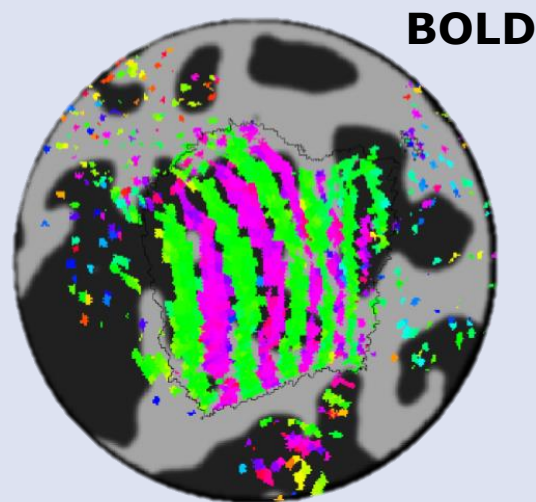


Huber et al. NeuroImage 2014, in collaboration with Jozien Goense

Layer-fMRI in V1

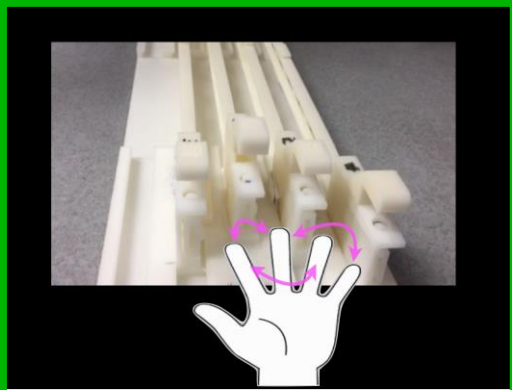
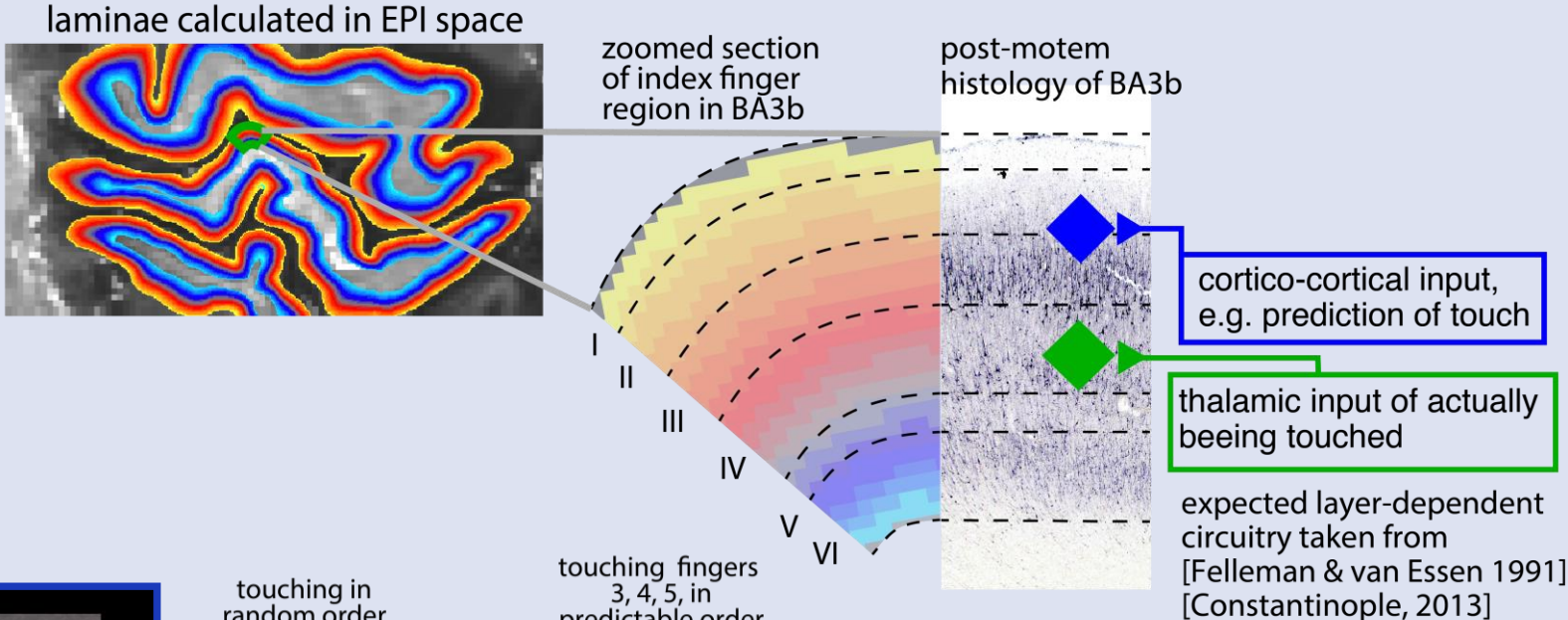


Huber et al. NeuroImage 2014, in collaboration with Joziën Goense



with **Eli Merriam** and **Zvi Roth**

layer-fMRI in S1



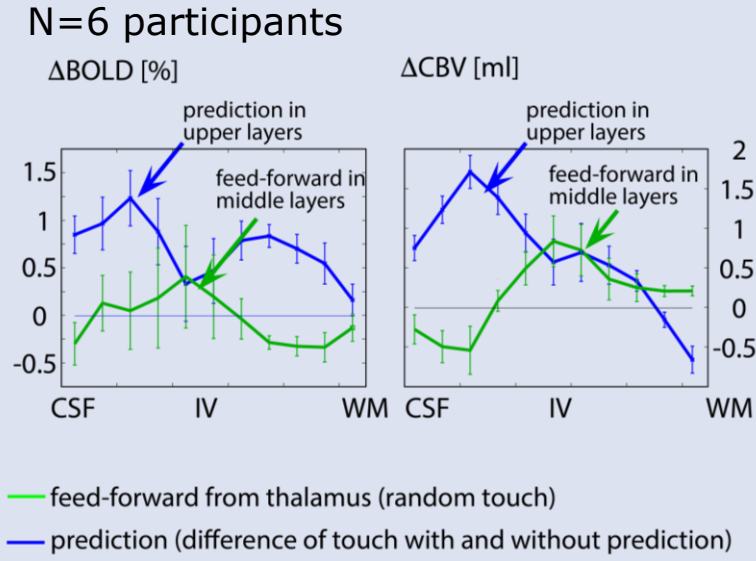
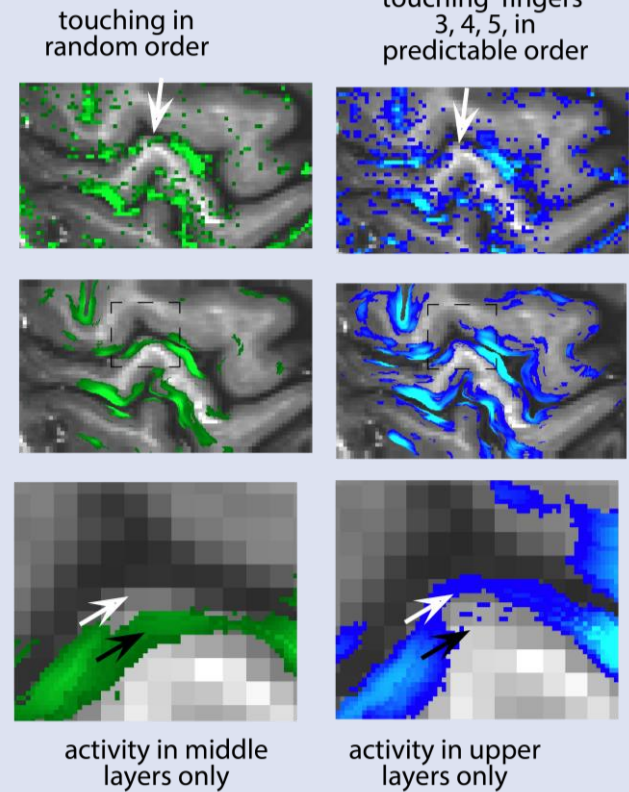
random touching of all fingers

index finger is touched (unexpectedly)



touching sequence of fingers 3,4,5

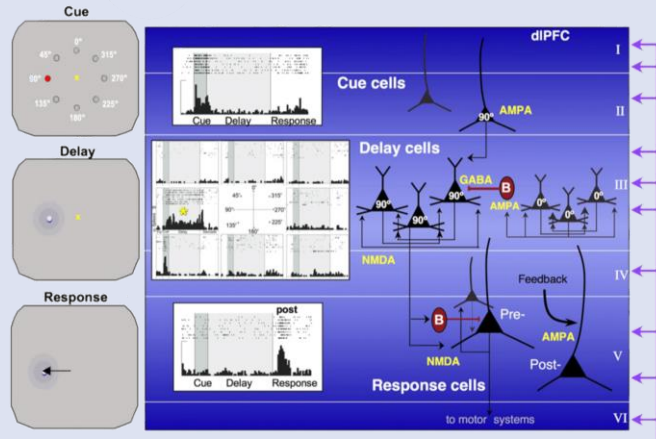
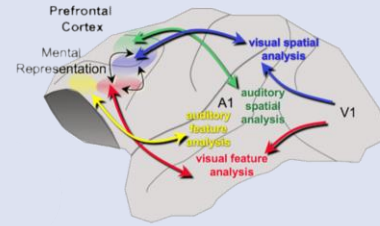
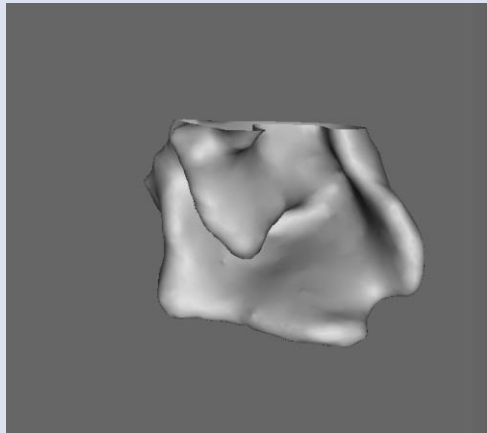
index finger is expected to be touched only



In collaboration with **Yinghua Yu**

Layer-dependent fMRI in "cognitive" area DLPFC

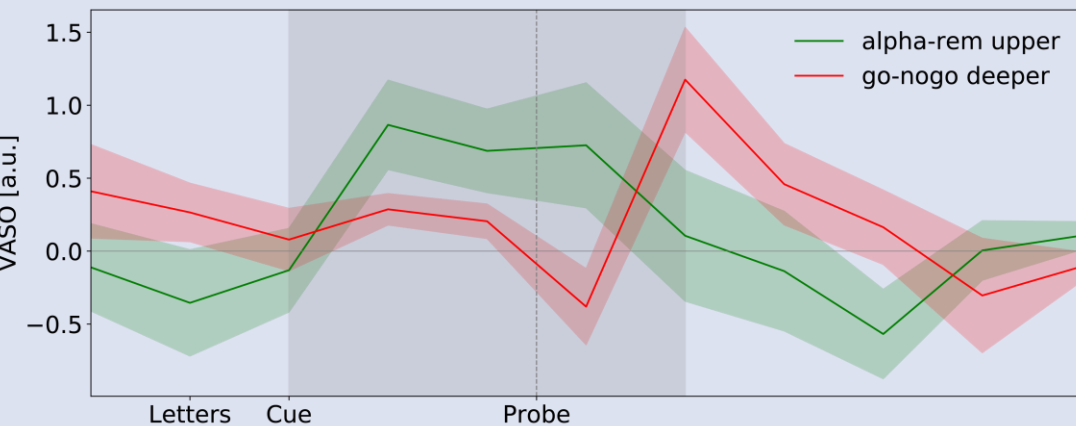
geometry



[Goldman-Rakic et al., 1996] [Arnseten 2012, Neuron]

N = 6 participants

Delay Response



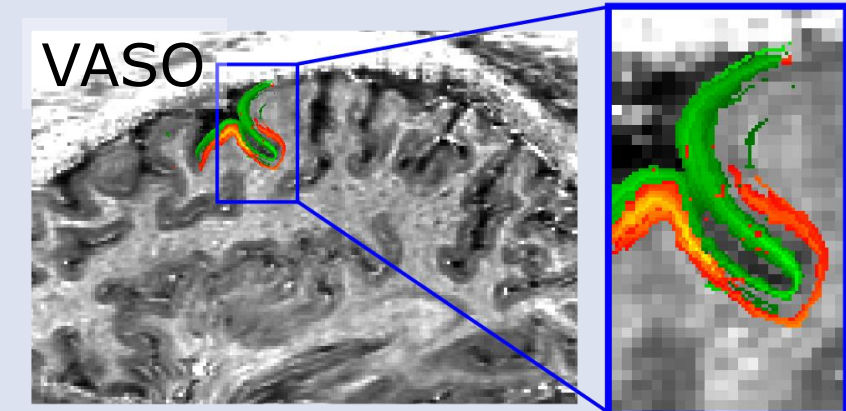
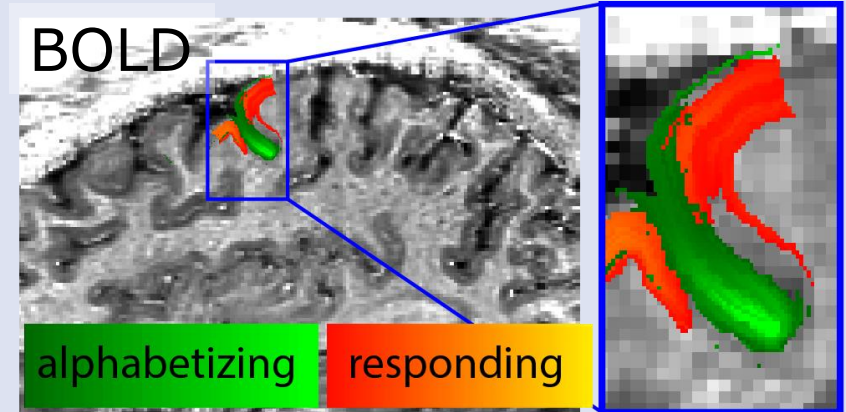
Task:

αpharβetize

[D'Esposito et al., 1999]



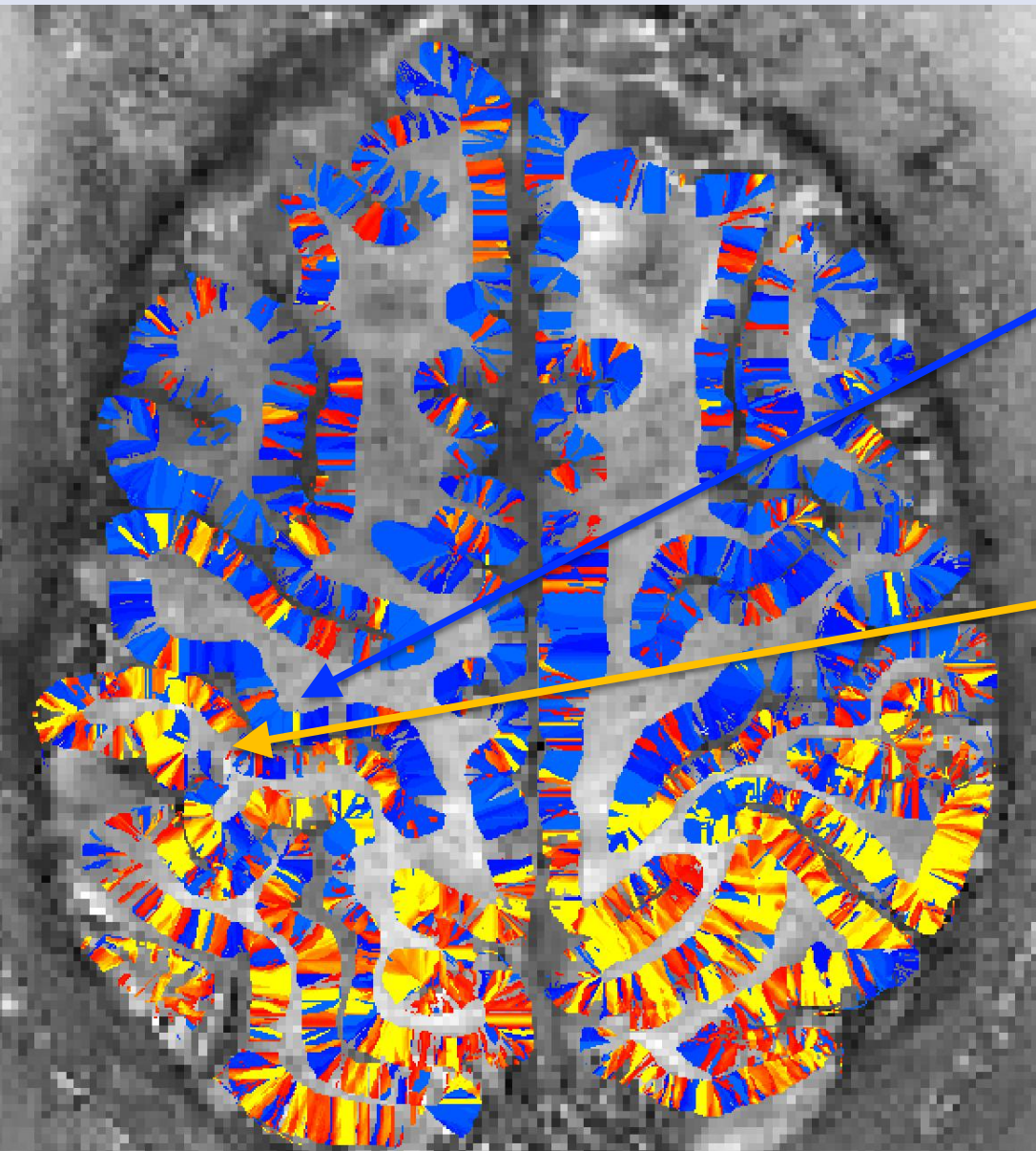
In collaboration with **Emily Finn**



7T, 32ch.
Nova,
Inpl. resol.
0.79mm,
pF = 6/8,
24 slices

hubness across layers

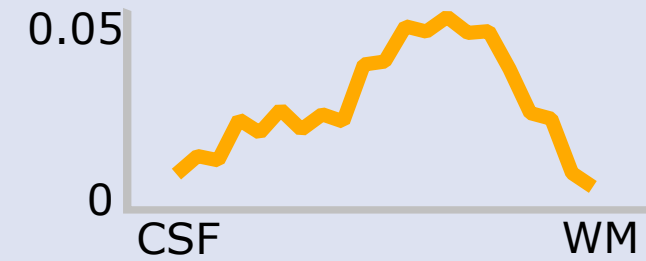
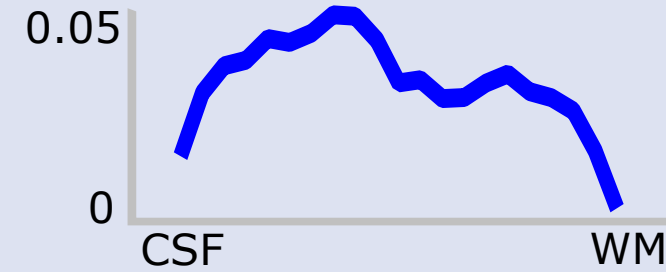
Hubness: functional connectivity strengths of one layers to all other layers



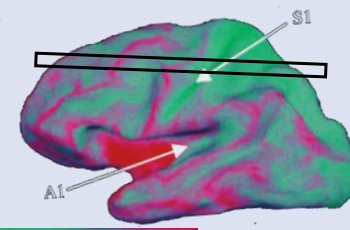
Hub in superficial layers
feed-back dominated
'columns'



Hub in middle and deeper layers
feed-forward dominated
'columns'

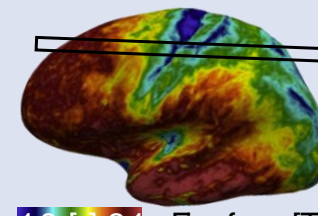


cortical thickness



2 [mm] 4 Fig. from [Fischl, Dale, PNAS, 2000]

myelination (T1)

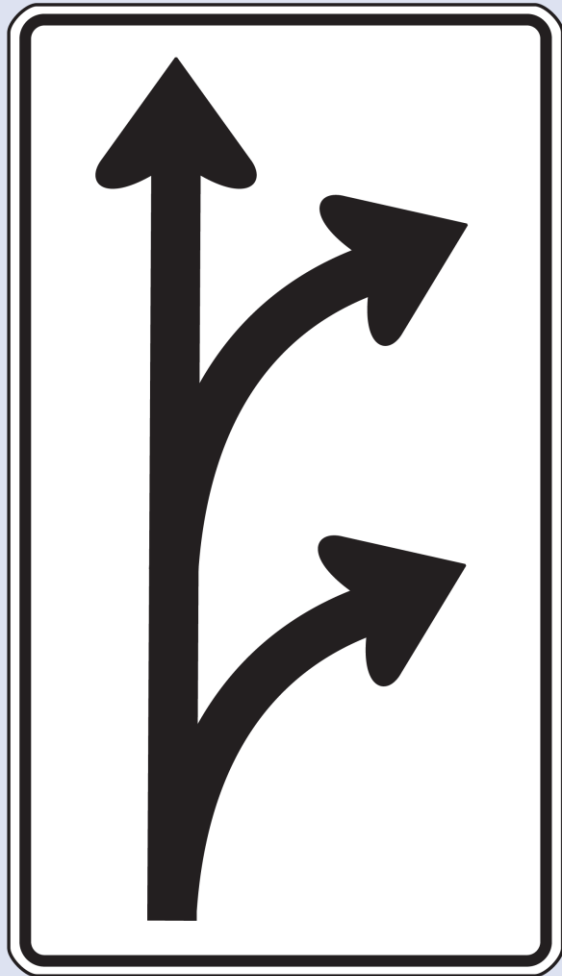


1.6 [s] 2.1 Fig. from [Tardif et al., NeuroImage, 2015]

future directions

Higher resolution

Higher sensitivity



Applications

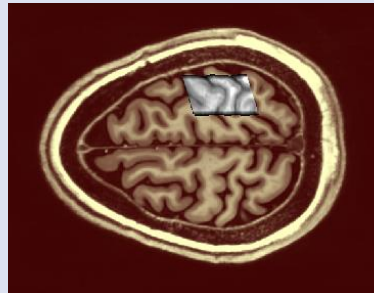
Streamlining:

- Large coverage,
- stable protocols,
- streamlined analysis

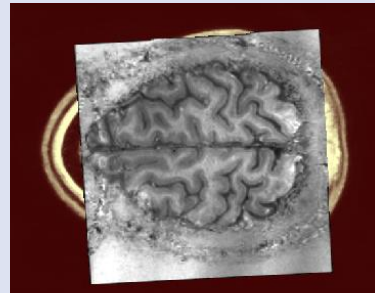
Future directions: coverage

$$8 \times 32 \times 96 = 0.86\%$$

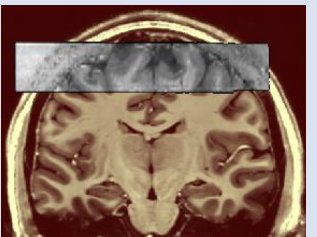
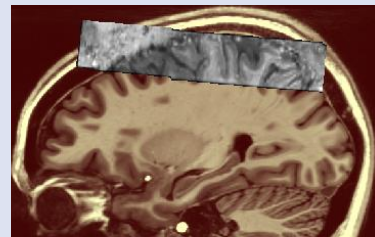
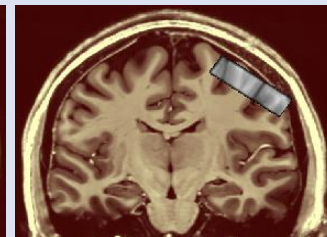
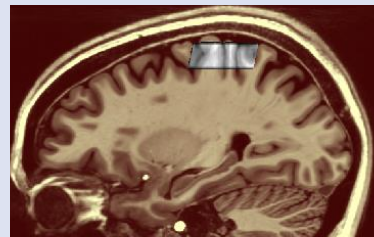
$$24 \times 162 \times 162 = 14\%$$



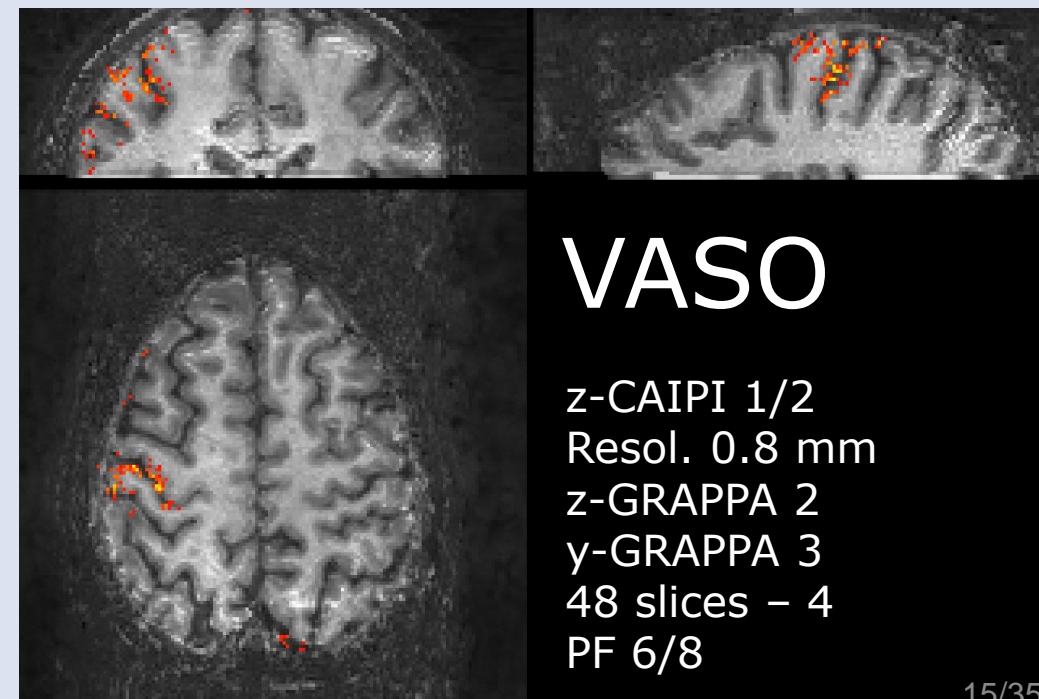
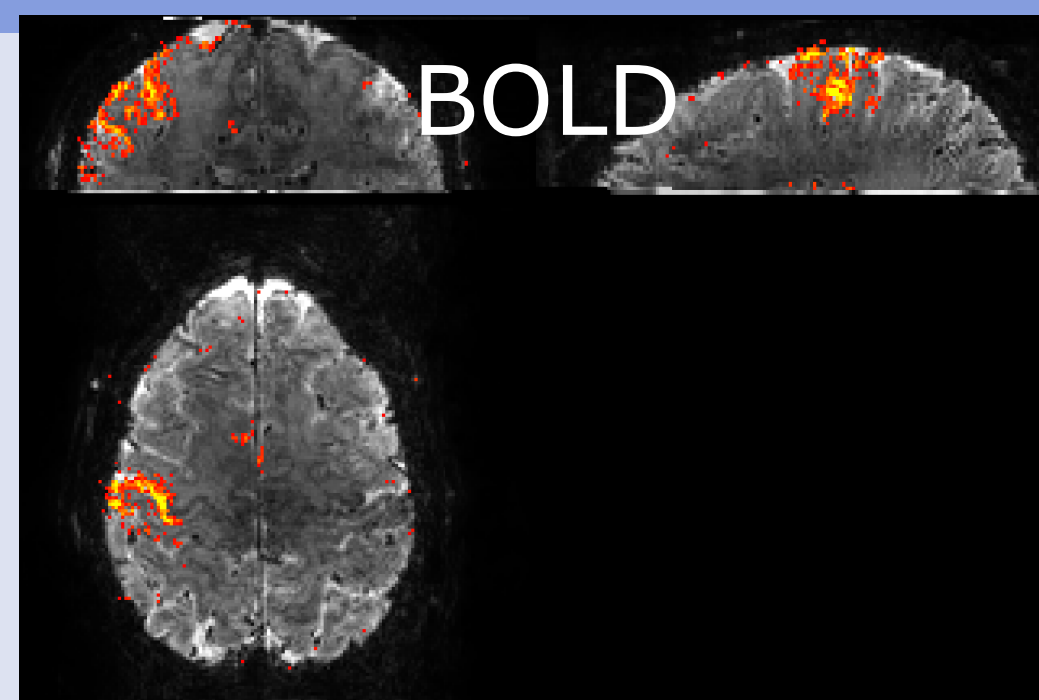
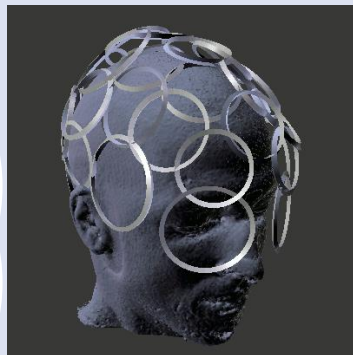
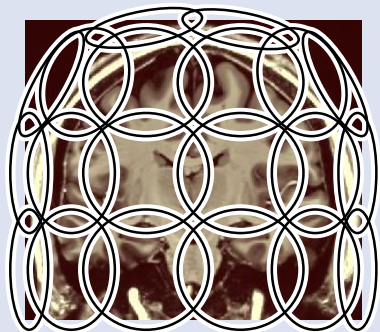
Original CBV-coverage for layer resolutions



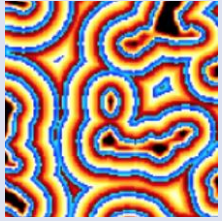
CBV-coverage for layer resolutions with 3D-EPI slab



RF-channel size is comparable to 3D-EPI slab coverage

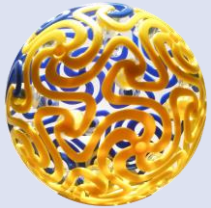


Future directions: streamlining analysis



Layering Code LAYNII:

[Github.com/layerfMRI](https://github.com/layerfMRI)



Blog with scanning and analysis tutorials and **slides**:

www.layerfMRI.com



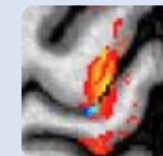
fMRI data to download:

<https://activecho.cit.nih.gov/t/i5d1hoj6>

Center for
Information
Technology

Thanks to

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- Yinghua Yu (NIMH)
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- Sriranga Kashyap (Maastricht)
- Chis Wiggins (Maastricht)
- Kamil Uludag (Maastricht)
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- Eli Merriam (NIMH)
- Zvi Roth (NIMH)
- Eli Merriam (NIMH)
- Zvi Roth (NIMH)



Twitter: @layerfMRI