

Laminar level subcortico-cortical interactions during naturalistic movie viewing

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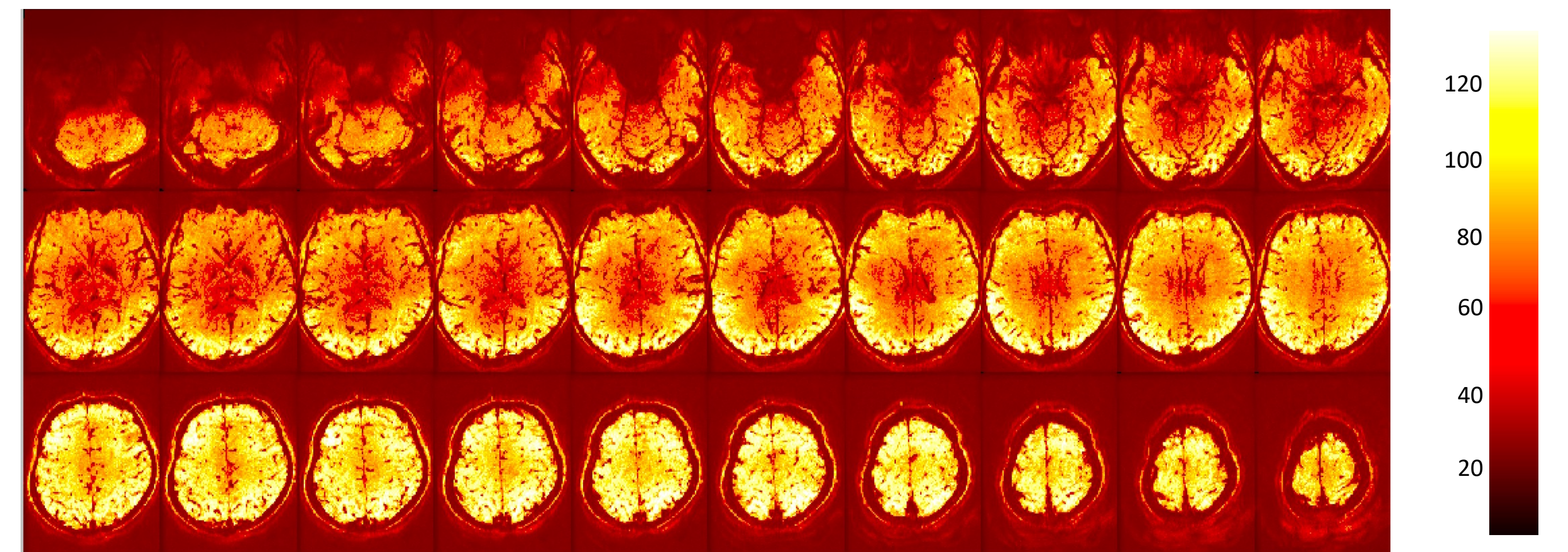
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INTRODUCTION

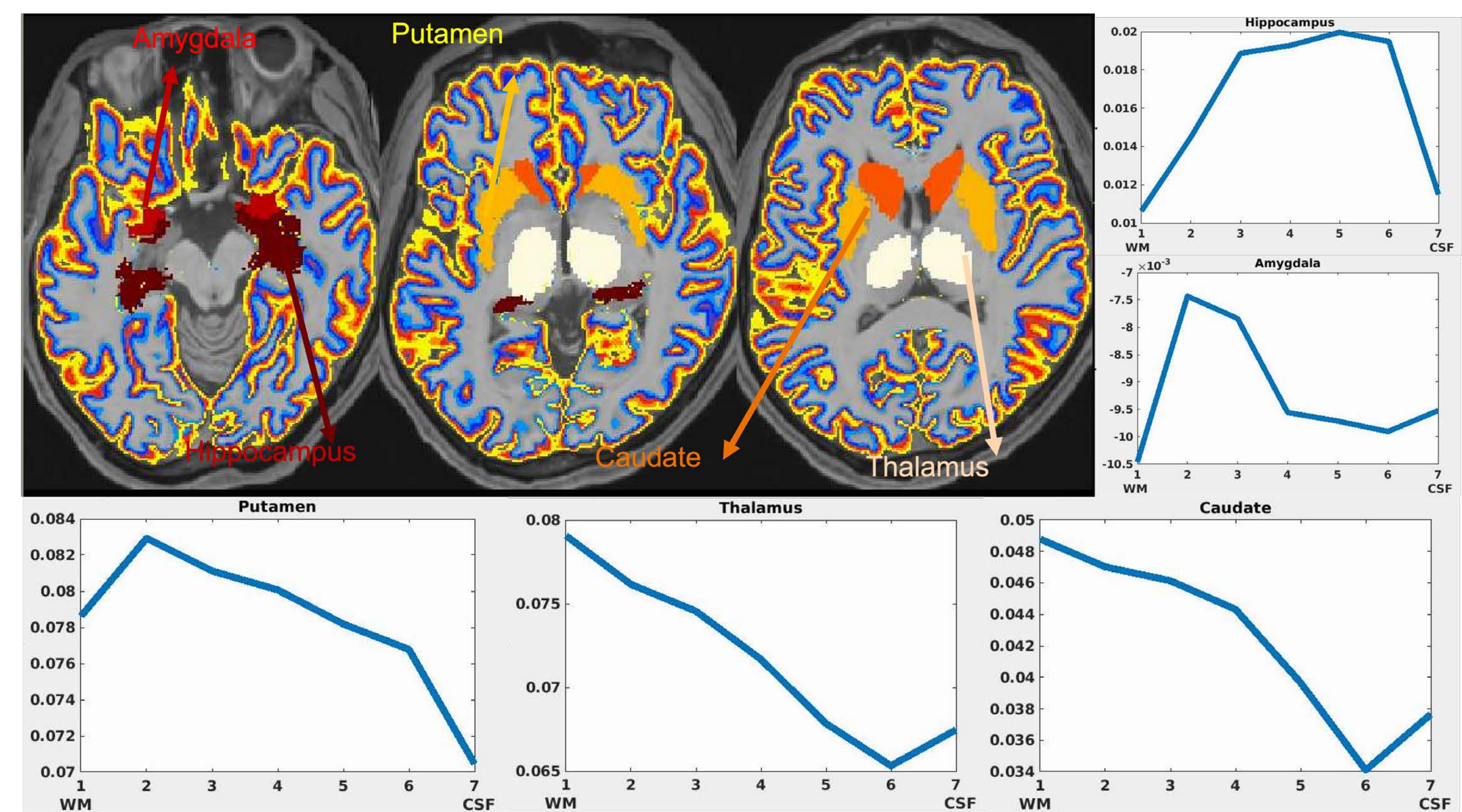
- Movie watching can engage multiple cortical networks simultaneously¹
- Multi-session open source laminar dataset² is used with the recent sequence improvements for whole brain layer resolution (~ 0.8mm iso)
- The first subject of the datasets discussed to be too artifact-dominated³ especially in the mid-brain regions, with the sequence improvement in the second version (second subject) may open possibility of analyzing subcortical time courses with reduced artifacts.
- Here we investigate and discuss subcortical contribution to whole cortex and their relation separately to each task related cortical network.



tSNR map of an averaged dataset, high values observable around the superior cortex and it gradually lowers itself to the inferior cortical regions.

RESULTS

- Putamen and Thalamus are deep layer dominant, also same for the caudate with a lower amplitude in correlation.
- Hippocampus has middle layer dominant correlation structure with the cortical ribbon
- Amygdala, having very low ('near-zero') correlation with the whole cortex, it has the highest connection with the Saliency network.
- Four networks identified manually by using ICA are the components with higher explained variance, possibly related with naturalistic movie task.
- The laminar profile of subcortical structures with the networks are sorted according to their strength, 4 out of 5 subcortical structures are highly correlated with Visual network with middle and deep layers dominant.
- Dorsal attention network is having second strong correlation with the subcortical structures. This followed by auditory network which indicates the modulatory interactions of the subcortical networks on the cortical ones during movie watching.
- tSNR values are very low in subcortical areas in comparison to cortex.



Global correlation profile : Subcortical ROIs are shown on axial anatomical images, and graphs below and on the right side shows laminar correlation values of each subcortical ROI to whole cortical gray matter. Y-axes are correlation values and X-axes are laminar bins divided into 7 starting from WM border to CSF.

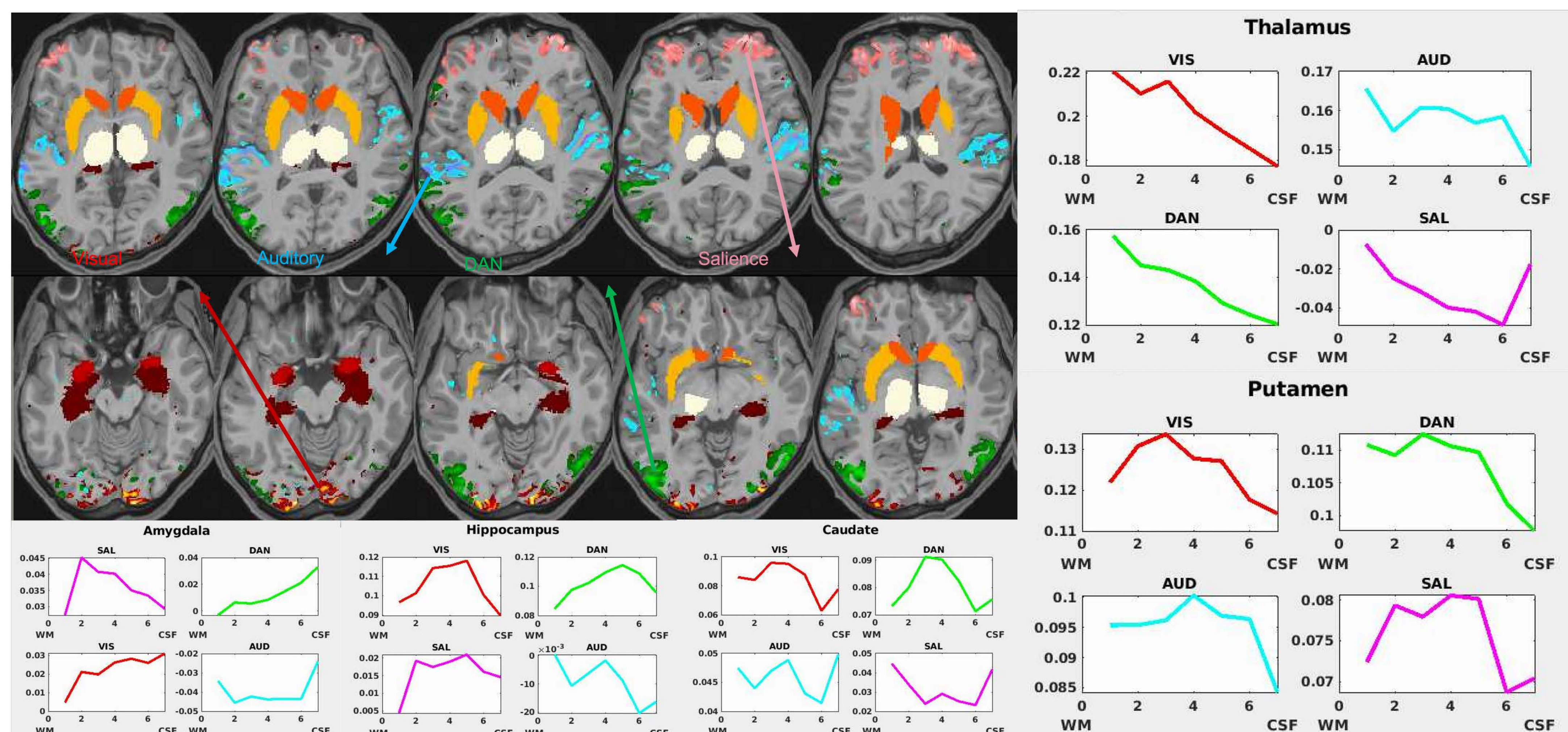
METHODS

Acquisition:

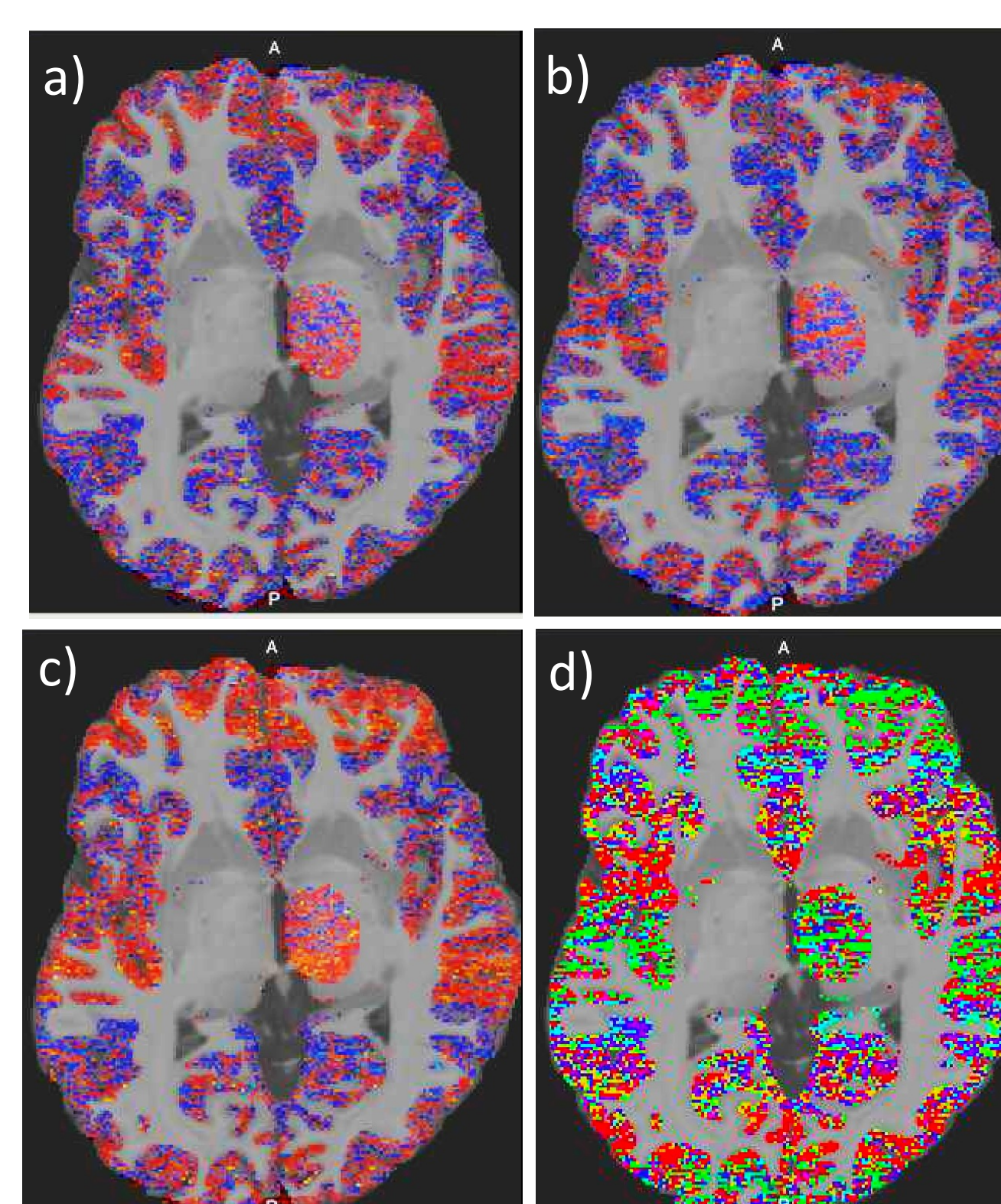
- An open-source whole brain layer fMRI dataset² acquired with **Siemens Magnetom 7T**
- scanning parameters, TR=5.1s (alternates with 5.2) and spatial resolution of 0.84mm
- sequence is blood volume sensitive(VASO) with an TA=14min and 5runs per session.
- Task is Human Connectome Project (HCP) audio movie.

Data Processing:

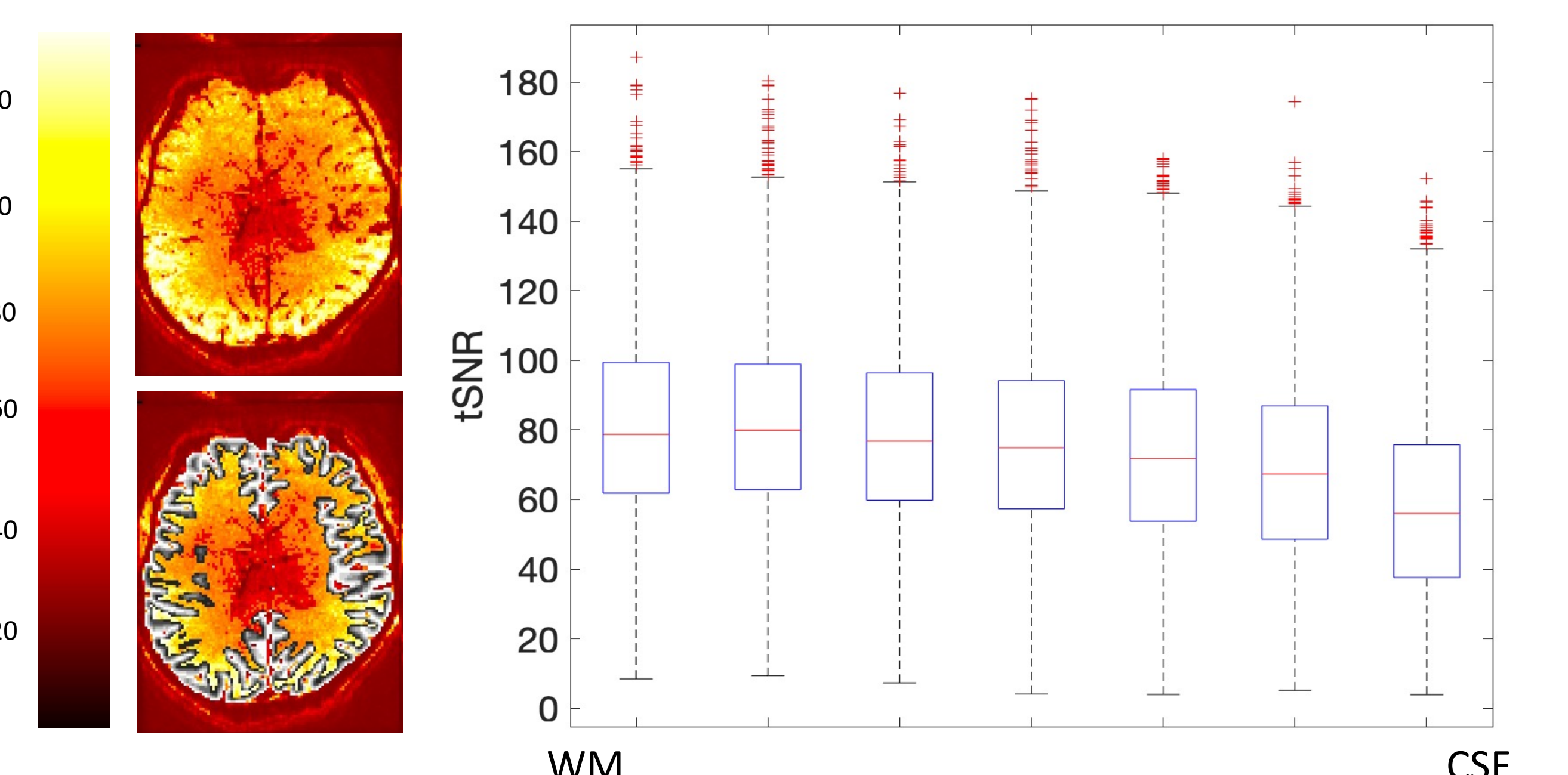
- All functional scans are aligned by using **ANTs registration**⁴
- 15 runs are used, and they are averaged across time.
- **LayNii**⁷ is used to grow cortical layers,
- **AAL atlas**⁵ is registered to native space to identify subcortical ROIs
- ROIs--> **Hippocampus, Amygdala, Thalamus, Caudate, Putamen**
- Subcortical time courses are extracted and correlation of those time courses to whole cortical GM are calculated
- averaged dataset is fed to FSLs MELODIC ICA with a cortical GM mask and four main network components are extracted as a result of an ICA; **Visual, Auditory, Dorsal Attention, Saliency**
- connectivity analysis in between the extracted subcortical time courses and the "task related networks" is done.
- Whole brain tSNR values are calculated
- Additionally, **K-means** analysis is done on left thalamus connectivity maps to discuss possible improvements of the analysis pipeline



Network correlation profiles : are shown in different colors, and subcortical correlations to each layers are shown in the graphs with the same line color of the cortical network, laminar correlation values are sorted according to their values. Cortical networks are determined by a result of an ICA -> Auditory (IC # 5), Dorsal Attention network (IC #14), Saliency (IC #7), Visual (IC #29)



K-means clustering : Thalamocortical connectivity maps are clustered in to 5 d), and three centroids are correlated with the seed region and the cortex



tSNR values across layers: on the left an axial slice of tSNR map and layers are shown, on the right distribution of the tSNR values across each layer bin are shown.

CONCLUSIONS

- Thalamus and visual network correlation is the highest among all network and subcortical regions, and deeper layers are more correlated than the superficial ones, thalamus is also known to be anatomically connected to deeper layers on the cortex⁸
- Global correlation values are higher for deeper layers which might be related with the tSNR differences across layers.
- Our analysis show layer profiles are highly dependent on subcortical and cortical region which indicates separability of the signal in the sub-cortex, makes possible to investigate laminar level subcortico-cortical correlation structures with VASO.
- This analysis will improve with
- → proper selection of seed location and size
- → future availability of more subjects and resting scans of whole brain laminar dataset.

REFERENCES

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