

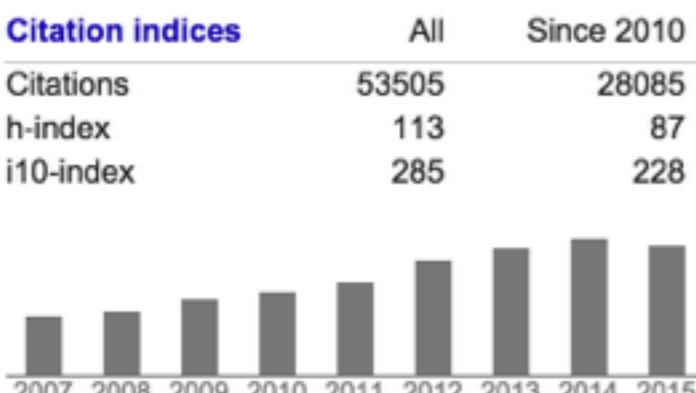
Introducing region-network priors to statistical estimators for fMRI data

Danilo Bzdok, Gaël Varoquaux, Bertrand Thirion

The structure of consciousness

NATURE|Vol 446|15 March 2007

One of the greatest challenges left for systems neuroscience is to understand the normal and dysfunctional operations of the cerebral cortex by relating local and global patterns of activity at timescales relevant

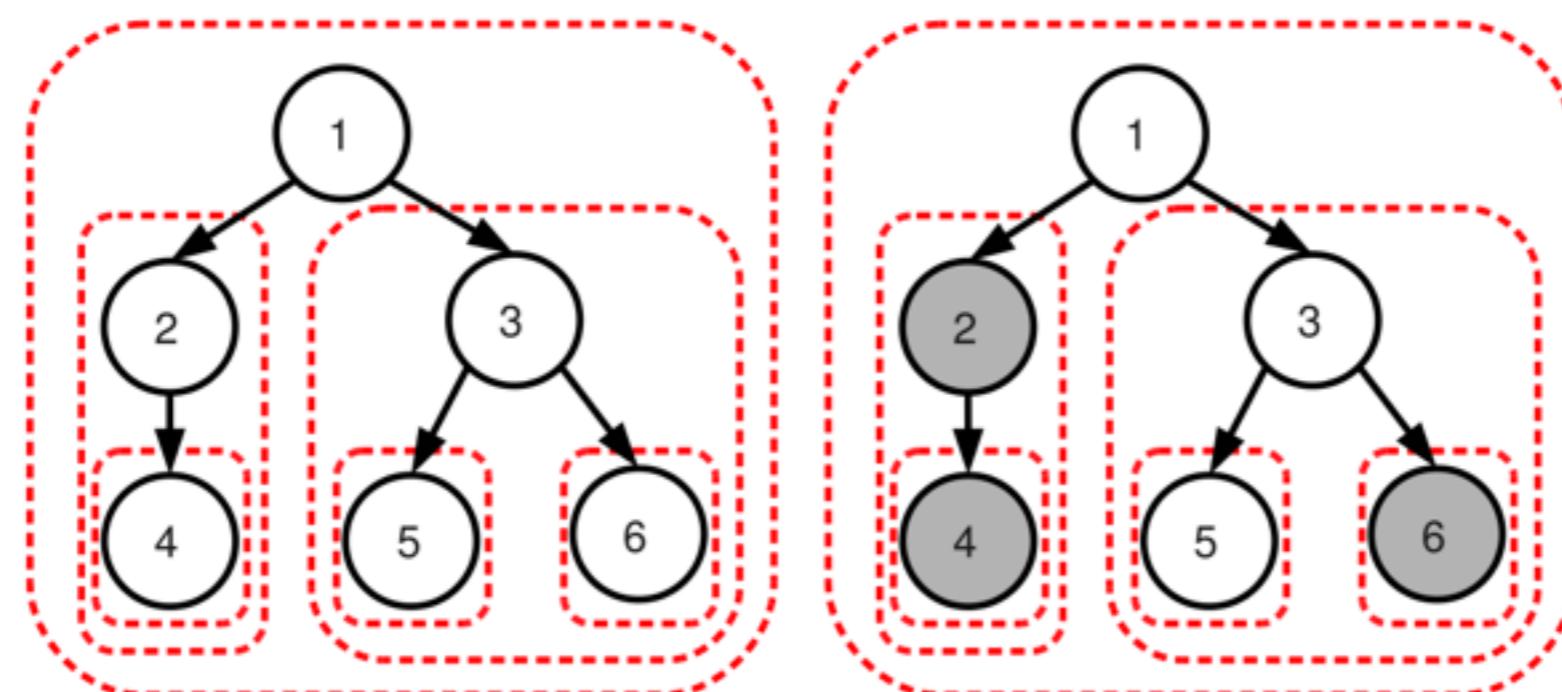
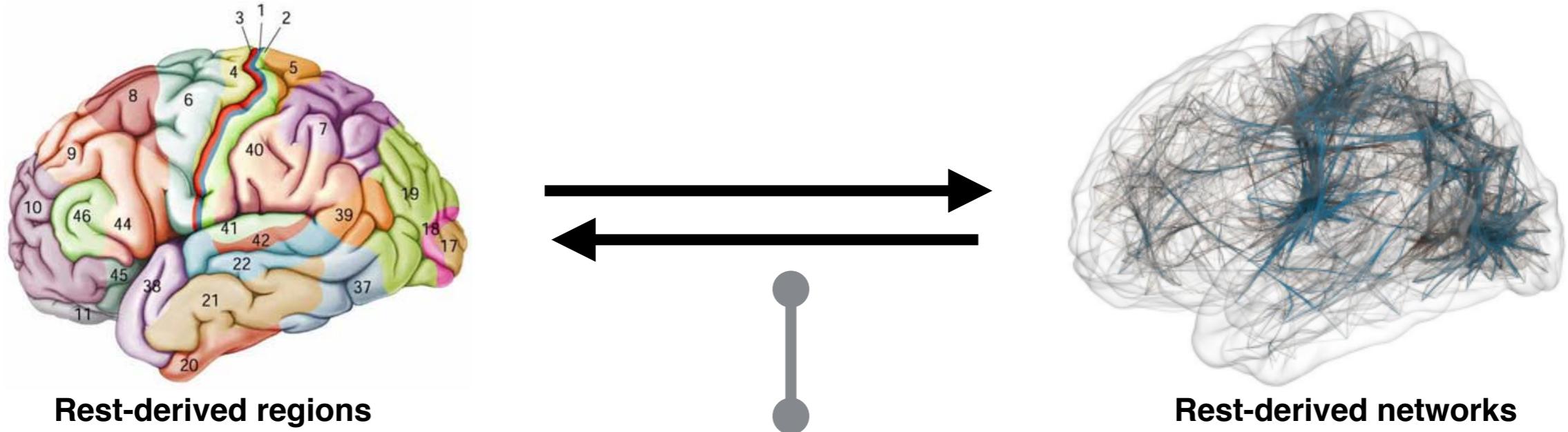


György Buzsáki



Intuition

Hierarchical Structured Sparsity could reintegrate the currently divorced **Functional Segregation (regions)** and **Functional Integration (ICA networks)** views/methods



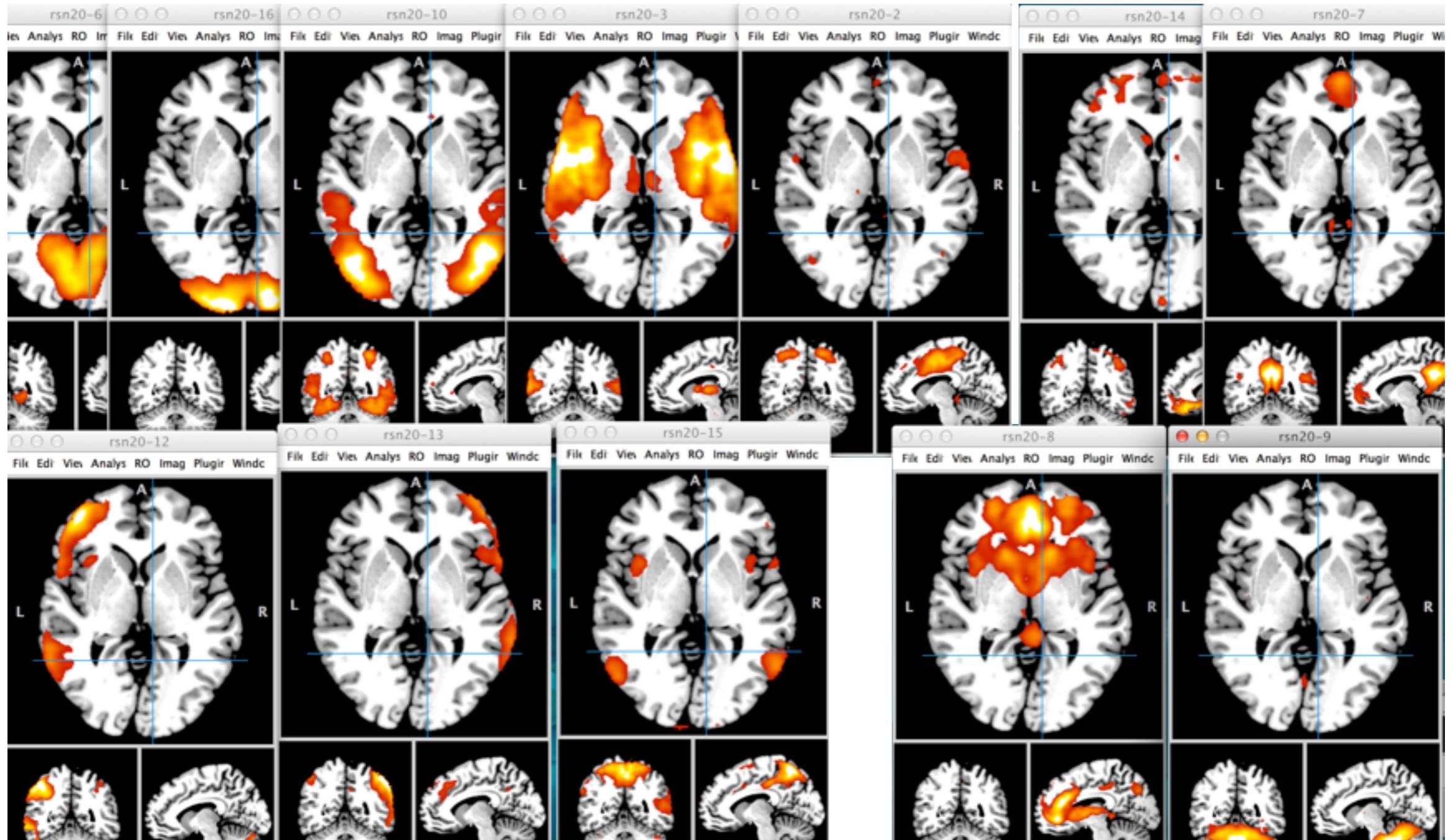
$$\min_{\alpha \in \mathbb{R}^p} \frac{1}{2} \|\mathbf{x} - \mathbf{D}\alpha\|_2^2 + \lambda \sum_{g \in \mathcal{P}} \|\alpha_g\|_2 + \lambda' \|\alpha\|_1$$

Network priors

Correspondence of the brain's functional architecture during activation and rest
[SM Smith, PT Fox, KL Miller... - Proceedings of the ...](#), 2009 - National Acad Sciences

Abstract Neural connections, providing the substrate for functional networks, exist whether or not they are functionally active at any given moment. However, it is not known to what extent brain regions are continuously interacting when the brain is "at rest." In this work, we ...

Zitiert von: 1453 Ähnliche Artikel Alle 26 Versionen Zitieren Speichern Mehr



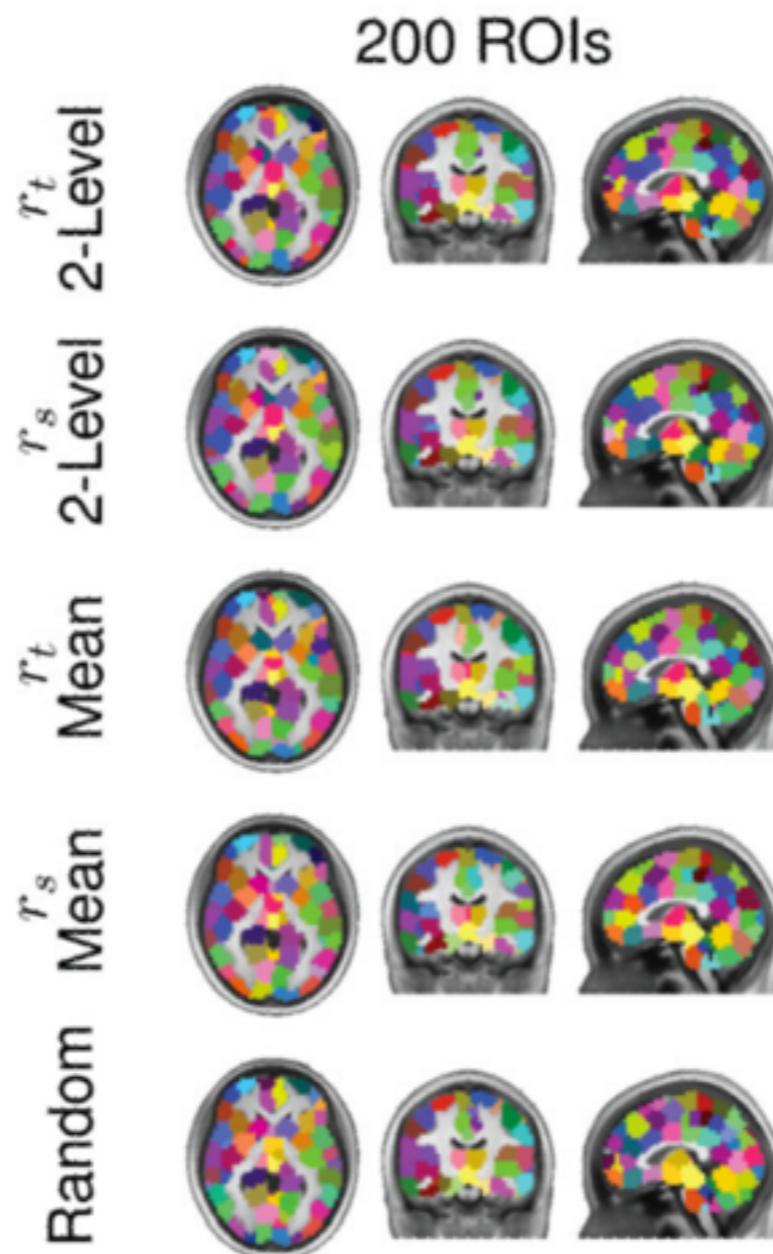
Network atlas from previously published ICA of task-unrelated brain activity

Region priors

A whole brain fMRI atlas generated via spatially **constrained** spectral clustering
[RC Craddock, GA James, PE Holtzheimer... - Human brain ...](#), 2012 - Wiley Online Library

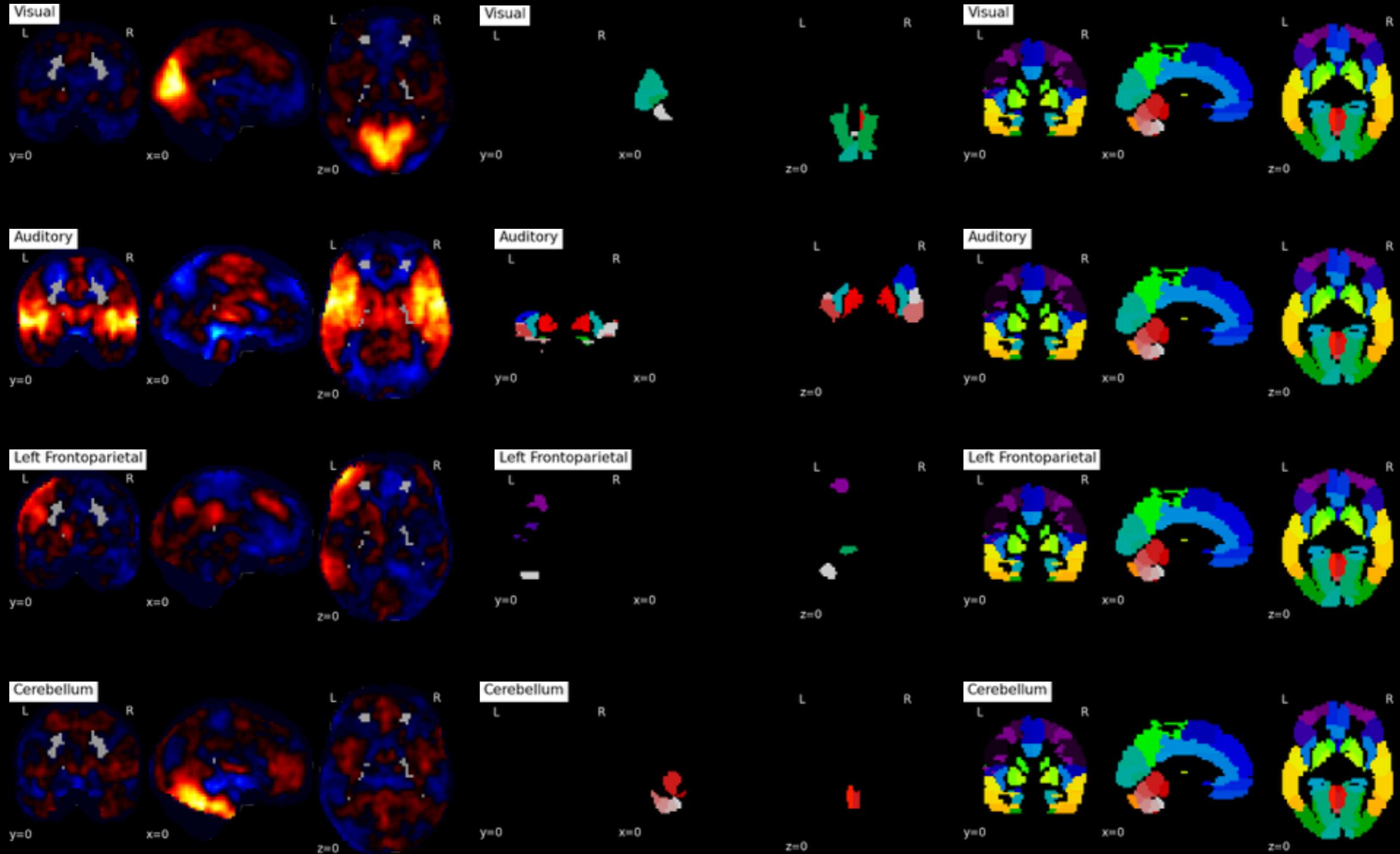
Abstract Connectivity analyses and computational modeling of human brain function from fMRI data frequently require the specification of regions of interests (ROIs). Several analyses have relied on atlases derived from anatomical or cyto-architectonic boundaries to specify ...

Zitiert von: 245 Ähnliche Artikel Alle 12 Versionen Zitieren Speichern Mehr



Region atlas from previously published spatially constrained clustering of task-unrelated brain activity

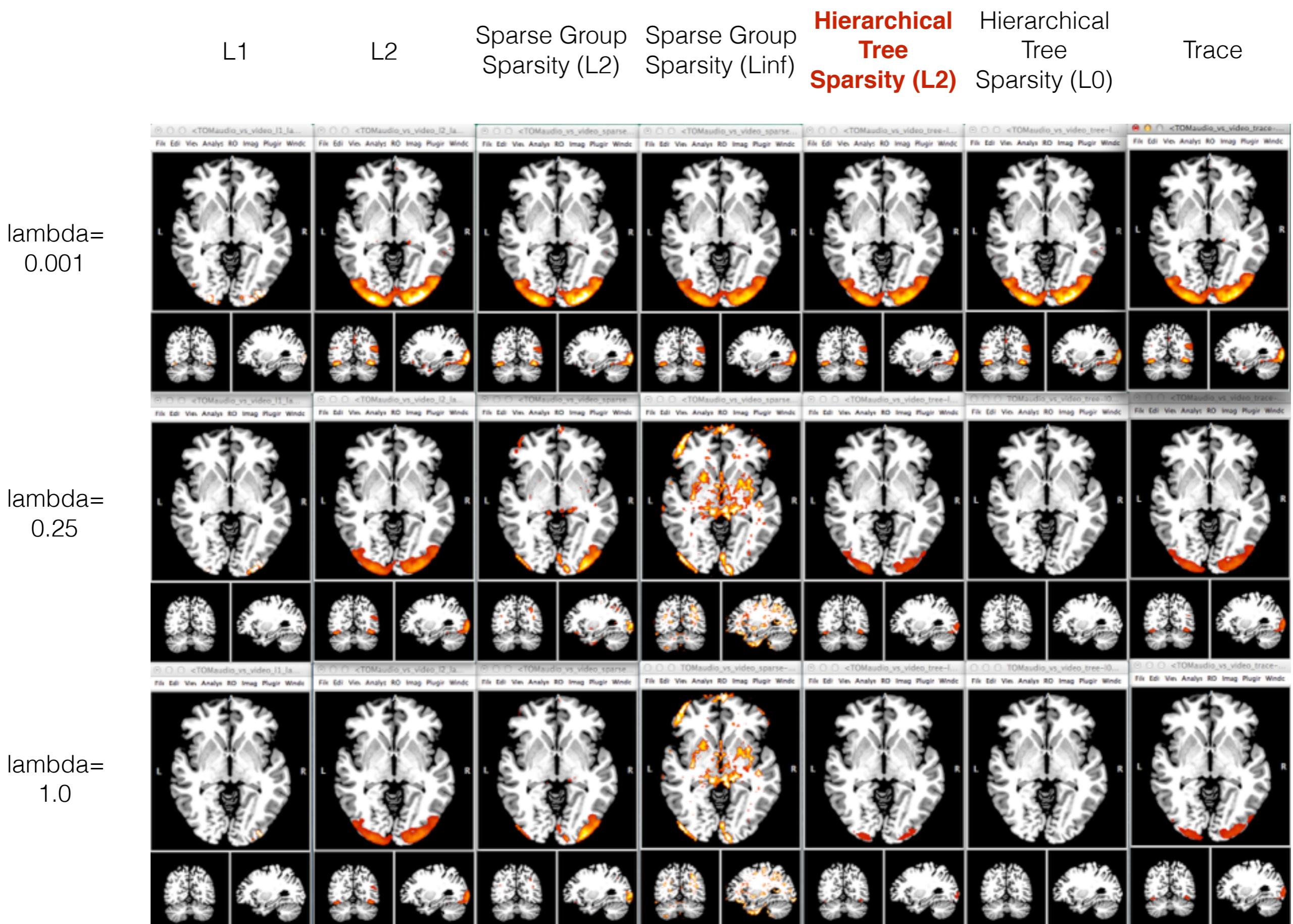
Region-network prior: 4 Examples



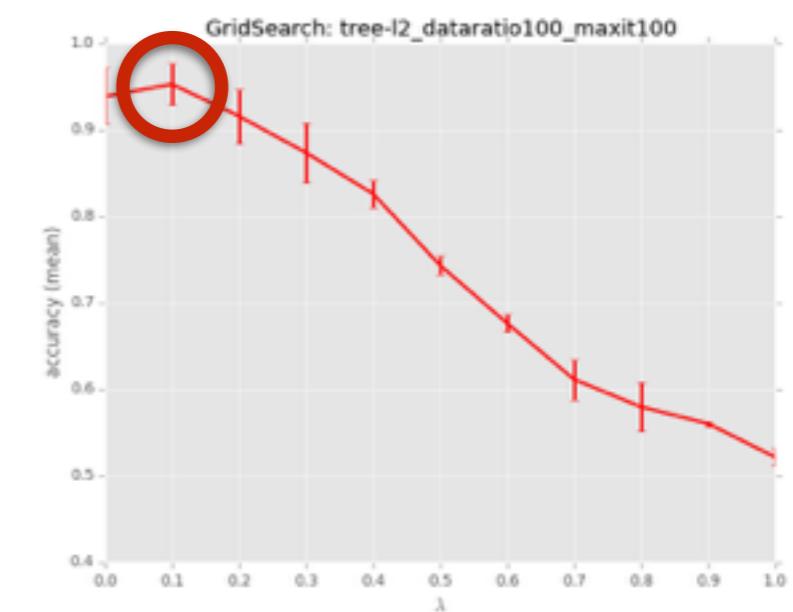
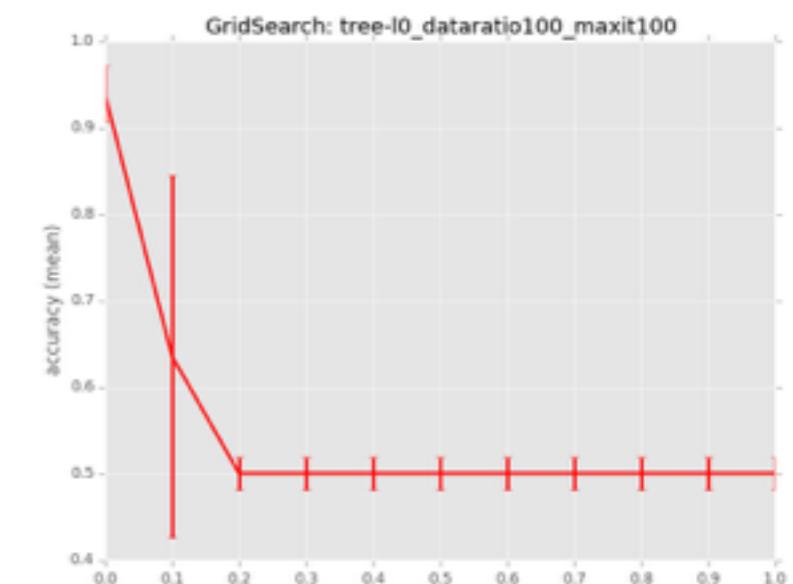
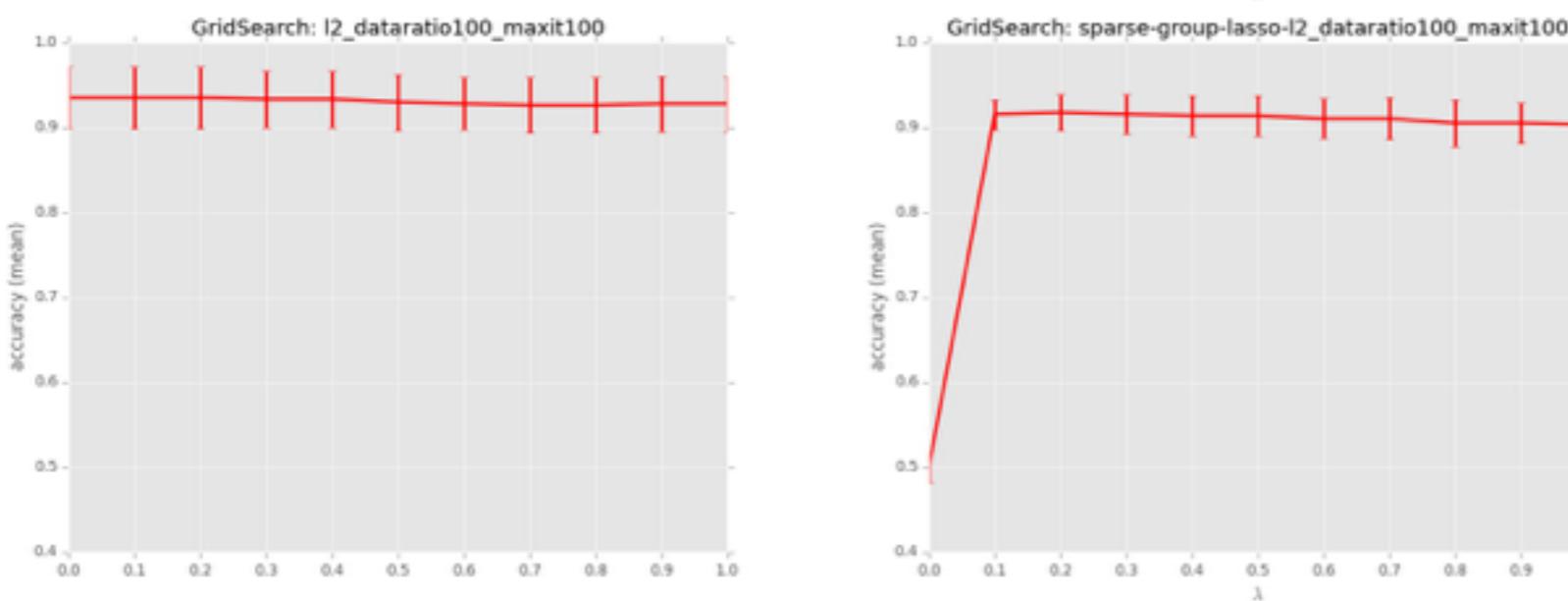
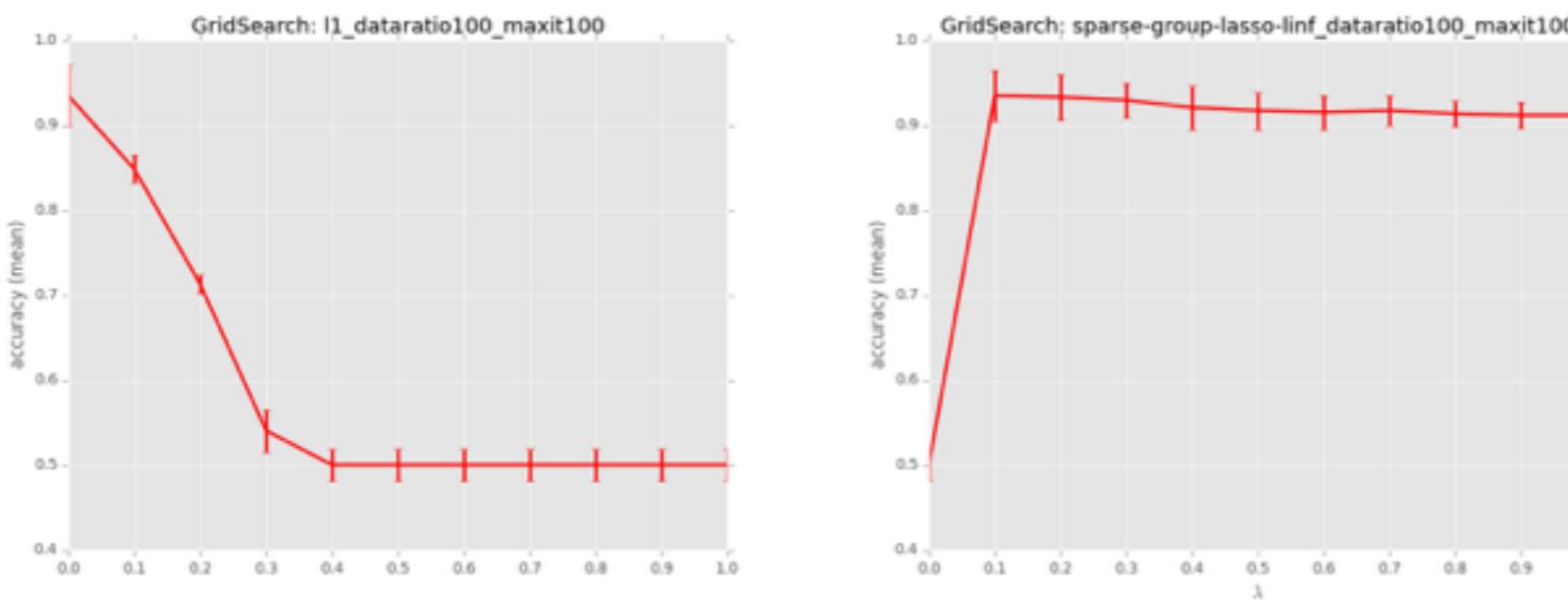
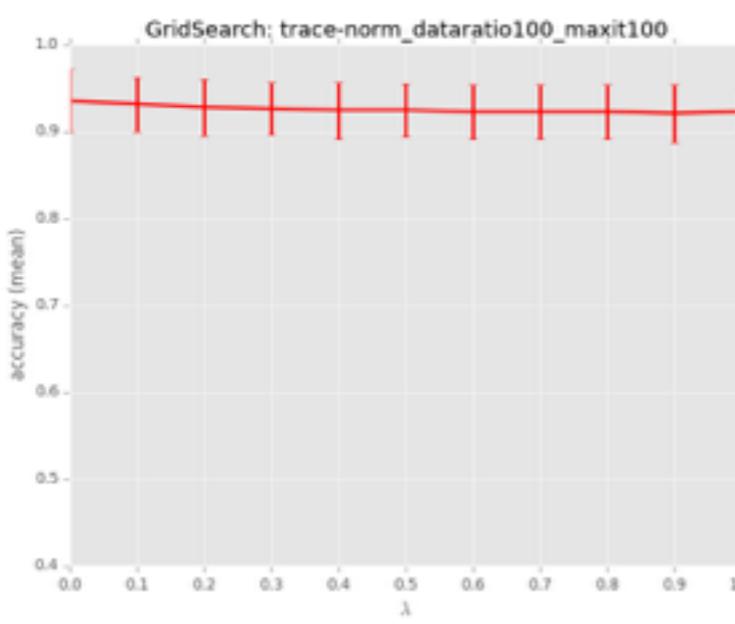
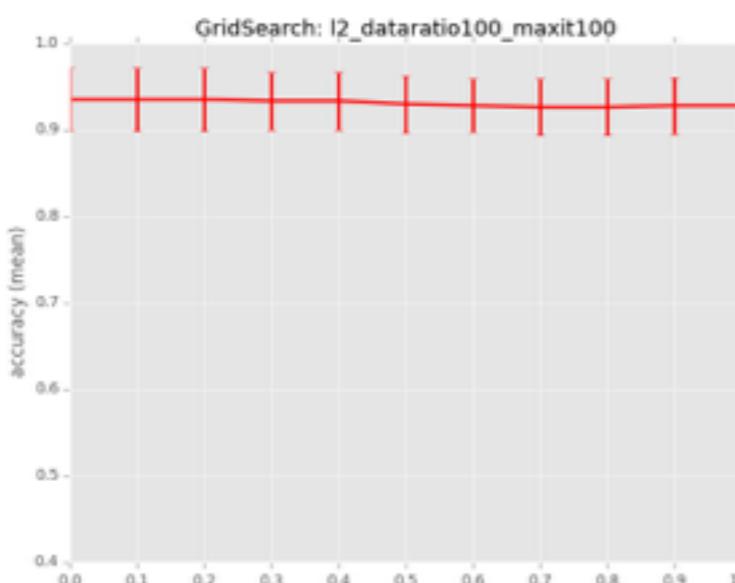
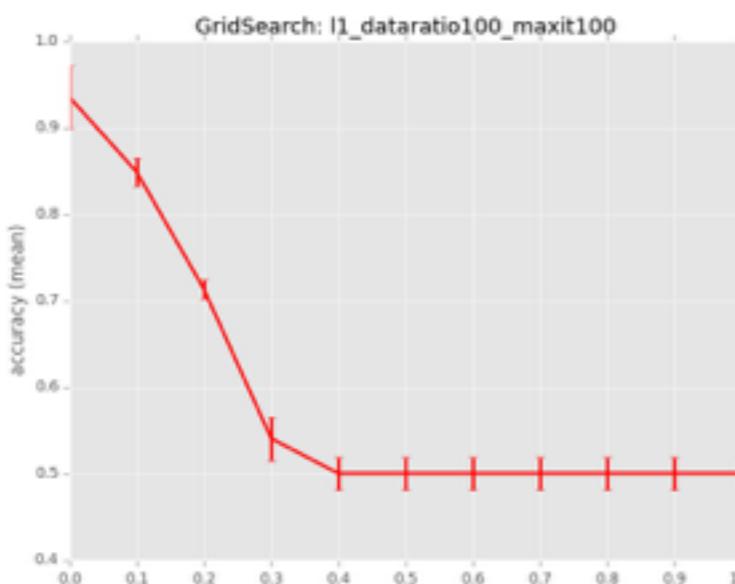
HCP: BINARY COMPARISON

Reward (0) versus Punish (1)

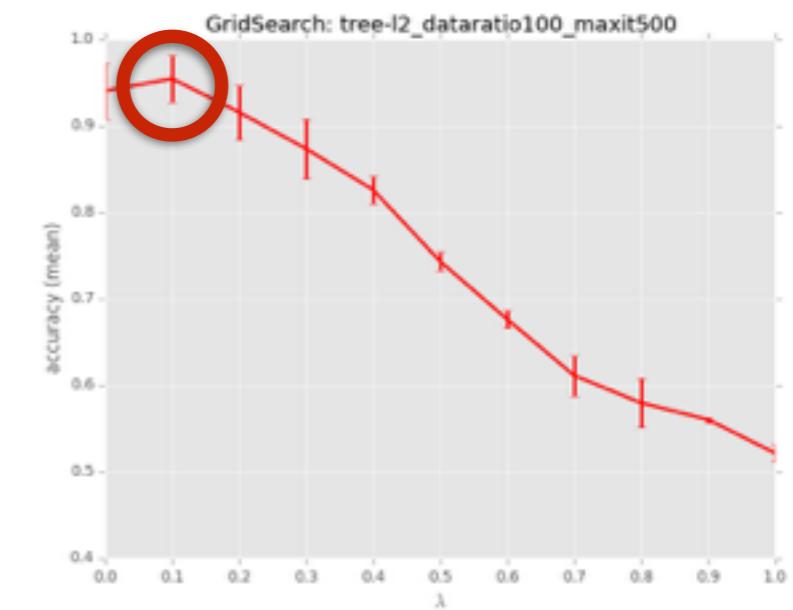
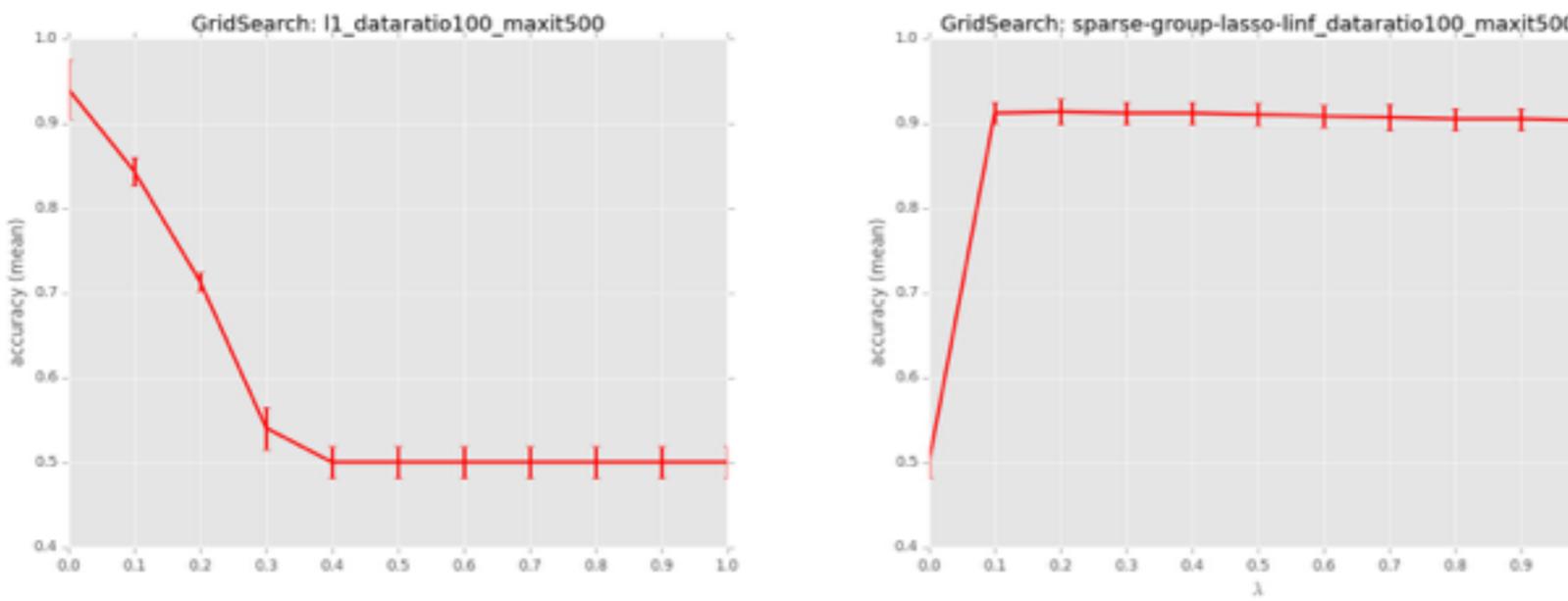
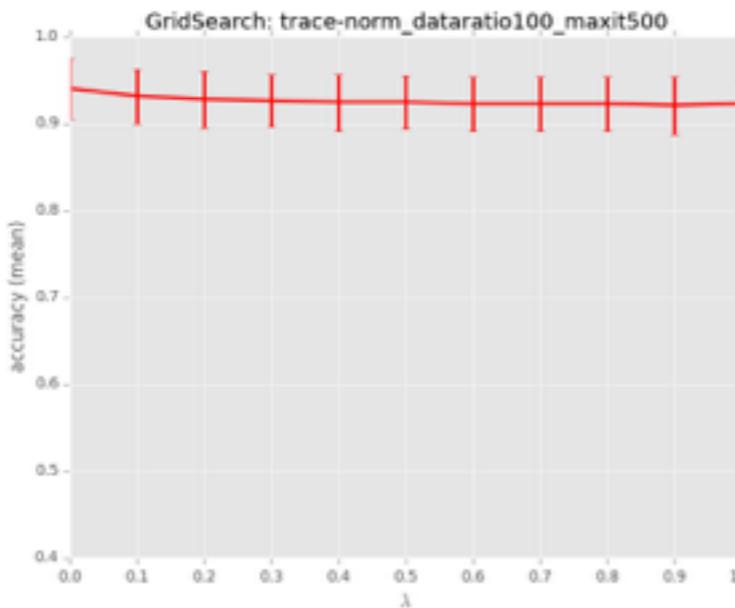
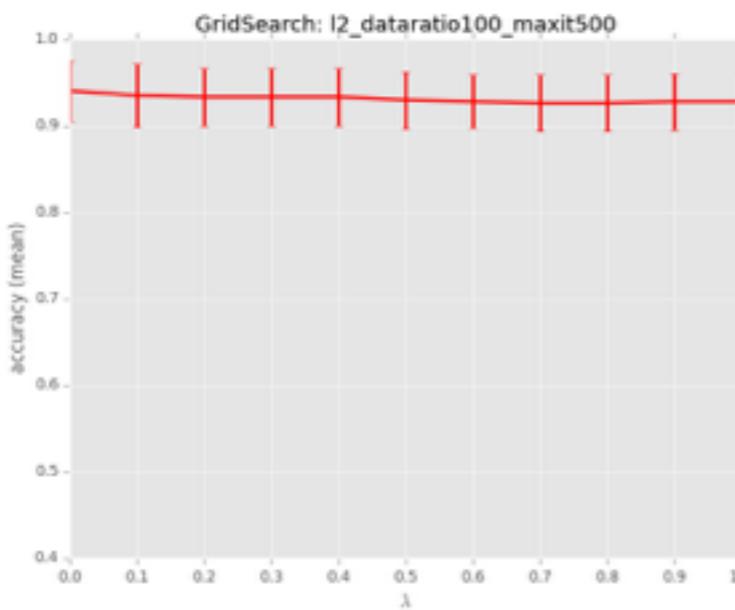
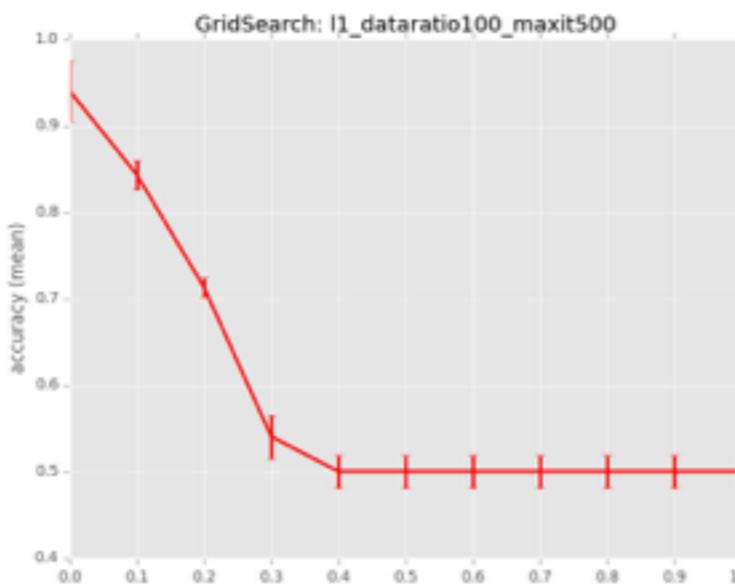
HCP: Visual versus auditory theory of mind



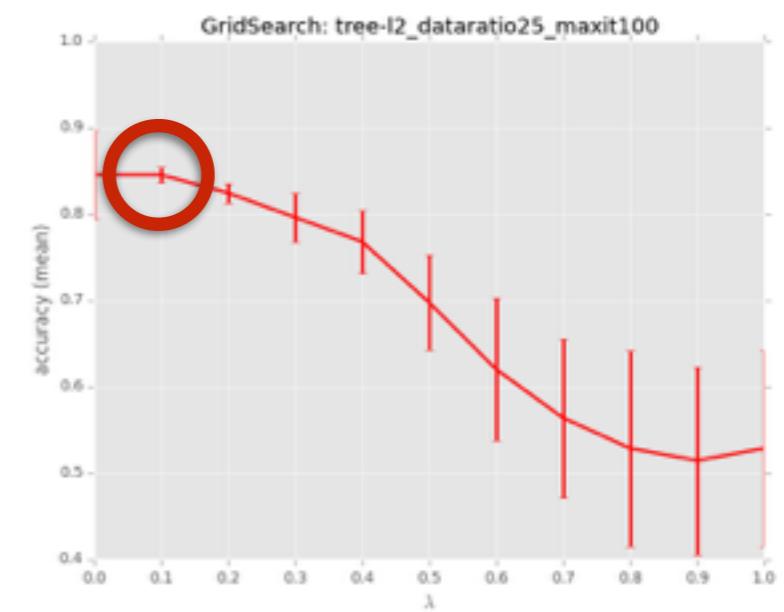
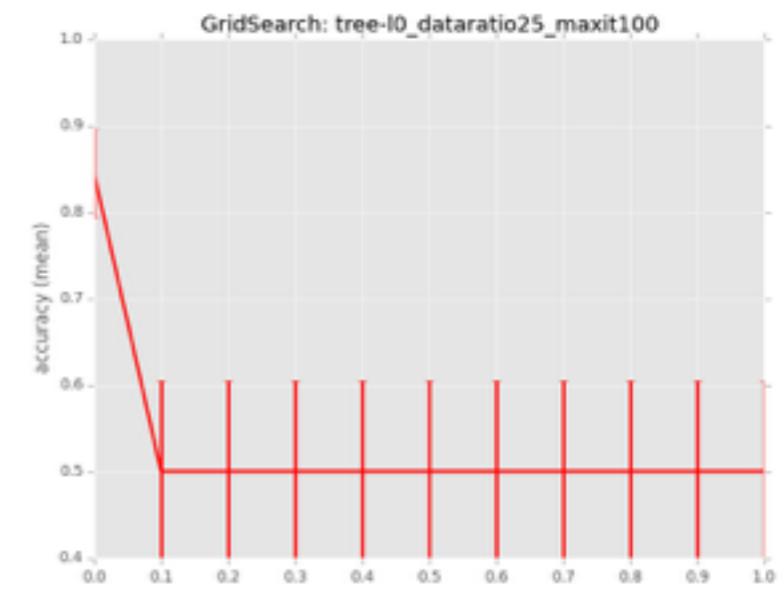
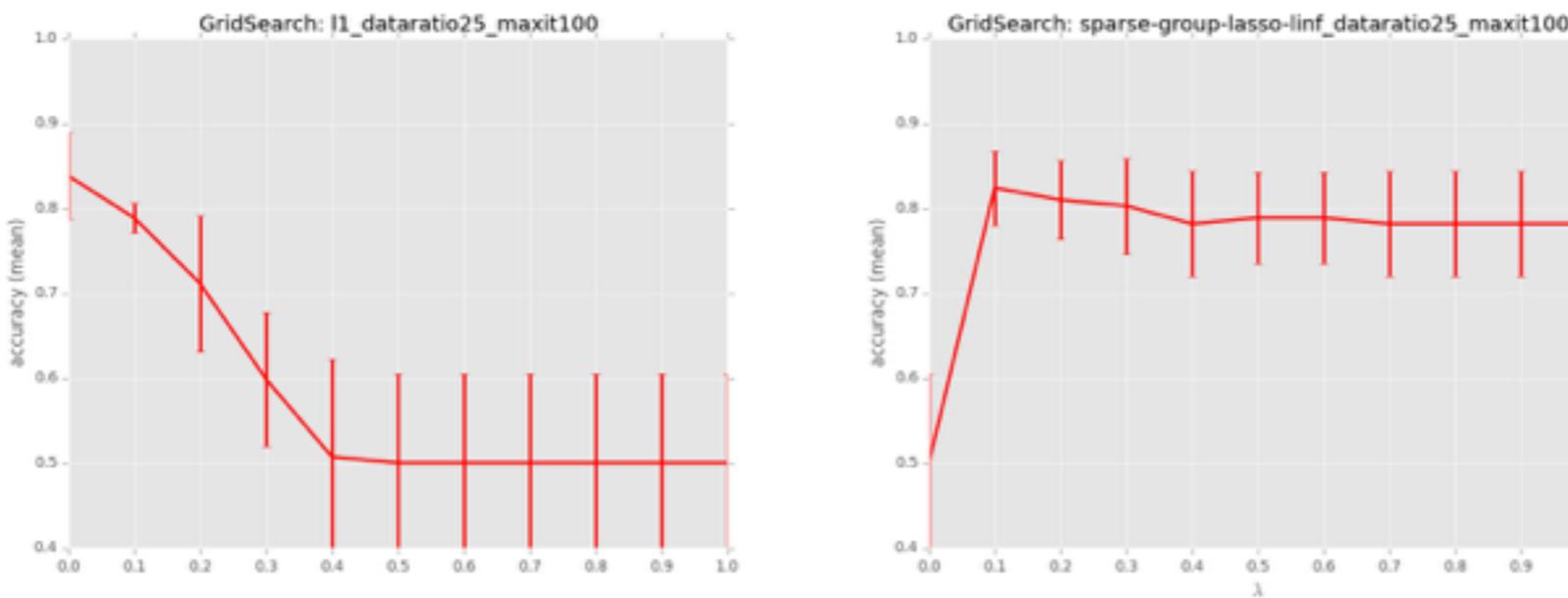
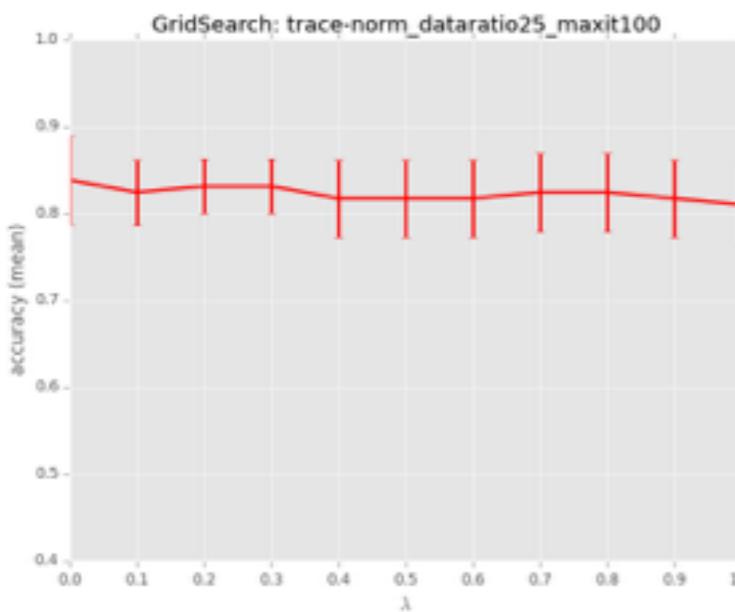
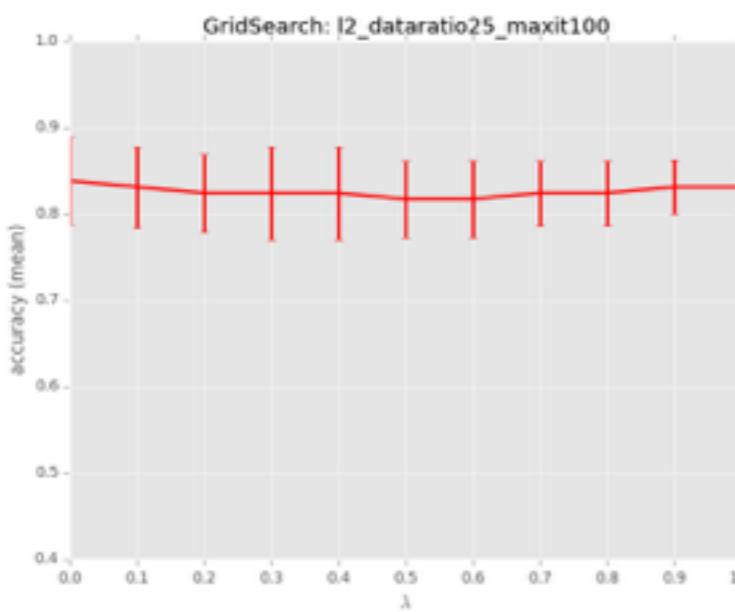
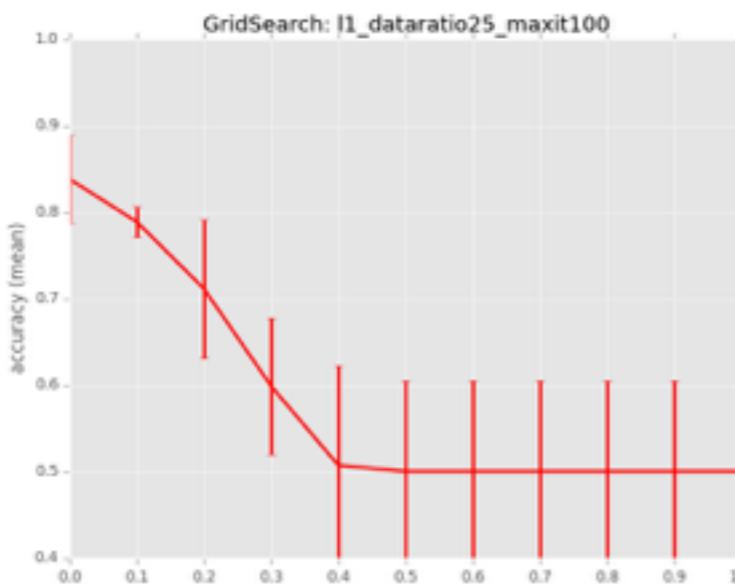
GridSearch: full data maxit100



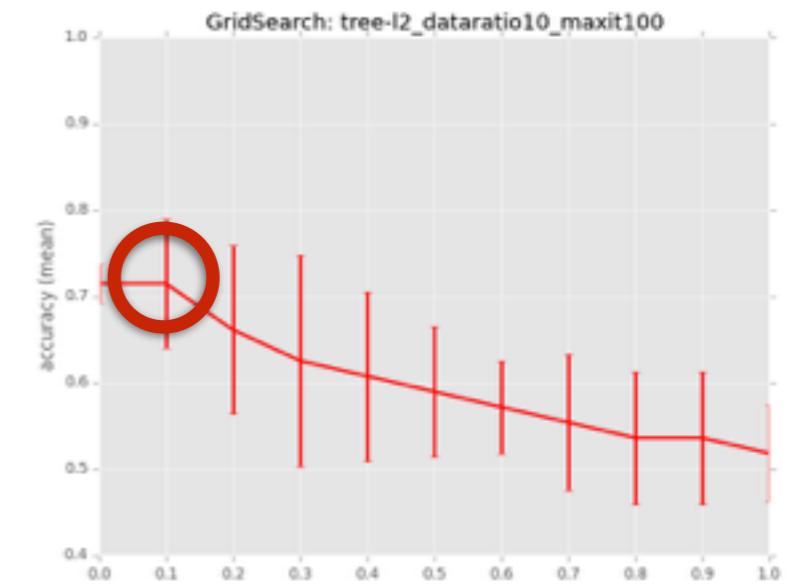
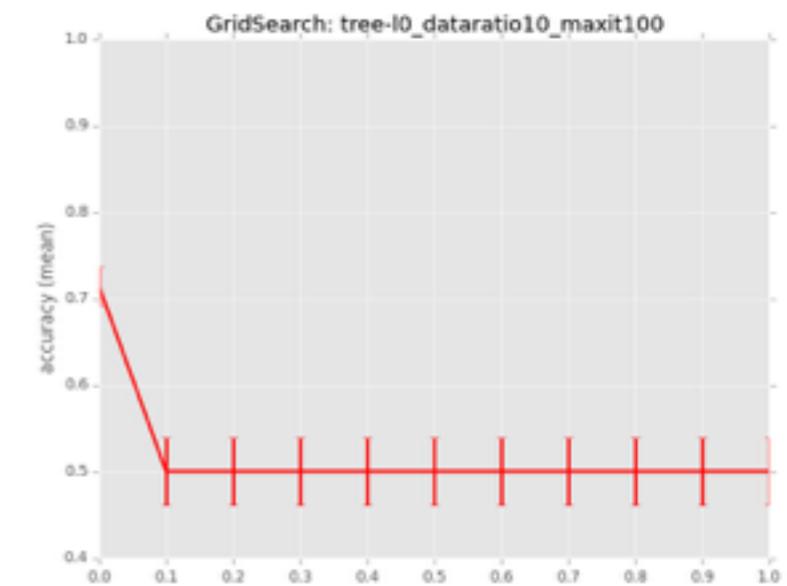
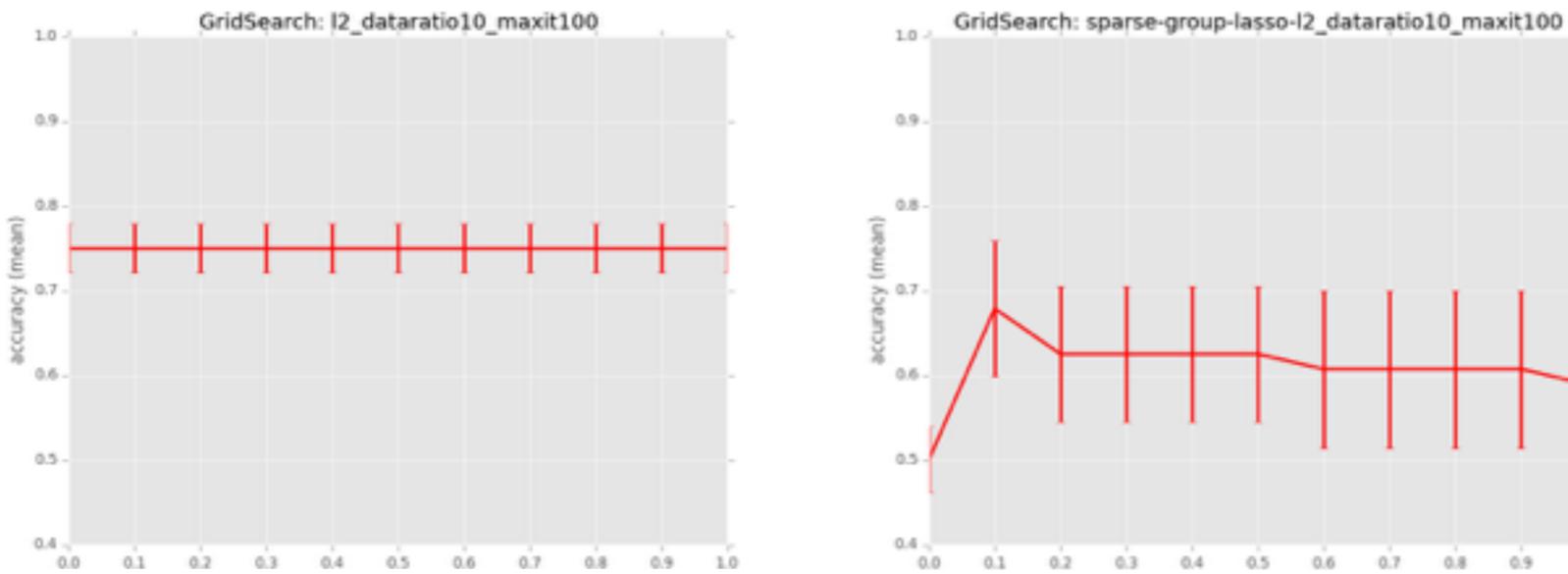
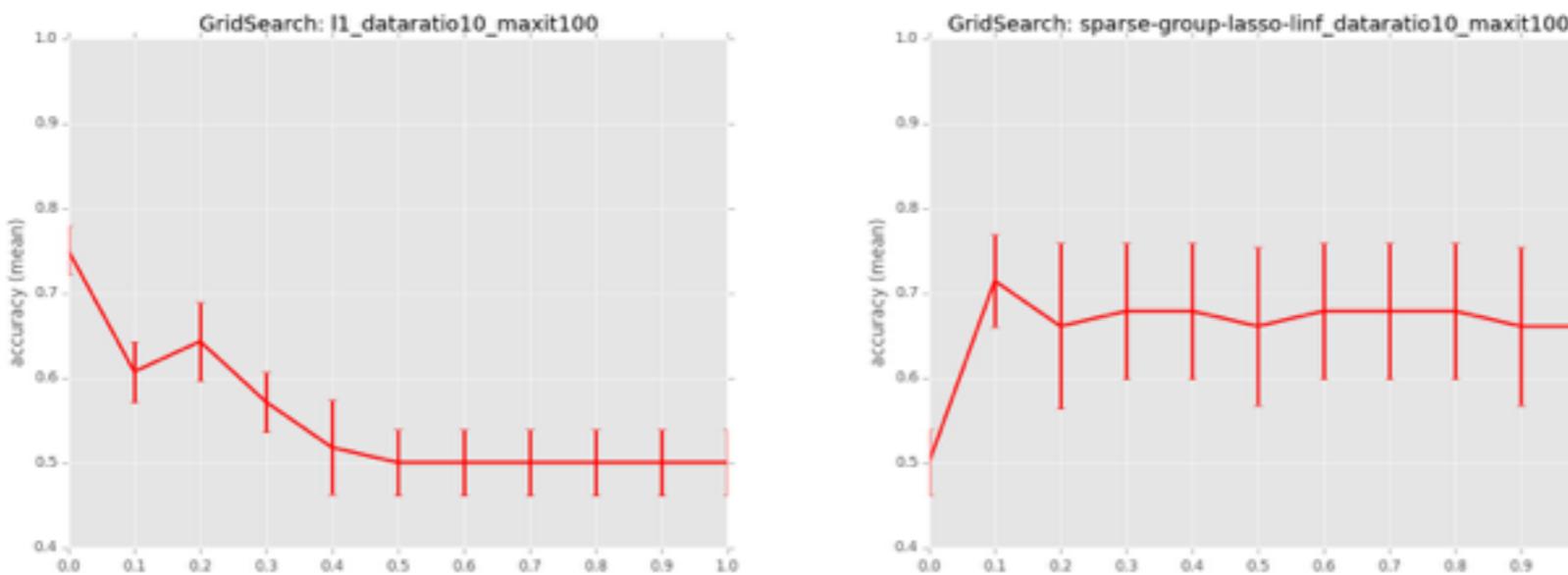
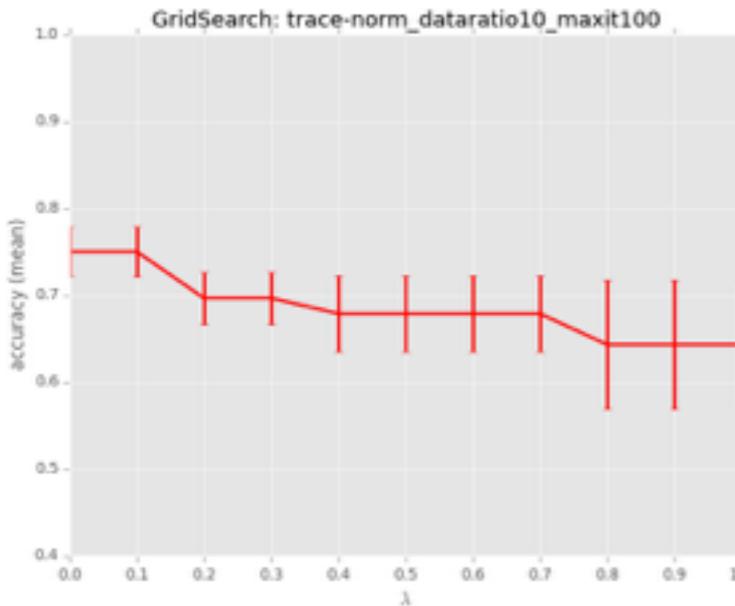
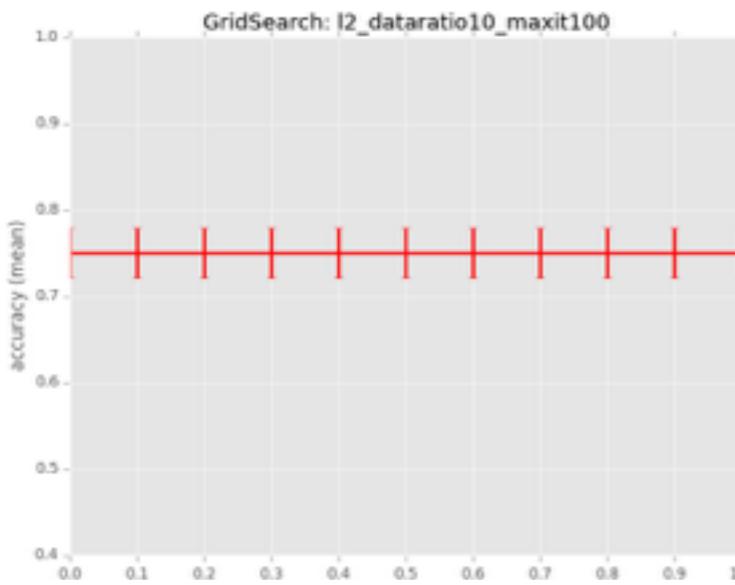
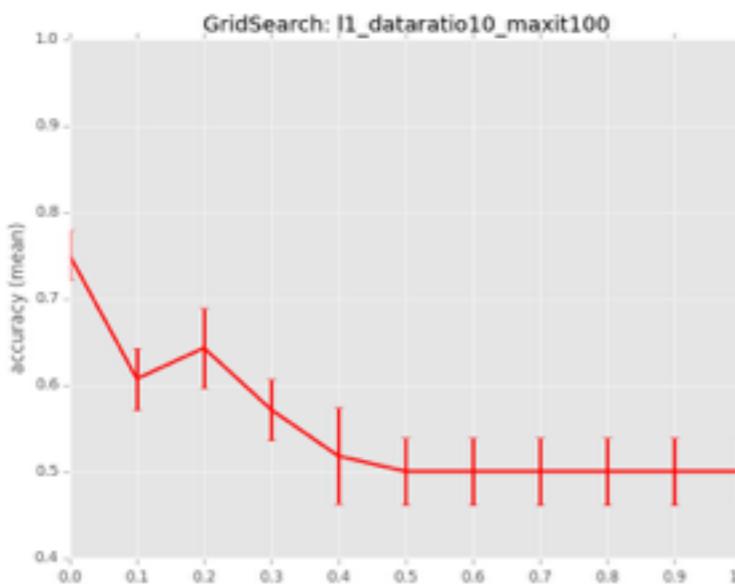
GridSearch: full data maxit500



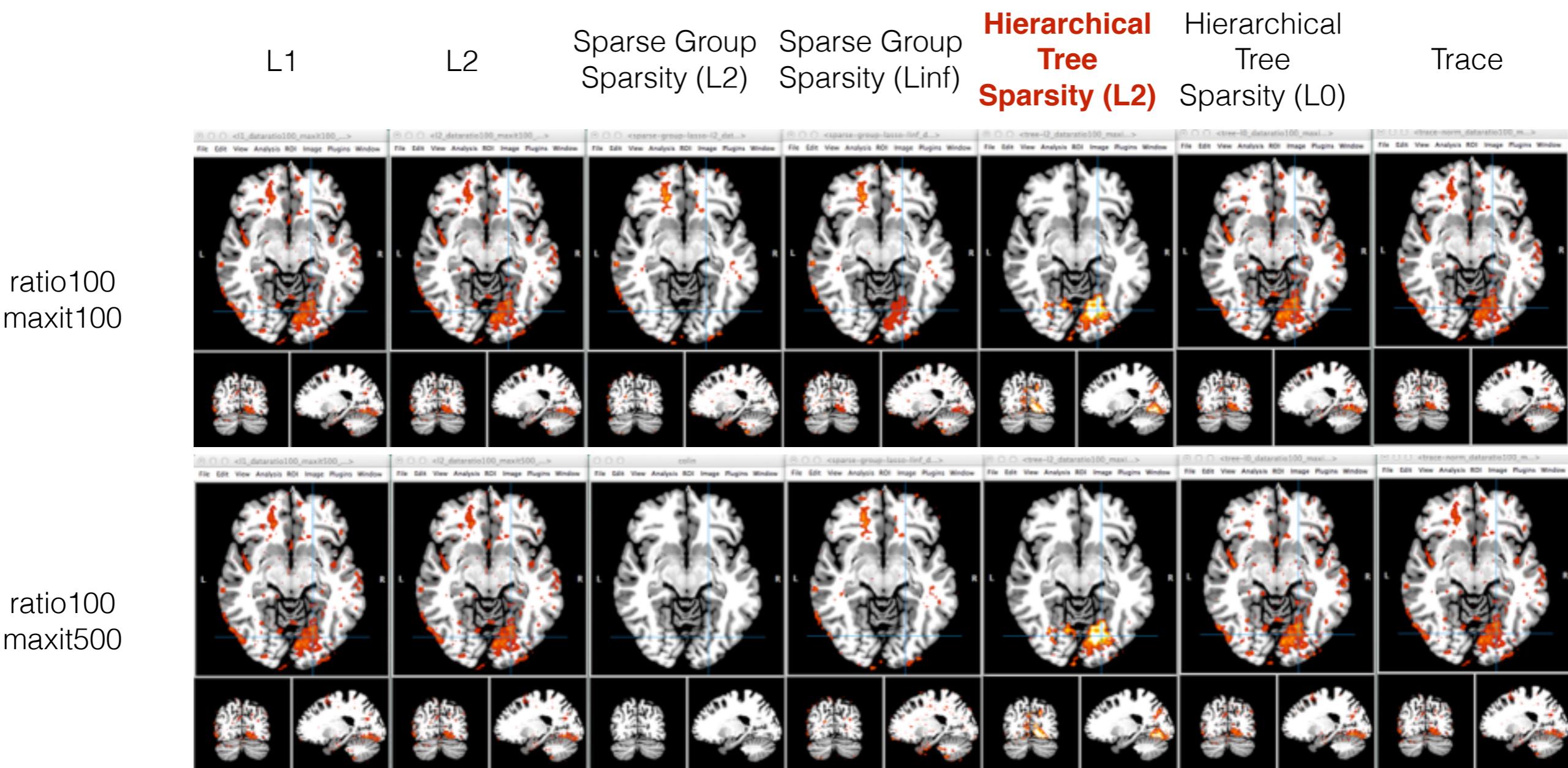
GridSearch: 25% data



GridSearch: 10% data

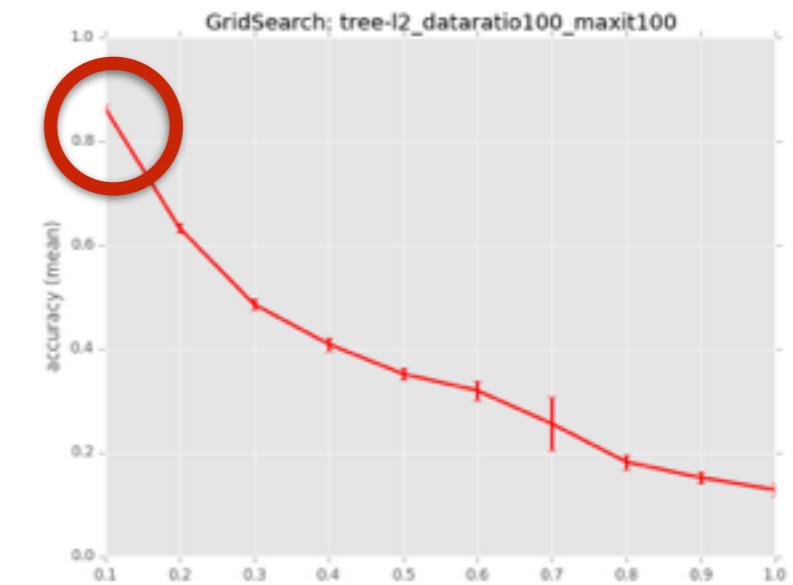
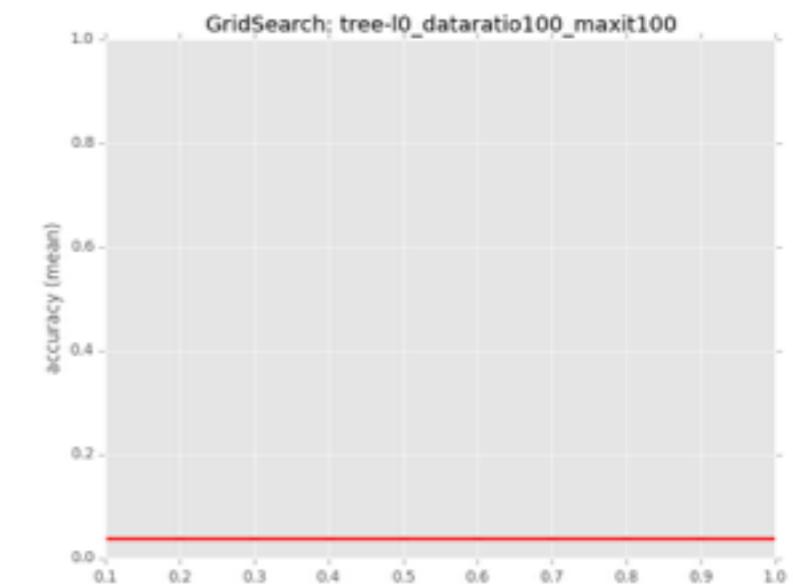
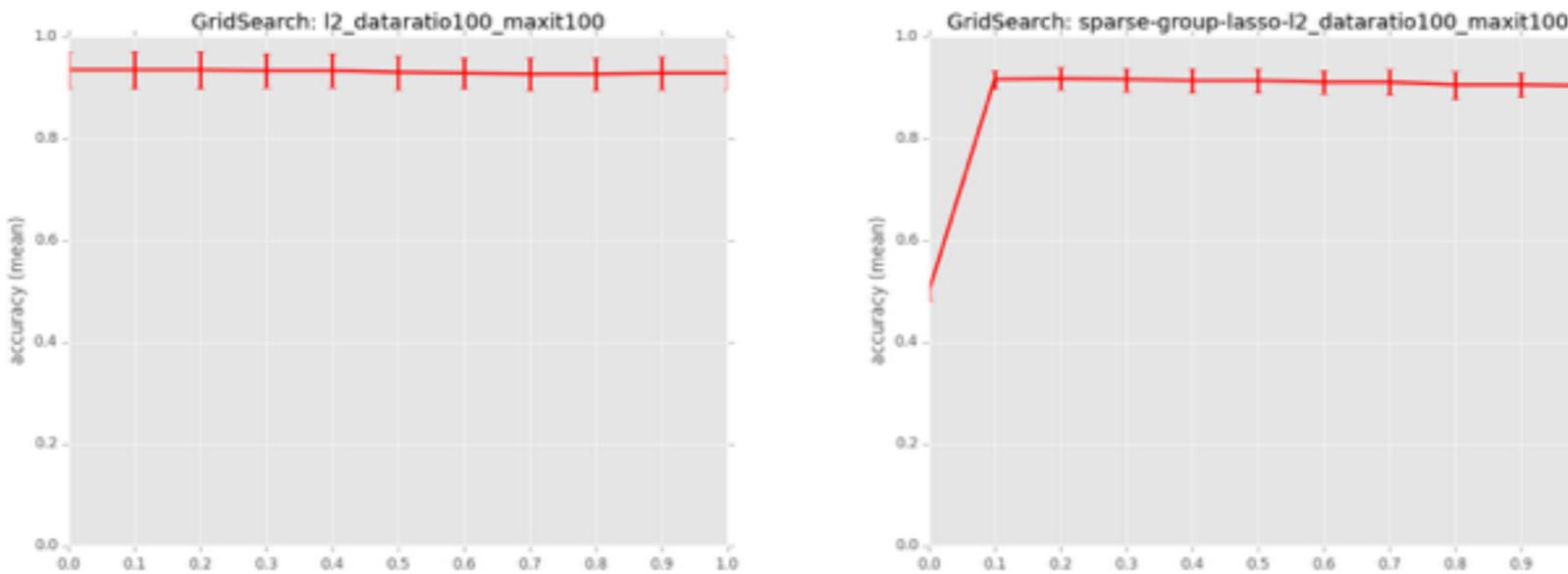
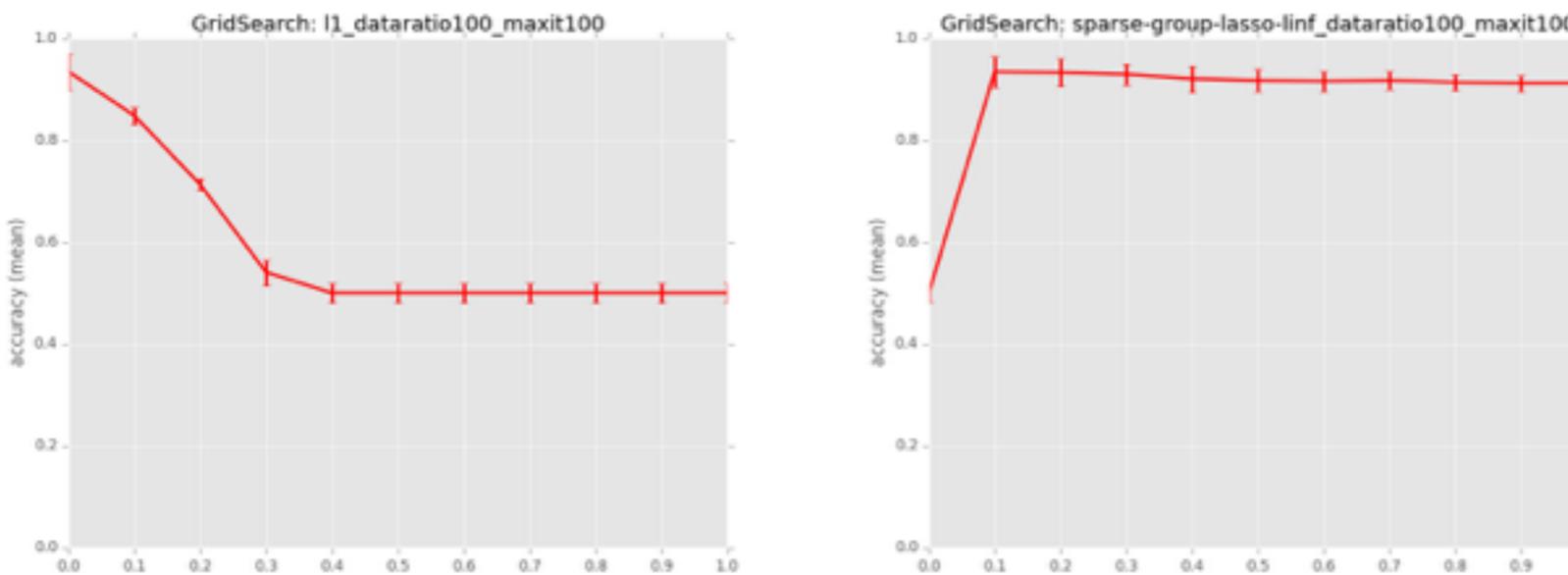
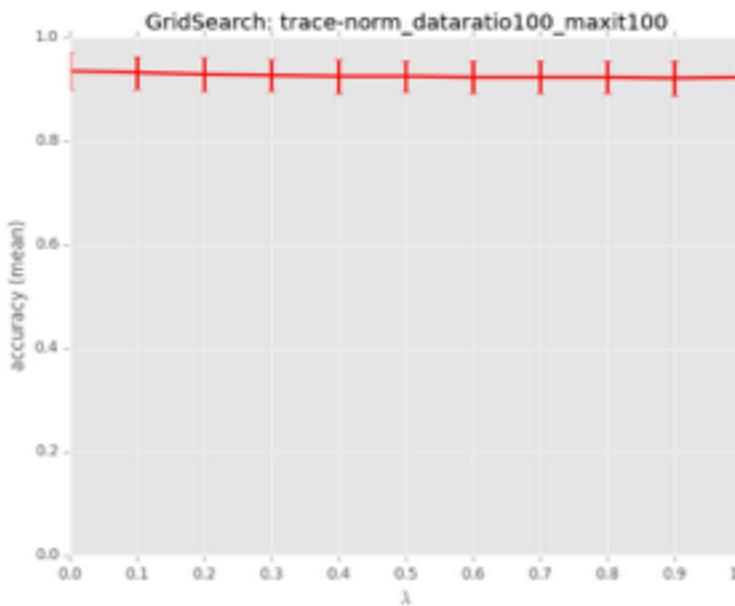
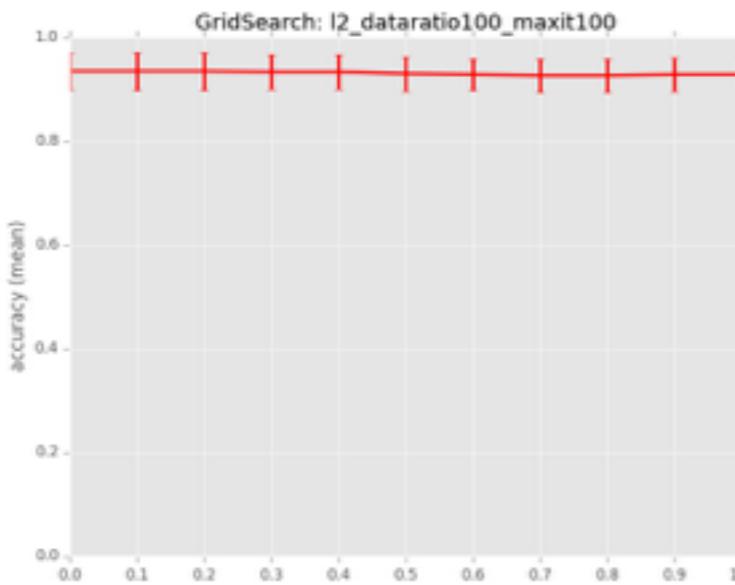
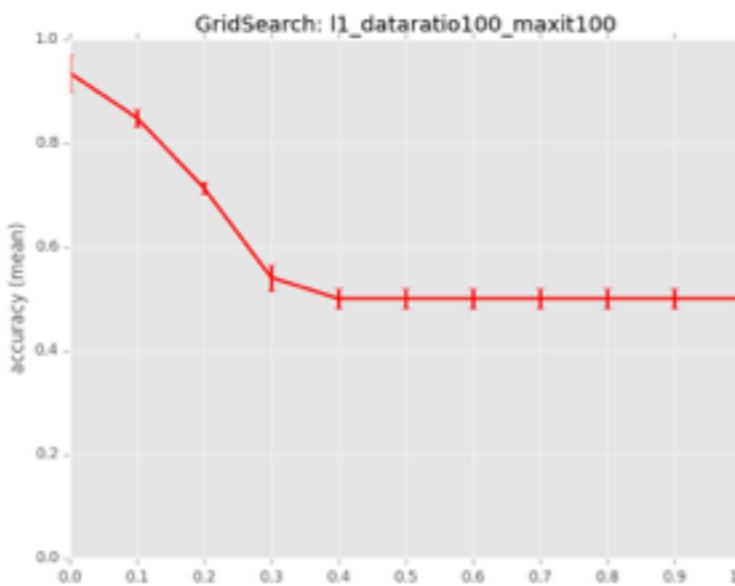


GridSearch: 0-versus-1



**HCP: distinguishing
18 psychological tasks**
(one-versus-rest)

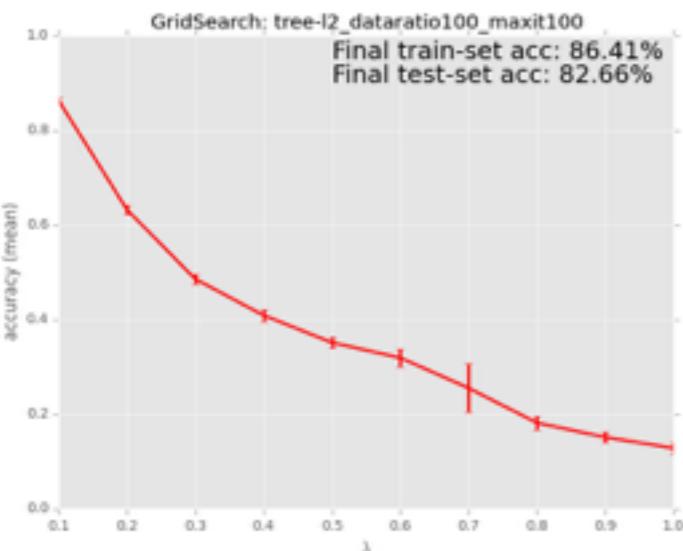
GridSearch: full data maxit100



GridSearch: full data maxit100

perturb group weights

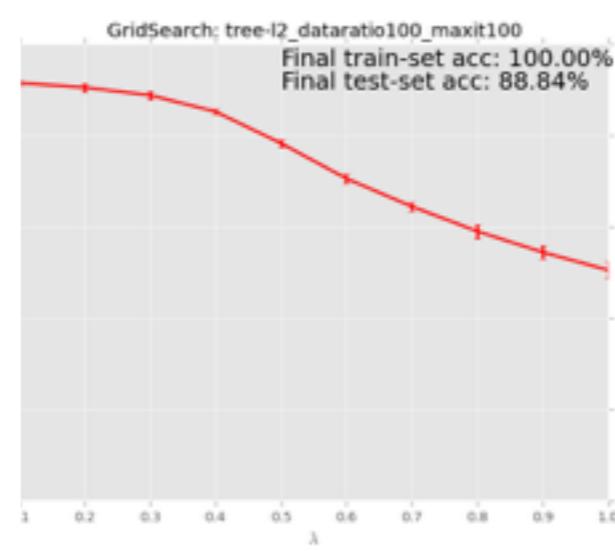
original



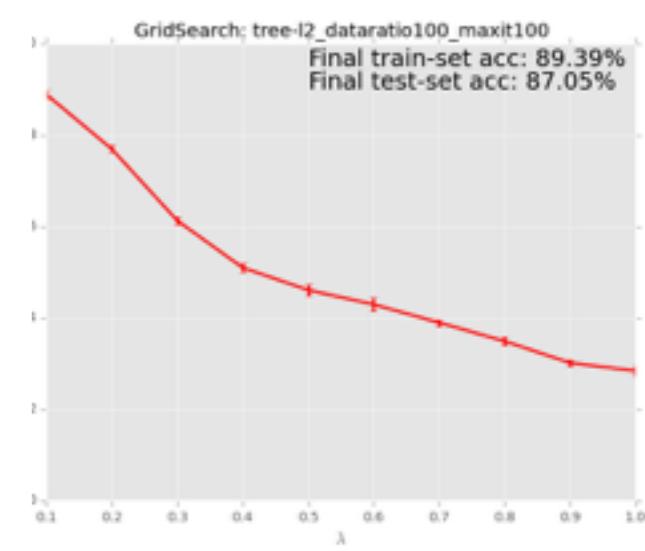
0-weight at brain level



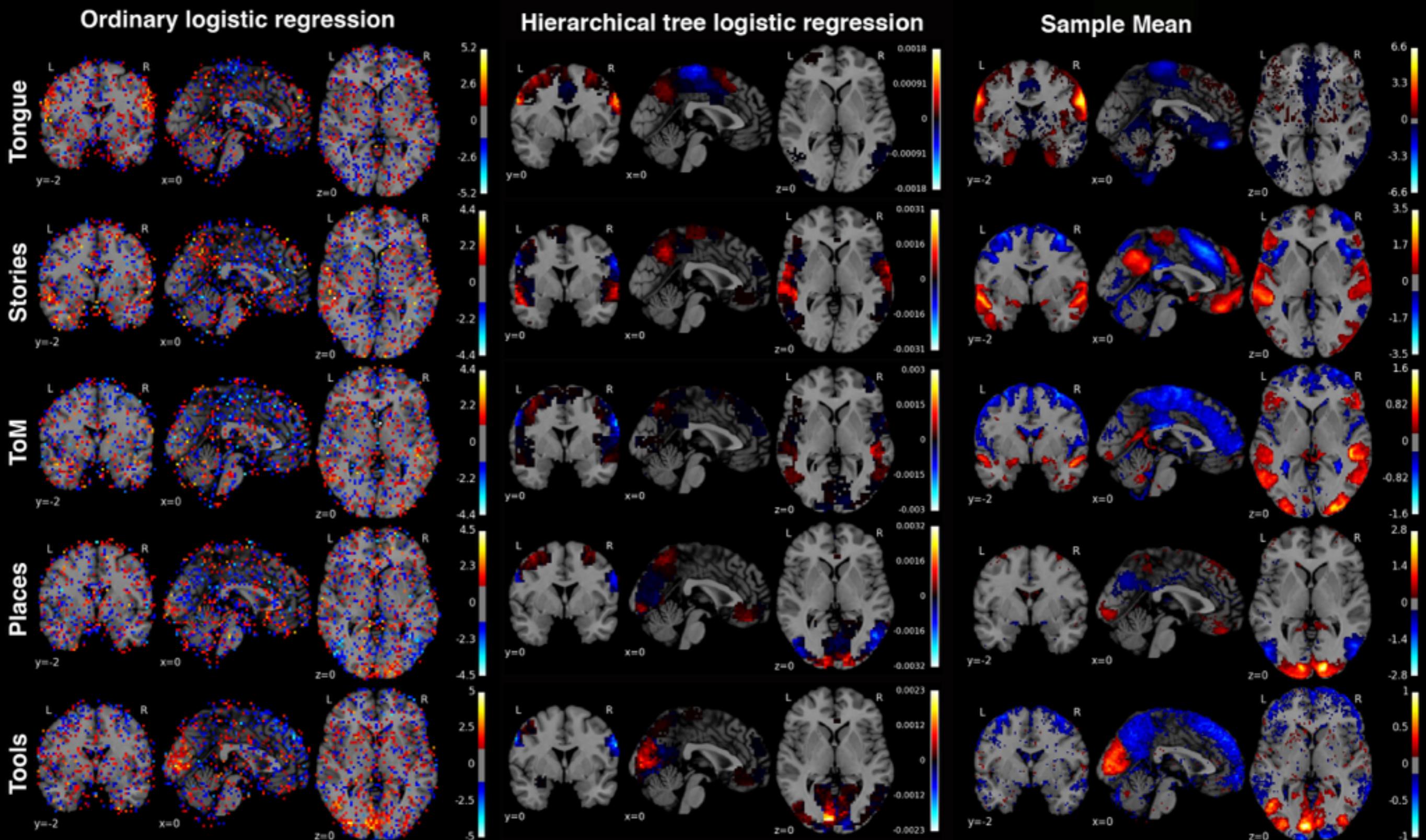
0-weight at reg level



0-weight at net level

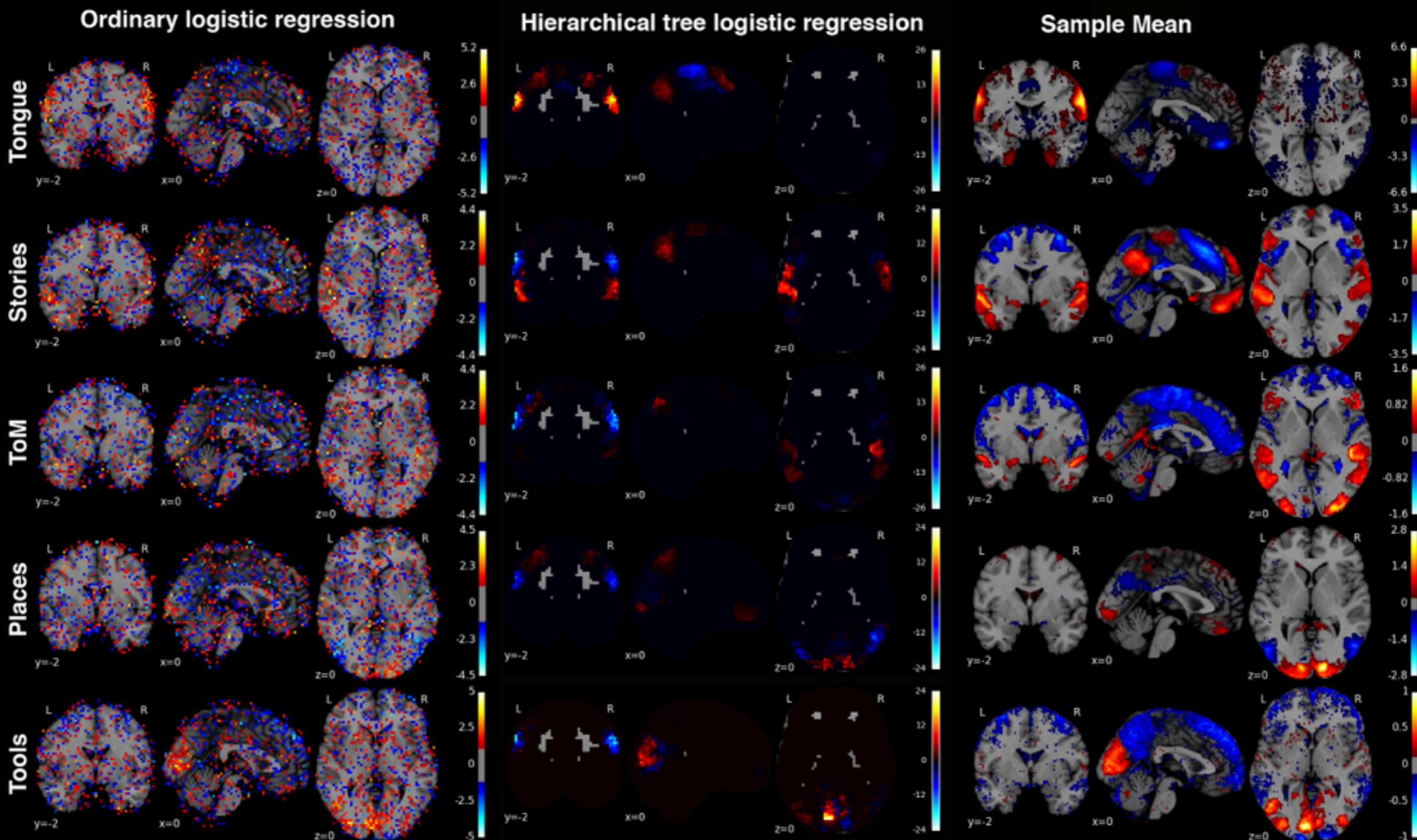


Preliminary results: original / maxit100_dataratio100



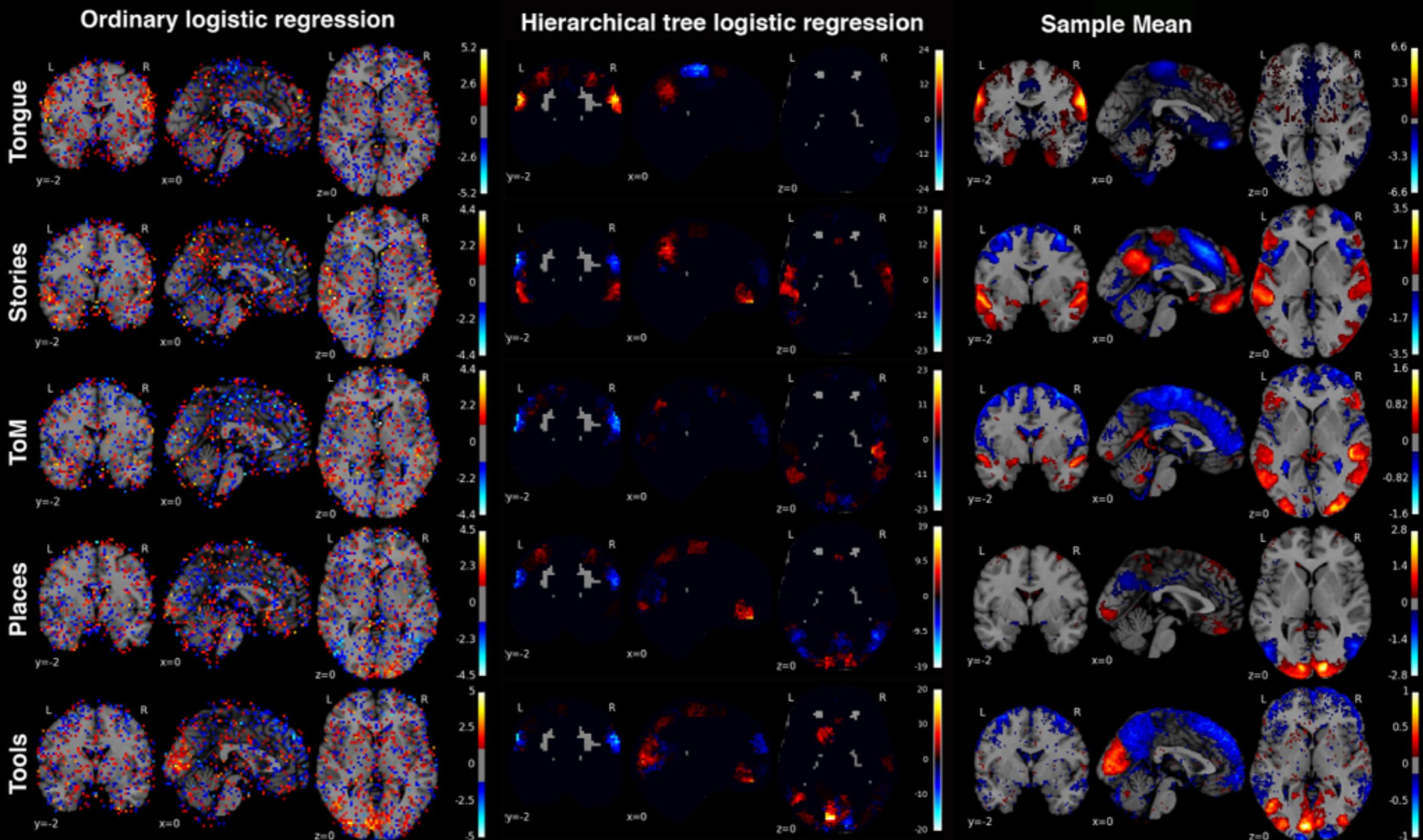
tree-l2 (lambda=0.1)

Preliminary results: 0-weight at brain level / maxit100_dataratio100



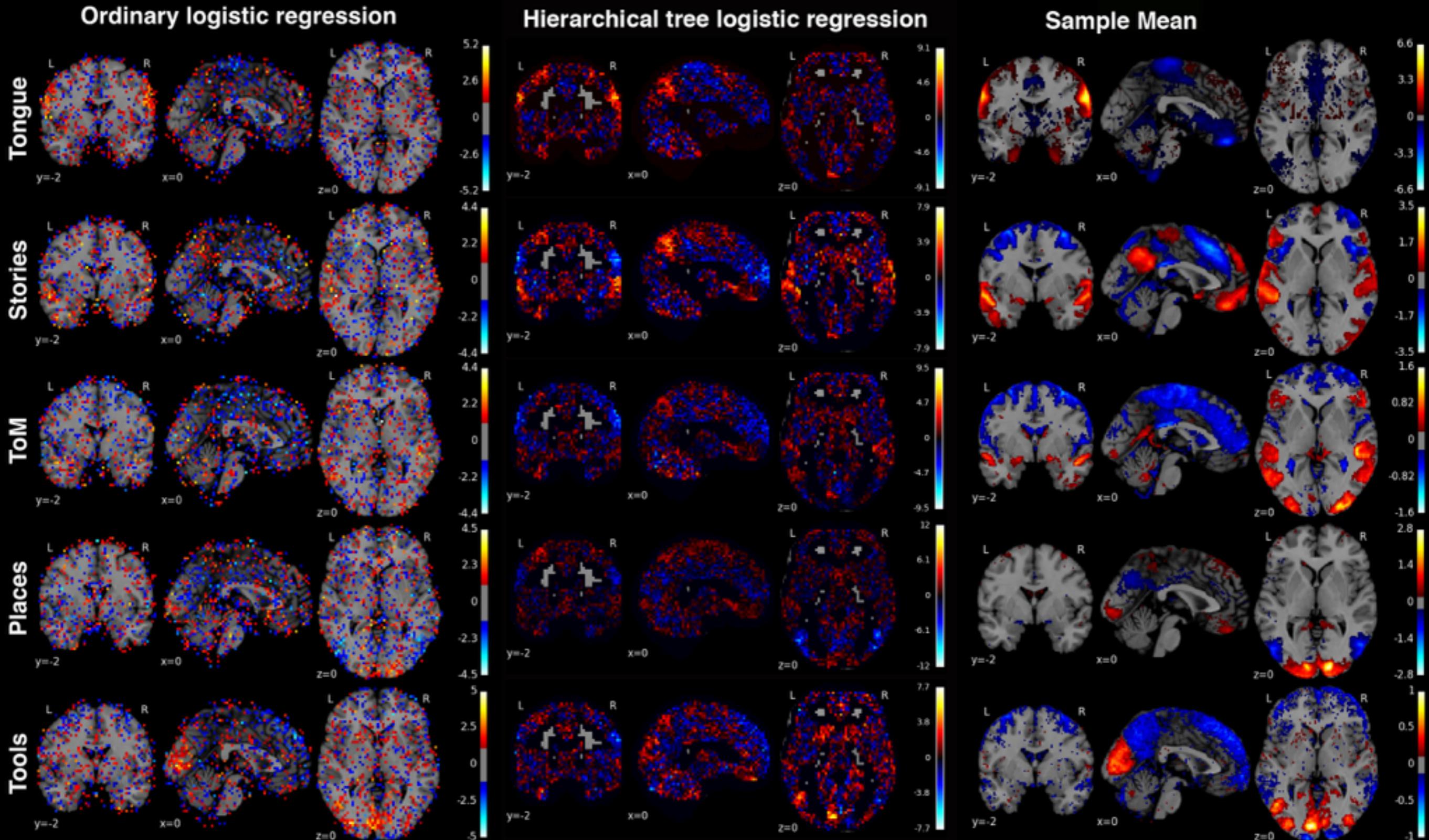
observation: weight are much bigger

Preliminary results: 0-weight at net level / maxit100_dataratio100



observation: less interpretability but higher generalization performance

Preliminary results: 0-weight at reg level / maxit100_dataratio100

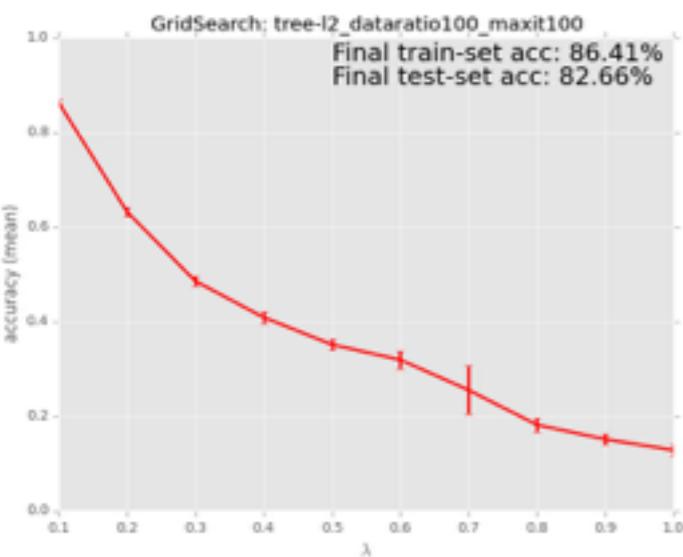


observation: less interpretability but higher generalization performance

GridSearch: full data maxit100

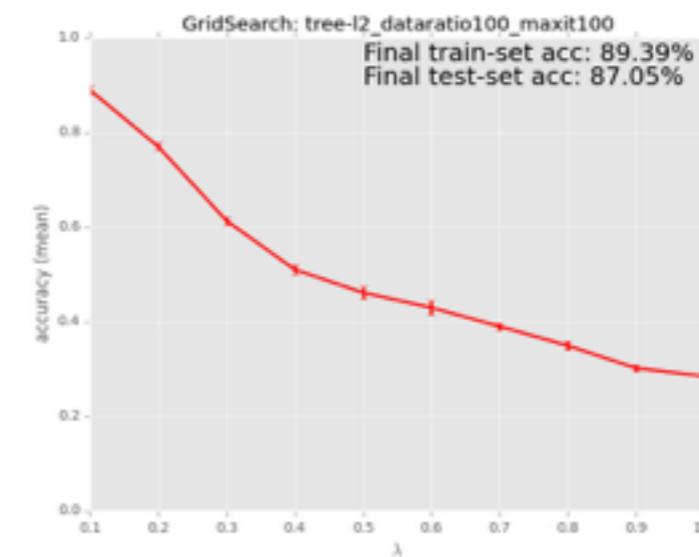
perturb tree groups

original

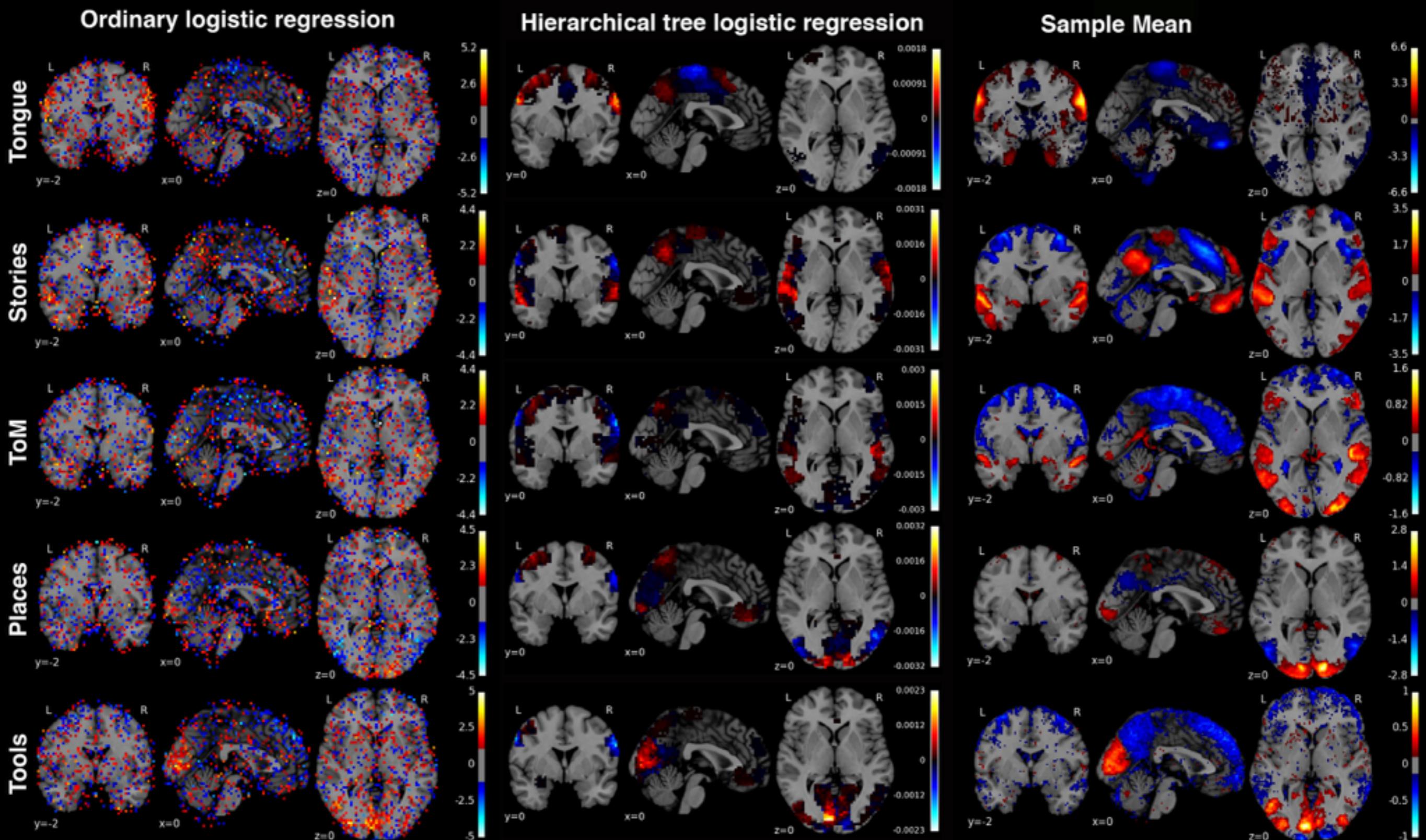


no reg groups

no net groups

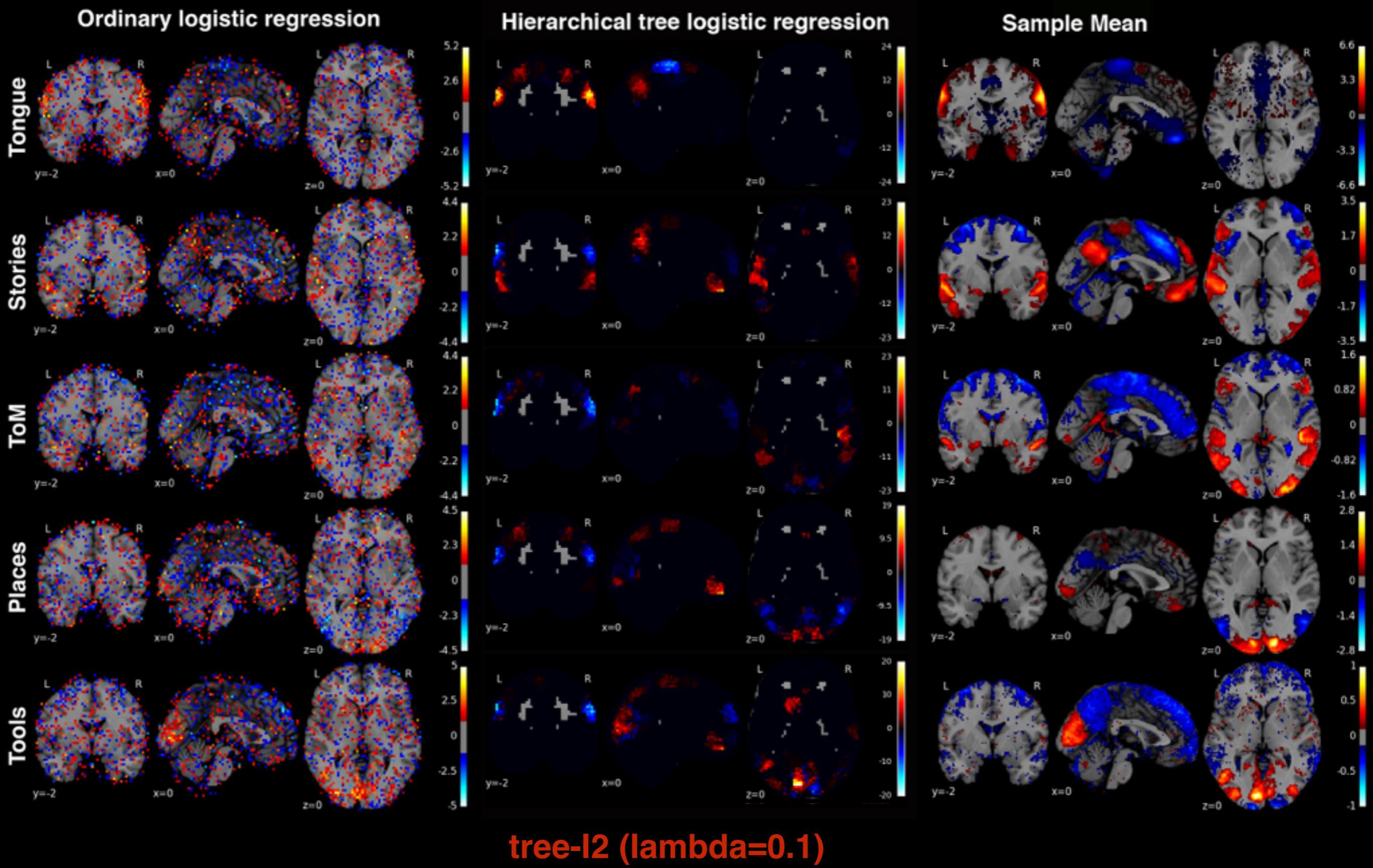


Preliminary results: original / maxit100_dataratio100



tree-l2 (lambda=0.1)

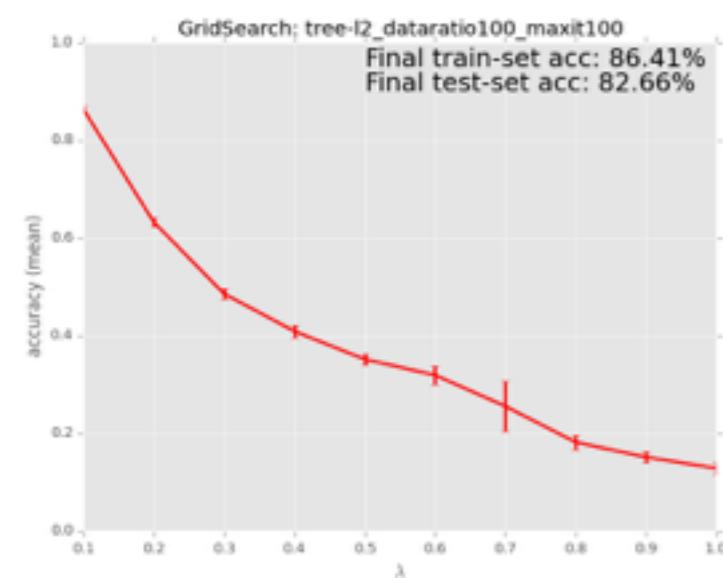
Preliminary results: no net groups / maxit100_dataratio100



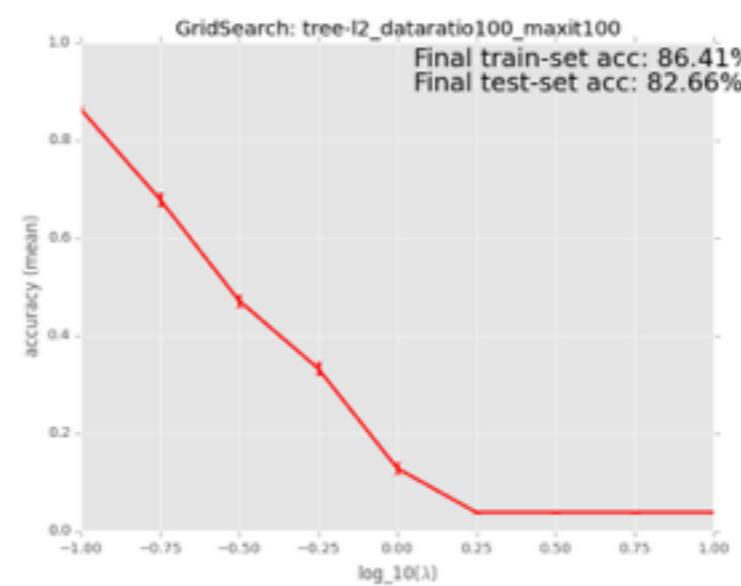
GridSearch: full data maxit100

decimal versus log scale

original



log10



Preliminary results: SpaceNet versus Hierarchical Tree Sparsity

HCP: distinguishing 18 psychological tasks

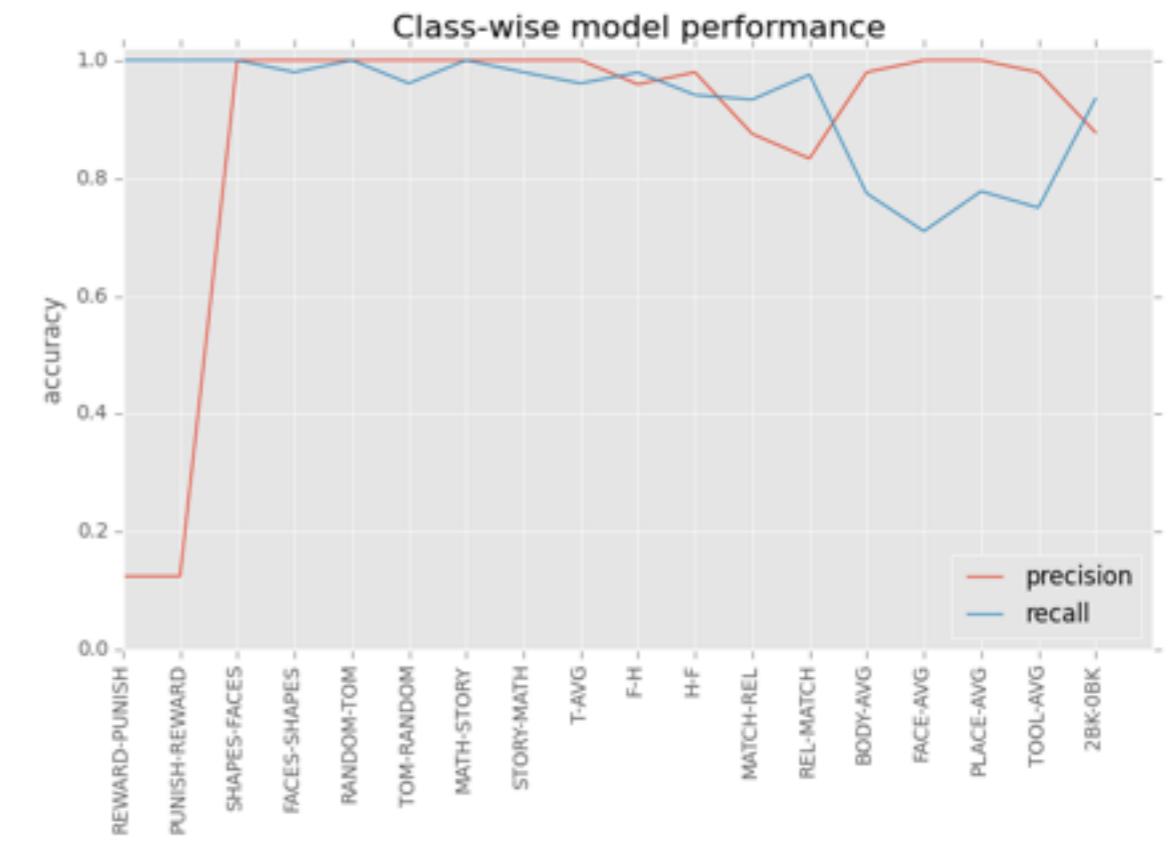
TV-I1
(I1=0.5, screen_per=100)



Model performance (out-of-sample):
86,94 %

Computational load (5 jobs):
34 hours 14 mins

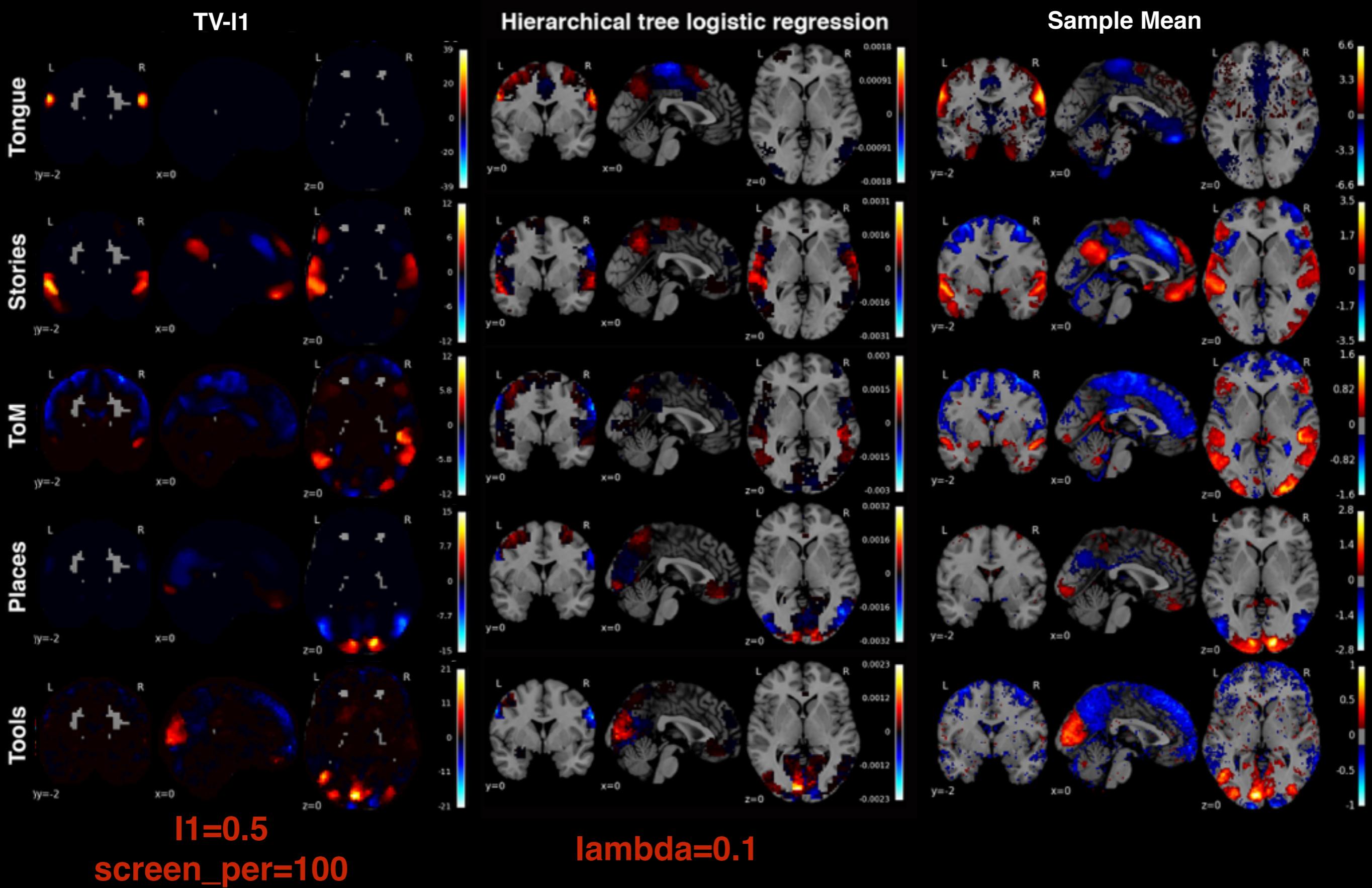
Tree-I2
(zerobrainlevel_weighted_loggrid)



Model performance (out-of-sample):
90,38 %

Computational load (5 jobs):
5 hours 8 mins

Preliminary results: SpaceNet versus Tree-L2

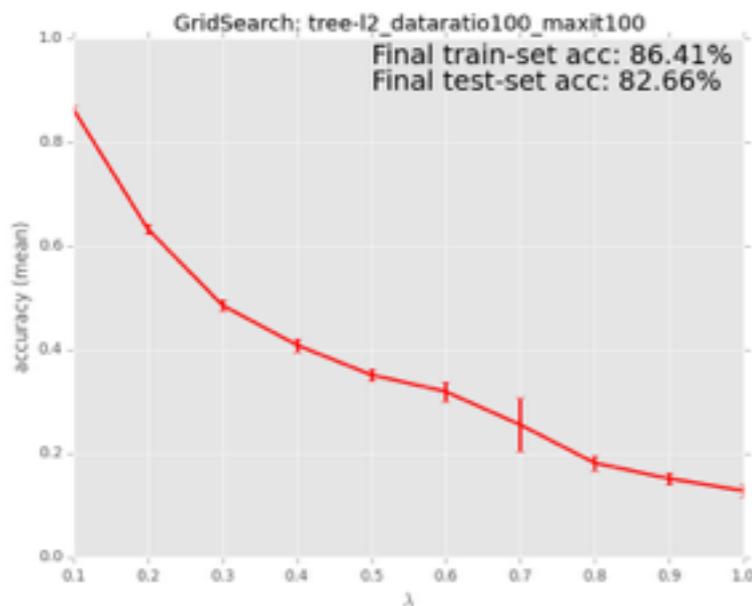


**HCP: distinguishing
18 psychological tasks**
(one-versus-rest)

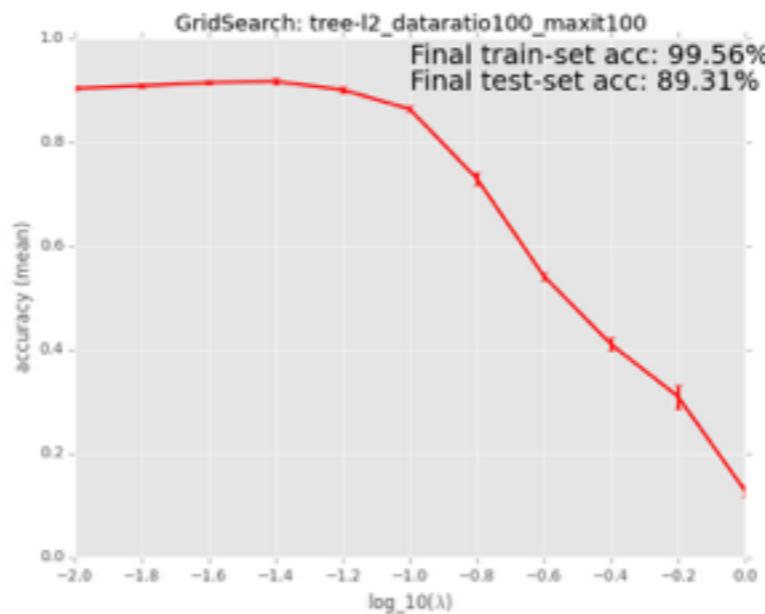
weighted groups!
(cf. Yuan2007)

GridSearch: full data maxit100

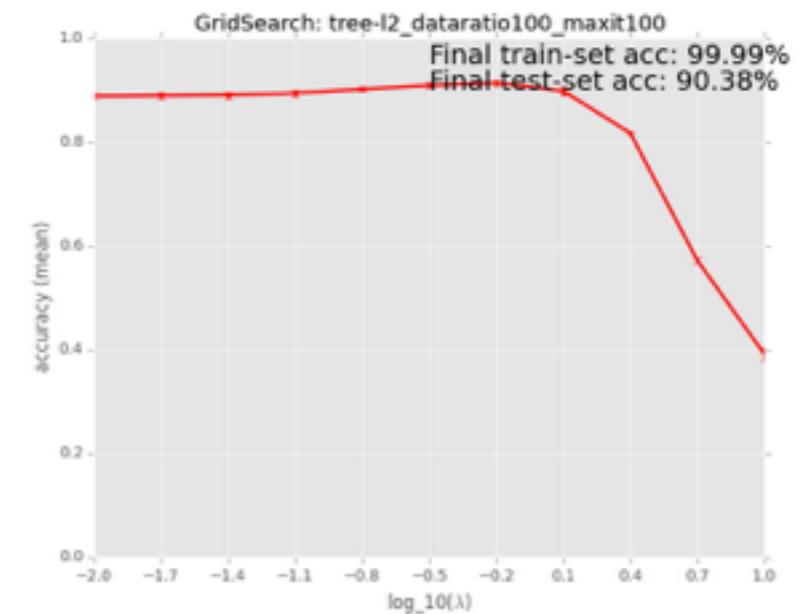
Tree-I2



Tree-I2
(zerobrainlevel_loggrid)



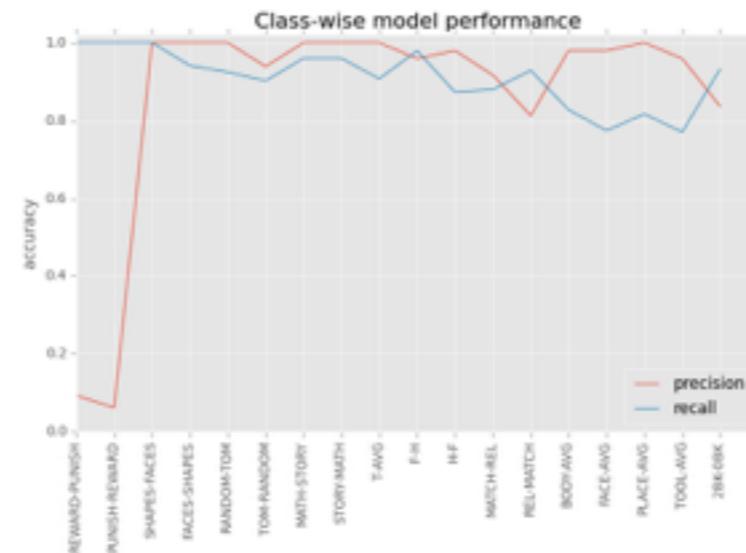
Tree-I2
(zerobrainlevel_weighted_loggrid)



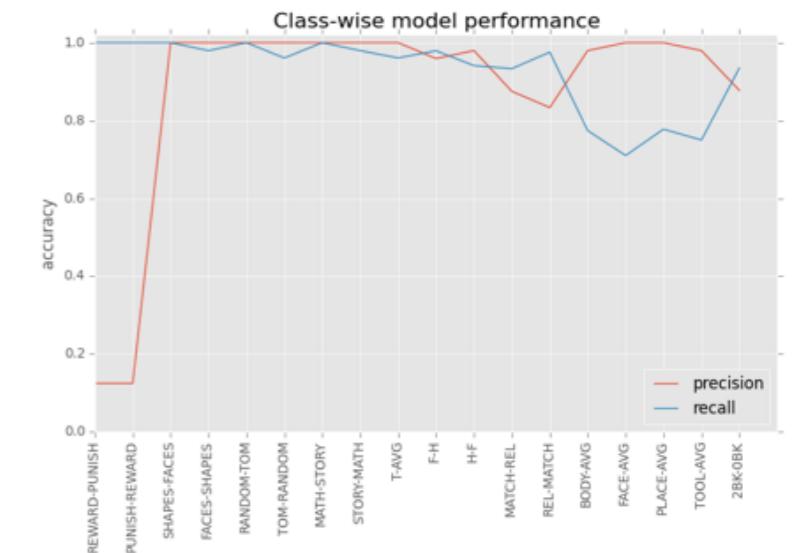
Class-wise model performance



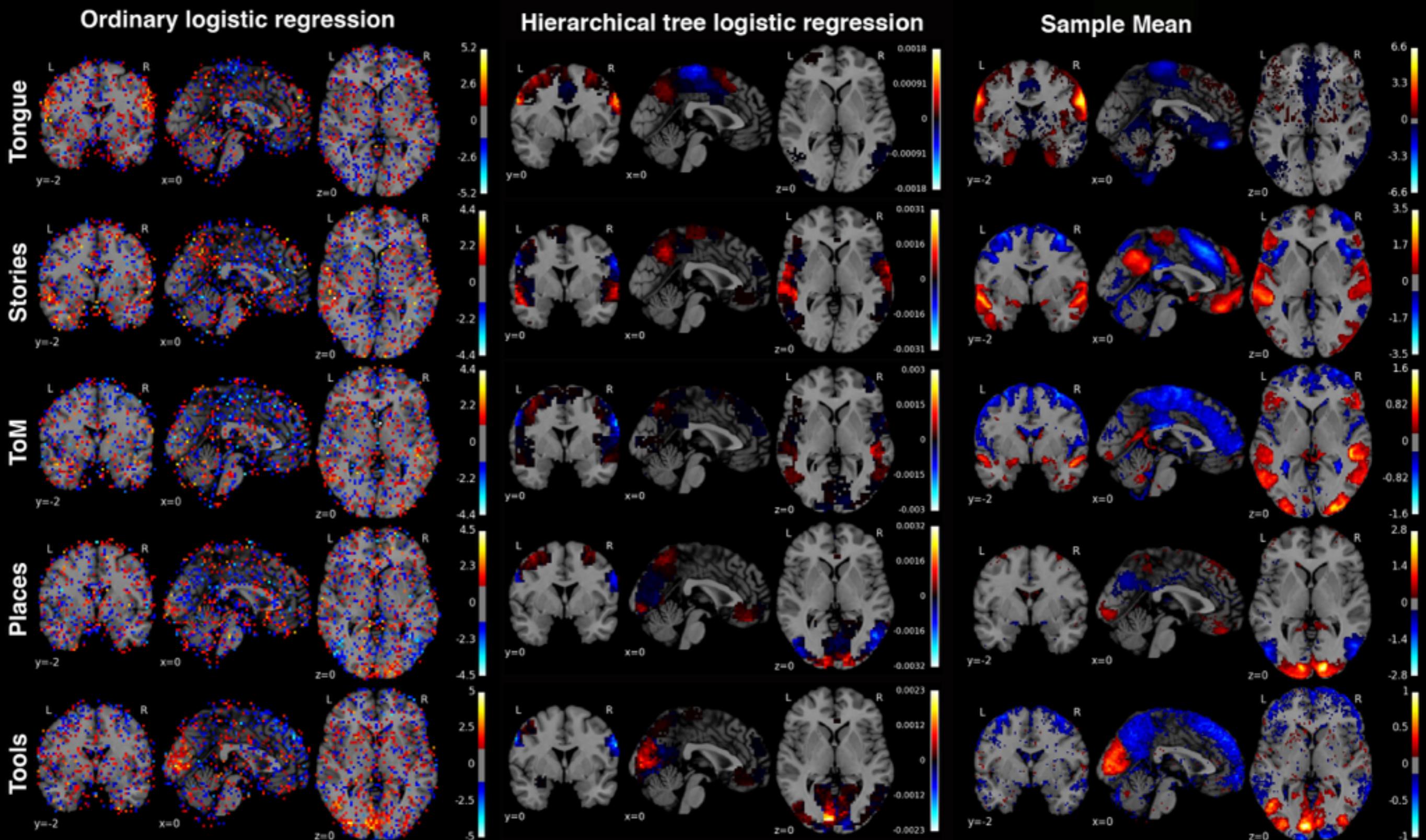
Class-wise model performance



Class-wise model performance

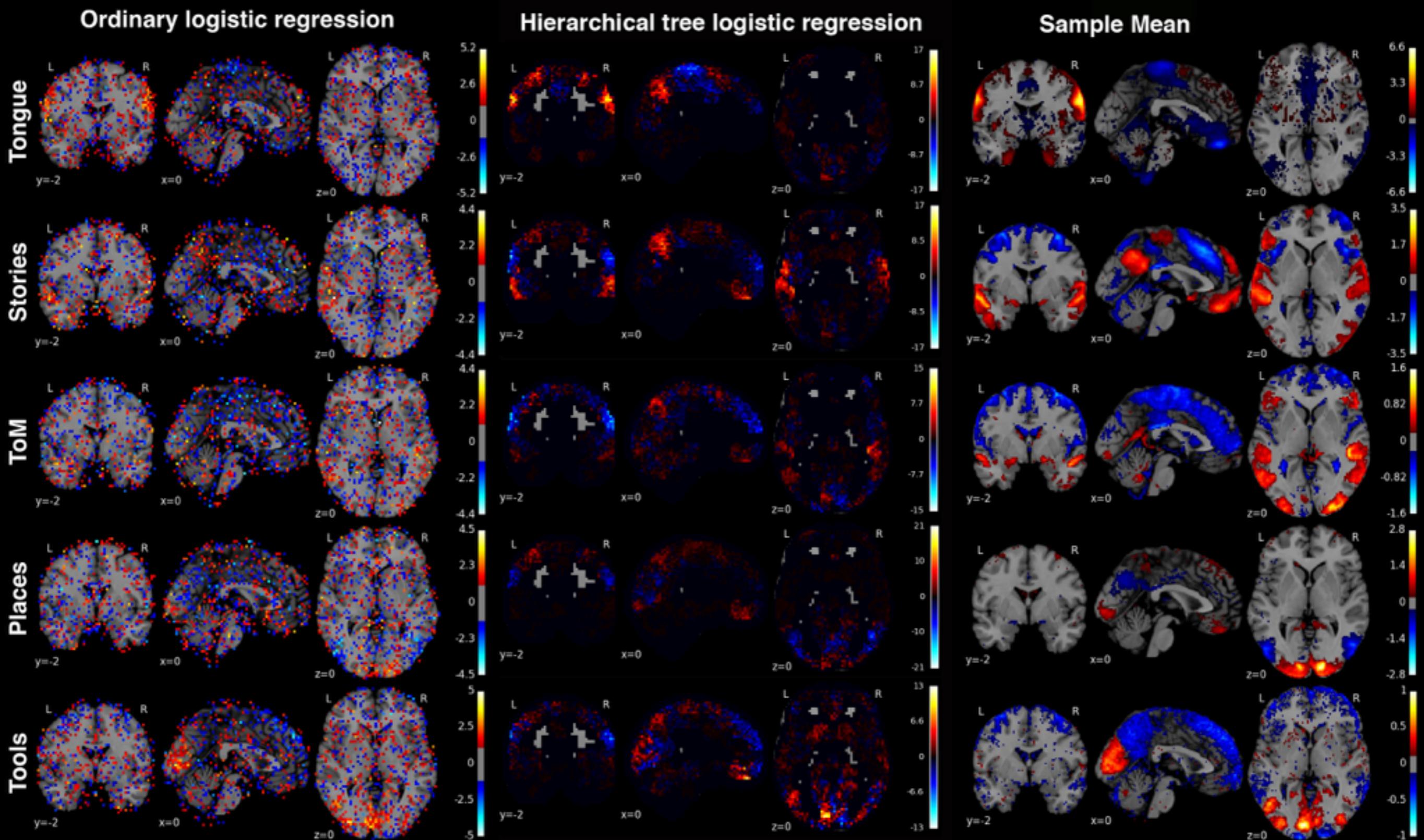


Preliminary results: original / maxit100_dataratio100



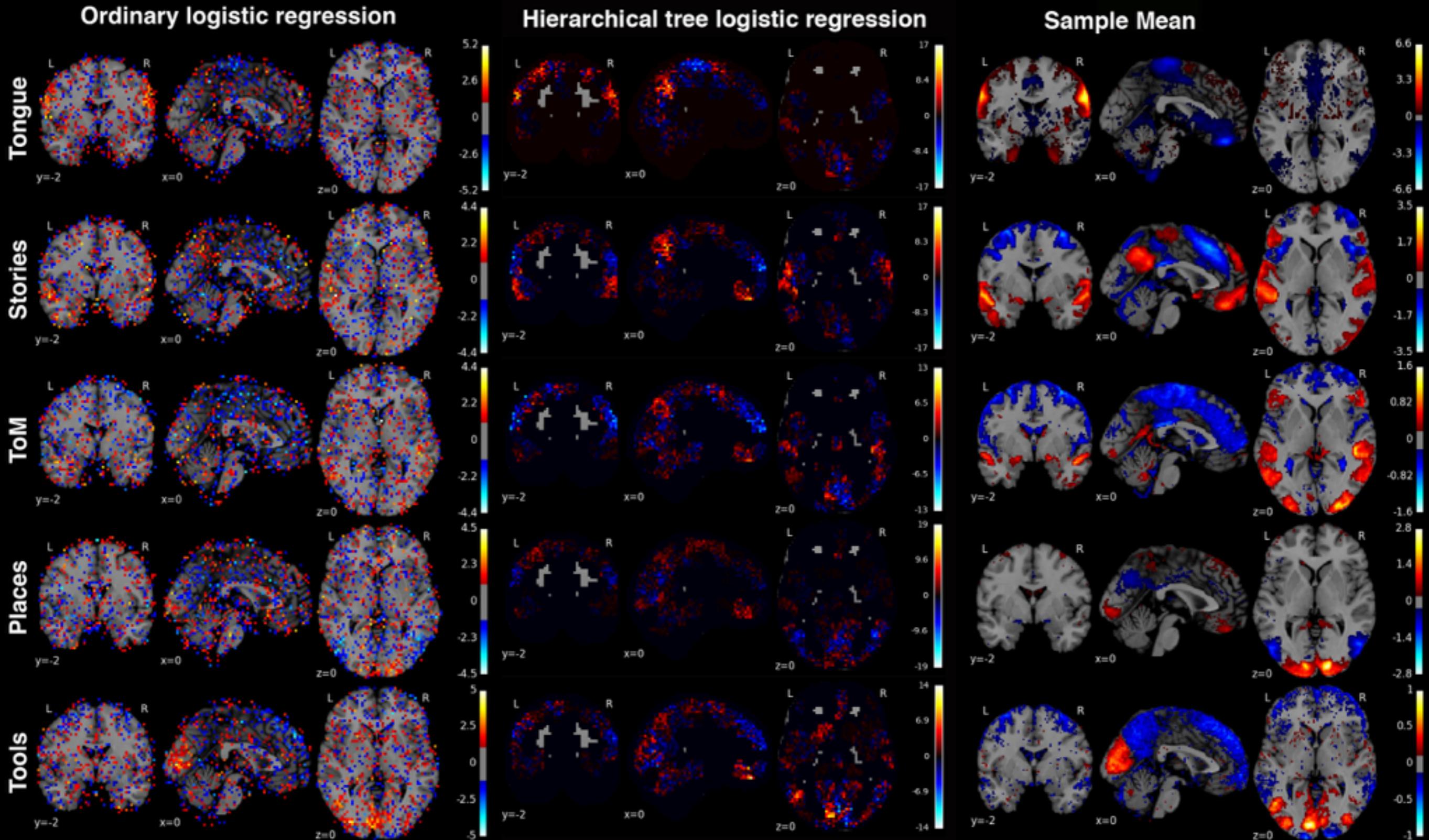
tree-l2 (lambda=0.1)

Preliminary results: zerobrainlevel_loggrid / maxit100_dataratio100



tree-l2 (lambda=0.040)

Preliminary results: zerobrainlevel_weighted_loggrid / maxit100_dataratio100



tree-l2 (lambda=0.63)

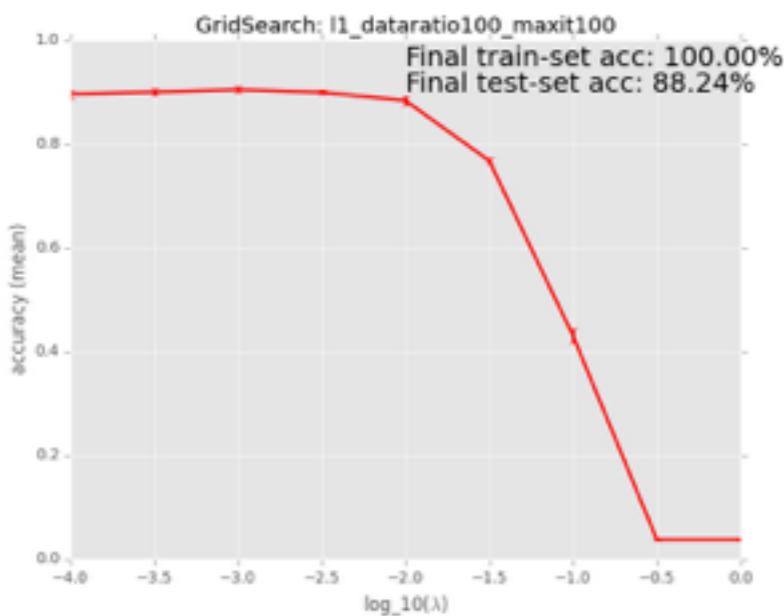
**HCP: distinguishing
18 psychological tasks**
(one-versus-rest)

weighted groups!
(cf. Yuan2007)

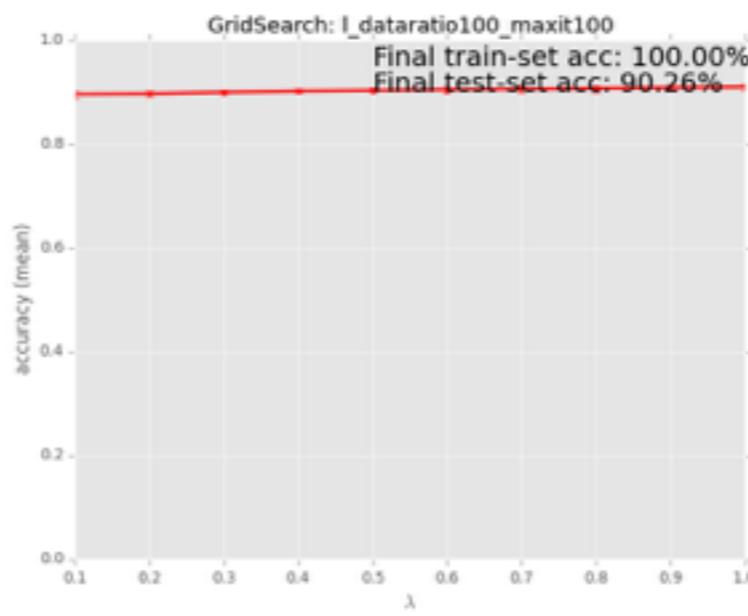
L1 vs L2 vs Tree-L2

GridSearch: full data maxit100

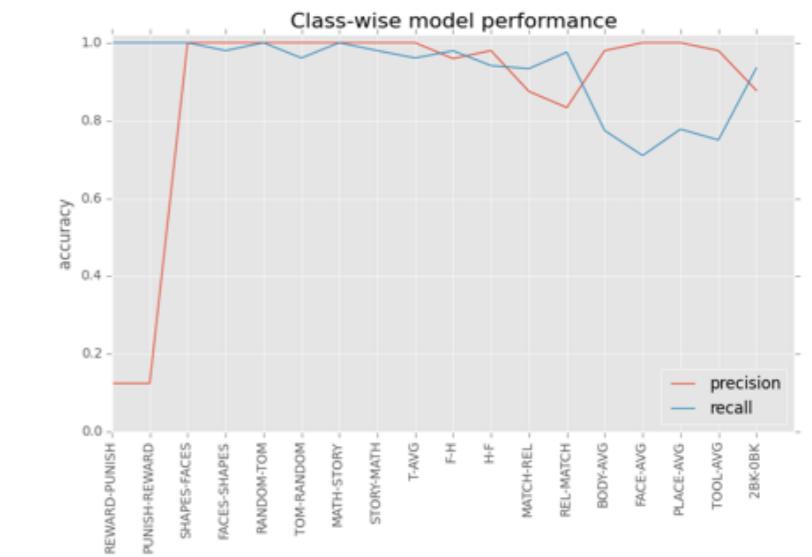
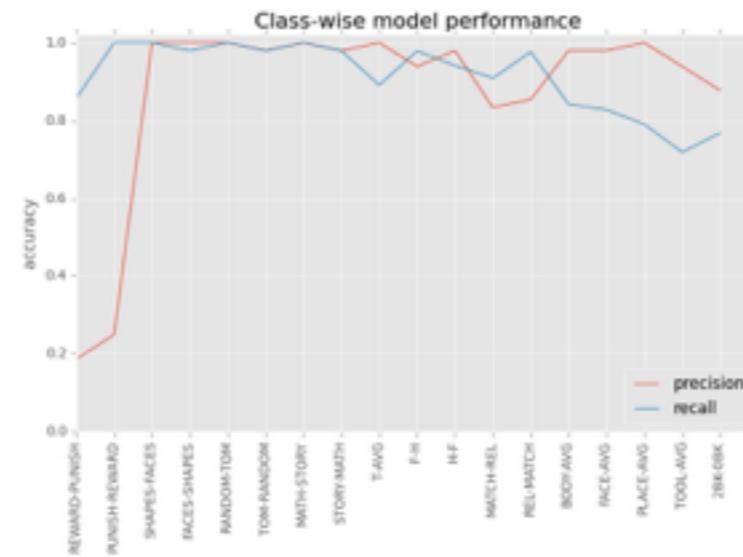
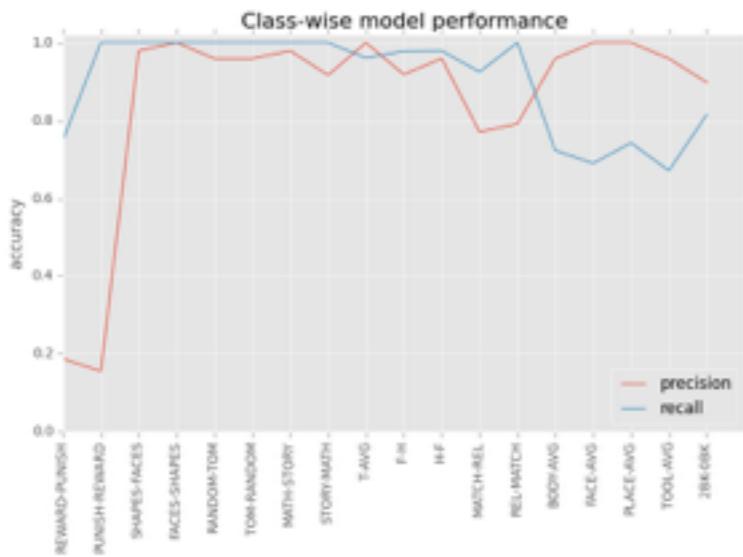
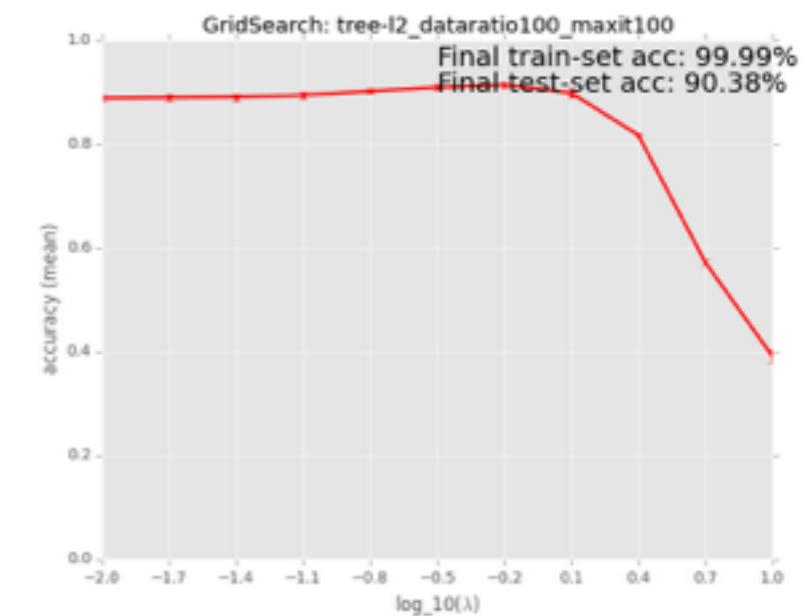
L1



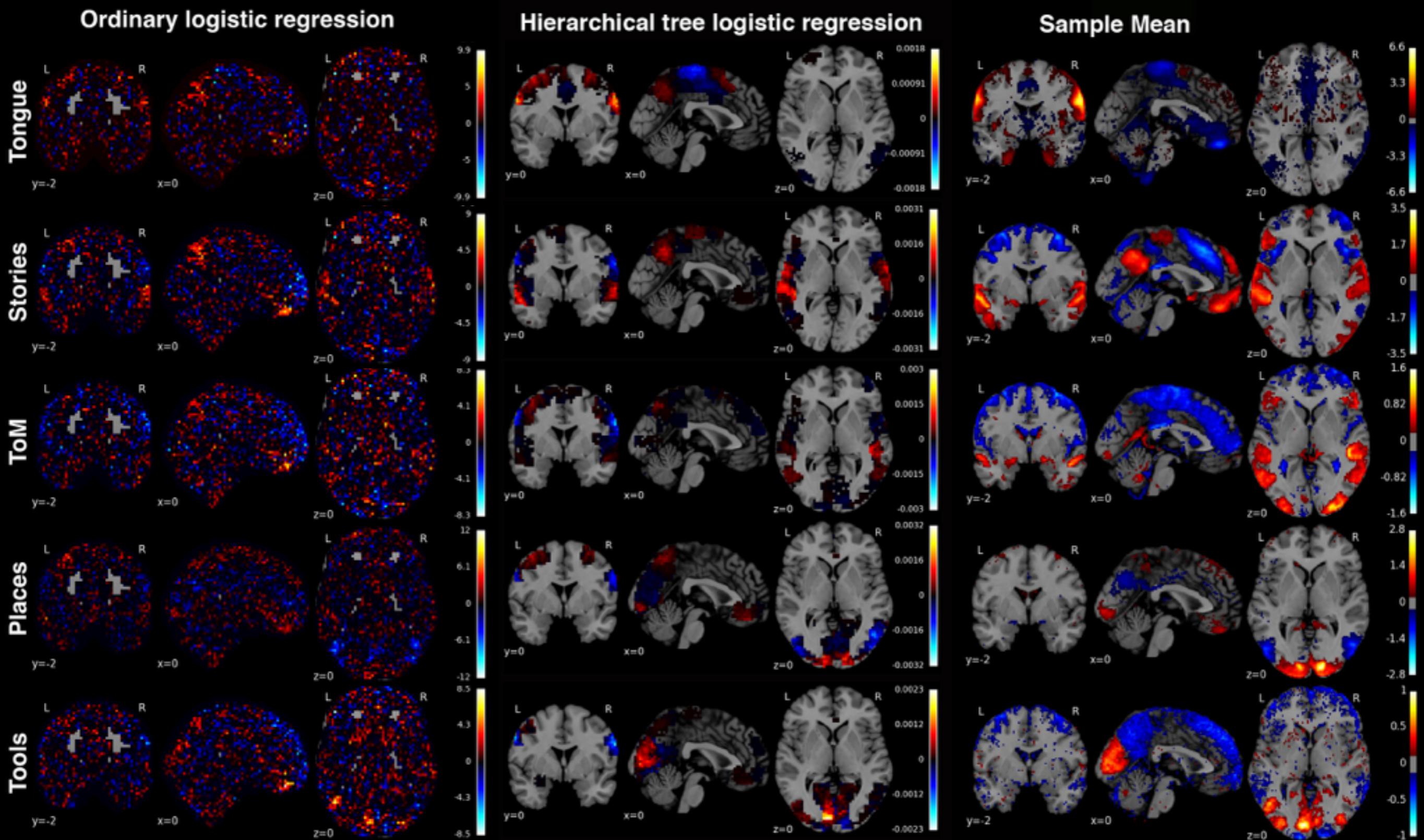
L2



Tree-I2
(zerobrainlevel_weighted_loggrid)



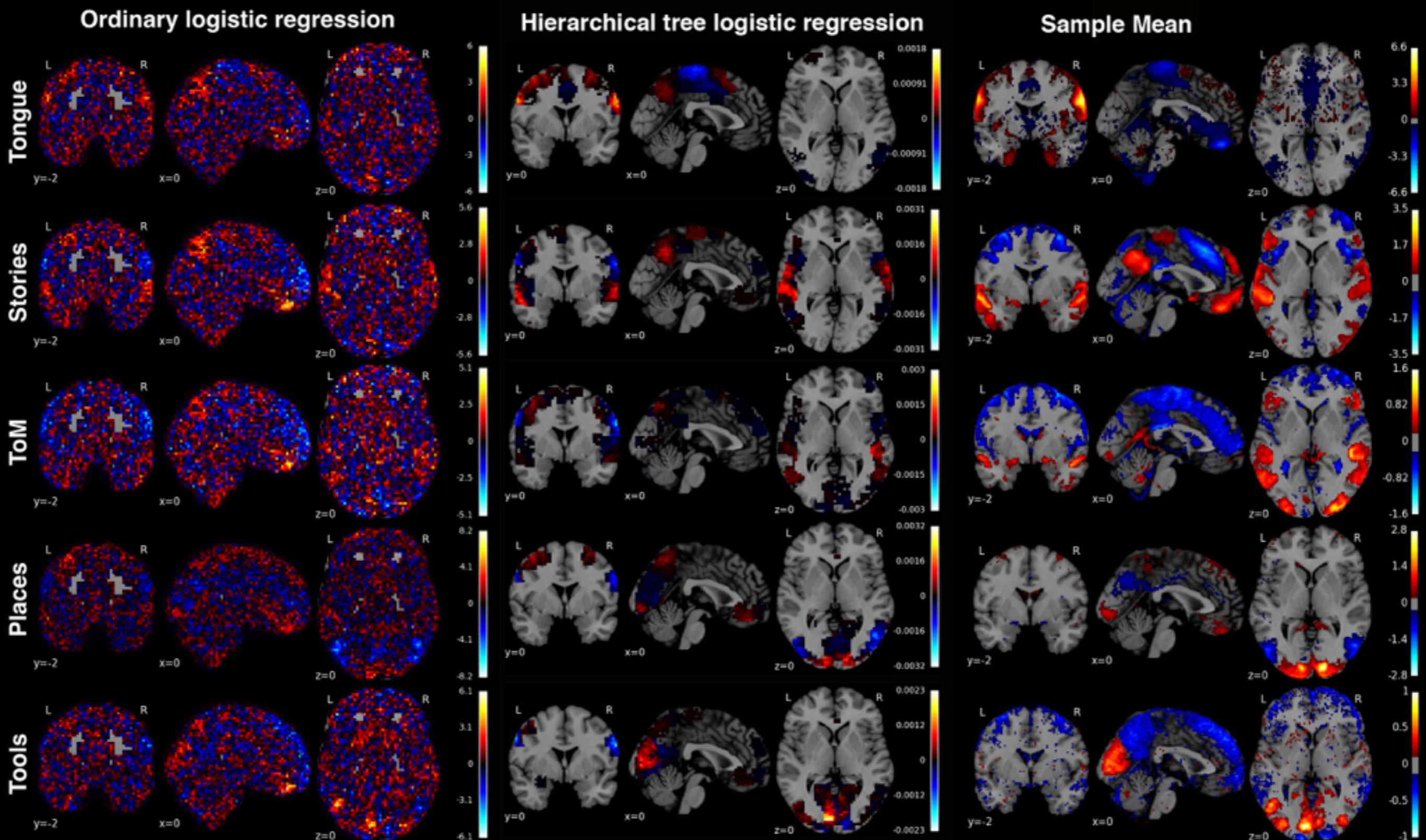
Preliminary results: L1 vs Tree-L2 / maxit100_dataratio100



L1 (lbd=0.001)

tree-l2

Preliminary results: L2 vs Tree-L2 / maxit100_dataratio100



L2 (lbd=1.0)

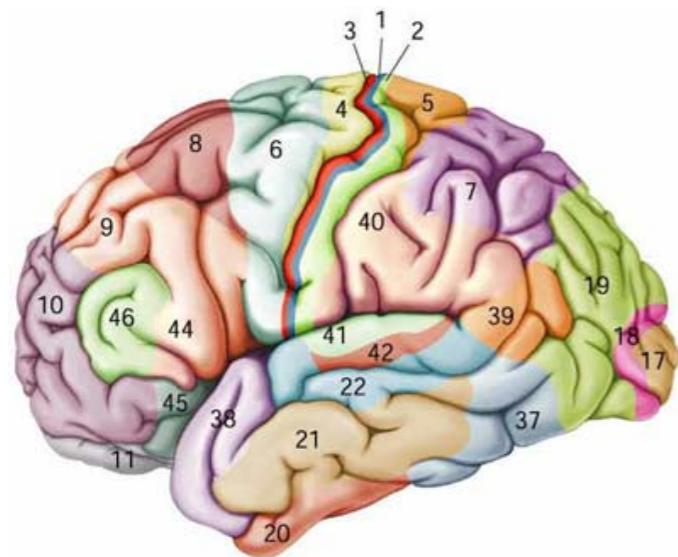
tree-l2

HCP: distinguishing 18 psychological tasks

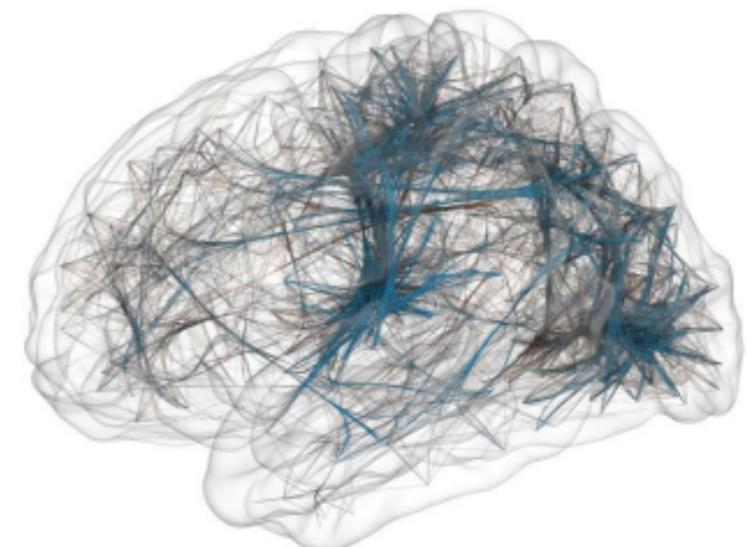
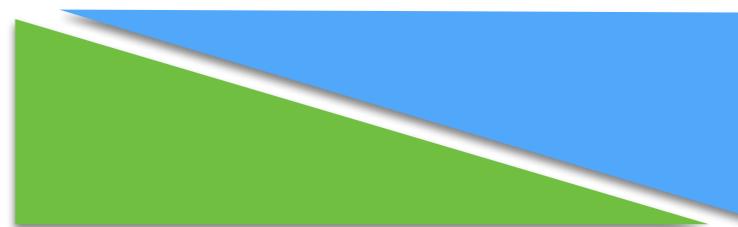
(one-versus-rest)

zero_brain_level + log_grid
weighted groups! + reg-net-ratio grid!

Idea: learn the region-network equilibrium as a hyperparameter



Rest-derived **regions**



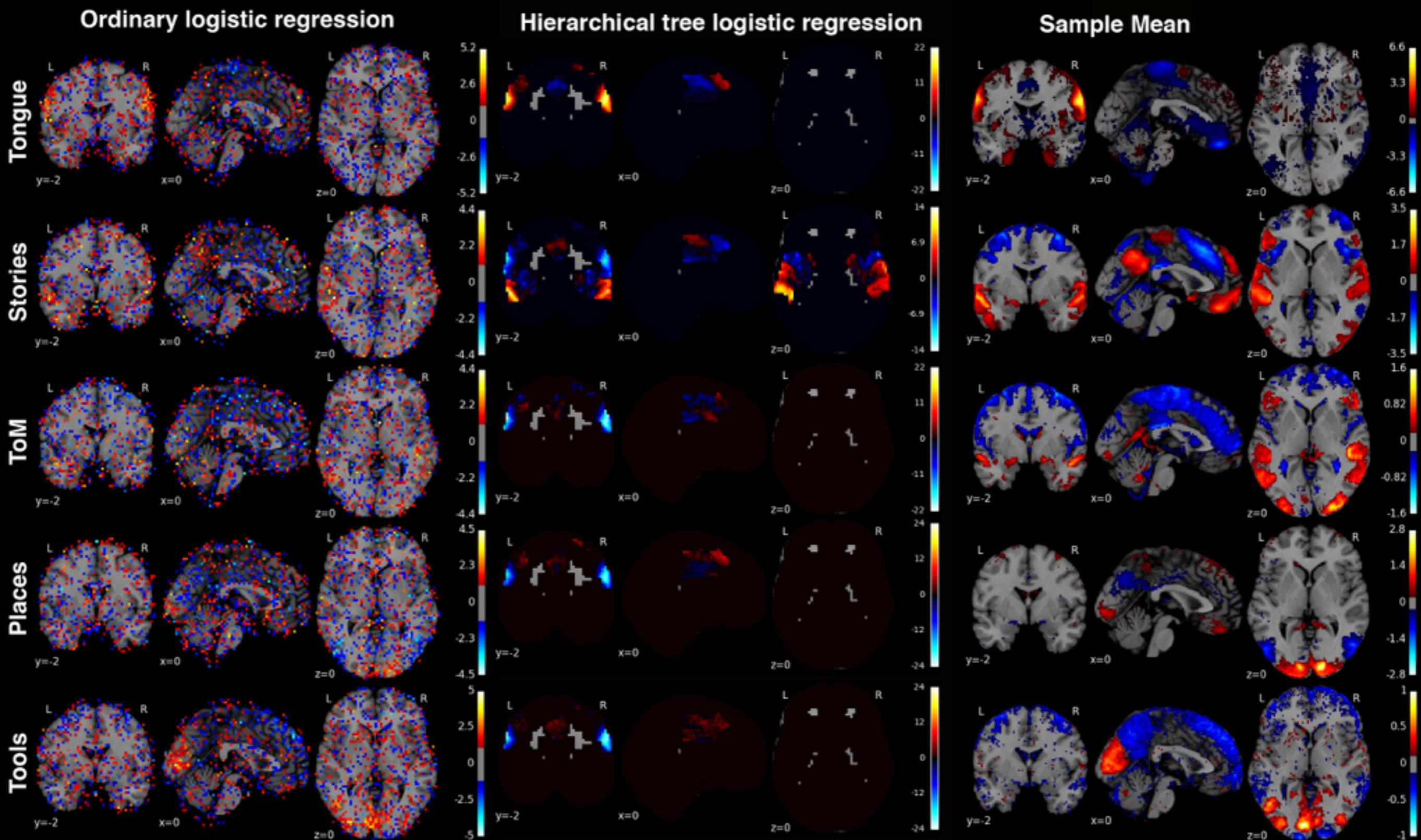
Rest-derived **networks**



$$\Omega(\mathbf{w}) \triangleq \sum_{g \in \mathcal{G}} \eta_g \|\mathbf{w}_g\|$$

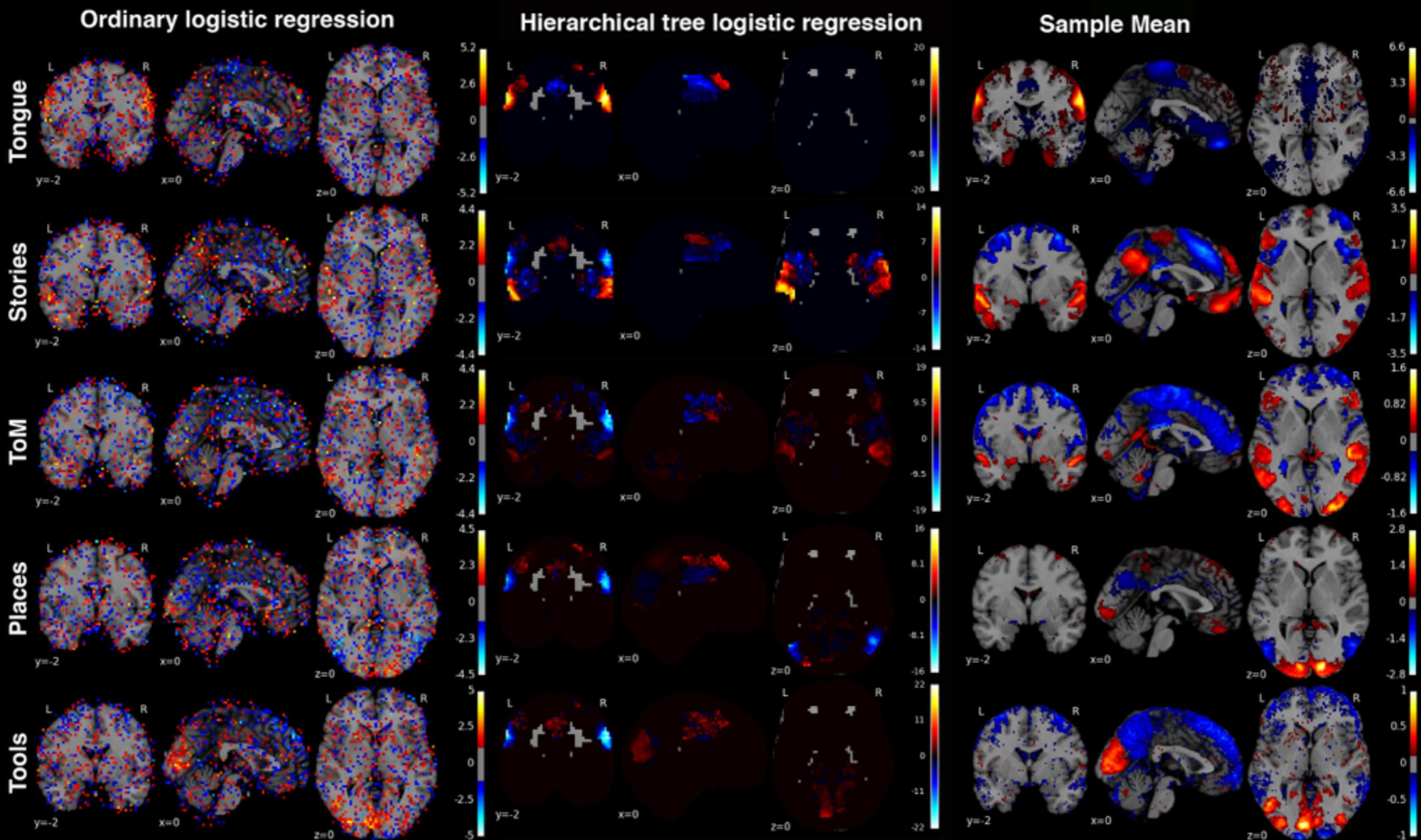
-> Optimized region-network ratio could inform about pertinence
of functional specialization versus functional integration interpretation of results

Preliminary results: reg-net-ratio 1/1000 / maxit100_dataratio100_lbd0.



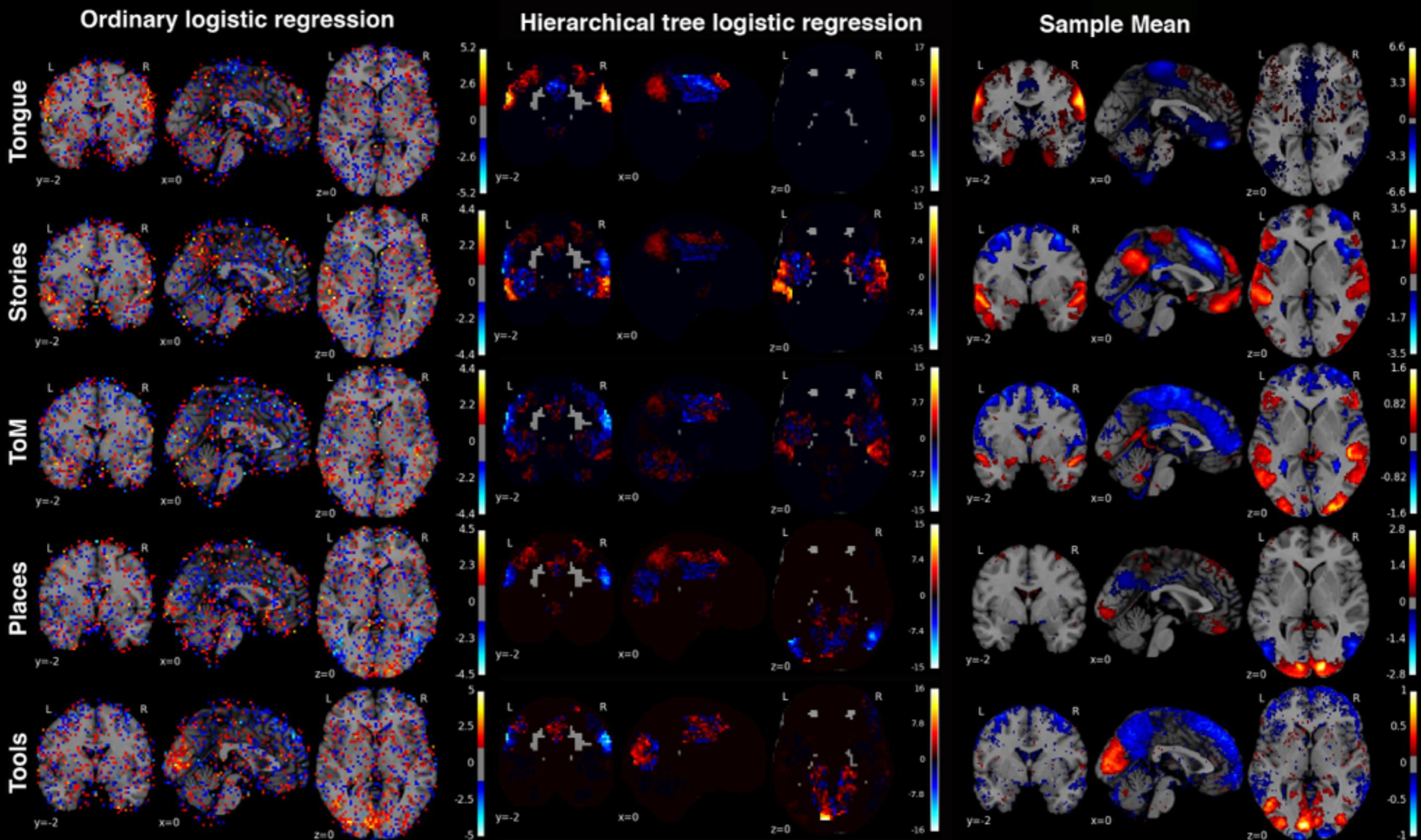
test-acc: 39,31%

Preliminary results: reg-net-ratio 1/500 / maxit100_dataratio100_lbd0.1



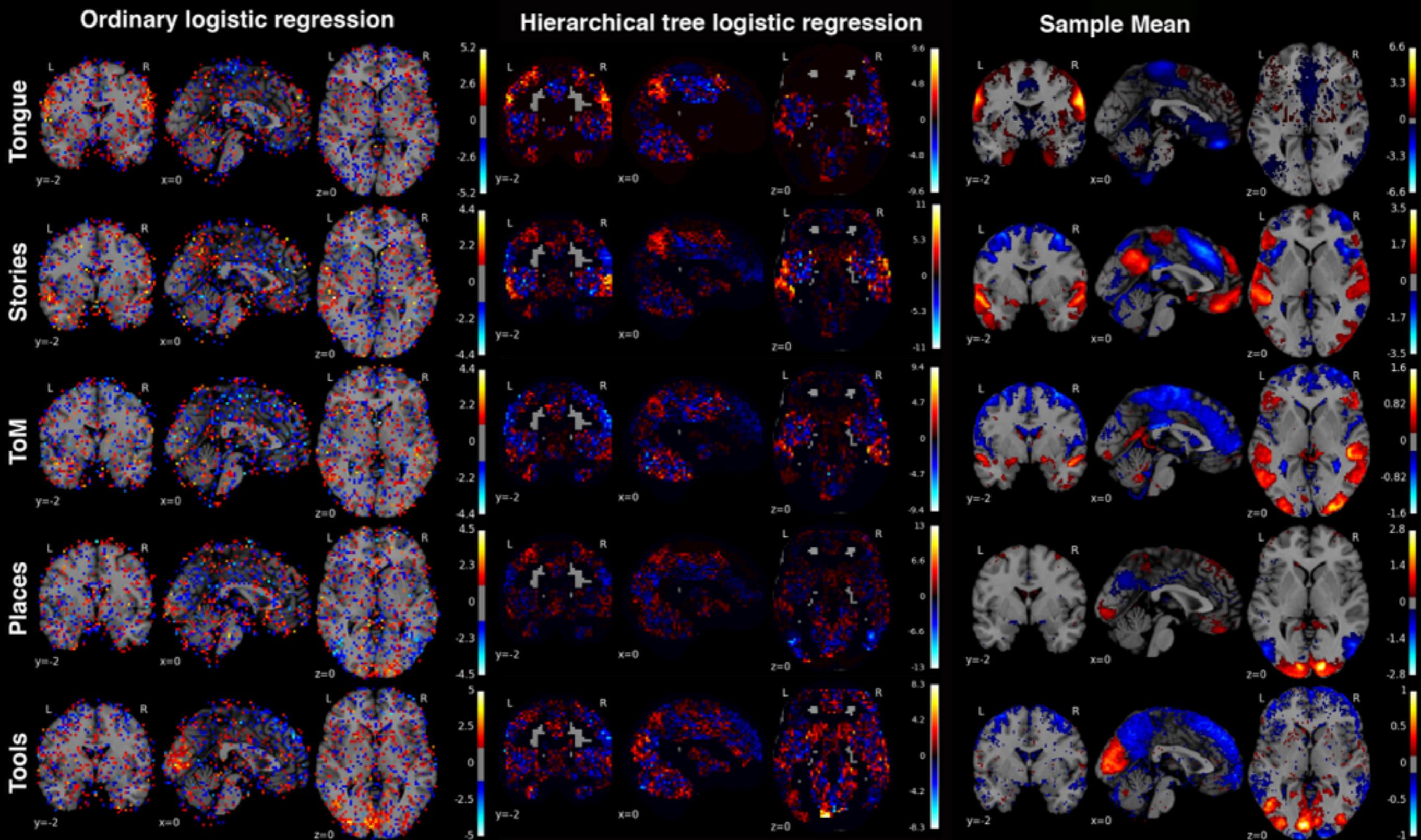
test-acc: 67,22%

Preliminary results: reg-net-ratio 1/250 / maxit100_dataratio100_lbd0.1



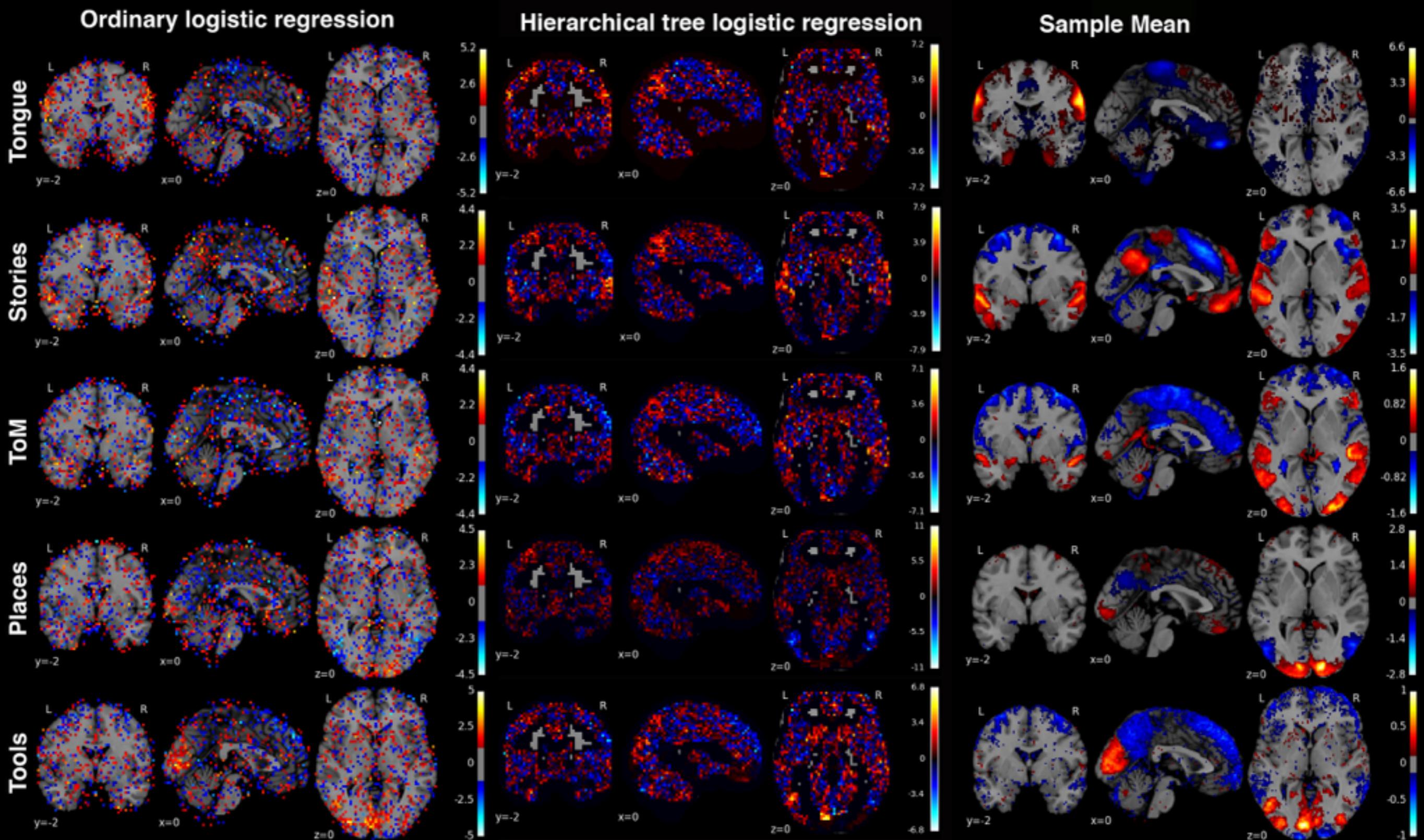
test-acc: 85,63%

Preliminary results: reg-net-ratio 1/100 / maxit100_dataratio100_lbd0.1



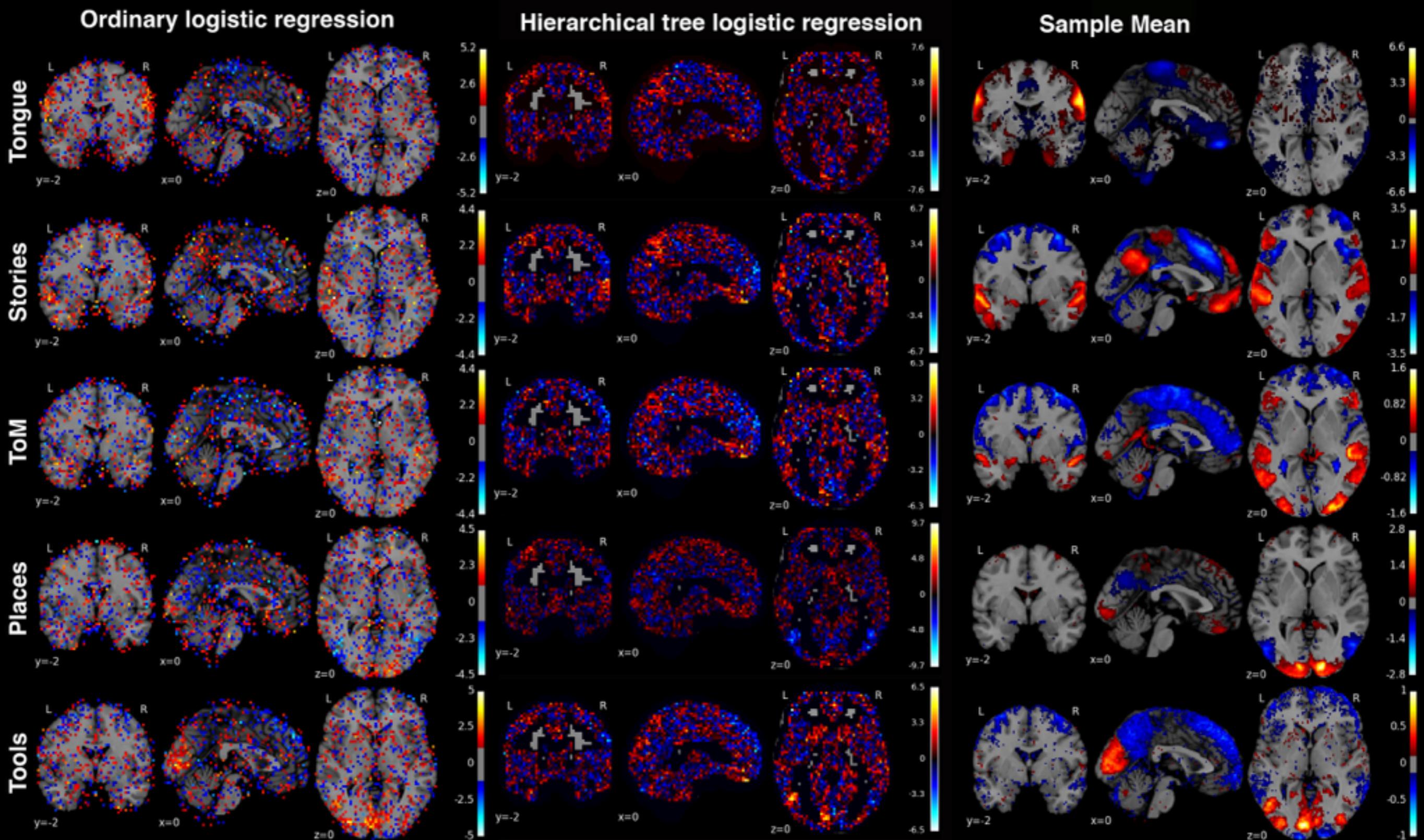
test-acc: 87,76%

Preliminary results: reg-net-ratio 1/50 / maxit100_dataratio100_lbd0.1



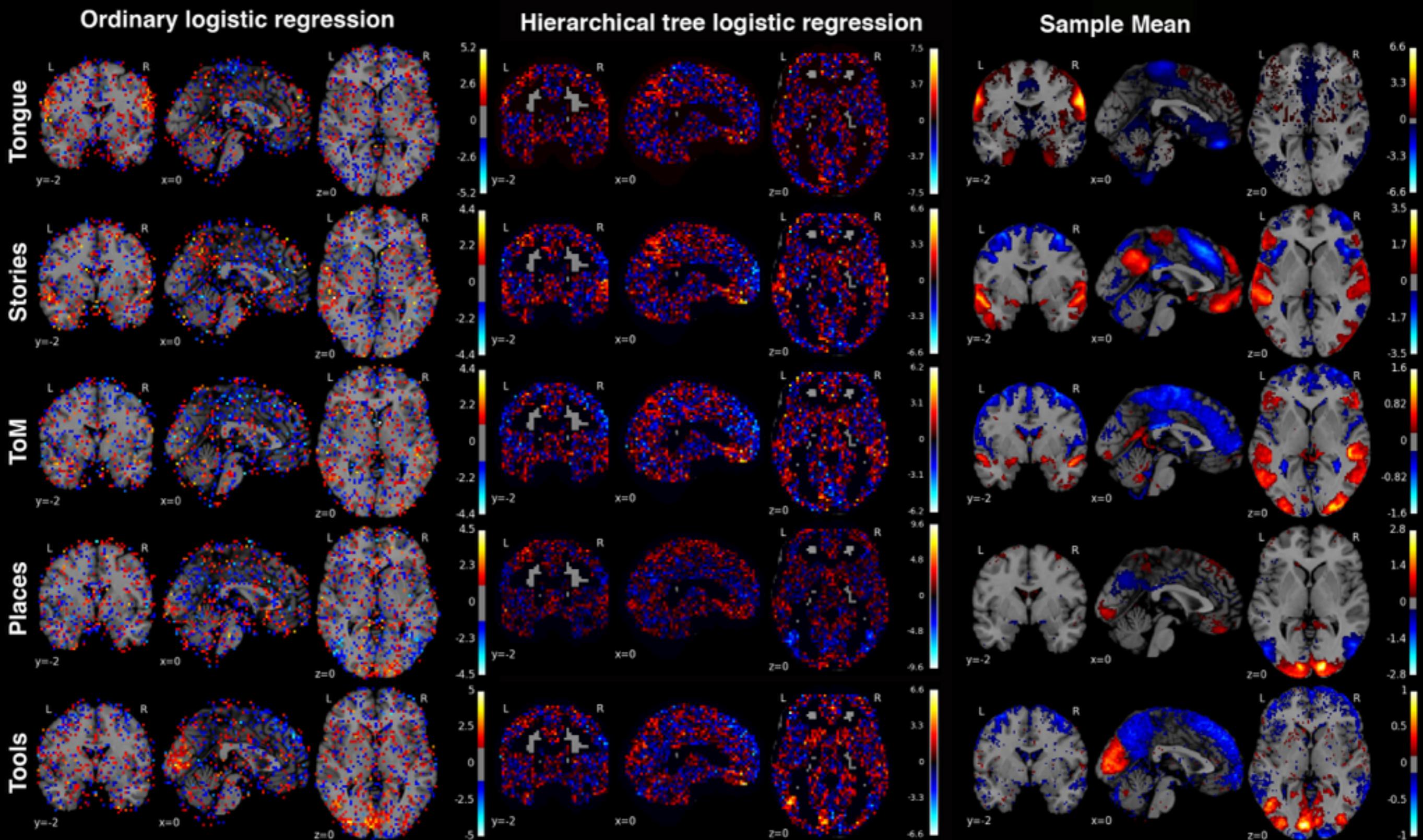
test-acc: 88,60%

Preliminary results: reg-net-ratio 1/10 / maxit100_dataratio100_lbd0.1



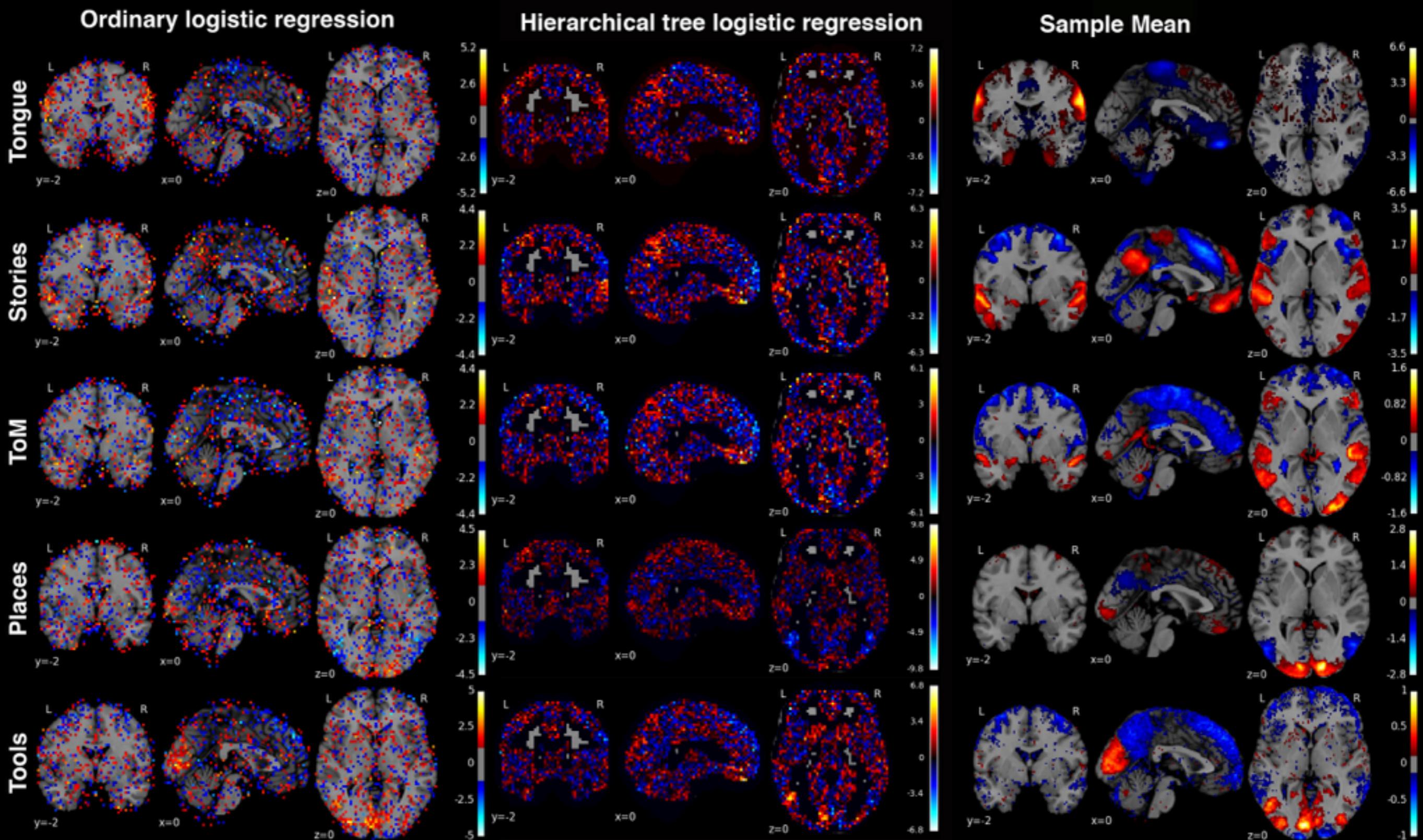
test-acc: 87,77%

Preliminary results: reg-net-ratio 1/5 / maxit100_dataratio100_lbd0.1



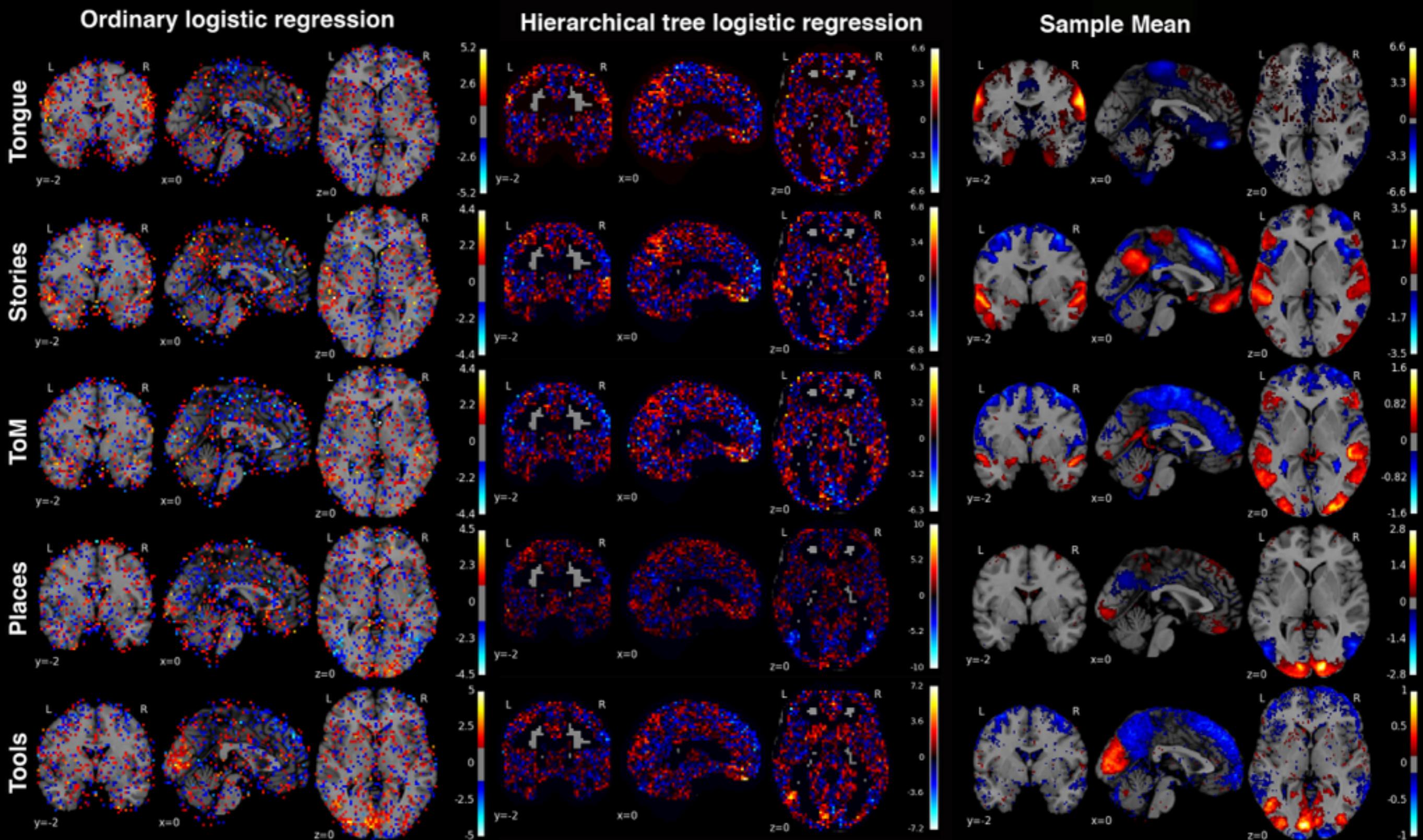
test-acc: 87,89%

Preliminary results: reg-net-ratio 1/2 / maxit100_dataratio100_lbd0.1



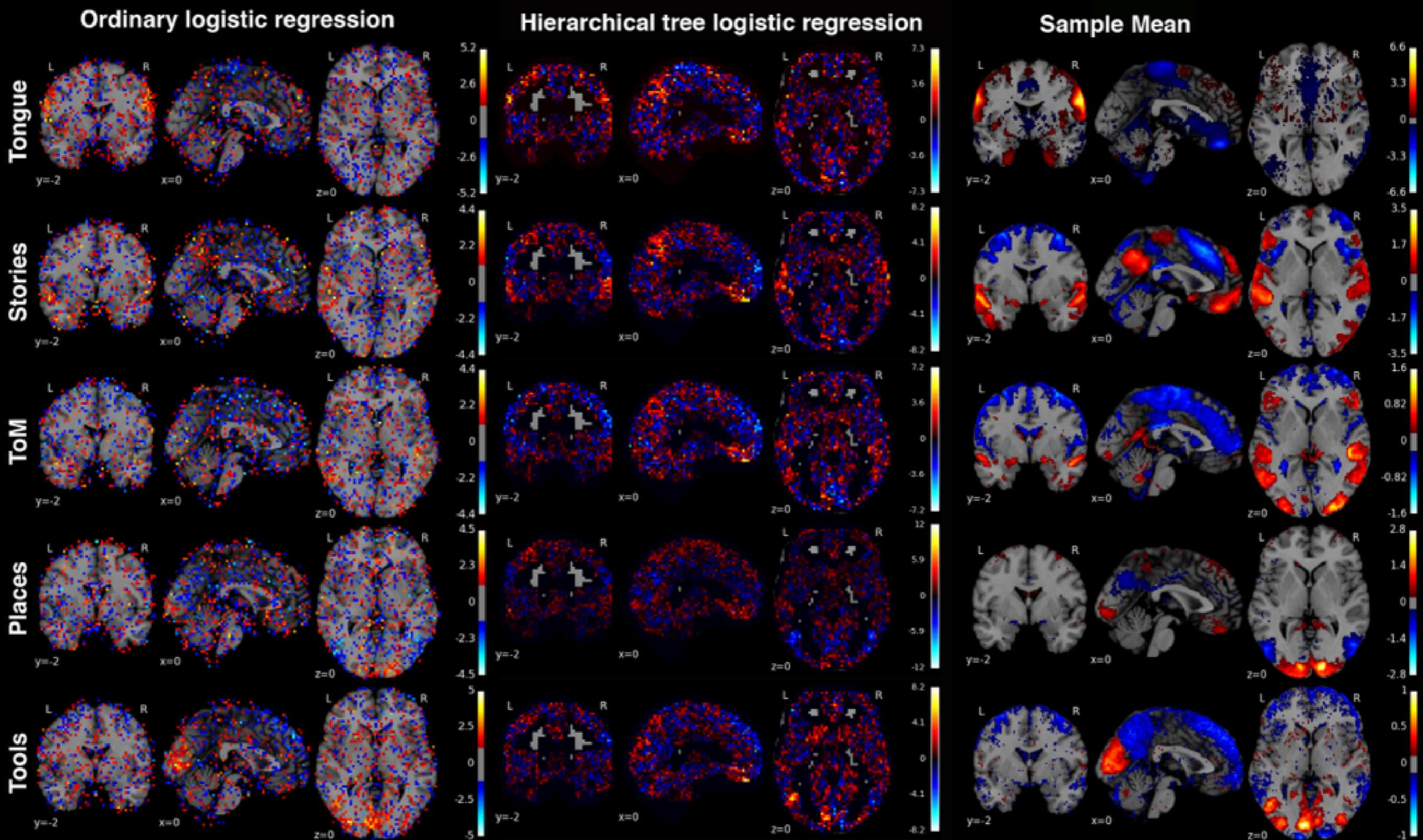
test-acc: 87,89%

Preliminary results: reg-net-ratio 1 / maxit100_dataratio100_lbd0.1



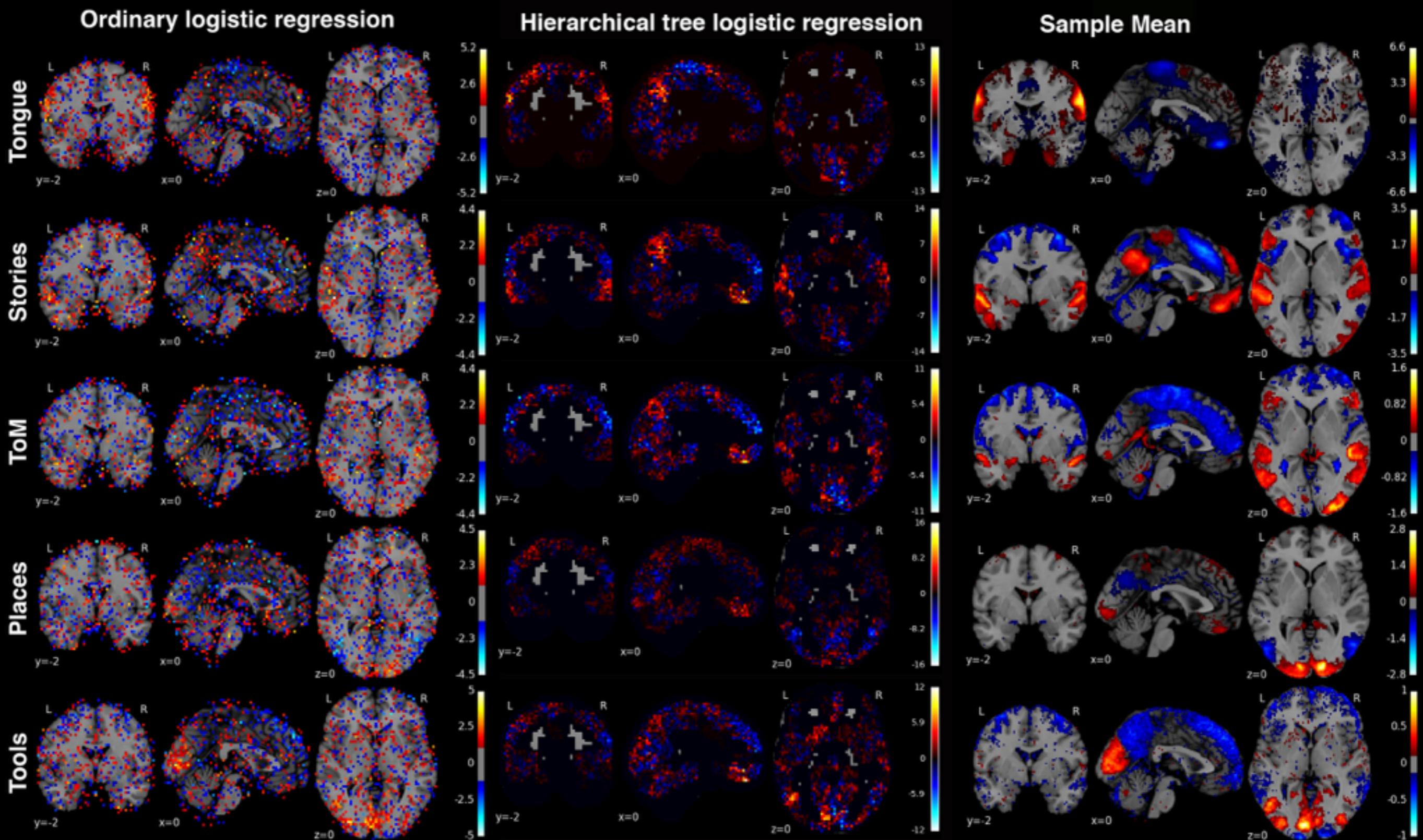
test-acc: 87,89%

Preliminary results: reg-net-ratio 2 / maxit100_dataratio100_lbd0.1



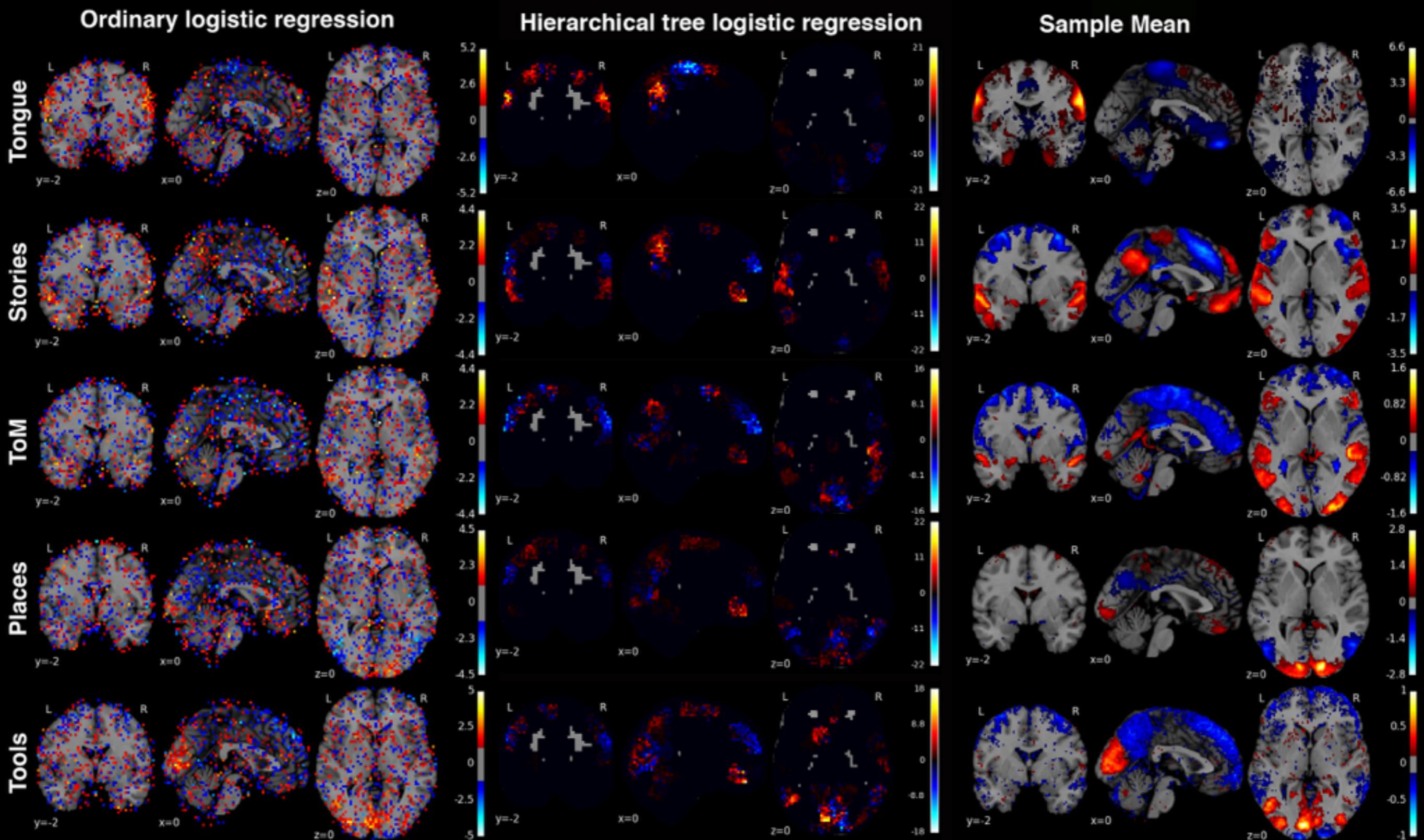
test-acc: 88,48%

Preliminary results: reg-net-ratio 5 / maxit100_dataratio100_lbd0.1



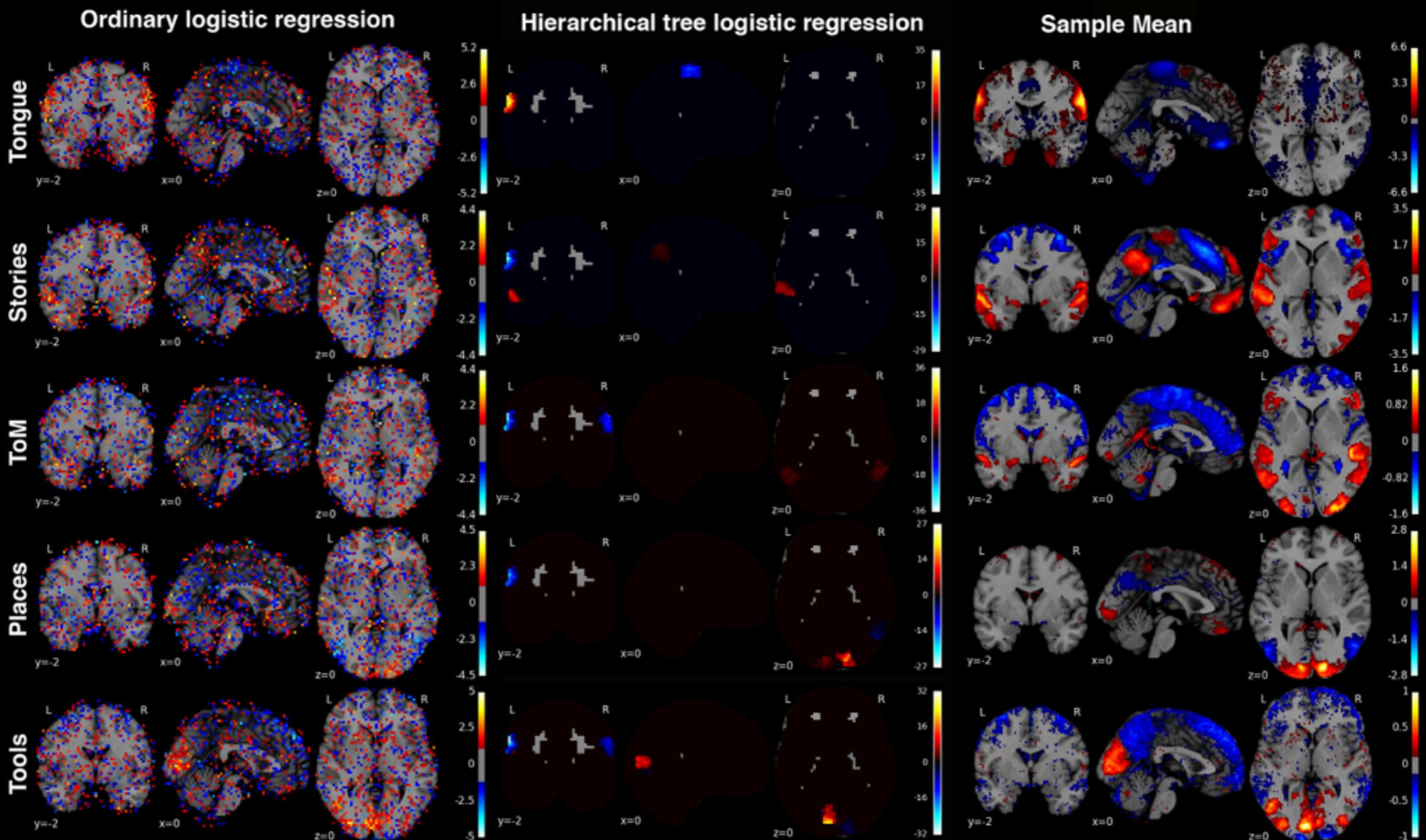
test-acc: 89,90%

Preliminary results: reg-net-ratio 10 / maxit100_dataratio100_lbd0.1



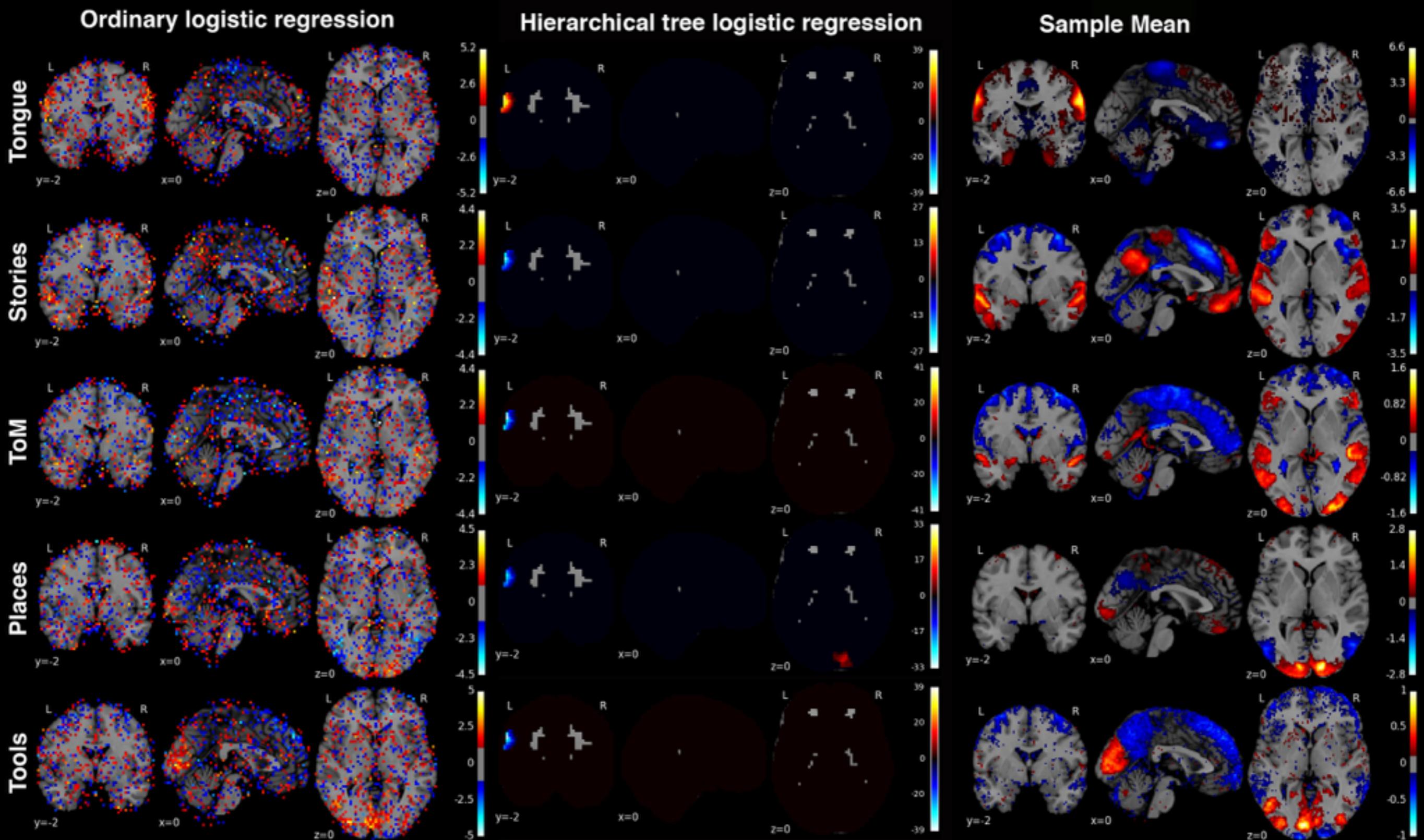
test-acc: 89,90%

Preliminary results: reg-net-ratio 50 / maxit100_dataratio100_lbd0.1



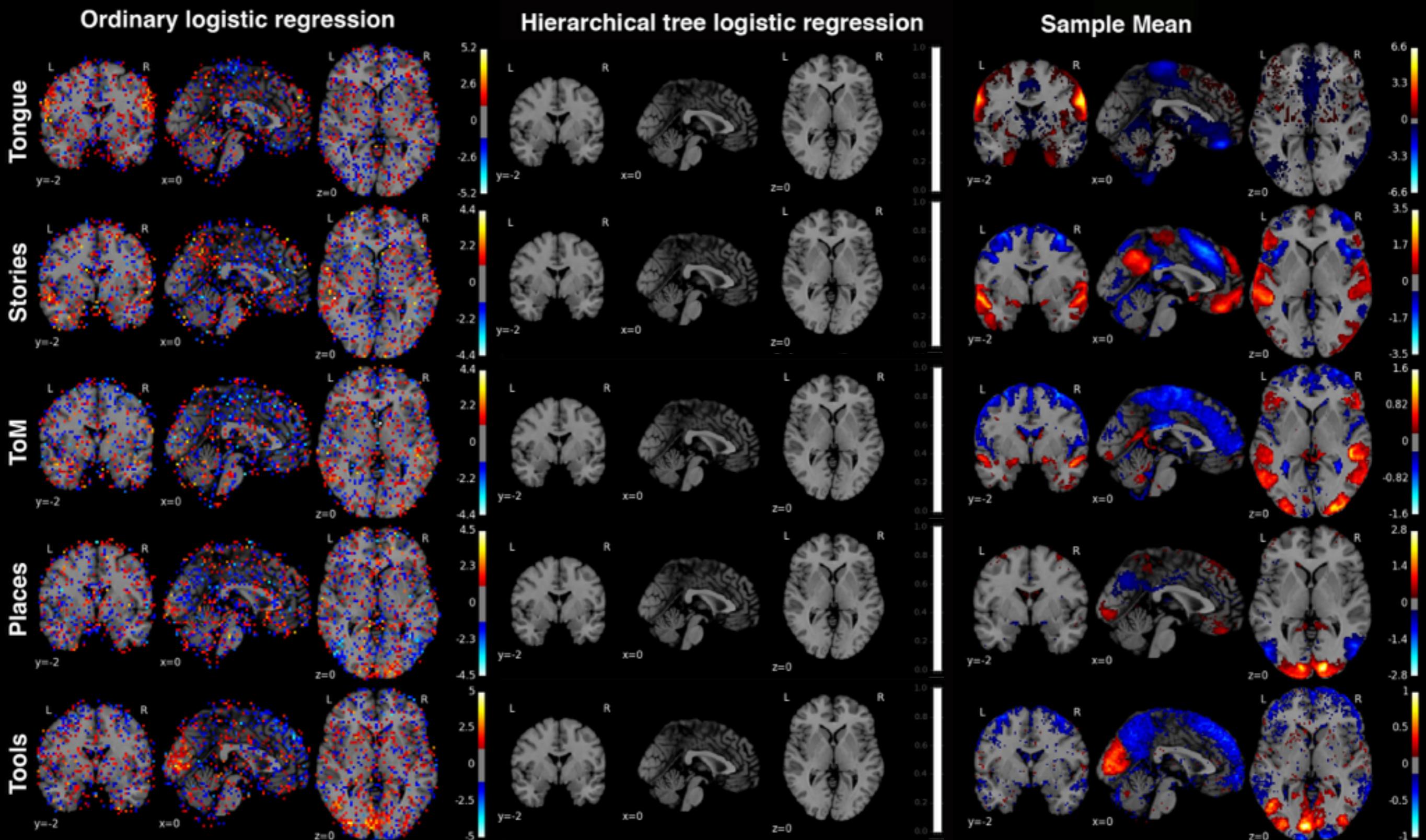
test-acc: 63,66%

Preliminary results: reg-net-ratio 100 / maxit100_dataratio100_lbd0.1



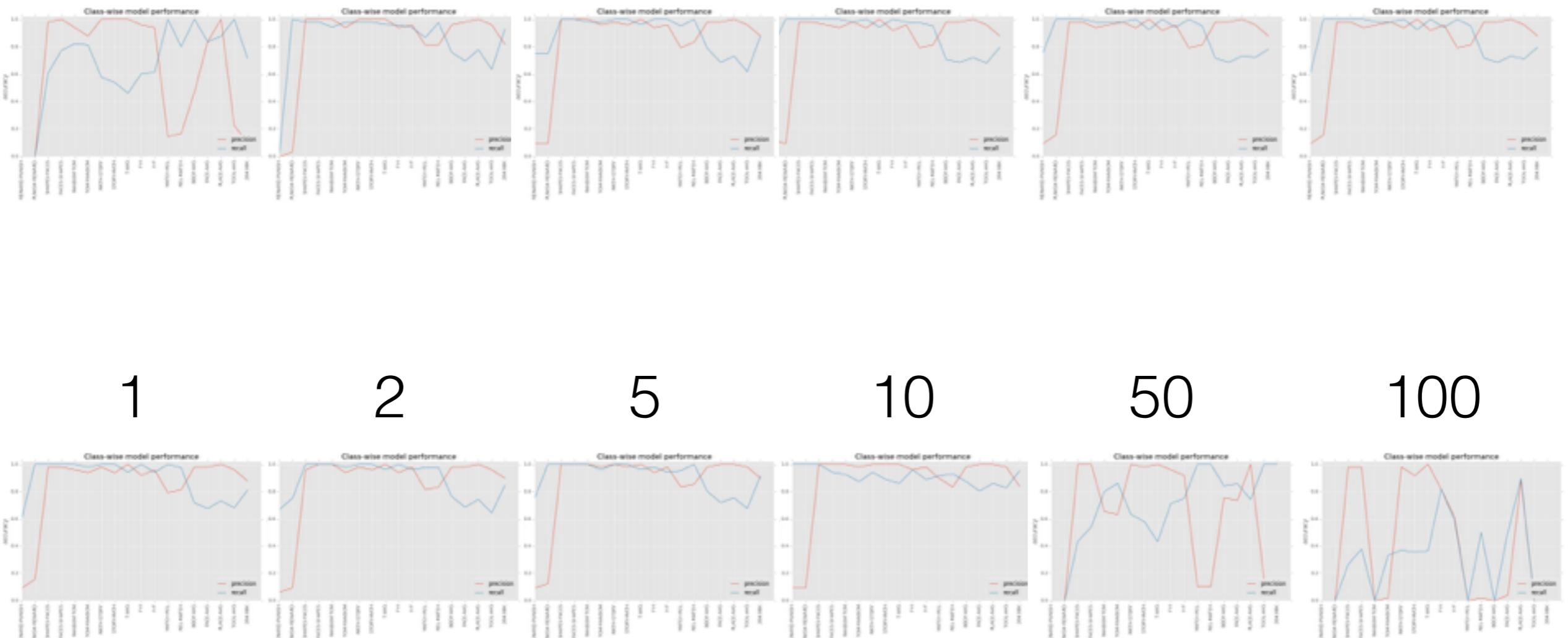
test-acc: 41,68%

Preliminary results: reg-net-ratio 500 / maxit100_dataratio100_lbd0.1



test-acc: 3,8%

0.02 0.01 0.02 0.1 0.2 0.5



- weight-increase/decrease across grid depends on task-level
- abc

