From data to RDMs

Practical demonstration

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Do it yourself: 5 steps

Step 1: preprocess data

Step 2: estimate single-subject activity patterns

Step 3: select voxels

Step 4: compute the distance Matrix

Step 5: statistical inference

Do it yourself: 5 steps

Step 1: preprocess data

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Step 1: preprocess

For each run:
- slice-scan-time correction
- motion-correction

Optional:
- normalisation to template (if random-effects searchlight analysis across subjects)
- spatial smoothing (to increase signal, sensitive to larger-scale spatial patterns)

Do it yourself: six steps

Step 1: preprocess

Step 2: estimate single-subject activity patterns

Step 3: select voxels

Step 4: train the classifier

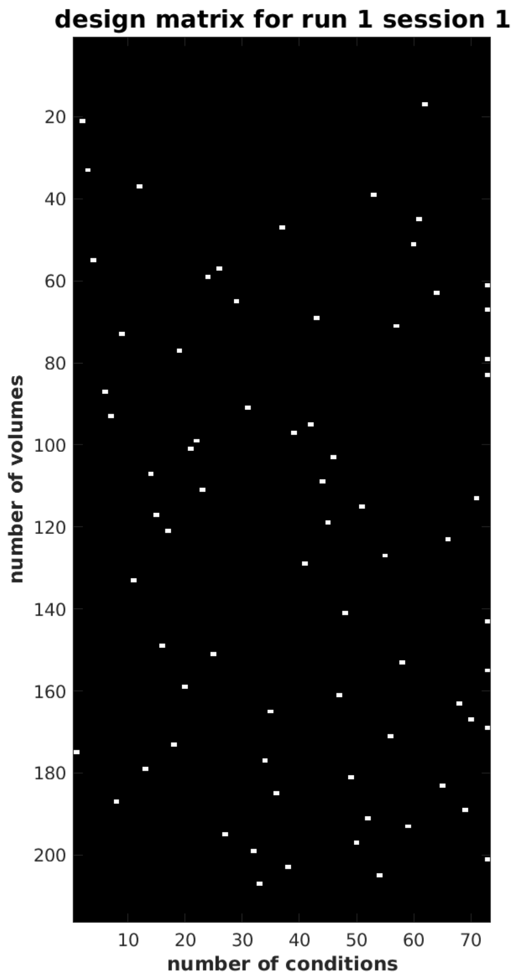
Step 5: test the classifier

Step 6: statistical inference

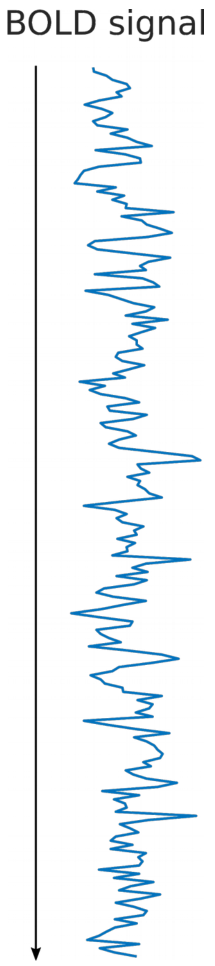
Step 2: estimate single-subject activity patterns

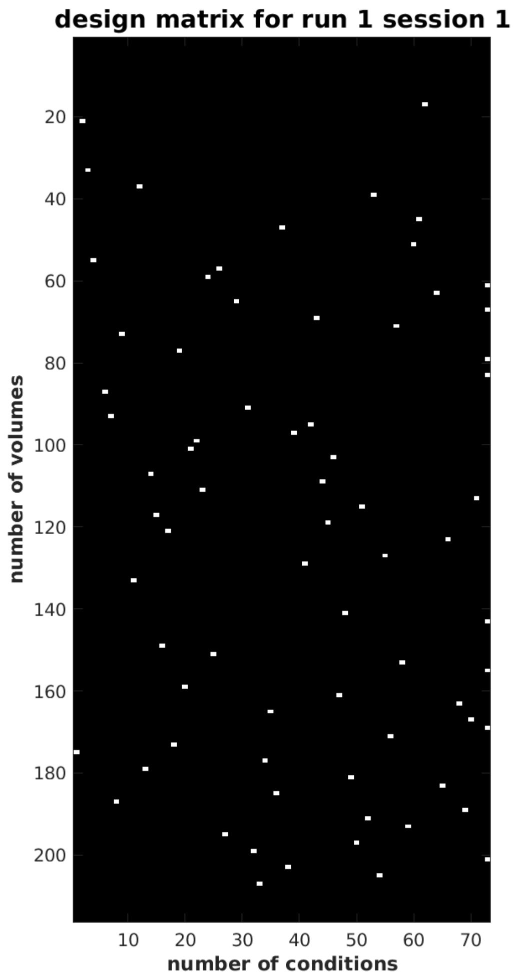
data

GLMdenoise

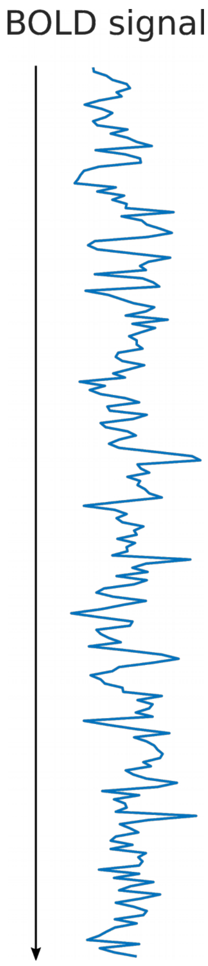

design matrix for run 1 session 1
number of volumes
20
40
60
80
100
120
140
160
180
200
10
20
30
40
50
60
70
number of conditions

GLMdenoise

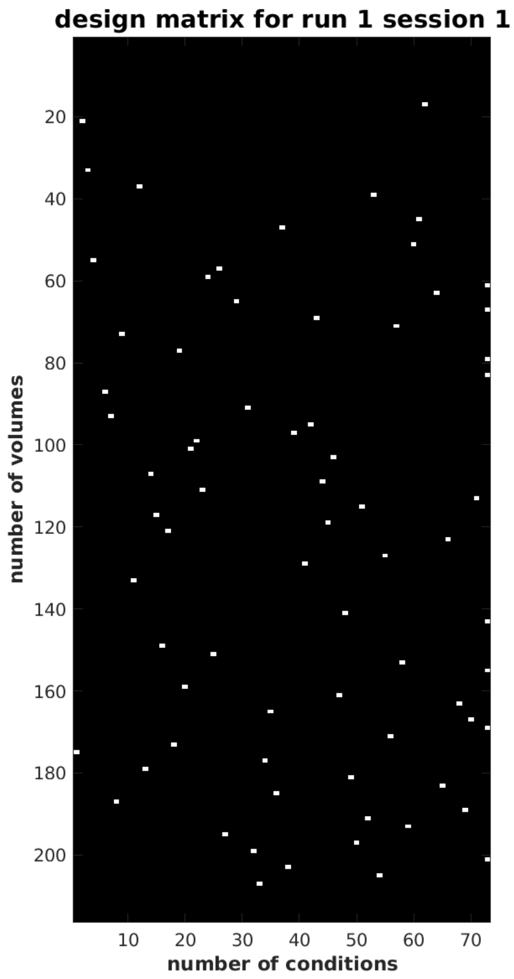

BOLD signal


design matrix for run 1 session 1
number of volumes
20
40
60
80
100
120
140
160
180
200
10
20
30
40
50
60
70
number of conditions

GLMdenoise

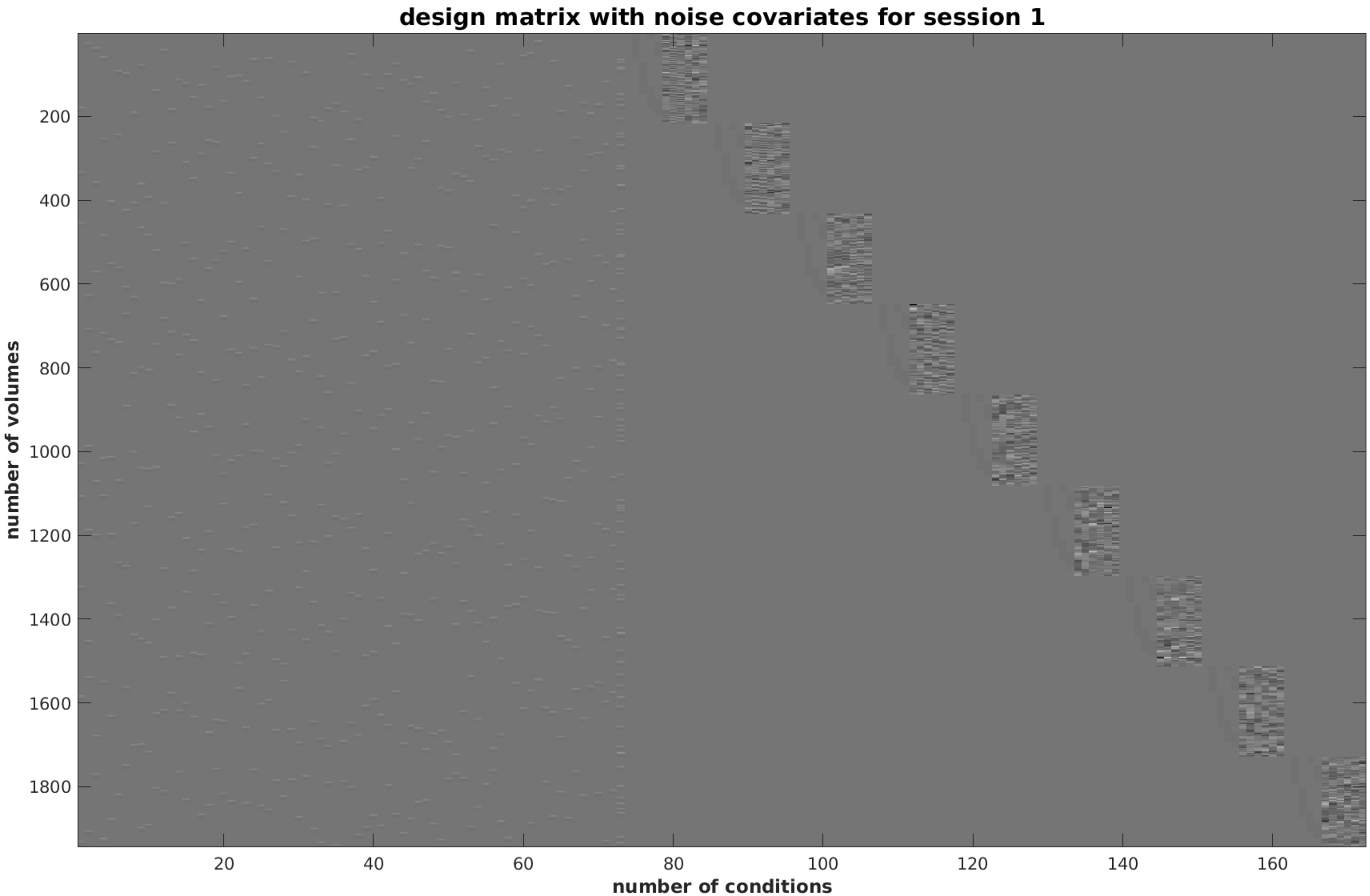


$= \beta *$

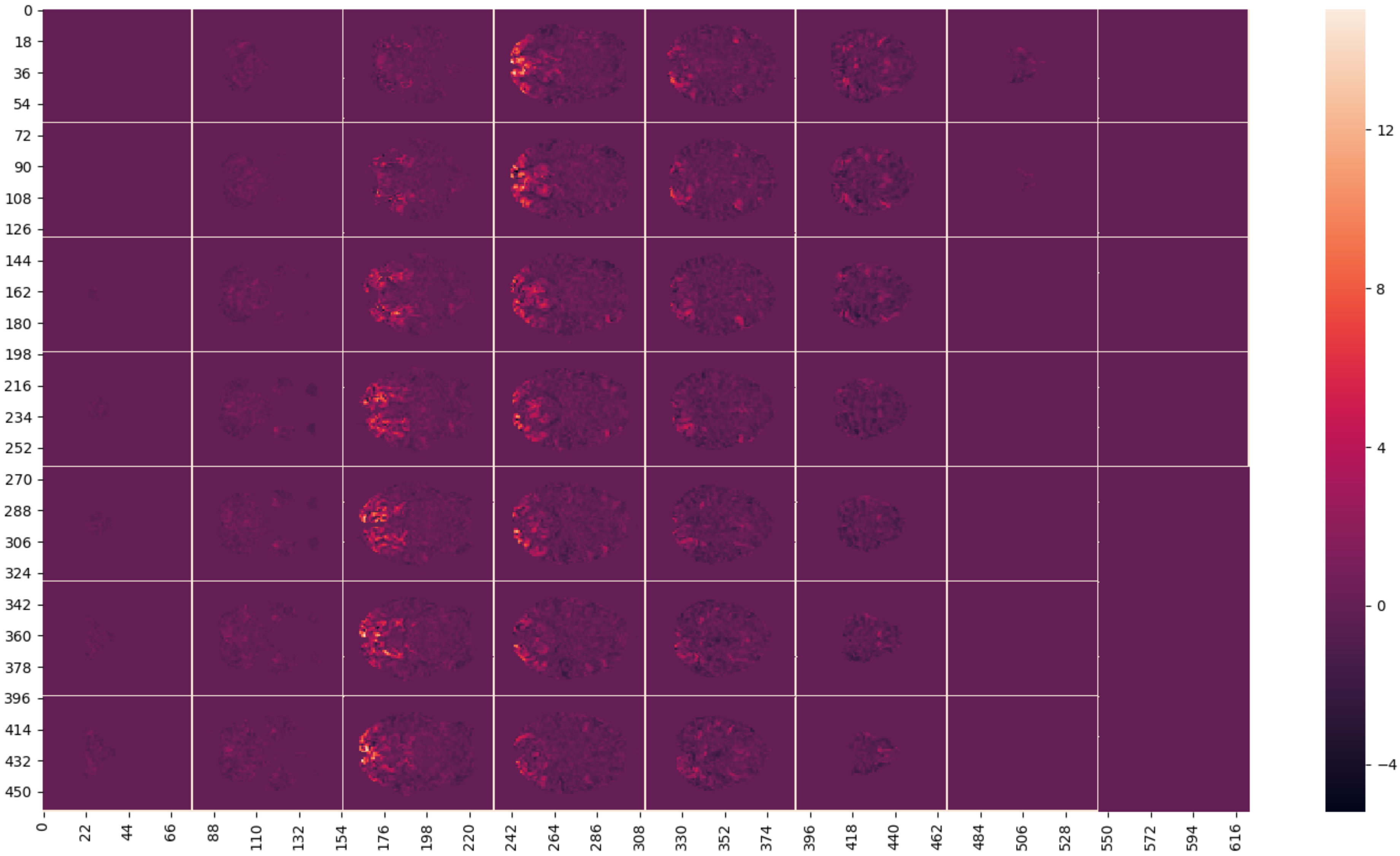


ε

GLMdenoise


design matrix with noise covariates for session 1
number of volumes
200
400
600
800
1000
1200
1400
1600
1800
20
40
60
80
100
120
140
160
number of conditions

GLMdenoise



0
18
36
54
72
90
108
126
144
162
180
198
216
234
252
270
288
306
324
342
360
378
396
414
432
450
0
22
44
66
88
110
132
154
176
198
220
242
264
286
308
330
352
374
396
418
440
462
484
506
528
550
572
594
616
12
8
4
0
−4

Do it yourself: six steps

Step 1: preprocess and split data

Step 2: estimate single-subject activity patterns

Step 3: select voxels

Step 4: compute the distance Matrix

Step 5: statistical inference

Step 3: select voxels

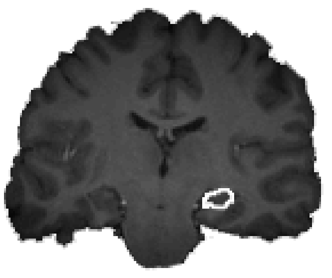
Most common ways of voxel selection:

- structural selection (anatomy)
- functional selection (activity)
    - univariate (activation differences)
    - multivariate (pattern differences)
- geometrical selection
    - multivoxel searchlight

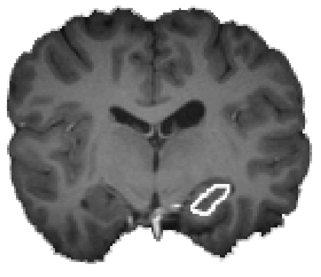
Make sure that voxel selection is based on data independent from test data set.

Step 3: select voxels

anatomy



subject 1



subject 2

•

•

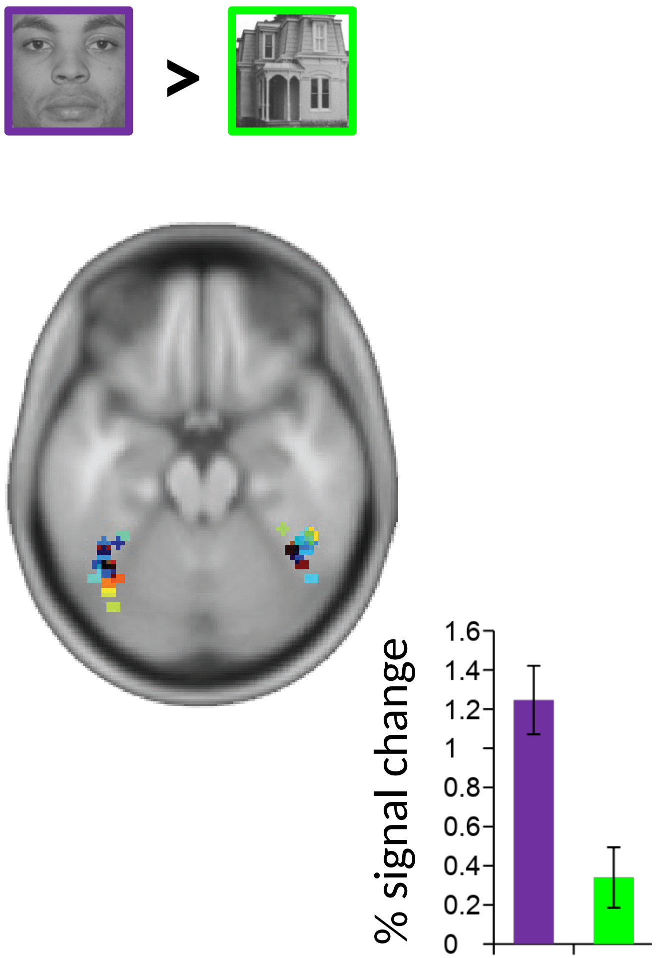
• subject n

For example: hippocampus

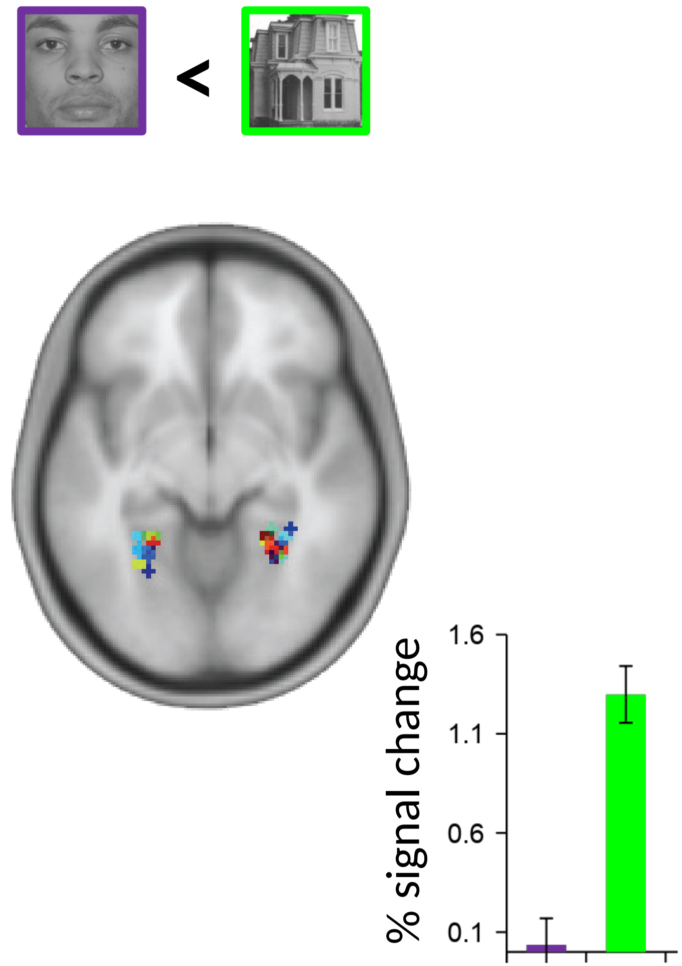
Step 3: select voxels

function (activation differences)

FFA

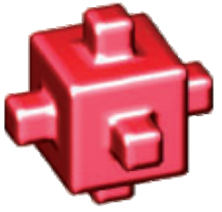


PPA



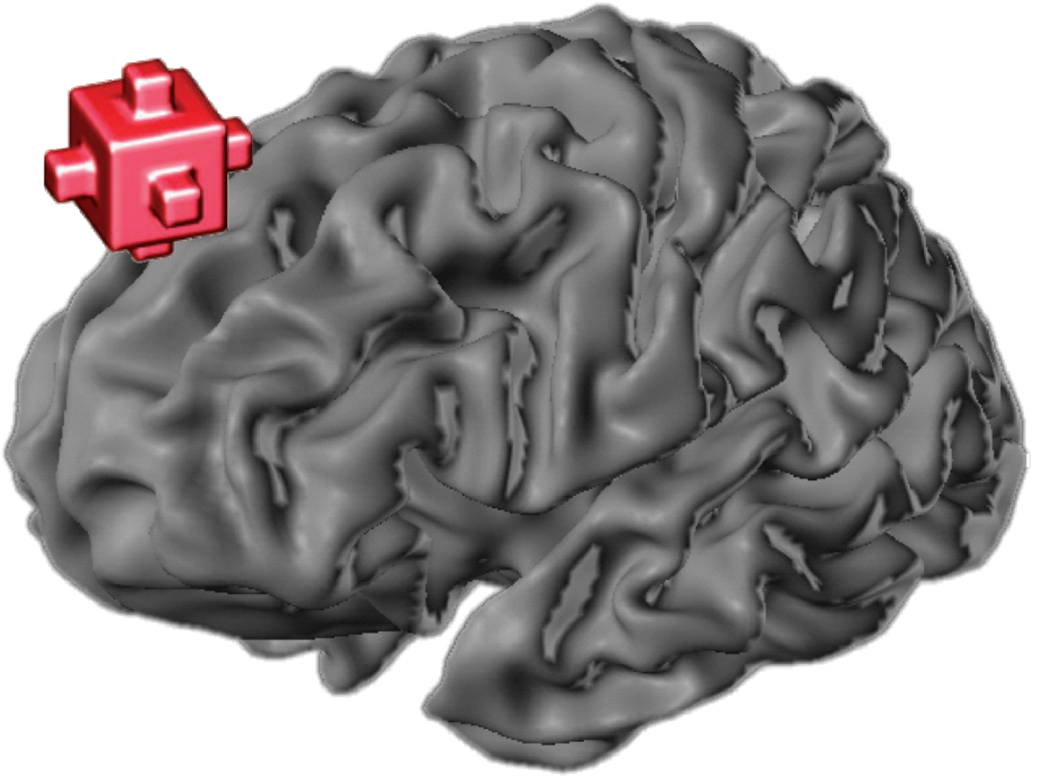
Step 3: select voxels

multivoxel searchlight



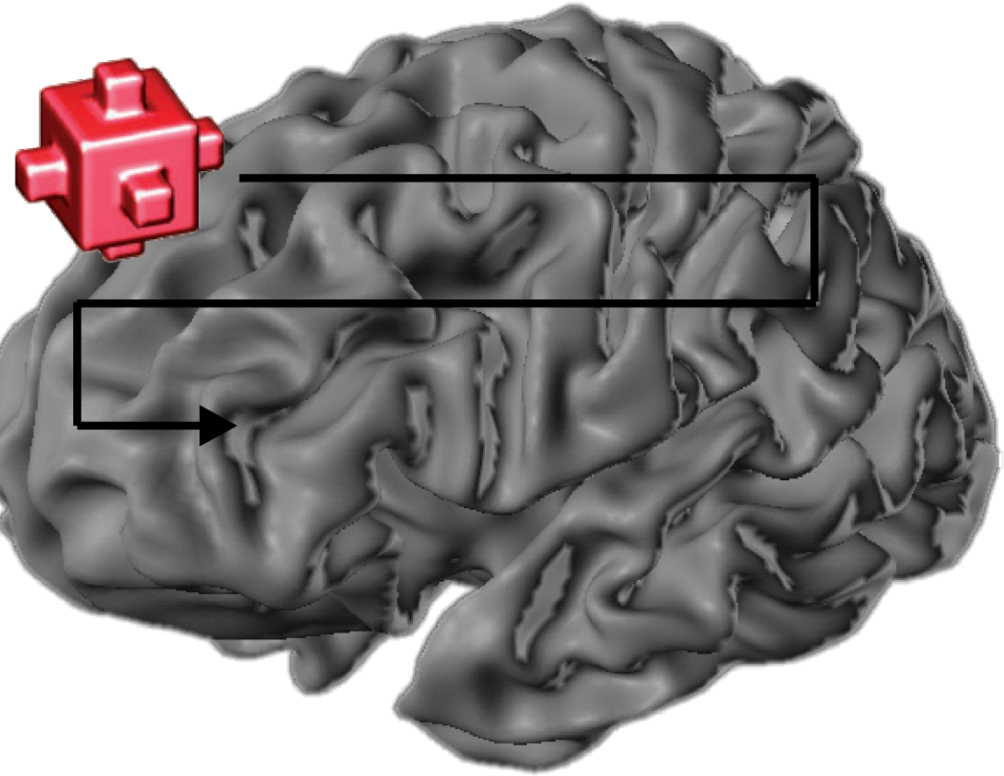
Step 3: select voxels

multivoxel searchlight



Step 3: select voxels

multivoxel searchlight



Kriegeskorte et al. 2006

Step 3: select voxels

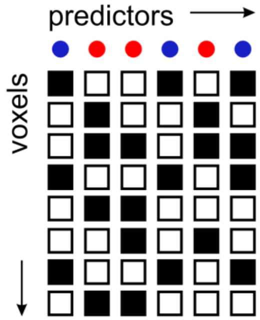
How many voxels?
Depends on the expected spatial extent of effects.

Find the right balance:
too few → risk of missing signal
too many → risk of overfitting (too noisy)

Common practice: select the same number of voxels in each subject.

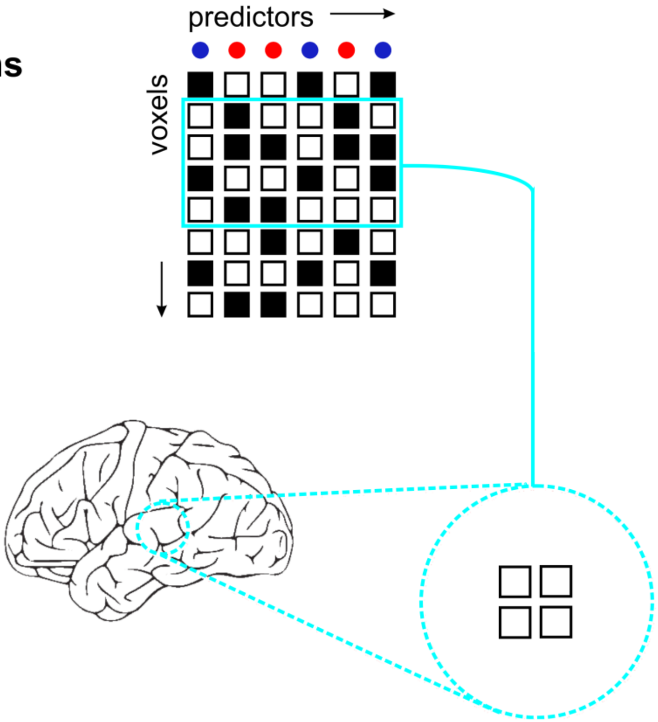
Step 3: select voxels

single-subject
activity patterns
(whole-brain)

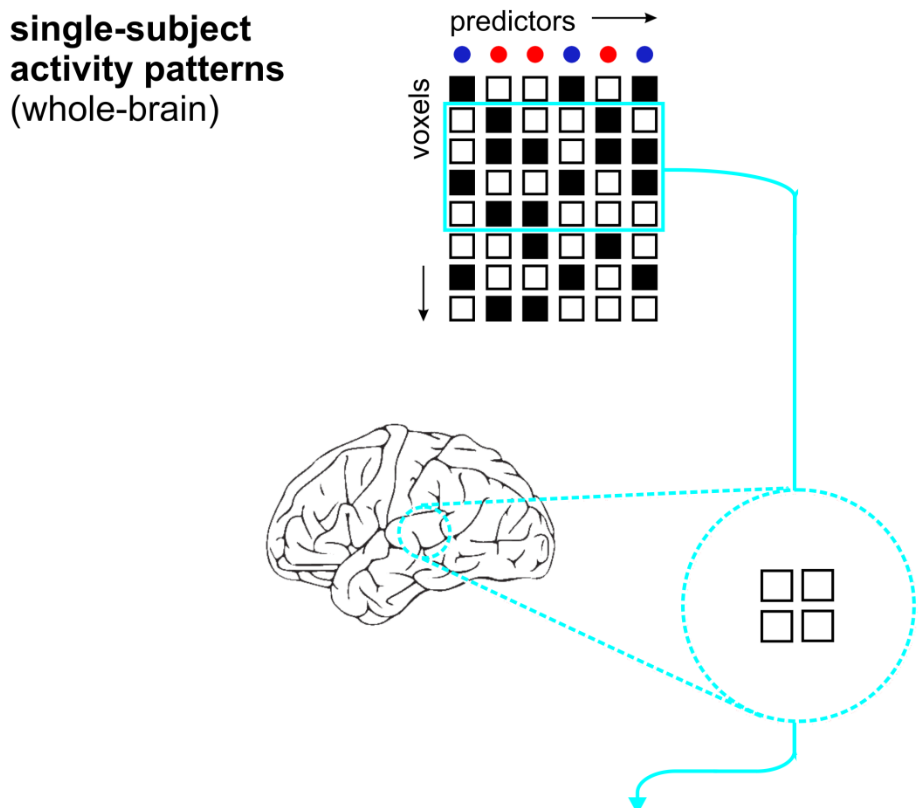


Step 3: select voxels

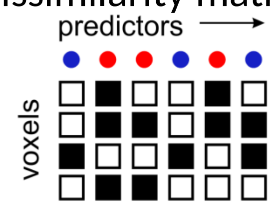
single-subject activity patterns
(whole-brain)

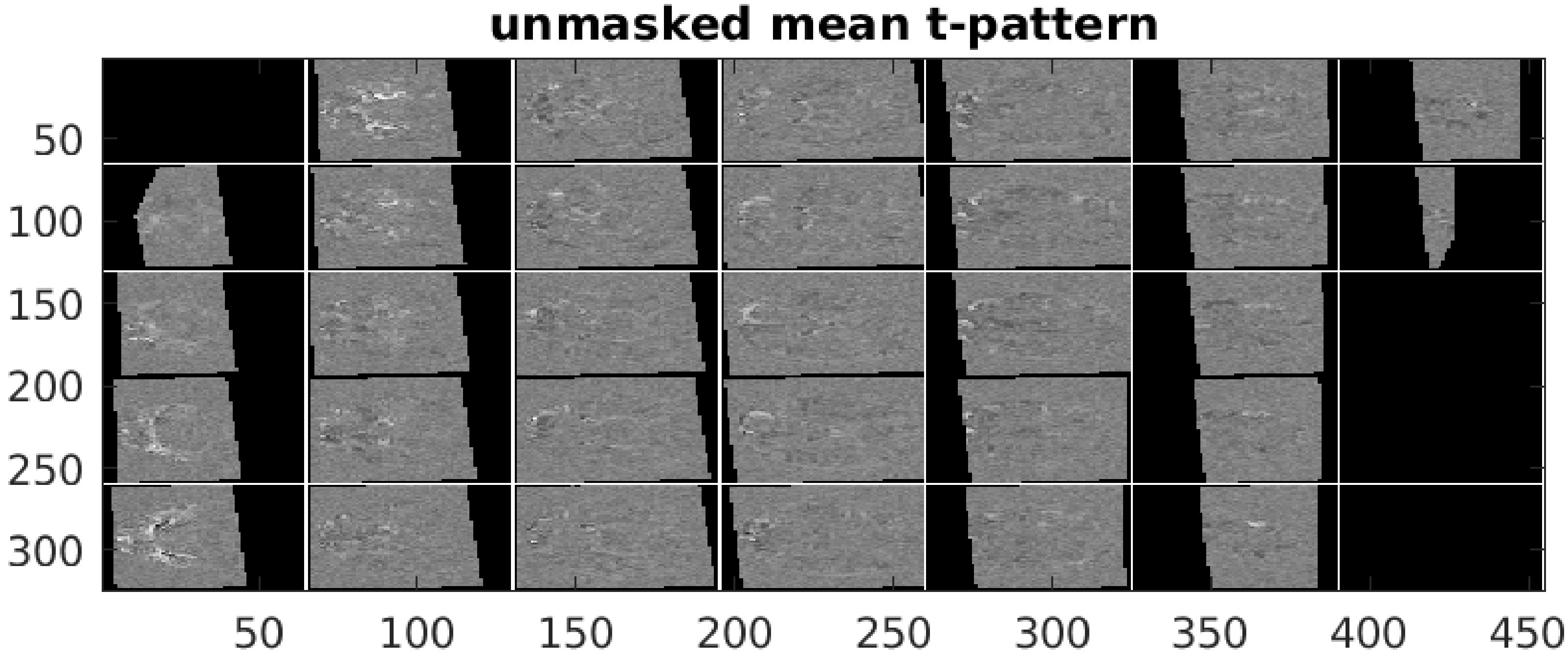


Step 3: select voxels

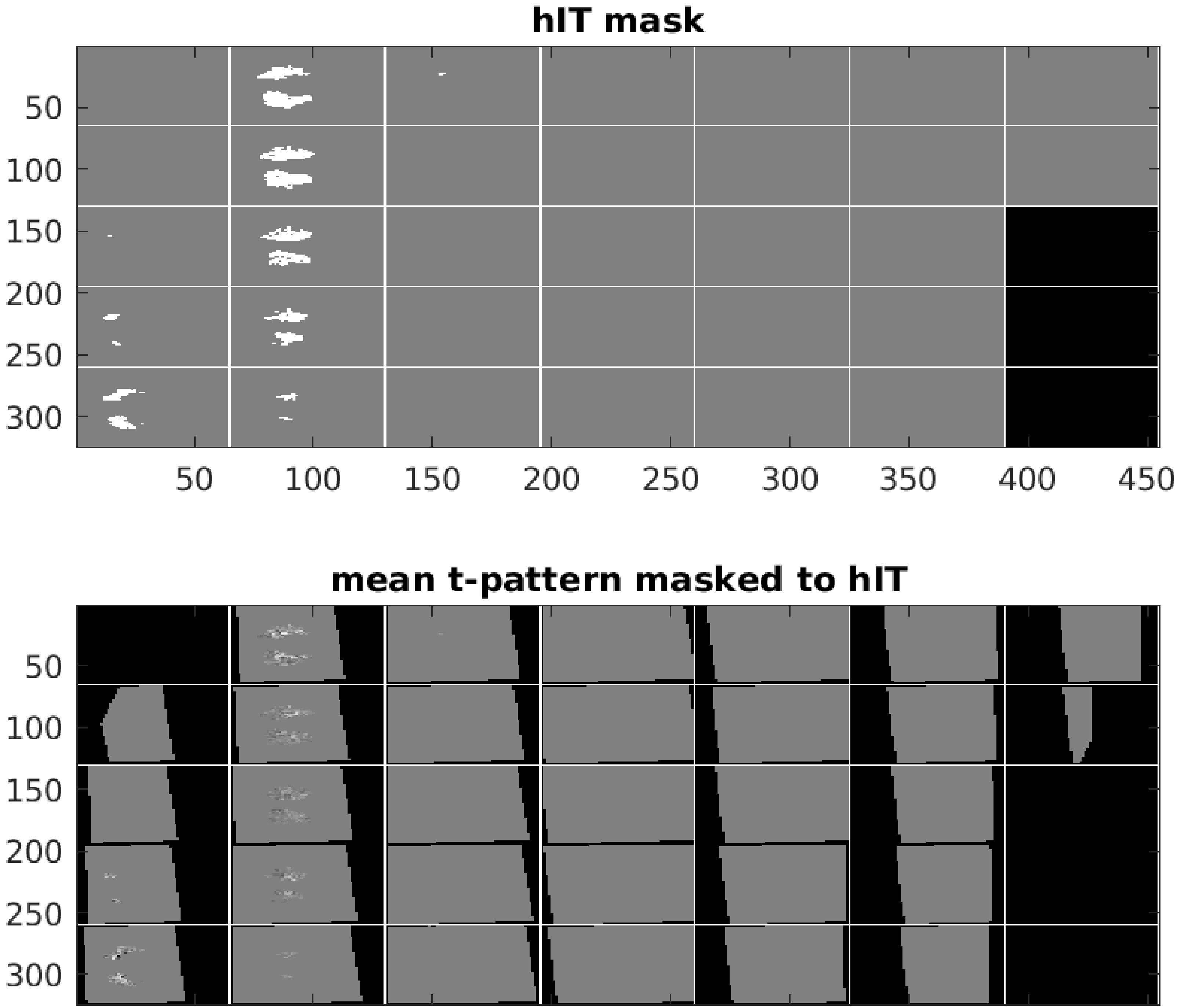


patterns for computing
dissimilarity matrix

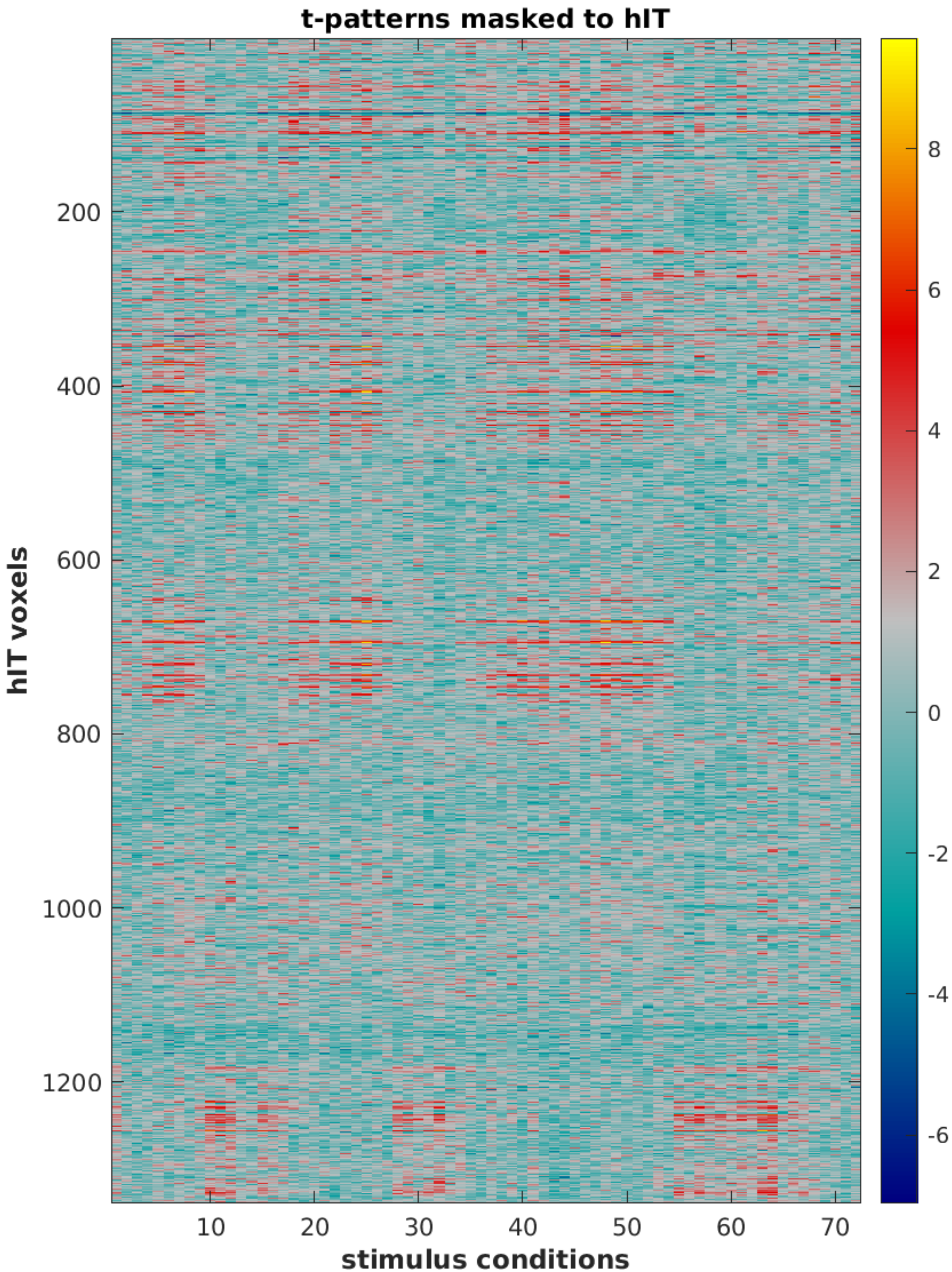




unmasked mean t-pattern
50
100
150
200
250
300
50
100
150
200
250
300
350
400
450



hIT mask
50
100
150
200
250
300
50
100
150
200
250
300
350
400
450
mean t-pattern masked to hIT
50
100
150
200
250
300


t-patterns masked to hIT
hIT voxels
200
400
600
800
1000
1200
10
20
30
40
50
60
70
stimulus conditions
8
6
4
2
0
-2
-4
-6

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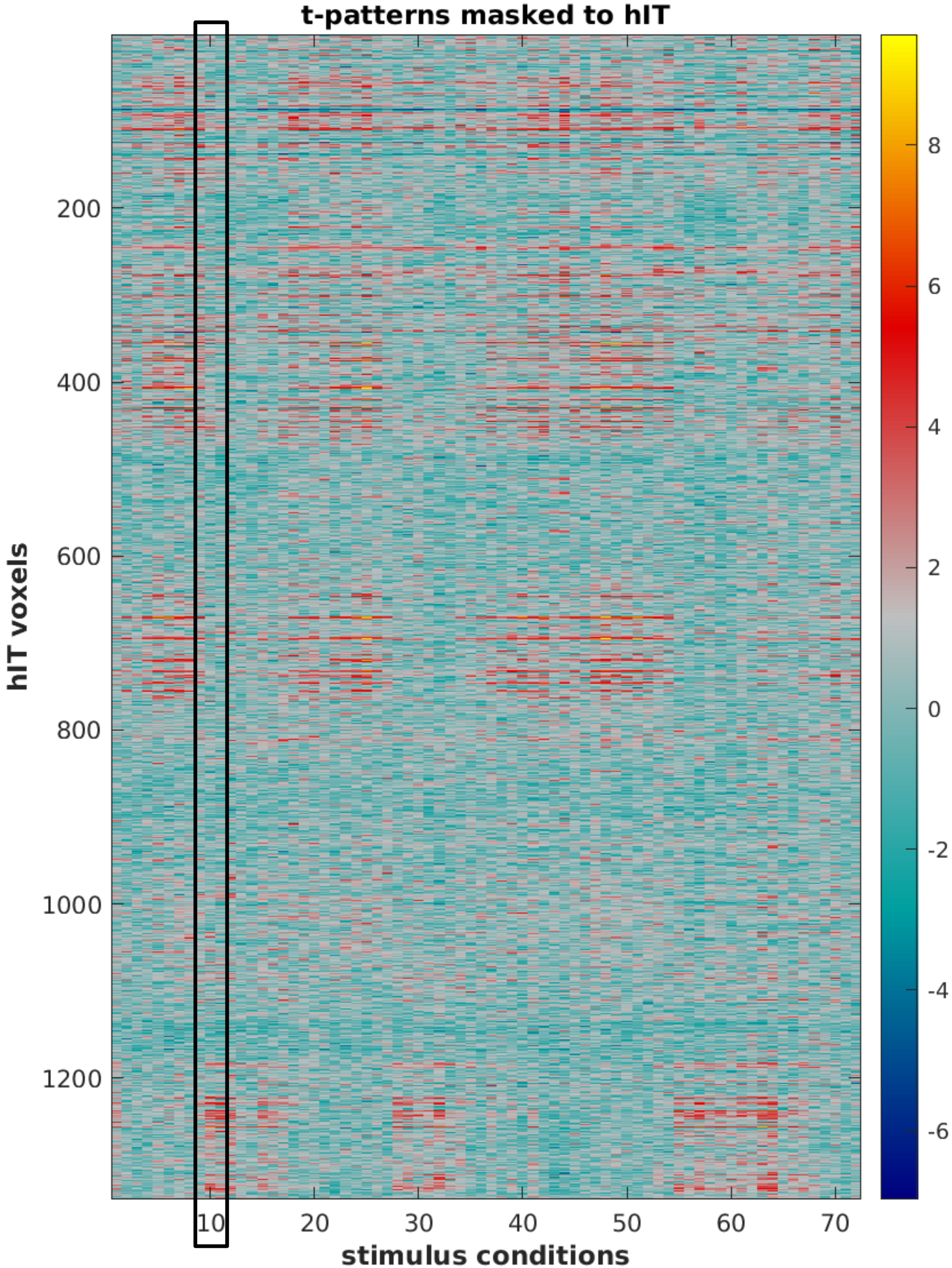
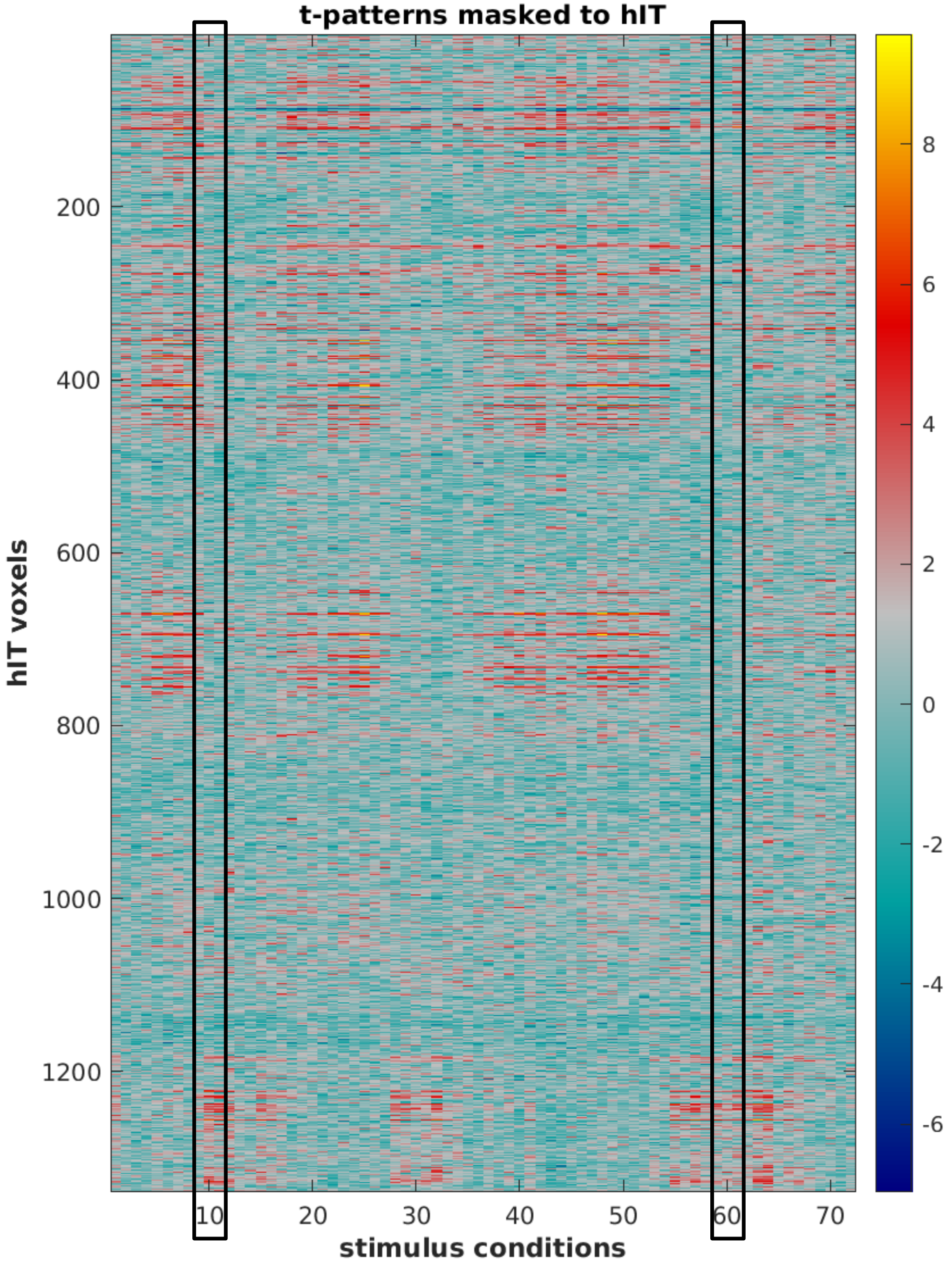
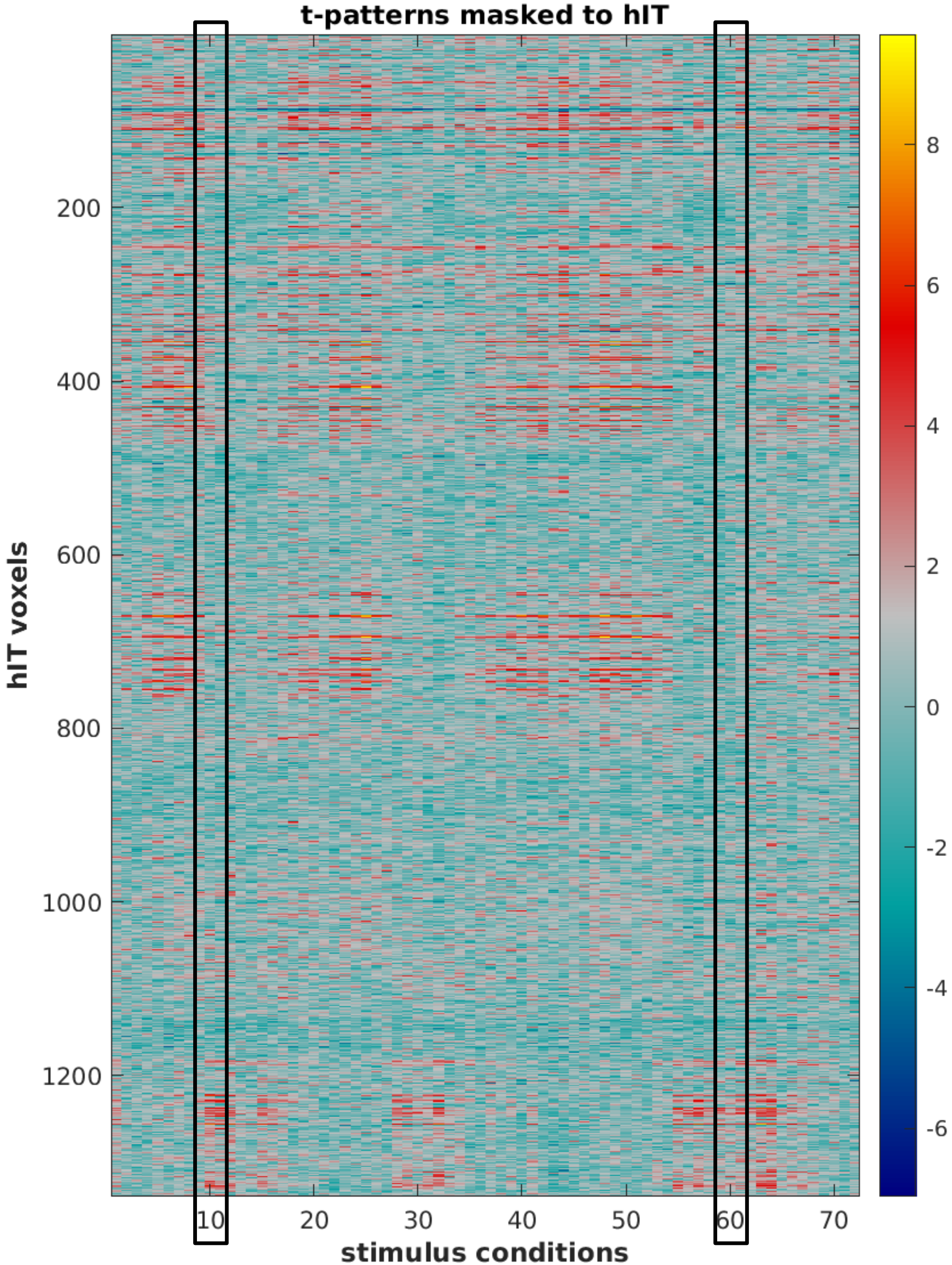


Extract a condition pattern vector

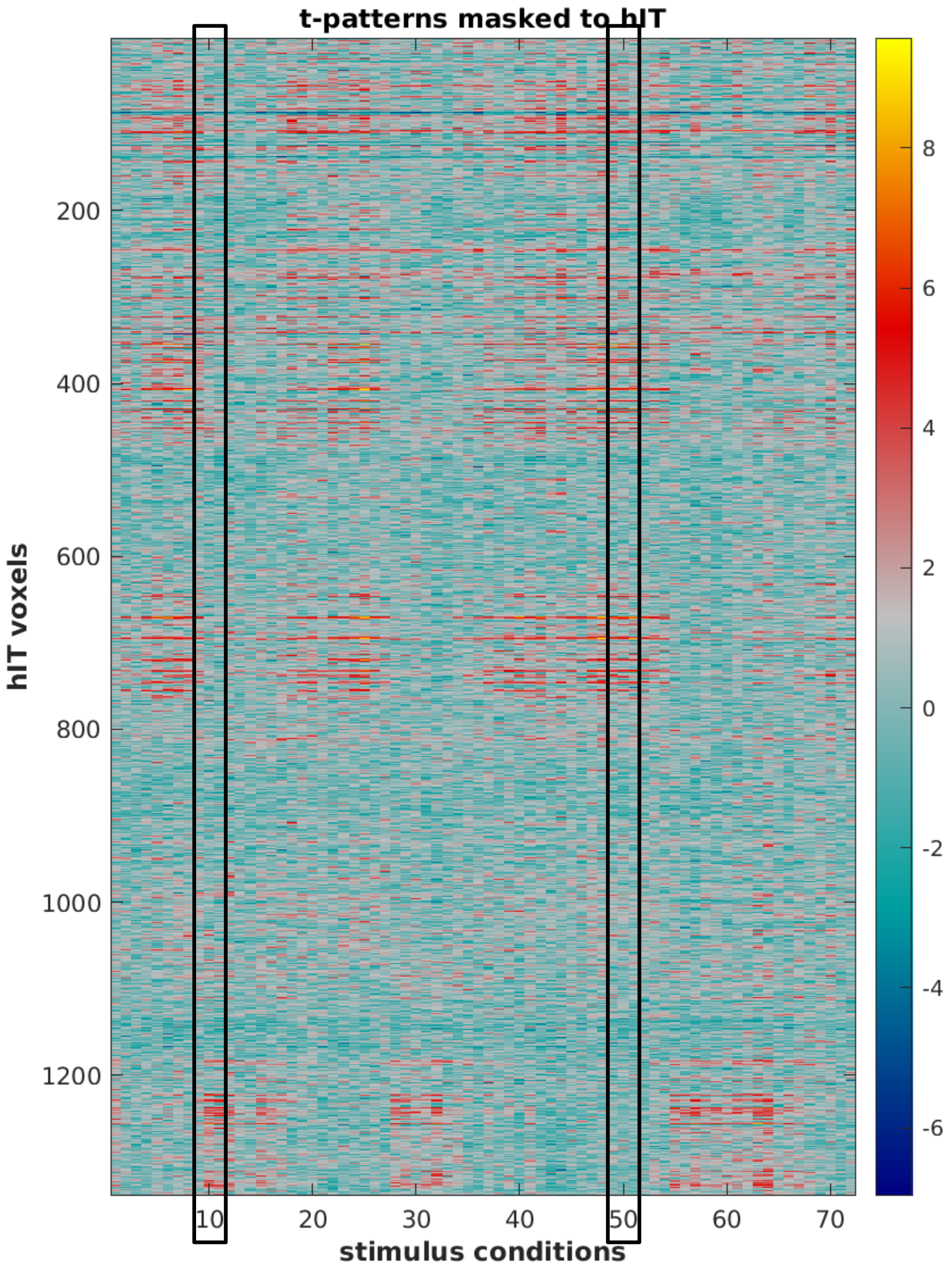


Extract a pair of condition pattern vectors



Extract a pair of condition pattern vectors

Compute their distance



Extract a pair of condition pattern vectors

Compute their distance

Representational Dissimilarity Matrix (RDM)

Charest et al. 2014 *PNAS*

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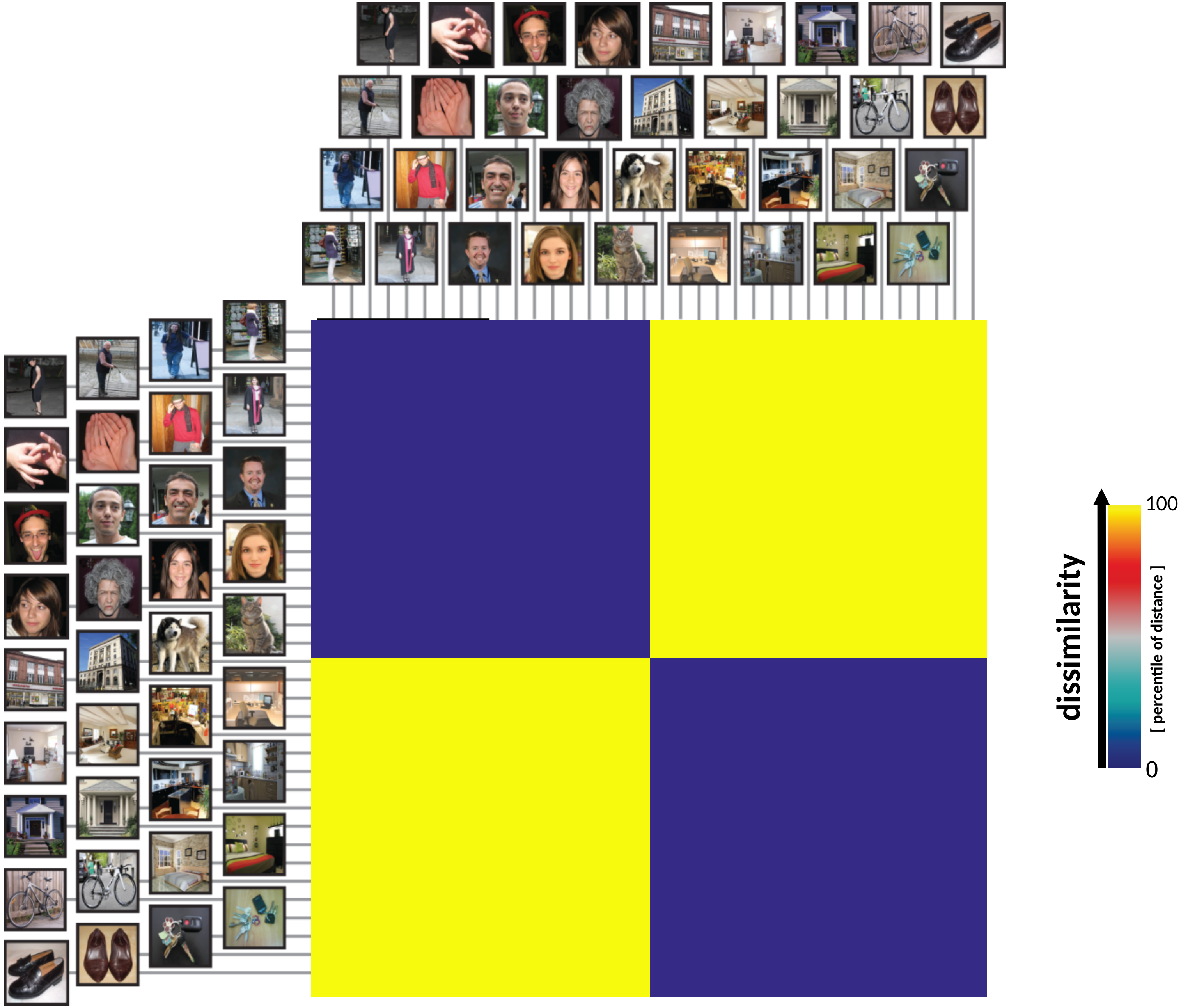
- **Model comparison**
- **RDM replicability (across folds or days)**

Representational Dissimilarity Matrix (RDM)

subject 1
(hIT)



Charest et al. 2014 *PNAS*

Step 5: statistical inference

Dominant in the literature:

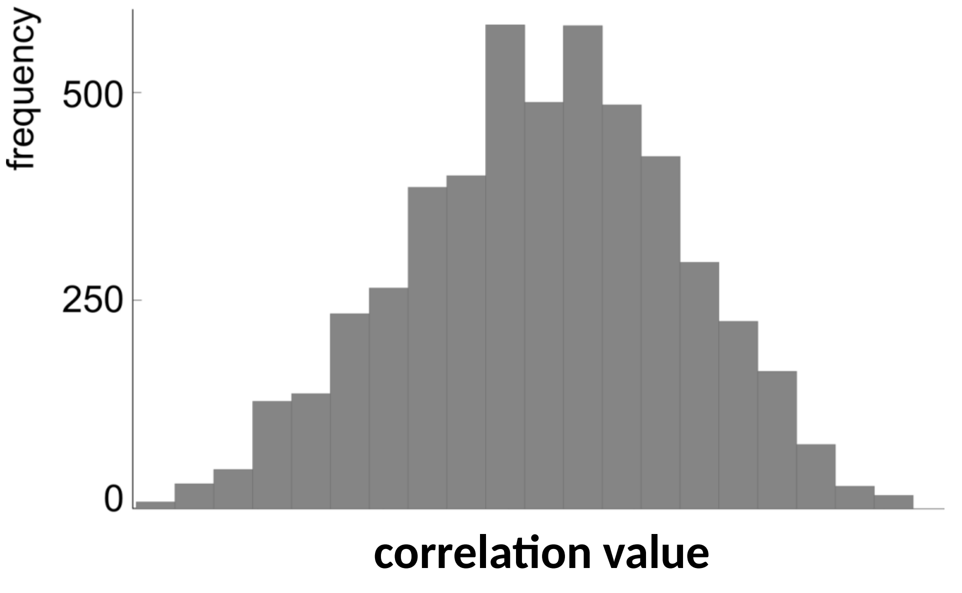
Random-effects analysis across subjects using a standard one-sample right-sided t test.

H_0: $r = 0$

H_a: $r > 0$

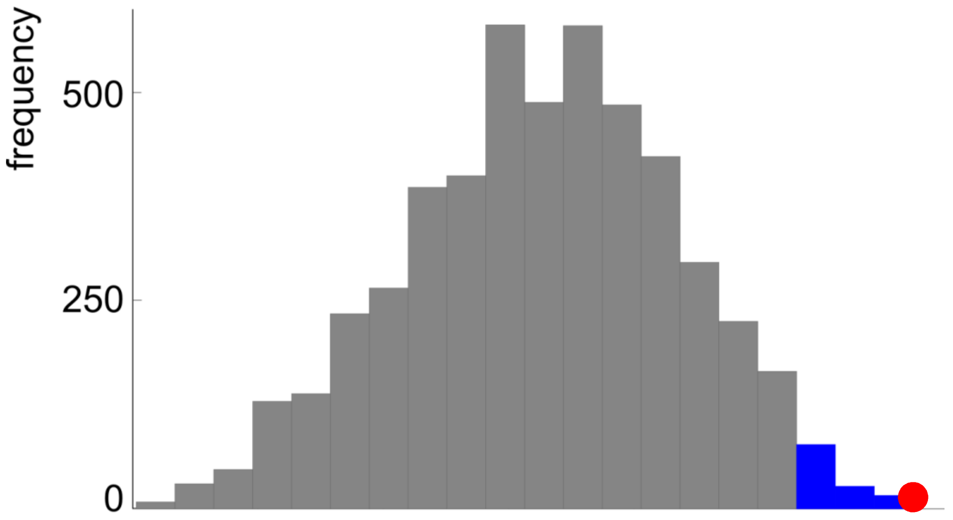
Step 5: statistical inference

null distribution of
RDM relatedness



Step 5: statistical inference

null distribution of RDM relatedness



correlation value

If the actual RDM correlation falls within the top 5% (blue) of the null distribution → reject H_0.