

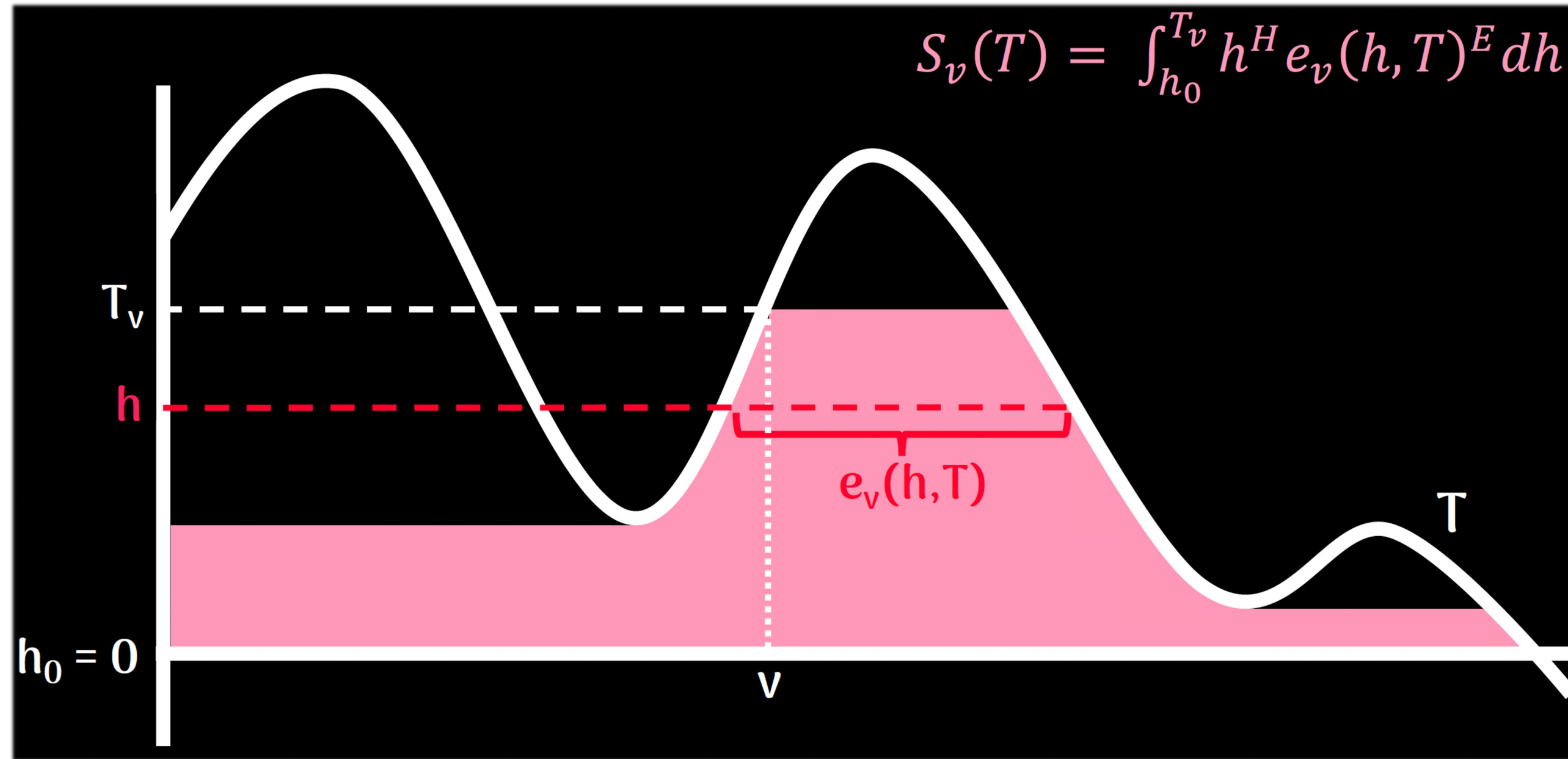
BRISBANE
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24-28

Localized Cluster Enhancement (LCE):
improving Threshold Free Cluster
Enhancement (TFCE) for better localization
of brain activity

Wouter Weeda

Thanks to Samuel Davenport

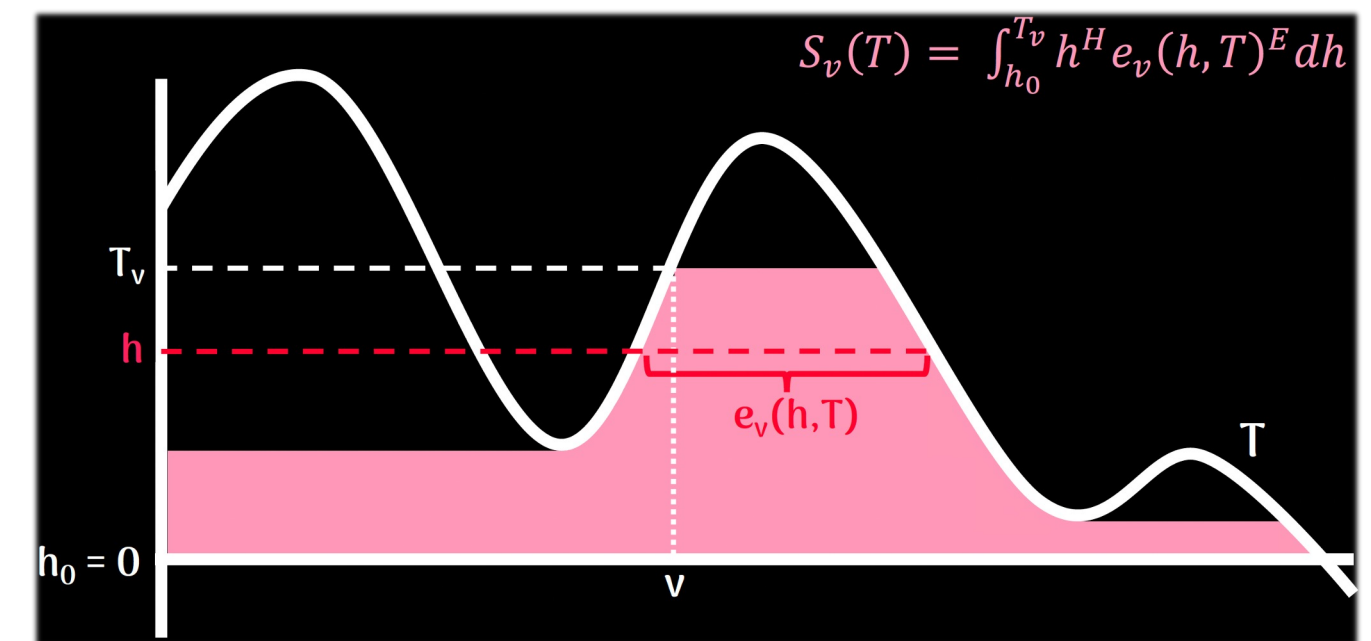
Threshold Free Cluster Enhancement



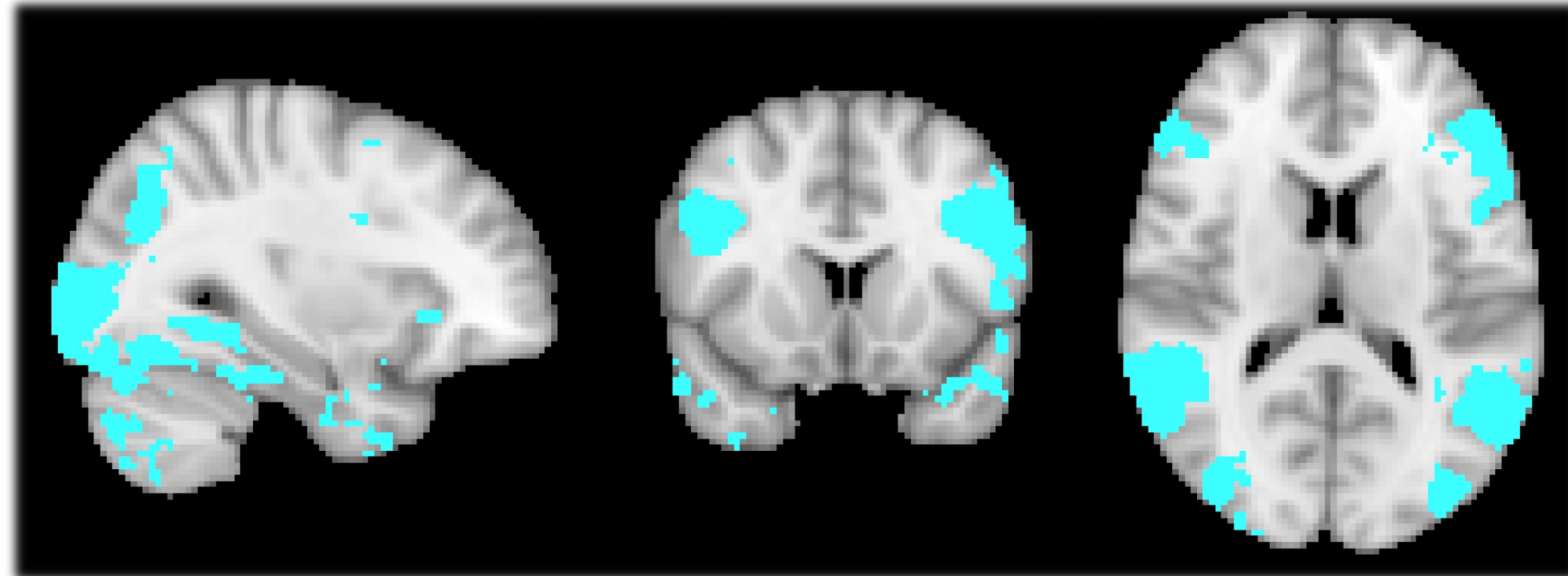
Threshold Free Cluster Enhancement (TFCE) uses neighboring voxels (support) to ‘enhance’ clusters found after thresholding.

Threshold Free Cluster Enhancement

- For every voxel v the TFCE-value (S_v) is the sum of all its ‘supporting’ voxels.
- The support is guided by a height (H) and extent (E) parameter and starts at H_0 .
- In the example, the TFCE-value for voxel v is the size of the pink area.
- Calculations are done for every voxel
- Permutations are used to calculate TFCE significance ($\max S_v$ under the null).

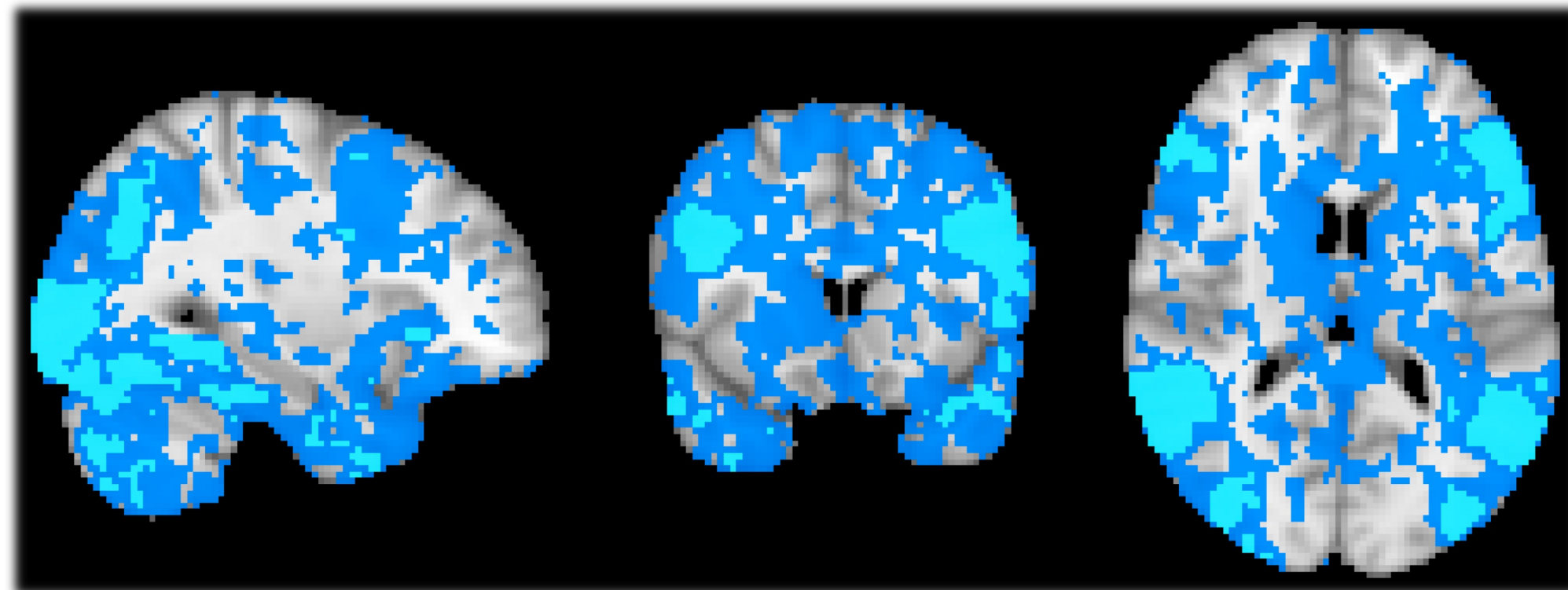


Threshold Free Cluster Enhancement



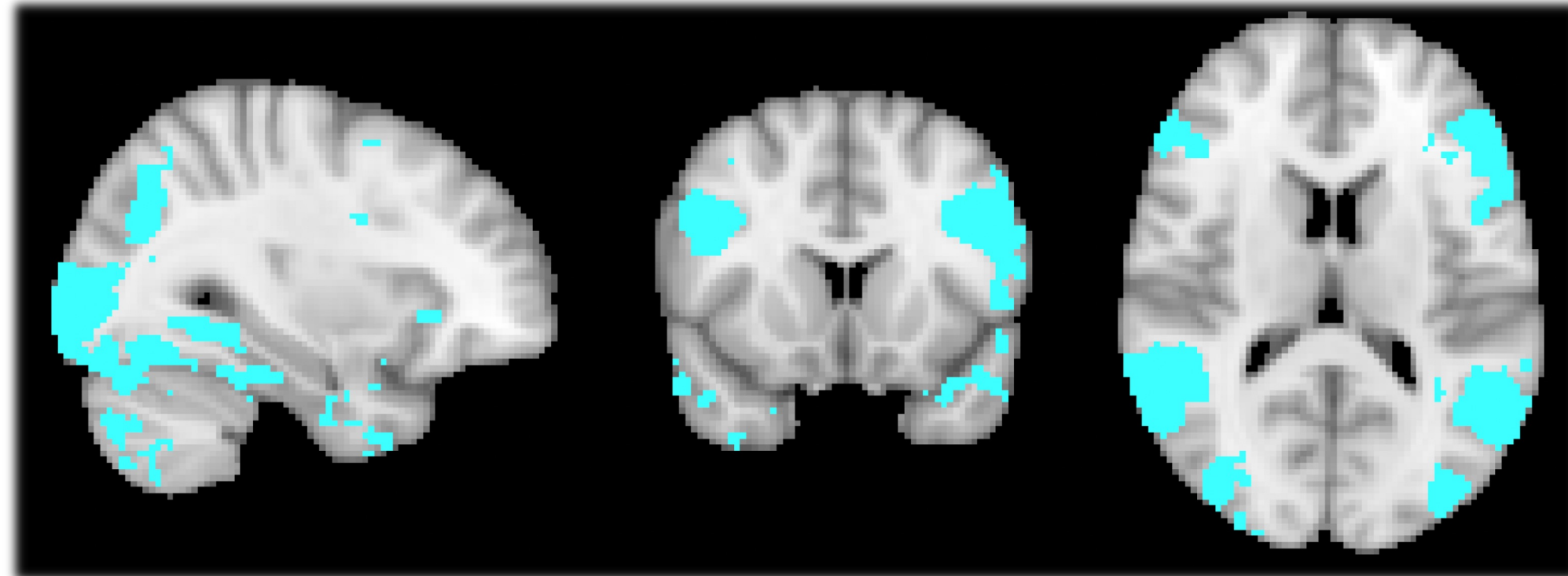
HCP ($n=20$) *Social* contrast

◀ significant TFCE clusters



◀ support of significant TFCE clusters

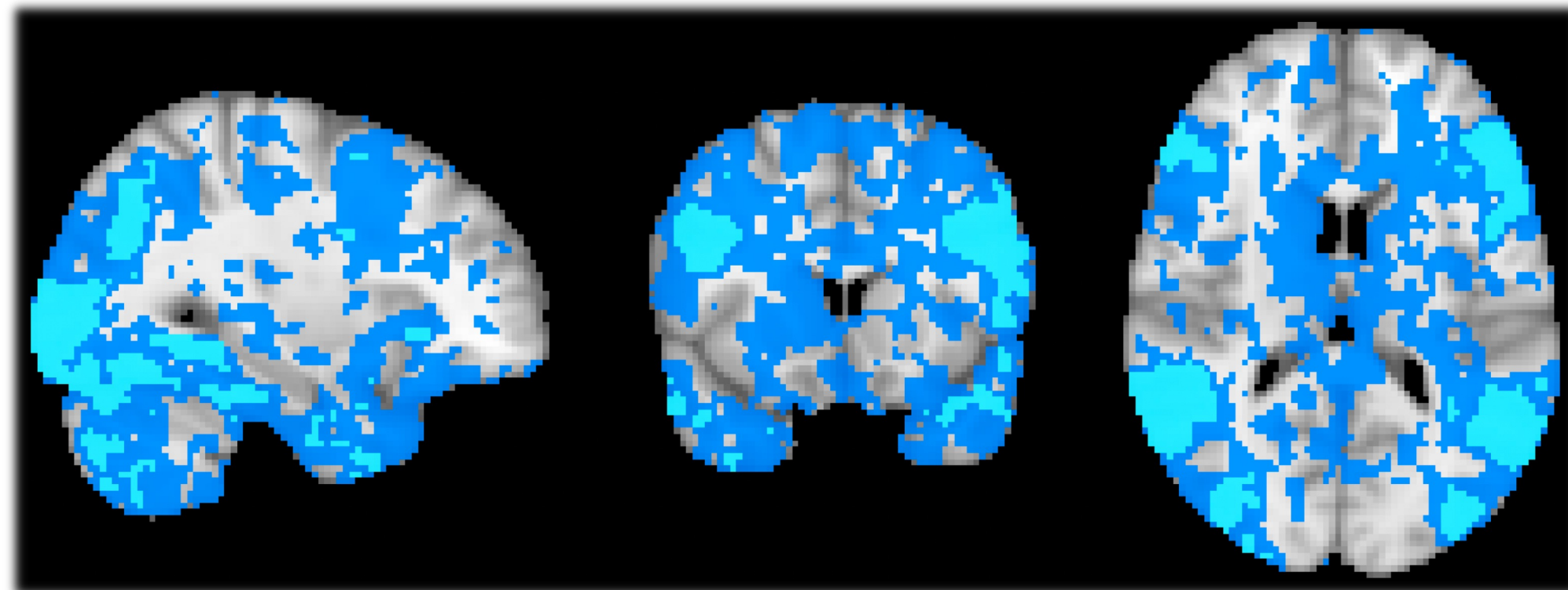
Threshold Free Cluster Enhancement



HCP ($n=20$) *Social* contrast

< significant

Localization not good

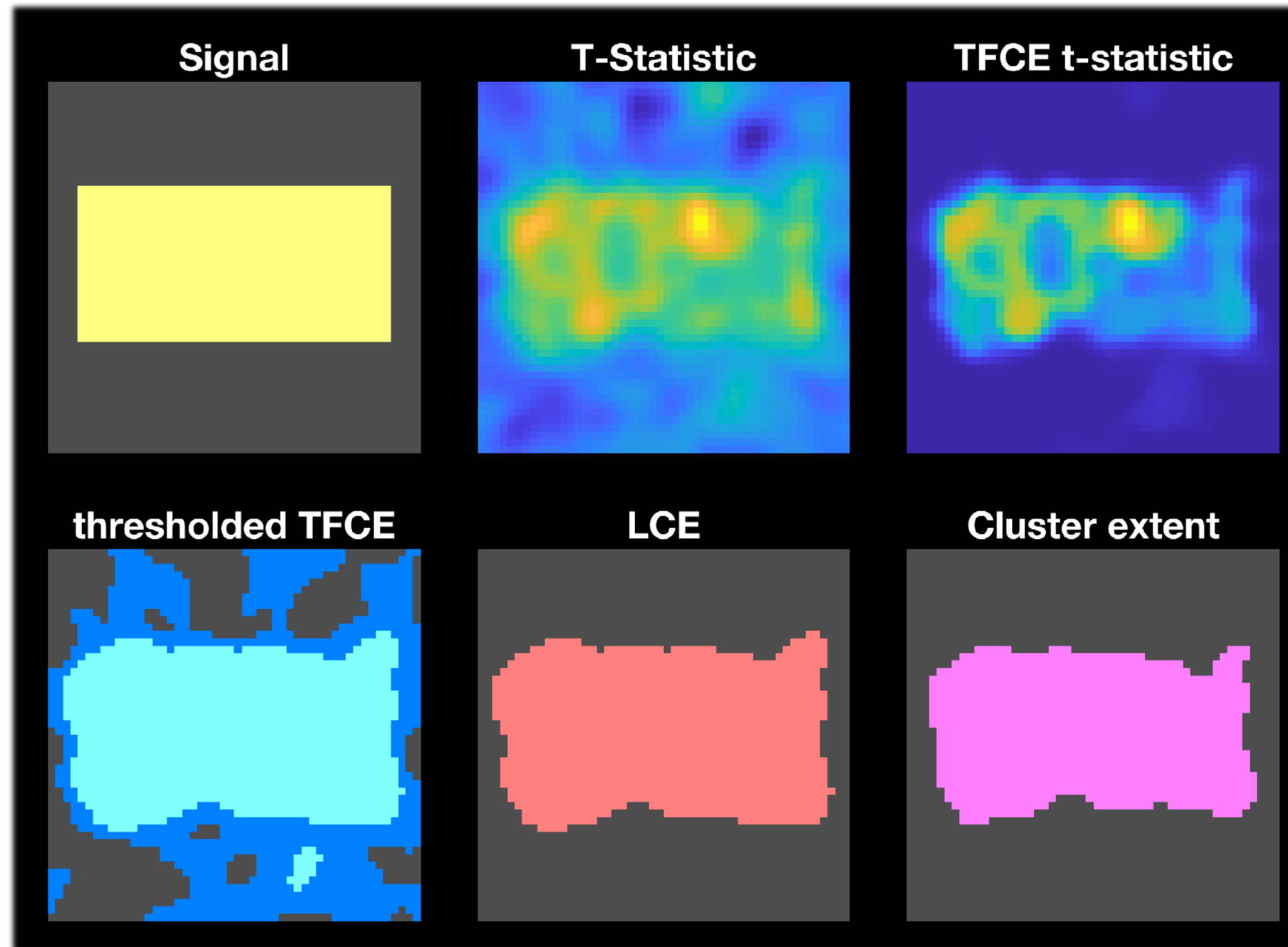


< SUPPLEMENTARY

Localization even worse

clusters

Threshold Free Cluster Enhancement

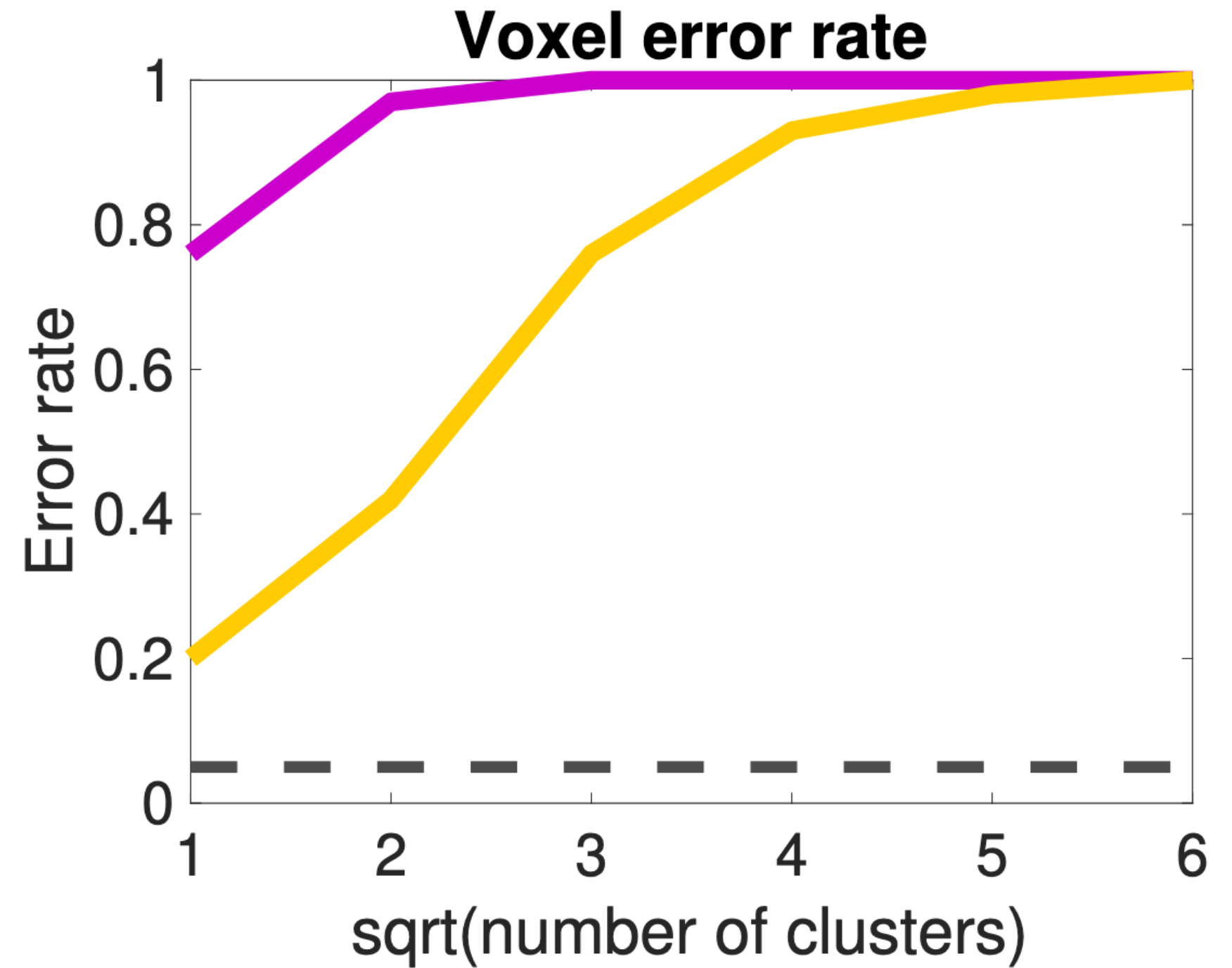
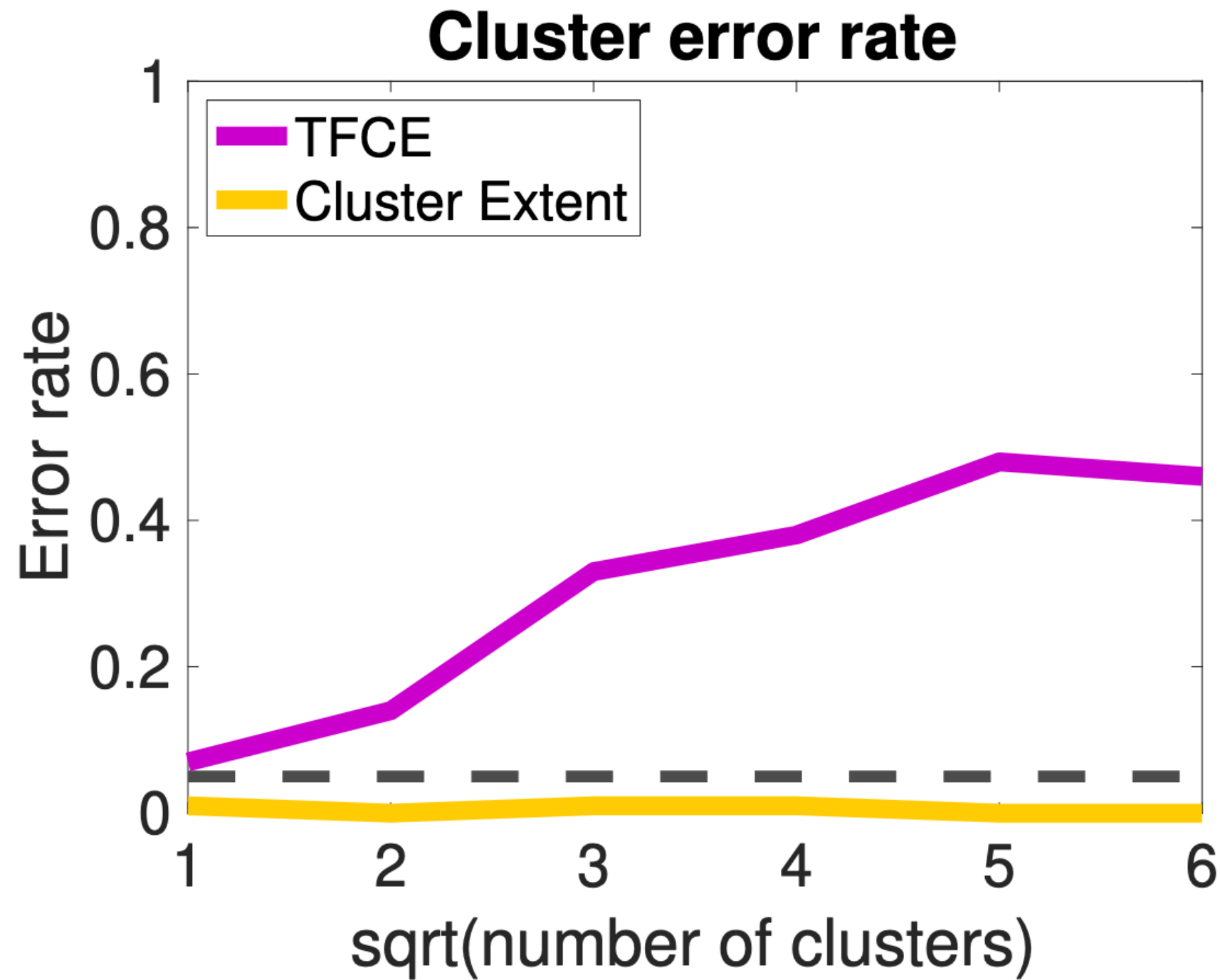


Simulated data with a rectangular signal shape

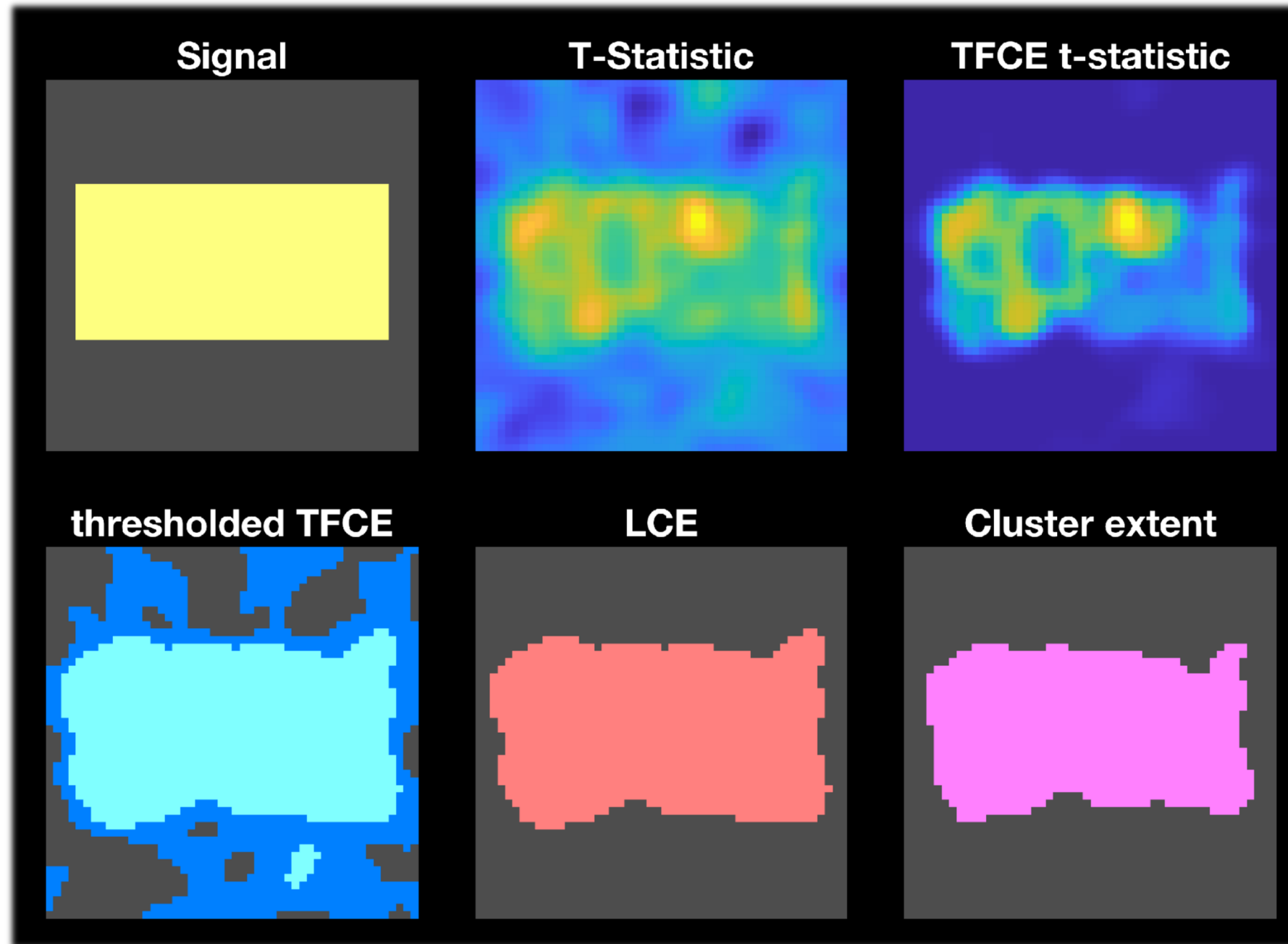
TFCE shows a false positive **cluster** and false-positive **voxels**

Cluster-extent and LCE show only false-positive **voxels**

Cluster and voxel error rates



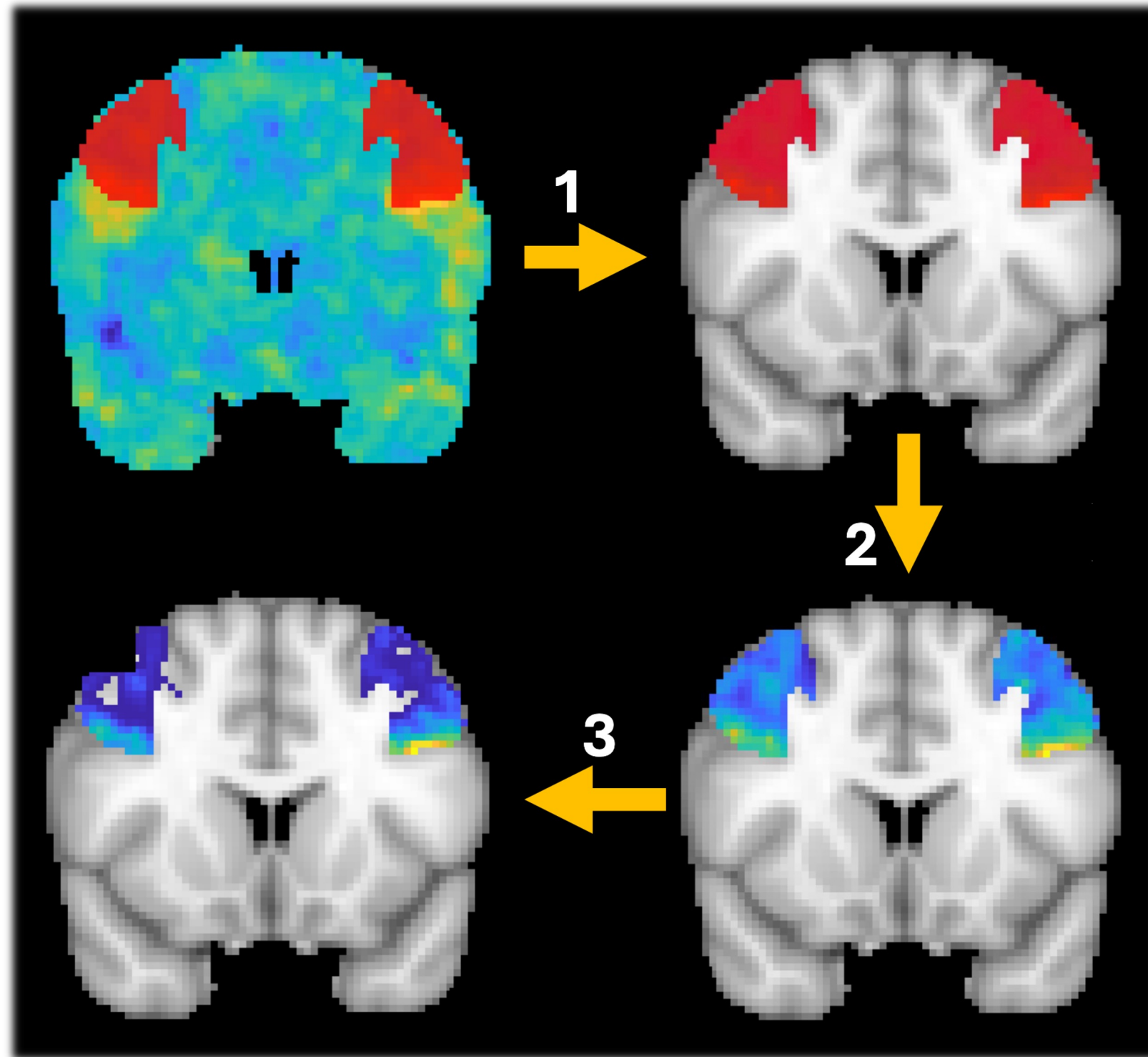
Localized Cluster Enhancement



Localized Cluster Enhancement

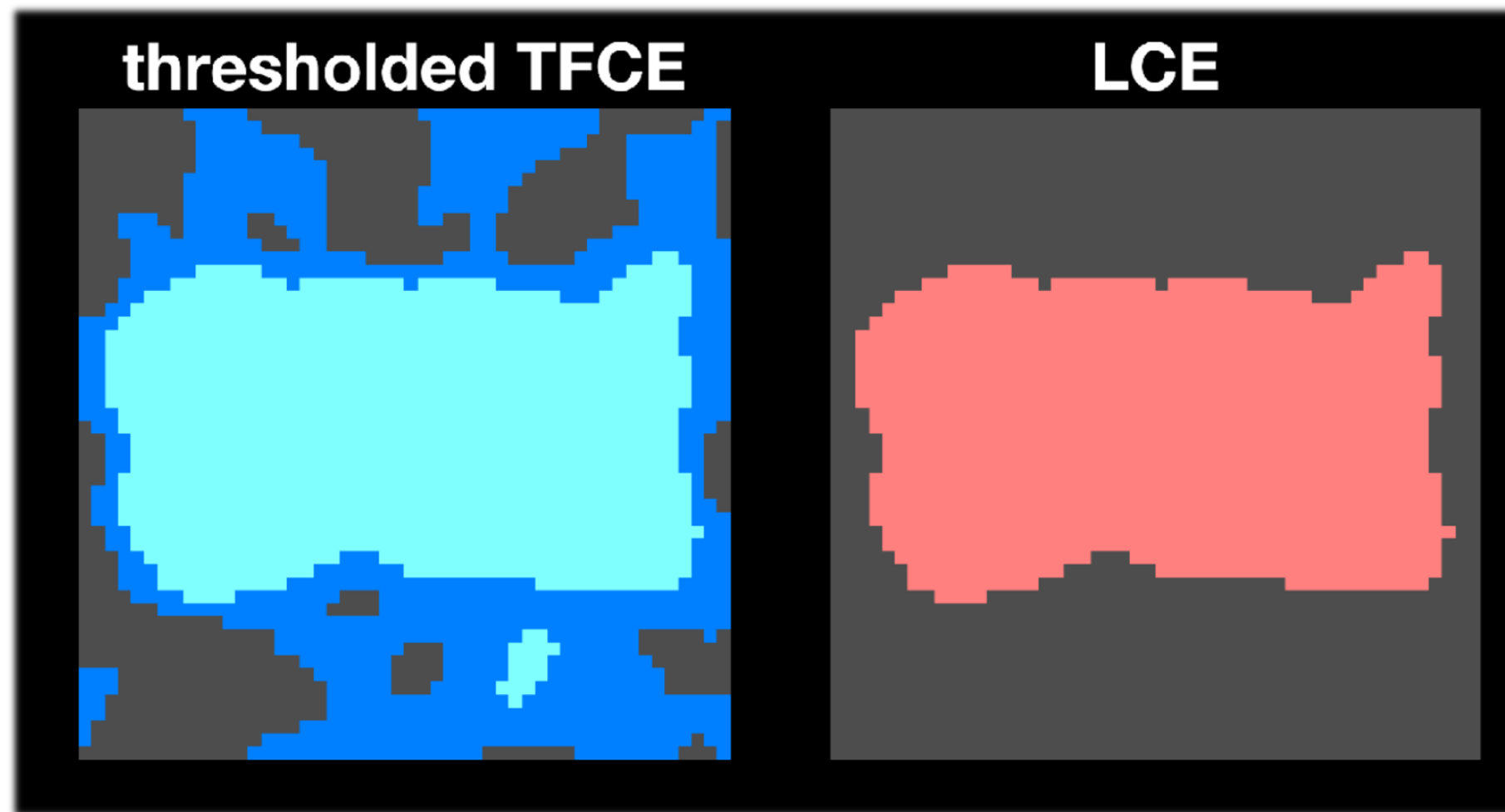
- LCE is the closed-testing version of TFCE.
- LCE provides a p -value for each region that is tested.
- In this case the thresholded TFCE map was used as a mask.
- LCE shows the red area to be significant but not the small blue region found by TFCE

Localized Cluster Enhancement



- (0) Starting with the TFCE statistic for all voxels.
- (1) Mask out the region-of-interest (can be chosen post-hoc and for as many regions you want. e.g., from a cluster-extent analysis or using anatomical masks).
- (2) Use the TFCE procedure on only the masked data.
- (3) use the local TFCE statistics to calculate LCE significance.

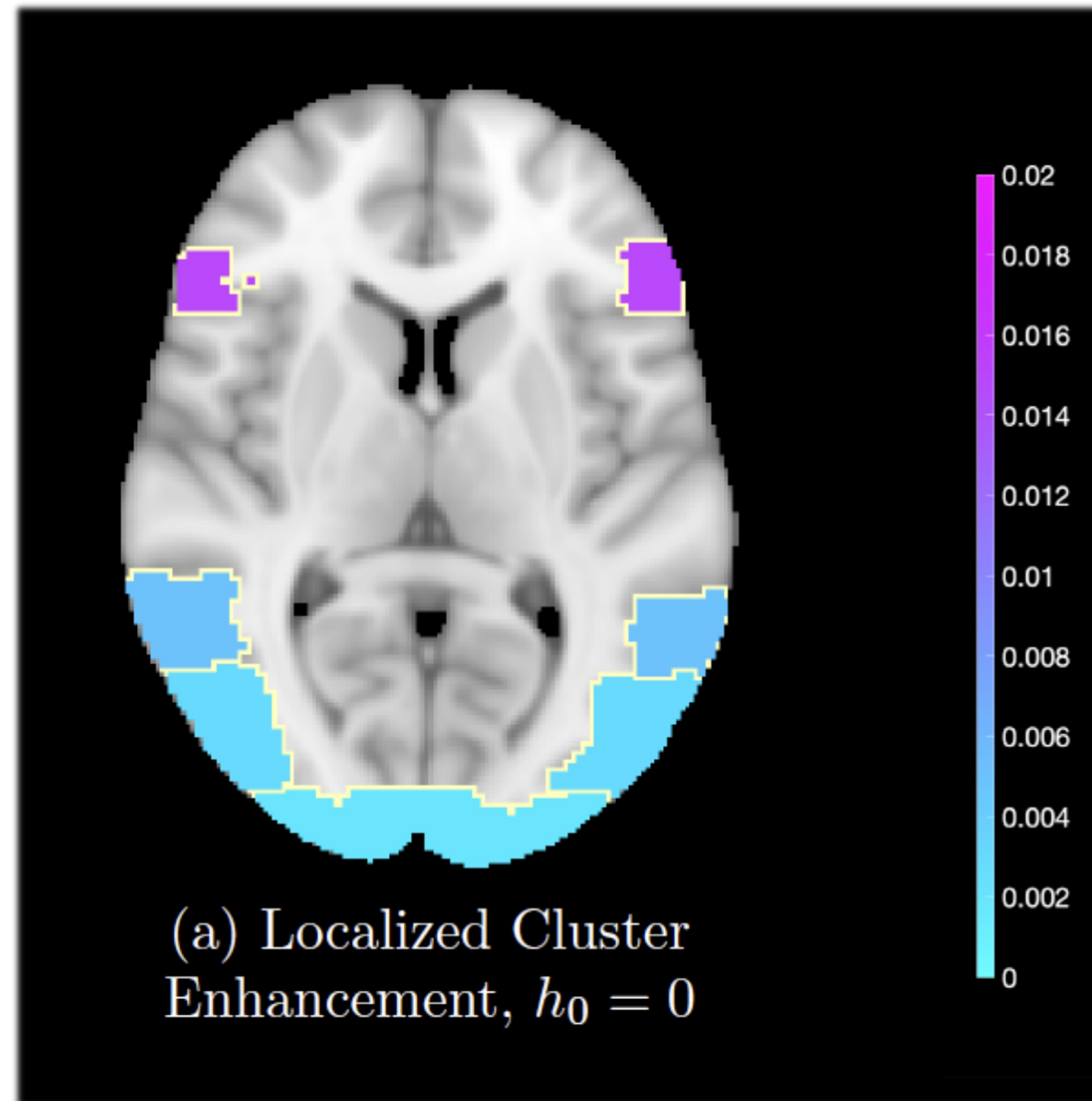
Localized Cluster Enhancement



Localized Cluster Enhancement

- LCE shows the red area to be significant but not the small blue region found by TFCE (light-blue region was the mask)
- LCE can be used to test any region for significance, even after seeing the data.

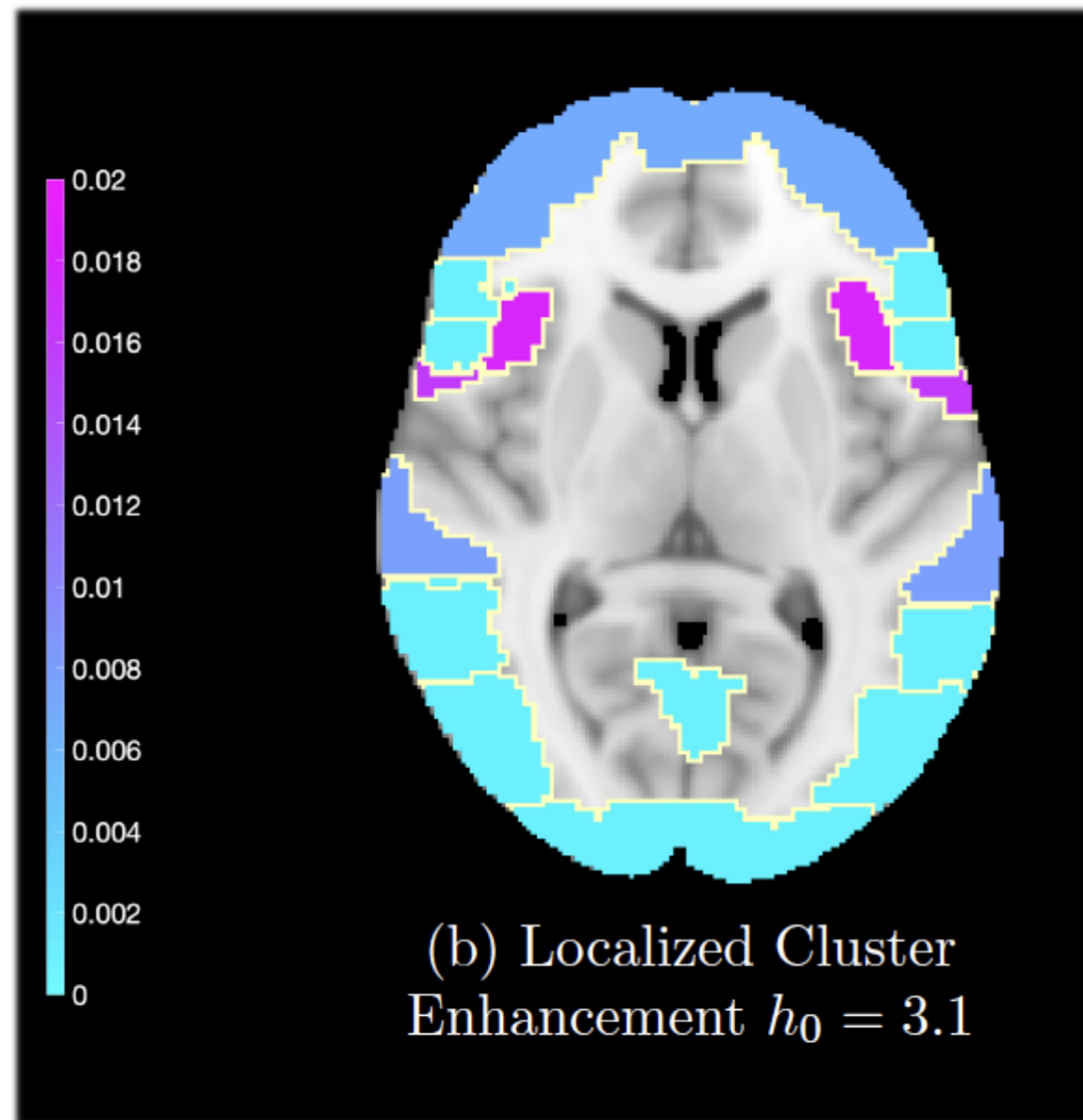
Localized Cluster Enhancement



Localized Cluster Enhancement

- For example, we can use the Harvard-Oxford atlas as a mask to test LCE significance.
- Shown here are the significant regions of the Social contrast.

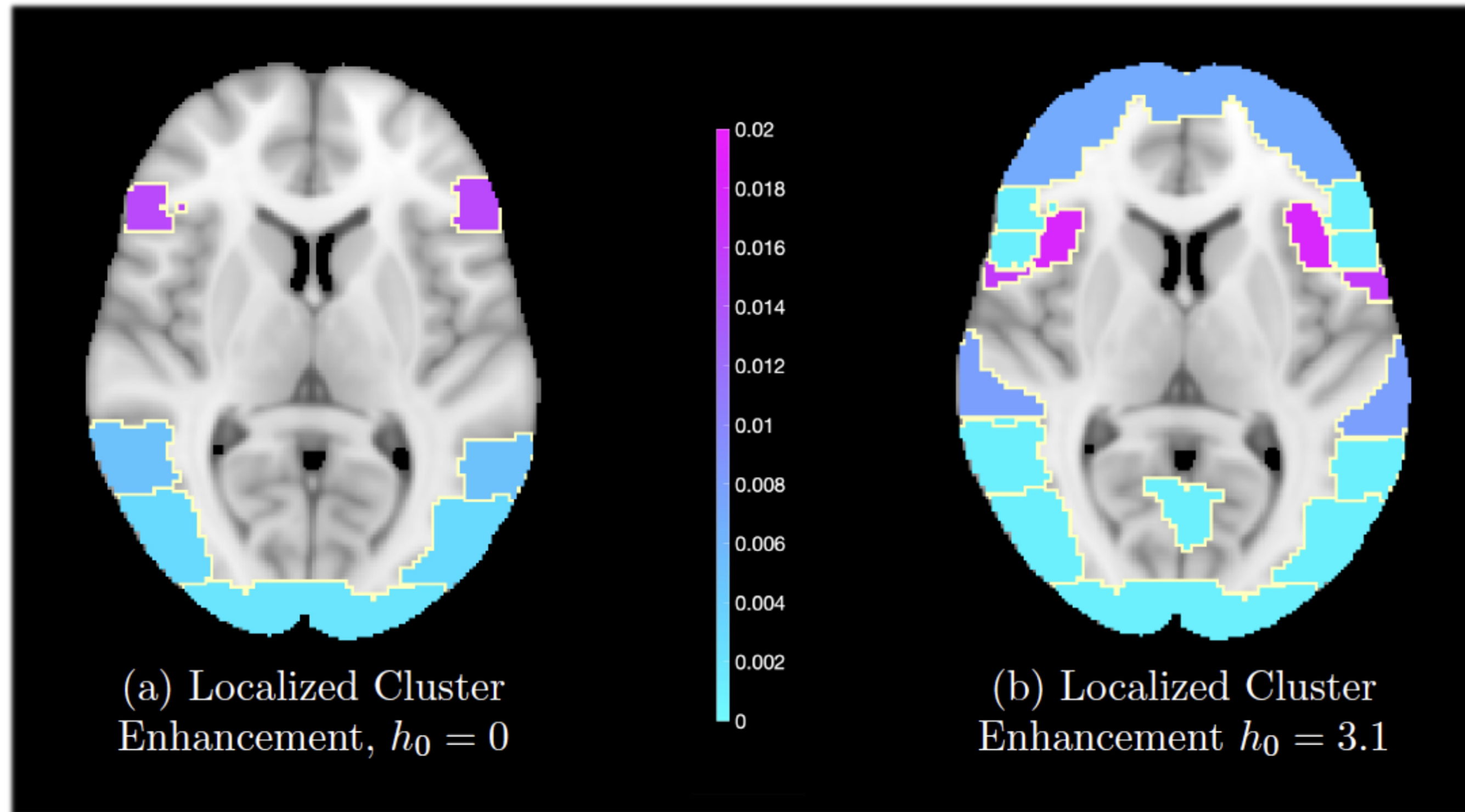
Localized Cluster Enhancement



Localized Cluster Enhancement

- One of the things that can be adjusted is the value of h_0 (essentially a threshold on where the support of the TFCE statistic starts).
- This must be set **before** doing the analysis, it cannot be changed freely after seeing the data.
- But you can test any region using LCE afterwards.

Localized Cluster Enhancement



Localized Cluster Enhancement

```
_talk/LCE_tutorial_educourse_real.mlx

lues using LCE
n_region] = LCE(tstat_orig, surviving_tfce_

significance for each cluster.

done!

TFCE cluster maps
he maps of both the TFCE and LCE analyses.

s
clusters
r_im, surviving_tfce_clusters, surviving_tf

clusters
rs_vec = surviving_tfce_clusters_vec(find(p
er_im( size(tfce_tstat), lce_significant_cl

Imask_small.nii'); % just for use as a temp
er_im.nii';
_cluster_im);

ter_im.nii' % use the same template, but ch
viving_tfce_cluster_im);

resh(squeeze(surviving_tfce_cluster_im(:,:,
```

tfce perm progress: 100.0

Progress: 100.0

pvals = 1x8

0.0090	0.1760	0.0070	0.1890	0.0760	0.0120	0.0200	0.0050
--------	--------	--------	--------	--------	--------	--------	--------

hdr = struct with fields:

fname: 'tfce_cluster_im.nii'

dim: [46 55 46]

dt: [16 0]

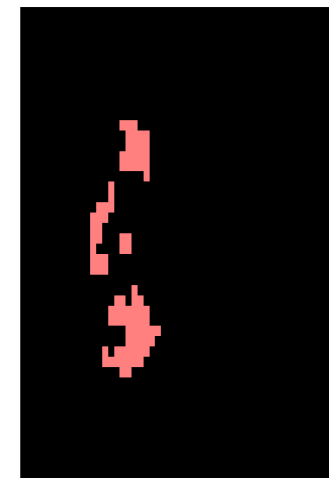
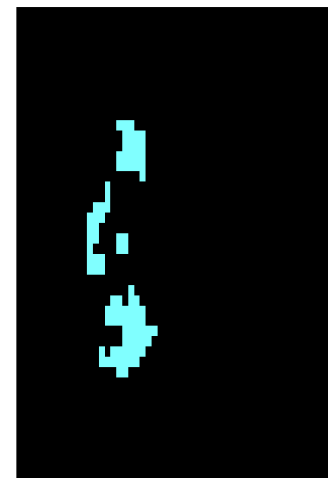
pinfo: [3x1 double]

mat: [4x4 double]

n: [1 1]

descrip: '2501.4 2025-04-22T09:56:22+01:00'

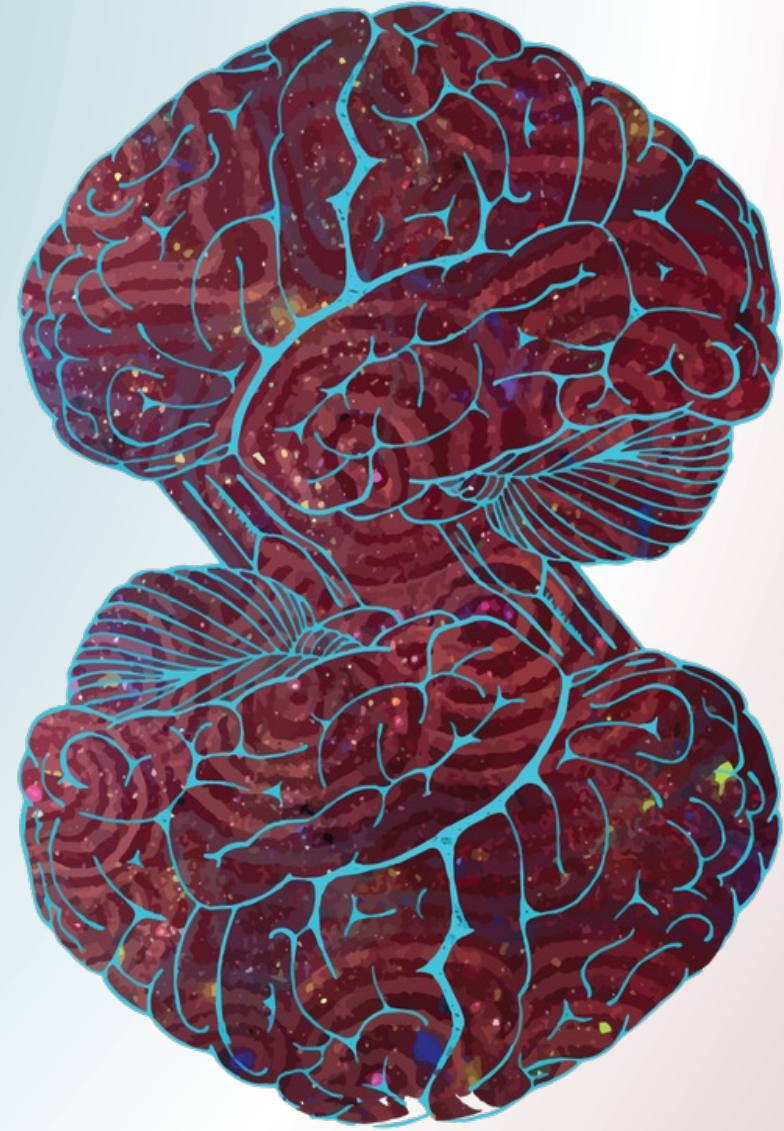
private: [1x1 nifti]



Localized Cluster Enhancement

Matlab implementation using the Statbrainz package (written by Sam Davenport).

github.com/sjdavenport/Statbrainz



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