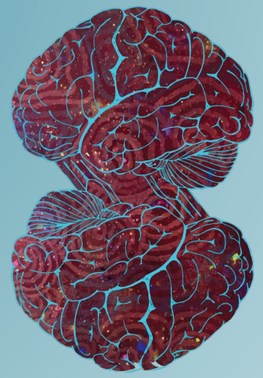


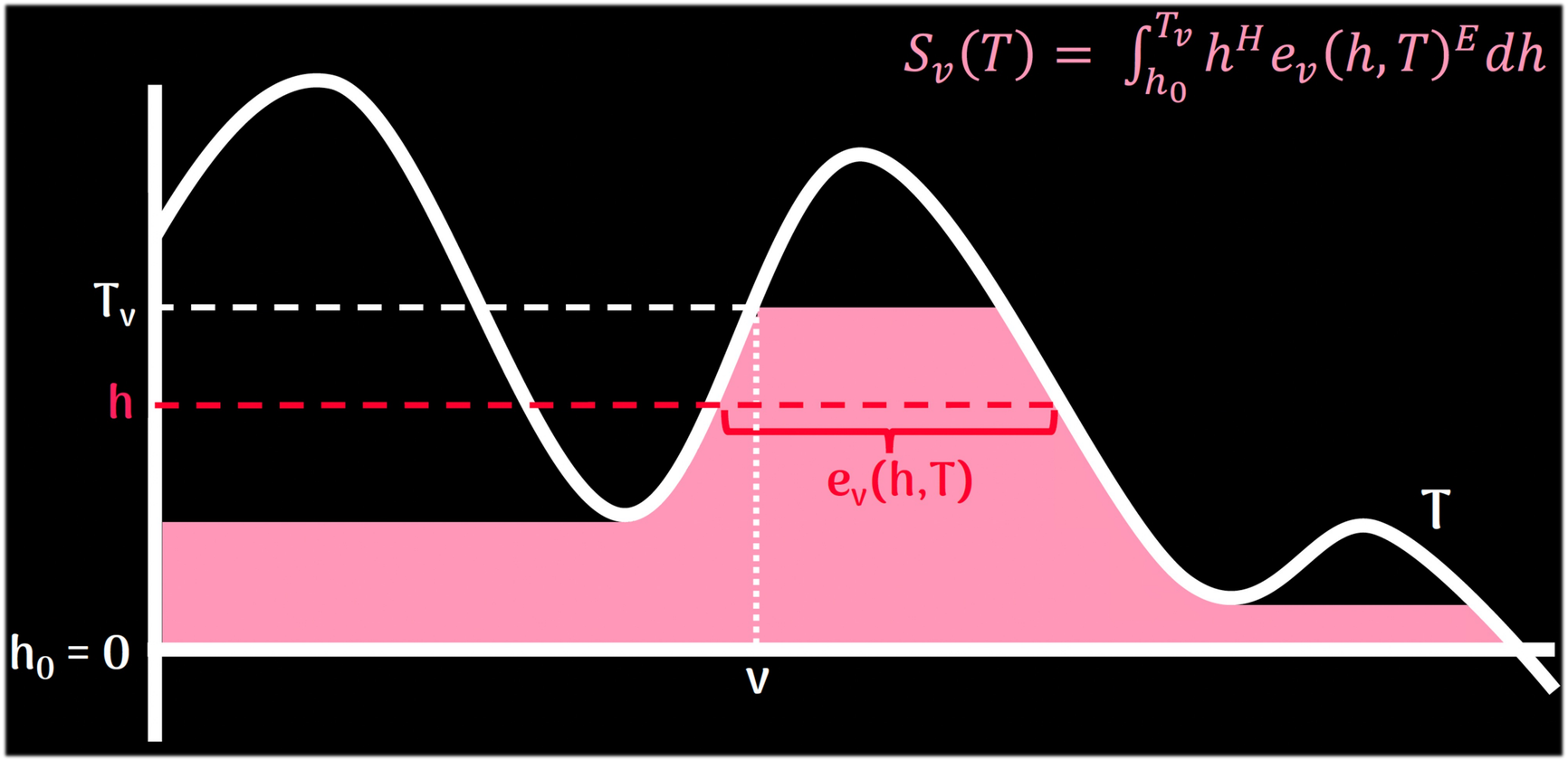
BRISBANE
OHBM 2025 JUNE 24-28

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

Wouter Weeda

Thanks to Samuel Davenport

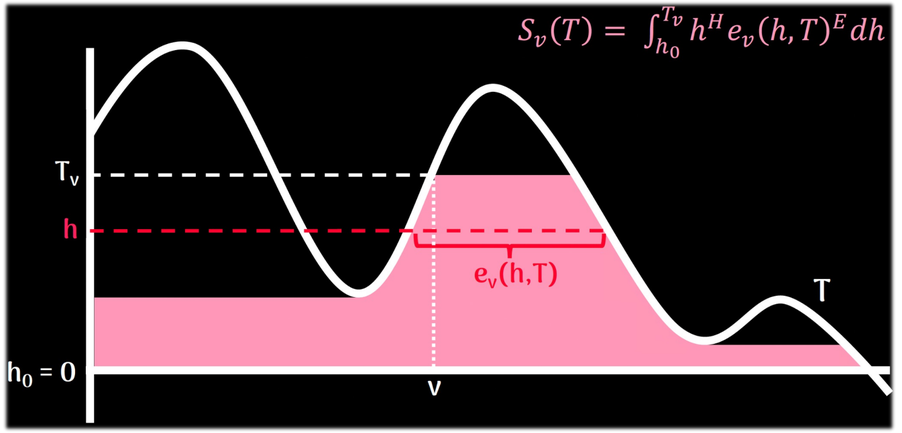
Threshold Free Cluster Enhancement



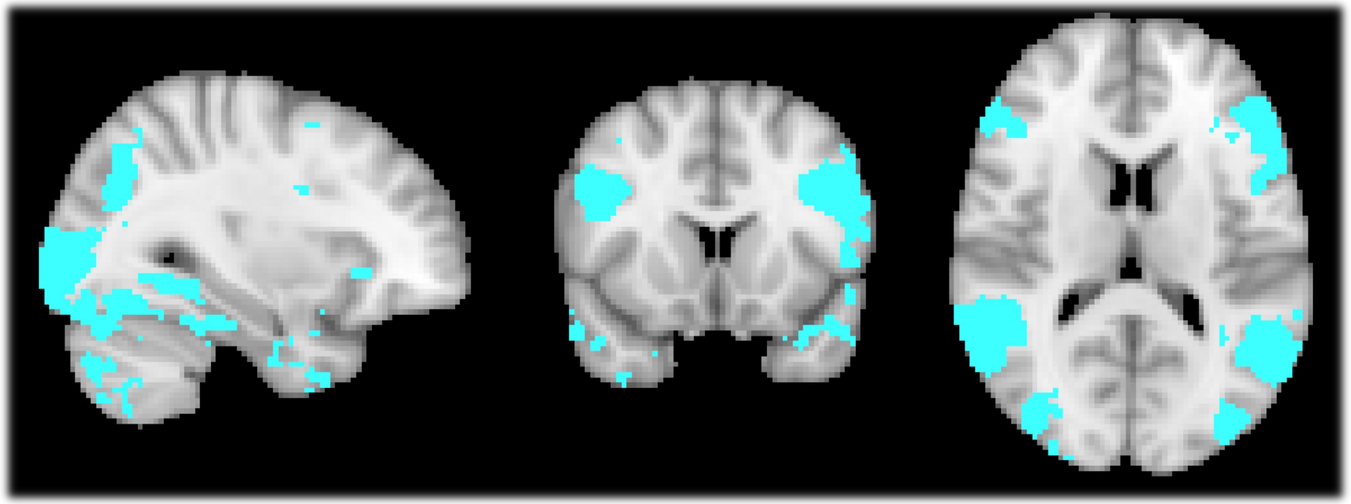
Threshold Free Cluster Enhancement (TFCE) uses neighboring voxels (support) to ‘enhance’ clusters found after thresholding.

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).

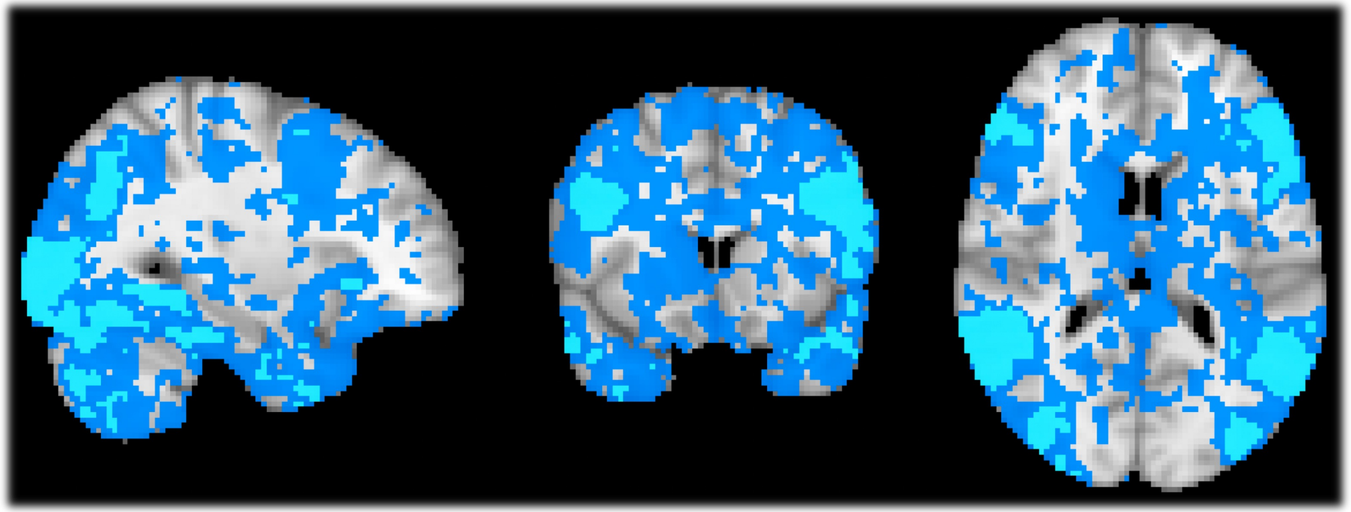


Threshold Free Cluster Enhancement



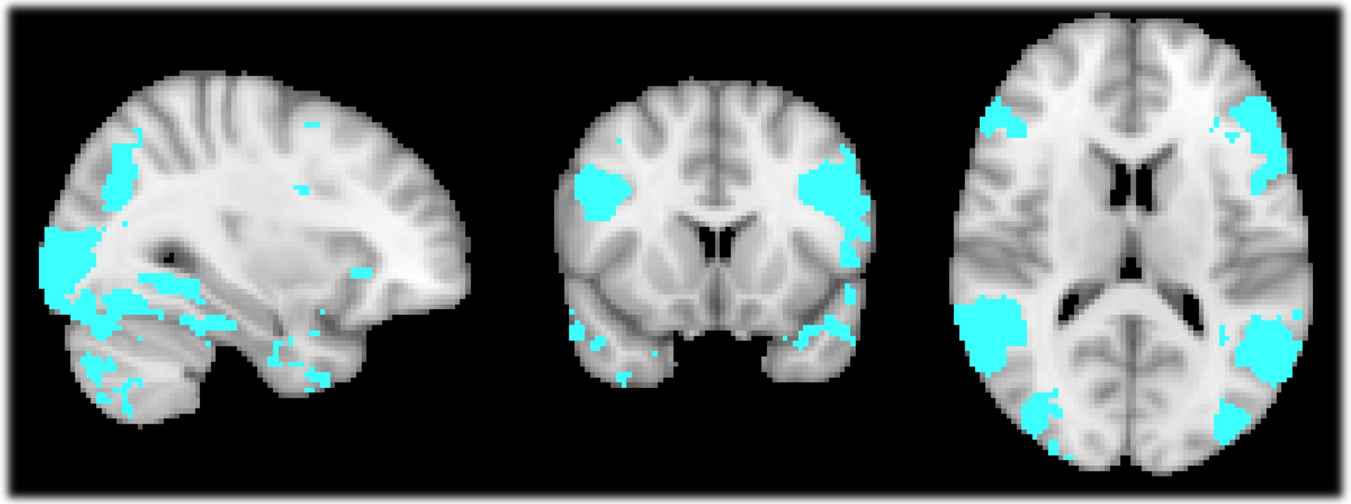
HCP (*n*=20) *Social* contrast

‹ significant TFCE clusters



‹ support of significant TFCE clusters

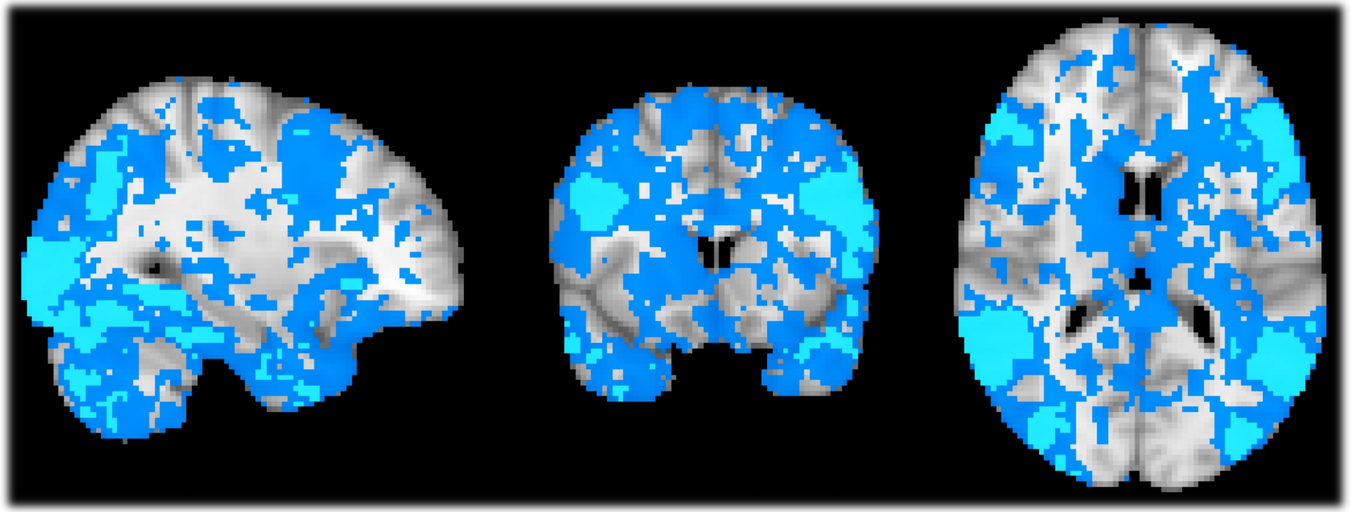
Threshold Free Cluster Enhancement



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

< significant T

Localization not good

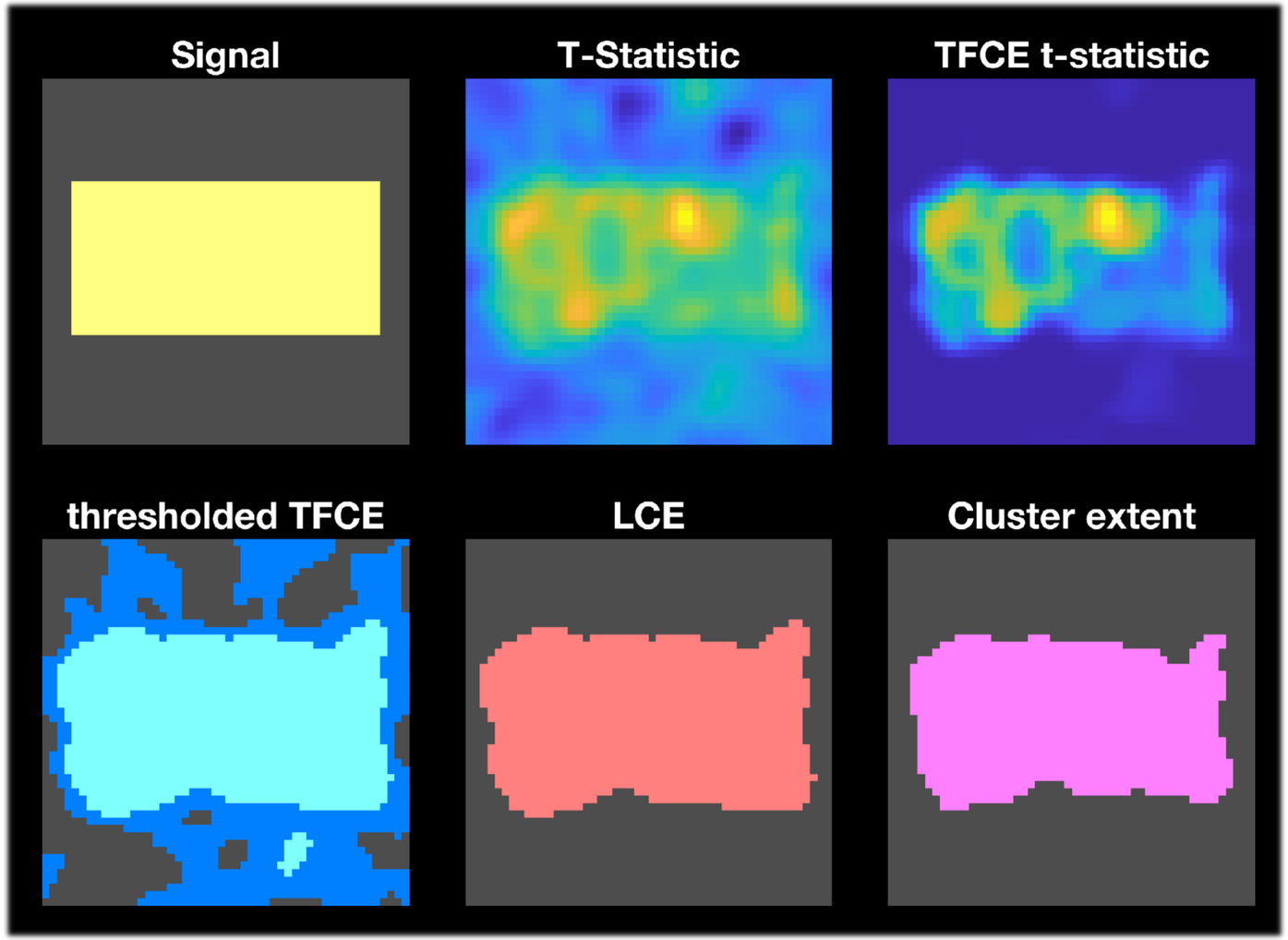


< SUPPORT

t-TFCE clusters

Localization even worse

Threshold Free Cluster Enhancement

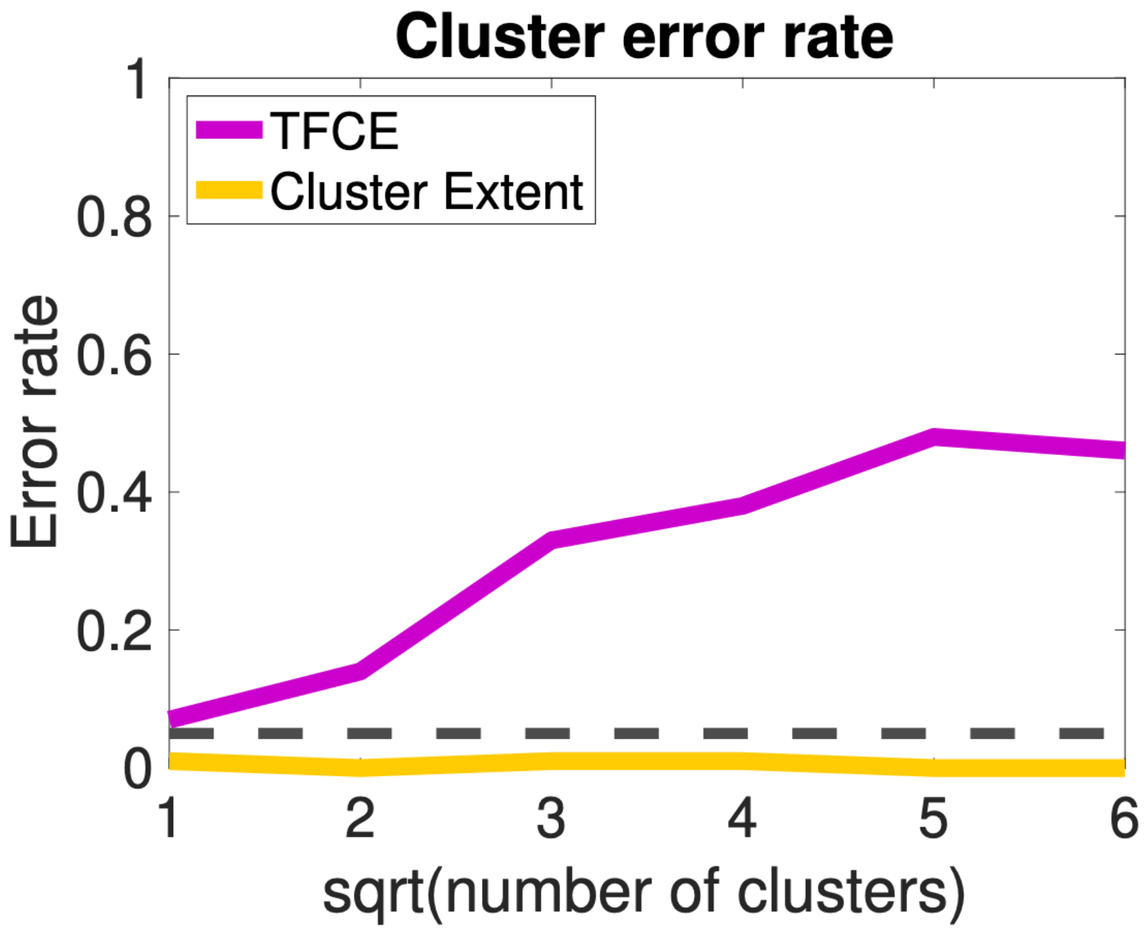


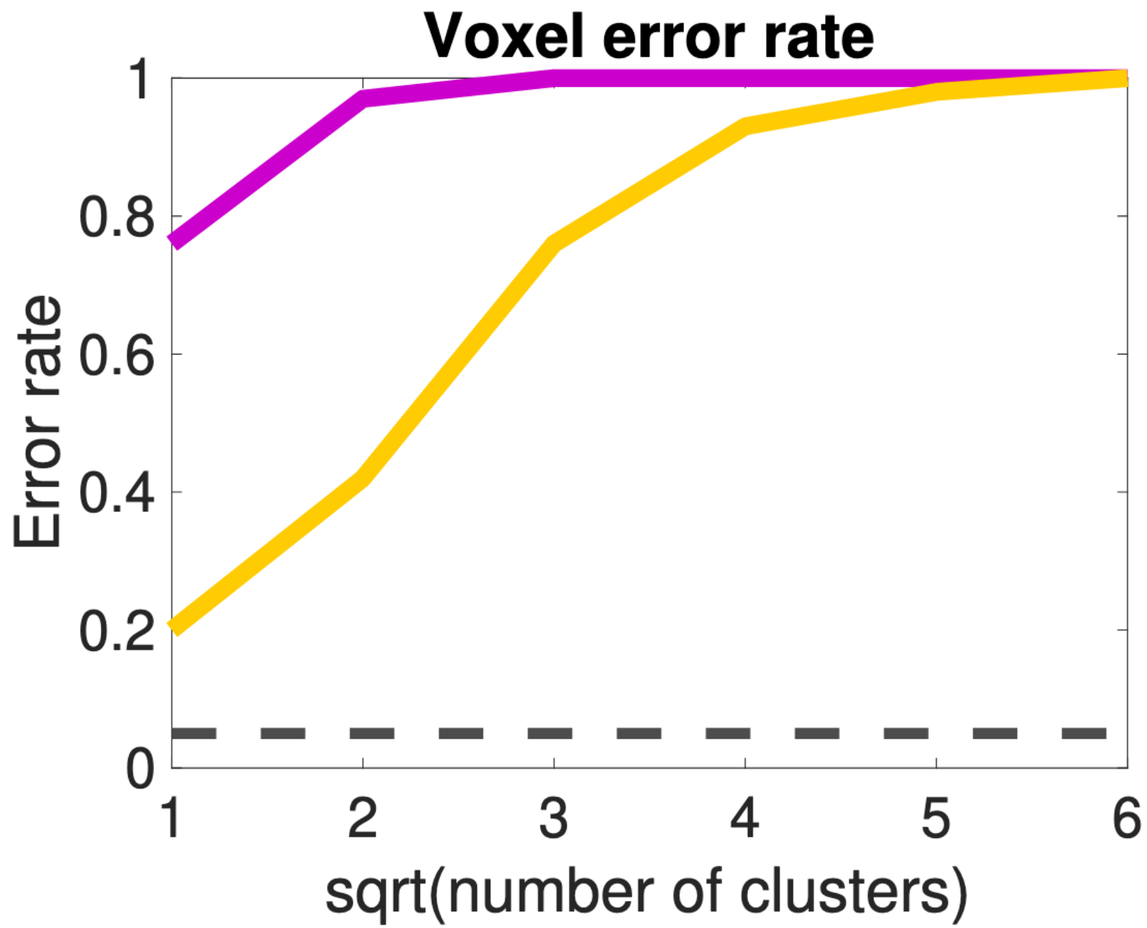
Simulated data with a rectangular signal shape

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

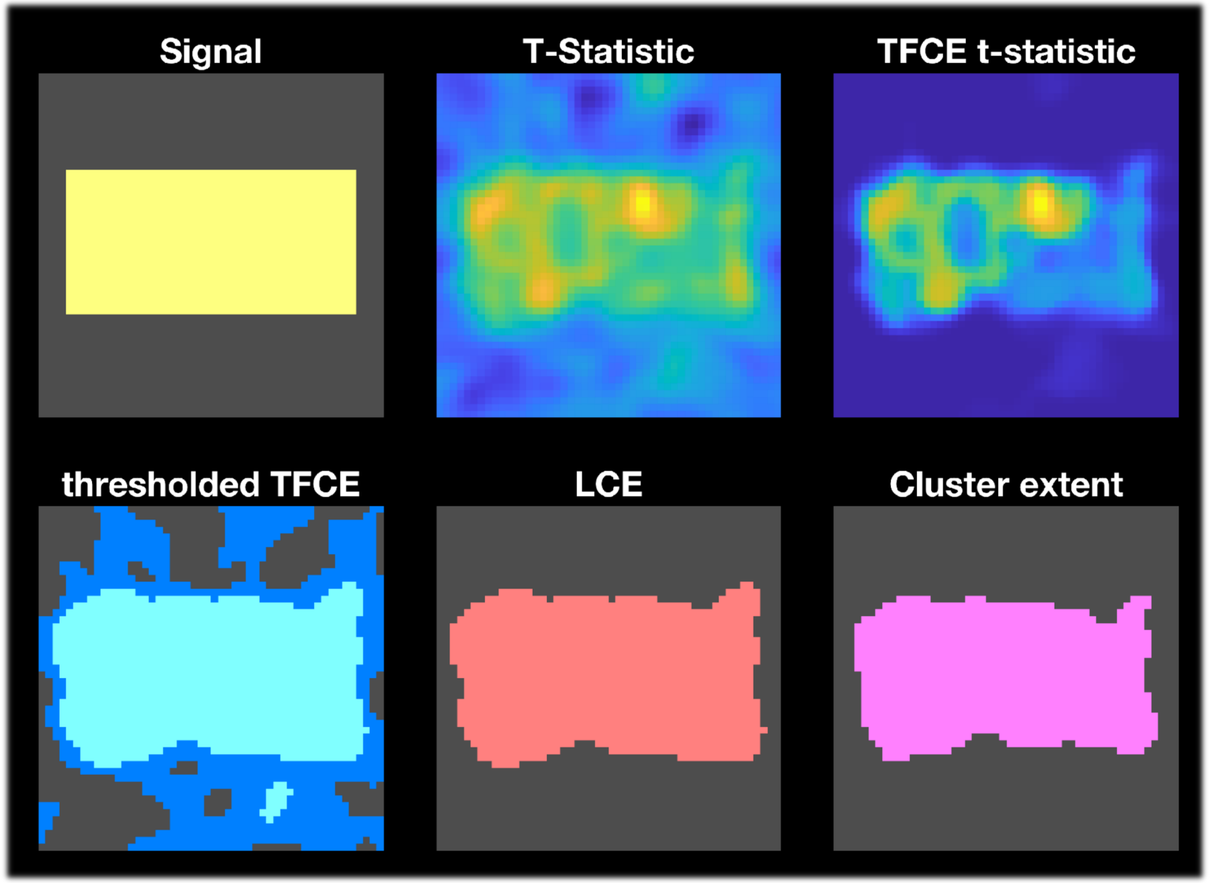
Cluster-extent and LCE show only false-positive **voxels**

Cluster and voxel error rates





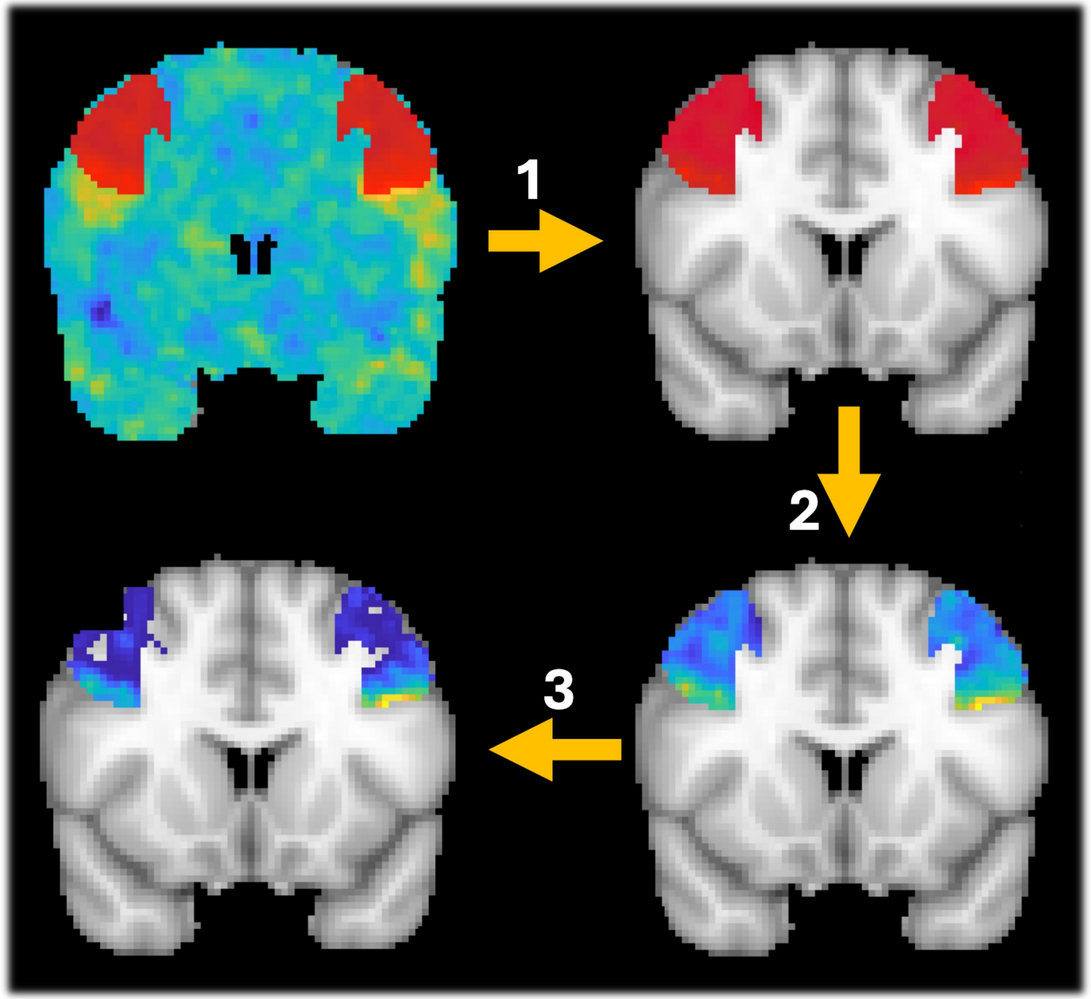
Localized Cluster Enhancement



Localized Cluster Enhancement

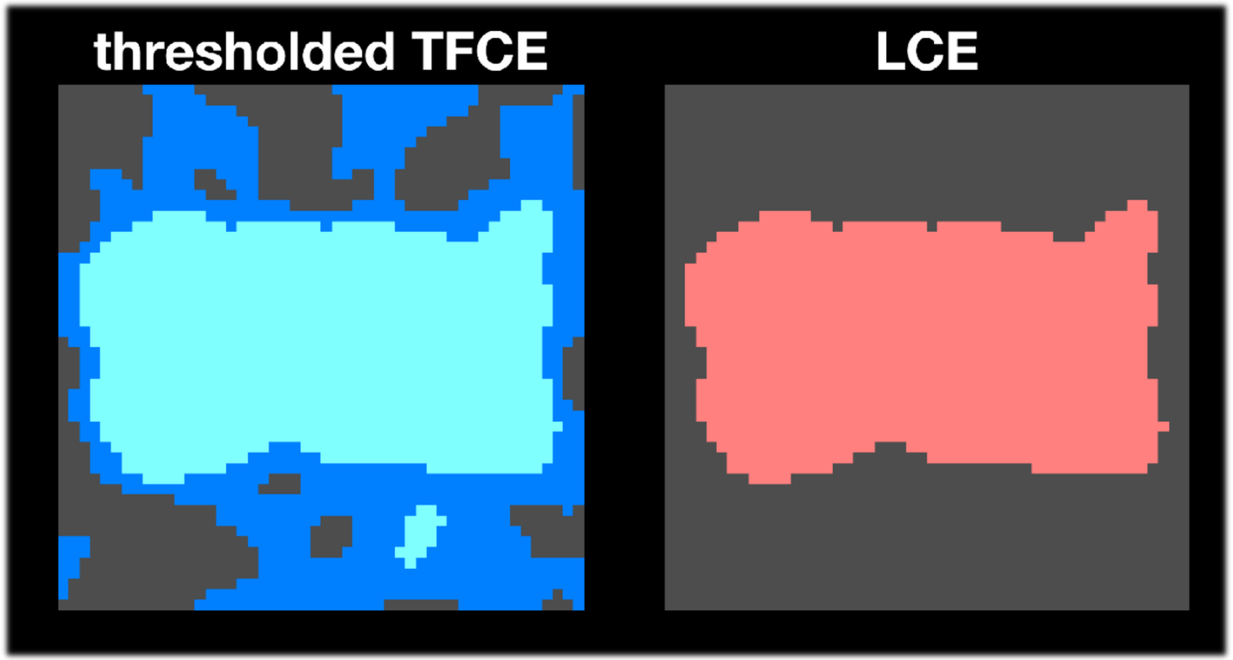
- LCE is the closed-testing version of TFCE.
- LCE provides a *p*-value for each region that is tested.
- In this case the thresholded TFCE map was used as a mask.
- LCE shows the red area to be significant but not the small blue region found by TFCE

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.

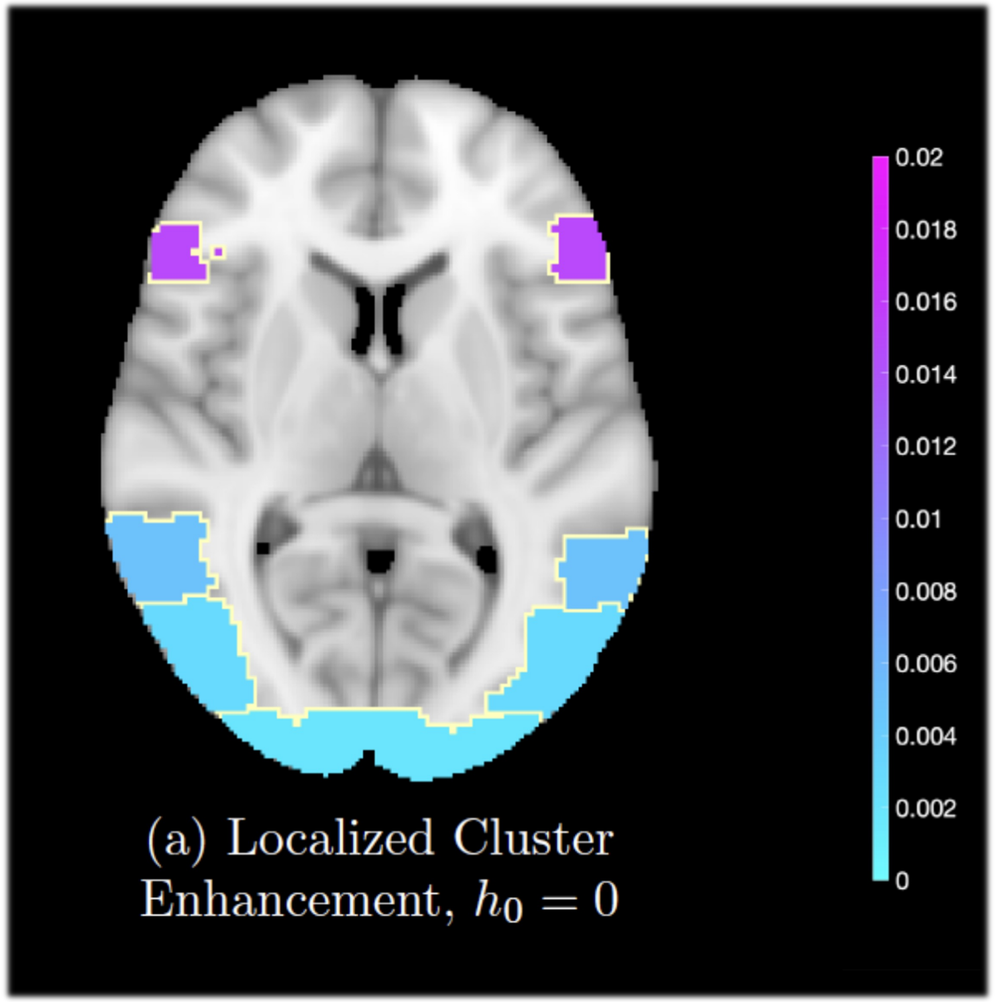
Localized Cluster Enhancement



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

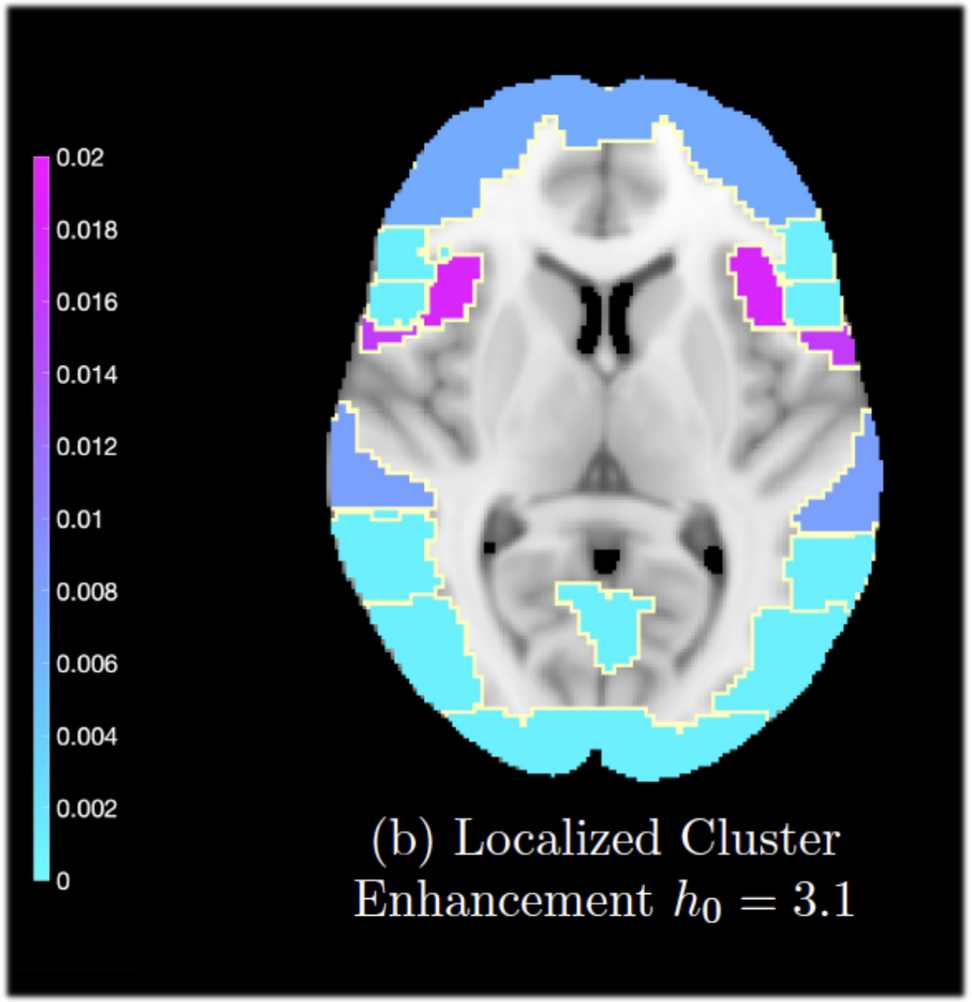


(a) Localized Cluster Enhancement, $h_0 = 0$

Localized Cluster Enhancement

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

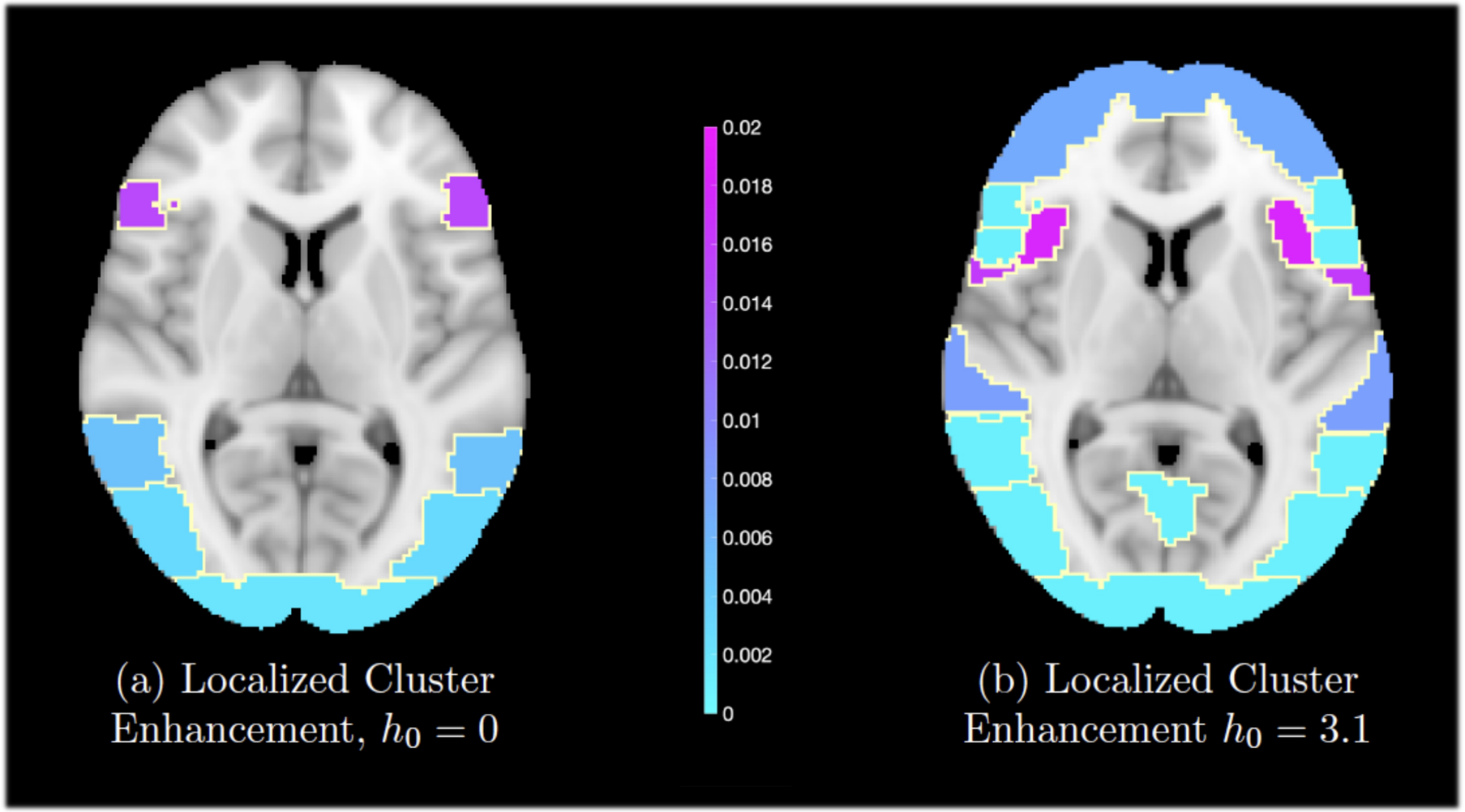
Localized Cluster Enhancement



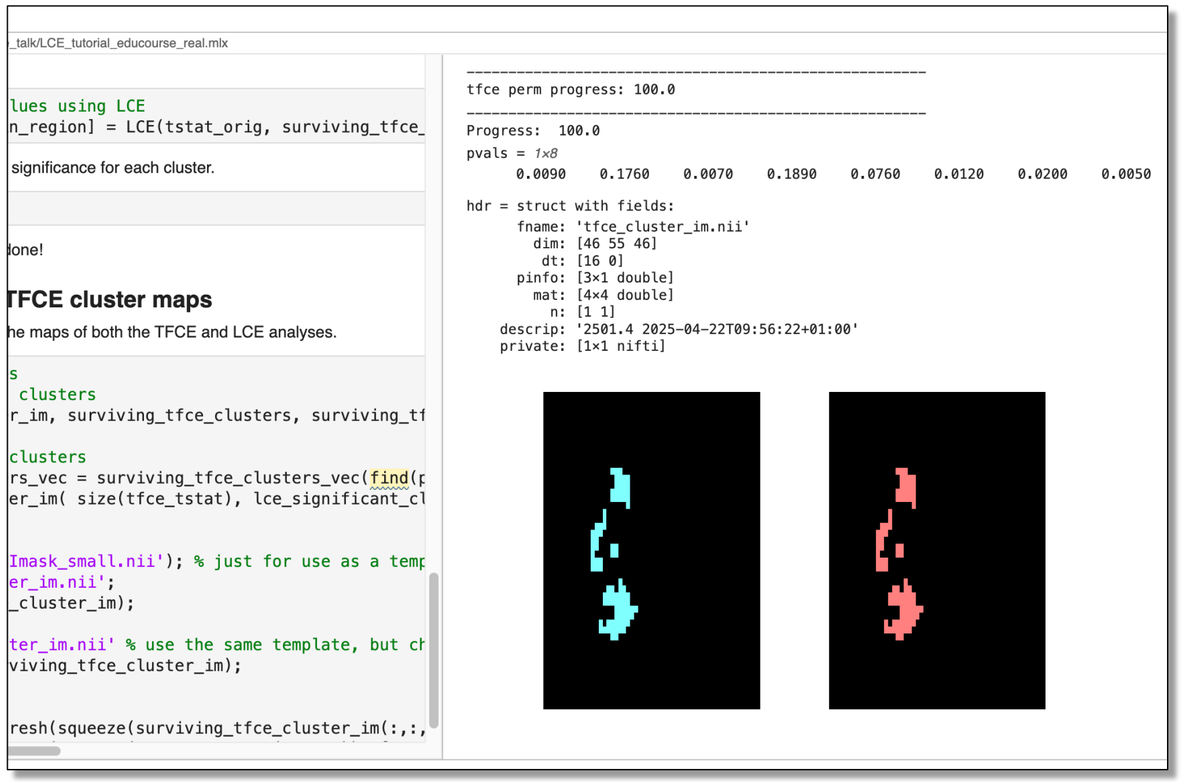
Localized Cluster Enhancement

- 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



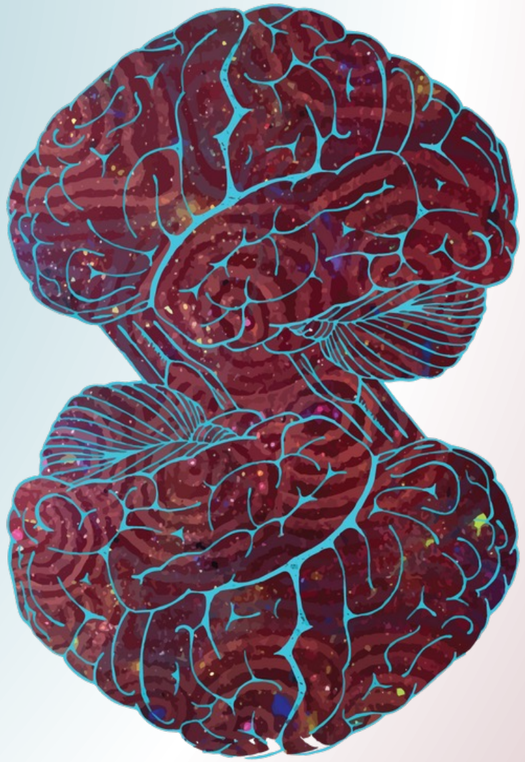
Localized Cluster Enhancement



Localized Cluster Enhancement

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

`github.com/sjdavenport/Statbrainz`



BRISBANE

OHBM 2025

JUNE
24–28