Retinotopic Map Exploration

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Injera/ RetinaZ
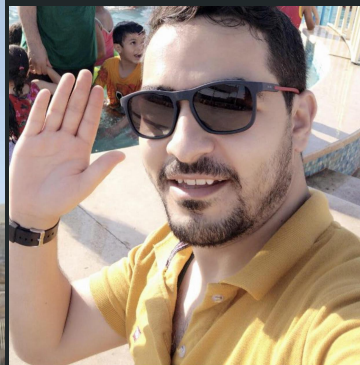
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Who Are We ?

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Contents:

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Retinotopy:

❖ Mapping of visual input from the retina to neurons [1]
❖ The acquisition, representation, and Analysis of human retinotopic maps have required in the use and development of various methods to investigate the neural activity of the visual cortex


● **Applications:**
● Computes the population receptive field from responses to a wide range of stimuli [2]
● Discovering the sizes and surface areas of different visual areas (V1, V2, V3) and finding the correlation between them [3]
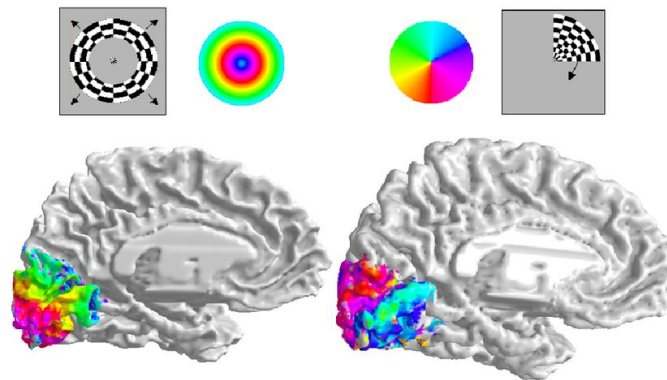
Q: How do neural responses differ when exposed to different types of stimuli?

- **Sub question 1:** Does the whole brain activity (average responses) show difference for each Stimulus?

- **Sub question 2:**
How the neural responses differ among voxels?
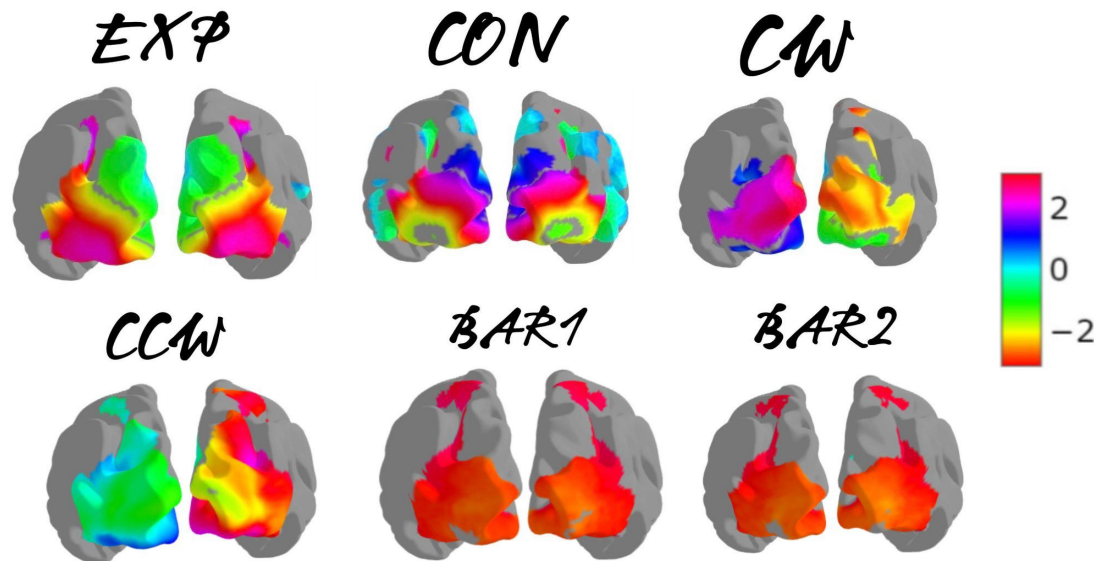
Hypotheses

❖ **H1:** Same responses when comparing averaged voxels

The data is averaged over 183 human subjects and the distribution of 91282 voxels responses will hide the exact differences

$$mu\_CON = mu\_EXP = mu\_CW = mu\_CCW = mu\_BAR1 = mu\_BAR2$$

❖ **H2:** Each voxels respond differently to stimuli

The neuronal response of the voxel depends on the selectivity to visual stimulus features

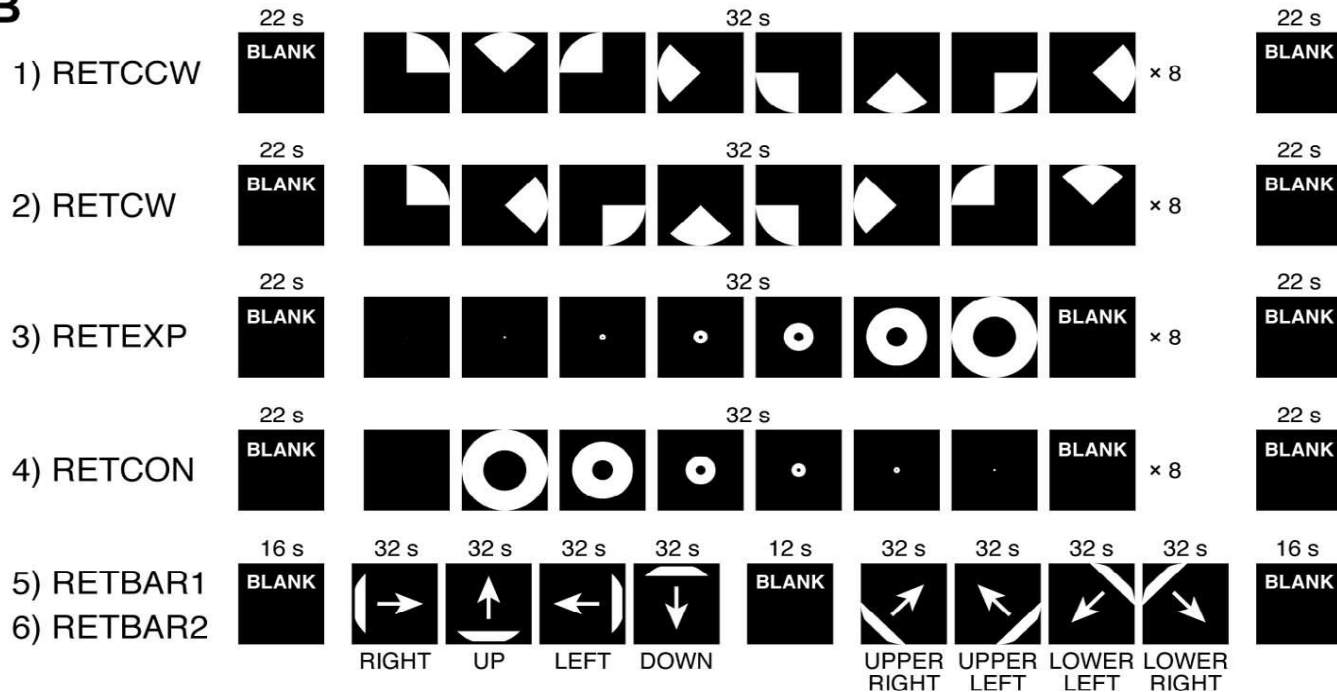$$mu\_i \neq mu\_j \; ; \; i \text{ and } j \text{ belongs to } \{1,2,\ldots,91282\}$$

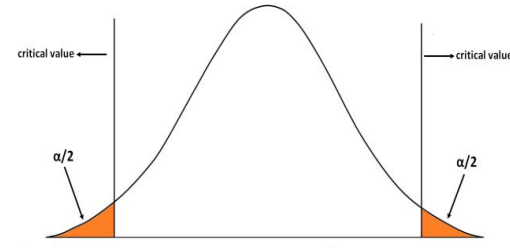# Dataset: HCP Retinotopic

- ❖ 183 Human subjects
- ❖ 6 stimuli:

{CCW - CW - Exp - Con

- Bar1 - Bar2}
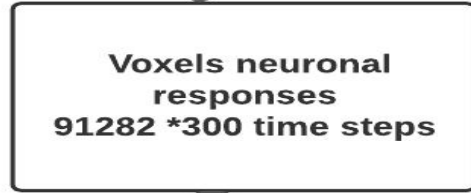
- ❖ 300*91282

Methodology

The Analysis at the distribution level

T_Test Results at the distribution level
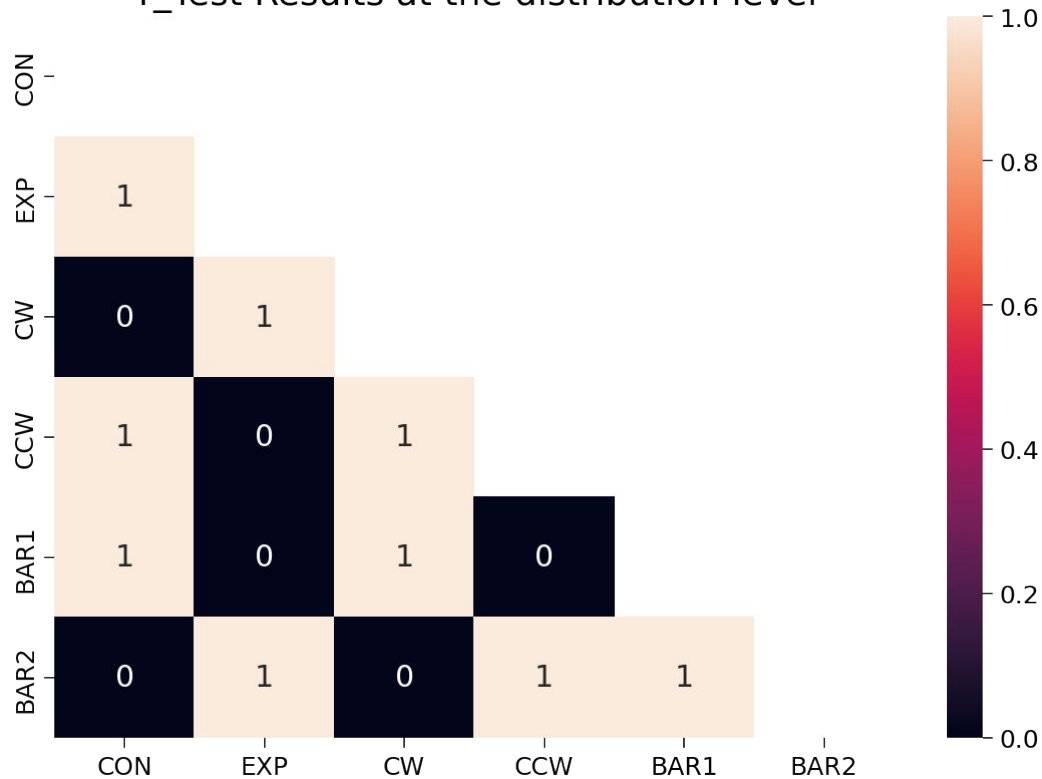
❖ 6 pairs show insignificant difference:

● {"CCW" and "BAR1"}
● {"CON" and "BAR2"}
● {"CW" and "BAR2"}
● {EXP and BAR1}
● {CON and CW}
● {CCW and EXP}

❖ 9 pairs show significant difference, like : EXP and CON

The analysis at the voxels level

❖ Voxels Level for whole **brain**:
  ● The t-test: more than 93% of the voxels are statistically different.

❖ Voxels Level for Regions of interest of:
  ● ROIs: **Visual cortex areas** tuned to moving objects, color, orientation, speed, direction. [5][6][7]

  ● There is slight difference for count of different voxels in each bair.

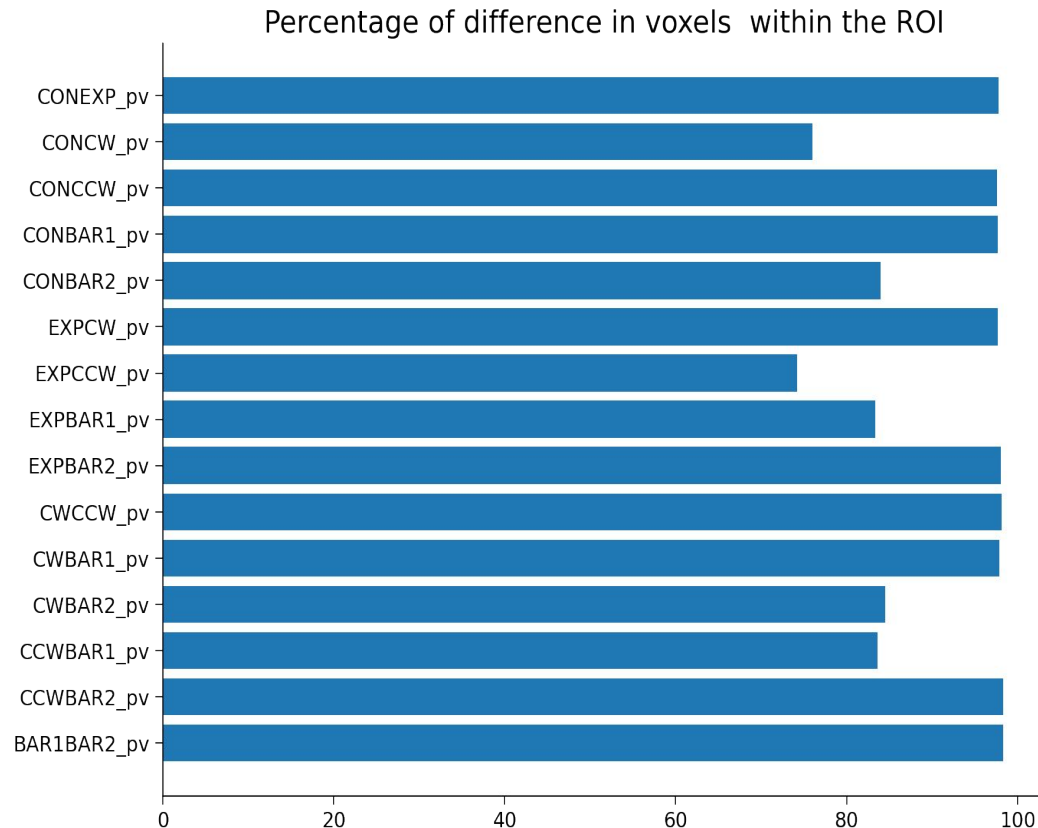
The ROI of the different voxels of BAR1BAR2
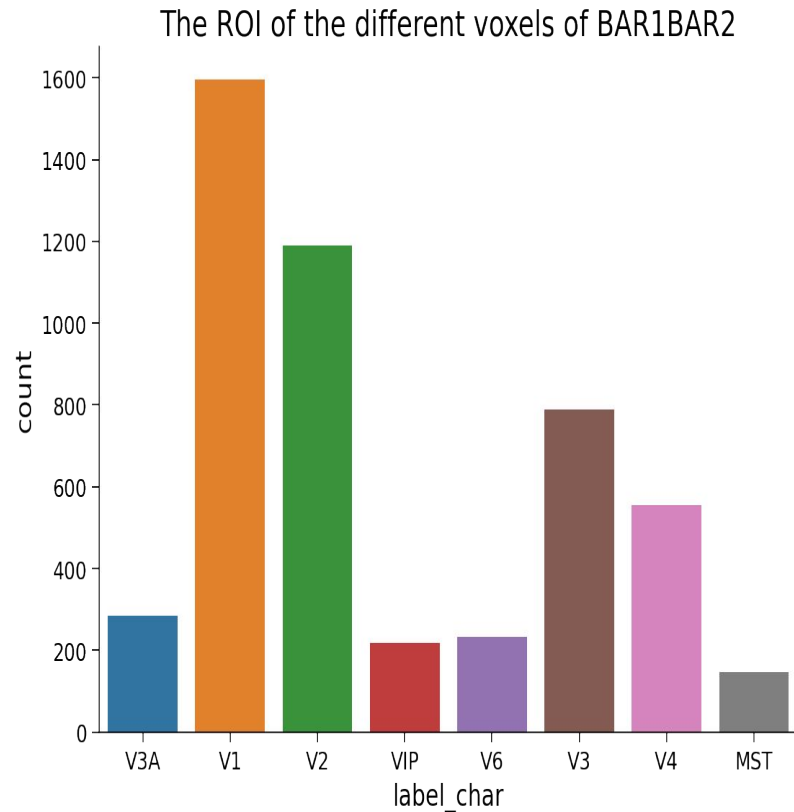
Visualization of the Regions of interest activity
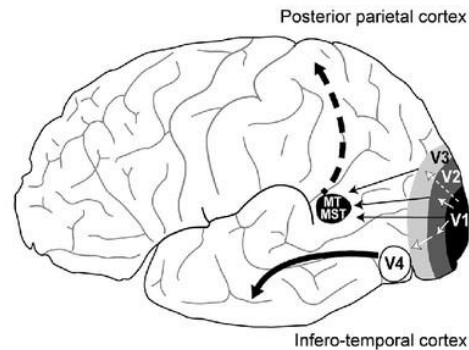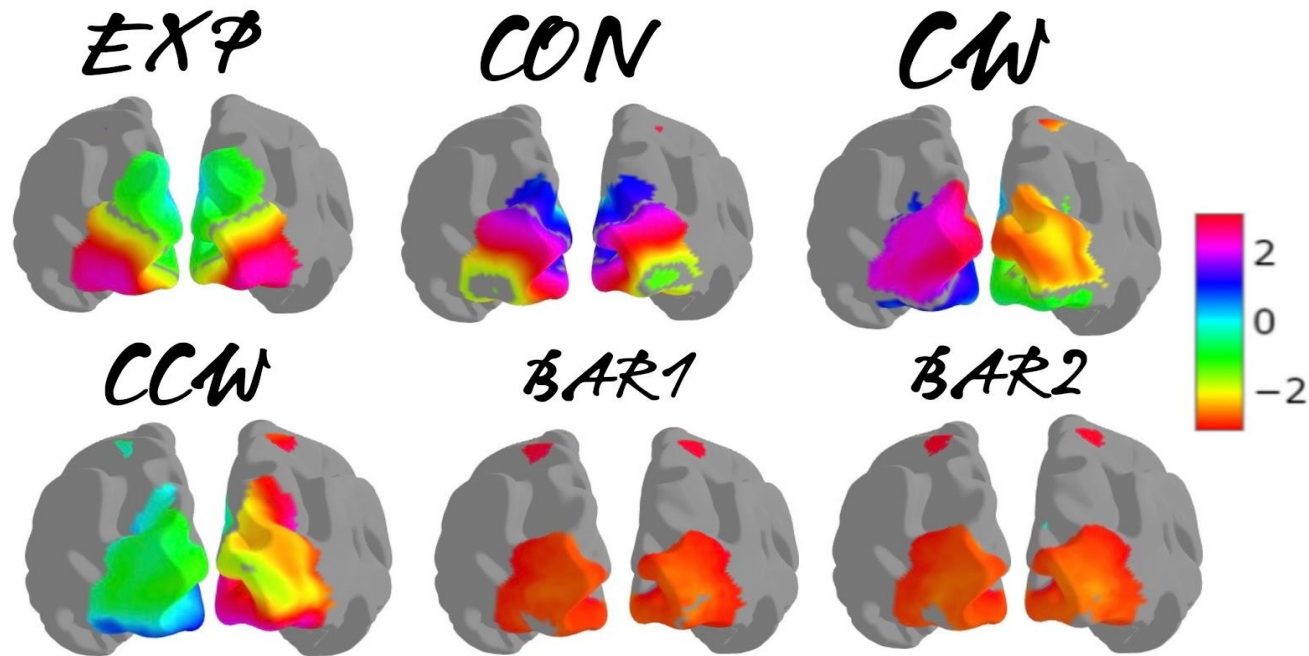
Results of voxel-by-voxel analysis of ROIs

❖ The t-test: Ranges in (74~98) % of the ROIs voxels are statistically different.

Percentage of difference in voxels within the ROI

Conclusion

- **At the whole brain level**: neural response showed difference between stimuli of opposite patterns (ex. CW & CCW), which means we can still use the overall distribution of responses to differentiate between opposite patterns.

- **At the voxel-by-voxel level for whole brain**: >93% of voxels respond differently even with pairs that showed insignificant difference in the whole brain analysis level.

- **At the voxel-by-voxel level for ROIs**: 74% ~ 98% of voxels are selective to pairs of stimuli.
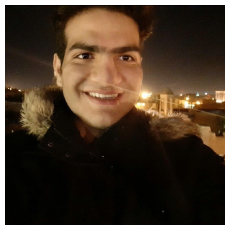
Future work:

❖ Analyze difference between stimuli at regions level (average voxels response over region).

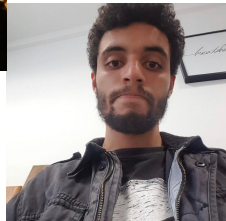❖ Individual fMRI dataset can be used in Biometrics widely as the dataset is individual selective.

References

[1] Wikipedia, https://en.wikipedia.org/wiki/Retinotopy

[2] Dumoulin, S. O. et al., Population receptive field estimates in human visual cortex, https://www.sciencedirect.com/science/article/abs/pii/S1053811907008269

[3] Dougherty, Robert F., et al. "Visual field representations and locations of visual areas V1/2/3 in human visual cortex, https://jov.arvojournals.org/article.aspx?articleid=2192509

[4] Benson, Noah C., et al. "The Human Connectome Project 7 Tesla retinotopy dataset: Description and population receptive field analysis." https://jov.arvojournals.org/article.aspx?articleid=2719988

[5] Wikipedia, https://en.wikipedia.org/wiki/Visual_cortex

[6] Direct Science, https://www.sciencedirect.com/topics/psychology/medial-temporal-lobe

[7] Scholarpedia, http://www.scholarpedia.org/article/Inferior_temporal_cortex

Many Thanks to ❤❤ ❤

Aryan

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