Face-deprived networks show distributed but not clustered face-selectivity

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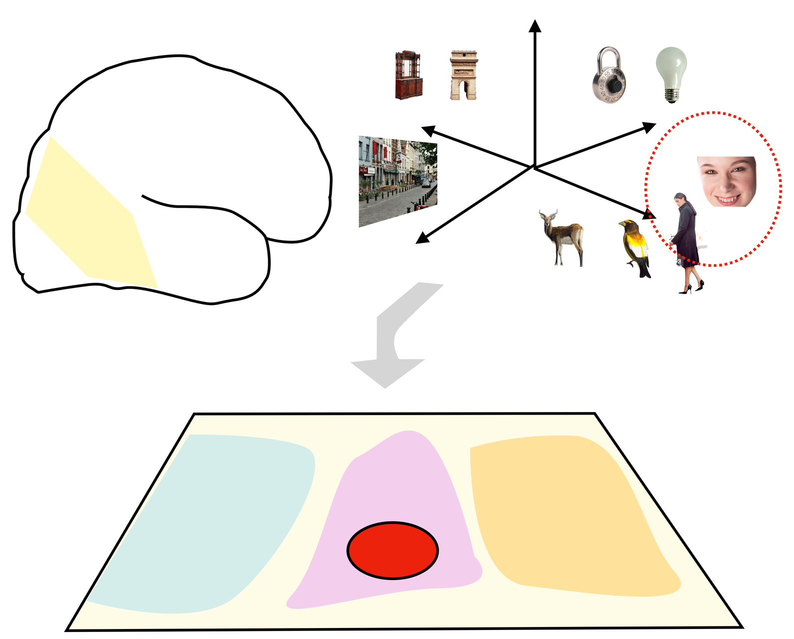
QUESTION

Depicted faces have particular sets of image statistics, and are known to drive particular regions of high-level visual cortex

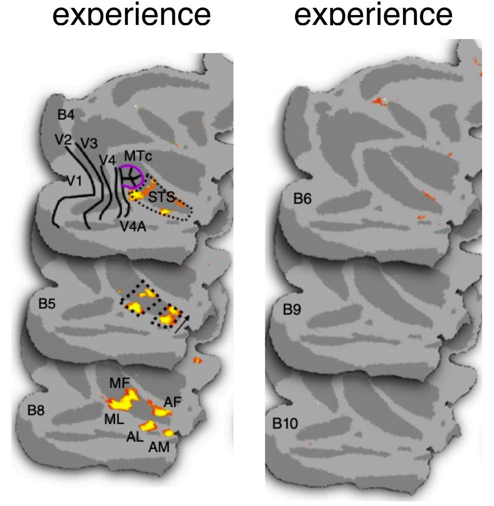
Hesse & Tsao, 2020

Hypothesis



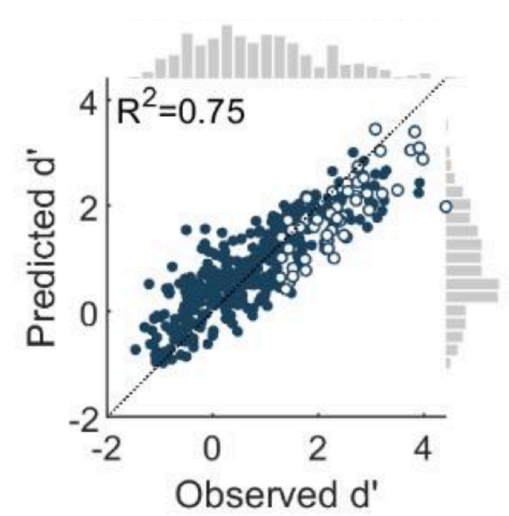
What kind of visual experience? Do we need to specifically see "faces" for face-selectivity to emerge?

No face patch in monkeys reared with face-deprivation



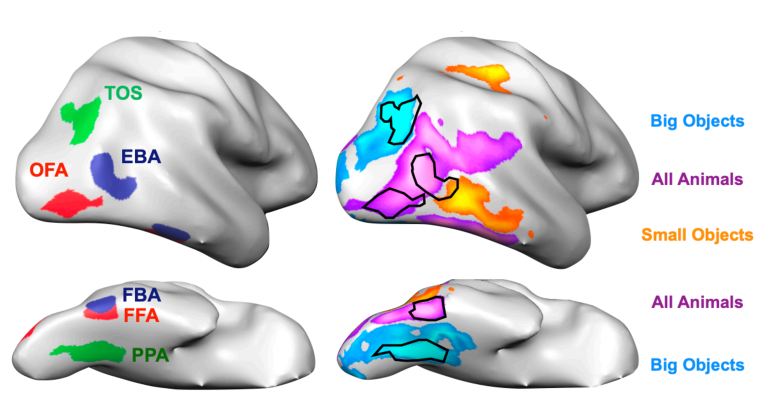
Arcaro et al., 2017

Face-selectivity in IT can be predicted with non-face objects that share visual features with faces



Vinken et al., 2022

Face-selective regions are facets of more general organizations

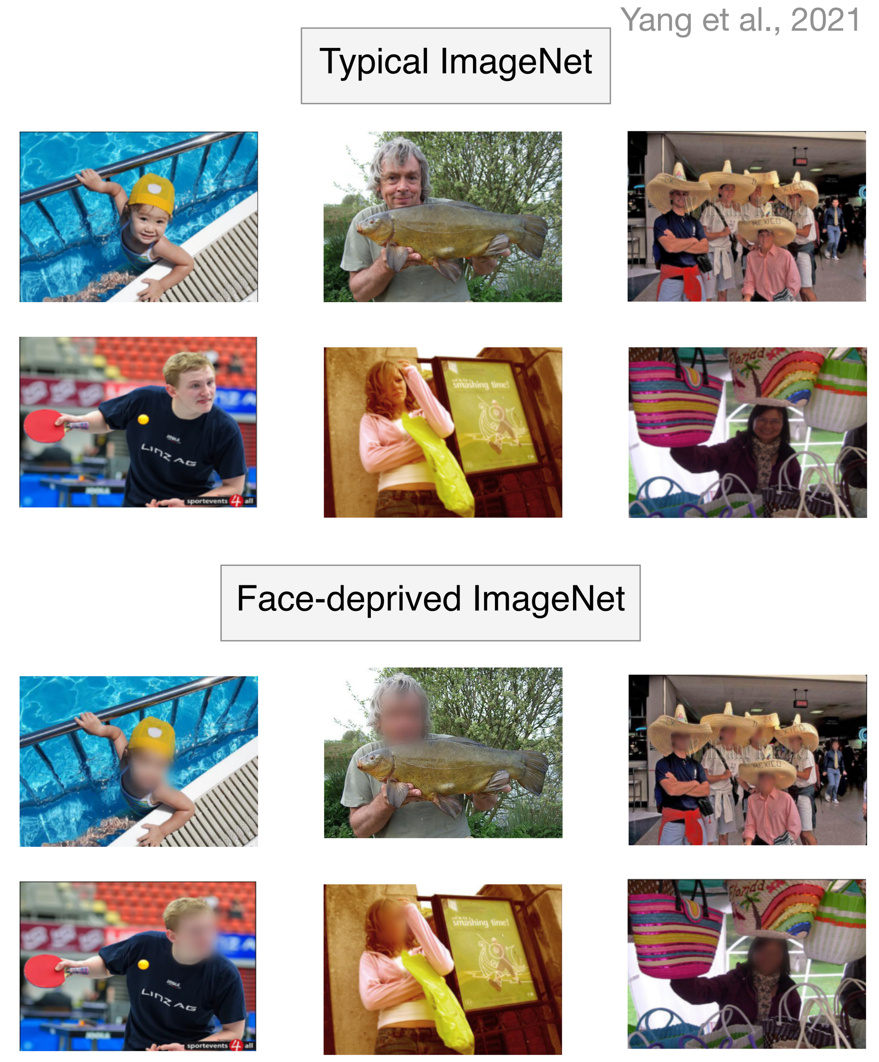


Konkle & Caramazza, 2013

METHOD

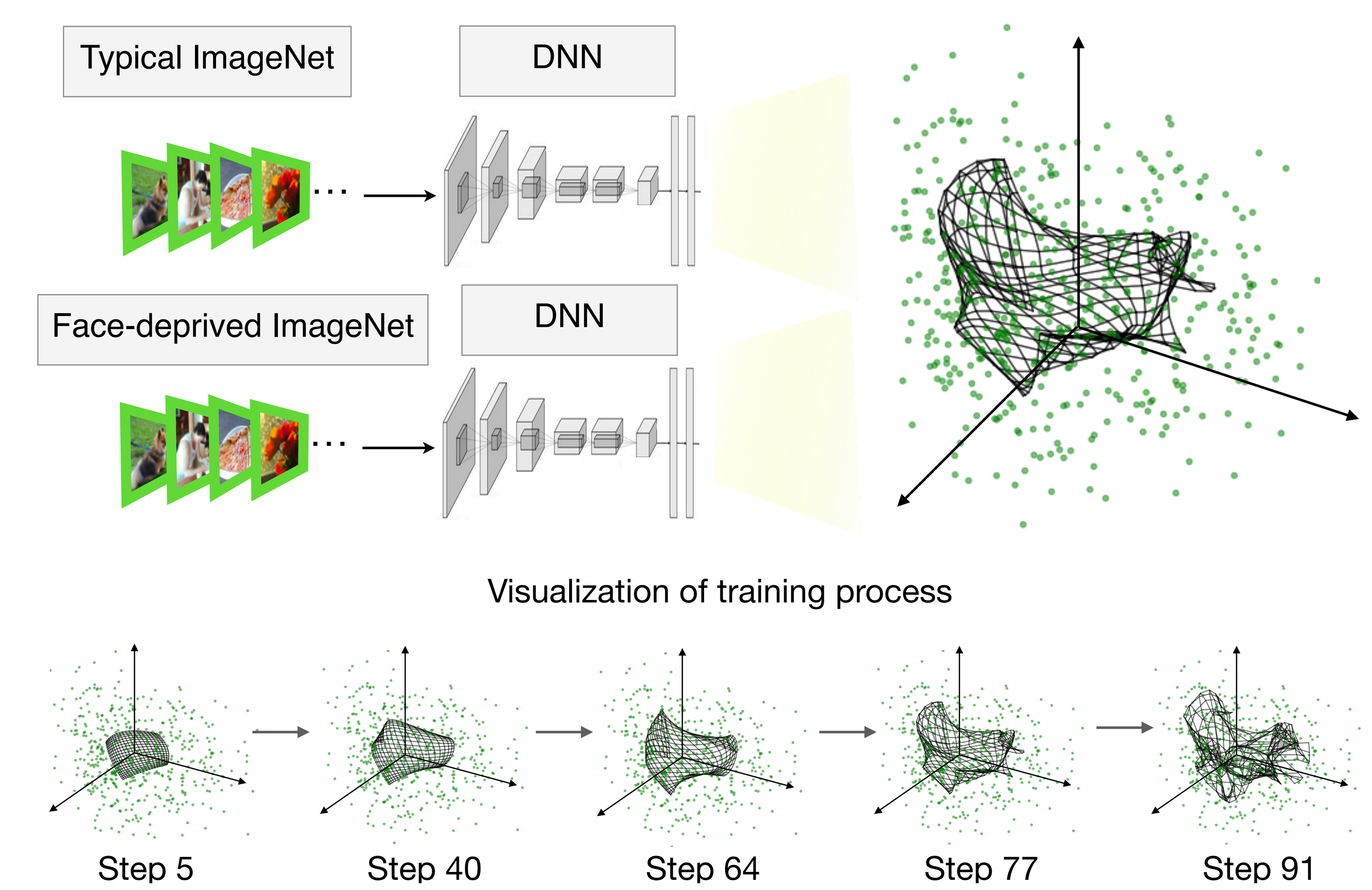
Critical Manipulation: Visual Diet

Yang et al., 2021

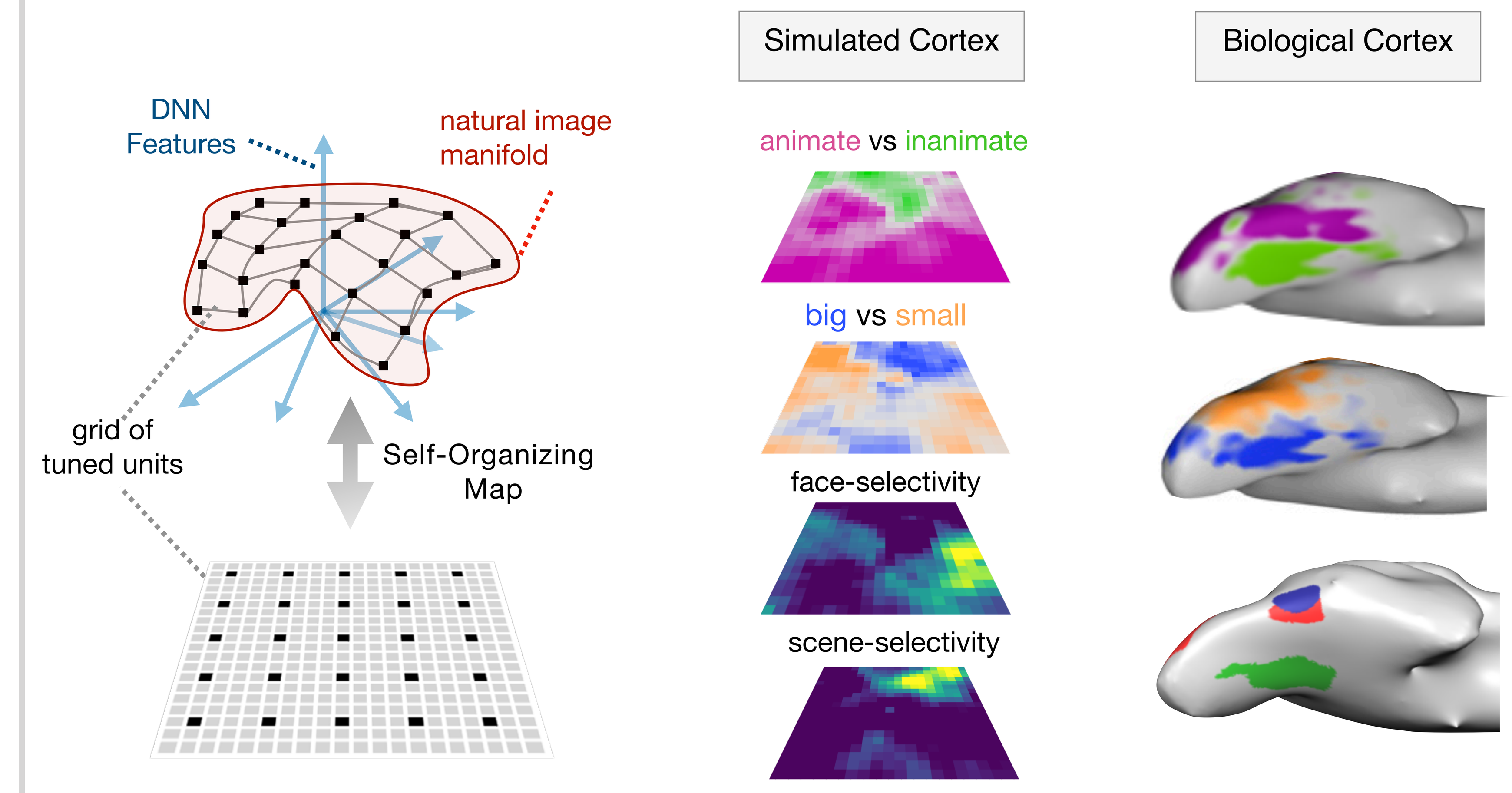


Training Self-Organizing Maps to smoothly map the learned feature spaces

Kohonen, 1990



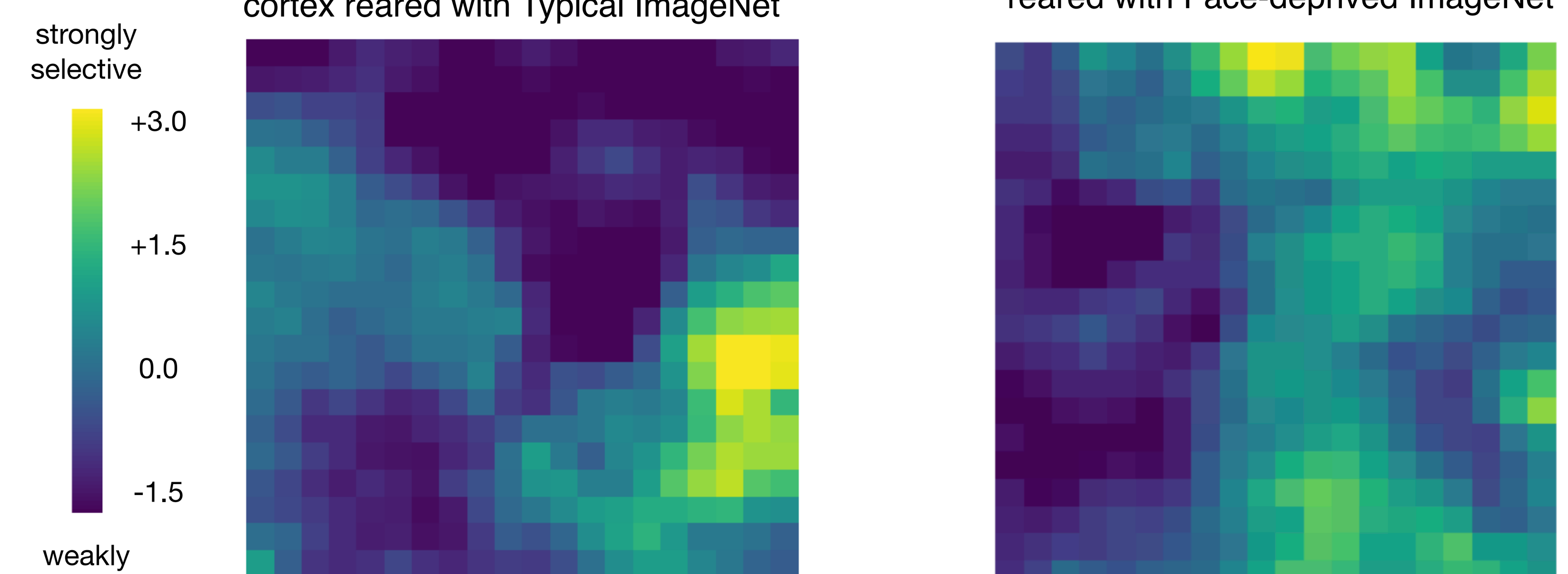
SOMs reveal cortical topographic motifs



Doshi & Konkle, 2023; Konkle & Caramazza, 2013

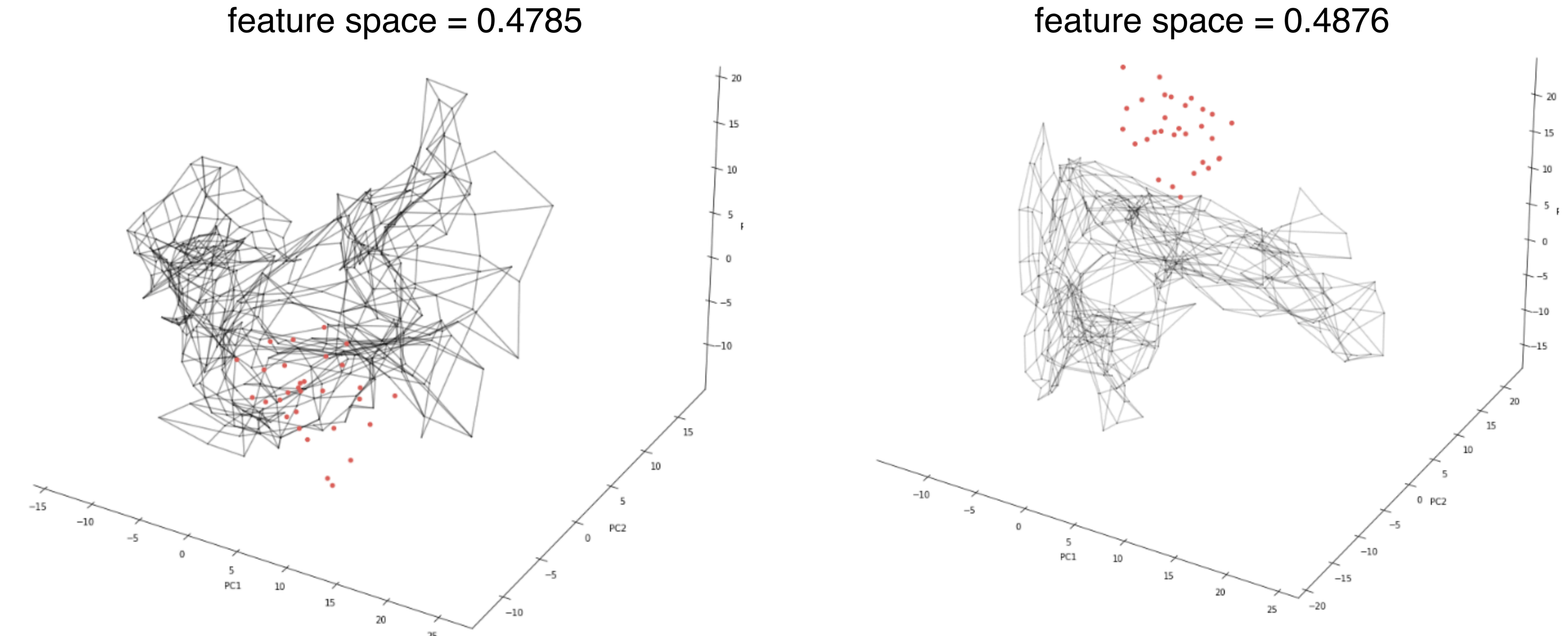
RESULT

How does face-selectivity get mapped in these 2 feature spaces?



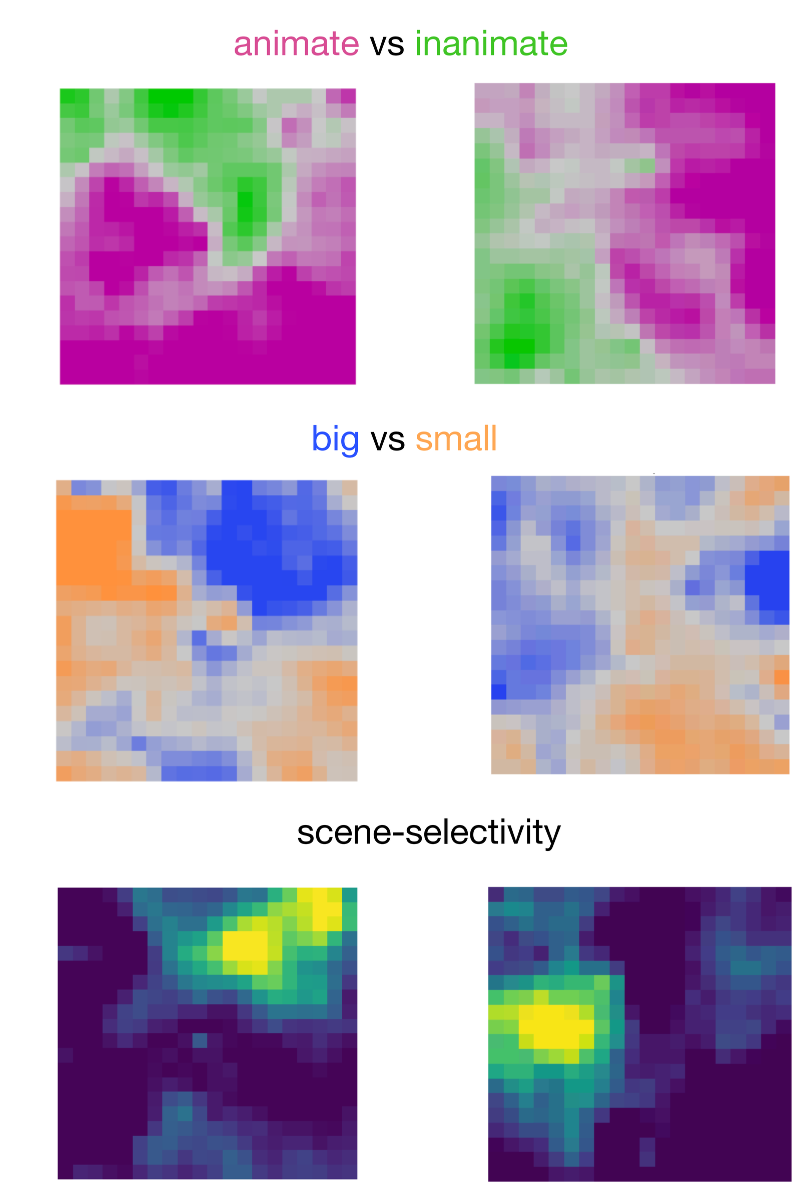
Pairwise cosine distance in DNN feature space = 0.4785

Pairwise cosine distance in DNN feature space = 0.4876



Experiencing human faces in addition to other image statistics leads to clustered human face-selectivity

What about other topographic organizations?



All other maps remain intact

CONCLUSIONS

This study reveals that certain shared characteristics between faces and non-faces result in non-faces invoking distributed face-selectivity.

Vinken et al., 2022

However, these analyses also suggest that faces have partially distinct image statistics; visual experience with faces leads to increased face-clustering in the population code and localized face-tuning regions in the self-organizing map.

REFERENCES

1. Hesse, J. K., & Tsao, D. Y. (2020). The macaque face patch system: a turtle's underbelly for the brain. *Nature Reviews Neuroscience*, *21*(12), 695-716.
2. Arcaro, M. J., Schade, P. F., Vincent, J. L., Ponce, C. R., & Livingstone, M. S. (2017). Seeing faces is necessary for face-domain formation. *Nature neuroscience*, *20*(10), 1404-1412.
3. Vinken, K., Prince, J. S., Konkle, T., & Livingstone, M. (2022). The neural code for 'face cells' is not face specific. *bioRxiv*, 2022-03.
4. Konkle, T., & Caramazza, A. (2013). Tripartite organization of the ventral stream by animacy and object size. Journal of Neuroscience, 33(25), 10235-10242.
5. Yang, K., Yau, J. H., Fei-Fei, L., Deng, J., & Russakovsky, O. (2022, June). A study of face obfuscation in imagenet. In *International Conference on Machine Learning* (pp. 25313-25330). PMLR.
6. Kohonen, T. (1990). The self-organizing map. *Proceedings of the IEEE*, *78*(9), 1464-1480.
7. Doshi, F. R., & Konkle, T. (2022). Visual object topographic motifs emerge from self-organization of a unified representational space. *BioRxiv*, 2022-09.

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