Hyperalignment Increases Reliability and Consistency of Individual Differences in Brain Responses

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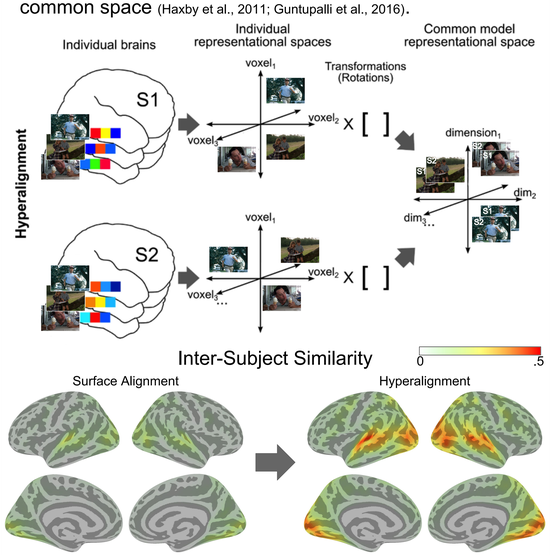
Background

Hyperalignment increases inter-subject similarities by transforming individual representational spaces into a common space (Haxby et al., 2011; Guntupalli et al., 2016).



Question

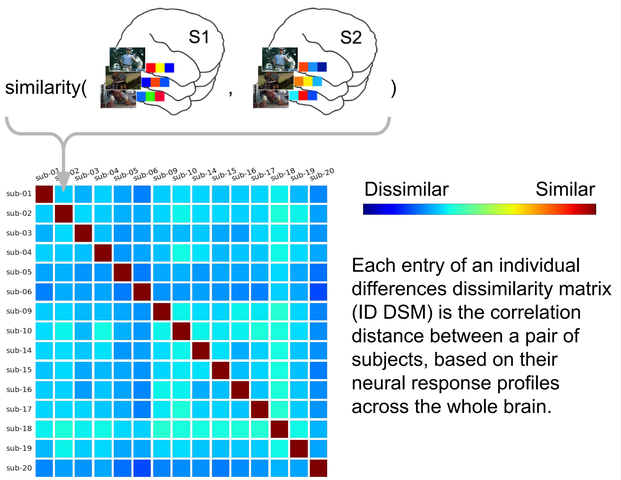
Do individual differences still persist with such increase of inter-subject similarities?

Datasets

- 15 subjects watched a full-length audio-visual movie (*Forrest Gump*) in an fMRI scanner (Hanke et al., 2016)

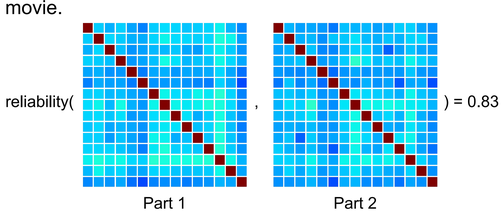
- Standard preprocessing
  - Aligned and projected to standard surface; Regressed out motion parameters and polynomial trends; Normalized
- Validation
  - Hyperaligned w/ the 1st half of the movie
  - The 2nd half of the movie was further split into 2 parts for analyses
- Replication w/ an independent movie dataset (*Raiders of the Lost Ark*)

Individual Differences Dissimilarity Matrices



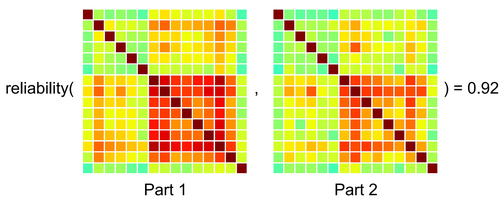
Each entry of an individual differences dissimilarity matrix (ID DSM) is the correlation distance between a pair of subjects, based on their neural response profiles across the whole brain.

ID DSM reliability was measured as the correlation between vectorized upper-triangles of ID DSMs from two different parts of the movie.



= 0.83

The analysis was repeated on the same dataset after performing searchlight hyperalignment (Guntupalli et al., 2016).



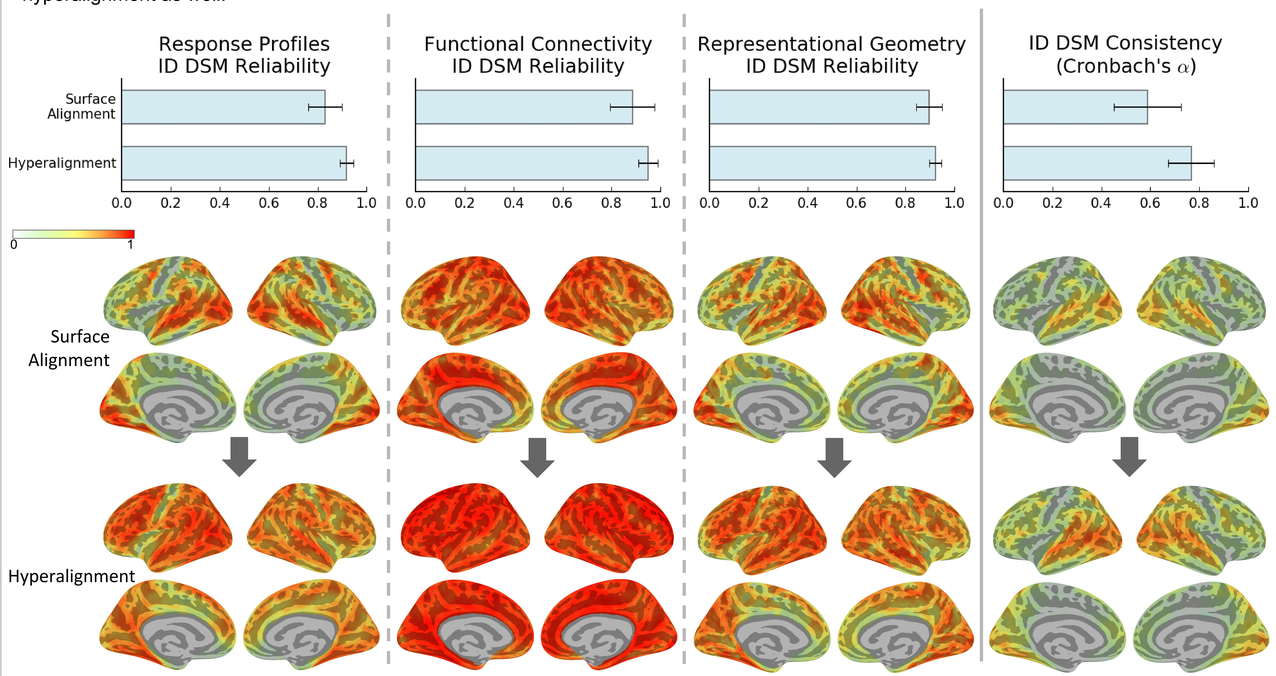
= 0.92

$p < .01$

ID DSM Reliability

ID DSMs could also base on individual differences in functional connectivity or representational geometry instead of neural response profiles, and they all have higher reliability after hyperalignment. Furthermore, the 3 kinds of ID DSMs' consistency, measured by Cronbach's α, also increased with hyperalignment.

Local ID DSMs, measured by responses from a 9-mm searchlight instead of the whole brain, have higher reliability and consistency after hyperalignment as well.



Replication

	Response Profiles	Functional Connectivity	Representational Geometry	Cronbach's α
Whole Brain	.84 → .88	.75 → .89	.61 → .64	.66 → .72
Searchlight Average	.47 → .66	.70 → .84	.43 → .60	.28 → .45

Summary

Individual differences in whole brain and local responses both become more reliable and consistent after hyperalignment.

References

Guntupalli, J. S., Hanke, M., Halchenko, Y. O., Connolly, A. C., Ramadge, P. J., & Haxby, J. V. (2016). A Model of Representational Spaces in Human Cortex. *Cerebral Cortex*, 26(6), 2919–2934. doi: 10.1093/cercor/bhw068

Hanke, M., Adelhöfer, N., Kottke, D., Iacovella, V., Sengupta, A., Kaule, F. R., ... Stadler, J. (2016). A studyforrest extension, simultaneous fMRI and eye gaze recordings during prolonged natural stimulation. *Scientific Data*, *3*, 160092. doi: 10.1038/sdata.2016.92

Haxby, J. V., Guntupalli, J. S., Connolly, A. C., Halchenko, Y. O., Conroy, B. R., Gobbini, M. I., ... Ramadge, P. J. (2011). A Common, High-Dimensional Model of the Representational Space in Human Ventral Temporal Cortex. *Neuron*, *72*(2), 404–416. doi: 10.1016/j.neuron.2011.08.026

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