Attention alters the representational geometry of a perceptual feature space

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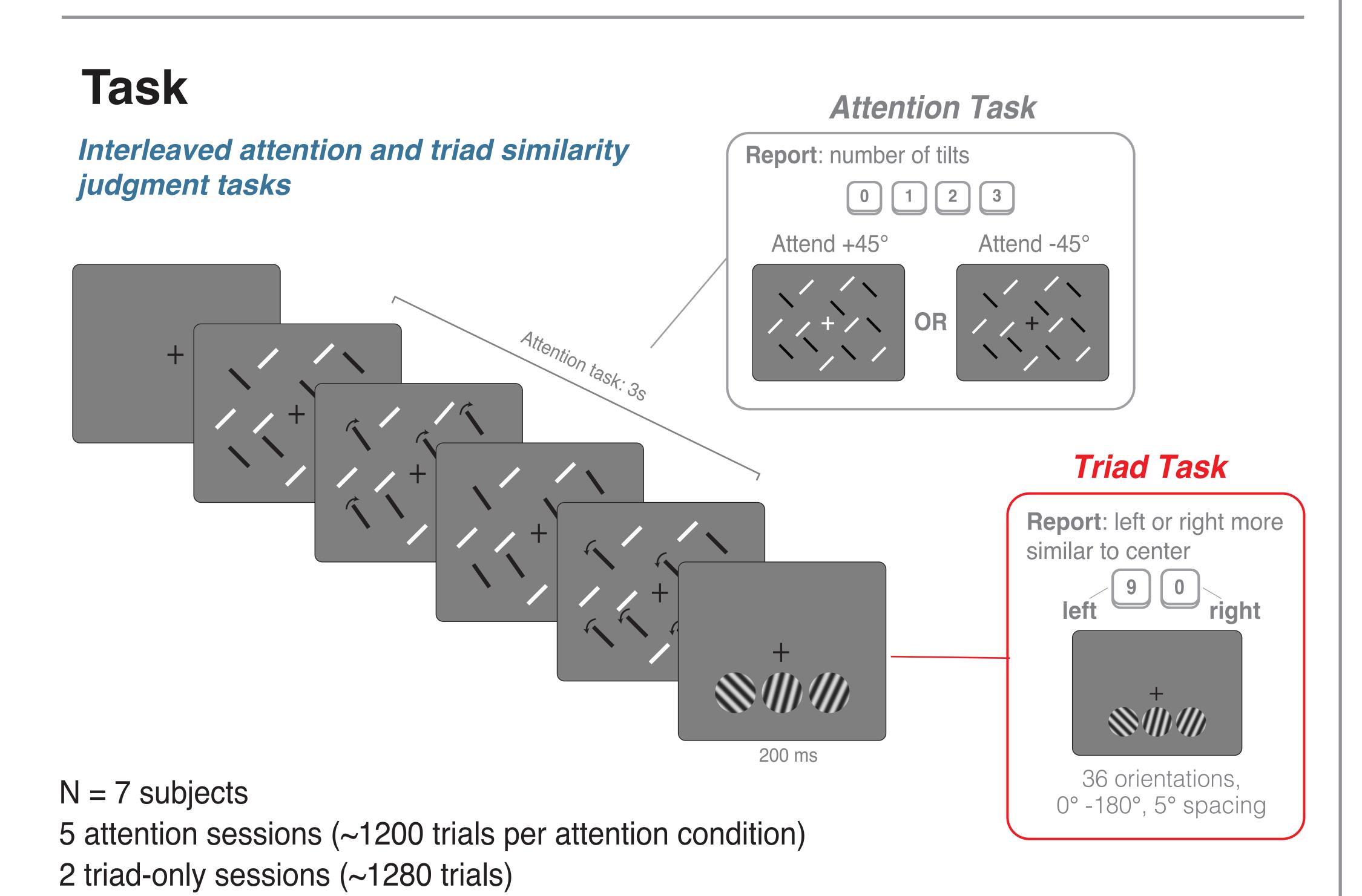Department of Psychological & Brain Sciences, Boston University

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Background

- Attention enhances the perception of visual information[1], and can alter the appearance of stimuli[2,3,4]
- These effects can be characterized by changes in **representational geometry** [5,6]: a computational framework that quantifes the structural relationship between different stimuli
- Attention can alter the representational distances near an attended feature[7], however the effects of attention on the entire representational space are yet to be investigated

Question

How does attention affect the global representational structure of orientation?

Task

Interleaved attention and triad similarity judgment tasks

N = 7 subjects
5 attention sessions (~1200 trials per attention condition)
2 triad-only sessions (~1280 trials)

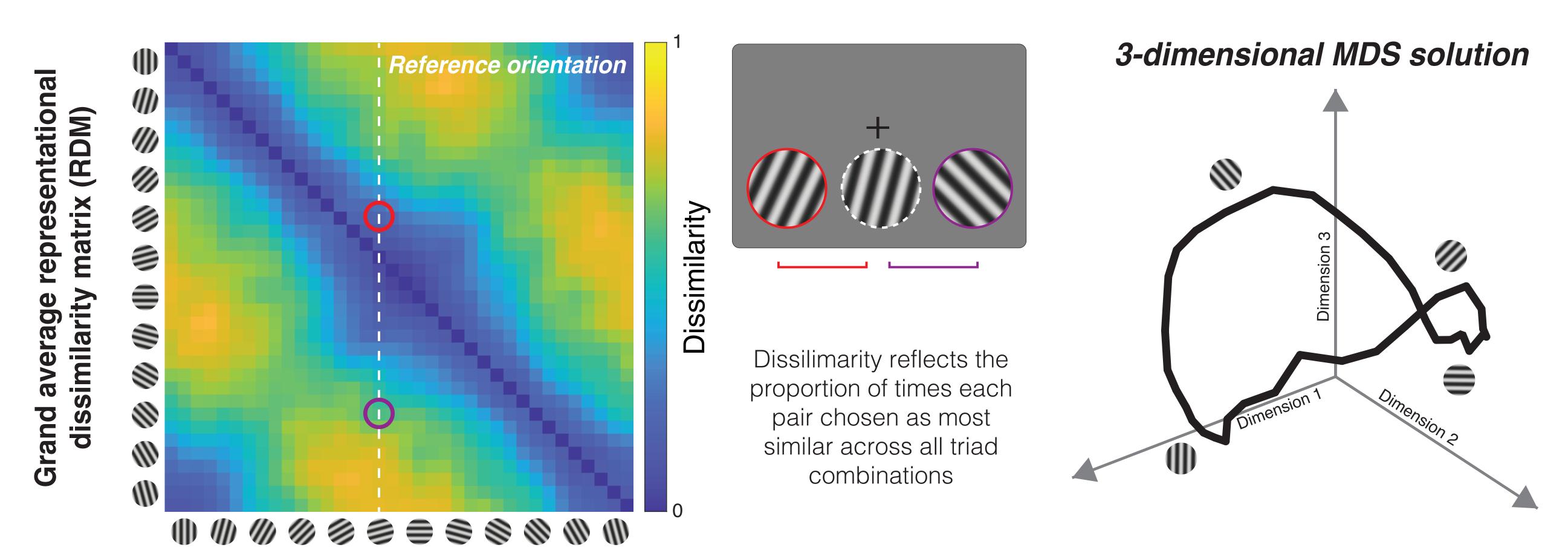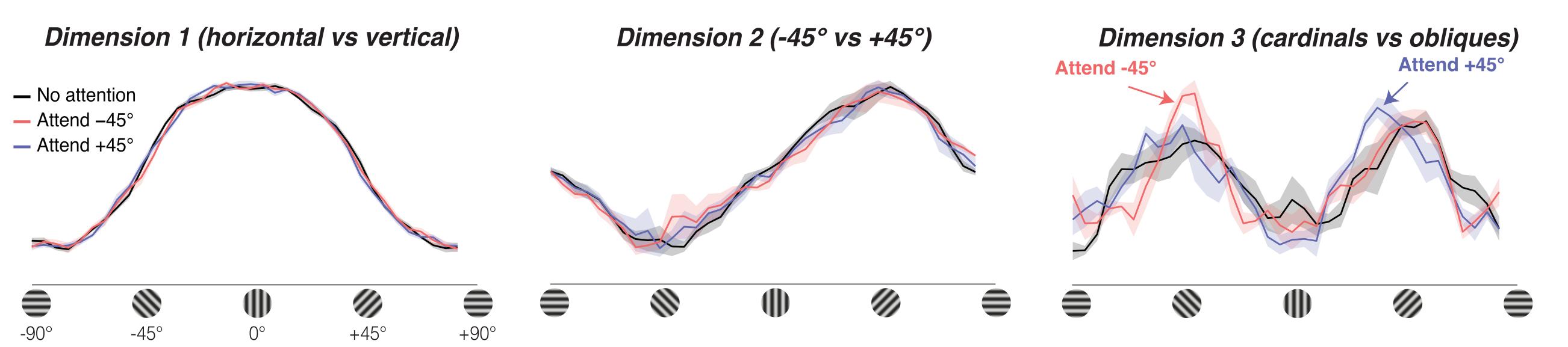## References

1. Carrasco, M. (2011). Vis Research, 51, 1484-1525.
2. Carrasco, M., Ling, S., & Read, S. (2004). Nat Neurosci, 7(3), 308-313.
3. Suzuki, S. & Cavanagh, P. (1997). J Exp Psychol: Hum Percept & Perform, 23(2), 443-463.
4. Chapman, A. F., Chunharas, C., & Störmer, V. S. (2023). Sci Rep, 13, 6487.401-412.
5. Kriegeskorte, N. & Kievit, R. A. (2013). TICS, 17(8), 401-412.
6. Kriegeskorte, N. & Wei, X.-X. (2021). Nat Rev Neurosci, 22, 703-718.
7. Chapman, A. F. & Störmer, V. S. (2024). TICS, 28(5), 416-427.

Attention affects the representational geometry of orientation

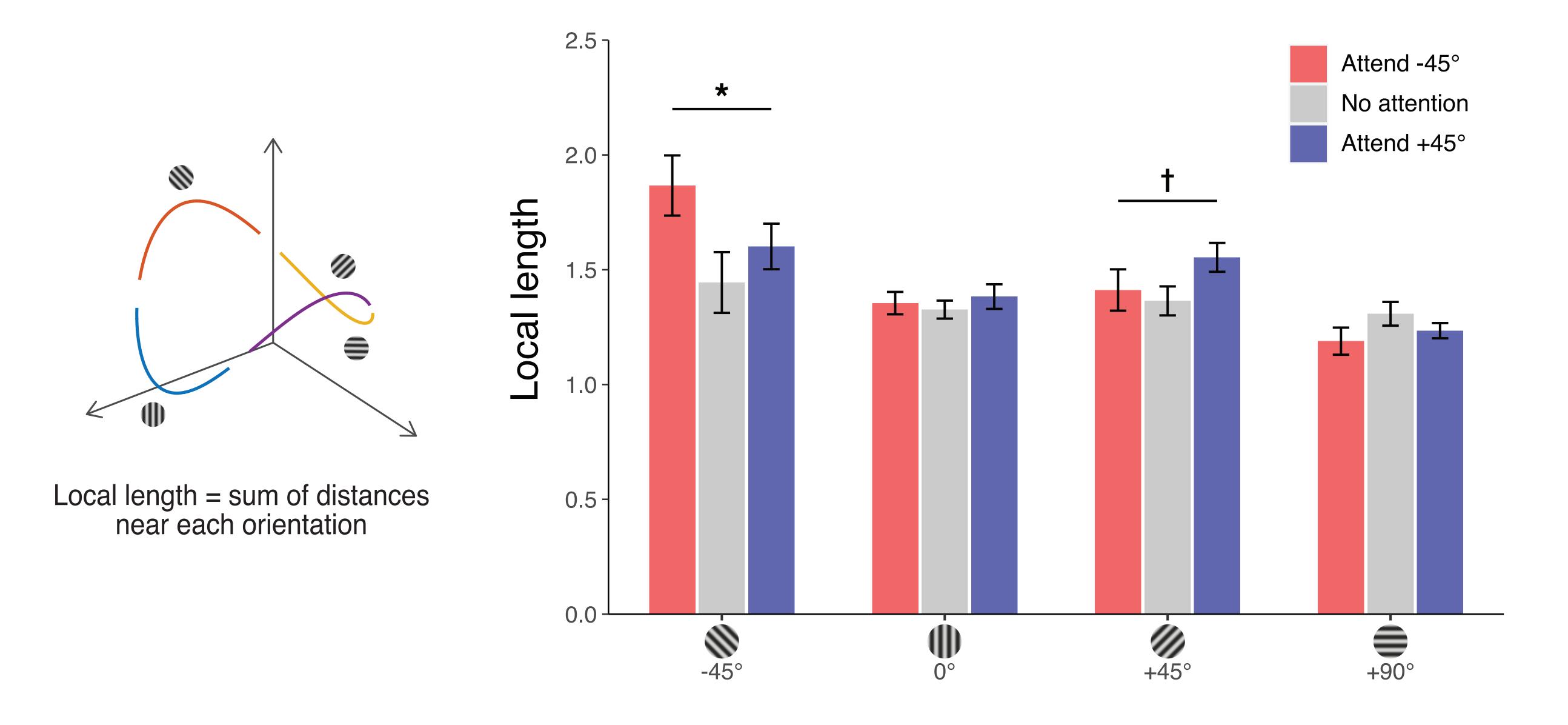### Multidimensional scaling reveals a 3-dimensional orientation representation

Dissimilarity reflects the proportion of times each pair chosen as most similar across all triad combinations
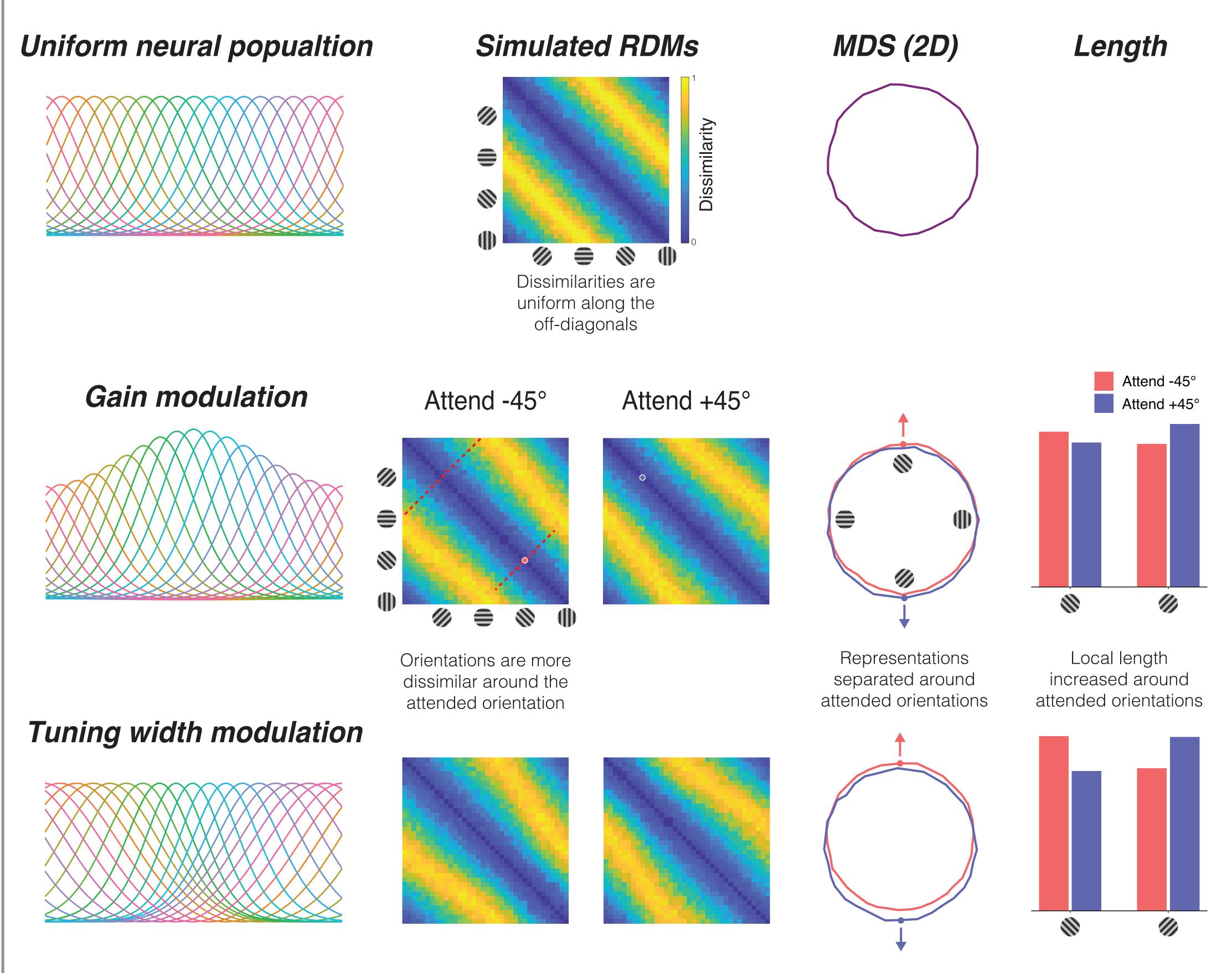
Representations around the target orientation are expanded by attention

Representational distance changed near but not far from attended orientation

Local length = sum of distances near each orientation

Simulation of representational changes under attention

Gain and tuning width modulations induce shifts in geometry

Dissimilarities are uniform along the off-diagonals

Orientations are more dissimilar around the attended orientation

Representations separated around attended orientations

Local length increased around attended orientations

Conclusions

- Triad task responses revealed a 3-dimensional representation of orientation
- Attention modulated this representation, resulting in increased length around attended orientations, however there was no evidence for changes around unattended orientations
- Simulations incorporating modulations in neural gain or tuning width resulted in changes in representational geometry consistent with the observed behavioral findings
- This suggests that attention acts to expand the representation around relevant features to enable efficient selection