

Using Closed-Loop Real-Time fMRI Neurofeedback to Induce Neural Plasticity and Influence Perception

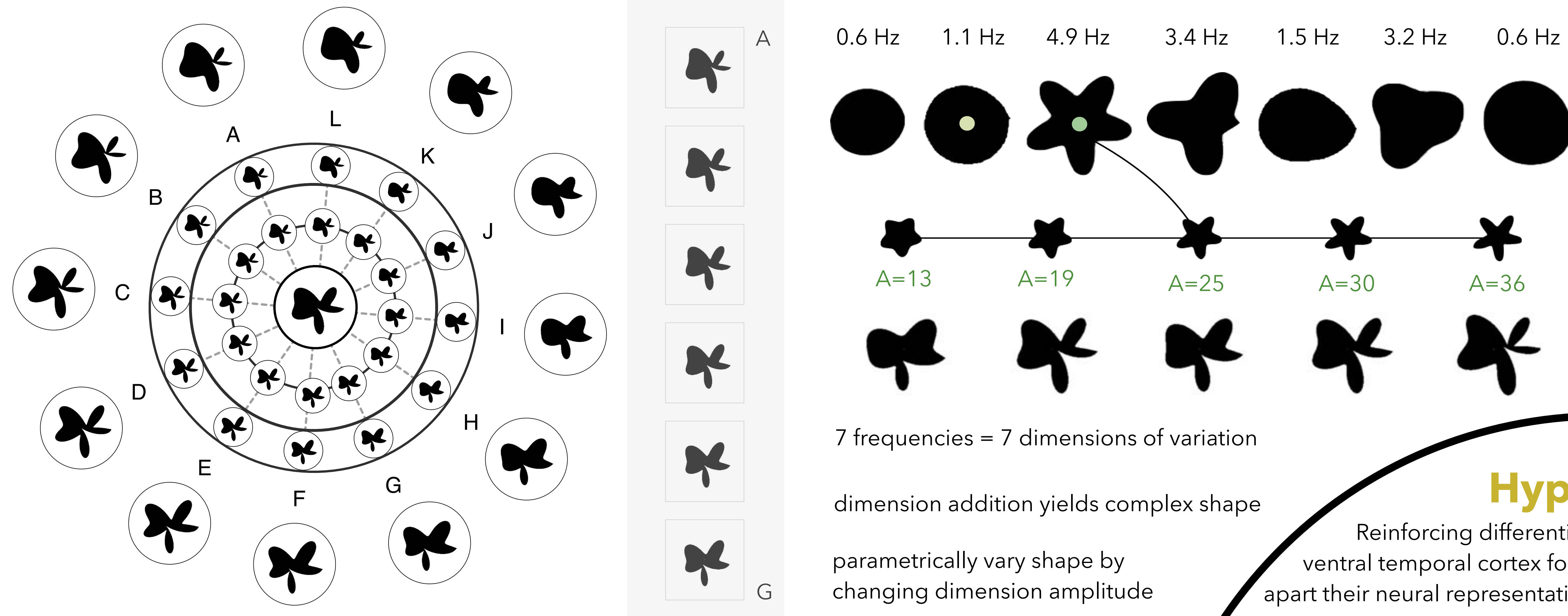


Marius Cătălin Iordan¹, Victoria J.H. Ritvo¹, Kenneth A. Norman¹, Nicholas B. Turk-Browne², Jonathan D. Cohen¹

¹Princeton Neuroscience Institute & Psychology Department, Princeton University ²Psychology Department, Yale University
 mci@princeton.edu vej@princeton.edu knorman@princeton.edu nicholas.turk-browne@yale.edu jdc@princeton.edu



Abstract Multidimensional STIMULUS SPACE



real-world objects
 features difficult to control
 decades of experience
 changes too transient?

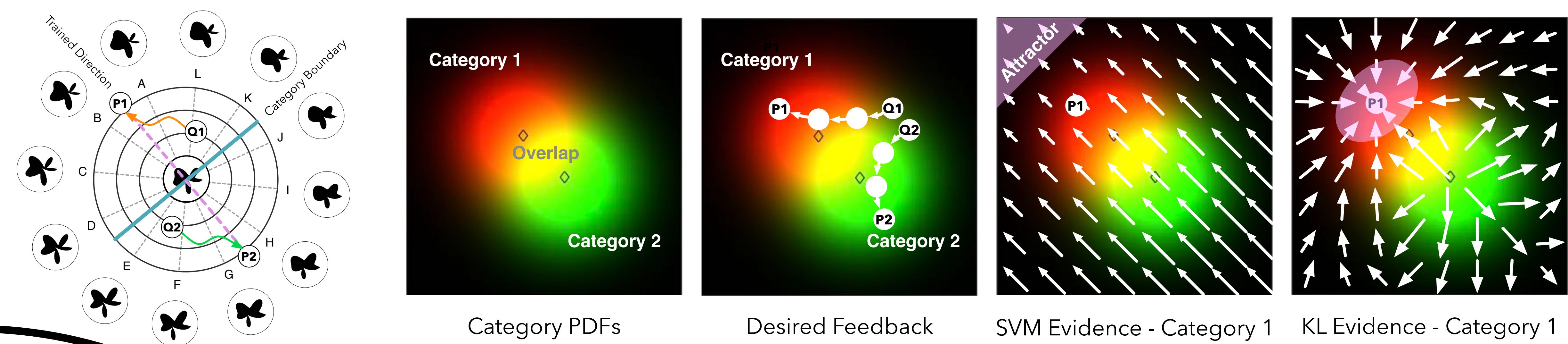
artificial object space
 full parametric control
 no extant category bias
 simple, but still 'objects'



NEUROFEEDBACK: KL-Evidence Model Simulations and Training Task

If the Neural Representations of Two Shapes Become More Similar, They May Be Perceived More Similarly

Drive neural activity for shapes near category boundary towards category prototypes (P1 & P2): $KL\text{-Evidence} = p1 * \log(p1/p2)$



Feedback based on standard MVPA classifier (SVM) drives activity away from category boundary in arbitrary directions
 KL-Evidence may do a better job at shifting activity patterns towards specific points in neural space: P1 & P2

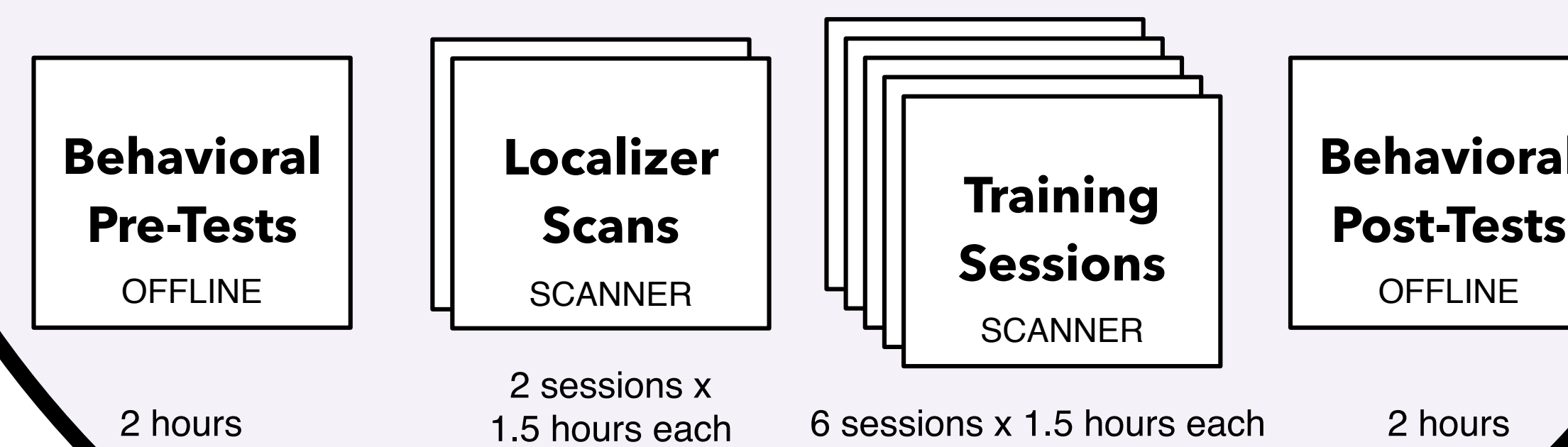
Hypothesis

Reinforcing differential neural activity patterns in ventral temporal cortex for visually similar shapes will drive apart their neural representations and reduce perceptual similarity

trial-level fast timescale access neural pattern change neural representation

real-time fMRI neurofeedback below threshold of awareness

no explicit top-down learning signal

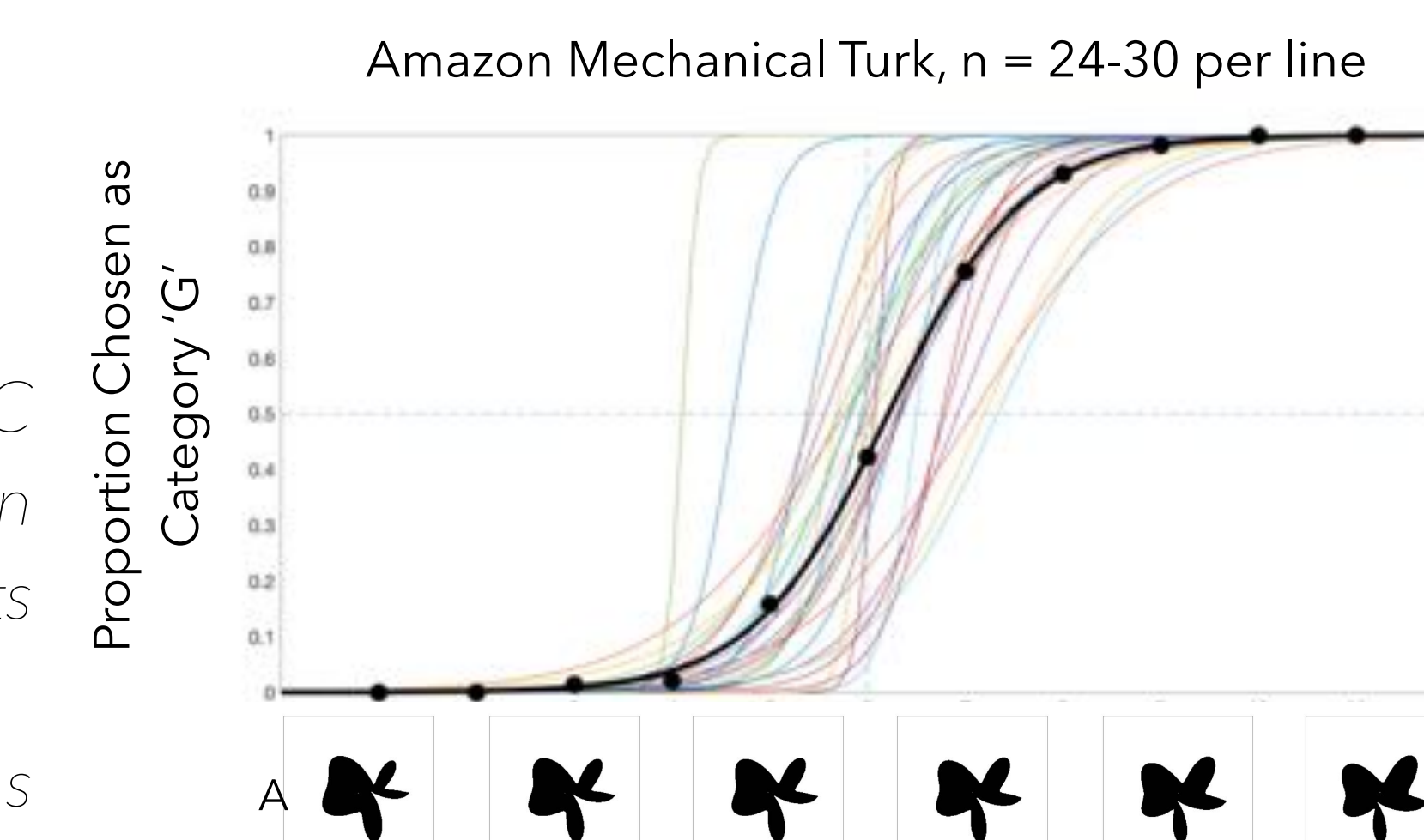


Experimental Design

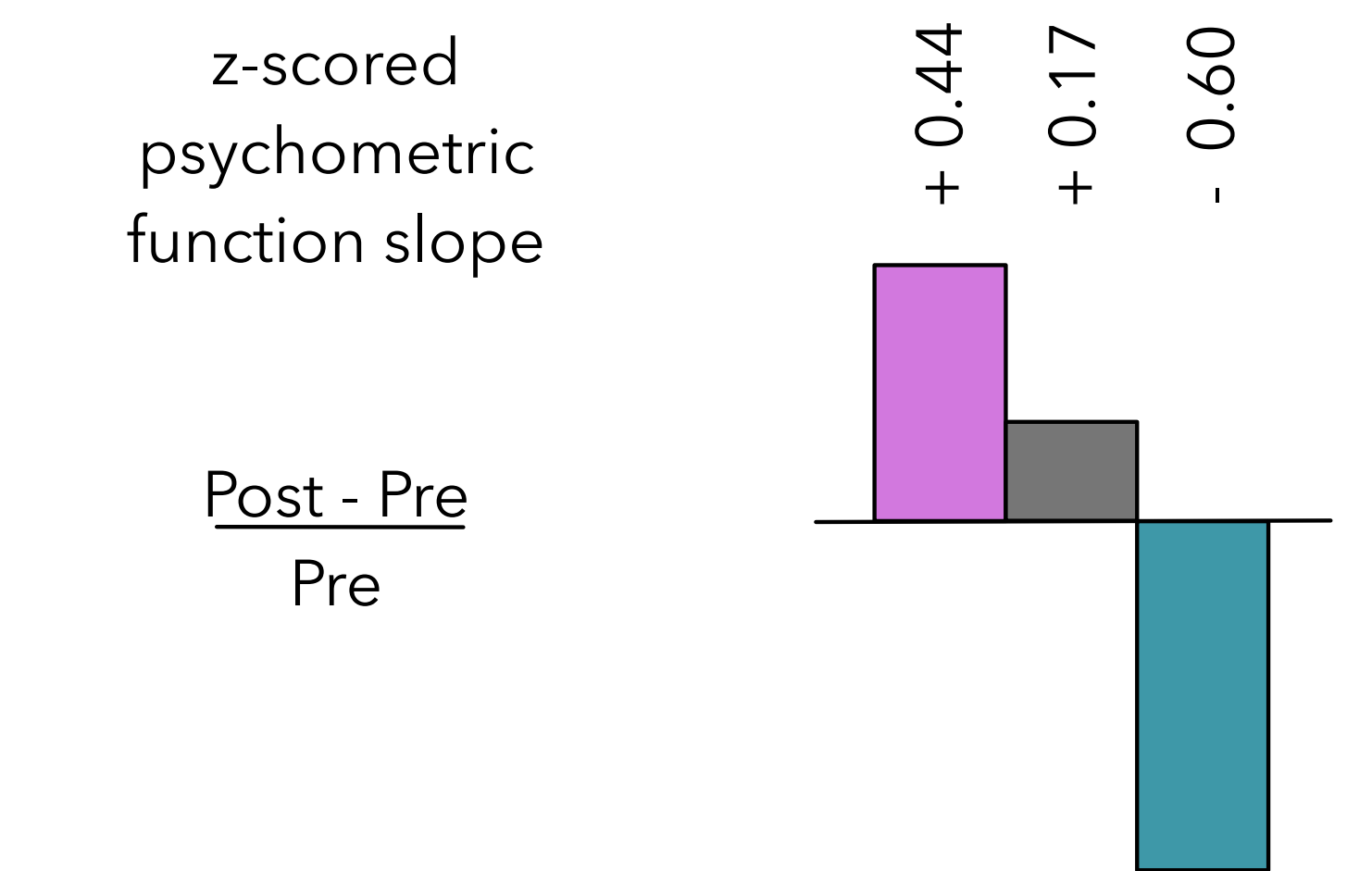
6 diameter directions

Inducing and Measuring PERCEPTUAL CHANGE

Categorical Perception of Shape Space

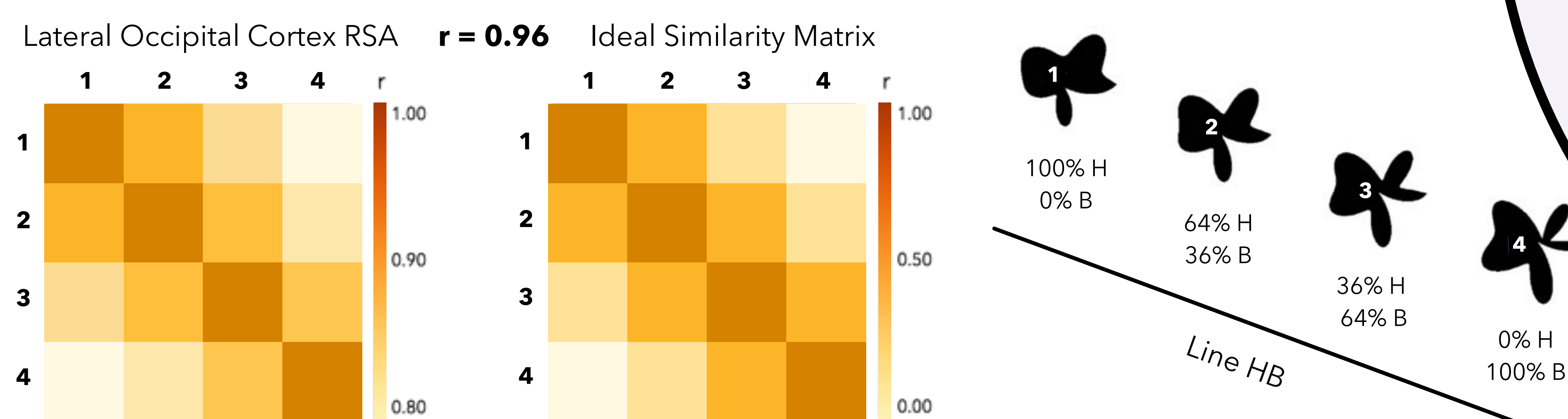


Preliminary Perceptual Results n=3

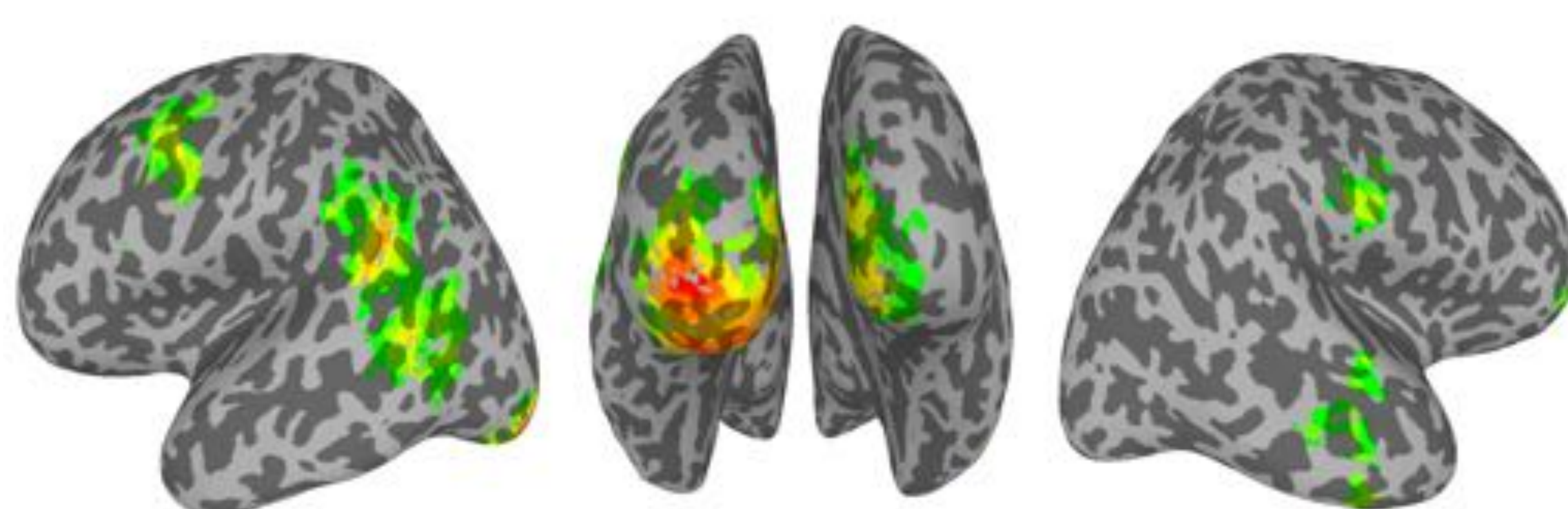


NEURAL REPRESENTATION of Shape Space

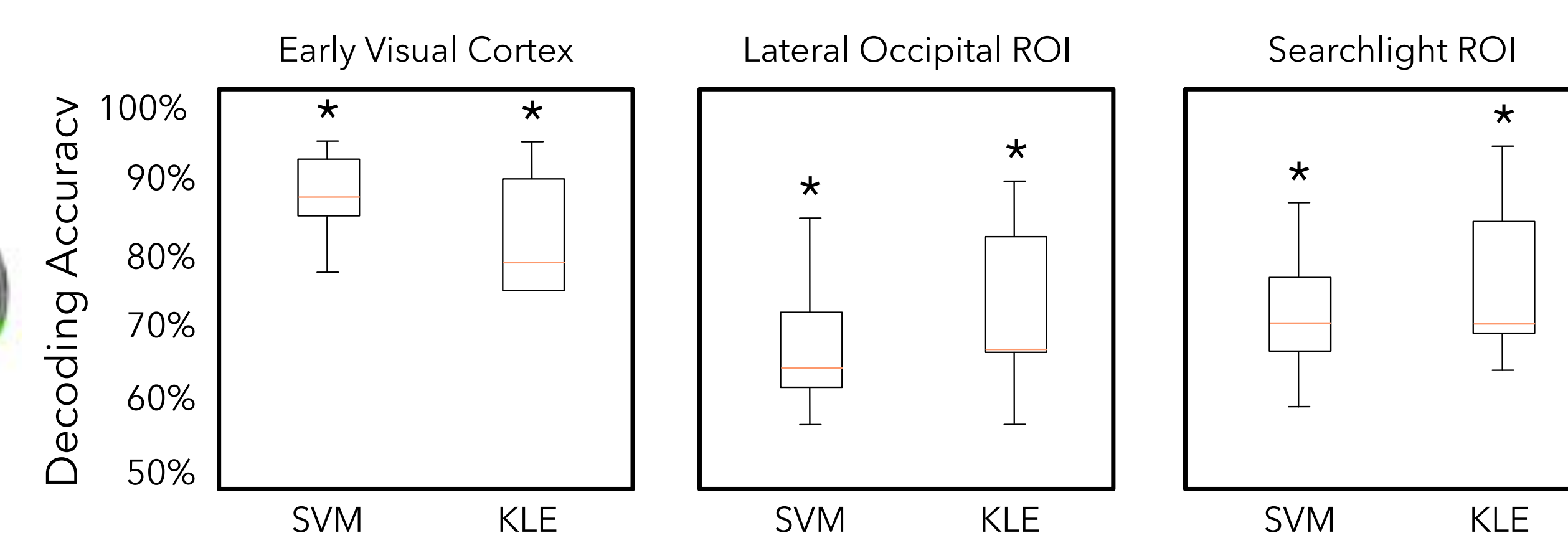
Parametric Shape Representation Localizer average 6 lines, n=8, anatomical ROI



Feedback ROI Searchlight for parametric regions: $r > 0.50$

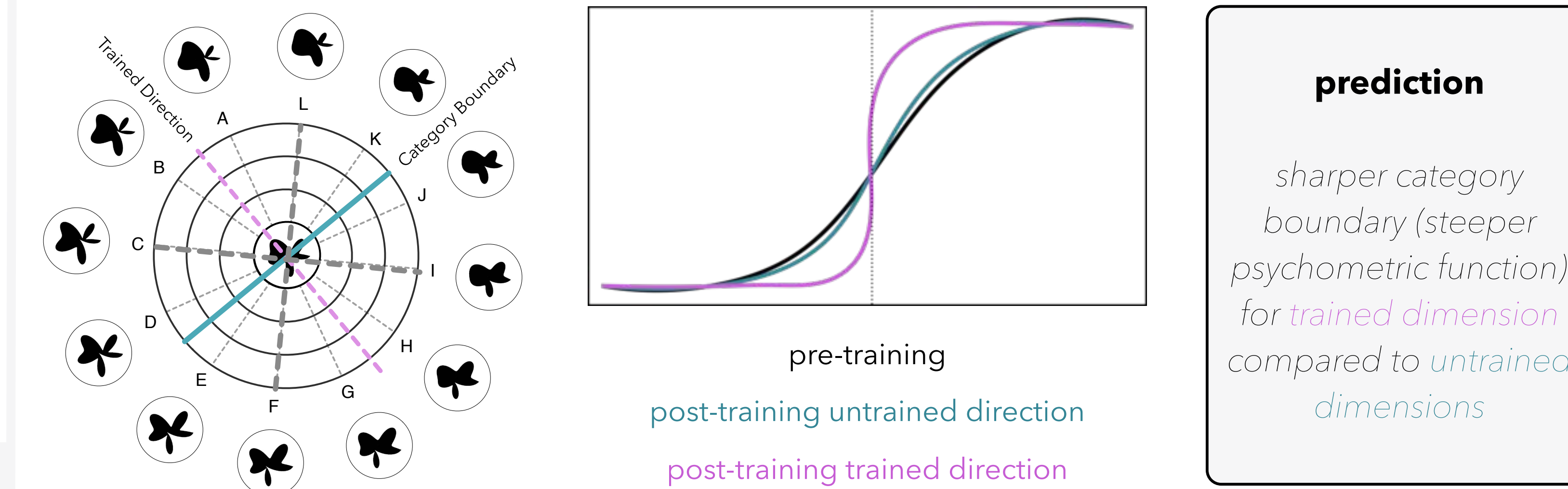


Category Decoding in Neural Feedback ROI n=7, LORO



Funding: John Templeton Foundation ♦ Intel Corporation ♦ NIH Grant R01 MH069456

Behavioral Prediction: Pre- vs. Post-Training psychometric function estimation



Radial distance from category boundary (degrees)

Line directions in shape space

Trained Neutral Untrained

preliminary evidence that **we can influence perceived similarity** of novel learned visual categories by using neurofeedback to induce neural plasticity across multiple brain regions