Training attractor dynamics in human visual working memory

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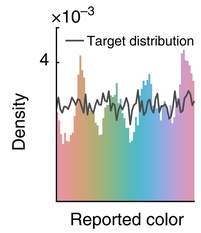
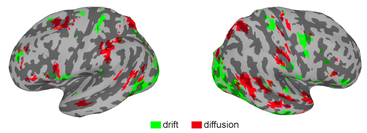
Background

Imprecision in working memory can be caused by random *diffusion* and *drift* towards stable attractor states. By fitting a *discrete attractor model*, both behavioral parameters increase as a function of memory load (Panichello, et al., 2019), and attractors can adapt to different environmental statistics.



In our recent work (Yu et al., 2020), we have demonstrated a dissociation of the neural correlates of load-dependent changes in diffusion and of drift, with the former related more to load-dependent activity in frontoparietal cortex and the latter related more to that in occipital cortex.

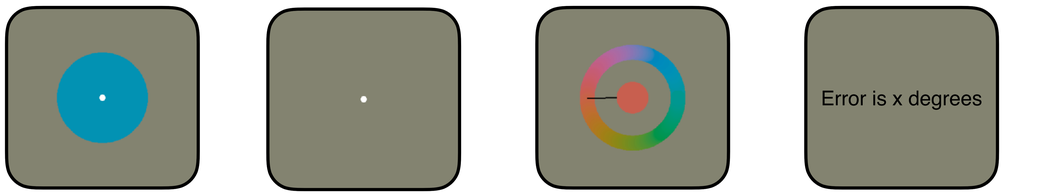


Here we further investigated the neural mechanism of the adaptive nature of attractor dynamics in a training study in combination with fMRI.

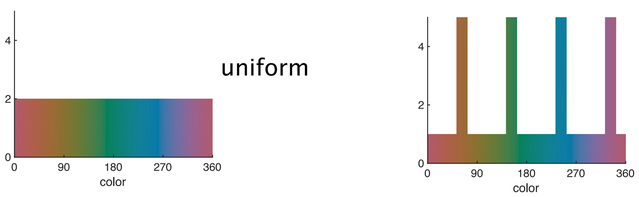
Method

Task

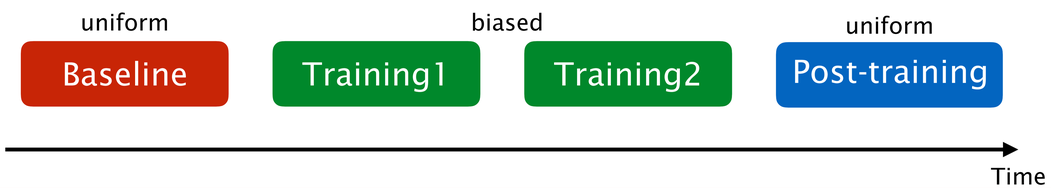
1-item delayed recall



Sample selection



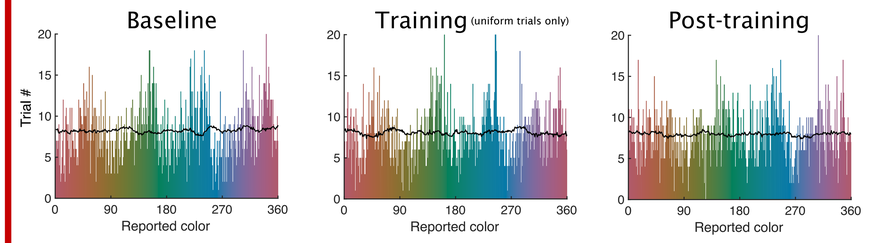
Procedure - 4 fMRI scanning sessions



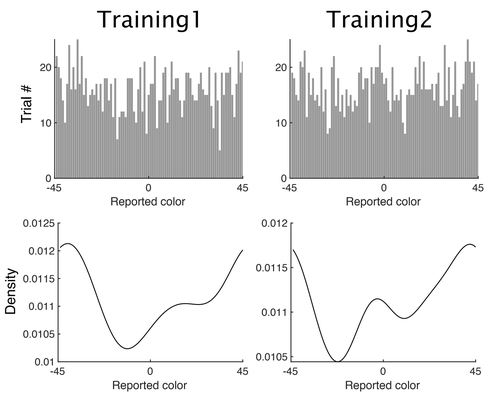
Panichello, M.F., DePasquale, B., Pillow, J.W., Buschman, T.J. (2019). Error-correcting dynamics in visual working memory. *Nature Communications. 10*(1), 3366.
Yu Q., Panichello, M.F., Cai, Y., Postle, B.R., Buschman, T.J. (bioRxiv). Delay-period activity in frontal, parietal, and occipital cortex tracks different attractor dynamics in visual working memory.

Behavioral Results

Participants' responses clustered around several color centers

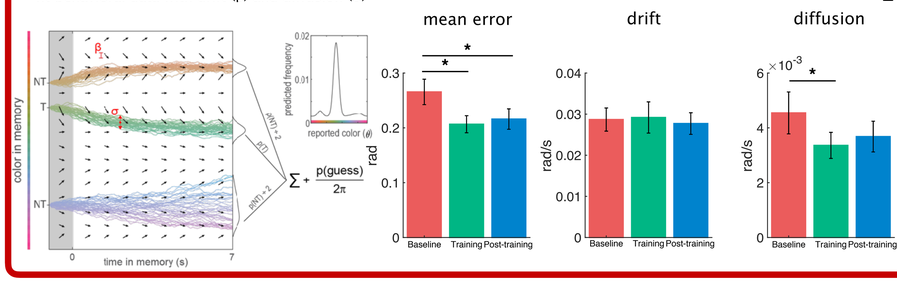


Response distribution around common colors



Discrete attractor model fitting

fit behavioral data with drift (β) and diffusion (σ)

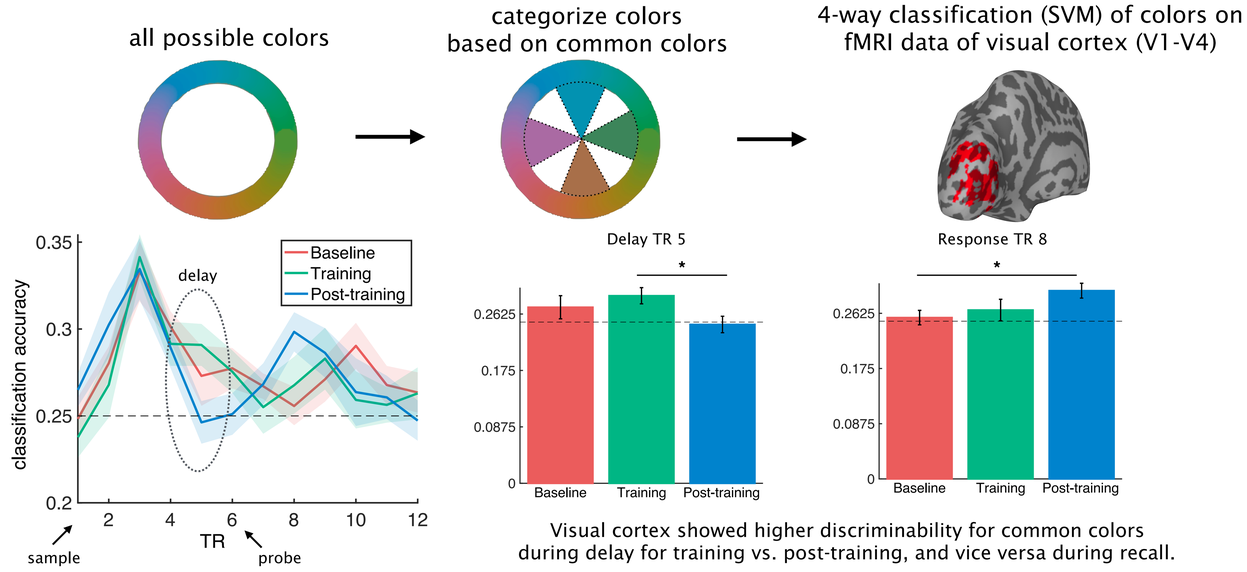


Exposure to common colors increased responses around these colors;

Training reduced diffusion but not drift.

fMRI Results

Classifying common colors in different sessions



Visual cortex showed higher discriminability for common colors during delay for training vs. post-training, and vice versa during recall.

Conclusion

Recruitment of discrete attractor dynamics in working memory persists after extensive training, suggesting it is a stable mechanism of working memory.

At the neural level, the effect of attractor biases can be observed at the early stage of visual processing, consistent with our previous finding on load-dependent changes in lateral occipital cortex.