BUMP ATTRACTOR DYNAMICS IN PREFRONTAL CORTEX EXPLAINS BEHAVIORAL PRECISION IN SPATIAL WORKING MEMORY

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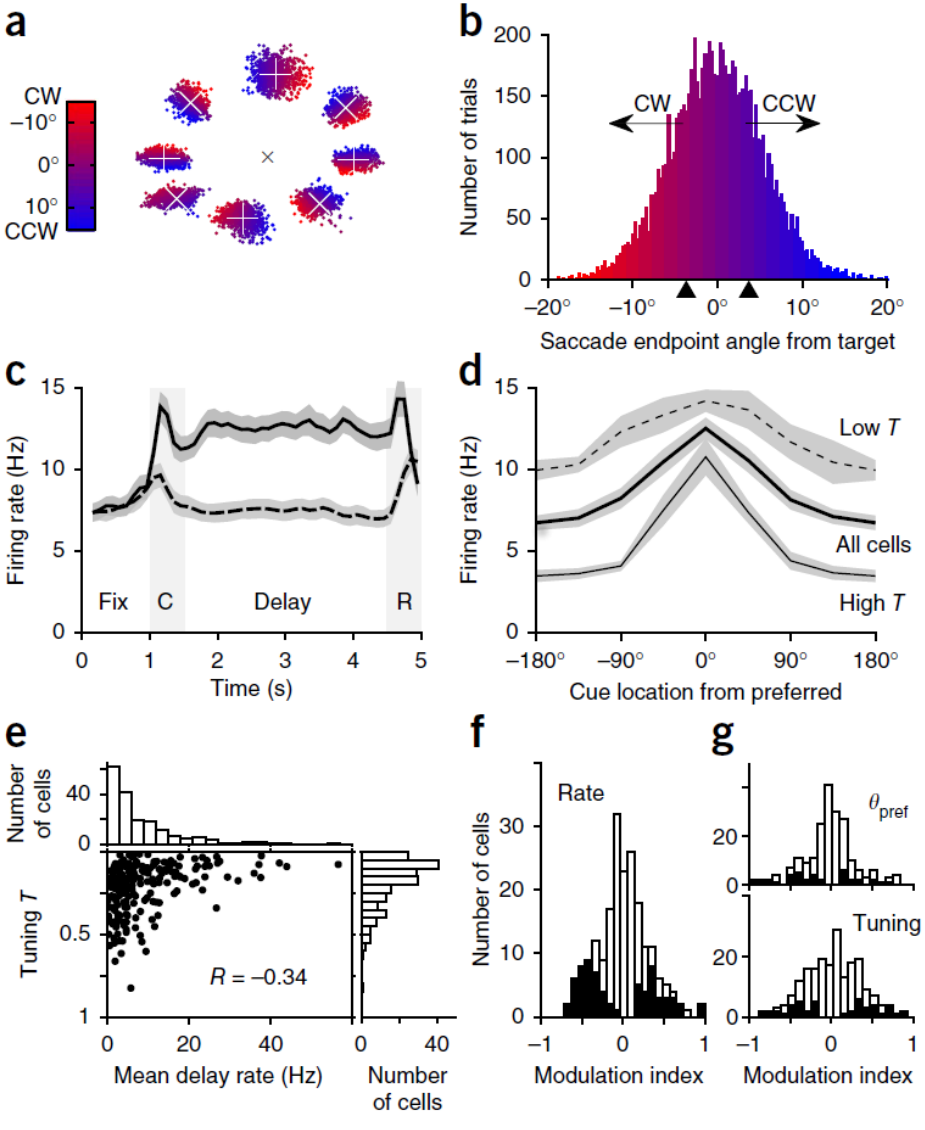
Nature Neuroscience 2014, AOP

SPATIAL WORKING MEMORY IN PFC



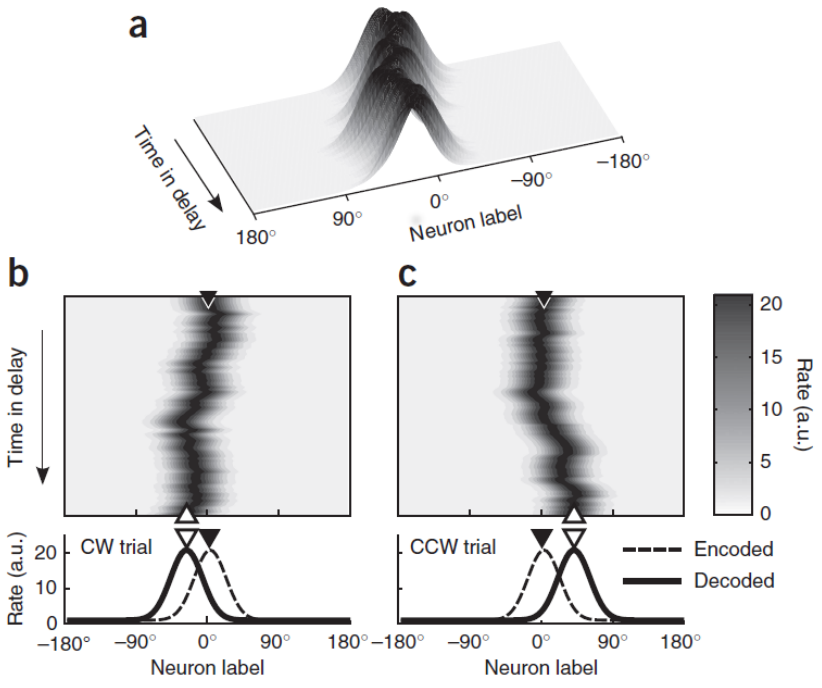
- 8 targets for saccades
- errors are clockwise (CW) or counterclockwise (CCW)
- persistent activity in dorsolateral PFC tuned to (remembered) object location

MODEL-BASED APPROACH

- start with the bump attractor model
- make predictions based on model properties
  - tuning curve bias, rate-behavior correlation, Fano factor and pairwise correlations
- test predictions in data
- problem: all p values are close to 0.05, results are weak.
- but there are 4 separate results, so 0.05 * 0.05 * 0.05 * 0.05 is very small, right?
- I don't think so, I think all 4 results are not independent of each other, in fact all results follow from the tuning curve bias result $\Rightarrow$ p-value of the whole paper is 0.024.

Correlation to behavior (P = 0.024) — construct tuning cuves of CW and CCW trials

- Systematic drifts of the bump change the remembered location, result in inacurate saccades
- Equivalently, tuning curves of neurons from CW trials only are systematically biased



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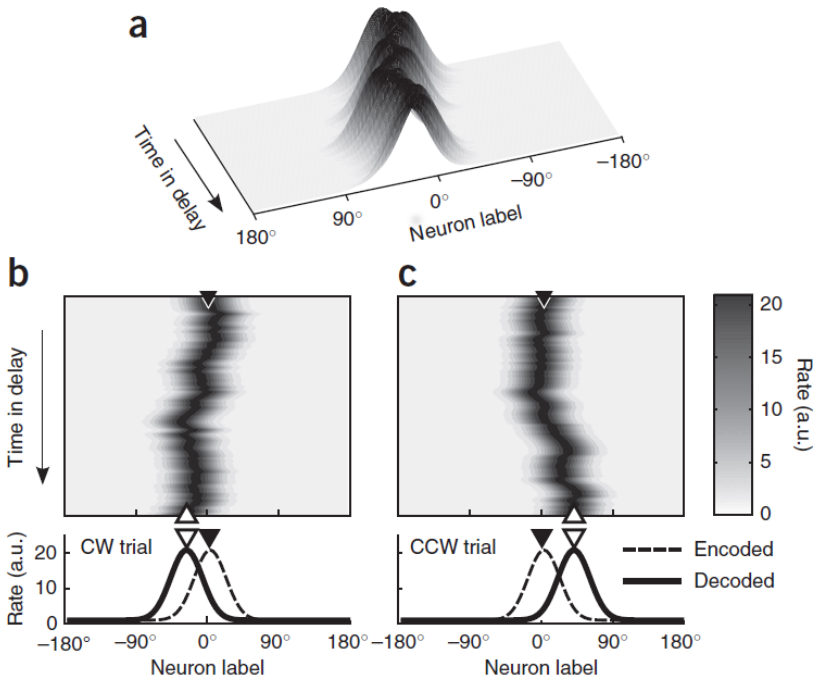
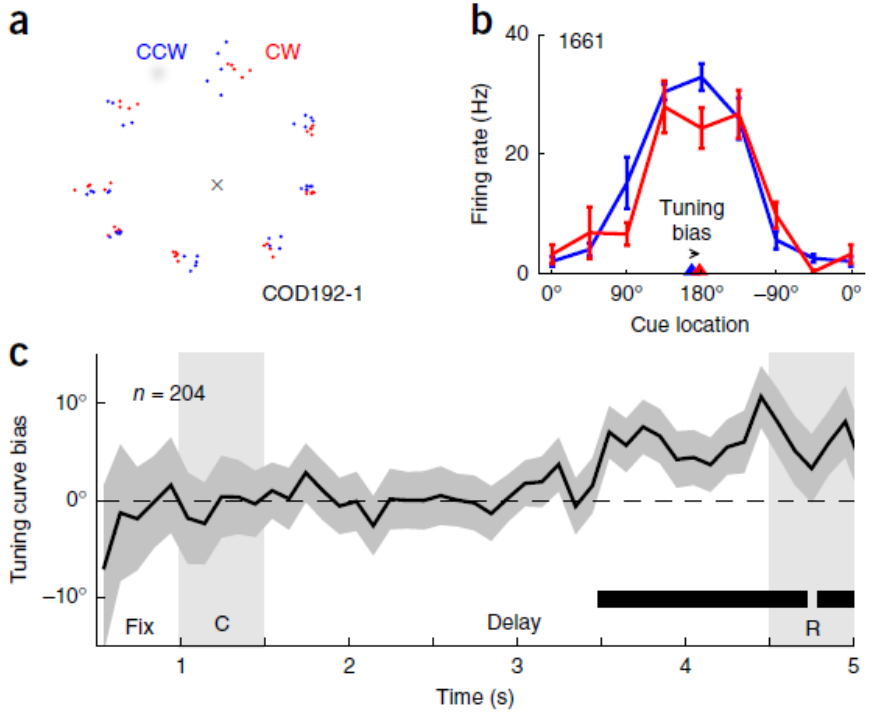
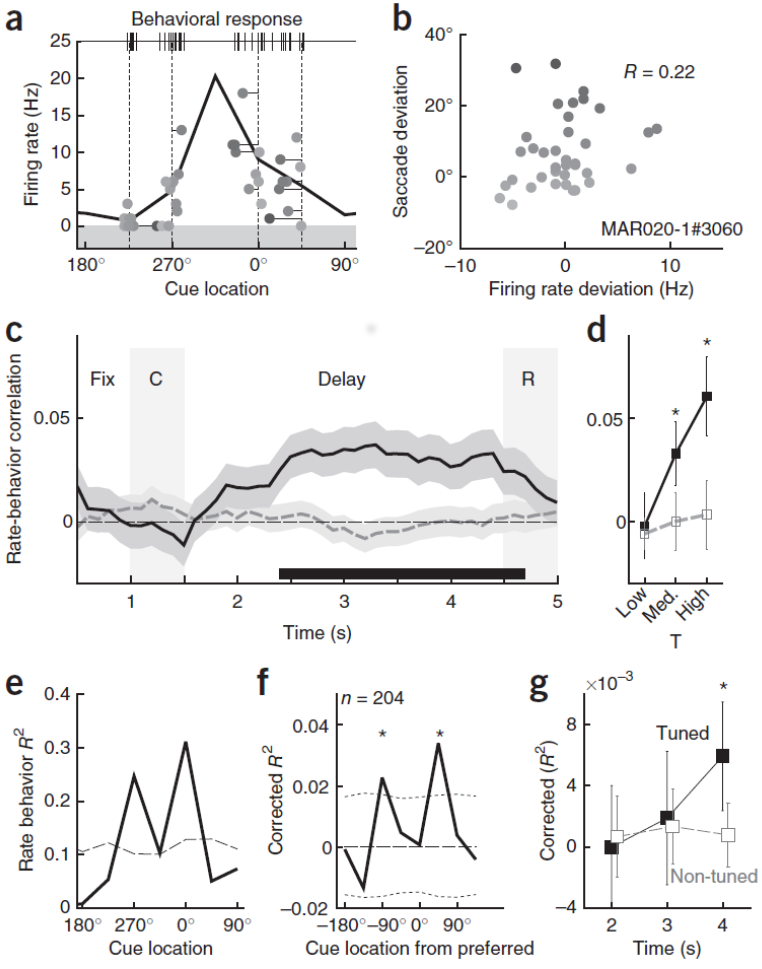


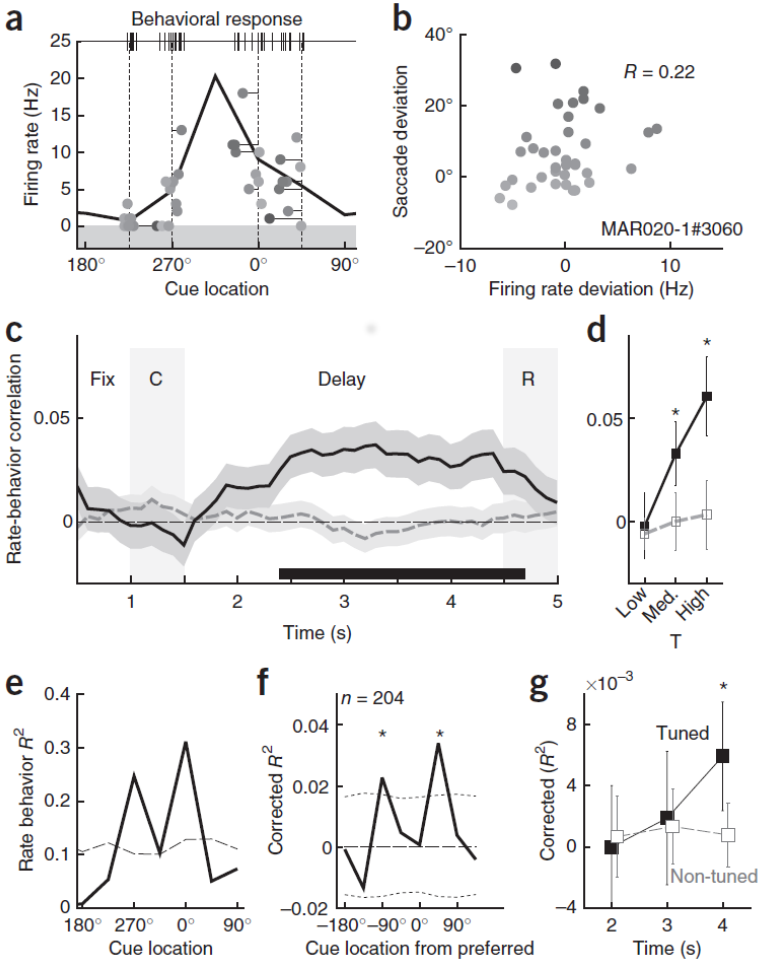
- ... and that's exactly what we see in the data?



Responses to flank stimuli correlate with upcoming behavior (P<0.05)



RESPONSES TO FLANK STIMULI CORRELATE WITH UPCOMING BEHAVIOR (P<0.05)



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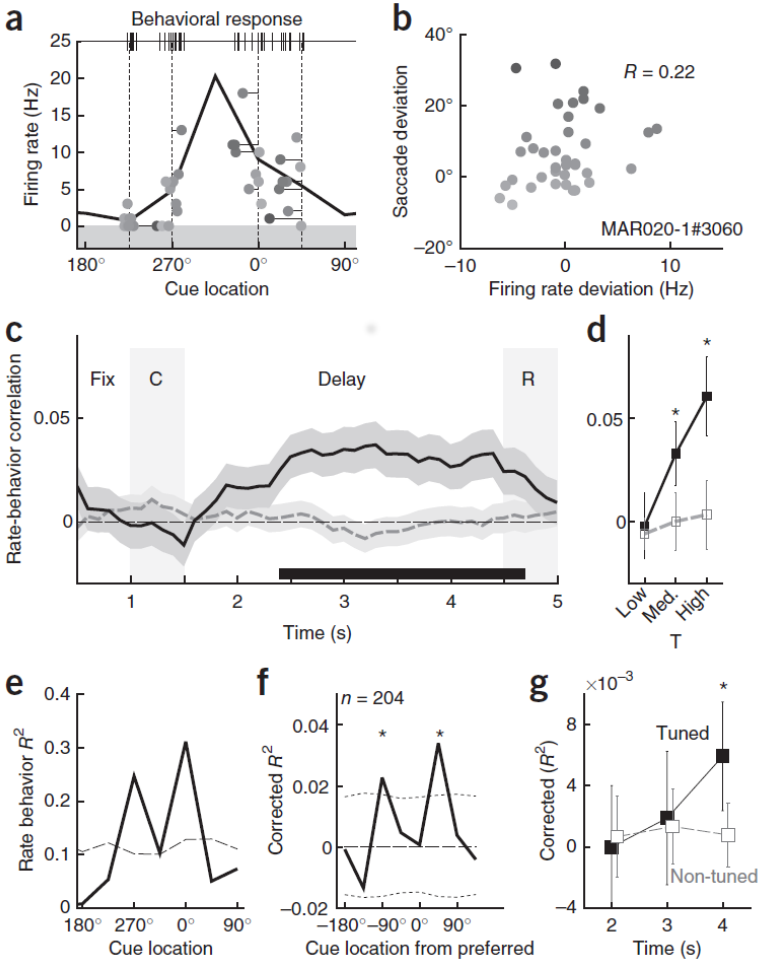

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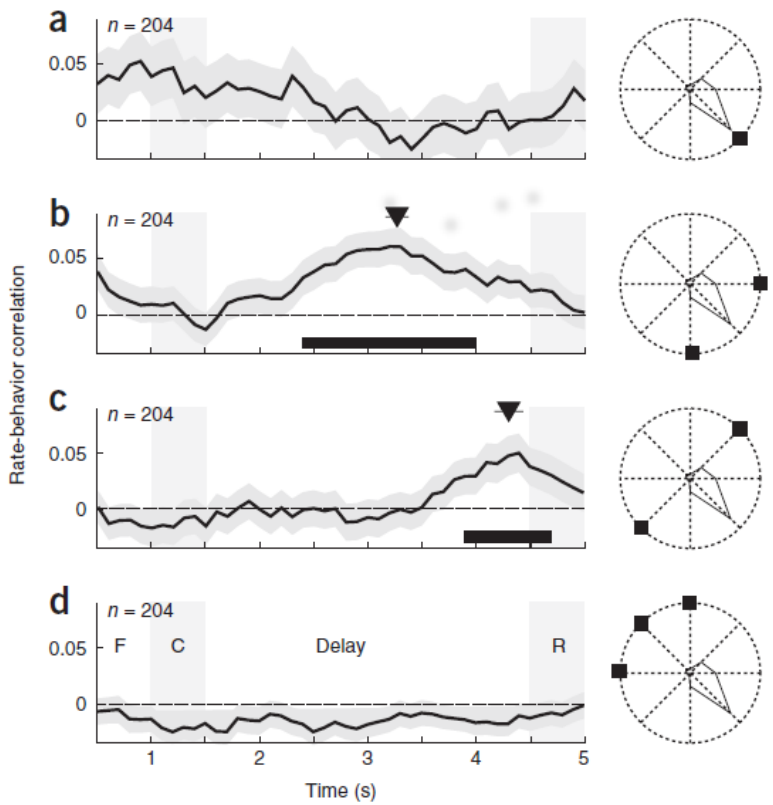
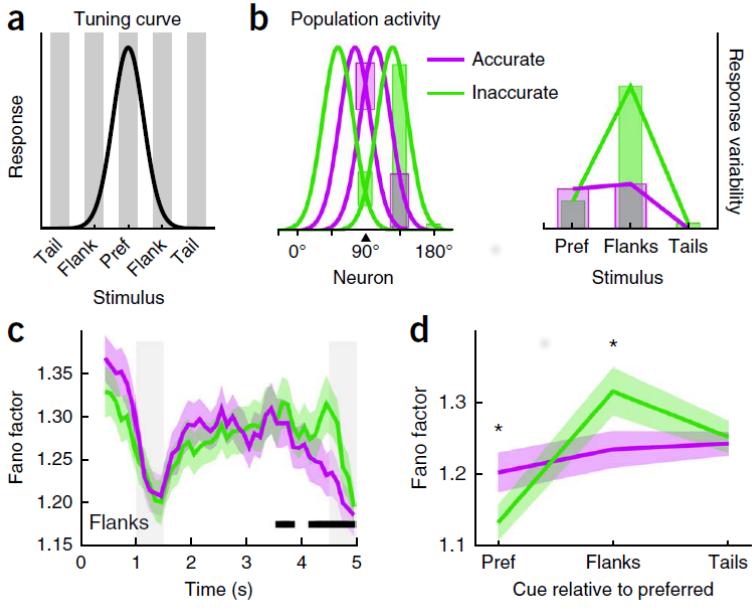
- Near flanks become correlated sooner than far flanks



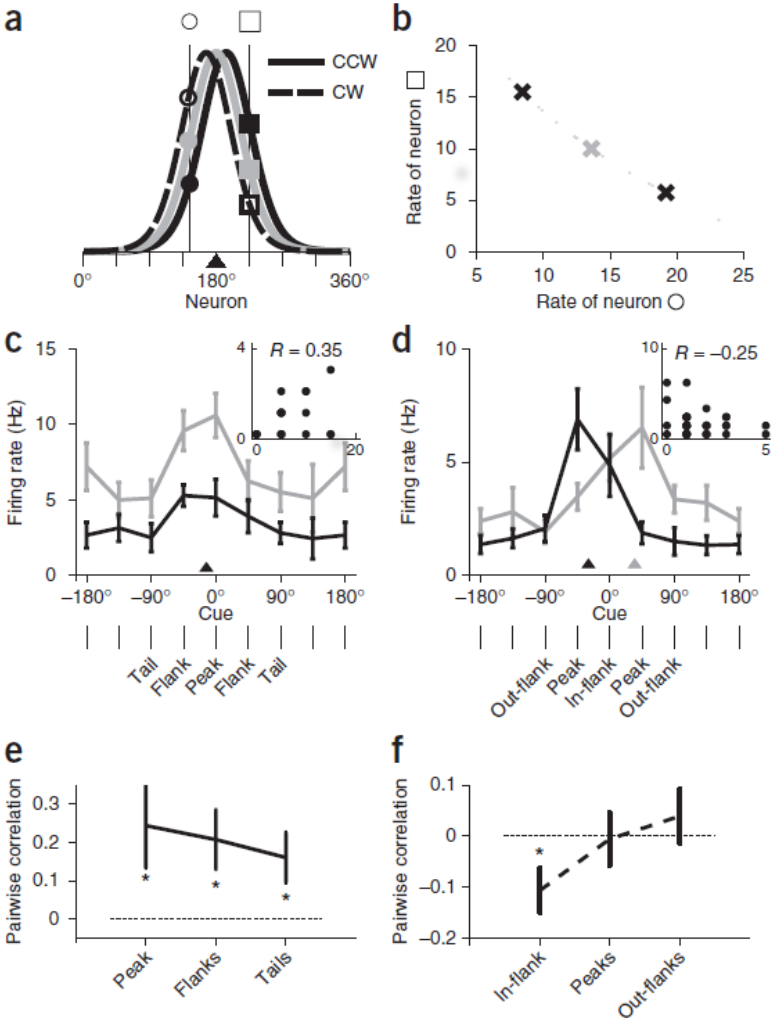
FANO FACTORS OF RESPONSES TO FLANKING STIMULI SHOULD BE LARGE FOR INACCURATE TRIALS ($P<0.05$)

- split accurate and inaccurate trials by error size
- Fano Factor to flanking stimuli becomes larger in inaccurate trials... but only in the last 500ms.



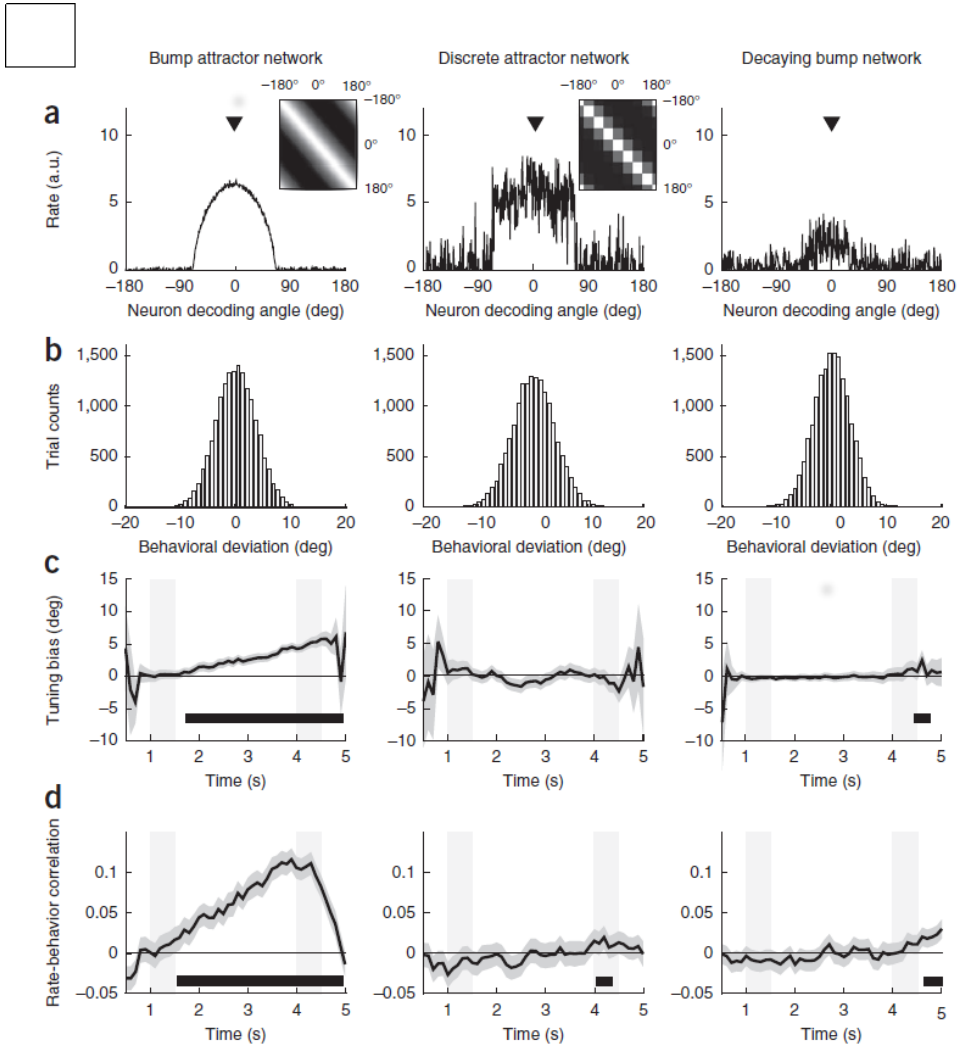
NOISE CORRELATIONS BETWEEN PAIRS OF NEURONS DEPEND ON STIMULUS ($P<0.05$)

- in the spirit of let's find more ways to report the same result...



WHICH MODEL IS NOT INCONSISTENT WITH THEIR EXPERIMENTAL OBSERVATIONS?

- They implemented a bunch of models.
- The discrete attractor model does not have a continuous representation of space.
- In the decaying bump network, behavior variability is induced by noise that is not correlated across neurons, hence correlations between single neurons and behavior will be much much weaker (effectively 0).



The alternative hypothesis: memory is discrete and stable but saccadic program is imprecise and planning starts in delay period

- I think discrete memory makes more sense: discrete number of cues, heavily trained monkeys
- would not be surprising if a little bit of the saccade planning variability shows up in PFC neurons
- no real evidence for accumulation of error through time
- however, they do say they also tried to exclude neurons with ramp-up activity
  - leap of faith: these are the saccadic neurons (???)
  - anyway, neurons can reflect the saccade location even without actively contributing to thei planning