space and time in the brain - cogs177
object-centered space
what is an object anyway? – an approach by Pasupathy and Connor (Nat. Neur. 2002) applied to area V4

Pasupathy and Connor Nat. Neuroscience, 2002
what is an object anyway? – can it be invisible?

Freedman and Assad, Nature, 2006
what is an object anyway? – does a route segment count?
object-based mapping in the frontal eye fields (of all places!)

the supplemental eye field (SEF) lies anterior to the primary motor cortex and is considered a type of premotor cortex (for saccades)

A-F: the basic delayed-saccade task – this SEF neuron has spatially-tuned firing with peak activity for saccades to the L

G-H: a task to dissociate egocentric from object-based spatial tuning

I-L: the same neuron fires whenever the target lies on the left side of the bar irrespective of where the bar lies egocentrically (and irrespective of the direction of the saccade)

about 50% of all SEF neurons will exhibit significant differences in activity according to L vs R status of the target

this neuron’s overall behavior cannot be explained according to a gain-field mechanism, but is instead better explained by a shift in reference frame (from the screen in A-F to the object in G-L)

Olson, Ann. R. Neuroscience, 2003
evidence for 'gain-fielding' as an explanation for object-centered activity

this neuron shows preference during delay 2 for the R-side of the object, but it's activity is especially high (i.e., 'gained') when the actual saccade is also to the R (egocentrically)

the jury is out on the question of whether object-based activity involves an explicitly object-based representation or can be described as a gain function of an egocentrically-based mapping
object-based mapping is not dependent on training / rule

in the experiment above, the rule used by the monkey is to use the color indicated during the cue period (panel 3) to guide saccade selection

targets positions and their colors are randomized, yet this neuron responds regularly when either the cue or target corresponds to the left of the two squares
Crowe et al., Neuron, 2011

**A. Shift-model trials**
- 1-square models
  - Incomplete copies
  - 2-square models
  - Incomplete copies

**B. Shift-copy trials**
- 1-square models
  - Choice array
  - 1st choice
  - 2nd choice

**C. Electrode penetrations**
- Monkey 1: IPS, STS
- Monkey 2: IPS, STS

**D. Shift-model model**
- 750 ms delay
- 8.3°

**E. Shift-copy model**
- Copy
- 750 ms delay

**Patterns of activity coding**
- Left and right averaged over training trials in bin 3
- Pattern of activity on single test trial in bin 12

**Training bins (average)**
- 1 2 3 4 5 6 7 8 9 10 11 12 13

**Test bins**
- 1 2 3 4 5 6 7 8 9 10 11 12 13

**Classification of test trial**
- Correct (test trial was left)
  - 0 1 1 1 1 0 1 0 1 0 1
- Proportion correct (over test trials)
  - .6 .8 .9 .8 .6 .5 .5 .5 .5 .5 .5 .5

**Proportion correct**
- Stationary
- Dynamic
- Train bin 3
- Train bin 9
we might consider object-centered mapping to be egocentrically based (always) if...we have object and object orientation (on the retina) already defined

Figure 2. Neural Networks for Computing Object-Centered Saccades
(A) Sketch of a basis function network computing a saccade to a specified part of an object. This network has three layers: an input layer coding for the command $I$, $\theta_0$, $\theta_0$, and $R$, a basis function layer (BF layer), and an output layer specifying the saccade. The saccadic motor command can be obtained through a linear combination of the activities of BF units, with the appropriate set of coefficients $c_i$. Other output layers are indicated to emphasize the fact that the same BF layer can be used for other tasks.
(B) Same as in (A), but for a network using an explicit object-centered representation. The explicit representation cannot be computed directly from the input layers; it requires an extra step, which can take the form of a basis function layer, with inputs $I$, $\theta_0$, $\theta_0$, and $R$. Likewise, the saccade cannot be computed directly from the explicit representation, again requiring a basis function layer taking the explicit object-centered representation, the object’s position on the retina $R_0$, orientation $\theta_0$, and size $S_0$ as input. In other words, an explicit representation does not alleviate the need for basis functions and requires a minimum of five layers, as opposed to three for the basis function approach.
we might consider object-centered mapping to be egocentrically based (always) if...parietal cortex can be considered a salience map

Pouget and Sejnowski, Neuron, 2001

the ‘relatively egocentric’ model for object-based neglect

in some hemi-neglect patients, detection of a letter (the ‘x’ here) takes longer when it sits to the left of the filled circles than when it sits to the right

one explanation is that items in the visual field are always in competition for ‘attention’ or ‘salience’ and that, due to the R parietal damage, hemi-neglect patients suffer from a gradient of attention biased toward the right visual field

In this case, the dots to the right of the x win a ‘competition’ for expression because they land in the stronger portion of the attentional gradient but lose when they lie to the left
an argument against the ‘relatively egocentric’ model for object-centered neglect in R-parietal patients

detection of a target on one of the circles takes longer if that target appears on the L circle unless
the objects are visibly connected and visibly rotated 180-degrees prior to target presentation

if connected and rotated, the deficit appears for the circle on the R (egocentrically) presumably
because it is perceived to be to on the L side of the circle pairing