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A bilateral band attractor model for the oculomotor system

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The oculomotor system controls the position of the eyes both during fixations and during saccades. Prime candidates for horizontal, fixational control are the so-called "position" neurons, which fire persistently with a strength that is proportional to the horizontal eye position. Since these neurons can maintain firing over several seconds at any of a continuum of levels and in the absence of proprioceptive feedback, previous modeling studies have suggested that the position neurons form a line attractor network [1]. Recently, a unilateral knockout experiment has shown that complete silencing of the ipsilateral position neurons impairs the functioning of the contralateral position neurons in one half of the oculomotor range [2]. This has let to the suggestion that the two sides of the oculomotor system work as independent line attractor networks, and that cross-connections serve the purpose of coordinating the two networks.

Here we show that this experimental result does not prove the independence of the two sides, but could be a simple consequence of the well-established recruitment order of the position neurons, i.e., of the finding that the slope of the neuron's tuning curves increases as their firing threshold moves towards more eccentric eye positions. Using a mean-field network approach with standard single neuron features, we study the class of networks with a rank-two weight matrix that obey the observed recruitment order. We find that under these constraints both ipsilateral excitation and contralateral inhibition are necessary to maintain eye position. Surprisingly, we also find that many of our network models naturally reproduce the unilateral knockout experiments [2]. Furthermore, many of the studied network models are hysteretic even though individual neurons are not bistable as in [3]. Hysteresis arises in the cases when the two networks form a two-dimensional band attractor rather than a one-dimensional line attractor. In response to saccadic inputs, our network models do generally not behave like integrators, but rather create single attractor states that depend on the strength, but not the length, of the external inputs.

References

1. Seung HS: **How the brain keeps the eyes still.** *PNAS* 1996, **93:**13339-13344.
2. Aksay E, *et al.*: **Functional dissection of circuitry in a neural integrator.** *Nat Neurosci* 2007, **10:**494-504.
3. Koulakov A, *et al.*: **Model for a robust neural integrator.** *Nat Neurosci* 2002, **5:**775-782.