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Supplemental Information

Neural Mechanisms of Speed-Accuracy Tradeoff

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SUPPLEMENTAL FIGURES AND LEGENDS

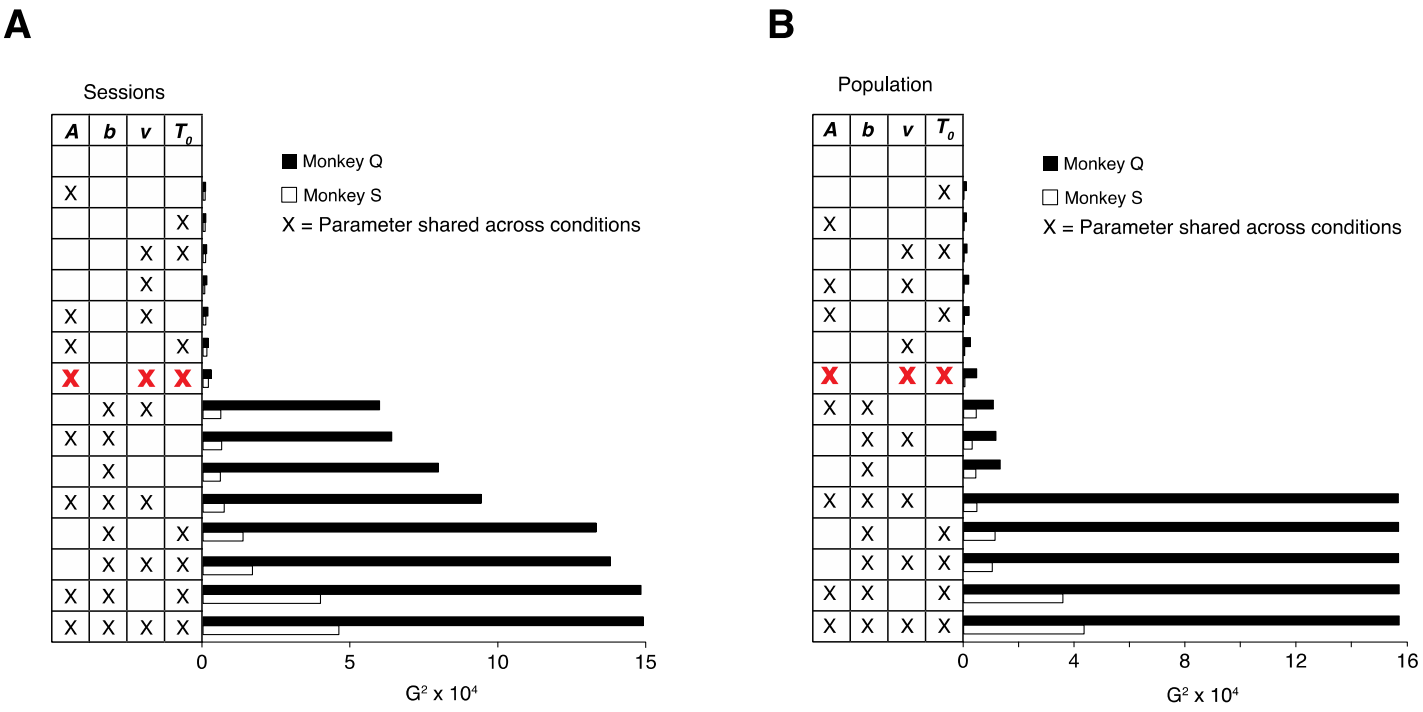

Figure S1. Fit statistics averaged across sessions (**A**) and averaged over all trials combined from all sessions (**B**). G^2 statistic was calculated as 2 x [LL_{full} – $LL_{restricted}$] where LL_{full} corresponds to the log likelihood from a model where all parameters were free to vary across conditions and $LL_{restricted}$ corresponds to log likelihood obtained from other models under consideration. Higher G^2 values indicate more deviation from the best-fitting, unrestricted model. G^2 values increase drastically when the threshold parameter (*b*) is fixed. Marked cells correspond to a fixed parameter, unmarked cells denote shared parameters. Fits from the model highlighted red are plotted in **Figure 1D-F**.

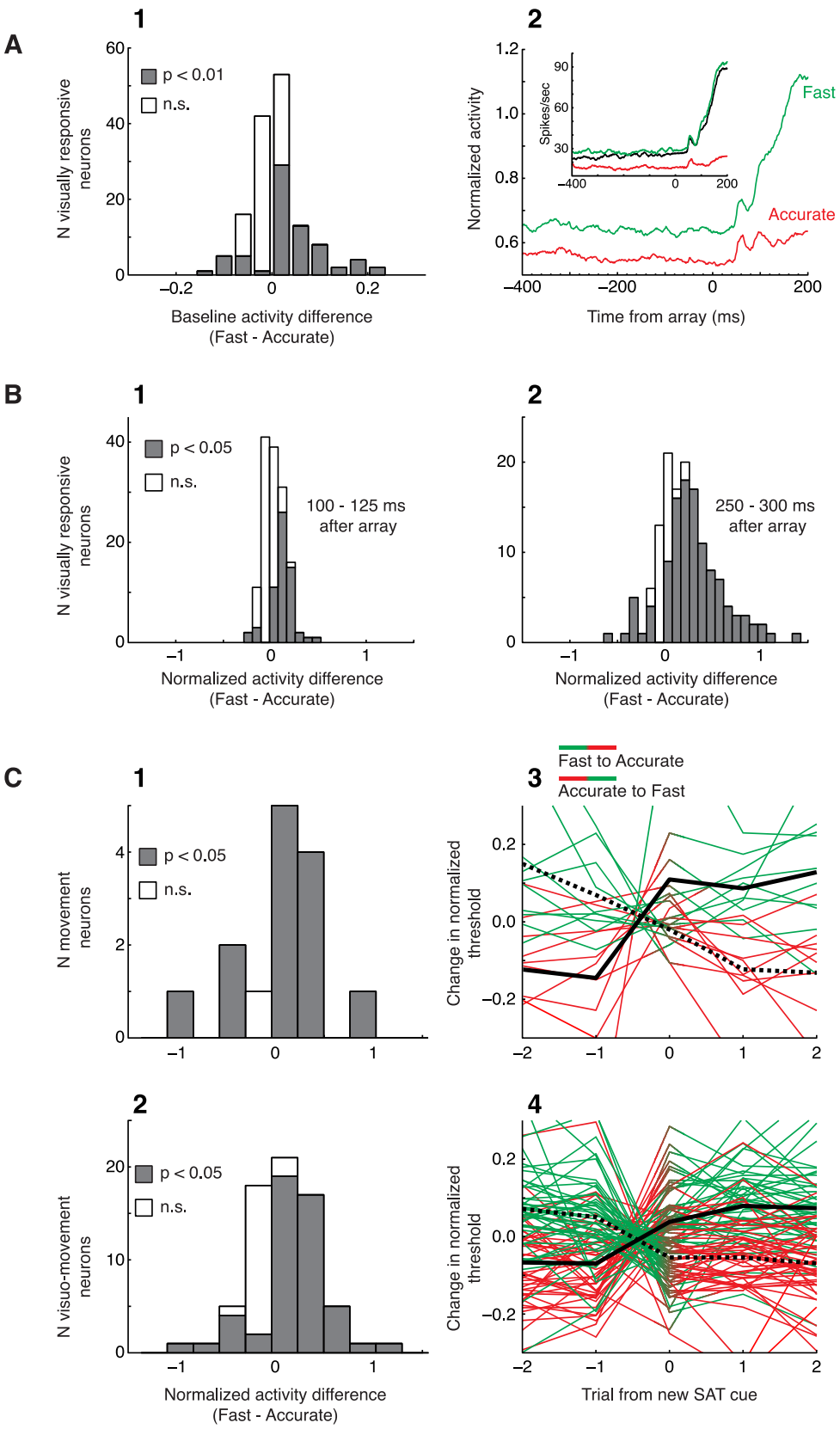

Figure S2. SAT-related neural modulation in FEF.
A, Baseline modulation. **A1**, The activity of 146 visually-responsive cells was averaged in the interval 300 ms before array presentation. All trials were included irrespective of trial type or behavioral outcome. Significant proactive modulation of baseline activity was observed in 54% of all visual and visuomovement neurons (two-tailed *t*-tests, all $p < 0.01$, filled bars). **A2,** The average activity in movement cells was tested in the interval 300 ms before array presentation. All trials were included irrespective of trial type or behavioral outcome. Significantly elevated baseline activity in the Fast relative to Accurate condition was observed in 29% of the 14 movement neurons recorded ($t_3 = -3.0$, $p = 0.06$). Only 1 of these neurons included data in the Neutral condition (inset).
B, Sensory gain modulation. The activity of 146 visually-responsive cells was averaged in the interval 100-125 ms (**B1**) and 250-300 ms (**B2**) after array presentation. Only correct Target-in-RF trials were included. Significantly elevated sensory gain in the Fast relative to Accurate condition was observed in 39% of neurons in the earlier period and 71% in the later period (two-tailed *t*-tests, all $p < 0.05$, filled bars).
C, Response threshold modulation. The activity of 14 movement (**C1, C3**) and 70 visuomovement (**C2, C4**) neurons was averaged in the interval 20-10 ms before saccade initiation. Only correct Target-in-RF trials were included. Significantly elevated response threshold in the Fast relative to Accurate condition was observed in the majority of movement neurons (71%) and visuomovement neurons (63%) (two-tailed *t*-tests, all $p < 0.05$, filled bars). The change in response threshold was immediate upon presentation of a new SAT cue (**C3**, movement neurons: Accurate to Fast: $t_{13} = -1.9$, $p = .08$; Fast to Accurate: $t_{13} = 2.6$, $p < 0.05$, two-tailed *t*-tests; **C4**, visuomovement neurons: Accurate to Fast: $t_{69} = -7.3$, Fast to Accurate: $t_{69} = 6.4$, all $p < 0.001$, two-tailed *t*-tests).

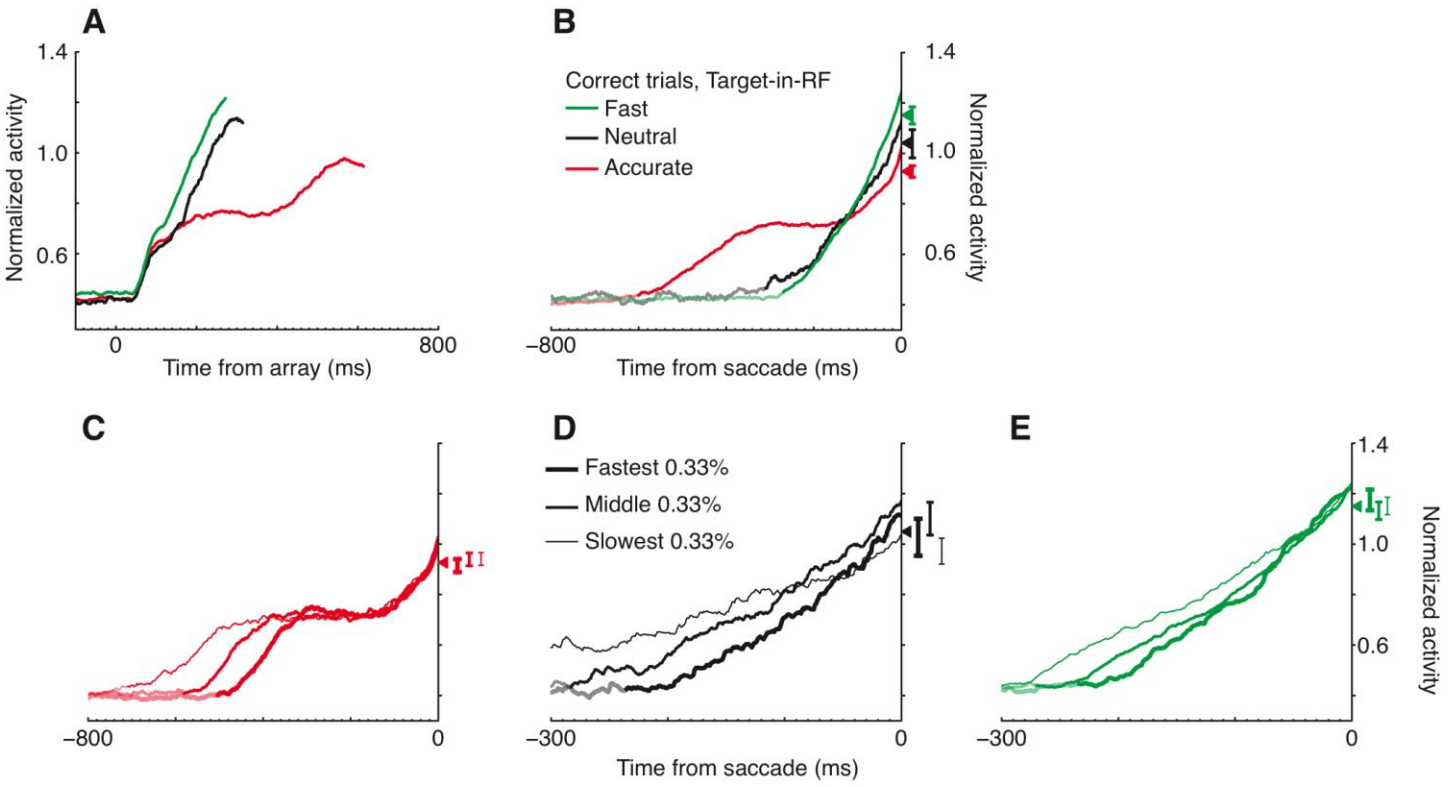

Figure S3. Adjustment of visuomovement neuron activity for SAT.
A, Average normalized discharge rate of all visuomovement neurons for correct trials when the target fell in the neuron's movement field, aligned on array presentation. Plots are truncated at mean RT. Note that the baseline adjustment reported in text is obscured by the averaging across neurons with and without the effect.
B, Average normalized discharge rate of all visuomovement neurons for correct trials when the target fell in the neuron's movement field, aligned on saccade initiation. Activity before mean RT is plotted lighter. On average, the slope of activity in the 100 ms preceding saccade increased with speed stress (Accurate: 2.1 < Neutral: 3.0 < Fast: 4.2 normalized sp/s^2; t_{69} = 4.5, p < 0.001, linear regression). Activity 20-10 ms before saccade increased with speed stress (t_{69} = 5.2, p < 0.001, linear regression). Note the appearance of a tonic level of activity in the Accurate condition. This is due solely to the temporal smearing of the visual onset response characteristic of visuomovement neurons. It is most evident in the Accurate condition due to the temporal separation between visual and movement response.
C-E, Discharge rates in Accurate, Neutral and Fast (bottom) conditions for correct Target-in-RF trials separated into fastest (thick), intermediate (thinner) and longest (thinnest) RT quantiles. Activity 20-10 ms before saccade varied across but not within SAT conditions (all p > 0.05, linear regression). All vertical bars represent $\pm$ 1 SEM.

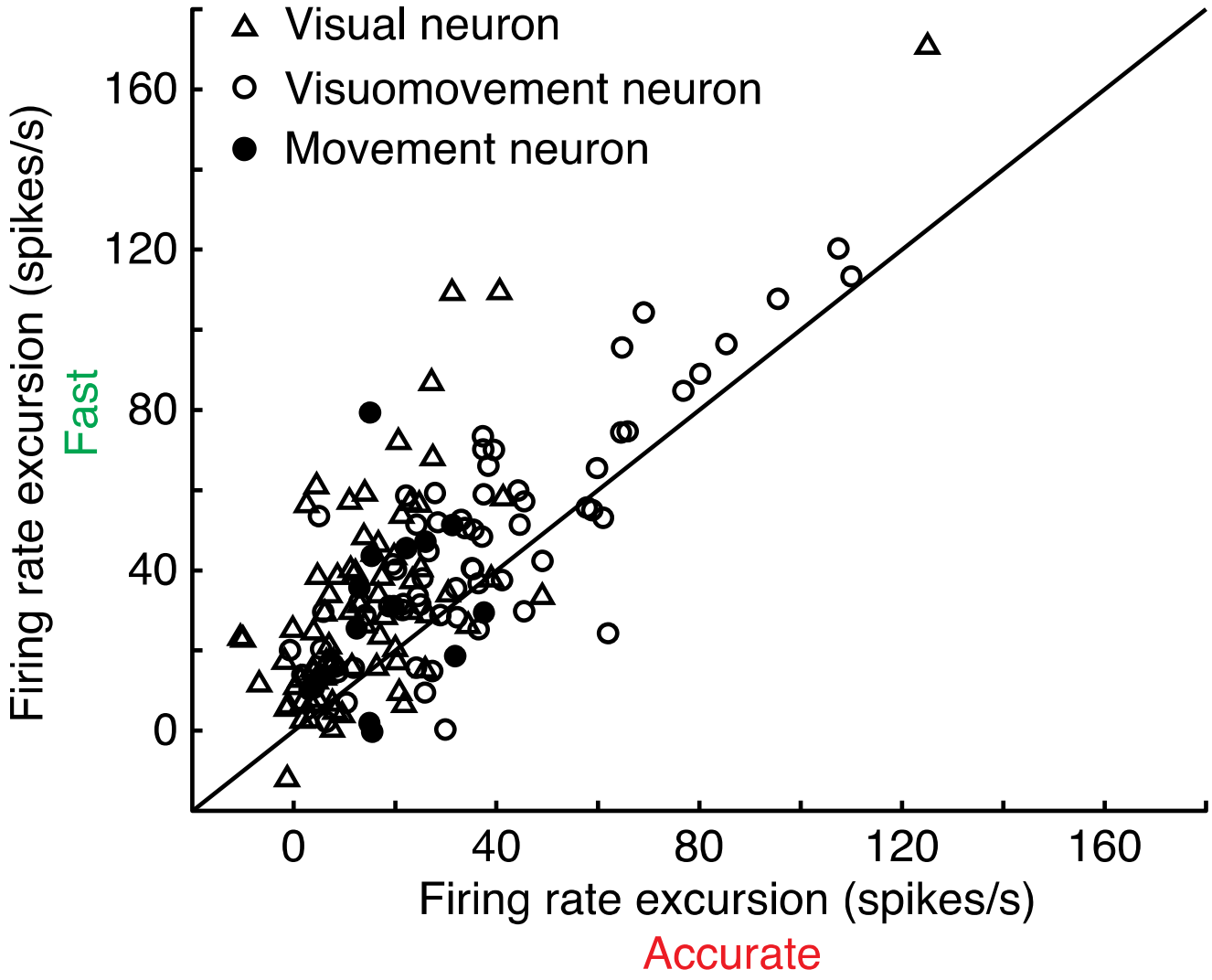

Figure S4. Firing rate excursion. For each neuron, we calculated the difference between average activity 20 – 10 ms prior to saccade and average activity in the 100 ms prior to array presentation. The excursion was significantly higher for the Fast condition as compared to the Accurate condition for all neuron types (Visual neurons: $t_{73} = -7.5$, $p < 0.001$; Visuomovement neurons: $t_{69} = -5.4$, $p < 0.001$; Movement neurons: $t_{13} = -2.1$, $p = 0.05$).

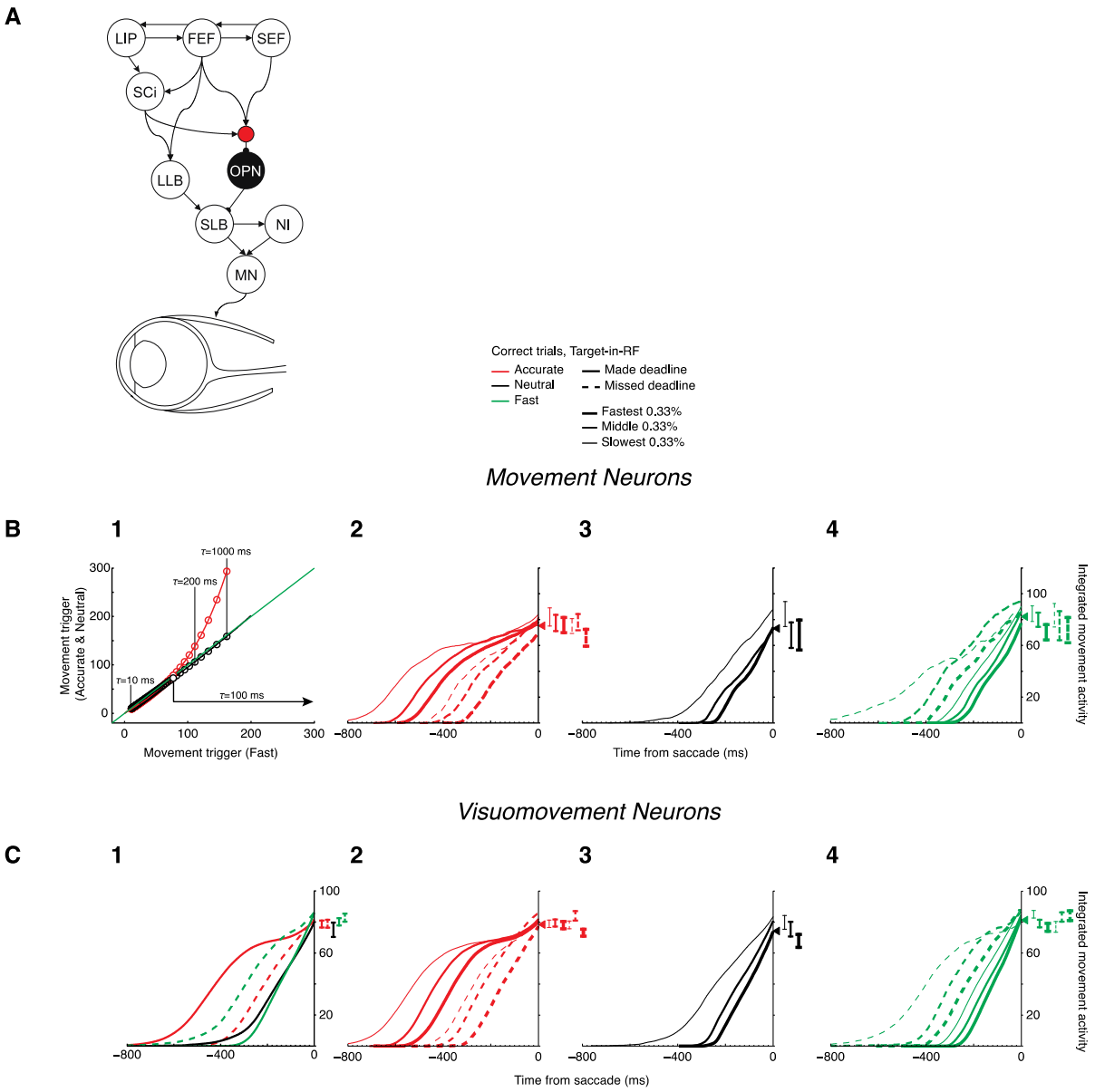

Figure S5. A, Diagram of key neurons, structures and connections that produce saccadic eye movements. The afferent visual pathway is not included. LIP, lateral intraparietal area; FEF, frontal eye field; SEF, supplementary eye field; SC_i, intermediate layers of superior colliculus; LLB, long lead burst neuron; OPN, omnipause neuron; SLB, short lead burst neuron; NI, neural integrator; MN, motor neuron. Saccades are initiated only when OPN are inhibited, represented by the red unit. This inhibition is a site of summation of influences from the FEF, SC, and SEF.

B, Integration of movement neuron activity. We explored the effect of integration time constant (τ) on the final value before saccade (**1**). For each τ the integrated value 20-10 ms before saccade initiation was measured for each SAT condition. Values from Accurate (red) and Neutral (black) conditions are plotted against values from the Fast condition. We submitted these trigger values to linear regression and found that trigger values between SAT conditions are invariant for time constants in the range $7.1 < \tau < 166.7$ ms. With $\tau = 100$ ms the time-course of integrated values are shown for Accurate (**2**), Neutral (**3**) and Fast (**4**) SAT conditions. Average integrated values divided into fastest (thick), intermediate (thinner) and longest (thinnest) RT quantiles with RTs distinguished by made (solid) and missed (dashed) deadlines. Triangles on ordinate mark mean integrated threshold within an SAT condition. Vertical bars reflect $\pm$1 SEM for each type of trial. None of the integrated values 20 – 10 ms before saccade were significantly different (linear regression).

C, Integrated visuomovement activity averaged for each SAT condition when conditions were made and missed (**1**, corresponding to Figure 5), and in RT quantiles for each SAT condition (**2-4**). Integrated visuomovement neuron discharge rates reach an invariant level 20 – 10 ms prior to saccade initiation (all $p > 0.05$, linear regression). The apparent plateau of activity during longer RT trials arises from averaging the visual responses inherent in visuomovement neurons.