

Supplemental Figure 1: Schematic pathways and horizontal vestibular and optokinetic behaviors in goldfish. A: Schematic of brainstem pathways showing reticular (burst) neurons projecting to the abducens (Abd) motoneurons (Mns) and internuclear neurons (Abd Int). The internuclear pathway ascends through the MLF to the contralateral medial rectus (MR) Mns (Suwa et al. 1996). The excitatory vestibuloocular reflex pathways are shown for either leftward head rotation or rightward planetarium motion with inhibitory connections omitted for clarity. Vestibular neurons project to 1) ipsilateral MR Mns via the Ascending Tract of Dieters (ATD), 2) contralateral Abd Mns and 3) contralateral Abd Int. Both nasal-to-temporal (N) and temporal-to-nasal (T) visual motion direction cells are illustrated from area pretectalis (APT) directly to the Abd and MR Mns along with vestibular nucleus consistent with the color-coded Left MR (red) and Right LR (blue) eye muscles. Eye position and velocity traces shown during either Vestibular or Visual stimulation was at 0.125 Hz and 15.7°/s peak head or planetarium velocity, respectively. B: Quantification of eye position time constant stability, leak and instability. Schematic of the optokinetic arrangement used for producing monocular tracking and time constant plasticity (adapted from Major et al. 2004). Two independent servo-controlled planetariums produced visual patterns each subtending 150° with a 30° central stimulus free region. Eye position and position-velocity (P-V) plots of spontaneous stable right eye movement (color coded for LR) are shown after 4 hrs of either leak or instability training. P-V plots during leak exhibit fixations with large centripetal drifts, negative P-V slopes and positive time constants. P-V plots during instability exhibit fixations with large eccentric drifts, positive P-V slopes, and negative time constants.

Supplemental Figure 2: Firing rate discrimination of HPNI neurons. A-D: Sample output of spike firing rate discriminator program illustrated for the HPNI neuron in Fig. 1. A: Peak-to-peak amplitude versus half width plots. Red circles indicate excluded data points. Black circles are accepted spikes. B: Histogram of peak amplitudes. C: Histogram of interspike intervals D: Superimposition of extracellularly recorded spikes.

Supplemental Figure 3: Long term maintenance of integrator time constant. A: P-V plots at 9 days and (B) 15 days after midline lesion depicted in b of Fig. 7C. LE and RE τ was 7.0s & 6.0s (A) and 13.3s & 44.1s (B). C: P-V plot at 90 days with LE and RE τ of 232.2s & 27.6s. D & F: P-V plots at 5 and (F) 15 days post lesion with oscillating eye position records shown in E (midline lesion in Fig. 7Ca). LE and RE τ were 28.6s & 25.2s (D) and -11.8s & -12.7s (F).