

SUPPLEMENTAL MATERIAL

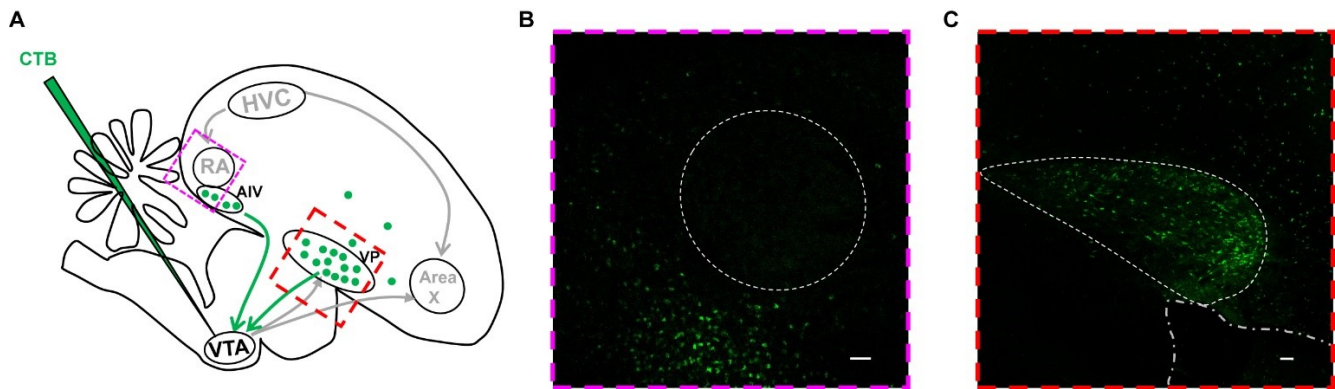


Figure S1. AIV and VP projects to VTA. Related to Figure 1A. (A) Schematic of tracing experiment. Injection of CTB into VTA retrogradely labeled cell bodies in AIV and VP, as previously reported (Gale et al., 2008; Mandelblat-Cerf et al., 2014). (B) Expanded view of magenta square from (A). VTA-projecting neurons are visible in AIV, which surrounds boundaries of RA, denoted by dashed white lines. (C) Expanded view of red square from (A). VTA-projecting neurons are visible in VP, bounded by dashed white lines, and overlying striatum. Scale bar in (B) and (C), 50 microns.

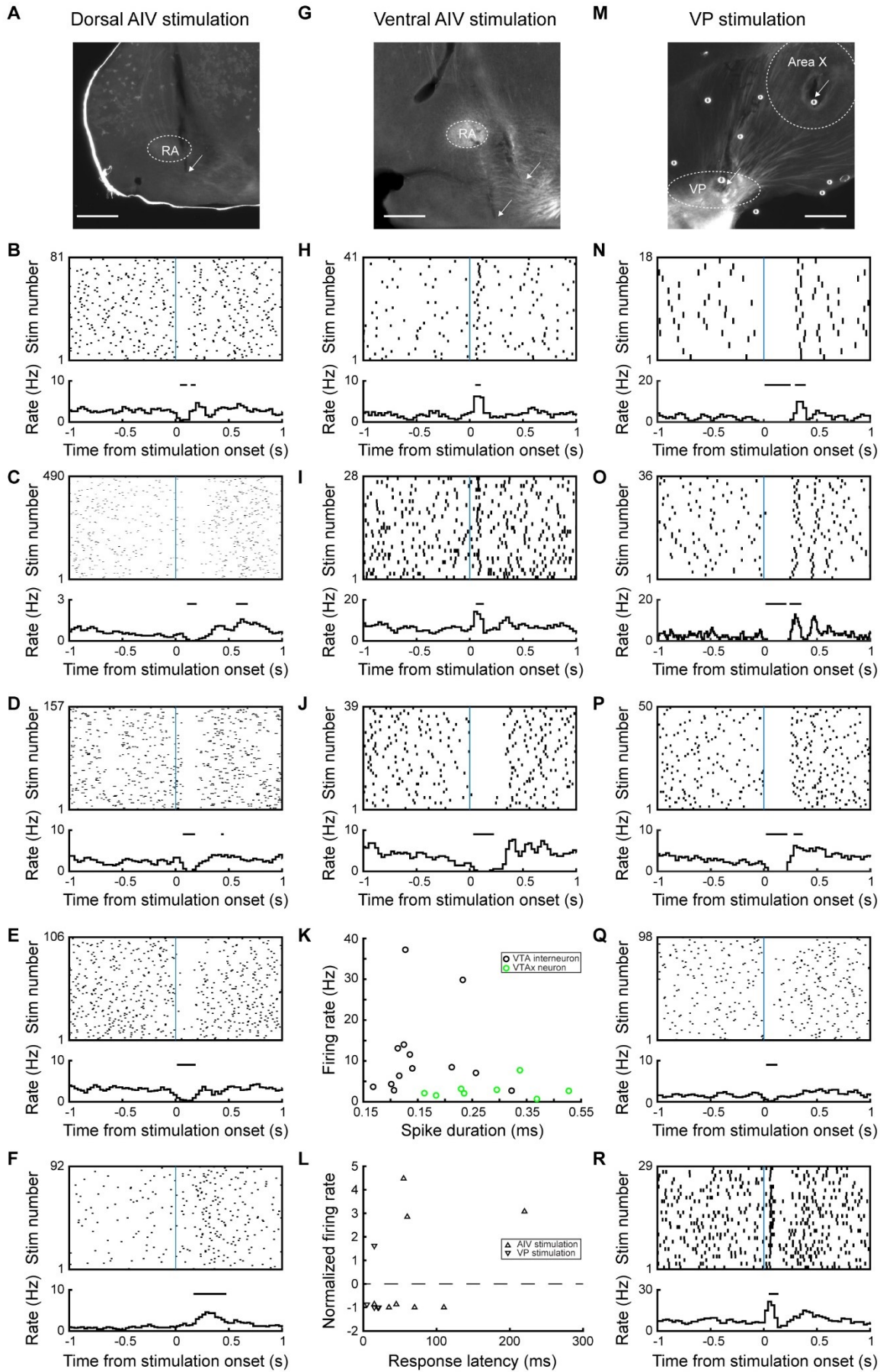


Figure S2. Auditory cortical and ventral pallidal stimulation drive diverse changes in VTax neuron firing. Related to Figure 1G. (A-J) Stimulating AIV drives diverse responses in VTax firing. **(A and G)** Stimulation electrode location in dorsal **(A)** or ventral **(G)** AIV (arrows). **(B-F)** Stimulation onset aligned raster plots and rate histograms for dorsal AIV stimulations. **(B)** is the same neuron as Figure 1E. Horizontal bars represent significant suppression or activation (z-test, $p < 0.05$, STAR Methods). **(H-J)** Same as **(B)** for ventral AIV stimulation. **(K)** Spike duration and baseline firing rate for all recorded VTA neurons (VTax neurons shown in green). **(L)** Scatter plot showing normalized response to stimulation versus latency to response for all recorded VTax neurons (Upward and downward triangles show responses to AIV and VP stimulation, respectively) **(M)** Stimulation electrode location in VP and Area X (arrows). **(N-R)** Same as **(B)** for VP stimulation. **(N)** is the same neuron as Figure 1F. Scale bars in **(A)**, **(G)**, and **(M)**, 500 microns.

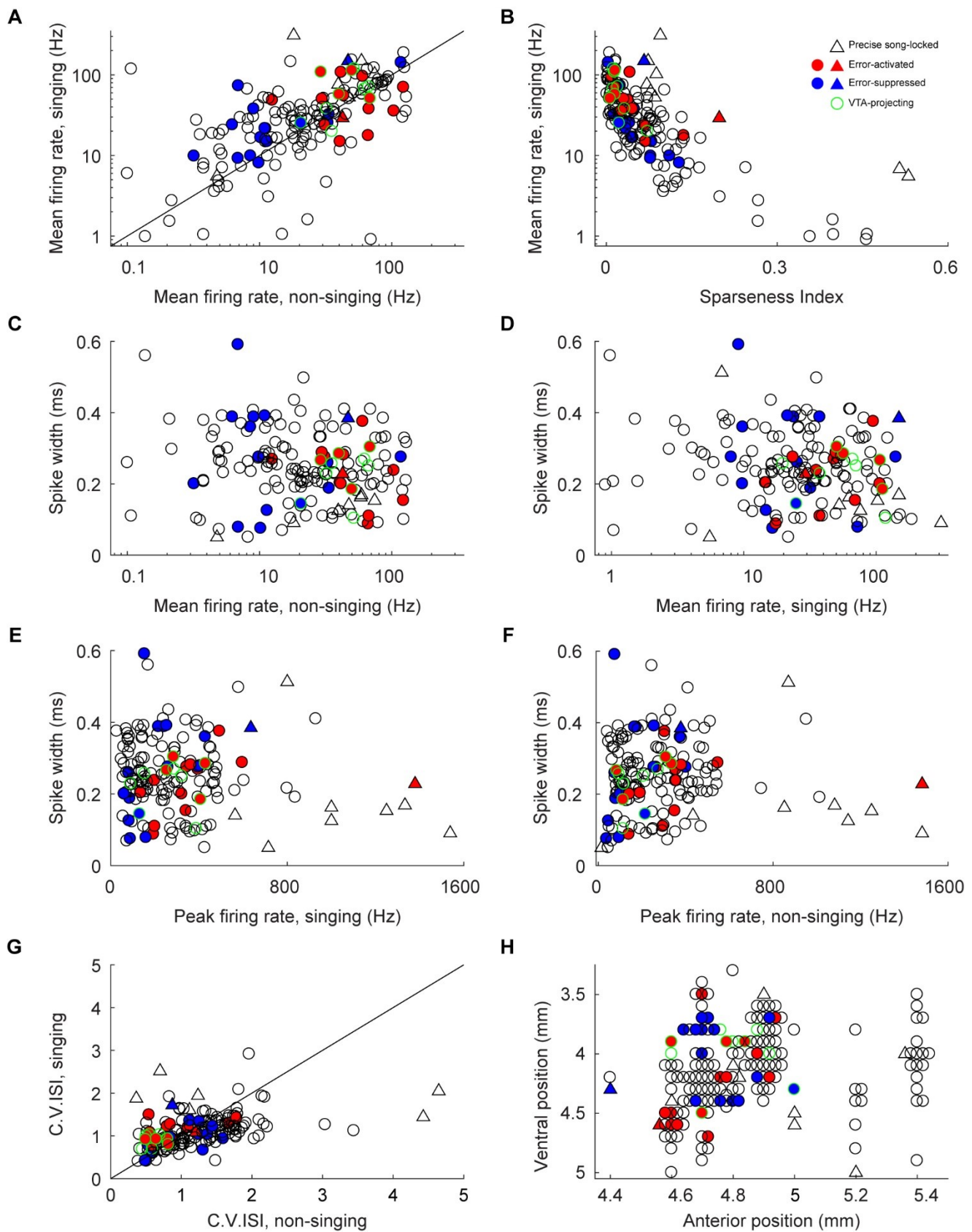


Figure S3. Firing patterns of VP neurons. Related to Figure 3. (A-H) VP neurons exhibited diverse firing pattern (A-F), sparseness during singing (B), spike width (C-F), discharge variability (G) and are

intermingled in space (**H**). Triangles: precisely time-locked neurons. Solid red fill: error-activated neurons. Solid blue fill: error-suppressed neurons. Green outline: VTA-projecting neurons.

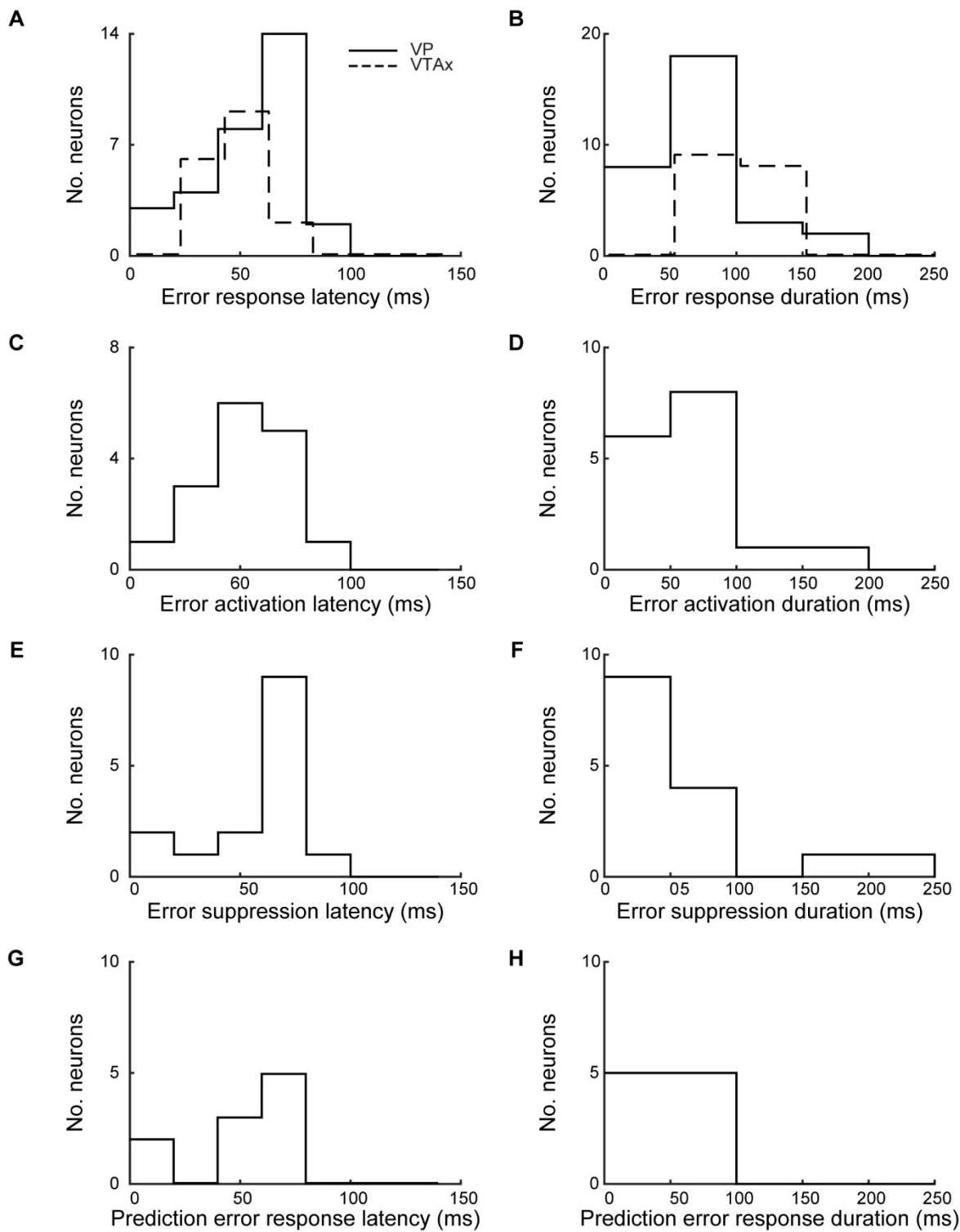


Figure S4. Latency and duration of VP error responses. Related to Figure 3E. (A) Distribution of latencies for VP error responsive neurons (solid line) and VTA dopamine neurons (dashed line) from (Gadagkar et al., 2016). (B) Duration of VP error response (solid line) and VTA error responses (dashed line). (C-D) As (A-B) for error activated VP neurons. (E-F) As (A-B) for error suppressed VP neurons. (G-H) As (A-B) for VP neurons that show prediction error response.

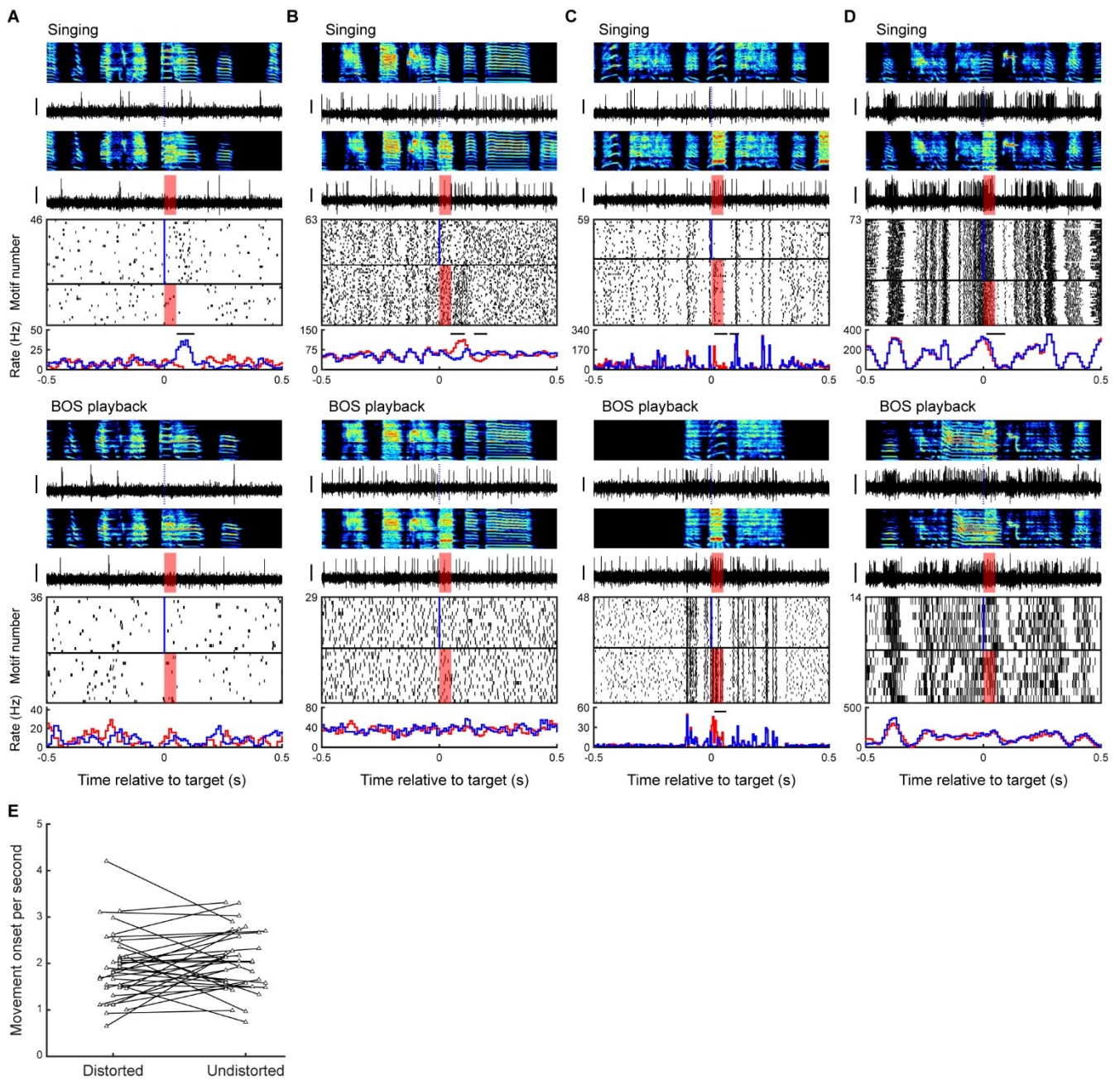


Figure S5. VP neurons can exhibit error signals that occur specifically during singing and was not attributable to animal movement. Related to Figure 3. (A-D) Examples of four neurons recorded during active singing, top row, and during passive playback of bird's own song (BOS), bottom row. Data plotted as in Figure 3B for all neurons in both conditions. Shown are examples of neurons that exhibited error responses only during singing (**A** and **B**) and the only two type 3 song locked neurons recorded in the dataset, which exhibited strong auditory responses to playback of BOS (**C** and **D**). Neuron in (**B**) is the VP_{VTA} neuron from Figure 5F. (**E**) Analysis of DAF-related movement responses across all birds. Each line represents data from one bird with average rate of movement onsets in 150 ms following distorted and undistorted syllables. There was no difference in movement onset rate between distorted and undistorted motifs ($p > 0.05$ in 35/35 birds, WRS test.)

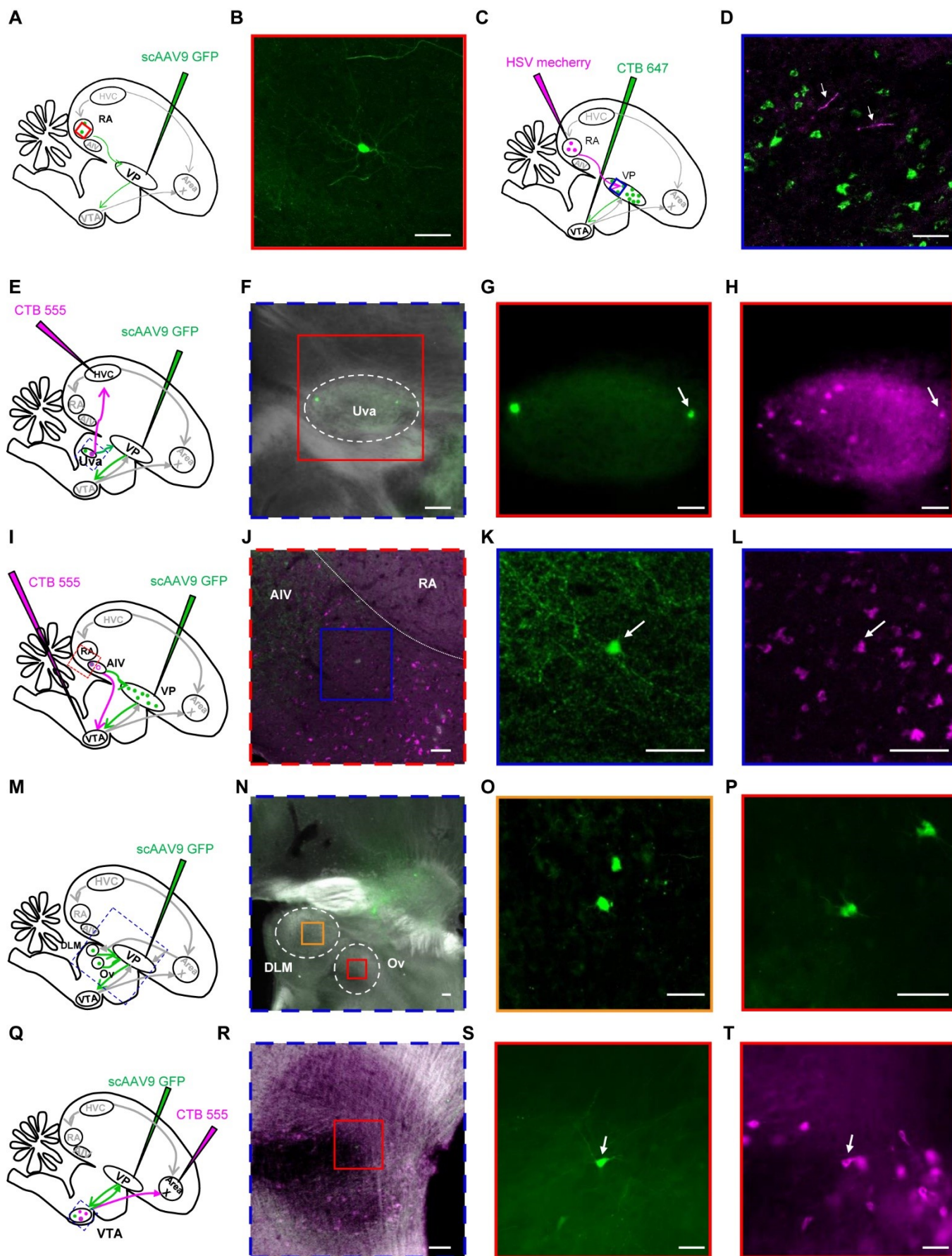


Figure S6. RA, Uva, AIV, DLM, Ov, and VTax project to VP. Related to Figure 6B. To label VP-projecting neurons, sparse retrograde scAAV9 virus was injected into VP (**A,E,I,M,Q**). (**A to D**) RA projects to VP. (**B**) Fluorescently labeled RA neuron following VP injection. (**C**) Anterograde virus (HSV mCherry) was injected into RA and CTB 647 was injected into VTA. (**D**) Photomicrograph of part of VP, with VTA-projecting neurons (green) in close proximity to RA axons (purple). (**E to H**) HVC-projecting nucleus Uvaeformis (Uva) thalamic neurons project to VP. CTB-555 was injected into HVC (**E**). Retrogradely labeled VP-projecting Uva neuron (arrow, **G**) was co-labeled with HVC-projecting Uva neuron (arrow, **H**). (**I to L**) VTA-projecting AIV neurons also project to VP. CTB-555 was injected into VTA (**I**). Retrogradely labeled VP-projecting AIV neuron (arrow, **K**) is co-labeled with VTA-projecting AIV neuron (arrow, **L**). (**M to P**) Area X recipient thalamus DLM and primary auditory thalamus Ovoidalis (Ov) project to VP. Retrogradely labeled DLM neurons (**O**) and Ov (**P**). (**Q to T**) Area X-projecting VTA dopamine neurons (VTax) send collaterals to VP. CTB-555 was injected into Area X (**Q**). Retrogradely labeled VP-projecting VTA neuron (arrow, **S**) was co-labeled with X-projecting VTA neuron (arrow, **T**). Scale bars are 50 microns.