Supplementary Figure/Table Legends

Supplementary Figure 1. Histological verification of fiber placements for all rats used in fMRI experiments. The middle row shows placements for two rats that were behaviorally non-responsive (NB *Th::Cre*). The first and last rows illustrate fiber placements for the remaining *Th::Cre* and wild-type rats, respectively.

Supplementary Figure 2. Group activation maps (same as Figure 2B) at different voxel-wise and cluster-wise thresholds. Statistical t-value maps overlaid on structural images for optical VTA stimulation in *Th::Cre* rats (n = 5 for BOLD and n = 6 for CBVw) at **(A)** voxel-wise threshold = $p < 0.025$; no family-wise threshold (cluster > 0 voxels); **(B)** voxel-wise threshold = $p < 0.05$; family-wise threshold = $p < 0.05$ (cluster > 42 voxels) ; and **(C)** voxel-wise threshold = $p < 0.01$; family-wise threshold = $p < 0.01$ (cluster > 19 voxels). Color bar indicates t-values.

Supplementary Figure 3. (A) Forepaw stimulation activation maps. Statistical t-value maps overlaid on structural images illustrate increased CBVw activity in right (top panel) and left (bottom panel) S1 of two representative wild-type rats after electrical stimulation of the contralateral forepaw (left forepaw for top panel and right forepaw for bottom panel). Voxel-wise and family-wise error correction (cluster size > 28 voxels) thresholds were set to $p < 0.025$, similar to VTA activation maps. White dashed lines delineate S1 in the structural images. **(B)** ROI analysis. Mean ± SEM t-values for correlation of CBVw signal changes within the entire S1 ROI with predicted hemodynamic response functions. S1 ROIs contralateral as well as ipsilateral to the stimulated forepaw were drawn on individual structural images for wild-type rats (n = 4) and NB *Th::Cre* (n = 2) rats, and data from wild-type and NB *Th::Cre* rats were combined. A two sample t-test resulted in a trend towards significant difference in t-values between S1 ROIs ($t(9) = 2.206$, $p = 0.055$) contralateral and ipsilateral to the stimulated side.

Supplementary Figure 4. Contralateral ROI analysis for VTA stimulation. Mean ± SEM t-values for correlation of **(A)** BOLD and **(B)** CBVw signal changes within ROIs with predicted hemodynamic response functions. Left hemisphere ROIs were drawn on individual structural images for *Th::Cre* rats (n = 5 for BOLD and n = 7 for CBVw), NB *Th::Cre* rats (n = 2 for BOLD and CBVw), and wild-type rats (n = 4 for BOLD and CBVw). Brown-Forsythe ANOVAs for each ROI yielded significant differences in activation t-values in the **thalamus** ($F(2,10) = 7.655$, $p = 0.013$) and **amygdala** ($F(2,10) = 6.386$, $p = 0.018$). Post-hoc two sample t-tests resulted in a significant difference in CBVw response between *Th::Cre* rats and wild-type rats ($t(9) = 2.455$, $p = 0.040$) in the thalamus only. There was no significant difference between NB *Th::Cre* and wild-type groups for any ROI. * = $p < 0.05$.

Supplementary Figure 5. Time courses. Mean ± SEM % BOLD (top) and CBVw (bottom) signal changes are plotted across time. Only ROIs that showed a significant difference in BOLD and CBVw activity between *Th::Cre* and wild-type rats in the ROI analysis (indicated in Figures 3A, 3B, and Supplementary Figure 4) are plotted for *Th::Cre* (n = 5 for BOLD and n = 7 for CBVw) and wild-type rats (n = 4 for BOLD and CBVw). % signal changes for NB *Th::Cre* rats are not shown. % signal changes in the left hemisphere ROIs corresponding to significant right hemisphere ROIs are also depicted. Optical stimulation started at t = 0 s and terminated at t = 20 s. All values are signal changes expressed as percentage of the baseline (-4 s to 0 s and 41 s to 55 s). Note that the signs of CBVw values are reversed so that increased signal changes represent increases in CBV.

Supplementary Figure 6. Immunohistological images from two representative *Th::Cre* rats showing ChR2 expression (green fluorescence) in the midbrain along the anterior-posterior axis of VTA. Boundaries of VTA and SN are outlined with white and yellow dashed lines,

respectively. Optical tracts terminating dorsal to VTA are highlighted with white dashed lines Scale bar: 300 µm.

Supplementary Figure 7. Structural MRI images (voxel size: 125 µm x 125 µm x 1 mm) show fiber tracts terminating in VTA region in all *Th::Cre* rats (excluding NB *Th::Cre*).

Supplementary Table 1. Number of animals used and excluded for each group for all experiments/figures.