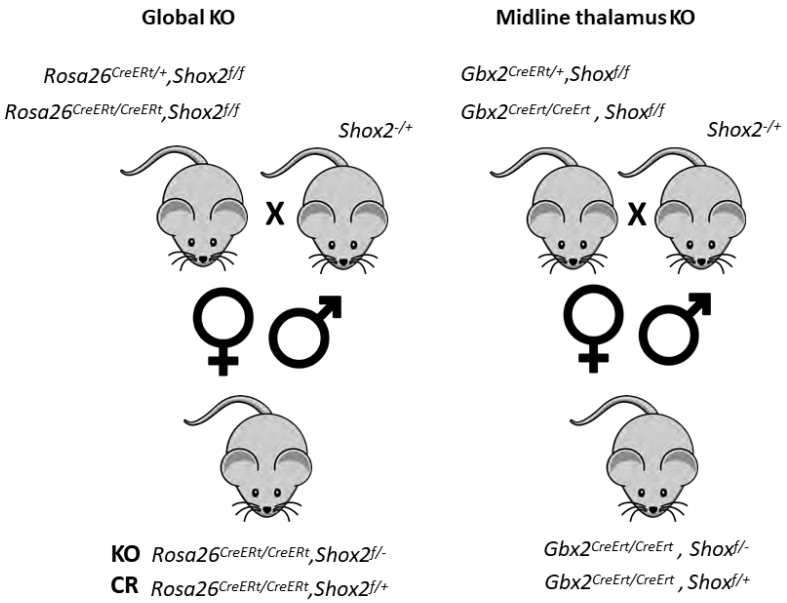
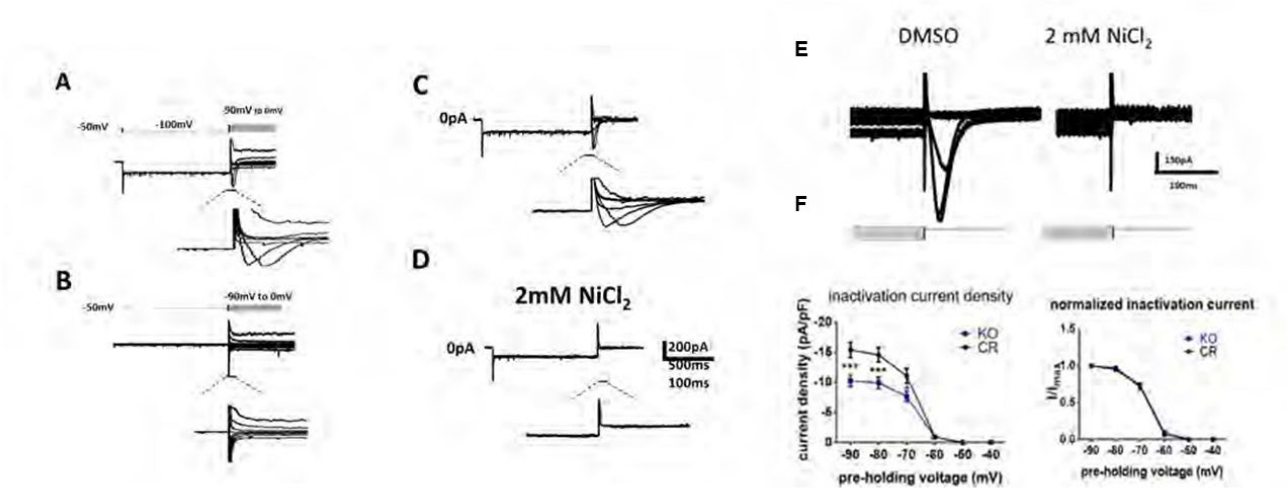
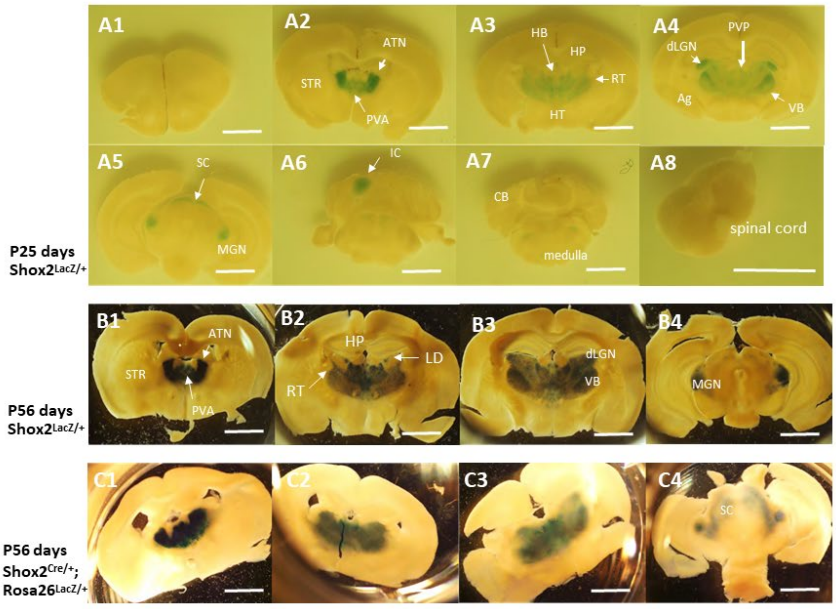
Supplemental Figures



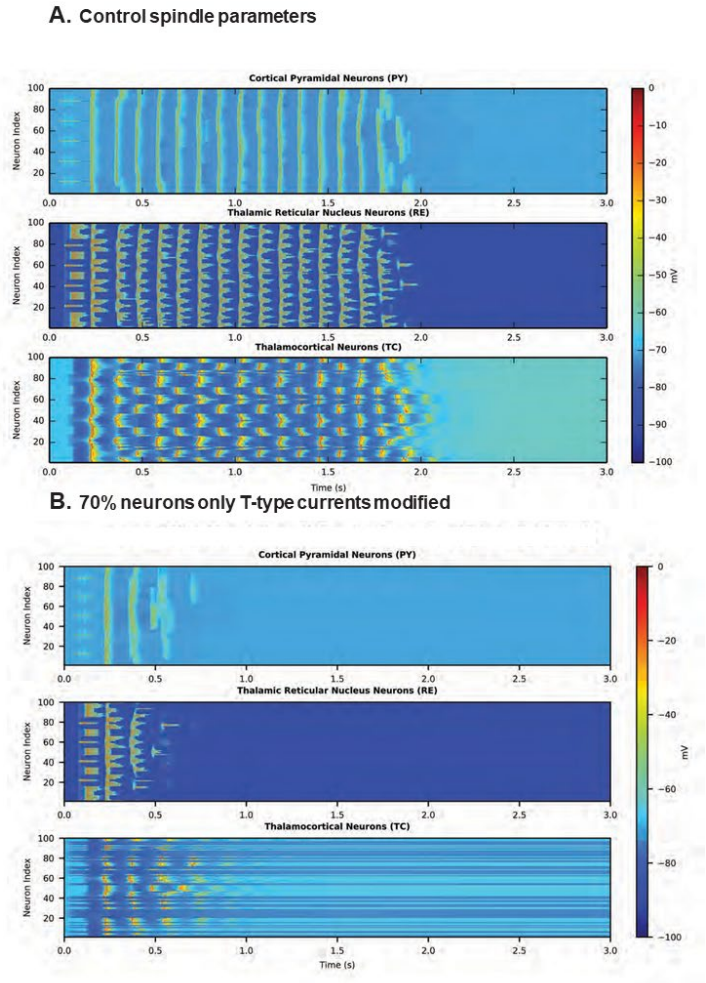
Supplemental Figure 1. Schematic diagrams of breeding schemes used to produce Rosa26$^{CreERt/CreERt}$, Shox2$^{f/-}$ and *Gbx2$^{CreErt/CreErt}$, Shox$^{f/-}$* mice.



Supplemental Figure 2. Isolation of T-type Ca^{2+} current: **A.** The membrane potential was hyperpolarized to -100mV for 1s from holding potential -50mV to remove inactivation of the T-type calcium current. **B.** T-type calcium currents were elicited by stepping from -100mV to a series of incremental depolarizations ranging from -90mV to 0mV. **B.** The same series of step voltages was applied to the same neurons without hyperpolarization to -100mV, instead, the membrane potential was held at -50mV in that time range. **C.** The T-type calcium currents were isolated by subtracting currents evoked in B from currents evoked in A. **D**. The isolated current was blocked by 2mM $NiCl_2$, confirming the isolated current is T-type calcium current. **E**. The T-type calcium currents were elicited at -50mV after recovery from 1s pre-holding step voltage ranging from -90mV to -40mV. The elicited T-type calcium current is confirmed by application of 2mM $NiCl_2$ to block it. **F.** The curve of T-type calcium current inactivation current density at different pre-holding voltage from CR neurons and KO neurons. Two-way repeated measures ANOVA indicated significant main effect of genotypes (CR vs KO, $F_{(1,21)} = 8.41$, $P<0.01$) and voltage ($F_{(5,105)} =218.7$, $P<0.001$) and significant interaction ($F_{(5,105)}=8.58$, $P<0.001$). **G.** The normalized inactivation current curves of CR and KO neurons are overlapped with each other.



Supplemental Figure 3. Shox2 expression is restricted to thalamus in adult and diencephalon throughout development. Brain sections demonstrating X-gal staining (or Shox2 expression) results from PND25 **(A1-A8)** and PND56 Shox2$^{LacZ/+}$ **(B1-B4)** and PND56 male Shox2$^{cre/+}$, Rosa26$^{LacZ/+}$ mouse **(C1-C4).** X-gal staining was observed in anterior thalamus nuclei (ATN), anterior paraventricular nucleus (PVA), ventrobasal thalamus (VB), dorsal lateral geniculate nucleus (dLGN) and medial geniculate nucleus (MGN) but was not observed in the cortex (CX), striatum (STR), hippocampus (HP), amygdala (Ag) or hypothalamus (HT). During development, *Shox2* did express in in habenula (HB), and some areas of the midbrain including superior colliculus (SC) and inferior colliculus (IC), but this expression is reduced in adults. Scale bar: 2 mm.



Supplemental Figure 4. T-type channel alterations alone do not sustain 4Hz absence seizures. A. (Same as figure 7A, baseline parameters generating spindle oscillations for comparison) **B.** In 70 random TCNs, T-type activation is shifted from –70mV to –60mV, HCN is unaffected. Oscillations are not sustained or 4Hz.