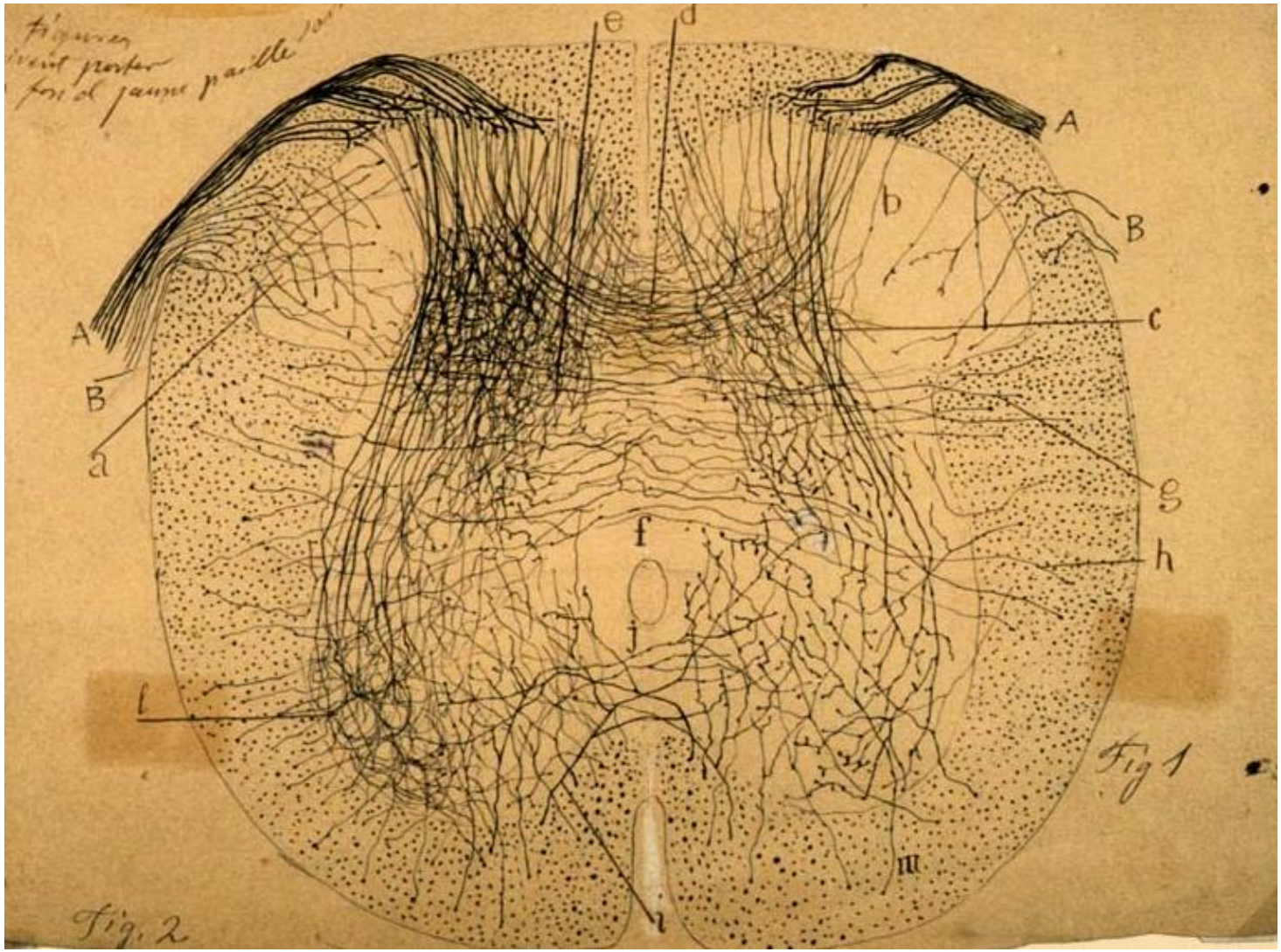
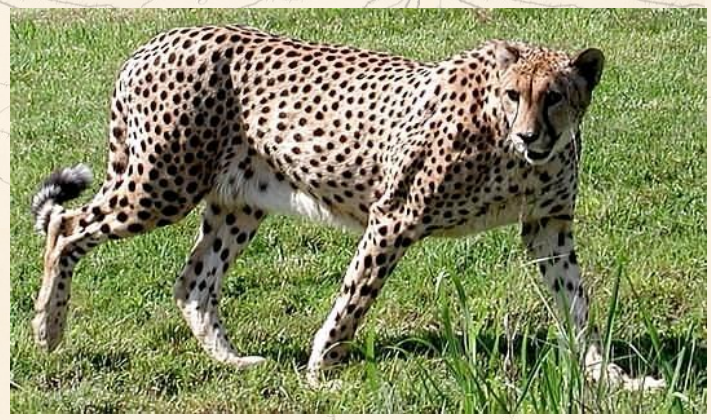
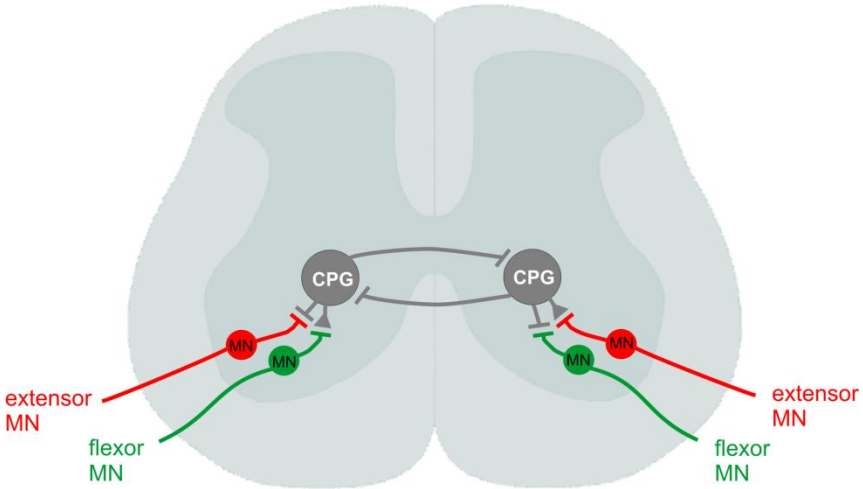
Interneurons and spinal motor control

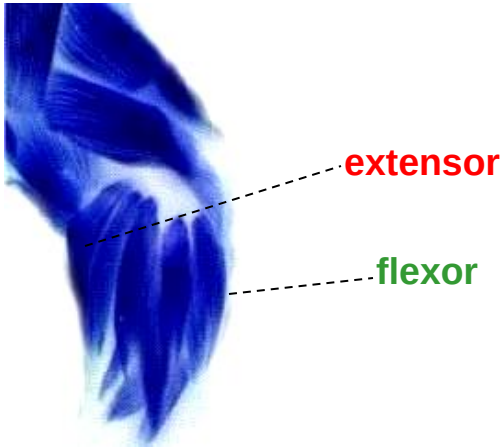


Motor circuitry and locomotion



Locomotion: Interneurons assign the pattern and force of motor output



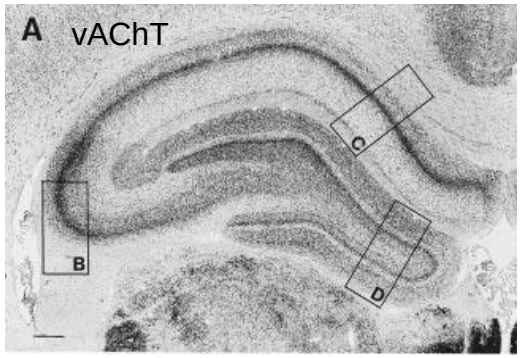


pattern

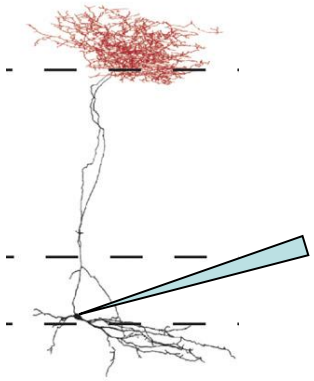
amplitude

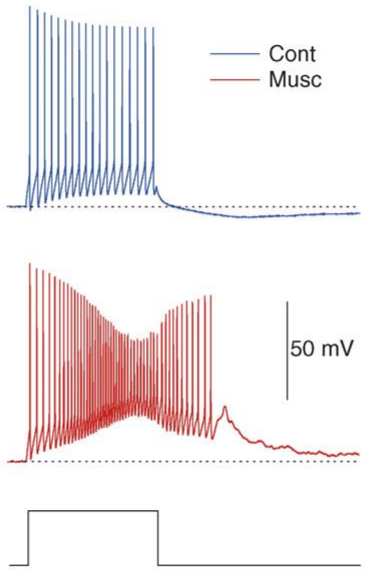
Cholinergic modulation in the CNS

Gensat



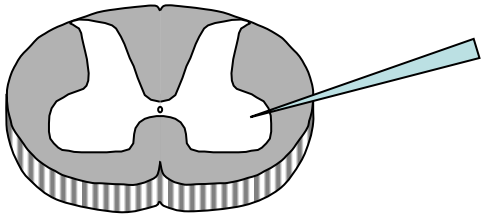
Schäfer et al., 1998

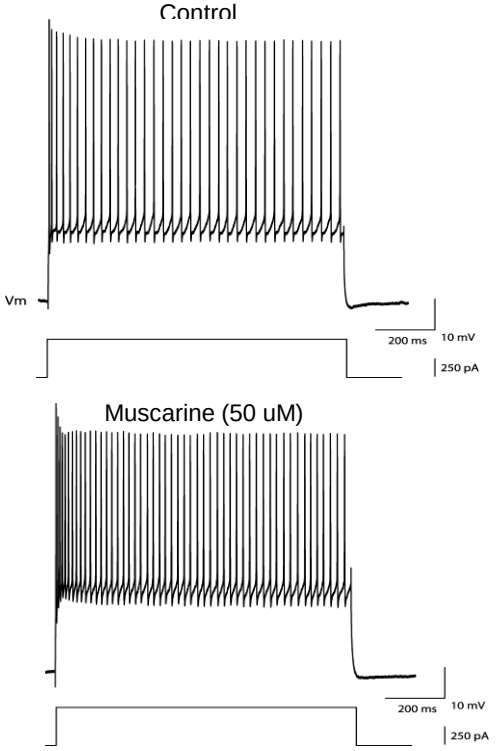


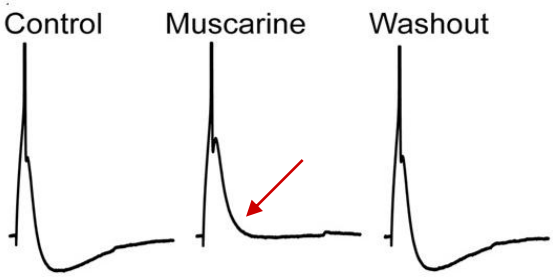


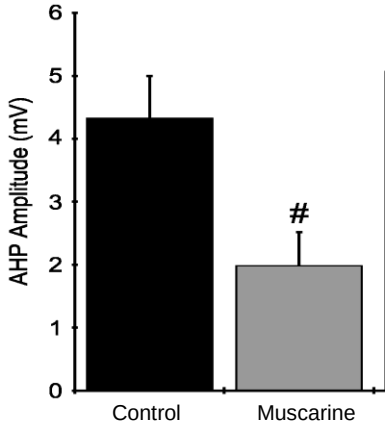
Widmer et al., 2006

Cholinergic (muscarinic) regulation of motor neuron excitability



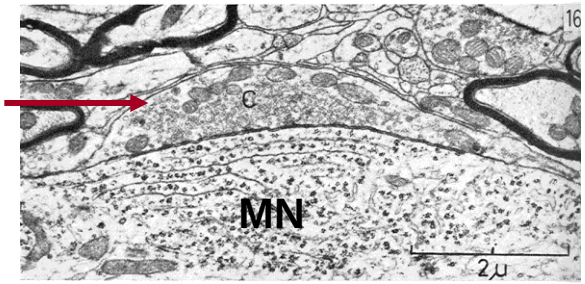




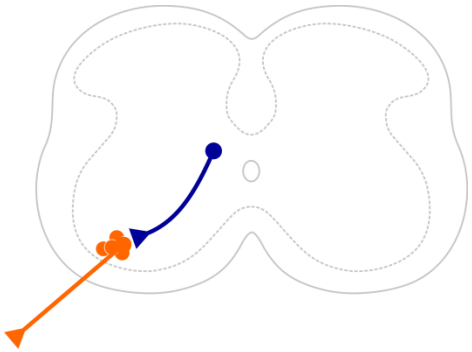


Miles et al, 2007

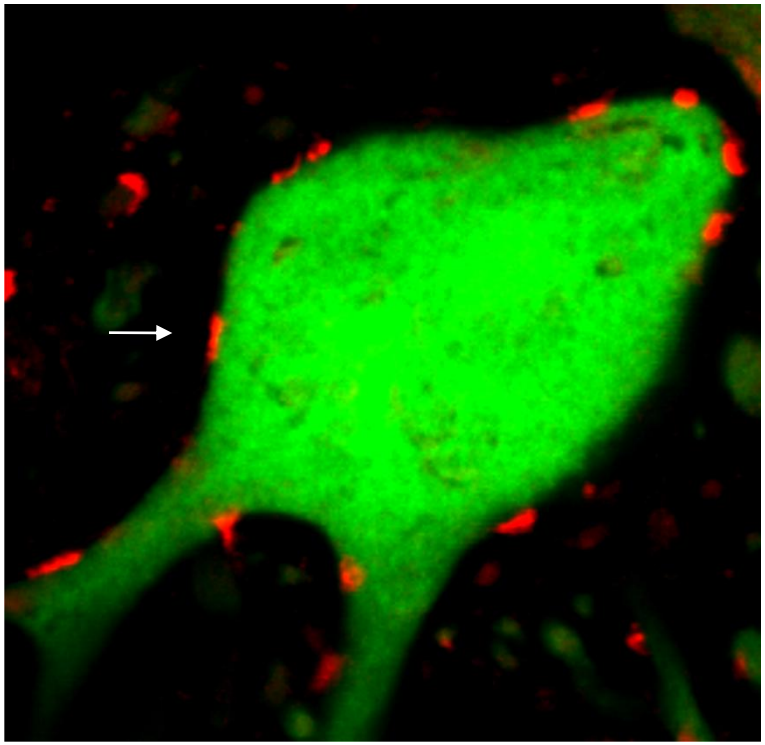
Cholinergic synapses with motor neurons: “C” boutons



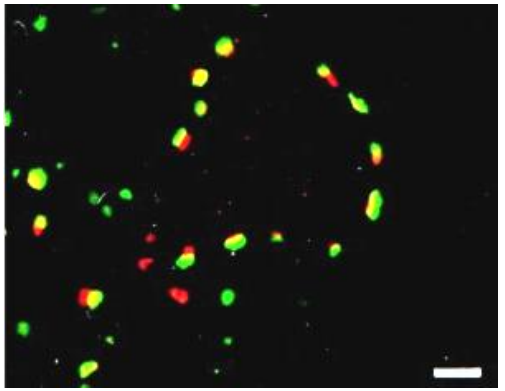
Conradi and Skoglund

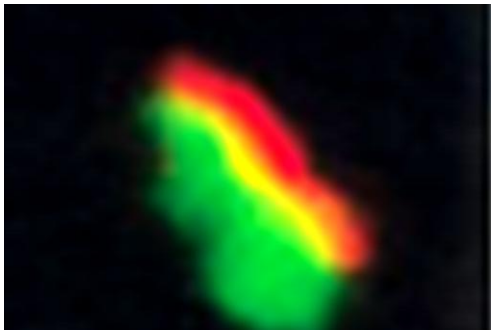


***Hb9*::eGFP vAChT**



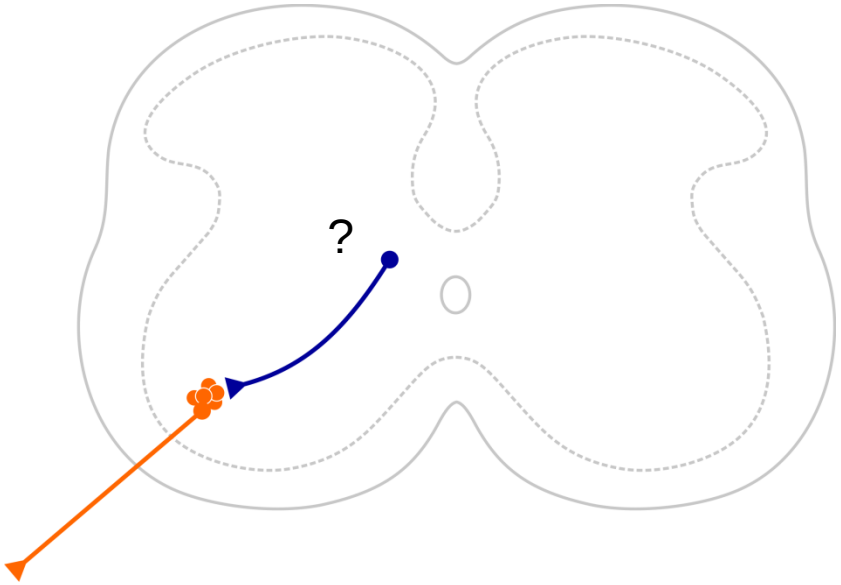
m2 vAChT



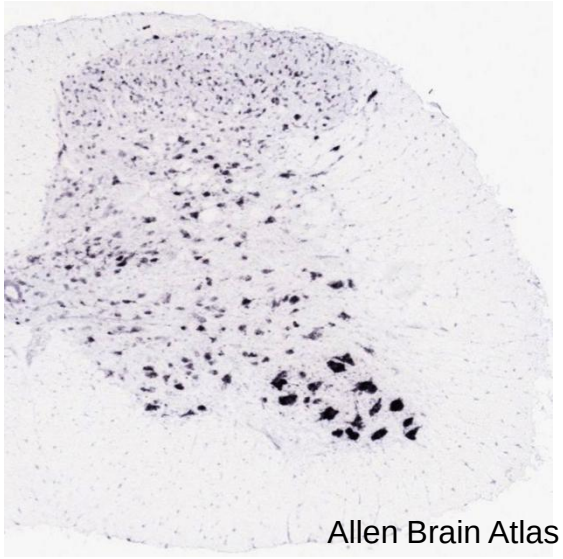


Skinner, Hellstrom, Wilson

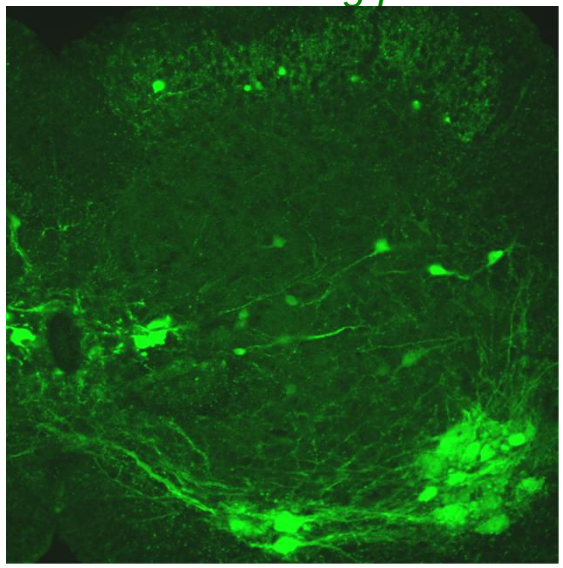
Finding the origin of the C-boutons



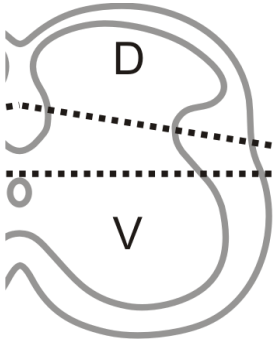
m2

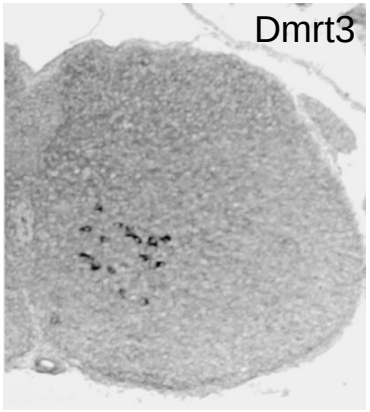


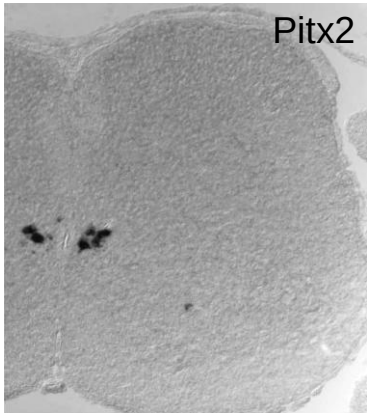
vAChT::egfp

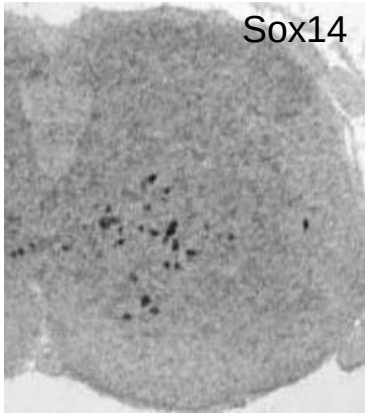


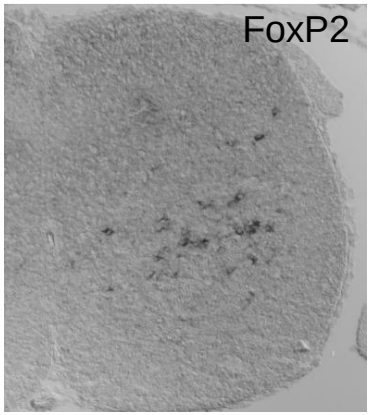
A screen for interneuron subpopulations

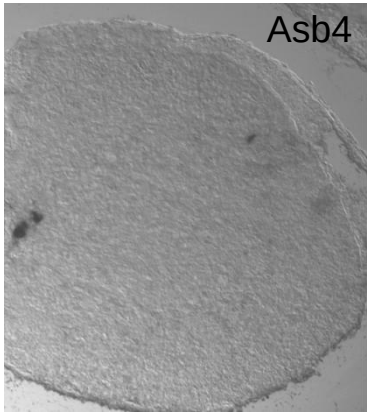




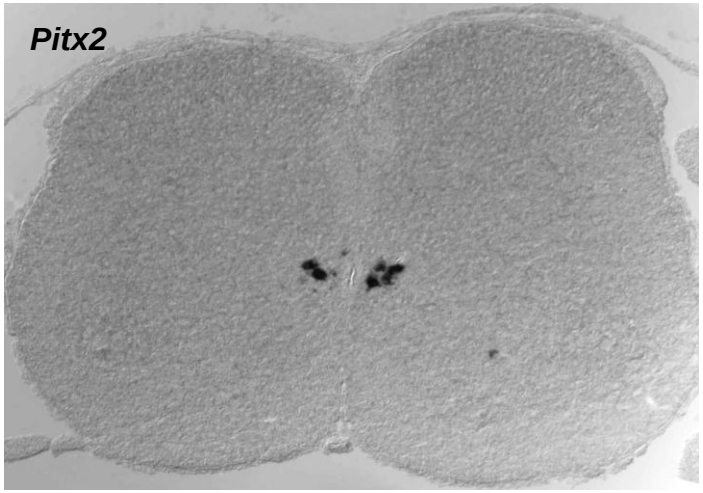


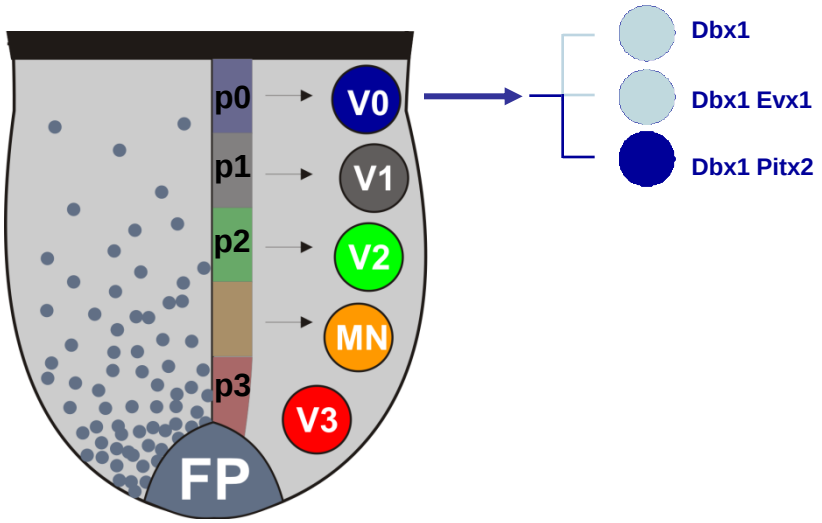




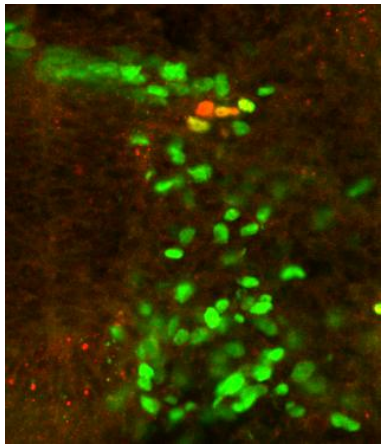


Pitx2^{+} neurons derive from p0 progenitors

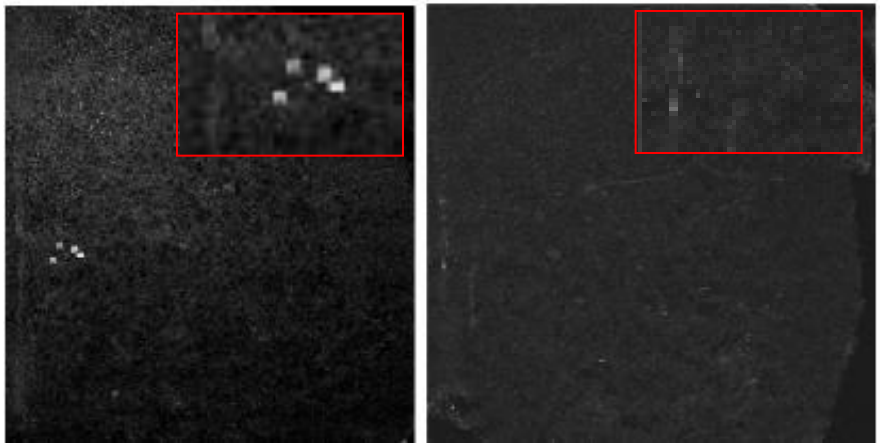




Pitx2 ***Dbx1::nlsLacZ***

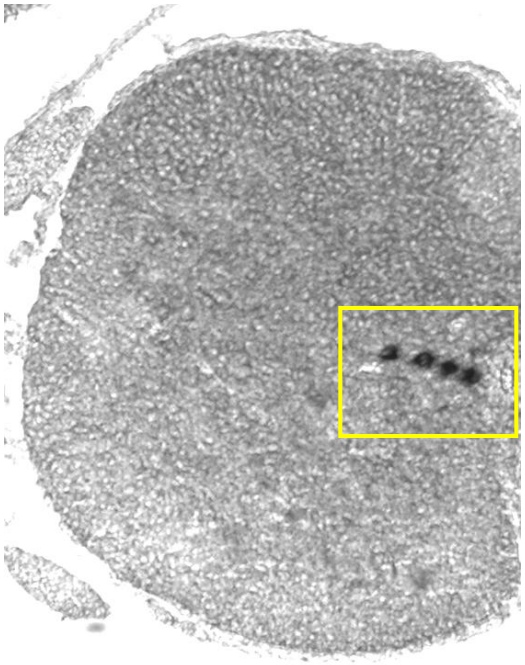


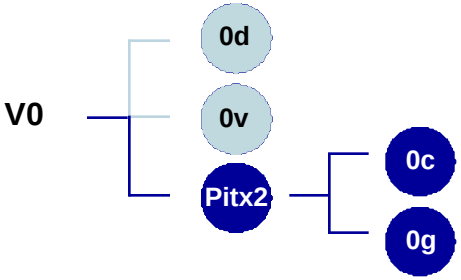
WT **Pitx2** ***Dbx1-/-***



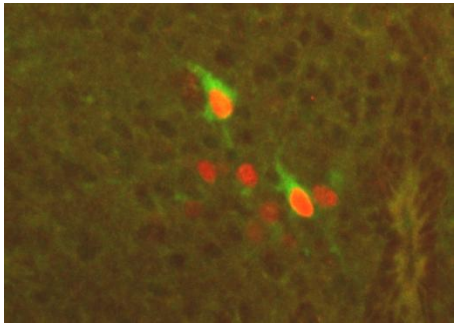
Cholinergic (V0c) and glutamatergic (V0g) subsets of Pitx2^{+} neurons

Pitx2

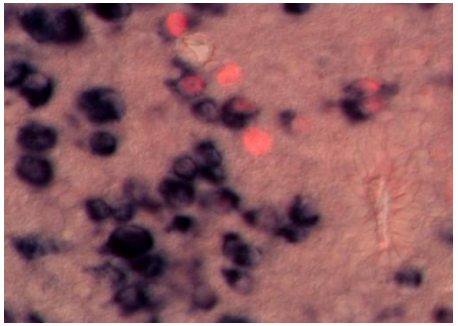




ChAT Pitx2

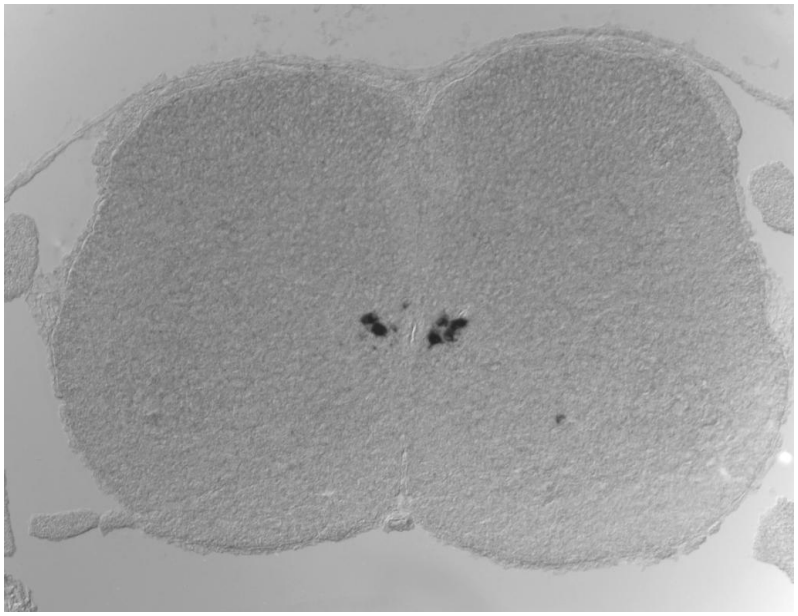


***vGluT2* Pitx2**



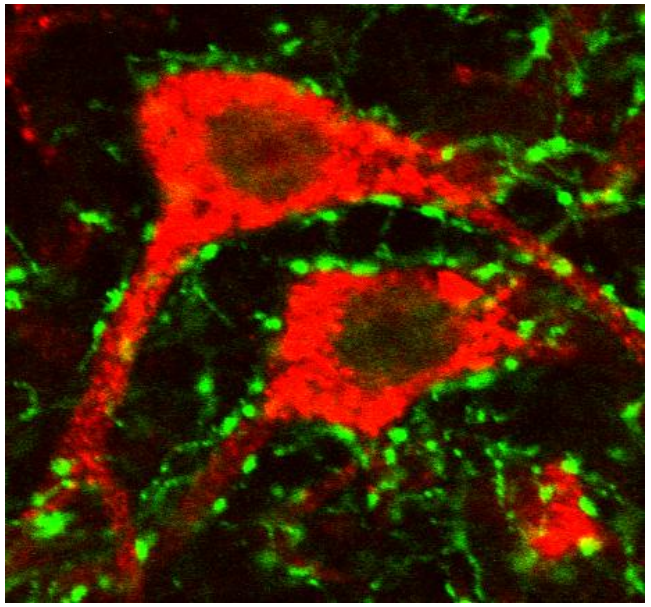
Linking transcriptional identity to synaptic organization:
the C-bouton puzzle

Pitx2

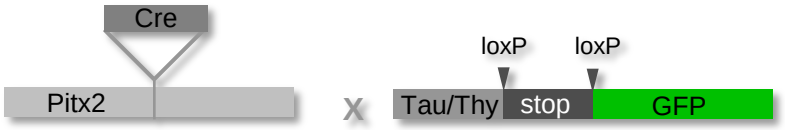


?

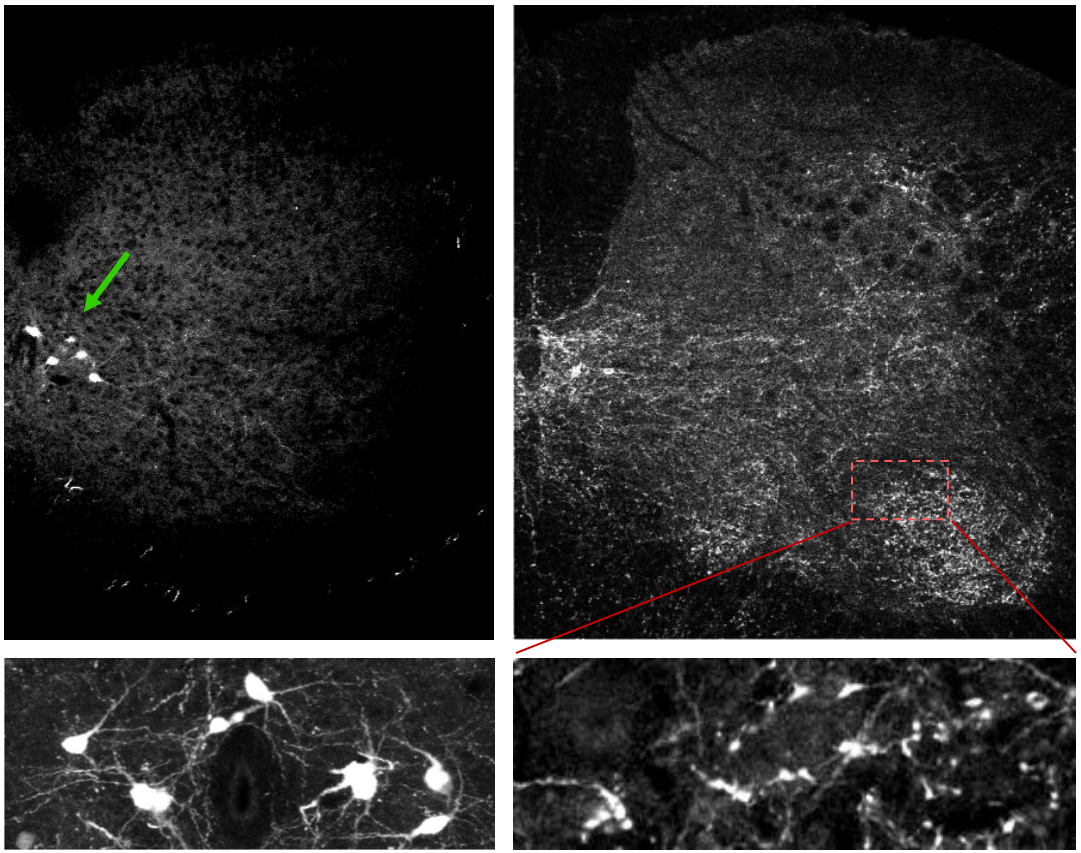
vAChT



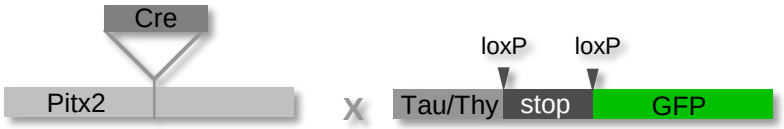
Tracing the connections of V0c neurons



GFP

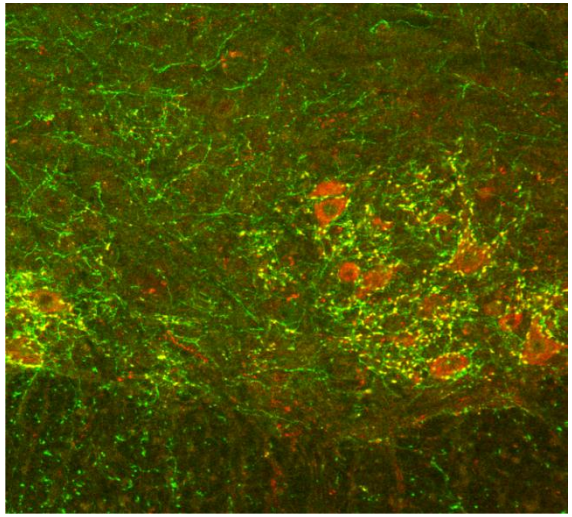


V0c neurons are the sole source of C-boutons

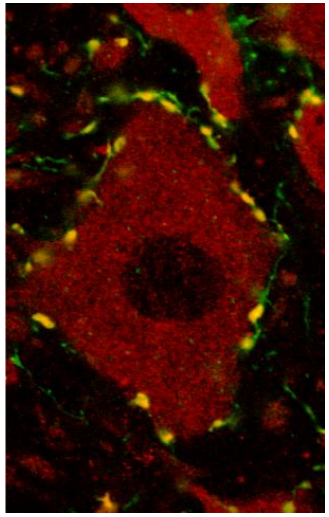


GFP

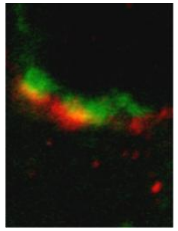
vAChT



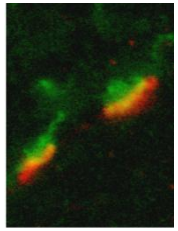
vAChT



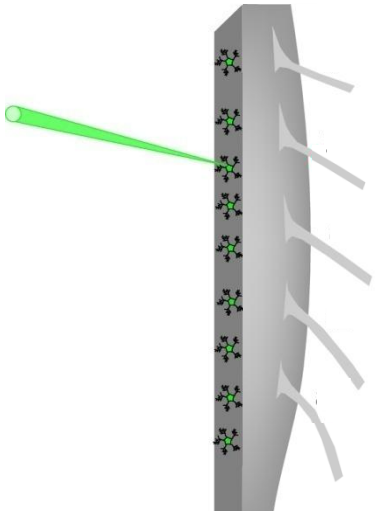
m2

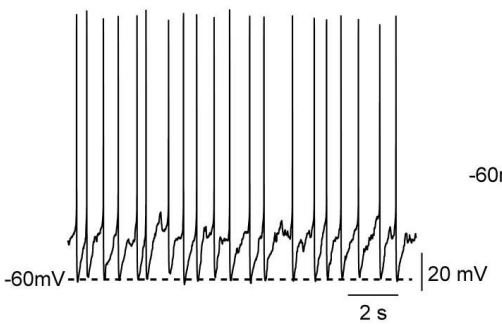


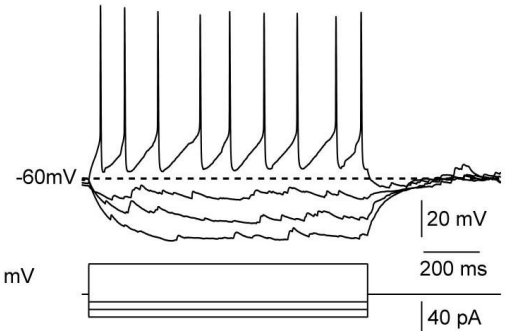
Kv2.1



Physiological properties of V0c neurons

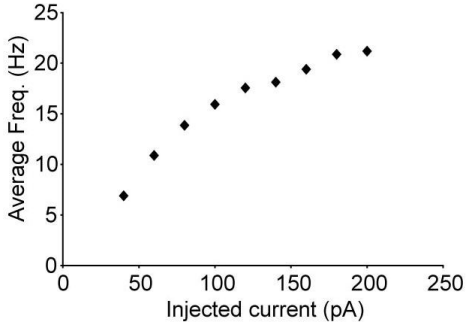




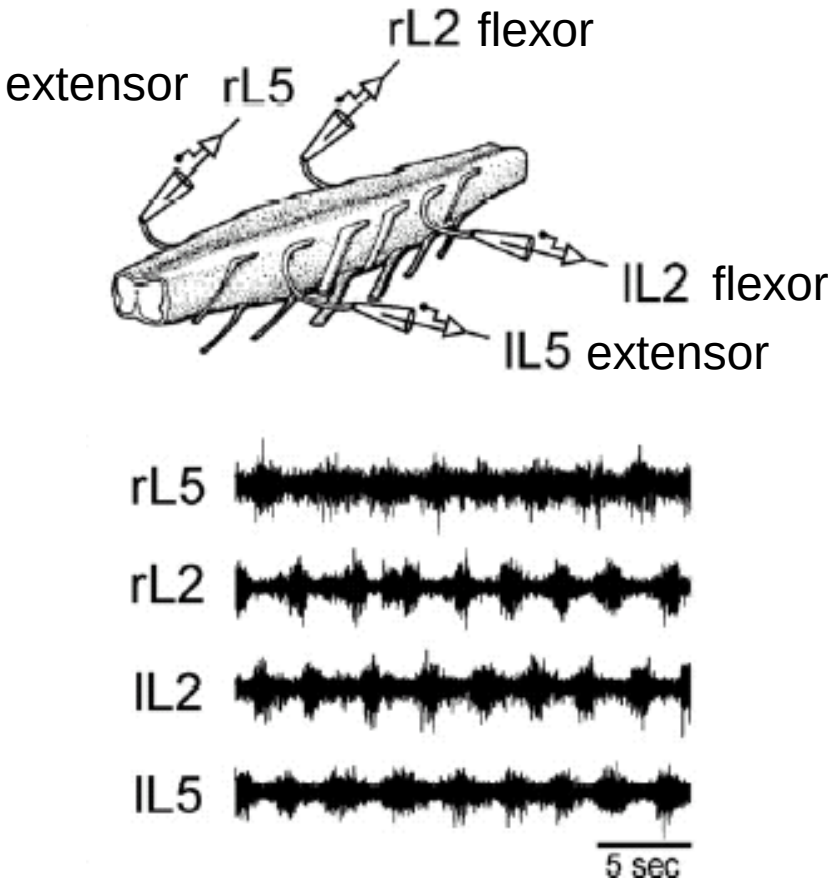


IR-DIC

YFP

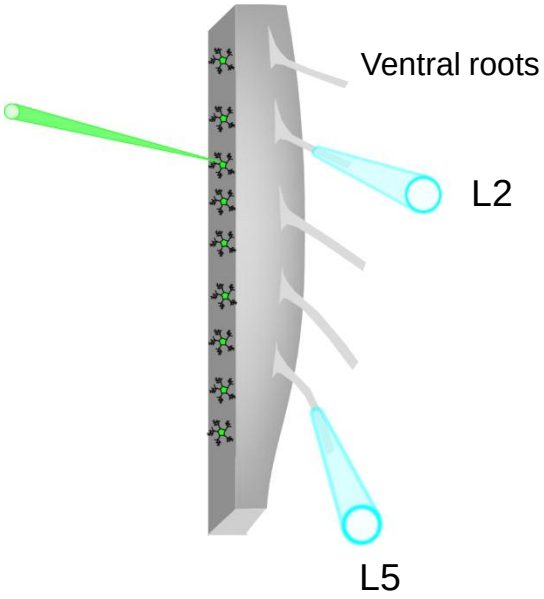


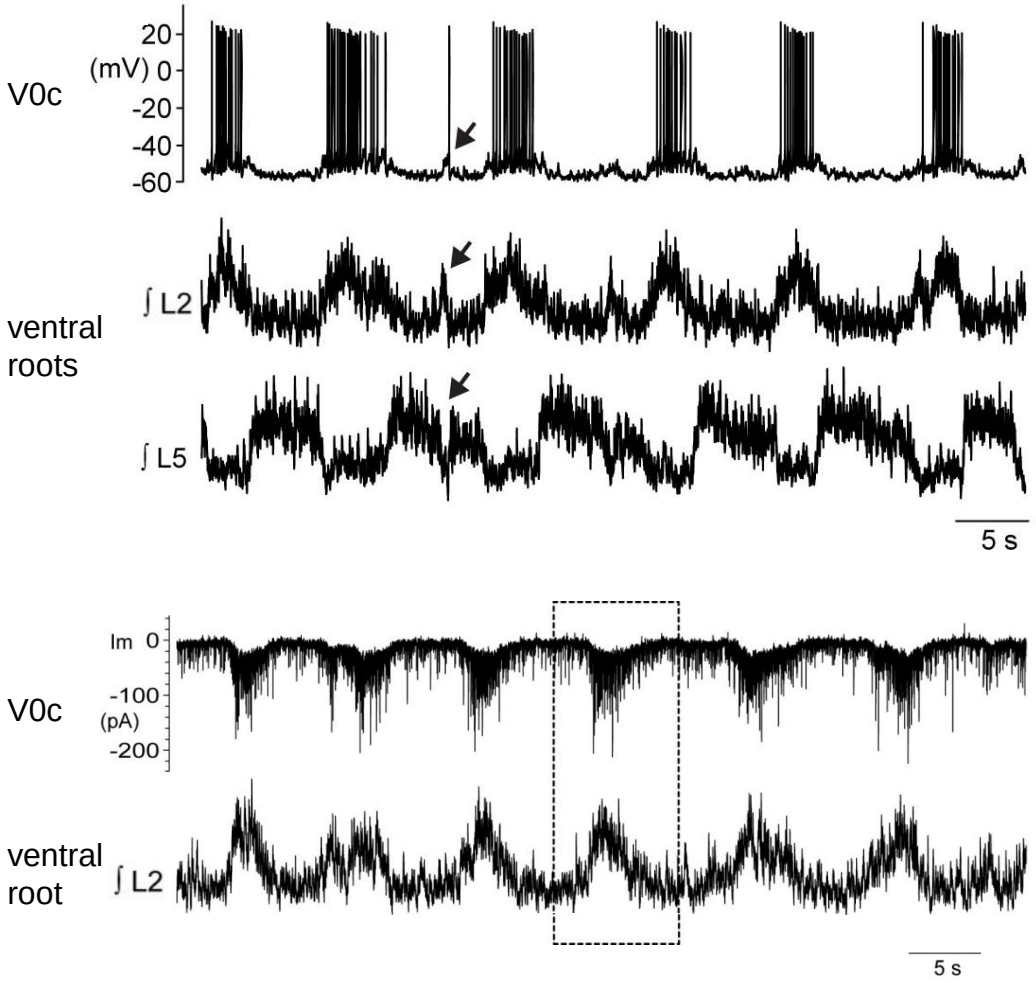
In vitro locomotion



Kiehn lab

V0c neurons fire in phase with segmental motor output

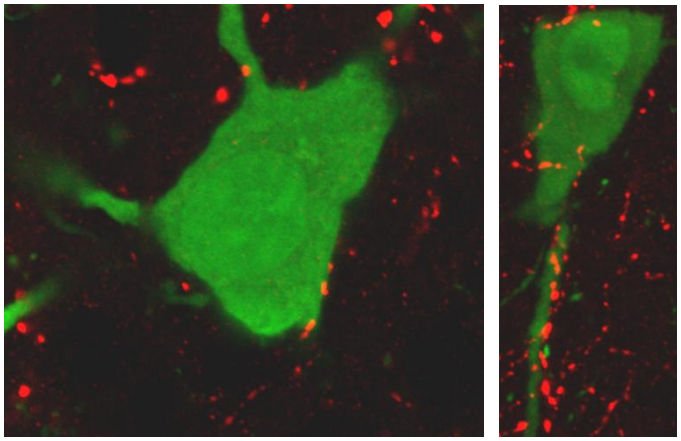


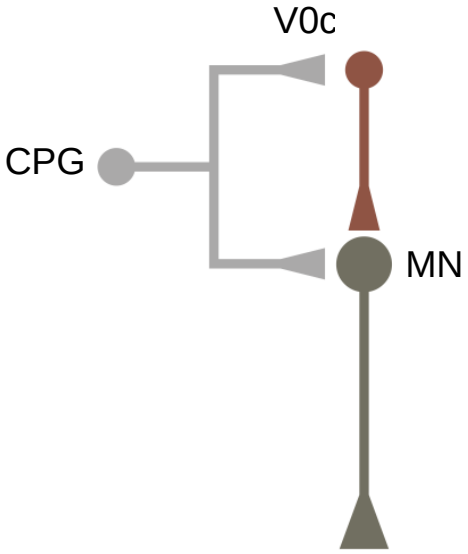


V0c neurons as integrators and modulators of motor output

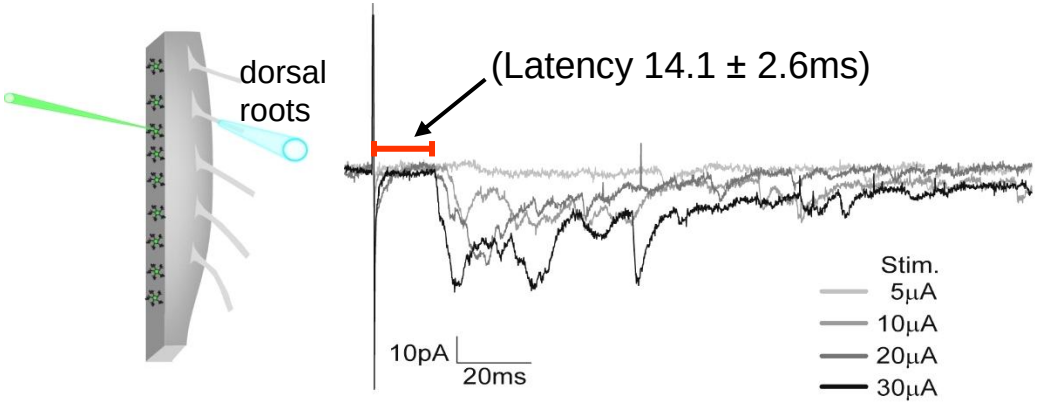
descending

5HT

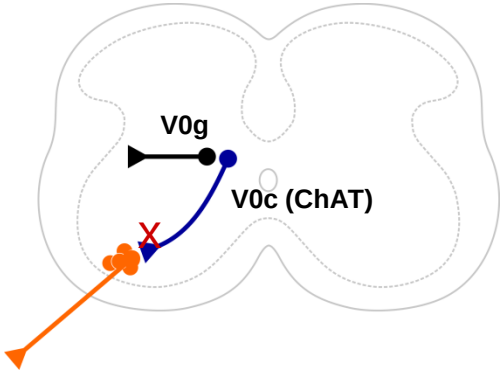


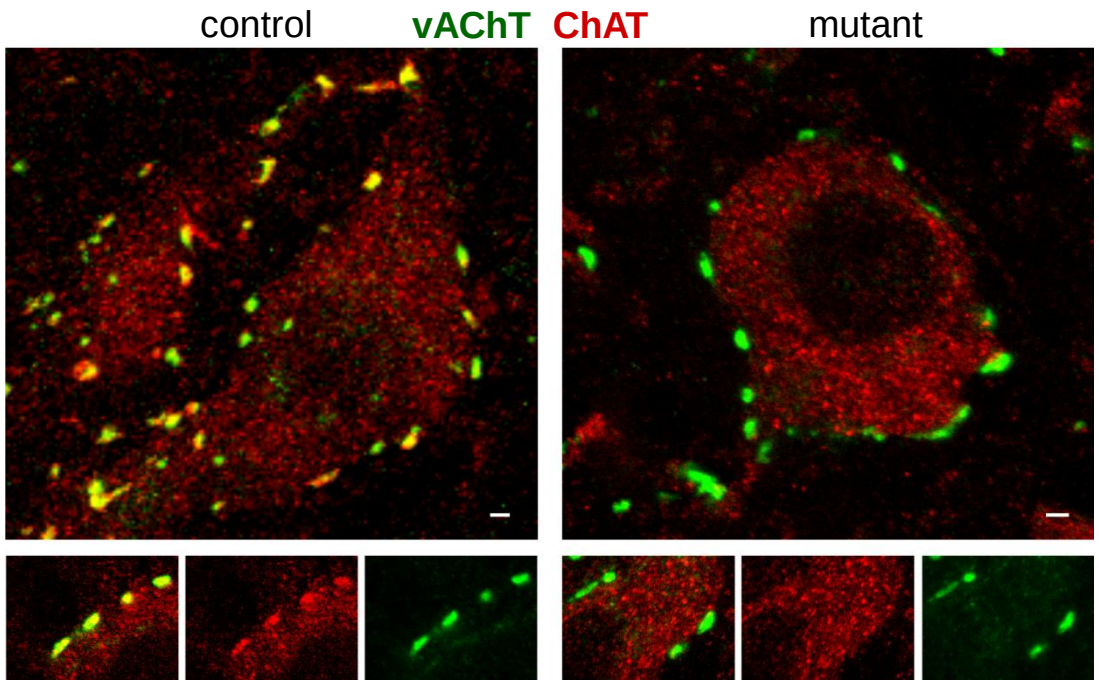


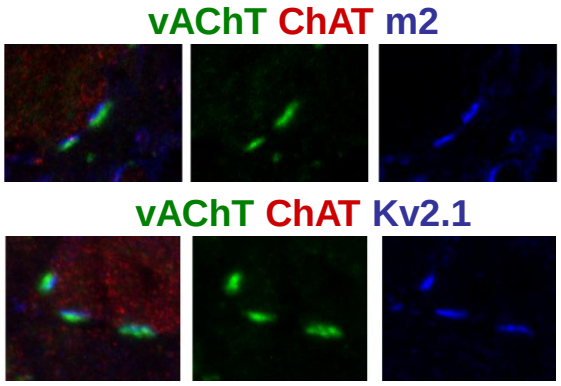
sensory



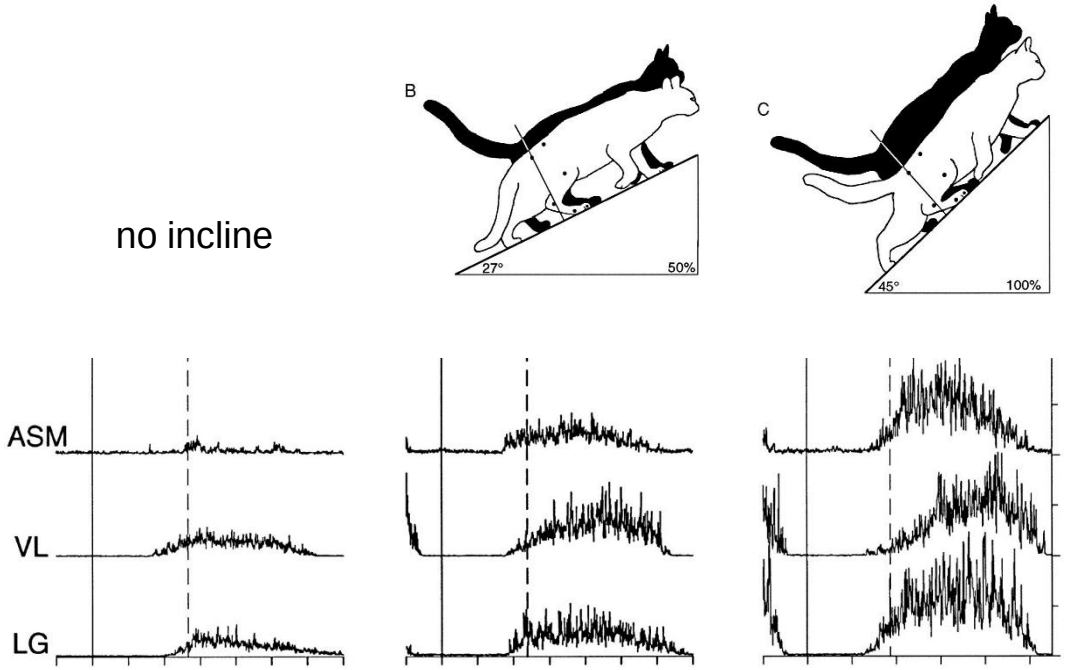
Genetic elimination of cholinergic output



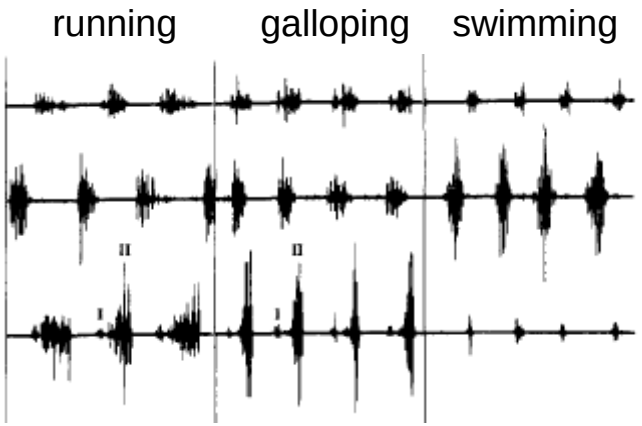




Task-dependent changes in locomotion detected through EMG amplitude



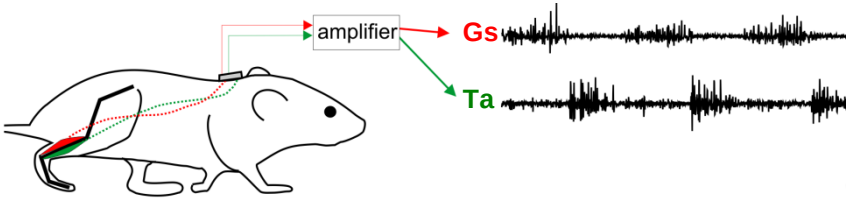
Carlson-Kuhta et al., 1998



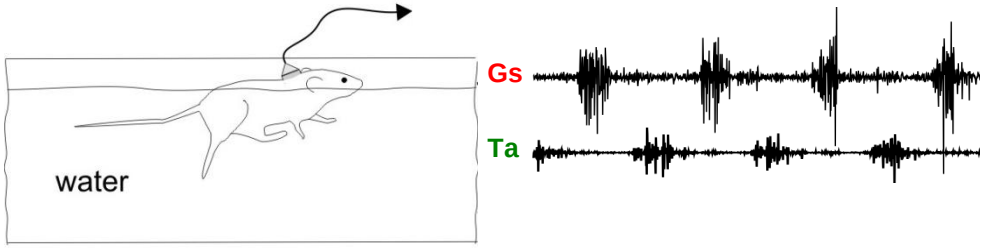
de Leon et al., 1994

Motor defects in the absence of V0c neurons

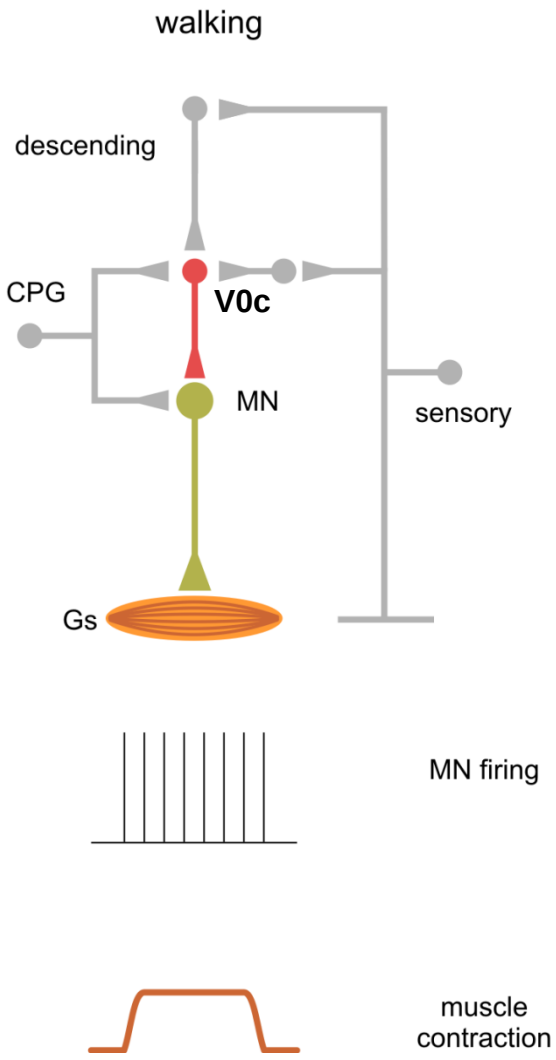
walking



swimming



V0c INT mediated enhancement of motor neuron firing



From molecular identity to circuitry and behavior