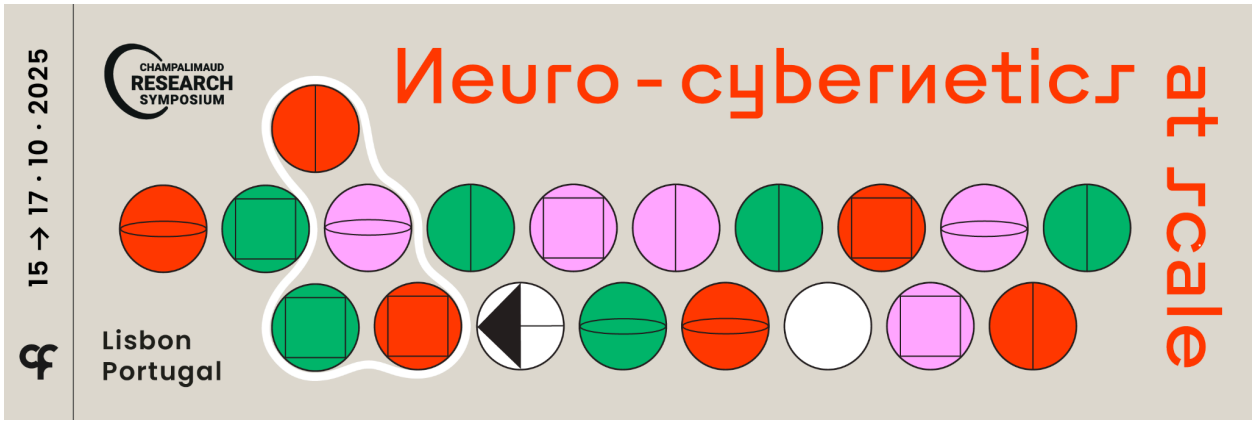

The superior colliculus directs goal-oriented forelimb movements

Shrivas Chaterji,1,2 Punarva H. Belliappa,1,3 and Anupama Sathyamurthy,1

1Centre for Neuroscience, Indian Institute of Science, Bengaluru, Karnataka 560012, India
2Present address: Champalimaud Centre for the Unknown, Lisbon 1400-038, Portugal
3Present address: Brown University, Providence, RI 02912, USA

Our ability to perform accurate goal-directed forelimb movements such as reaching and grasping is fundamental for interacting with and manipulating objects in our environments. Despite decades of research into the neural basis of forelimb movements, the underlying neural architecture, particularly the contributions of midbrain regions, remains only partially elucidated. Here we present evidence that the superior colliculus, an evolutionarily-conserved midbrain structure known to control saccadic and orientation movements, is also essential for executing accurate forelimb reaches in mice. Using intersectional circuit monitoring and manipulation techniques, we found that excitatory neurons in the mouse lateral superior colliculus are active during a skilled forelimb-reaching task, and phase-specific silencing of these neurons during reaching movements differentially impairs reach accuracy. Anatomical studies identified neurons in the deep cerebellar nuclei and the pars reticulata region of the substantia nigra as sources of input to the lateral superior colliculus, and manipulation of these pre-synaptic partners revealed a role for the nigrotectal but not cerebellotectal neurons in facilitating reach accuracy in skilled mice. Notably, inhibition of the nigrotectal pathway resulted in deviation of the paw that was diametrically opposite to the kinematic deviation observed upon collicular silencing. In summary, our findings establish the superior colliculus as a pivotal regulator of skilled forelimb use, highlighting the coordinated action of the substantia nigra and the superior colliculus in controlling reach accuracy and enriching our understanding of how the brain orchestrates complex forelimb movements.

superior colliculus, skilled forelimb control, neural circuit monitoring and manipulation, droplet-retrieval task