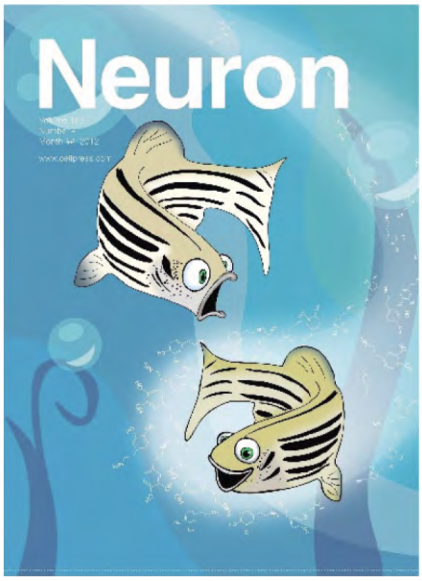
Behavior selection controlled by a dopaminergic-inhibitory neural circuit

With the supports by the National Natural Science Foundation of China, Chinese Academy of Sciences, and the Ministry of Science and Technology of China, the team led by Prof. Du Jiulin (杜久林) at the Institute of Neuroscience, Center for Excellence in Brain Science & Intelligence Technology, Chinese Academy of Sciences, recently reported that a visually responsive dopaminergic-inhibitory neural circuit controls behavior selection via regulating visuomotor transformation (*Neuron*, 2016, 89: 598—612).



Appropriate behavioral responses to ever-changing visual cues in the natural environment are critical for animals' well-being and survival. Animals behave differently in response to visual cues with distinct ethological meaning, a process usually thought to be achieved through differential visual processing. Using a defined zebrafish escape circuit as a model, the team found that behavior selection can be implemented at the visuomotor transformation stage through a visually responsive dopaminergic-inhibitory circuit module. In response to non-threatening visual stimuli, hypothalamic dopaminergic neurons and their positively regulated hindbrain inhibitory interneurons increase activity, suppressing synaptic transmission from the visual center to the escape circuit. By contrast, threatening visual stimuli inactivate some of these neurons, resulting in dis-inhibition of the visuomotor transformation and initiation of escape behavior. Importantly, the distinct patterns of the dopaminergic-inhibitory neural module's visual responses account for this stimulus-specific visuomotor transformation and behavioral control. Thus, the team identified a behavioral relevance-dependent mechanism that controls visuomotor transformation and behavior selection, and revealed that neuromodulation can be tuned by visual cues to help animals generate appropriate responses.

It is the first identification of a neural circuit mechanism underlying behavior selection in vertebrates from synaptic, circuit to behavioral levels. The behavioral relevance-dependent control mechanism uncovered in this work expands our knowledge of sensorimotor transformation control and further reinforces the importance of neuromodulation in behavior selection. Furthermore, the sensory stimulus-responsive property of neuromodulatory neurons may represent a general mechanism through which neuromodulation can be tuned by sensory cues to help animals generate suitable behaviors in a natural environment. Together with previous findings from Du's lab (*Neuron*, 2012, 75: 479—489; *Neuron*, 2012, 75: 688—699; *Journal of Neuroscience*, 2015, 25: 15291—15294), they put forward a novel hypothesis—*Bi-Modal Brain Function*, in which, via detecting behavior-relevant information of sensory cues, neuromodulatory systems regulate sensorimotor pathways in real time, enabling animals to generate adaptive behaviors.

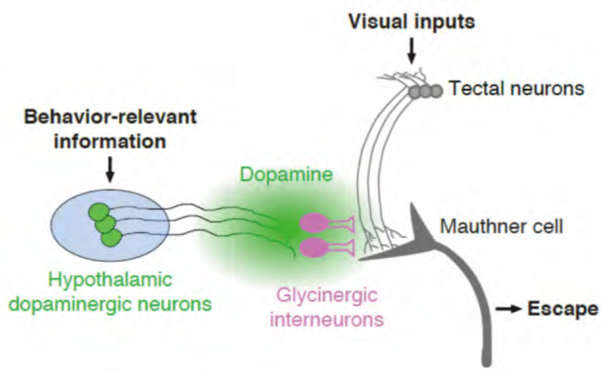


Figure Neuromodulatory systems regulate sensorimotor pathways.