Characterization of neuronal networks mediating the effects of energy homeostasis control systems on visual processing and decision-making during foraging in zebrafish

Summary

The sense of vision to forge for food and the preference regulating approach towards small prey-like stimuli or aversion towards large predators is tightly coupled to the energy needs of the animal. While the hypothalamic melanocortin circuitry plays a vital role in integrating the information from circulating hunger and satiety hormones and maintaining energy homeostasis, whether the central melanocortin 4 receptor (Mc4r) system directly modulates processing of visual information associated with foraging is unknown. We found that hypothalamic Pomca axons project to the optic tectum, the visual processing center in larval zebrafish. A subpopulation of tectal periventricular (PVNs) neurons express mc4r, potentially serving as second-order targets of Pomca neurons. Pharmacological activation of Mc4r in hungry larvae modulates population response properties of tectal PVNs and shifts their tuning towards large predatory-like stimuli. This modulation translates to a preferential switch from approach to avoidance behavior. Selective disruption of Mc4r signaling in the tectum of a well-fed fish led to an increase in approach towards prey-like stimuli, resembling the state of a hungry larva. Our findings emphasize the vital role of Pomca innervations in the optic tectum of larval zebrafish and describe their role in modulating visual processing and foraging behavior.