Study reveals how ellipsoid body ring neurons regulate sleep in Drosophila

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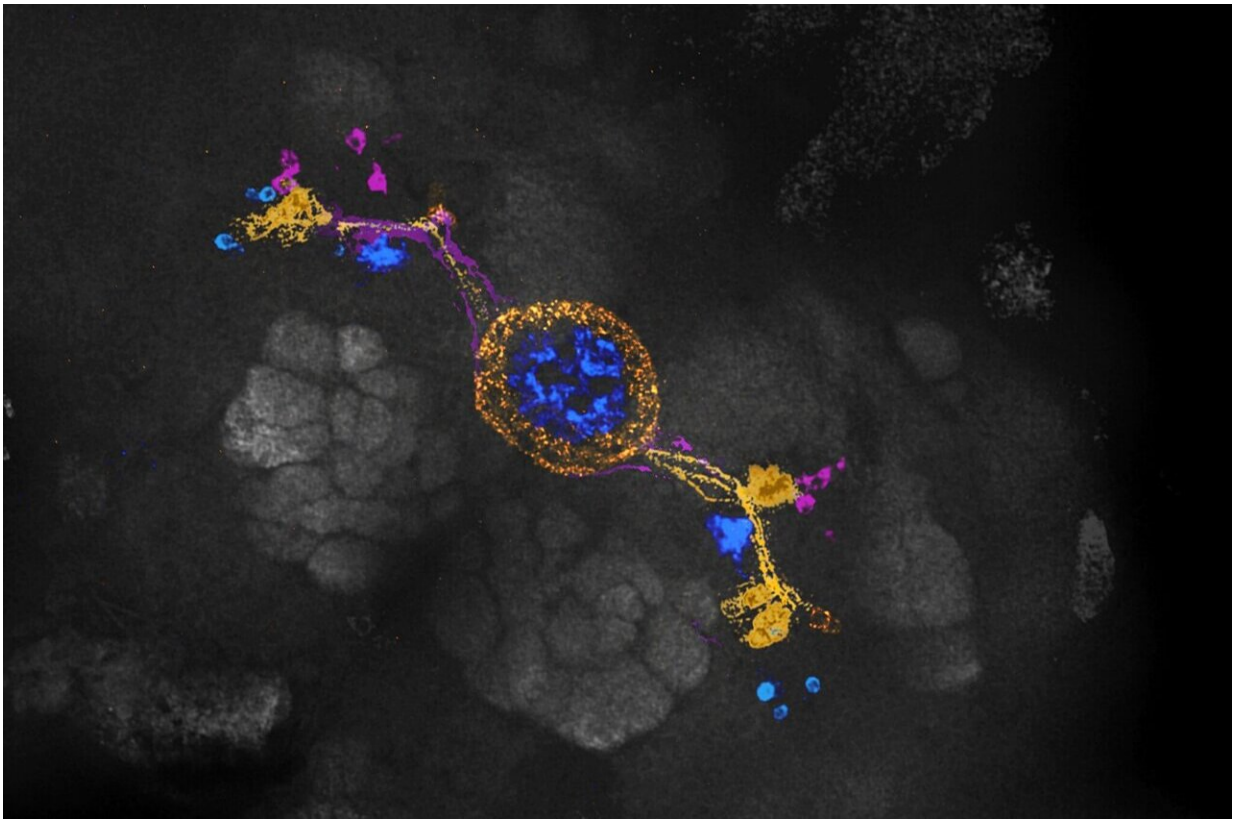


Expression of subtypes of ellipsoid body ring neurons: R3d/m/p labeled by R28E01-GAL4 (blue), R5 labeled by VT038828-GAL4 (magenta) and R4d labeled by R12B01-GAL4 (yellow). Credit: Liu Chang and Zhou Muru

The ellipsoid body (EB) is a major structure in the central complex of the Drosophila melanogaster (fruit fly) brain. It exhibits a high level of

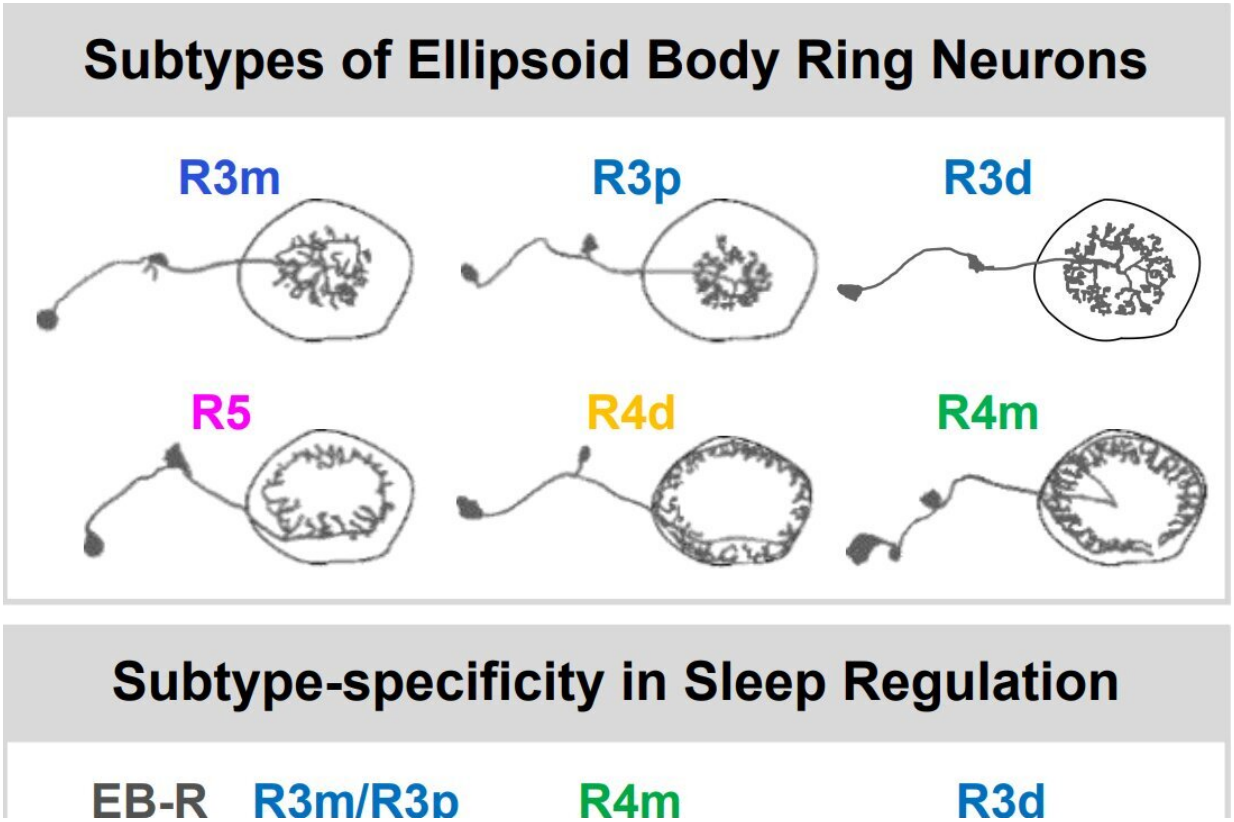
connectivity and functional heterogeneity while tuning multiple behaviors in real-time, including sleep.

Twenty-two subtypes of EB ring neurons have been identified. However, the cell-type specificity of sleep regulation has remained largely unknown.

A research team led by Prof. Liu Chang from the Shenzhen Institute of Advanced Technology (SIAT) of the Chinese Academy of Sciences (CAS), in collaboration with Prof. Leslie C. Griffith's team from Brandeis University, U.S., investigated how EB ring neurons regulate sleep in Drosophila. The study was published in *The Journal of Neuroscience*.

The researchers provided an overview of how multiple ring neurons participate in the modulation of amount of sleep, sleep structure and their effects on sleep pressure and/or depth upon activation of these neurons.

In addition, based on data for the probability of transition from wakefulness to sleep or from sleep to wakefulness and a mathematical model (mixed Gaussian model) clustering, the researchers detected five clusters of GAL4 drivers that had similar effects on sleep pressure and/or depth during the day and/or night, respectively.



Schematic of sleep/structure regulation by multiple subtypes of ring neurons. Credit: Liu Chang

The lines within each cluster shared a common ring neuron subtype. For example, they found that lines driving arousal contained R4m neurons, whereas lines that increased sleep pressure had R3m cells.

Through a general linear model analysis correlating ring cell subtype and activity-dependent changes in sleep parameters across all lines, they identified several cell types significantly associated with specific sleep effects: R3p neurons were daytime sleep-promoting, and R4m neurons were nighttime wake-promoting.

Moreover, the researchers discovered that R3d cells, a subpopulation of

neurons that exclusively affect sleep structure, contributed to fragmentation of sleep during both day and night.

"Overall, multiple subtypes of ring neurons distinctively control sleep amount and/or structure," said Prof Liu. "The unique highly interconnected structure of the EB suggested a local-network model worth future investigation, and we believe these findings will aid in revealing the principles of integration and cooperation in the brain."

More information: Wei Yan et al, Subtype-Specific Roles of Ellipsoid Body Ring Neurons in Sleep Regulation in Drosophila, *The Journal of Neuroscience* (2022). DOI: 10.1523/JNEUROSCI.1350-22.2022

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