The neural circuit mechanism of spatial orientation in *Drosophila*

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The ability of maintaining spatial orientation is crucial for an animal to perform goal-directed movements. Recent *Drosophila* studies have revealed the critical role of the ellipsoid body (EB) in tracking spatial orientation, but the precise neural computation and underlying mechanisms remain unclear. We analyzed connectomic data of *Drosophila* central complex and discovered that the circuit connecting EB and the protocerebral bridge (PB) form symmetric and asymmetric rings. The asymmetric rings can be further divided into two sub-rings, one with counterclockwise and the other with clockwise patterns. We further constructed a spiking neural circuit model based on the circuits reconstructed from the connectomic data. We demonstrated that the symmetric ring is capable of sustaining persistent neural activity that encodes spatial orientation, while the asymmetric rings perform angular path integration and update orientation when the body rotates in the dark. We tested this model by performing neural functional and behavioral experiments based on a modified Buridan’s paradigm. We investigated how orientation working memory is maintained in wild-type flies and in flies with hyperactivated symmetric or asymmetric rings. We discovered that, as predicted by the model, manipulation of the two rings gave rise to distinct behavioral changes, with one characterized by inaccurate working memory of spatial orientation after the offset of the visual cues and the other by loss of spatial orientation even with the presence of the visual cues.