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Proteomics dissection molecular underpinnings in sub-organs of honeybee brain reveal stronger learning and memory in eastern bees than western bees

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Eastern and western honeybees are two major species and evolve distinct biology by natural selection. Despite well-known cerebral functions of the brain in western honeybees, knowledge on how proteome underpins specialized neural functions in different anatomical regions in western bees and the differences between both bee species are still lacking. Proteomes of mushroom bodies (MBs), antennal lobes (ALs) and optical lobes (OLs) in the brain of *Apis cerana cerana* (Acc) and Apis mellifera ligustica (Aml) were characterized and compared and biologically validated by IHC, Western Blooting, qPCR and enyzamtic assay. In MBs and OLs, Acc and Aml have evolved similar proteome signatures to drive their domain-specific neural activities. In MBs of both bee species, the most abundantly enriched functional groups related to protein metabolism and enhanced functional classes were associated with calcium ion transport, compared to ALs and OLs. These observations suggest that protein and calcium ion homeostasis play key roles in learning and memory via modulation of synaptic structure and signal transduction to consolidate memory traces. In OLs of both species, the mainly enriched ribonucleoside metabolism manifests its role as second messenger in promoting phototransduction. Remarkably, distinct proteome settings have evolved in ALs of both species to prime olfactory learning and memory. Enriched cytoskeleton organization in ALs of Acc indicates its key role in sustaining olfactory signaling by regulating the plasticity of glomeruli and intracellular transport. Furthermore, enriched hydrogen transport and hydrogen ion transport in ALs of Aml are suggestive of their roles in supporting olfactory processes by regulation of synaptic transmission. Notably, the enhanced activity of protein metabolism in both ALs and MBs of Acc demonstrate that stronger senses of olfactory learning and memory have developed in Acc than in Aml. Our in-depth proteome data of sub-organs in honeybee brains help us gain novel insight into the molecular bases of neurobiology and is potentially helpful as a solid resource for further analysis of neuronal activity in the brain of honeybees and other insects.

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