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Proteomics reveals the molecular underpinnings of stronger learning and memory in eastern compared to western bees

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The eastern (*Apis cerana cerana*, Acc) and western (*Apis mellifera ligustica*, Aml) honeybee are two major honeybee species. Surprisingly, little is known about the fundamental molecular neurobiology of brain sub-organs of Acc and Aml. We characterized and compared the proteomes of mushroom bodies (MBs), antennal lobes (ALs) and optical lobes (OLs) in the brain of both species, and biologically validated the functions related to learning and memory. Acc and Aml have evolved similar proteome signatures in MBs and OLs to drive the domain-specific neural activities. In MBs of both species, commonly enriched and enhanced functional groups related to protein metabolism and Ca²⁺ transport relative to ALs and OLs, suggests that proteins and Ca²⁺ are vital for consolidating learning and memory via modulation of synaptic structure and signal transduction. Furthermore, in OLs of both species, the mainly enriched ribonucleoside metabolism suggests its vital role as second messenger in promoting phototransduction. Notably, in ALs of both species, distinct proteome settings have shaped to prime olfactory learning and memory. In ALs of Acc, this is supported by the enriched cytoskeleton organization to sustain olfactory signaling through modulation of plasticity in glomeruli and intracellular transport. In ALs of Aml, however, the enriched functional groups implicated in hydrogen ion transport are indicative of their importance in supporting olfactory processes by regulation of synaptic transmission. The biological confirmation of enhanced activities of protein metabolism and signal transduction in ALs and MBs of Acc relative to in Aml demonstrates that a stronger sense of olfactory learning and memory has evolved in Acc. The reported first in-depth proteome data of honeybee brain sub-organs provide a novel insight into the molecular basis of neurobiology, and is potentially useful for further neurological studies in honeybees and other insects.

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