Tiny but adaptable wasp brains show ability to alter their architecture

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For an animal that has a brain about the size of two grains of sand, a lot of plasticity seems to be packed into the head of the tropical paper wasp *Polybia aequatorialis*.

Researchers from the universities of Washington and Texas have found that the brain architecture of these wasps undergoes dramatic changes as they cycle through a sequence of specialized jobs during their lives. The scientists previously had discovered that parts of the brains of this wasp species enlarged as the animal engage in more complex tasks.

The new work describes how this happens as dendrites, or extensions from individual neurons, reach out to receive information from other brain cells and form a dense network of connections. These networks help the wasps integrate information from visual, olfactory and touch sensory systems.

"I was astounded when we found that some of the individual neurons had dendrites that were seven to eight millimeters long in a brain that is roughly the size of two grains of sand. That's packing a huge amount of computing power in a small amount of space," said Sean O'Donnell, a UW associate professor of psychology and co-author of the new study. "These animals live in a complicated world and individuals face challenges that require a lot of brain power."

Co-authors of the paper are Theresa Jones, a UT associate professor of psychology, and Nicole Donlan, a UT research associate.

"The architecture of the wasp brain is different from that in humans," said O'Donnell. "They evolved independently from us, but some of the problems they face are similar to ours because both of us are social animals. This gives researchers the opportunity to ask if there are similarities or differences in brain plasticity for social animals."

P. aequatorialis wasps live in colonies of 2,000 or more adults. The adult workers perform different jobs for the colony in a developmental sequence that is accompanied by behavioral changes as they age. They begin by performing tasks in the dim interior of the nest before moving outside where they work on the exterior of the nest. Finally, they leave the nest to forage for food and building materials for the colony and then find their way back to the nest. Each job change is accompanied by an increase in the complexity of the tasks.

The researchers found the biggest changes in brain neuron architecture occurred when the wasps shifted from working on the nest exterior to foraging.

"The forager brain is quite different. The neuron dendrite network is more complex and dense than for other job classes," said O'Donnell. "These brain changes seem to be a semipermanent way for the animals to deal with the cognitive challenges they are facing. Our earlier work showed that once workers change jobs they don't go back to previous tasks. It is plausible that they do not have the cognitive ability to do the old tasks."

He said the change in environment encountered by wasps as they develop is comparable to what people face over the course of a day. People wake up in the familiar environment of the home and family, but once they leave for home or school they face the tasks of driving a car or taking the bus in more complex environments where there are many unfamiliar people, traffic and a lot more stimulation.

Exactly what spurs the changes of the dendrite branches isn't known yet, but the researchers suspect increasing light levels outside the nest may trigger the some of changes in brain architecture. In a part of the brain that processes visual input, the neuron branches actually shrank during the on-nest phase of life, only to rebound to even greater size during the foraging phase. This shrinkage, or "pruning" of neuron branches may prepare the brain for later neuron growth to even larger sizes, perhaps also allowing new connections to form. These changes allow the wasps to function in a new environment that has different cognitive challenges.

Source: University of Washington (news : web)