Studying bumblebees to learn more about human intelligence and memory

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(Phys.org)—A team of researchers at Queen Mary University in the U.K. has found that bumblebees with more "synaptic complexes" in their brains are able to learn new things more quickly and also have better memories than those with fewer of them. In their paper published in *Proceedings of the Royal Society B* the group describes studying neural connections in individual bee brains and comparing what they found with cognitive abilities.

Scientists have developed a variety of methods over the years to measure human intelligence levels, but have made little progress in understanding what underlies the differences they find. In this new effort, the researchers studied bumblebee brains because they are far simpler than human brains.

In their experiments, the researchers taught several bumblebees to discriminate between two different types of fake flowers—one type provided sugar water while the other offered quinine, which bees do not like. The team noted how long it took the individual bees to figure out which type of flower would offer a reward and which would not. The group then tested all of the bees two days later to see how well they remembered what they had learned, again taking note of how well the individual bees did on the test.

The team then looked closely at the brains of all of the bees using confocal microscopy, which allowed for viewing nerve cells and the connections between them. The team reports that those bees that figured out the flower problem the fastest and had the best memory turned out to have denser neural connections called synaptic complexes than those who performed less well.

The researchers suggest theirs is the first study to show that learning, at least visually, can be correlated to increased nerve connection density in some parts of the brain. They also suggest that some degree of the increased density likely could be associated with more opportunities to learn. And while the study was meant to enhance understanding of the factors present in differing levels of intelligence in humans, it is not clear if the results of these experiments are applicable.

More information: Li Li et al. A possible structural correlate of learning performance on a colour discrimination task in the brain of the bumblebee, *Proceedings of the Royal Society B: Biological Sciences* (2017). DOI: 10.1098/rspb.2017.1323

Abstract
Synaptic plasticity is considered to be a basis for learning and memory. However, the relationship between synaptic arrangements and individual differences in learning and memory is poorly understood. Here, we explored how the density of microglomeruli (synaptic complexes) within specific regions of the bumblebee (Bombus terrestris) brain relates to both visual learning and inter-individual differences in learning and memory performance on a visual discrimination task. Using whole-brain immunolabelling, we measured the density of microglomeruli in the collar region (visual association areas) of the mushroom bodies of the bumblebee brain. We found that bumblebees which made fewer errors during training in a visual discrimination task had higher microglomerular density. Similarly, bumblebees that had better retention of the learned colour-reward associations two days after training had higher microglomerular density. Further experiments indicated experience-dependent changes in neural circuitry: learning a colour-reward contingency with 10 colours (but not two colours) does result, and exposure to many different colours may result, in changes to microglomerular density in the collar region of the mushroom bodies. These results reveal the varying roles that visual experience, visual learning and foraging activity have on neural structure. Although our study does not provide a causal link between microglomerular density and performance, the observed positive correlations provide new insights for future studies into how neural structure may relate to inter-individual differences in learning and memory.

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