Chemicals in brain that make honeybees more likely to sting discovered

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A team of researchers from France and Australia has identified the neurological mechanism that underlies honeybee aggression in response to threats. In their paper published in *Proceedings of the Royal Society B,* the group describes their study of honeybees and what they found.

Most people know that if you disturb a beehive, it is not just the guards that come after you, it is generally most of the bees in the hive. But what neurological mechanism is involved in causing the other bees to attack? This is what the researchers with this new effort sought to learn.

The team started with the knowledge that bees secrete pheromones as a means of communication—and prior research has shown that one of the main components in honeybee pheromones is isoamyl acetate. Suspecting it likely served as a trigger, the researchers exposed bees in their lab to the substance and then measured their brain chemicals to see what happened. They report that the bees experienced an immediate rise in dopamine and serotonin levels.

As part of their study, the researchers also tested bees from four hives that served different roles—guard bees from two of the hives in particular showed a greater desire to sting than those from the other two hives when stoked. The researchers found that the two more aggressive bees had higher levels of serotonin in their central brains, suggesting it was the chemical responsible for elevating aggression.

Further tests showed that exposing bees to isoamyl acetate caused an increase in production of both dopamine and serotonin levels in the central brain, which in turn led to an increased desire to attack and sting. They also noted that serotonin levels were even higher in brain parts used in controlling aggressive behavior such as the sub-oesophageal zone and the optic lobes. The researchers also found that the more of the pheromone the bees were exposed to, the more aggressive they became. They also found that reducing serotonin levels using an antidote caused a

reduction in aggressive behavior.

The researchers suggest their findings indicate that they have identified the neural mechanism involved in inciting bees throughout a hive to attack after guards outside identify a threat.

More information: Morgane Nouvian et al. Cooperative defence operates by social modulation of biogenic amine levels in the honey bee brain, *Proceedings of the Royal Society B: Biological Sciences* (2018). DOI: 10.1098/rspb.2017.2653

Abstract
The defence of a society often requires that some specialized members coordinate to repel a threat at personal risk. This is especially true for honey bee guards, which defend the hive and may sacrifice their lives upon stinging. Central to this cooperative defensive response is the sting alarm pheromone, which has isoamyl acetate (IAA) as its main component. Although this defensive behaviour has been well described, the neural mechanisms triggered by IAA to coordinate stinging have long remained unknown. Here we show that IAA upregulates brain levels of serotonin and dopamine, thereby increasing the likelihood of an individual bee to attack and sting. Pharmacological enhancement of the levels of both amines induces higher defensive responsiveness, while decreasing them via antagonists decreases stinging. Our results thus uncover the neural mechanism by which an alarm pheromone recruits individuals to attack and repel a threat, and suggest that the alarm pheromone of honey bees acts on their response threshold rather than as a direct trigger.