ScienceWatch – Thrill-Seeking Bees

"We found massive differences in brain gene expression between scouts and non-scouts" – G. E. Robinson

Scientists have long known that certain behaviors in humans and other mammals are controlled, in large part, by chemicals released from brain cells. For example, eating ice cream, driving our new car, riding a roller coaster or engaging in any pleasurable, novel or thrilling behavior causes dopamine to be produced in our brains. The release of that chemical and others like glutamate, γ-aminobutyric acid (GABA), and catecholamine are considered "rewards' because they result in a feeling of pleasure. This sense of well-being and satisfaction is so desirable that some people become addicted to overeating, thrill-seeking or worse, to drugs like cocaine, which keeps dopamine levels high.

As social insects honeybees (*Apis mellifera*) exhibit an array of behaviors. However, there are also striking differences among individual bees. Some bees act as scouts while others never do. Food scouts (~20% of the bees) search for new flower patches and communicate the information to foragers by dancing in the hive. Nest scouts (<5% of the new swarm) look for new nest sites when a portion of the colony decides to move. They enter new cavities on their own and then collectively choose the best one. Whether seeking new food sources or a new nest site, scouts appear to desire novelty.

A team of behavioral geneticists, headed by Gene E. Robinson, University of Illinois, Urbana-Champaign, decided to see what causes scouts to behave so differently from other bees. They report in the March 9, 2012 issue of *Science* that certain brain genes are active (expressed) in scouts but not in other bees, and these genes produce the same chemicals that cause people to seek out thrills and novelty.

First the scientists identified and marked nest scouts from 8 swarms seeking a new nest site. After the swarms found a nest the researchers moved the hives at night and noted which bees were food scouts the following day. They found that nest scouts are 3.4 times more likely than other bees to be food scouts after the new colony is established. This result implies there is a genetic basis for scouting behavior.

Next they identified the best food scouts by noting which bees consistently went to novel feeders, in which odors, visual cues and locations were changed each day for several days, instead of occasionally returning to familiar ones that remained unchanged day after day.

To determine if these "super" scouts were genetically different from ordinary foragers, the team collected brain gene products from super scouts and non-scouts and used a molecular procedure known as "whole-genome microarray analysis"* to see which brain genes of super scouts were being actively expressed as compared to those from foragers that never performed scouting. The results showed that the scouts' brain genes producing GABA or catecholamine or glutamate were highly active compared to non-scouts.

The researchers also confirmed that scouting behavior was causally influenced by a brain gene product. They fed non-scouts large amounts of monosodium glutamate (MSG) to increase their levels of glutamate, which turned them into scouts.

These findings demonstrate that certain bees are genetically hard-wired to behave as scouts because their brain genes produce the same chemicals that make humans thrill-seekers.

"Our results say that novelty-seeking in humans and other vertebrates have parallels in an insect," Robinson said. "One can see the same sort of consistent behavioral differences and molecular underpinnings. People are trying to understand what is the basis of novelty-seeking behavior in humans and in animals," he continued. "And a lot of the thinking has to do with the relationship between how the [brain's] reward system is engaged in response to some experience."

By understanding the genetic and molecular mechanisms controlling bee behavior, Robinson hopes to gain further insights into the various behaviors among humans.

When last seen the scout bees were heading for the cyclone at Coney Island.

Saul Scheinbach

* DNA microarrays (gene chips) are small, solid glass or silicon supports onto which the DNA sequences from thousands of different genes are immobilized as dots in a regular pattern. Each dot represents one gene. The precise location and DNA sequence of each dot is recorded in computer database. If a gene product is present in the sample added to the chip it will bind to the gene dot on the microarray, generating a pinpoint of light, which is read by the computer. This signal means the gene was expressed in the sample being tested. To learn more about this procedure go to: *learn.genetics.utah.edu/content/labs/microarray*