If only a robot could be more like a cockroach

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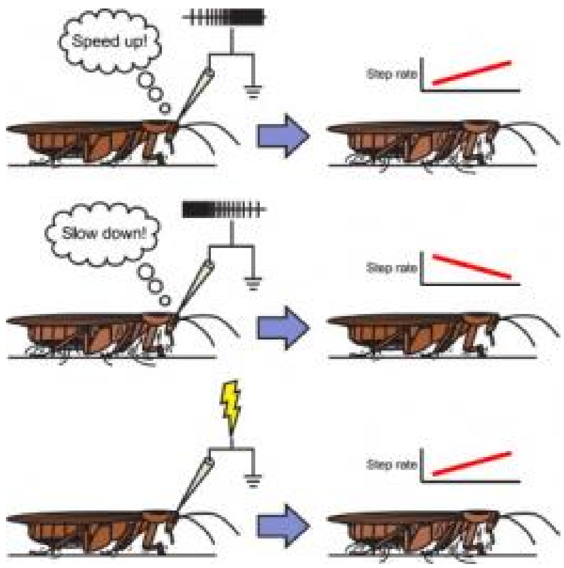

Studies have indicated that insects rely on their brains to respond to what they feel and see. But for the first time, researchers have shown a direct link between neurons at the center of an insect brain and changes in behavior. The findings and a video are published online in *Current Biology* at noon U.S. eastern time May 6.

A team led by Roy Ritzmann, Case Western Reserve University biology professor, recorded neural activity in the central complex of walking cockroaches - that in itself is a painstaking first.

They found that in the same area of the brain where visual, chemical and tactile information from the world outside is processed, the firing of neurons is correlated to the insect's stepping rate. That is, cockroaches walk or run when their brains decide to do so.

So what? Well, what if robots could do as much?

"Robots were sent into the World Trade Center after 911," Ritzmann said. "By the time the driver would see an obstacle, they were stuck."

"We see in these animals an ability to adapt to difficult and changing terrain and conditions," he continued. "What we'd like to see is a robotic brain that can make these kinds of decisions."

He believes the research could help lead to better robots to search collapsed mines and buildings, to pilot drones, and for space exploration, where signals from Earth to a far off planet takes minutes, hours or longer.

So, to make a robot that can turn, back up, climb over or burrow under and obstacle without the guidance of a far off rescue worker using computer controls, what could be better than mimicking an insect's comparatively simple brain?

Easier said than done. To get these first recordings of neural activity, Research Assistant Allan Pollack spent more than a year perfecting techniques to perform brain surgery in an area the size of the head of a pin.

After delicately cutting through the brain sheath and exposing the central complex, he inserted a hair-thin braid of four wires that can monitor activity of groups of neurons or stimulate the groups with electricity.

With the braid implanted, cockroaches were tethered over the simplest version of a treadmill: a greased glass plate. The researchers waited, sometimes for three hours or more, for a cockroach to begin walking, and to change speeds, all without prodding.

"We wanted to study the cockroach when it wants to move," Ritzmann said.
The researchers filmed the insects walking in place while recording groups of neurons firing. A clip can be seen at http://www.cell.com/current-biology/home.

John Bender, a postdoctoral research associate, crunched the raw data. He found that when he graphed the sums of the insects' step rates and sums of the neural firing, they produce a similar pattern. The steps come about 450 milliseconds after the neural firing.

To test whether neural activity is more than coincidental to stepping, the researchers used electrical stimulation to make the neurons fire. In some, the step followed about 450 milliseconds later.

"This is a breakthrough on a number of different levels," said Sasha Zill, a professor of anatomy and pathology at the Joan C. Edwards School of Medicine at Marshal University. Zill, who studies how the nervous system generates movement, and is familiar with this research, said, "It was a real accomplishment to record the neural activity of walking. The interesting finding is the cockroach can control speed with the brain."

Zill explained research shows animals from humans to - now, cockroaches - walk by sending a signal from the brain down to a part of the spinal cord or the equivalent, which generates a pattern of signals that direct the orderly contraction of muscles needed for each step.

To take a closer look at what's occurring in the cockroach brain to initiate and speed stepping, Ritzmann, Pollack and Bender plan next to record changes within individual neural cells.

More information: Paper: www.cell.com/current-biology/a … 0960-9822(10)00380-5

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