PUBLIC RELEASE: 13-OCT-1997

Evidence For A Radio Like Mechanism In The Brain Found At The Weizmann Institute

AMERICAN COMMITTEE FOR THE WEIZMANN INSTITUTE OF SCIENCE

REHOVOT, Israel, October 14, 1997...Research conducted at the Weizmann Institute of Science may give a whole new meaning to the phrase "stay tuned." Institute scientists have found evidence that when the brain interprets sensory input, it uses a mechanism remarkably similar to that of an FM radio.

In a study reported in the October 14, 1997, issue of the Proceedings of the National Academy of Sciences (PNAS), the researchers describe how the brain uses this radio-like mechanism to "tune in" to a particular frequency, allowing information gathered through touch to be translated into data about external objects.

This research provides a possible new explanation for the way the brain processes sensory information.

"We hope that our study will contribute to the deciphering of the neural code, the way in which information is encoded by the sensory organs and decoded by the brain," says research team leader Dr. Ehud Ahissar of the Weizmann Institute's Neurobiology Department. He conducted the study with departmental colleague Dr. Sebastian Haidarliu and Dr. Miriam Zacksenhouse of the Technion-Israel Institute of Technology.

"Cracking" the neural code would immensely advance brain research, just as the discovery of the genetic code revolutionized genetics and molecular biology.

Like an FM receiver

When we touch an object, the nerve endings in our skin send electric neural signals to the brain. Until now, scientists studying touch -- or, for that matter, other senses -- have focused on identifying the brain cells that receive these signals and on assessing the signals' intensity.

However, according to Weizmann Institute researchers, this is not the whole story of how the brain actually knows what it's being told by the senses. In the new study, they argue that the timing of the signals also plays a crucial role in this process.

"We found that certain circuits in the brain work on the same principle as an FM radio," says Dr. Ahissar.

In frequency modulation (FM) receivers, the radio is tuned to a particular frequency, or station. During the broadcast this frequency is being constantly altered, or modulated, and the receiver translates these modulations into different sounds.

Similarly, the brain appears to be tuned to its own "radio stations." In the past decade, scientists discovered that the sensory cortical areas of the brain contain cells that oscillate at regular frequencies due to intrinsic mechanisms that do not rely on external stimuli. In their study in PNAS, Ahissar and colleagues show that neural signals generated by touch modulate the oscillation frequency of these cells.

Because the cortex oscillations are regular and persistent, they provide the brain with a "yardstick" against which the timing of incoming signals can be compared. The comparison probably takes place in the thalamus, which receives input both from the cortical areas containing the oscillating cells and from the external sensory stimuli.

It is this comparison that allows the brain to track the timing, or frequency, of the incoming signals, enabling it to decode the information about the object being touched.

Imagine, for example, that you rub your finger against a ribbed surface, such as corduroy fabric. Nerve endings in the skin would send a signal to the brain every time they hit upon one of the fabric's ridges. The thinner and closer-spaced the ridges, the more frequent the signals would be. Thus, the frequency of the signals encodes sensory information about the surface.

In fact, this may be the reason we need to move the finger over a surface in order to better assess its texture: movement allows us to assess the distribution of sensory input over time and better define the object being touched. "The timing of the sensory signals appears to be an inherent part of the neural code," says Ahissar. "In fact, this timing contains so much information about the external world that it would be surprising if the brain made no use of it."

Clarifying the mechanism

The researchers conducted their study on rats, that twitch their whiskers when scouring for food. The rats' brains translate the input from their whiskers into data about the location of objects. The whiskers twitch rapidly, at a rate of about eight motions per second. These motions "notify" the oscillating neurons in the cortex to tune in to a "transmission frequency" of about 8 Hz. When the whiskers hit upon an object, they trigger additional neural signals to the brain, which perturb, or modulate, the regular 8 Hz transmission. The timing of these perturbations is determined by the object's location. Therefore, it allows the brain to create an internal representation of the object's whereabouts. "The brains of primates contain similar oscillating cells, which are tuned to the characteristic frequencies generated when the fingertips rub against an external object," says Ahissar. "Thus, the human brain could use similar FM-radio-like mechanisms to process information obtained through touch and perhaps through other senses as well."

In an extension of this research, Weizmann scientists are currently seeking to demonstrate that the same principle applies when the brain decodes information perceived through other senses, particularly vision.

This research was funded in part by the Minna-James-Heineman Foundation, Germany; the Israel Science Foundation; and the United States-Israel Binational Science Foundation, Israel.

The Weizmann Institute of Science, in Rehovot, Israel, is one of the world's foremost centers of scientific research and graduate study. Its 2,500 scientists, students, technicians, and engineers pursue basic research in the quest for knowledge and the enhancement of the human condition. New ways of fighting disease and hunger, protecting the environment, and harnessing alternative sources of energy are high priorities.

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