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Why Sensory Perception Changes When the Brain Rests

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Even when our eyes are closed, the visual centers in our brain are humming with activity. Weizmann Institute scientists and others have shown in the last few years that the magnitude of sense-related activity in a brain that's disengaged from seeing, touching, etc., is quite similar to that of one exposed to a stimulus. New research at the Institute has now revealed details of that activity, explaining why, even though our sense centers are working, we don't experience sights or sounds when there's nothing coming in through our sensory organs.

The previous studies of Prof. Rafael Malach and research student Yuval Nir of the Neurobiology Department used functional magnetic resonance imaging (fMRI) to measure brain activity in active and resting states. But fMRI is an indirect measurement of brain activity; it can't catch the nuances of the pulses of electricity that characterize neuron activity.

Together with Prof. Itzhak Fried of the University of California at Los Angeles and a team at the EEG unit of the Tel Aviv Sourasky Medical Center, the researchers found a unique source of direct measurement of electrical activity in the brain: data collected from epilepsy patients who underwent extensive testing, including measurement of neuronal pulses in various parts of their brain, in the course of diagnosis and treatment.

An analysis of this data showed conclusively that electrical activity does indeed take place, even in the absence of stimuli. But the nature of the electrical activity differs if a person is experiencing a sensory event or undergoing its absence. In results that appeared recently in *Nature*

Neuroscience, the scientists showed that during rest, brain activity consists of extremely slow fluctuations, as opposed to the short, quick bursts that typify a response associated with a sensory percept. This difference appears to be the reason we don't experience hallucinations or hear voices that aren't there during rest. The resting oscillations appear to be strongest when we sense nothing at all - during dream-free sleep.

The slow fluctuation pattern can be compared to a computer screensaver. Though its function is still unclear, the researchers have a number of hypotheses. One possibility is that neurons, like certain philosophers, must "think" in order to be. Survival, therefore, is dependant on a constant state of activity. Another suggestion is that the minimal level of activity enables a quick start when a stimulus eventually presents itself, something like a getaway car with the engine running. Nir: "In the old approach, the senses are 'turned on' by the switch of an outside stimulus. This is giving way to a new paradigm in which the brain is constantly active, and stimuli change and shape that activity."

Malach: "The use of clinical data enabled us to solve a riddle of basic science in a way that would have been impossible with conventional methods. These findings could, in the future, become the basis of advanced diagnostic techniques." Such techniques might not necessarily require the cooperation of the patient, allowing them to be used, for instance, on people in a coma or on young children.

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The Weizmann Institute of Science in Rehovot, Israel, is one of the

world's top-ranking multidisciplinary research institutions. Noted for its wide-ranging exploration of the natural and exact sciences, the Institute is home to 2,600 scientists, students, technicians, and supporting staff. Institute research efforts include the search for new ways of fighting disease and hunger, examining leading questions in mathematics and computer science, probing the physics of matter and the universe, creating novel materials, and developing new strategies for protecting the environment.

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