askthe**Brains**

Could certain frequencies of electromagnetic waves or radiation interfere with brain function? *—L. Chamas, Montreal*

Amir Raz, assistant professor of clinical neuroscience at Columbia University, replies:

DEFINITELY. Radiation is energy, and research provides at least some information concerning the ways in which specific types of energy may influence tissue, including the brain. I will review what we know about several types.

MAGNETIC FIELDS. In some cases, the effect can be therapeutic. For example, transcranial magnetic stimulation (TMS) is a technique used to induce a short-term interruption of normal activity in a relatively restricted area of the brain. Head-mounted wire coils deliver magnetic pulses directly into focal brain regions, painlessly delivering minute electric currents. TMS may be helpful in alleviating certain symptoms, including those of depression.

Also, magnetic resonance imaging (MRI) of the living brain uses an externally imposed magnetic field. Preliminary findings suggest that bipolar-disorder patients' moods improve immediately after they undergo a specific MRI procedure; further investigation is warranted.

IONIZING VS. NONIONIZING RADIATION. Researchers typically differentiate between the effects of ionizing radiation (such as far ultraviolet, x-ray and gamma ray) and nonionizing radiation (including visible light, microwave and radio). The ionizing variety can cause DNA damage and mutations; thus, we should limit exposure to its sources—radioactive materials and sunlight among them. In ionizing radiation, an individual particle or photon carries enough energy to ionize (remove an electron from) an atom or molecule.

The picture for nonionizing radiation is less clear. Extremely low frequency electromagnetic fields (EMF) surround home appliances as well as high-voltage electrical transmission lines and transformers. Given modern technology, nonionizing radiation from power lines, personal wireless devices, cell phone towers and other sources is practically unavoidable.

Evidence of health effects from EMF is inconclusive, and the probability that EMF exposure is a health hazard seems small. Nevertheless, exposure to high levels of nonionizing energy, at radio-wave frequencies, for example, can damage the structure and function of the nervous system. Microwave frequencies below 3,000 megahertz can penetrate the outer layers of the skin, be absorbed in the underlying tissues, and result in all the known biological effects of heating—burns, cataracts and possibly death.

Some scientists claim that human tissue, including the brain, may be affected at nonthermal levels. Regrettably, differences in exposure parameters, such as frequency, orientation, modulation, power density and duration, make it difficult to directly compare experiments and draw specific conclusions. It is important to remember as well that, perhaps expectedly, interpretations of findings in this area of investigation are shrouded in controversy, particularly because special interests may influence some of the research. The publication of findings does not necessarily scientifically validate a study.

RADIO-FREQUENCY FIELDS. At lower levels of exposure, evidence for specific effects that may occur as a result of direct neural interactions with radio-frequency fields is sparse. In addition, many of the studies that claim provocative results have yet to be replicated by independent laboratories. Other studies describe potential associations. For example, a recent report suggests that the low-intensity electromagnetic field of geomagnetic storms—disturbances in the earth's magnetic field caused by gusts of solar wind—may have a subtle but measurable influence on suicide incidence in women.

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In recent years, cell phones, which transmit and receive at radio frequencies, have become ubiquitous. Researchers have investigated whether these low-intensity radio waves influence the central nervous system and cognitive performance. A few studies concluded that cell phone exposure actually enhanced certain aspects of cognitive performance as measured by reaction time and accuracy; others showed no difference, and a few, including a recent investigation, showed that exposure had detrimental effects in specific contexts such as attentional tasks. Replication of either negative or positive effects of exposure on cognition is sorely lacking in the scientific literature, and more work is required to explain and reconcile reports of contradictory results. Even if effects exist, they are likely to be very small. M

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DEBORAH RAZ