Can Wi-Fi Affect Brain Function?

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The accompanying article by Zentai et al. (1) investigates possible effects of radiofrequency (RF) energy from Wi-Fi signals on human brain wave activity. The possible existence of cognitive effects of RF energy has been one of the more contentious discussions in the forever-contentious issue of whether exposure to RF energy at levels that we all commonly encounter in the environment has any health consequences. Are there any physiological effects from such exposures; and if so, do they have any health significance to exposed individuals?

To date, more than 100 studies have been published on effects of RF energy on electroencephalograms (EEGs) recorded in sleeping or awake individuals [for reviews see Regel and Achermann (2) and van Rongen et al. (3)]. In addition, many studies have examined other end points related to cognition and brain function. Not unreasonably, most of these studies were directed at uncovering possible biological effects from use of mobile phones or other communications equipment held close to the head. While the results are mixed, a fairly consistent finding is that short (10–20 min) RF energy exposures to the head produce small, but statistically significant, changes in the EEG of resting and sleeping subjects, most commonly a decrease in the amplitude of the EEG signal in the alpha band (8–12 Hz). In some studies, no clear changes were observed from exposure to mobile phone RF [e.g., Loughran et al. (4)], while other studies point to RF-related electrode artifacts as a potential source of error (5). In their reviews of the subject, most health agencies acknowledge these findings, but do not consider them as evidence for adverse health effects. For example, a recent review sponsored by the European Commission (6) concluded that “relevance of the small physiological changes remains unclear and mechanistic explanation is still lacking”.

Now Zentai and colleagues have waded into this morass, searching for effects of a single hour-long exposure to Wi-Fi signals on resting EEG and other end points related to cognition in humans. This well-designed study has meticulous exposure assessment and careful statistical analysis. Arguably, it is one of the best studies on effects of RF energy on human cognition in the literature; and its results were completely negative.

While there is a scattering of articles related to biological effects of Wi-Fi signals (7), there is an almost complete dearth of studies on effects of Wi-Fi signals on human cognition. In 2011, Papageorgiou et al. (8) reported that Wi-Fi exposure (from an access point mounted 1.5 m from the subjects) caused statistically significant reductions in the amplitude of event-related potentials (P300 response) in subjects performing linguistic tasks. However, the Zentai and Papageorgiou studies are quite different and their results are neither mutually supportive nor contradictory.

The frequency range of exposure (2.45 GHz) used in Zentai’s study was broadly similar to the operating frequency of cellular telephones (which operate in several bands from 698 to 2,690 MHz) but the exposure levels were far smaller. Mobile phones and Wi-Fi transmitters both emit RF energy in the form of pulses, at (very roughly) similar peak output powers [up to about 0.1 W (Wi-Fi) and 1 W (cell phone)]. Phones typically transmit energy at high duty cycles (i.e., a high fraction of their time is spent transmitting). The duty cycle for Wi-Fi access points (the little boxes in the home that transmit Wi-Fi signals throughout the house) and client cards (the transmitters that are built into laptop computers and smart phones that connect the devices to the wireless network) varies tremendously depending on the user’s activity and network conditions. The average duty cycle may be <0.1% for a laptop when the user is simply surfing the Internet or reading emails. But peak duty cycles for access points may exceed 50% for brief periods in very heavily loaded networks where a large number of users are uploading or downloading media.

When held against the head, a mobile phone will produce a peak specific absorption rate (SAR) in the head of the order of 1 W/kg averaged over 10 g of tissue, with very roughly ten times lower exposure levels in the brain itself. The Wi-Fi access point used in the Zentai study was...