Health Effects

Mental Process in Humans and Exposure to Cell-Phone Radiation

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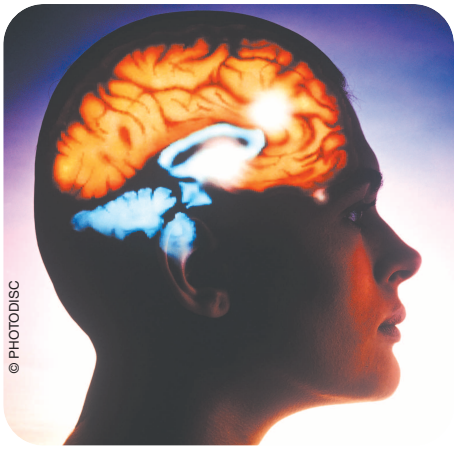
Some investigators have reported that exposure to cell-phone microwave fields can affect such mental processes (or cognitive functions) as attentional function, short-term memory tasks, information manipulation, or response-reaction times.

In fact, most people experience difficulties with attention, remembering names, or with finding the right words, at times. These are normal, everyday lapses in mental processes and are seldom mistaken as something that is more serious. However, for subjects who perform poorly on tests of several different types of cognitive function, these can be indicative of symptoms or problems that are of a more serious nature.

A paper by Preece et al. [1] had reported that exposure to microwave radiation from simulated cellular telephone transmissions at 915 MHz affects cognitive function in humans, in particular, a choice reaction time. Among 15 different cognitive function tests in randomized laboratory test sessions, subjects showed a significant microwave power-dependent decrease in reaction time (or an increase in speed) compared with the control subjects. Reaction time is a type of cognitive function test in which a stimulus is presented to elicit a response. The reaction time is the time from the onset of the stimulus to the beginning of the response. It is a measure of the latency between sensory perception of the stimulus by the nervous system and the effector motor response, including the neural processing.



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Since then, several papers have appeared in scientific journals, reporting on cognitive function and exposure to cell-phone microwave fields. Subjects exposed at 900 MHz showed faster responses in simple reaction time [2] and in choice reaction time [3]. In addition, these investigators found that exposure to cell-phone microwave fields have a facilitatory effect on cognitive functioning, especially in tasks that required attention and manipulation of information in working memory. Working memory refers to the ability to hold something in mind briefly and then to use that information for some other mental process. Recently, the same group failed to confirm their earlier findings when they repeated their experiments with improved methodology [4].

On the other hand, as a follow-up to the reports by Koivisto et al. [2], [3], a different research group examined the relationship between the reported facilitating effect and cell-phone exposure [5]. The results indicated that attentional functions were differentially enhanced after exposure to the microwave fields emitted by mobile phones.

In another experiment, where subjects were exposed to cell-phone fields for 30 min, significant differences were found on attentional functions and processing speed in serial subtraction [6]. In all instances, performance was facilitated by cell-phone exposure. Serial subtraction is a task that uses working memory.

It is interesting to observe that, while two subsequent investigations had obtained results consistent with previous observations, the group that had originally reported improved mental processes, such as attention, reaction time, and working memory changes, failed to confirm their earlier findings.

How can these conflicting results be resolved, or is it possible to resolve these conflicting results?

One possibility is the conclusion of the Koivisto group that "the reported findings are just statistical noise, or that the effect is so small that it can be detected on a behavioral level only occasionally" [4].

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This suggestion may find justification in the fact that the reported effects on attention, reaction time, and working memory were found in a fraction of different tasks used for cognitive function tests. The highest fraction was found in three out of a total of six tasks tested [6]. However, this conclusion may need to be balanced by the fact that there were two sets of independently reported results of performance facilitation for cell-phone exposure. While the numbers of pertinent tests may be small as a fraction, they were consistent with the same observations initially reported by Koivisto et al., even though they had failed to confirm their own findings later.

Another potential complication is the experimental design or protocol. For instance, experimental design or protocol may seem to be straightforward; they also could be some of the more significant factors contributing to the discrepancy between the earlier studies by Koivisto et al. and their most recent study [4]. They may not be the only factors. The latter study had been conducted with improved experimental protocols, including a double-blind design and the culling of experiences from two independent but coordinated laboratories that conducted the same experiments using identical equipment.

The complexity of experimental research into the potential health effect from exposure to cell-phone microwave fields, while apparent, deserves special notice. For an unequivocal outcome, there must be a detailed assessment of the exposure environment in a given experimental protocol and a clear understanding of field distributions inside and outside the subject. Neither of these is easy to come by in some cases. More often than not, they are taken for granted.

There are also factors from the behavioral experimentation standpoint that could influence the outcome of cognitive function tests. In most tasks, the subject is instructed to respond to a stimulus by pressing a button or keyboard. Familiarity and practice can help the accuracy and speed of the response. Sometimes, the response and stimulus are determined by cultural norms or by population stereotypes. For instance, males could make more errors in a cognitive function test, while females are largely unaffected. Thus, a measurable effect on human cognitive performance may only be replicable if the number of male and female subjects is identical. Likewise, a difference in age group may confound a given replication effort as well. Indeed, there is a preliminary report that suggests exposure to cell-phone microwave fields can facilitate spatial memory in male, but not female, university undergraduate students [7]. Moreover, a relative decline in memory performance with time has been widely reported. Older adults generally perform more poorly than younger adults at tasks that require knowledge of the information that was recently encountered.

It is interesting to note that one study had shown that the cell-phone users performed better on a measure of attention than did nonusers [8]. The result may imply that exposure to microwave fields emitted by cell phones has a mild facilitating effect on attention functions, which is consistent with previous observations on cognitive processing. The study also could be revealing the possibility that cell-phone users may be naturally better or may be conditioned to be better at multitasking tasks, and, thus, the result may bear little relation to exposure to cell-phone microwave fields.

On the other hand, a study in normal subjects on the effect of cell-phone microwave fields in a memory task of spoken words showed no significant effect on the number of incorrect answers in the short-term memory tasks [9]. A systematic double-blind replication of this work (the earlier study was single blind) showed cell-phone microwave exposure resulted in a statistically significant increase in the percentage of incorrect answers. The mean percentage of incorrect answers was nearly 20% when the microwave field was on, as compared to 6% when it was off [10]. Confronted with the unexplained findings, the authors had concluded that cell-phone microwave effects on the performance of the short-term memory tasks "may be variable and not easily replicable for unknown reasons."

Nevertheless, some authors have speculated that the observed effect on cognitive function in humans from cell-phone microwave fields might be due to

a localized heating effect [1]–[3]. A slight temperature rise in brain tissue was noted by the investigators. As mentioned previously [11], the speed of propagation of nerve impulses is known to rise—or fall, in the case of conduction latency—with small increases in temperature: 0.3 and 0.6 °C. Thus, the increase in responsiveness or decrease in choice reaction time of human volunteers is consistent with the effects of mild localized heating of the underlying nervous tissue.

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