Acute Effect of Mobile Phone Usage on Cognitive Function

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Abstract

To assess the short term effects of the usage of mobile phones on audio-visual response times. Twenty-one males in the age group of 25 to 35 years, who were regular users of mobile phones, participated in the study. Audio-visual response times (ART & VRT) were recorded under basal condition. Same variables were recorded after a five minute conversation on landline and on mobile phones. Paired *t*-test was used for statistical analysis. It was observed that following conversation on mobile phones, ART changed from 231.58±26.04 to 210.9±25.22 millisecond ($P<0.001$) and VRT from 213.29±24.16 to 198.94±35.62 ($P<0.001$). However there was no statistically significant alteration in these variables following conversation over landline phones. The observed changes are attributable to thermal and non-thermal effects of radio-frequency radiations of mobile phones.

Key Words: *auditory response times, mobile phones, radiofrequency radiation, visual response times*

Mobile phone communication system uses a large number of low power wireless transmitters in base stations to create cells. The cells are geographic service areas of a wireless communication system. Cell size is fixed based on subscriber density and demand within the area by altering power levels of base station. As the mobile users travel from one cell to another cell, their conversations are "handed off". Handing off is transferring of a call from radio channel of one cell to that of the next cell, in order to maintain seamless service. Each mobile uses a separate temporary radio channel for communication. Channels use a pair of frequencies for communication. One frequency is used for transmitting the signals from the cell site and the other for receiving signal from the user.[1]

Global System for Mobile communication (GSM) is a worldwide standard for digital cellular communication. As per the European mobile telephone standards for pan European use, GSM operates within a radio frequency range between 900 to 1800 MHz. The non European countries have also accepted GSM standards.[1]

The earlier studies in literature have shown that holding a mobile phone near the ear during conversation causes a significant decrement in audio-visual response times.[2-4] While other studies have concluded that usage of mobile phones has no effect on response times.[5] The present study was under taken in view of conflicting reports about the impact of short term exposure to cell phone on the central processing of sensory information.

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Methods

Twenty-one healthy males in the age group between 25 to 35 years with a mean age of 32±7 years participated in the present study. Ethical clearance was obtained from the institutional Ethical Review Board. The subjects belonging to various professions were contacted personally and explained the protocol of the study. Informed consent was taken from volunteers who participated in the study. All the subjects were free from any ailment. Two of them were occasional smokers, but were asked to abstain from smoking on the day of study. Subjects were using mobile phones for duration of around a year and more.

Response time is a time interval between the presentations of visual or auditory signals to the registration of response by the subject. For the measurement of visual response time the visual cues were given by illuminating a green LED, the timer starts as soon as the light glows and stops as soon as the subject registers the response. The time interval is read out directly from the digital display. Similarly for measuring the auditory response time buzz sound delivered through a headphone is used as the auditory cue. The response time includes the time required for conduction of impulses of impulses in the sensory and motor pathways in addition to central information processing. As the conduction through sensory and motor pathways remain constant the alteration in the response times is attributable to central processing speed, which is an indicator of cognitive function.[6]

The subjects preferred to participate in the study during their leisure time. Hence the study was conducted after 9 pm. On the day of recording, subjects relaxed for a period of 20 minutes in sitting position after reporting. The subjects received training in responding to the response analyzer. Basal recordings were made after the period of rest. The Audio-Visual Response Times (ART & VRT) were recorded using a response analyzer (Yantrashilp, Pune, India). A set of six recordings of ART and then a set of six VRT were

made. The averages of these six recordings were considered as the basal values.

After the basal recordings, subjects were made to converse for duration of five minutes on a landline telephone (BPL, India). During this conversation, subjects answered a questionnaire pertaining to their personal details and about their mobile phone and its usage. The questionnaire contained general questions to avoid any emotional disturbance which could influence physiological functions. All the subjects used their right ear for telephonic conversation. At the end of conversation, ART and VRT were recorded. They were designated as "landline values".

After a gap of twenty minutes the subjects answered the same questionnaire, but this time they used a mobile phone (model 3310, Nokia, Finland). The mobile phone operated in the bandwidth of 900 to 1800 MHz. To ensure uniformity, same landline and mobile phone instruments were used by all the participants. ART and VRT were recorded at the end of conversation. The values recorded were designated as "mobile values".

Statistical Analysis

Data was expressed as mean ± SD. Statistical analysis was done by applying Student's paired *t*-test. *P* value less than 0.01 was considered significant.

Results

Basal recording showed ART of 231±26.04 milliseconds and VRT of 213±29 milliseconds. At the end of conversation for five minutes on the landline telephone, the corresponding values for ART were 230.76±26.72 milliseconds and for VRT they are 213±24.59 milliseconds (Table 1).

The ART was 210±25.52 milliseconds and VRT was 198.94±35.62 milliseconds after five minutes of conversation on mobile phone (Table 2). There was a statistically significant decrease in ART immediately following the five minute conversation on mobile phone.

The VRT was also decreased to statistically significant levels after conversation on mobile phone. However there was no significant alteration in these values after conversation on landline telephones with respect to basal values.

Table 1. Comparison of "basal", "landline" and "mobile" values

Variable	Basal values	Landline values	Mobile values
Auditory Response Time (milliseconds)	231.58±26.04	230.9±26.72	210.9±25.22*
Visual Response Time (milliseconds)	213.29±24.16	213.85±24.59	198.94±35.62**

* $P<0.01$, ** $P<0.001$

Discussion

Conversation on mobile phone for duration of five minutes produced a statistically significant decrease in ART and VRT. The basis of this change is still not clearly known[5] but can be attributed to the thermal, vascular and electrical effects of radio-frequency radiations of the mobile phones.

The radiofrequency radiations of mobile phones have been shown to increase the local temperature of tissues have demonstrated a rise temperature of cerebral cortex and they have postulated that this may be the cause in cognitive function.[4] The local rise in temperature may be due to the effect of resonance produced by mobile phones.[6] At high frequencies between 900 MHZ to 1.8 GHZ (frequency range of mobile phones) there is interaction with the tissues nearby (brain tissue). As these fields oscillate, polar molecules follow similar patterns of oscillations. This results in dissipation of energy in the thermal form. Hence temperature of the brain increases.[7]

Huber et al. observed that there is an increase in regional cerebral blood flow in the dorsolateral prefrontal cortex on the side of exposure to a mobile phone exposure.[8,9] The increase in regional blood flow may cause the observed changes in response times.

The human body is controlled by several oscillating electrical signal systems. These signals are interfered with by the oscillating waves of GSM mobile phones. The frequency range of several human body electrical systems is close to that of the mobile phones.[9] Thus several organized electrical systems at cellular levels are likely to be affected by the waves of the GSM phones.[11-13] The interference in the electrical activities of the human body by the electromotive forces of mobile phones may produce cognitive effects as observed in this study.

The conversation on land line phone did not produce significant alteration in audio-visual response times. This observation establishes the fact that the alteration in the variables is due to radio frequency radiations produced by mobile phones. Hence there is a need to look into the other effects of radiations[13,14] on general health of the individual. Further it is desirable that remedial measures be contemplated to reduce the radiation level or to devise means to minimize the effect of it on health.

Conclusion

It can be concluded that a change in response times by short term exposure to mobile phone radiations is a matter of concern. Conversation on landline phones did not show any significant change in the response times. Such changes may be viewed seriously especially in the context of the usage of mobile phones while driving vehicles.

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