

Gender Differences in Acute Effect of Mobile Phone Radiation on Human Attention

Ashita Nain

Post Graduate, Department of Physiology, Pt.B.D.Sharma PGIMS, Rohtak, Haryana, India

ABSTRACT

Background and aim: Rapid rise of use of mobile phone has raised the concern of possible health effects of electromagnetic radiations (EMR) emitted from it on various body functions. Literature available about the role of gender in the mobile phone radiation induced effects on brain cognitive functions is scarce and inconclusive so far. Present study was planned to evaluate the effect of acute exposure to electromagnetic radiation from mobile phone on attention and the possible influence of gender.

Material and methods: Study was conducted on 40 healthy right-handed subjects. Twenty male and twenty female subjects within age group 18-40 years were recruited for the study. Trail Making Test part A (TMT A) and part B (TMT B), Digit Letter Substitution Test (DLST) and Perceptual Speed Test (PST) were conducted to test attention before and after exposure to mobile phone (SAMSUNG GSM 90; for 10 minutes). Statistical analysis was done by paired 't' test using SPSS 20.

Results: A statistically significant improvement in TMT A performance was seen in female subjects after exposure while males performed significantly better in TMT B after exposure to mobile phone radiation. Both genders performed significantly better in DLST after exposure. No significant effect was seen in performance of PST.

Conclusion: The findings suggest that even a single acute exposure to mobile phone radiation may alter the attention processes of brain and the effects may be gender dependent.

Key words: Electromagnetic radiation (EMR), Mobile Phone, Attention, Cognition

INTRODUCTION

Mobile phone has become an integral part of the modern-day life. Mobile phone usage is not limited to making calls and sending text messages, they also serve as a means of social networking, online communication, quick access of information, source of entertainment etc. [1] as these devices work on electromagnetic radiation (EMR), there has been a concern regarding the impact of indiscriminate exposure to these radiations on human health. Research suggests that mobile phone can alter the electrical activity of the brain. [2] It may induce changes in motor evoked potential; sleep disturbances, changes in reaction time and working memory. [3-5]

Studies have been conducted previously regarding the effect of mobile phone radiation on various cognitive domains. [6] However, very little data is available on the significance of gender in various cognitive and behavioral effects of EMR. Smythe and costall (2003) studied the effect of 15 min exposure to 900 MHz EMR from mobile phone on memory and reported that the male subjects made significantly less error on exposure while no effect was seen in the female subjects indicating that the EMR effects may be gender related. [7] Attention is the cognitive process of selectively focusing on an object or stimulus while effectively ignoring the other simultaneous stimuli. Divided attention is

the ability to respond to more than one stimulus simultaneously whereas sustained attention is the ability to maintain attention and respond consistently during a repetitive or continuous activity. Shifting attention is the mental flexibility to shift from one task to another as required.^[8] Present study was planned to investigate the effect of EMR on attention using psychometric tests and whether the effect of EMR on attention is gender specific.

MATERIALS AND METHODS

Present study was conducted on a total of 40 healthy subjects consisting of 20 males and 20 females, all right-handed, in the age group 18-40 years in the department of physiology, Pt. B.D.Sharma PGIMS, Rohtak. Ethical clearance was given by institutional ethics committee.

Inclusion criteria:

Healthy subjects in the age group of 18 to 40 years and minimum of tenth grade education, willing for the test.

Exclusion criteria:

- History of head trauma
- History of drug administration for last one month
- History of any neurological disorder
- History of any psychiatric disorder

Assessment of attention:

Following three psychometric tests for evaluating divided, sustained and shifting attention respectively were used:^[9]

1. Trail Making Test (TMT): It is a subtest of Halstead-Reitan neuropsychological battery. It is given in two parts, A and B. Worksheet of TMT A consisted of circles numbered 1 to 25. Subjects were asked to connect the numbers in ascending order as quickly as possible and without lifting the pen or pencil. If the subject made any error he or she was allowed to correct it. Worksheet of TMT B consisted of circles with numbers and alphabets. Subject was asked to draw lines to connect the circles in an ascending pattern but with added task of

alternating between numbers and alphabets.

Scoring: Results were reported as the time (in sec) taken to complete the task.

2. Digit letter substitution test (DLST): It is a subtest of Wechsler Adult Intelligence Scale (WAIS). The DLST worksheet consisted of an array of random digits 1 to 9 in 8 rows and 12 columns. A key was given at the top numbered 1 to 9 with each number being ascribed to a different alphabet. Subject was asked to substitute as many alphabets as possible in 90 second period starting with first row and working from left to right.

Scoring: The total number of substitutions and number of wrong substitutions were counted and the net score was calculated by deducting the wrong substitutions from the total number of substitutions.

3. Perceptual speed test (PST): This test was developed by Moran and Mefferd in 1959. PST worksheet consisted of a chart containing 0-9 numbers arranged in 34 columns and 20 rows. Instructions were given to subject to mark with a circle the same digit in the row as the one in the circle at the beginning of the row. 60 seconds time was given to complete the test.

Scoring: The number of total digits marked and the number of wrong digits marked were counted. Total score was calculated by deducting the number of wrong digits from the total digits marked.

PROCEDURE

Subject was seated comfortably in a quiet room. Whole of the procedure was explained to the subject and written consent was taken. The three psychometric tests for attention were then conducted. The subject was then exposed to electromagnetic waves emitted from mobile phone (GSM type Samsung model GT-E1207Y with maximum head SAR. 960 W/Kg) for a period of 10 minutes (average duration of a

common phone call). During the call examiner read a fixed text from a newspaper into another mobile phone which the subject was hearing. The psychometric tests were again conducted after the exposure. The tests scores were filled in the subject's proforma.

Statistical Analysis:

The statistical analysis of data was done using SPSS 20 software PC version. Student 't' test was applied to the data and p value was calculated. A p-value of <0.05 was considered significant.

RESULTS

Present study tested divided, sustained and shifting attention using three psychometric tests in 20 male and 20 female subjects. Demographic characteristics of the subjects were as given in table 1:

Table 1: Demographic characteristics of the subjects

| | Males (n=20) (Mean±S.D.) | Females (n=20) (Mean±S.D.) |
|-------------|-----------------------------|-------------------------------|
| Age (Years) | 28.75±6.26 | 23.25±4.40 |
| Height(cms) | 170.7±8.53 | 160.8±5.32 |
| Weight(Kg) | 70.85±8.18 | 55.4±9.09 |

It was observed that before exposure to mobile phone there was no statistically significant difference in the performance of

males and females in either of the three tests (TMT, DLST and PST).(Table 2)

Table 2: Comparison of test scores of males and females before exposure to mobile phone

| | Males (Mean±S.D.) | Females (Mean±S.D.) | p-value |
|---|----------------------|------------------------|---------|
| Trail Making Test A time (secs) | 39.2±15.07 | 40.55±15.32 | >0.05* |
| Trail Making Test B time (secs) | 81.95±30.94 | 72±20.34 | >0.05 |
| Digit Letter Substitution test score (net attempts) | 49.05±10.81 | 53.1±14.93 | >0.05 |
| Perceptual Speed Test Score (net attempts) | 40.65±9.14 | 42.9±10.34 | >0.05 |

*>0.05 = non-significant

The average TMT A time in females decreased significantly after exposure (p value <0.05) to mobile phone i.e. the performance improved whereas no significant effect was seen in males. In TMT B the females did not show any significant effect on performance following exposure to mobile phone while in males the TMT B time was decreased significantly (p value <0.05). The average DLST scores increased significantly (p value <0.05) in males as well as females after exposure. However no significant effect was found in PST scores.(Table3)

Table 3: Comparison of test scores before and after exposure to mobile phone in males and females

| | | Before exposure (Mean±S.D.) | After exposure (Mean±S.D.) | p-value |
|--|---------|--------------------------------|-------------------------------|----------|
| Trail Making Test A time (secs) | Males | 39.20±15.07 | 34.90±17.93 | > 0.05* |
| | Females | 40.55±15.32 | 35.75±14.69 | < 0.05** |
| Trail Making Test B time (secs) | Males | 81.95±30.94 | 66.3±27.93 | < 0.05 |
| | Females | 72±20.34 | 65.30±15.98 | > 0.05 |
| Digit Letter Substitution test score(net attempts) | Males | 49.05±10.81 | 52.8±11.51 | < 0.05 |
| | Females | 53.1±14.93 | 56.6±16.01 | < 0.05 |
| Perceptual Speed Test Score(net attempts) | Males | 40.65±9.14 | 41.95±7.58 | > 0.05 |
| | Females | 42.9±10.34 | 44.45±8.57 | > 0.05 |

*>0.05=non-significant **<0.05=significant

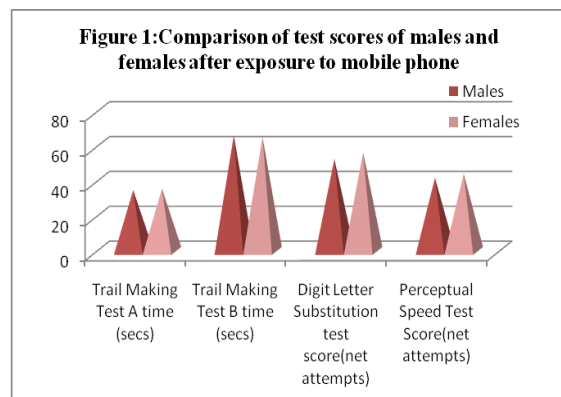


Figure 1: Comparison of test scores of males and females after exposure to mobile phone

On comparison of post exposure scores between males and females, no significant difference was found in the performance in any of the three tests (TMT, DLST and PST). (Figure1)

DISCUSSION

Performance of attention tasks requires concentration, visual scanning, and information processing and visuo-motor coordination. Trail Making Test (TMT) is a test of divided attention. TMT A mainly

assesses visual scanning and psychomotor speed while TMT B is a more complex task and reflects visual scanning ability and cognitive flexibility (executive functions).^[10,11] Kimura et al reported in their study that males are better in spatial tasks, intercepting a moving target, spatial rotation, mathematical reasoning and perform increasingly better than females with increasing complexity of problems while females are better in verbal memory, perceptual skills and mathematical calculations indicating that information processing may be different in males and females.^[12] We found no difference in the baseline scores (scores before exposure to mobile phone) of males and females in the three tests. However, after exposure to EMR from mobile phone males performed significantly better in TMT B when compared to pre-exposure scores while females showed a significant improvement in TMT A performance. While both males and females performed significantly better in sustained attention task (DLST) after exposure to EMR. This indicates that EMR may have different effects in males and females depending upon the complexity of task.

In the present study it was not possible to determine the underlying mechanism of EMR effects on attention. Earlier researchers have proposed that heat produced by EMR may increase synaptic transmission in cerebral cortex.^[13] Maganioti et al found that EMR induced changes in cortical excitability are gender related and may influence normal physiology.^[14] Neural structures involved in sustained attention and divided attention have been found to be primarily localized in the inferior parietal site and the prefrontal cortical site respectively.^[15,16] Moreover performance in TMT A has been related to left cerebral hemisphere while that in TMT B depends on right cerebral hemisphere.^[17] It has been found that males show a pronounced lateralization pattern towards right or left hemisphere in various cognitive tasks while in females hemispheric

differences are less prominent.^[18] Huber et al (2002) in their study reported increased regional cerebral blood flow in ipsilateral prefrontal cortex and contralateral parietal cortex.^[19] Aalto et al (2006) in another study demonstrated that MP radiation causes a decrease in regional cerebral blood flow in the temporal cortical area and an increase in the prefrontal cortical area.^[20] They suggested that these regional cerebral blood flow changes are related to the changes in neuronal activity induced by EMW. Thus the gender related difference in EMF effects may be attributed to the fact that males and females use different regions of brain while performing a task and the EMF have different effects on different regions of brain. Studies have shown that EMR can cause changes in blood brain barrier. Papageorgiou et al (2004) speculated that sex related differences in blood brain barrier may have a role in gender specific EMF effects.^[21]

CONCLUSION

From the study it may be concluded that the effect of EMF on different types of attention may vary depending upon gender. However, further research is required with a larger sample size to confirm the findings and determine the possible underlying mechanism.

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