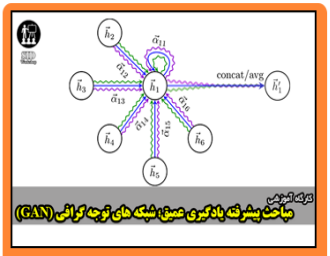
کارگاه های آموزشی مرکز اطلاعات علمی جهاد دانشگاهی

کارگاه آنلاین مکالمه روزمره انگلیسی

کارگاه آنلاین آموزش استفاده از وب آو ساینس



مباحث پیشرفته یادگیری عمیق؛
شبکه های توجه گرافی
(Graph Attention Networks)

Iranian Journal of Medical Physics

ijmp.mums.ac.ir

Effects of Short-term Exposure to Electromagnetic Fields Emitted by 3G and 4G Mobile Phones on Reaction Time and Short-term Memory

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ARTICLE INFO

Article type:
Short Communications

Article history:
Received: Aug 26, 2018
Accepted: Nov 12, 2018

Keywords:
Electromagnetic Fields
Mobile Phone Data
Radiofrequency
Short-Term Memory
Reaction Time

ABSTRACT

Introduction: There have been many studies conducted on the effects of mobile phones radiations on people's health due to increasing number of mobile phones users. The present study aimed to investigate the effects of electromagnetic waves generated from 3G and 4G mobile phone radiations on student's reaction time and short-term memory.

Material and Methods: This was a cross-sectional and descriptive-analytic study. A sample of 85 medical students from Shiraz University of Medical Sciences in the age range of 18-22 years was selected. After 10-min exposure to 3G and 4G mobile waves without any prognoses if mobile phone was on or off, response time and short-term memory tests were taken at once. The groups then left laboratory for about 2 h to take a rest, and they came back to laboratory to carry out the second mode of testing after two h (mobile phones on or off related to previous test). Both tests were performed in the afternoon to make students almost identical in terms of daily fatigue conditions. The data were analyzed in SPSS software (version 19) using t-test technique. The difference was statistically considered significant ($P<0.05$).

Results: The results revealed that the reaction time and average short-term memory following the exposure to electromagnetic waves emitted from mobile 3G and 4G mobile phones increased and decreased, respectively. However, this difference was only significant in the reaction time. The electromagnetic waves generated by the 3G and 4G mobile phones led to slower response time among students under emission, compared to the control group.

Conclusion: According to our findings, it can be concluded that the frequency of electromagnetic waves increased the response to stimulus time.

►*Please cite this article as:*
Movahedi MM, Tavakoli Golpaygani A, Safari A, Amani S. Effects of Short-term Exposure to Electromagnetic Fields Emitted by 3G and 4G Mobile Phones on Reaction Time and Short-term Memory.Iran J Med Phys 2019; 16: 250-254. 10.22038/ijmp.2018.32826.1398.

Introduction

The third generation of mobile networks (3G)[1] is a way to transfer information across cell phones and wireless systems. The new generation of mobile networks is multimedia that enabled the Global System for Mobile Communication (GSM). As a generation for voice and data transmission, 3G provides high speed for multimedia transfer. In the third generation, data are transmitted in the form of digital information. Third-generation mobile phones are high-speed; therefore, some features, such as wireless video calls have high quality [1]. The intensity of the radio frequency (RF) waves of 3G generated is higher than that of GSM mobile phones. Also, the fourth-generation of mobile network (4G)[2] is the next generation of wireless networks that replaced 3G to provide high-speed, high capacity, low cost per bit, and data transfer (i.e., audio and video) [2].

The results of various studies on animals and humans indicate the adverse effects of electromagnetic waves of mobile phones on health. The RF radiation can penetrate into the tissues, be absorbed, and generate heat. The heat of biological tissue owes the absorption of energy to the water inside the tissue. The rate of absorption and energy distribution of electromagnetic fields (EMF) in an organism depends on various factors, such as

[1]The third generation of wireless mobile telecommunications technology

[2]The fourth generation of wireless *mobile* telecommunications technology

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frequency, shape, geometry, and distance from the source [3].

According to the findings of human studies, it was revealed that mobile phones have an impact on sleep and memory performance [4]. Mobile phones affect the electrical activity of the brain; they can reduce the arousal and prediction of alarm triggers [5]. The results of some studies demonstrate that cell phone waves cause symptoms, such as a fever in the ear, memory weakness, fatigue, and symptoms of depression and temporary severe headaches [6-10].

The studies on the effect of electromagnetic waves on the mean score of reaction time have reported different findings. However, most of them represent a reduction in reaction time due to the effect of mobile phone EMFs. For example, Mortazavi et al. studied the effect of electromagnetic waves emitted by GSM mobile phones on the visual reaction time in 160 students within the age range of 18-31 years. The reaction time was recorded by visual reaction time (VRT) before and after 10 min in real and sham exposure of mobile phones and the results showed that there was no significant relationship between the reaction time and age**.** The reaction time in male students was shorter than that in the female ones, and the exposure to mobile waves reduced the reaction time [11].

In another study, Mortazavi et al. investigated the effects of radar-generated waves on reaction time, which revealed that radar waves reduced reaction time [12]. In another study, Ellyyahu et al. showed that the reaction time in people exposed to 890 MHz RF waves decreased [13]. Barth et al. reported a reduction in reaction time by examining the effect of GSM mobile waves on neurotic behavior [14]. Preece also concluded that the reaction time was significantly reduced by examining the effect of GSM 915 MHz electromagnetic waves on 36 volunteers within 25-30 min of irradiation [15].

Finally, the results of a study carried out by Kolodynski et al. demonstrated that the students living in the environment around the Skrunda radio station in Latvia had significantly different memory and attention than the those in control group (their attention and reaction time were significantly lower than them) [16]. On the other hand, the results of a study carried out by Hamblin et al. have shown that the exposure to electromagnetic waves significantly increases the reaction time [17]. The aims of our study was to investigate the effect of 3-G and 4-G mobile phone electromagnetic waves (data mode) on reaction time and short-term memory of university students.

Materials and Methods

This is a cross-sectional and descriptive-analytic study. Volunteer people participated in this study were 85 students at Shiraz University of Medical Sciences within the age range of 18-22 years, with full knowledge and consent form, and they were exposed to 3G and 4G mobile phone radiation in real and sham exposure. The third- and fourth- generation mobile phone protocols (3G and 4G) support higher data rates intended for applications other than voice-centric. The new generation of mobile phones not only gives users fresh ways to communicate but also a variety of new services, such as browsing the Internet, e-mail, instant, short, and multimedia messaging, video-conferencing, and digital television [18].

Firstly, the students were trained how to work with the software; they were not allowed to separate the mobile phone from the ear during a conversation (calling gesture). In addition, they did not have to use the cell phone while they are resting between two on and off modes and performed the test in a relaxed and stress-free state. Six mobile phones (SONY Experia Z2, Sony Technology Thailand Co., Ltd.) were used, and 3G-4G facilities of them was tested in laboratory area; furthermore, reaction time and short-term memory test software was installed.

Computer-assisted-tests of VRT and short-term memory were administered. Reaction time or response time refers to the amount of time that takes places between when we perceive something to when we respond to it. It is the ability to detect, process, and respond to a stimulus. In the present study, it was the amount of time it took an individual to physically respond to the visual stimulus on the display of a laptop computers. Instructions: when the red circle appear in random position on the laptop display, move the mouse toward it as quickly as they can. Ten trials for each student, counting the best average in milliseconds (ms). The testing was carried out with dominant hands and the students were trained how to work with the VRT test. The students' VRT was recorded with a simple blind computer assisted-test, before and after a 10 min real/sham 3-4G mobile phone exposure. Also, for measurement of students' short term memory, they have to memorize some random numbers that displays sequentially, and then rewrite them on paper. The number of correct guesses equal to the students' short-term memory score.

The laboratory situation should be under consideration because the mode of the devices sometimes varied between 3G and 4G, and there were no constant conditions. Then the students were grouped in the laboratory for 10 min without knowing the mode of the device (the device was placed in the cover, so it was unclear whether it was on or off), in a quiet and stress-free environment, and the phone was placed in a talk mode gesture.

After 10 min, the students delivered the cell phones and took reaction time and short-term memory tests immediately. The groups then left the laboratory for about 2 h to rest (they were not allowed to use the phone during this time) and then went back to the laboratory to perform the second mode of experiment (real or sham exposure). Both tests were performed in the afternoon to make sure that the students were identical in terms of

daily fatigue conditions. The obtained data were analyzed in SPSS software (version 19) using t-test for the two correlated samples. In all cases, the differences were statistically considered significant (P<0.05).

Results

Study samples are in the age range of 18-22 years. In this project, 44.7% and 55.3% of the participants were male and female, respectively. The descriptive characteristics for 85 people (Group 1 and 2) are presented in Table 1.

Table 1. Descriptive characteristics of all participants

Descriptive Characteristics	Frequency (n)
Age	18-22
Number of medical students	85
Male	38 (44.7%)
Female	47 (55.3%)

For these 85 people, a test of reaction time was performed, and the results of reaction time test are presented in figure 1.

Regarding the significance level, the difference between the two modes of switched off and on (conversation) was significant indicating that their reaction time in conversation mode (495.71 msec) was higher than that in silent mode (468.43 msec) that led to a decrease in the level of student reaction to stimuli. Figure 1 shows the mean reaction time of individuals for on and off modes.

Also, the results of the visual reaction test are presented in Figure 2.

Regarding the P-value that was higher than 0.05, the test results were not significant. It meant that the mean scores of the measured variables in the two groups of on and off did not have a significant difference in the visual reaction test.

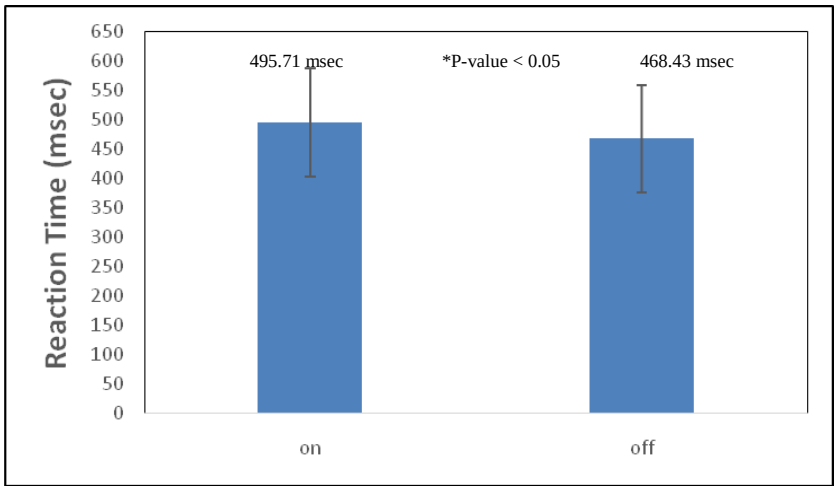

Figure 1. Mean (±SD) reaction time of students for two modes of mobile data (3G and 4G) on and turn mobile phones off

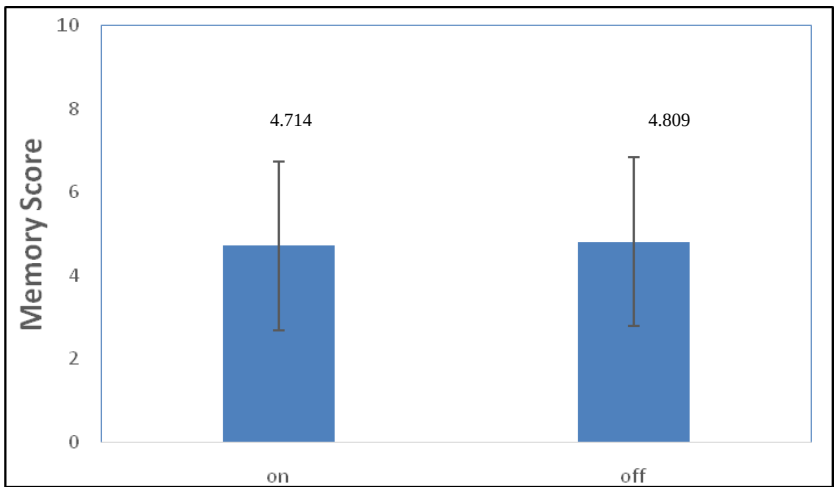

Figure 2. The mean short-term memory scores of student for two modes of 3-4G on and switched off mobile

Discussion

The purpose of this study was to investigate the effect of 3G-4G electromagnetic waves on reaction time and short-term memory on the students of Shiraz University of Medical Sciences. The findings demonstrated that the electromagnetic waves were emitted from 3G and 4G cell phones resulted in longer reaction time of the participants and reduced their visual memory. However, only the reaction time change was significant.

The findings of this study are not consistent with the results of studies carried out by Mortazavi et al. [12], Ellyyahu et al. [13], Barth et al. [14], Preece [15], and Kolodynski et al. [16]; however, they are consistent with the findings of a study conducted by Hamblin et al.[17]. They revealed that the exposure to electromagnetic waves significantly increased the reaction time. In a study performed by Unterlechner et al., the exposure to electromagnetic waves emitted by Universal Mobile Telecommunications Service (UMTS) did not have a significant effect on reaction time [19].

In 2014, we examined whether elementary students exposed to the short-term exposures of mobile RF waves experienced a change in the reaction time and short-term memory. Sixty students in the age range of 8-10 years were selected and exposed to mobile phone radiation with 30 min intervals. The findings revealed that reaction time in students was reduced due to mobile phone radiation while their short-term memory performance increased [20]. The results of our previous study are inconsistent with the findings of the present study as the waves of 3G and 4G mobile phones in this study led to an increase in the reaction time (slower reaction of the subjects).

Jarideh et al**.** examined the effect of RF waves that were emitted from radar equipment on the short-term memory and reaction time of Shiraz International Airport workers. They compared 32 Shiraz International Airport workers in the range of 27-67 years with 37 employees working in the city who did not have any history of exposure to radar systems. The findings revealed that the mean reaction time for the airport employees was shorter than that in the control group. Moreover, the airport staff scores in all short-term memory subscales, such as pair words test, forward digit span, backward digit span, and verbal recognition, were lower than those of the control group employees [21].

There was a difference between the findings of the studies carried out by Mortazavi et al. [12], Barth et al. [14], Preece [15], Movahedi et al. [20], and the present study that might be due to the difference in the frequency of the GSM cellular phones. The 3G cellular frequency (up to 2100 MHz) was higher than the GSM mobile frequency (between 900 and 1800 MHz). Hence, it had an adverse effect on reaction time, and resulted in slower reactions to stimuli. In addition, the distance to the source of the radiation is also an important factor indicating that the higher the distance, the lower the effect of electromagnetic waves. However, these findings require further investigation.

Conclusion

According to our findings, it can be concluded that the frequency of electromagnetic waves increased the response to stimulus time. In this way, as an example due to the dramatic increase in global mobile subscribers, the number of people talking on mobile phones while performing the tasks that require focus, such as driving is increasing. The results of studies showed that the reaction time of drivers who talked on the phone while driving is 18% lower than that of focused drivers [22]. According to their findings and our results, traffic accidents increased when drivers were using mobile phones. Thus, the development of culture and the provision of solutions for appropriate use of mobile phones are necessary especially in case focus is required.

Acknowledgment

The authors would like to thank the medical students at Shiraz University of Medical Sciences who kindly helped us in conducting this study.

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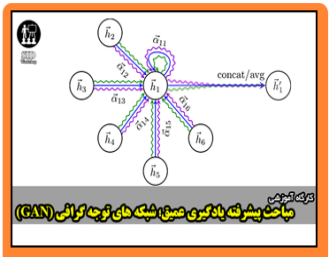

مباحث پیشرفته یادگیری عمیق؛ شبکه های توجه گرافی (Graph Attention Networks)